Appendix A

Notice of Preparation, Comments, and Scoping Meeting Transcript

Notice of Preparation

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January 4, 2013

State of California
Office of Planning and Research
1400 Tenth Street
Sacramento, California 95814

NOTICE OF PREPARATION
DRAFT ENVIRONMENTAL IMPACT REPORT

Project Title:	Richmond Bay Campus 2013 Long Range Development Plan and Phase 1 Development
Project Location:	Richmond Bay Campus, Richmond Field Station
County:	Contra Costa

Project Description:
The University of California (UC) proposes to establish a new major research campus at properties it owns in Richmond, California, for consolidation of biosciences programs of the Lawrence Berkeley National Laboratory (LBNL) and for development of additional research-related facilities for both LBNL and UC Berkeley. This campus would jointly serve UC LBNL and UC Berkeley. The proposed 2013 Long Range Development Plan (LRDP) for the Richmond Bay Campus (RBC) would guide campus development through 2050. Initial development under Phase 1 would occur through 2018. More information appears in the project description included in the Initial Study attached to this Notice of Preparation.

Agency Review and Comments:
In compliance with the State and University of California Guidelines for implementation of the California Environmental Quality Act (CEQA), this Notice of Preparation is hereby sent to inform you that UC is preparing a Draft Environmental Impact Report (EIR) on the RBC 2013 LRDP and Phase 1 development. The EIR will provide program-level analysis of the full LRDP development and project-level analysis of Phase 1 development.

As Lead Agency, UC needs to know the views of your agency as to the scope and content of the environmental information that is germane to your agency's statutory responsibilities in connection with the proposed project (anticipated areas of analysis are identified in the attached Initial Study). Please designate a contact person in your agency and send your response to the address below.

Environmental Review Process:
UC will be the Lead Agency and will prepare a Program/Project EIR to evaluate and disclose the potential environmental effects of implementing the proposed 2013 LRDP and Phase 1 development. The EIR will include a program-level environmental review of RBC development through 2050 and a project-specific analysis of the environmental effects from construction and operation of Phase 1. The LRDP and EIR would also inform decisions of the state Department of Toxic Substances Control regarding workplans for remediation of legacy pollutants at portions of the RBC site that are subject to a site investigation and remediation order and are proposed for development.

The LRDP EIR will programmatically analyze a series of related actions at the University of California's Richmond properties as part of the RBC 2013 LRDP. The programmatic evaluation will serve as the base environmental review for tiering purposes when implementing the 2013 LRDP. Future projects proposed within the scope of the RBC 2013 LRDP will be analyzed to determine whether there are any impacts requiring further CEQA documentation or whether any documentation is required in addition to the LRDP EIR.

The EIR's project-specific analysis will provide a comprehensive and detailed evaluation of the environmental impacts of implementing the Phase 1 development.

An Initial Study was prepared pursuant to the UC CEQA Guidelines to identify the environmental issues that will be addressed in the RBC 2013 LRDP EIR. The Initial Study is attached to this Notice of Preparation. Copies of the Initial Study are available for review at the main branch of the Richmond Public Library, 325 Civic Center Plaza, Richmond; the UC Berkeley Doe Memorial Library; and online at http://www.lbl.gov/Community/env-rev-docs.html.lbl.gov.

Due to time limits mandated by State law, this Notice of Preparation will include a 30-day comment period that extends from January 4, 2013, to February 4, 2013. Comments must be received before 5:00 PM on February 4, 2013, to be considered in the preparation of the RBC 2013 LRDP EIR. They may be e-mailed to LRDP-EIR@lbl.gov or mailed to:

Jeff Philliber
Environmental Planner
Lawrence Berkeley National Laboratory
One Cyclotron Road, MS 76-225
Berkeley, CA 94720

A public scoping meeting for the RBC 2013 LRDP EIR will be held from 7:00 to 9:00 PM on January 23, 2013, at the Richmond City Council Chambers, 403 Civic Center Plaza. The US Department of Energy may use this scoping meeting to fulfill requirements under the National Environmental Policy Act and under 10 CFR Part 1022 regarding floodplain and wetland analysis.

Sincerely,

Jeff Philliber
LBNL Environmental Planning Group

Ernest Orlando Lawrence
Berkeley National Laboratory

One Cyclotron Road, MS 76-225
Berkeley, California 94720

January 4, 2013

INITIAL STUDY
RICHMOND BAY CAMPUS
2013 LONG RANGE DEVELOPMENT PLAN
AND PHASE 1 DEVELOPMENT

I. PROJECT INFORMATION

Project Title:	Richmond Bay Campus 2013 Long Range Development Plan and Phase 1 Development
Lead Agency:	University of California
Contact Person:	Jeff Philliber, (510) 486-5257
Project Location:	1301 South 46th Street, Richmond, California 94804

II. PROJECT DESCRIPTION

See below.

III. ENVIRONMENTAL FACTORS POTENTIALLY AFFECTED

The environmental factors checked below may be potentially affected by this project and will be carried forward for full analysis in the 2013 Long Range Development Plan and Phase 1 Development Environmental Impact Report:

■	Aesthetics	□	Agriculture/Forest Resources	■	Air Quality
■	Biological Resources	■	Cultural Resources	■	Geology/Soils
■	Greenhouse Gas Emissions	■	Hazards & Haz. Materials	■	Hydrology/Water Quality
■	Land Use/Planning	□	Mineral Resources	■	Noise
■	Population/Housing	■	Public Services	■	Recreation
■	Transportation/Traffic	■	Utilities/Service Systems	■	Mandatory Findings of Significance

IV. DETERMINATION: (To be completed by the Lead Agency)

On the basis of the initial evaluation that follows:

_____ I find that the proposed project COULD NOT have a significant effect on the environment, and a NEGATIVE DECLARATION will be prepared.

_____ I find that although the proposed project could have a significant effect on the environment, there will not be a significant effect in this case because revisions in the project have been made by or agreed to by the project proponent. A MITIGATED NEGATIVE DECLARATION will be prepared.

■ _____ I find that the proposed project MAY have a significant effect on the environment, and an ENVIRONMENTAL IMPACT REPORT is required.

_____ I find that the proposed project MAY have a "potentially significant impact" or "potentially significant unless mitigated" impact on the environment, but at least one effect 1) has been adequately analyzed in an earlier document pursuant to applicable legal standards, and 2) has been addressed by mitigation measures based on the earlier analysis as described on attached sheets. A TIERED ENVIRONMENTAL IMPACT REPORT is required, but it must analyze only the effects that remain to be addressed.

_____ I find that although the proposed project could have a significant effect on the environment, because all potentially significant effects (a) have been analyzed adequately in an earlier EIR or NEGATIVE DECLARATION pursuant to applicable standards, and (b) have been avoided or mitigated pursuant to that earlier EIR or NEGATIVE DECLARATION, including revisions or mitigation measures that are imposed upon the proposed project, no further environmental document is required. FINDINGS consistent with this determination will be prepared.

Signature J Philliber Date 12-30-12

Jeff Philliber LBNL Environmental Planner
Printed Name

Richmond Bay Campus 2013 Long Range Development Plan and Phase 1 Development PROJECT DESCRIPTION

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1.0 Introduction

The University of California (UC or the University) proposes to establish a new major research campus, at properties it owns in Richmond, California, for consolidation of biosciences projects and activities managed or led by the University of California Lawrence Berkeley National Laboratory (UC LBNL) and for development of additional facilities for both LBNL[1] and UC Berkeley for research and development focused on energy, environment, and health. The University proposes to rename the properties as the "Richmond Bay Campus" (hereinafter "RBC").

The University is preparing a Long Range Development Plan (LRDP) in support of the research and academic goals for this proposed new research campus. An LRDP is defined by statute (Public Resources Code 21080.09) as a "physical development and land use plan to meet the academic and institutional objectives for a particular campus or medical center of public higher education." The proposed RBC 2013 LRDP is being prepared to guide the growth and development of the campus through the year 2050. The University and State law also require an Environmental Impact Report (EIR), pursuant to the California Environmental Quality Act (CEQA), to be prepared for any new or updated LRDP.

The University is also developing Phase 1 development plans that would involve constructing three buildings and associated infrastructure on the RBC. Two of these buildings would be approximately 110,000 to 150,000 gross square feet (gsf) each, and one of these buildings would

[1] Lawrence Berkeley National Laboratory is a federally funded research and development center managed and operated by the University of California under a contract with the Department of Energy.

be up to 300,000 gsf for a total of up to 600,000 gsf. These facilities would house the following institutions:

- **Joint Genome Institute (JGI)**, which UC LBNL manages for the U.S. Department of Energy (DOE)
- **Joint BioEnergy Institute (JBEI)**, a multi-institutional partnership led by UC LBNL
- **Advanced Biofuels Process Development Unit (ABPDU)**, which UC LBNL manages for DOE
- **Knowledge Base (KBase)**, a multi-institutional collaboration led by UC LBNL.

In addition, the facilities would house other LBNL biosciences projects and activities, and a conference facility, a dining facility, and various support facilities. Construction of Phase I would commence in 2014 and the buildings would be occupied starting in 2017 or 2018. Development of Phase I would add approximately 1,000 to the average daily population (adp) of the site, increasing the adp from 300 to 1,300.

The LRDP EIR will provide a comprehensive program-level analysis of the RBC 2013 LRDP and its potential impacts on the environment, in accordance with Section 15168 of the CEQA Guidelines. In accordance with Section 15161 of the CEQA Guidelines, the LRDP EIR will also include project-specific analysis of the first phase of development to be built and operated under the RBC 2013 LRDP. The 2013 LRDP would establish RBC growth parameters through 2050; LRDP amendment(s) would be required in order to exceed those growth parameters. Subsequent proposals for specific development at the RBC would be reviewed for consistency with the LRDP, its EIR, and any necessary further compliance with CEQA.

The RBC LRDP is a unique joint proposal of UC LBNL and UC Berkeley. While LBNL and UCB have a close existing partnership and both are managed under the auspices of the Regents of the University of California, the institutions are distinct administrative entities. Upon determination by the Regents to approve the 2013 LRDP and certify the EIR, however, UC LBNL and UC Berkeley expect to establish a joint operating committee to oversee the Richmond Bay Campus and implement the LRDP. The committee would advise the UC Berkeley Chancellor and the LBNL Director.

As of fall 2012, the University has conducted three community-wide meetings related to its planning for the RBC and its LRDP.[2] This Notice of Preparation commences the University's

[2]While not the topic of this Notice of Preparation, the University recognizes that a key concern voiced at community meetings is whether the RBC will create jobs for the Richmond community. UC LBNL and UC Berkeley expect the new

CEQA process and invites interested agencies and members of the public to comment on the scope of the environmental analysis and evaluations of alternatives. A Draft LRDP EIR is expected to be available for public and agency review in early or mid-2013. The University expects to submit the draft 2013 LRDP and Final LRDP EIR to The Regents of the University of California for their consideration for approval in late 2013. The Department of Energy expects to conduct a National Environmental Policy Act (NEPA) review of this project concurrently and in coordination with the timing of this CEQA process. The LRDP and LRDP EIR would also inform decisions of the state Department of Toxic Substances Control regarding workplans for remediation of legacy pollutants at portions of the RBC site subject to a site investigation and remediation order and proposed for development (see section 3.1, below).

2.0 Project Location and Surrounding Land Uses

The approximately 133-acre RBC site is located at 1301 South 46th Street in the South Shoreline area of the City of Richmond, approximately 5 miles northwest of the UC Berkeley campus and the LBNL site in Berkeley.[3] The properties are bounded on the west by a Pacific Gas and Electric (PG&E) service station, on the northwest by Regatta Boulevard, on the northeast by Meade Street, on the east by South 46th Street, and on the south by the San Francisco Bay. Interstate 580 (I-580) runs parallel to Meade Street along the northeastern boundary of the site.

Land uses surrounding the RBC site include industrial/office uses and a major interstate freeway, with low-/medium-density residential neighborhoods. Regatta Boulevard, along the northern boundary of the RBC, is adjacent to a railroad spur and a business complex developed with one- to two-story buildings. Bio-Rad Laboratories, a private research equipment manufacturing company, is located immediately west of the uplands parcel. The adjacent property to the east is the location of former chemical production operations previously owned by several entities, including Stauffer and Zeneca, and is currently owned by Cherokee Simeon Venture I, LLC.

The Marina Bay residential neighborhood, across Meeker Slough and southwest of the RBC site, consists of a mix of multi- and single-family residences. Low- and medium-density residential uses are also located across I-580, north of the Meade Street boundary of the RBC site.

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campus to be a catalyst for new innovation and clean industries in the area that would generate jobs; and both institutions expect to partner with the City and community to bring job training and opportunity to the area.

[3] The University owns properties in Richmond that total 194.6 acres. The properties are composed of four parcels: a 109.5-acre parcel that contains the currently developed upland portion known as the Richmond Field Station; a recently acquired 23.4-acre developed parcel along Regatta Boulevard immediately west of the upland area; and two submerged parcels in San Francisco Bay made up of 46.1 and 15.6 acres, respectively. Only the Richmond Field Station and Regatta Boulevard parcels would be developed under the 2013 LRDP.

3.0 Existing Site Conditions

3.1 Site Conditions

The 133-acre RBC site consists of upland areas developed with buildings that are used for academic teaching and research activities and spaces leased by private entities, a north-south oriented planting of eucalyptus trees in the central portion of the site, areas of coastal grasslands, a tidal salt marsh (known as the Western Stege Marsh), and a transition zone between the upland areas and marsh. Grasslands occur in a number of meadows on the RBC site. The Bay Trail is south of the site.

The University purchased the original Richmond Field Station landholdings in 1950. From 1870 to 1950, much of the property belonged to the California Cap Company, which manufactured explosives. The southeast portion of the uplands area was used for explosive materials manufacturing from the 1870s until 1948. Levels of contamination that exceed regulatory agency screening criteria have been found on the site. The primary contaminants of concern include metals, volatile organic compounds, and polychlorinated biphenyls (PCBs). The University is currently conducting an investigation and remediation of the site in accordance with a California Environmental Protection Agency, Department of Toxic Substances Control, Site Investigation and Remedial Action Order No. I/SE-RAO 06-07-004. On-site contamination and remediation is discussed in many reports completed under the Order, and addressed in an earlier CEQA document, all available on the web at rfs-env.berkeley.edu.

3.2 Existing On-Site Land Uses

The two upland parcels are currently developed with approximately 80 one- and two-story buildings, roadways, parking lots, and landscaped areas. The uplands area, which has been the location of a variety of industrial enterprises dating back to the mid-19th century, also contains previously disturbed, currently undeveloped open space. The site is currently developed with 1,050,000 gsf of facilities, including more than 500,000 assignable square feet of research space; the Northern Regional Library Facility (NRLF), which serves as an archive for 7.7 million volumes of lesser-used books for the four northern UC campuses; one of the world's largest earthquake shaking tables; test facilities for advanced transportation research; and a regional laboratory for the US Environmental Protection Agency (US EPA). The University purchased the Regatta parcel (former Price Club site) in 2007, which added 23.4 acres to its Richmond properties. The Regatta parcel is developed with a warehouse building and surface parking. The warehouse building currently housing University archives and other uses

As of late 2012, the RBC site has a daily population of approximately 300 persons.

3.3 Transportation, Circulation, and Parking

The existing main entrance to the RBC site is located at South 46th Street and the junction of Seaver Avenue and Robin Drive, accessed via the junction of Meade Street and Seaver Avenue. The site is accessible via interstate freeways I-80 and I-580. There are three interchanges on I-580 that provide access to the RBC site—Marina Bay Parkway interchange, Regatta Boulevard interchange, and Bayview Avenue interchange. The Regatta Boulevard and Bayview interchanges are both about 0.35 miles from the main entrance and provide the most direct access to and from the freeway. The Marina Bay Parkway and Regatta Boulevard interchanges provide the most direct access between the freeway and the Regatta property. Side-street access to the RBC is provided via overpasses at Bayview Avenue, Regatta Boulevard/Juliga Woods Street, Marina Bay Parkway/South 23rd Street, Marina Way, Harbor Way and others further west. Bay Trail access to the RBC is provided to bicyclists and pedestrians via underpasses/overpasses at Central Avenue, Buchanan Street, Gilman Street, University Avenue, the Berkeley bicycle and pedestrian bridge, and others further south. Bay Trail access to the RBC is also provided to bicyclists and pedestrians along the length of the entire Southern Gateway district in the City of Richmond.

The major vehicular circulation routes within the RBC site include east-west-running Robin Drive and Lark Drive, and north-south-running Egret Way. The primary vehicular entries into the RBC are:

- South 46th Street and the junction of Seaver Avenue and Robin Drive;
- South 46th Street at Building 194;
- Regatta Boulevard near South 34th Street; and
- Regatta Boulevard (multiple locations) for the western property.

Parking is accommodated in several surface lots. There are currently a total of 760 parking spaces on the site. UC Berkeley operates a shuttle bus that runs hourly between the UC Berkeley main campus and the Richmond Field Station.

3.4 Utilities and Infrastructure

The RBC site is connected to the local utility companies for electrical power, natural gas, water, and telecommunications services and to the City of Richmond wastewater system. PG&E provides electricity to the site through multiple overhead 12-kilovolt electrical lines, with both aerial and underground power lines comprising the electrical service infrastructure on the site. PG&E also provides natural gas service to the site through multiple high-pressure gas mains, with underground gas lines serving the larger facilities on site. The East Bay Municipal Utility District

(EBMUD) provides potable and firefighting water via multiple high-pressure water mains, with underground potable and firefighting water lines distributed throughout the site. AT&T provides communications service to the site. Site sanitary sewer discharge flows to the City of Richmond publicly-owned wastewater treatment plant, located approximately three miles to the west on Canal Boulevard.

4.0 2013 Long Range Development Plan

4.1 Main Features of the LRDP

The proposed 2013 LRDP addresses sustainability, land use, access and circulation, utilities and infrastructure, and open space and landscaping, and provides a policy and design framework to guide the development of up to 5.4 million square feet of new research, education, and support space at the site. Design principles in the proposed LRDP feature preservation of the site's important natural open spaces including the Bay, marsh, and coastal grasslands. The site plan organizes development into distinctive groupings to promote a sense of community within the site, particularly during initial phases of campus growth.

Building heights across the RBC are expected to vary, with lower buildings at the Bay front edge and taller buildings behind them. Four and five story buildings are expected to be a common building module, with heights of 100 feet providing for a five story building with tall floor-to-floor heights that allow building systems to be easily altered as laboratory uses change over time. Neighborhoods within the campus may also feature iconic buildings that help establish a sense of place. An example would be Sather Tower (the Campanile) at UC Berkeley, which measures 303 feet to the top.

The proposed LRDP demonstrates commitment to sustainability through site design, building design, and infrastructure. As the RBC site is developed, the campus itself would be open to the community, providing community resources such as auditorium, exhibit, and event space for educational programs. The proposed LRDP describes and highlights the multiple connections to the site by road, bicycle, and pedestrian path, and incorporates a robust transportation demand management system to facilitate site access.

The RBC would be the centerpiece of the Southern Gateway district of the City of Richmond, envisioned as a revitalized hub of innovation, and the proposed RBC 2013 LRDP emphasizes connectivity beyond the site, and the importance of the campus as a catalyst for its vicinity.

4.2 Anticipated Research Programs

In the near term, research at the RBC would focus on cleaner biofuel development processes; an advanced understanding of the genomics of plants, microbes, and microbial communities; production of nonpetroleum based essential materials and chemicals; advanced diagnostic equipment and techniques for bioscience; industrial process development; and cancer research. Existing research programs at the RBC site in sustainable transportation and earthquake engineering, among others, would continue; the site would also continue to house important collections of the University library and UC Berkeley museums. In addition, the bioscience programs at the RBC would maintain a close connection to the research conducted on the main campuses of LBNL and UC Berkeley. In the longer term, the RBC research would span the biosciences, energy and environmental sciences and technology, computing sciences, engineering and materials sciences, chemical sciences, climate sciences, and other disciplines. UC Berkeley expects that student research and teaching programs would also occur at the site, as part of the educational mission of the campus.

4.3 Campus Population Projections

The University expects the campus population to increase incrementally over time as the RBC is developed over the approximately 40-year horizon of the 2013 LRDP, from approximately 300 persons in 2012 to approximately 10,000 persons in 2050. Phase 1 development is projected to add 1,000 people.

4.4 Building Space Projections

Total building space on the RBC is projected to increase from approximately 1,050,000 gsf at the present time to 5,400,000 gsf at full implementation of the 2013 LRDP. Of the existing 1,050,000 gsf of building space, about 750,000 gsf would be demolished and about 300,000 gsf would be retained. The retained space includes the US EPA building (46,000 gsf) and NRLF (254,000 gsf). The new building space that would be added to the RBC site includes about 350,000 gsf for the expansion of the NRLF and about 4,750,000 gsf of research, education, and support facilities for occupancy by UC LBNL, UC Berkeley, and partner institutions. UC LBNL and UC Berkeley would explore ways to accommodate existing programs housed in space to be demolished at the site in new space at the RBC.

4.5 Sustainability

The sustainability vision is for the RBC to be a showcase of sustainable design and operations to motivate and inspire staff, the community, the nation, and the world. The RBC would assert and grow the University's reputation as a hub of energy efficiency research and best practices. The

facilities would demonstrate building efficiency technology innovations developed by the University and its industry partners in a fully functional laboratory environment.

In August 2011, the University adopted the most recent update of the UC Sustainable Practices Policy[4], which set goals to advance environmental practices in eight areas: green building, clean energy, transportation, climate protection, sustainable operations, waste reduction and recycling, environmentally preferable purchasing, and sustainable food service. All projects and operations at the RBC would meet or exceed the goals defined in this, or any successor, sustainability policy.

4.5.1 Energy

Physical development at the RBC would incorporate principles of energy efficiency in all capital projects, renovation projects, operations, and maintenance within budgetary constraints. In cases where the type of facility, such as a laboratory or data center, is not required to meet code requirements for energy consumption, the project would be required to meet specific energy and carbon performance metrics such as those defined by the “Labs21” (LBNL), “Smart Labs” (UC Irvine), or similar successor programs.

4.5.2 Water

In order to minimize the use of water to the extent practicable, the RBC would implement measures such as installing water-efficient landscaping and drip or other efficient irrigation systems, using water-efficient fixtures in new construction, and capturing rainwater and storm water for use in irrigation.

4.5.3 Municipal Solid Waste

The RBC would comply with the UC Sustainable Practices Policy for zero municipal solid waste by 2020.

4.5.4 Materials

Building materials would be selected to reduce embodied energy, maximize building lifespan, and be recyclable or reusable. Material use overall would be minimized, whether in buildings or in other site operations (e.g., paper), and recycled wherever practicable. Materials would be locally sourced and from renewable sources to the degree feasible, including re-use and recycling of materials from structures proposed for demolition.

[4] http://www.universityofcalifornia.edu/sustainability/policy.html

4.5.5 Transportation

In addition to providing shuttle access improvements, the RBC would implement a Transportation Demand Management program that would include alternate mode use incentives such as discounted transit passes, parking cash-out, Guaranteed Ride Home, and flexible car share programs.

4.5.6 Landscape

The RBC would support bio-diversity and habitat conservation through the use of native plant materials wherever possible. In addition, the RBC would utilize low-impact development design techniques and Bay-Friendly landscape design (see www.stopwaste.org) and make storm water management a site feature. As described below, natural open spaces would also be maintained.

4.6 Land Use Plan

The proposed 2013 LRDP identifies two land use designations to inform the pattern of development at the RBC: (1) Research, Education, and Support, and (2) Natural Open Space. Definitions for each land use designation are provided below. **Figure 1, LRDP Land Use Plan,** shows proposed land uses under the 2013 LRDP. A possible layout of the site is shown in **Figure 2, LRDP Conceptual Layout**.

4.6.1 Research, Education, and Support

The Research, Education, and Support land use designation applies to land areas on the RBC site that are either currently developed with facilities that would remain in their present form or be expanded, and areas that would be developed with new facilities. This land use would include approximately 108 acres of the RBC site, which would be sufficient to meet projected program needs. The types of facilities that would be allowed in designated Research, Education and Support areas would include:

- Laboratory, classroom, office, and administration buildings for researchers, faculty, postdocs, students, and non-University public and private entities.
- Product and process development space for private sector startups, small businesses, and industry counterparts that are synergistic with UC Berkeley and LBNL research areas.
- Support infrastructure and facilities for operations, transportation, utilities, renewable power generation, firefighting, security, safety, hazardous materials management, and corporation yard uses including vehicle and materials shops and storage. Support facilities for specialized research programs such as plant and animal research facilities, greenhouses, and clinical spaces.
- Community outreach and education uses including exhibit, lecture, and event spaces as well as conference facilities and meeting rooms focused on public education.

- Amenities such as dining, short-term accommodation facilities (for visiting researchers), retail, and recreation facilities.
- Transportation-related facilities including parking lots and structures; bus and shuttle stops; and roadways/circulation pathways. Parking structures might house transportation administration offices, bicycle support facilities, and utility structures such as distributed central plants.
- Developed open spaces that would be usable by the campus population and visitors, ranging from courtyards, terraces, and quad-like spaces, to walkways, tree groves and recreational fields. Existing landscaping, including non-native eucalyptus trees in these areas, may be removed and replaced. Open spaces in this zone might be paved or landscaped, with or without seating or other site furnishings. They would range in scale from larger areas for outdoor gatherings to smaller spaces for small group interaction or individual reflection. Storm water would be managed within these zones in swales and other landscaping. Small structures such as pavilions or overlook platforms might be located in these areas.
- Transition zones would buffer site buildings from the Natural Open Space areas, allowing for maintenance access and minimizing the transference of non-native species or noise or light intrusions. Permanent structures within 25 feet of the Natural Open Space areas would not be allowed.
- Throughout the RBC, paving would be pervious wherever practicable, stormwater would be carefully managed to protect natural areas, and any planting would consist of native or non-invasive species.

Childcare would not be considered an appropriate use in the Research, Education and Support land use designation; if childcare is proposed for the RBC the LRDP would be amended to identify or create an appropriate zone.

4.6.2 Natural Open Space

The RBC site includes natural areas such as the San Francisco Bay, Stege Marsh, and coastal grasslands. Human engagement and disruption to these spaces would be limited, with the intent to protect, restore, and maintain these resources in their natural condition. Activities would be limited to access for interpretation, education, maintenance, and research. Improvements in this zone would be limited to minor access roads for maintenance vehicles and limited boardwalks or pathways, consistent with education and conservation goals. Approximately 25 acres within the upland portion of the RBC site and 62 acres within the Bay portion of the site for a total of approximately 87 acres would be designated Natural Open Space to encompass those natural areas that the University plans to protect from development and maintain in their natural condition.

4.7 Circulation and Parking

4.7.1 Vehicle Access and Circulation

Vehicle access would continue to be provided from the existing exits from I-580. The existing ingress and egress points at the site would likely remain as primary or service access points. New points of ingress and egress would be added from the east off of South 46th Street, from the north off of Meade Street, and from the west at multiple locations off of Regatta Boulevard. A calm, mixed use street would potentially extend the existing Lark Drive to connect with Regatta Boulevard east and west. Roadways within the RBC would provide calm, mixed-use streets for internal circulation, direct access to facilities, pedestrians, bicycles, and utilities pathways. Regatta Boulevard would be rerouted to the west to allow the eastern and western portions of the RBC site to be unified. The existing north-south alignment of Egret Way would link the main entrance to the Phase 1 buildings. Phase 1 would utilize all existing roads and would not require any re-routing or new access.

4.7.2 Bicycle Circulation

Bicycle access to and from the RBC would be provided via overpasses at Bayview Avenue, Regatta Boulevard/Juliga Woods Street, Marina Bay Parkway/South 23rd Street, Marina Way, Harbor Way and others further west. Extended Lark Drive would provide bicycle connectivity to downtown Richmond and neighborhoods west of the RBC. Additional bicycle access to the RBC on the Bay Trail would be provided via underpasses/overpasses at Central Avenue, Buchanan Street, Gilman Street, University Avenue, the Berkeley bicycle and pedestrian bridge, and others further south Bicycle lanes would be provided on any new roads within the RBC site. A bike sharing system may also be implemented both for circulation within the RBC site and for travel to retail and other points nearby during the day.

4.7.3 Parking

Approximately 690 of the existing 760 vehicle parking spaces located in surface parking lots would be removed and, as needed over time, replaced in strategic locations. Surface parking would continue to be provided as a short term measure to serve the first few facilities. Later, parking structures would be constructed to provide for the majority of the approximately 6,000 vehicle parking spaces projected to be needed in the long term. Parking structures would be located at the periphery to support a more pedestrian-friendly, vehicle-free interior district with similarities to a traditional higher education campus. Small surface parking lots would be located adjacent to all new facilities for disabled access, shipping/receiving, and short-term visitor

parking. All parking areas would be provided with an appropriate system designed to treat stormwater runoff from parking areas in conformance with the Clean Water Act.

Bicycle parking would be provided at a rate of at least 20 percent of the RBC population at any given time period, in accordance with Leadership in Energy and Environmental Design (LEED) requirements; this would amount to approximately 2,000 spaces at full LRDP implementation. New buildings would have indoor secure bicycle parking, showers and clothes lockers, as well as outdoor bicycle racks, some of which may be secure and/or covered.

4.7.4 Transit

Two shuttle lines are proposed for the RBC. The LBNL-UC Berkeley-RBC Shuttle would provide a no-transfer 20-minute ride from LBNL to the RBC with a single stop at the main UC Berkeley campus en route. The Bay Area Rapid Transit (BART)-RBC Shuttle would run continuously between the El Cerrito Plaza BART station and the RBC, providing a nonstop nine-minute ride from BART to the RBC. The El Cerrito Plaza BART station would also serve as a connection point to the Alameda-Contra Costa Transit District (AC Transit) system.

5.0 Phase 1 Development

The University proposes to demolish 25 existing structures totaling approximately 107,000 gsf and consolidate existing LBNL bioscience programs currently in leased space into three new buildings totaling up to 600,000 gsf with an occupancy of approximately 1,000 adp. Building demolition and site preparation work would occur on a 16-acre portion of the RBC site. The facilities that would be developed under Phase 1 are shown in **Figure 3, Phase 1 Site Plan**.

5.1 Utilities Rerouting and Building Demolition

The Phase 1 development would first disconnect all utility services from, and demolish, 25 existing structures totaling approximately 107,000 gsf. This work would include all existing buildings south of Lark Drive, with the exception of Building 201, the US EPA laboratory. Storm and sanitary sewer drains required to continue flowing through the Phase 1 area would be rerouted to the eastern and western perimeters of the Phase 1 area in accordance with the utility corridor plan in the LRDP.

5.2 Tree Removal and Landscaping

Approximately 170 immature and mature pine and eucalyptus trees would be removed as part of the Phase 1 site preparation work. The remainder of the existing site trees would not be disturbed during Phase 1 development. Approximately 75 immature drought-resistant trees would be planted as a feature of the Phase 1 development.

5.3 Earthwork

The southern portion of the Phase 1 is in an area which is potentially subject to water inundation due to projected sea level rise, a tsunami, or a 100-year flood. In order to protect the Phase 1 facilities from this potential water inundation, the base elevation of the Phase 1 area would be increased from an average of approximately 10 feet above sea level (asl) to approximately 15 feet asl and the base elevation of the facilities would be constructed at 15 feet asl. This would require adding approximately 70,000 cubic yards of soil at varying depths over an area of approximately 12 acres.

5.4 Utilities Infrastructure

All-new utility services would be required to serve the Phase 1 area facilities. The points of connection to the utilities to serve the Phase 1 area facilities would be near the main entrance of the RBC at Meade and 46th Streets. Secondary points of connection would be located at Regatta Boulevard and 32nd Street. Utilities would be connected to the new facilities, and sized adequately to serve up to 800,000 gsf, providing capacity for some additional future development in the area.

5.5 New Construction

Three new research buildings totaling up to 600,000 gsf would be constructed to house a mix of laboratory, office, and interaction space. The facility to be constructed at the southernmost end of the RBC developable area is referred to hereinafter as Building 2 (“Energy building” on Figure 3). The facility to be constructed to the north of Building 2 is referred to hereinafter as Building 1 (“BIF building” on Figure 3). The facility to be constructed to the east of Building 2 is referred to hereinafter as Building 3 (“Health building” on Figure 3). Building 1 would house JGI, ABPDU, and KBase, an imaging center, and a conference facility. Building 2 would house LBNL’s JBEI and closely-related programs as well as a dining facility. Building 3 would house UC LBNL biosciences projects and activities, closely related projects and activities, and synergistic research institutions. Building 1 would likely be a three-story facility totaling 110,000 to 150,000 gsf. Building 2 would likely be a two-story facility totaling 110,000 to 150,000 gsf. Building 3 would likely be a three- to four-story facility totaling up to 300,000 gsf. Two new surface parking lots would be constructed on approximately 7 acres of land to accommodate approximately 870 vehicles associated with the new employees. These surface parking lots would become the locations for new facilities and a parking structure over time.

5.6 Sustainability

The Phase 1 buildings would incorporate green building strategies with goals of design, construction, and commissioning to achieve a minimum LEED Silver level for non-energy measures rating from the US Green Building Council. As appropriate, each building would meet specialized energy performance metrics and Environmental Performance Criteria credits developed for laboratories and data centers by the Labs21 Program.

The buildings would be oriented with their long facades facing south and north and short facades facing east and west in order to minimize solar gain in summer, maximize passive solar heating in the winter, and maximize natural light in the interior spaces. The buildings would also be positioned to provide wind protection in winter, encourage natural ventilation in summer, and benefit from western sun shading. The exterior material of the building would be compatible with the surrounding environment and maritime elements. The exterior cladding is anticipated to include a mix of concrete, metal, and glass.

5.7 Stormwater

Because the proposed Phase 1 site would be “downstream” of and at a lower elevation than the balance of the RBC, the Phase 1 area drainage would be sized for ultimate buildout conditions to accommodate the rest of the site’s stormwater runoff through the Phase 1 area. Phase 1 development would incorporate State Water Resources Control Board post-construction standards for storm water runoff in addition to other local and regional requirements. Runoff treatment facilities would be installed and other permanent best management practices (BMPs) would be implemented commensurate with regulatory requirements and sustainability policies established in the RBC LRDP. For Phase 1, this would primarily consist of bioswales and retention ponds between the building and parking lot stormwater drainage systems and the marsh area.

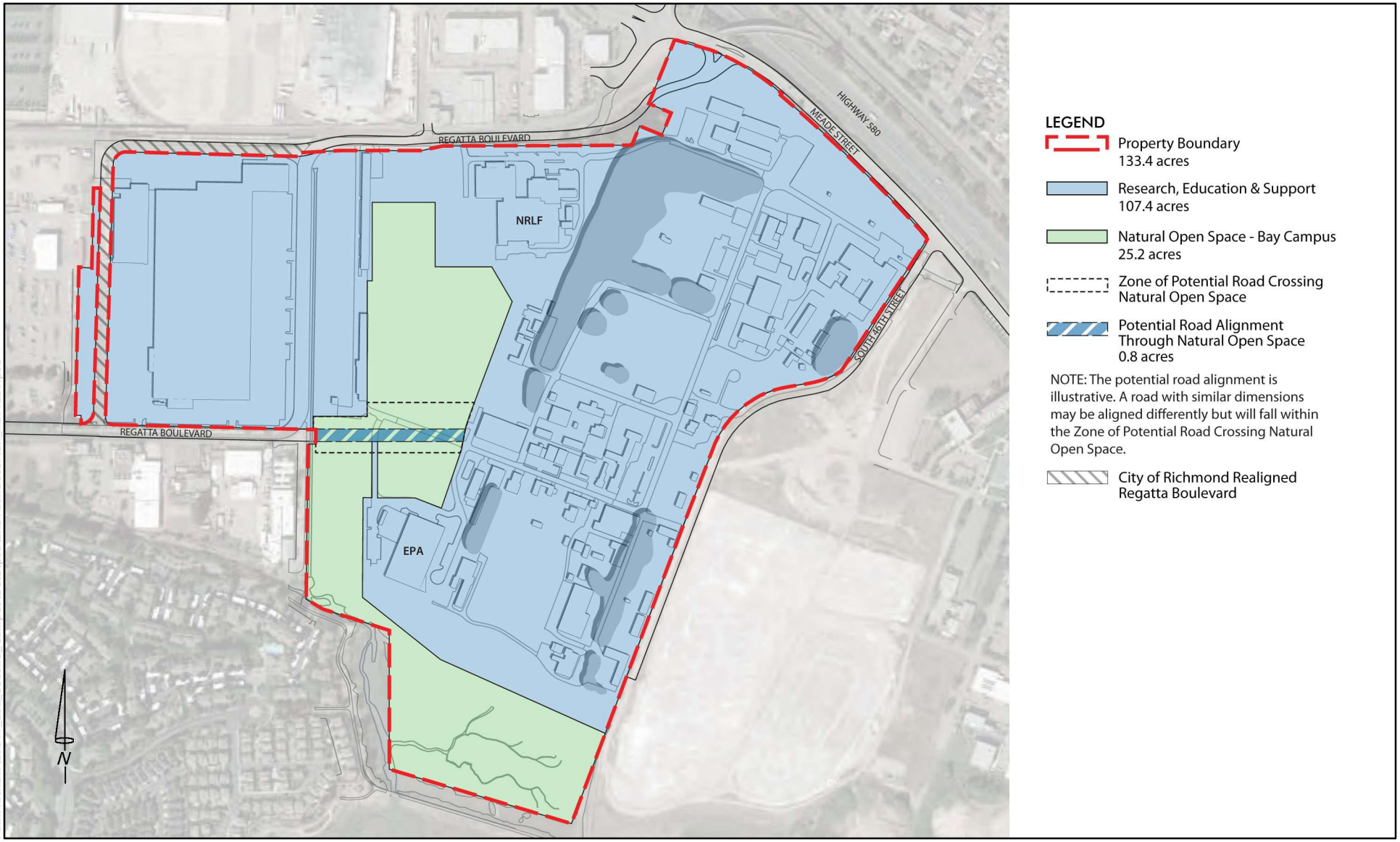
5.8 Construction Schedule

Phase 1 construction is anticipated to occur over a four-year period beginning in 2014 and continuing through 2018.

6.0 Alternatives

The LRDP EIR will include an examination of alternatives to the proposed 2013 LRDP, including the “no project” alternative required by CEQA. While the final list of alternatives will be developed in conjunction with the environmental analyses, alternatives likely to be considered for inclusion in the EIR are:

- **Reduced Growth Program:** Under this alternative, the RBC would be developed at the Richmond site, but with a reduction in the total building square footage and employee population.
- **Alternate Development Program:** Under this alternative, the RBC would be developed at the Richmond site as proposed, but it would provide for the development of a large-scale scientific facility or machine (referred to hereinafter as a "Future Scientific Facility.") with no net increase in the maximum 5.4 million gross square feet of development proposed..
- **Off-site Alternative:** Under this alternative, the LRDP would be implemented at another site, such as Alameda Point in the City of Alameda. The LRDP's building square footage, projected uses, and employee population would be the same.
- **No Project:** Under this alternative, the LRDP would not be implemented, and the Richmond Field Station and other components of the Richmond site would continue their current operations. UC LBNL would continue to lease off-site space for ongoing bioscience research and related programs.



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LRDP Land Use Plan

Richmond, California

TETRA TECH

Figure 1

LRDP Conceptual Layout

Richmond, California

TETRA TECH

Figure 2

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Phase 1 Site Plan

Richmond, California

TETRA TECH

Figure 3

Potential Effects

The following is a preliminary assessment of potential environmental issues that may be analyzed in the LRDP EIR. This assessment will be used to help determine the scope of the EIR.[5] The EIR will consider all areas below. Topic areas that are expected to be impacted by the proposed project will be fully analyzed. Topic areas not expected to be impacted will be addressed briefly or in appropriate depth.

	Will be Analyzed in EIR	No Additional Analysis Required
1. AESTHETICS -- Would the project:		
a) Have a substantial adverse effect on a scenic vista?	☒	☐
Public views of the RBC site are limited from public viewing points north of the site due to tree cover and distance imposed by I-580; private property owners in the hills above the site have broad views that include the Richmond properties, the bay and San Francisco beyond. The chief public viewpoint of the site is from the Bay Trail. Although the visual conditions of the project site and surroundings are not expected to present major aesthetic issues, the EIR will include an evaluation of the project location and massing to determine if campus development under the LRDP, including Phase 1, will have substantial adverse effects on scenic vistas.		
b) Substantially damage scenic resources, including, but not limited to, trees, rock outcroppings, and historic buildings within a state scenic highway?	☐	☒
The RBC site does not contain scenic resources, nor is it on or near a state scenic highway. Regional access to the site is by I-80 and I-580. Portions of I-580 are designated as scenic, but these occur from its junction with State Route 24 to the San Leandro city limit, and a portion in eastern Alameda County away from the project area. Therefore, no impact would occur to scenic resources present within a state scenic highway and further analysis in the EIR is not required.		
c) Substantially degrade the existing visual character or quality of the site and its surroundings?	☒	☐
The RBC site to date has retained its industrial character. The site and vicinity, however, is designated a “Change Area” in the City of Richmond General Plan 2030. The existing physical and visual configuration of buildings would be gradually replaced by a mixture of buildings and facilities with greater massing and density than those currently on site. The EIR will analyze the potential for campus development under the proposed LRDP, including Phase 1, to degrade the visual character and quality of the site and its surroundings.		
d) Create a new source of substantial light or glare which would adversely affect day or nighttime views in the area?	☒	☐
With the inclusion of new buildings and facilities, development of the RBC, including Phase 1, could create new sources of light and glare visible from off-site viewpoints. The EIR will analyze the potential impacts of these new light and glare sources.		

[5] Brief explanations are provided in shaded boxes. These explanations represent a best estimate based on the current preliminary understanding of the proposed LRDP, including Phase 1, and its likely effects.

	Will be Analyzed in EIR	No Additional Analysis Required
2. AGRICULTURE AND FOREST RESOURCES -- In determining whether impacts to agricultural resources are significant environmental effects, lead agencies may refer to the California Agricultural Land Evaluation and Site Assessment Model (1997) prepared by the California Dept. of Conservation as an optional model to use in assessing impacts on agriculture and farmland. In determining whether impacts to forest resources, including timberland, are significant environmental effects, lead agencies may refer to information compiled by the California Department of Forestry and Fire Protection regarding the state's inventory of forest land, including the Forest and Range Assessment Project and the Forest Legacy Assessment project, and forest carbon management methodology provided in Forest Protocols. Would the project:		
a) Convert Prime Farmland, Unique Farmland, or Farmland of Statewide Importance (Farmland), as shown on the maps prepared pursuant to the Farmland Mapping and Monitoring Program of the California Resources Agency, to non-agricultural use?	☐	☒
No active agriculturally-used lands are on the RBC site; therefore, further analysis in the EIR is not required.		
b) Conflict with existing zoning for agricultural use, or a Williamson Act contract?	☐	☒
The RBC site is not zoned for agricultural use and is not subject to a Williamson Act contract; therefore, further analysis in the EIR is not required.		
c) Involve other changes in the existing environment which, due to their location or nature, could result in conversion of Farmland to non-agricultural use?	☐	☒
No agricultural lands are adjacent or near the RBC site. Therefore, the development of the RBC site into a research campus will not result in the conversion of any farmland to a non-agricultural use. Further analysis in the EIR is not required.		
d) Conflict with existing zoning for, or cause rezoning of, forest land (as defined in Public Resources Code Section 12220(g) or timberland (as defined by Public Resources Code Section 4526)?	☐	☒
The site is not zoned for timber production or forest land; the proposed RBC does not conflict with existing zoning and would not cause rezoning related to forest land or timberland. Further analysis in the EIR is not required.		
e) Result in a loss of forest land or conversion of forest land to non-forest uses?	☐	☒
The RBC site contains eucalyptus trees planted by previous owners to reduce impacts from explosives once manufactured at the site; these trees are not forest land. Further analysis in the EIR is not required.		

	Will be Analyzed in EIR	No Additional Analysis Required
3. AIR QUALITY -- Where available, the significance criteria established by the applicable air quality management or air pollution control district may be relied upon to make the following determinations. Would the project:		
a) Conflict with or obstruct implementation of the applicable air quality plan?	☒	☐
The US EPA and the California EPA have established ambient air quality standards for certain pollutants referred to as criteria pollutants. The federal standards are known as the National Ambient Air Quality Standards and the state standards are known as the California Ambient Air Quality Standards. For each standard, air basins are classified as attainment, unclassified, or nonattainment. The project site is in the San Francisco Bay Area Air Basin (SFBAAB) that is currently designated as a nonattainment area for state and national ozone standards, state and national fine particulate matter ($PM_{2.5}$), and state inhalable particulate matter (PM_{10}). For all other standards, the SFBAAB is designated as attainment or unclassified. LRDP-related increases in staff, laboratory space, equipment, and construction activities, including site remediation conducted in accordance with agency-approved work plans, would likely add incrementally to regional ambient air pollutant emissions, including short- and long-term emissions of criteria air pollutants from mobile and stationary sources, including PM_{10} and ozone. The impact of these air emissions will be evaluated in the EIR. Standard emission control and reduction measures, such as dust control for excavation, use of alternative fuel vehicles on-site, shuttle service to public transportation, filtration on exhaust systems, etc., will be identified in the EIR where appropriate.		
b) Violate any air quality standard or contribute substantially to an existing or projected air quality violation?	☒	☐
The EIR will examine the potential for mobile, area, and stationary source emissions from campus development under the LRDP, including Phase 1, to violate state and federal air quality standards or contribute to existing air quality violations. The potential for mobile source, construction and operational emissions from the LRDP implementation to influence air quality will be examined. The analysis will include examination of criteria pollutants that could result from project implementation.		
c) Result in a cumulatively considerable net increase of any criteria pollutant for which the project region is non-attainment under an applicable federal or state ambient air quality standard (including releasing emissions which exceed quantitative thresholds for ozone precursors)?	☒	☐
The SFBAAB is designated as a non-attainment area for ozone and PM_{10} standards. The EIR will examine the total emissions through 2050 that would result from campus development under the LRDP, including Phase 1, and determine whether increases in nonattainment criteria pollutants would be cumulatively considerable.		
d) Expose sensitive receptors to substantial pollutant concentrations?	☒	☐
The EIR will evaluate whether LRDP-related remediation, construction and development activities, including Phase 1, would expose sensitive receptors, including nearby schools, to substantial pollutant concentrations.		
e) Create objectionable odors affecting a substantial number of people?	☒	☐
Ongoing activities from the proposed project are not expected to create nuisance or objectionable odors affecting substantial numbers of people, on or off the site. The RBC would house research and office facilities that would not contain large scale manufacturing or industry that might be a source of objectionable odors affecting substantial numbers of people. Actions at the RBC that might create objectionable odors include asphalt-laying and other related construction activities. Because construction of the RBC is expected to occur periodically over several decades, the EIR will analyze potential impacts related to construction under the proposed LRDP, including Phase 1, and recommend mitigation measures where applicable.		

	Will be Analyzed in EIR	No Additional Analysis Required
f) Expose people to substantial levels of toxic air contaminants (TACs), such that the exposure could cause an incremental human cancer risk greater than 10 in one million or exceed a hazard index of one for the maximally exposed individual?	☒	☐
Development of the RBC would add research facilities, entail site remediation conducted in accordance with agency-approved work plans, and expand existing campus uses that are potential sources of low levels of toxic air contaminants and airborne radionuclides. The EIR will include estimates of emissions from full implementation of the RBC, including Phase 1, and will incorporate the results of a human health risk analysis conducted to determine if the project would expose people on or off the site to levels of toxic air contaminants that could cause a health risk.		
4. BIOLOGICAL RESOURCES -- Would the project:		
a) Have a substantial adverse effect, either directly or through habitat modifications, on any species identified as a candidate, sensitive, or special status species in local or regional plans, policies, or regulations, or by the California Department of Fish and Game or U.S. Fish and Wildlife Service?	☒	☐
The RBC site contains sensitive habitats, including seasonal wetlands, a native cordgrass marsh, coastal terrace prairie grassland, habitat for the federally listed endangered California clapper rail, as well as tidal mudflats and eelgrass beds. The EIR analysis will include potential project impacts to candidate, sensitive, or special status plant and animal species present in these habitats from the development of the campus under the LRDP, including Phase 1. In addition, potential impacts to primary habitat and transitory and migratory habitats will be addressed.		
b) Have a substantial adverse effect on any riparian habitat or other sensitive natural community identified in local or regional plans, policies, regulations or by the California Department of Fish and Game or US Fish and Wildlife Service?	☒	☐
As discussed under item a) above, the RBC site contains sensitive habitats. The EIR will examine possible impacts from campus development under the proposed LRDP, including Phase 1, to riparian habitat and other sensitive natural communities.		
c) Have a substantial adverse effect on federally protected wetlands as defined by Section 404 of the Clean Water Act (including, but not limited to, marsh, vernal pool, coastal, etc.) through direct removal, filling, hydrological interruption, or other means?	☒	☐
Seasonal wetlands and marsh habitat are present on the RBC site. The EIR will examine possible impacts to wetlands on the site as a result of development of the RBC including Phase 1, in accordance with federal requirements and statutes.		
d) Interfere substantially with the movement of any native resident or migratory fish or wildlife species or with established native resident or migratory wildlife corridors, or impede the use of native wildlife nursery sites?	☒	☐
The EIR will evaluate the potential impacts of campus development under the proposed LRDP, including Phase 1, to migratory species and areas on the site that are potential wildlife corridors or may include native wildlife nursery sites.		
e) Conflict with any local applicable policies protecting biological resources?	☒	☐
The EIR will evaluate the consistency of the LRDP with federal and state plans, policies, laws and regulations, such as the Migratory Bird Treaty Act, that are relevant to potentially occurring biological resources. Although local ordinances would not apply to the project, the EIR will include a determination of consistency with local policies concerning the protection and conservation of biological resources, including the City of Richmond General Plan 2030.		

	Will be Analyzed in EIR	No Additional Analysis Required
f) Conflict with the provisions of an adopted Habitat Conservation Plan, Natural Community Conservation Plan, or other applicable habitat conservation plan?	☐	☒
The RBC site is not known to be subject to or designated for any adopted Habitat Conservation Plan, Natural Community Conservation Plan, or other approved conservation plan. Further analysis in the EIR is not required.		
5. CULTURAL RESOURCES -- Would the project:		
a) Cause a substantial adverse change in the significance of a historical resource as defined in §15064.5?	☒	☐
Campus development under the proposed LRDP would result in the demolition of several existing buildings at the RBC site. Some of these buildings are 45 years old or greater and are associated with current and previous uses at the site. A survey is being conducted to assist in determining which structures that would be demolished for Phase 1 development may be historical resources as defined in CEQA Section 15064.5 and which may be eligible for the National Register of Historic Places pursuant to the National Historic Preservation Act. The results of this survey and other investigations will be included in the EIR analysis and will be used to evaluate whether implementation of the LRDP, including Phase 1, could cause a substantial adverse change in the significance of a historic resource.		
b) Cause a substantial adverse change in the significance of an archaeological resource pursuant to §15064.5?	☒	☐
There are no known archaeological resources at the RBC site. No archaeological artifacts have been discovered during past excavations and grading on the RBC site, and no archaeological sites have been recorded at the RBC site. However, given the size of the LRDP area and the site disturbance necessary for excavation and construction, and given the inclusion of the Regatta property in the area of the LRDP, the potential for discovery of unexpected archaeological resources during construction will be addressed and standard best practices and mitigations proposed in the EIR.		
c) Directly or indirectly destroy a unique paleontological resource or site or unique geologic feature?	☒	☐
There are no known unique paleontological resources or unique geologic features at the RBC, and none are anticipated. However, given the size of the LRDP area and the site disturbance necessary for excavation and construction, the potential for discovery of unanticipated paleontological resources during construction will be addressed and standard best practices and mitigations proposed in the EIR.		
d) Disturb any human remains, including those interred outside of formal cemeteries?	☒	☐
There is no known evidence of prehistoric habitation of the RBC site, or any indication that the site has been used for burials in the recent or distant past. However, given the size of the LRDP area and the site disturbance necessary for excavation and construction, the potential for discovery of human remains during construction will be addressed and standard best practices and mitigations proposed in the EIR.		

	Will be Analyzed in EIR	No Additional Analysis Required
6. GEOLOGY AND SOILS -- Would the project:		
a) Expose people or structures to potential substantial adverse effects, including the risk of loss, injury, or death involving:		
i) Rupture of a known earthquake fault, as delineated on the most recent Alquist-Priolo Earthquake Fault Zoning Map issued by the State Geologist for the area or based on other substantial evidence of a known fault? Refer to Division of Mines and Geology Special Publication 42.	☐	☒
A portion of the Hayward Fault Zone occurs within the City of Richmond, more than two miles northeast of the site. However, no fault is present on the RBC site and there is no potential for fault rupture. Further analysis in the EIR is not required.		
ii) Strong seismic ground shaking?	☒	☐
The EIR will analyze the stability of the underlying geologic materials in a strong earthquake on the Hayward Fault and other Bay Area faults, and the potential impacts of strong seismic ground shaking to campus development under the proposed LRDP, including Phase 1.		
iii) Seismic-related ground failure, including liquefaction?	☒	☐
The site has not been officially assessed by the State of California for its liquefaction potential but based upon the soil type, the relatively young age of the soil, and the shallow depth to groundwater, the sandy site areas could potentially be susceptible to liquefaction during an earthquake. The areas dominated by clay are less susceptible to liquefaction. The EIR will address the stability of the underlying geologic materials in a strong earthquake, including ability to resist lateral forces associated with a maximum credible magnitude earthquake near the project, and the potential for subsidence, differential settlement, and liquefaction impacts to campus development under the proposed LRDP, including Phase 1.		
iv) Landslides?	☐	☒
The RBC site is relatively flat, at the distal end of an alluvial plain. There is no potential for landslide risk at the site. Further analysis in the EIR is not required.		
b) Result in substantial soil erosion or the loss of topsoil?	☒	☐
The RBC site is relatively flat and not at risk for substantial soil erosion. All of the properties are previously disturbed and not a source of quality topsoil. Standard construction regulation and best practices, including implementation of National Pollutant Discharge Elimination System permit requirements, would mitigate any risk of substantial soil erosion or loss of topsoil. However, given the size of the LRDP area and the site disturbance necessary for raising the ground level, excavation and construction, standard best practices and mitigations will be discussed in the EIR to reduce risk of soil erosion.		
c) Be located on a geologic unit or soil that is unstable, or that would become unstable as a result of the project, and potentially result in on- or off-site landslide, lateral spreading, subsidence, liquefaction or collapse?	☒	☐
The EIR will analyze the stability of the underlying geologic materials in a strong earthquake, including ability to resist lateral forces associated with a large magnitude earthquake near the project, the potential for subsidence, differential settlement, and liquefaction.		
d) Be located on expansive soil, as defined in Table 18-1-B of the Uniform Building Code (1997), creating substantial risks to life or property?	☒	☐
The EIR will analyze the potential effects of the soil types of the site to development of the RBC under the proposed LRDP, including Phase 1.		

	Will be Analyzed in EIR	No Additional Analysis Required
e) Have soils incapable of adequately supporting the use of septic tanks or alternative waste water disposal systems where sewers are not available for the disposal of waste water?	☐	☒
The Richmond properties are served by the City of Richmond wastewater treatment system, and RBC is not proposed to be served by septic systems or alternate waste water disposal systems; therefore, this topic will not be further analyzed in the EIR.		
7. GREENHOUSE GAS EMISSIONS -- Would the project:		
a) Generate greenhouse gas emissions, either directly or indirectly, that may have a significant impact on the environment?	☒	☐
The EIR will estimate the level of greenhouse gas (GHG) emissions anticipated with the development of the campus under the proposed LRDP, including Phase 1, to determine whether these emissions would result in a significant impact requiring mitigation.		
b) Conflict with any applicable plan, policy or regulation adopted for the purpose of reducing the emissions of greenhouse gases?	☒	☐
Assembly Bill 32, the California Global Warming Solutions Act, requires a statewide GHG emission cap for 2020 based on 1990 emission levels. Senate Bill 375 requires local land use and transportation planning to achieve the state's GHG reduction goals. The Bay Area Air Quality Management District, charged with regulating GHGs in the region, has established CEQA air quality standards that are currently under legal review. The EIR will evaluate the development of the RBC in the context of state, regional and local laws and UC Sustainable Practices Policy requirements concerning the reduction of GHGs.		
8. HAZARDS AND HAZARDOUS MATERIALS -- Would the project:		
a) Create a significant hazard to the public or the environment through the routine transport, use, or disposal of hazardous materials?	☒	☐
The RBC site includes some areas of contaminated soil and groundwater. The University is in the process of investigating and remediating site contamination in accordance with a California Department of Toxic Substances Control (DTSC) Order. These actions are ongoing, and further site development would in some instances require site remediation conducted in accordance with agency-approved work plans. Current operations at the RBC site include the use of solvents, adhesives, cements, paints, cleaning agents, degreasers, and vehicle fuels. Arsenic, copper, lead, mercury and polychlorinated biphenyls have been detected in the soil at levels exceeding hazardous waste criteria. Development of the RBC would spur development of additional facilities that would use, store, and require the transportation of additional hazardous materials and disposal of hazardous waste (including mixed waste, combined waste, and radioactive waste). The EIR will characterize anticipated new and expanded on-site hazardous materials remediation use, transport and disposal, will identify projected increases in these activities that could occur under the LRDP program, including Phase 1, and will evaluate potential impacts associated with these increased activities.		
b) Create a significant hazard to the public or the environment through reasonably foreseeable upset and accident conditions involving the release of hazardous materials into the environment?	☒	☐
The EIR will characterize hazardous waste, mixed waste, combined waste, and radioactive waste handling and hazardous materials use in research, operations, maintenance, and construction, and their transport, handling and disposal. It will identify projected increases in these activities that could occur under development of the RBC, including Phase 1, and will evaluate associated potential impacts, including potential risks from reasonably foreseeable accidents or upset conditions.		

	Will be Analyzed in EIR	No Additional Analysis Required
c) Emit hazardous emissions or handle hazardous or acutely hazardous materials, substances, or waste within one-quarter mile of an existing or proposed school?	☒	☐
The RBC site is not within one-quarter mile of an existing or proposed school per CEQA Guideline 15186. While the RBC would handle certain hazardous materials, these materials and their handling protocols are subject to extensive regulations, procedures and oversight. Although the proposed RBC (including Phase 1) and remediation conducted in accordance with agency-approved work plans as the site is developed is not anticipated to be a major new source of on-site hazardous materials or handling, the EIR will include an analysis of anticipated materials and the potential impacts of their use.		
d) Be located on a site which is included on a list of hazardous materials sites compiled pursuant to Government Code Section 65962.5 and, as a result, would it create a significant hazard to the public or the environment?	☒	☐
The RBC site is listed on the current California EPA Hazardous Waste and Substances Sites List, also known as the "Cortese list." This listing is due to prior site activities that resulted in soil contamination at specific site locations. As discussed above in Sec. 8.a, the DTSC is directing remediation efforts to address the effects of this past contamination. Information regarding the background, remediation activities, and current status may be found at: http://www.envirostor.dtsc.ca.gov/public/profile_report.asp?global_id=07730003. These remediation activities, their status, and current and future remediation efforts will be discussed in the EIR, as well as any additional measures if necessary due to development of the RBC, including Phase 1.		
e) For a project located within an airport land use plan or, where such a plan has not been adopted, within two miles of a public airport or public use airport, would the project result in a safety hazard for people residing or working in the project area?	☐	☒
The RBC site is neither within an airport land use plan nor within two miles of a public airport; therefore, further analysis in the EIR is not required.		
f) For a project within the vicinity of a private airstrip, would the project result in a safety hazard for people residing or working in the project area?	☐	☒
The RBC site is not near a currently operating or planned private airstrip; therefore, further analysis in the EIR is not required.		
g) Impair implementation of or physically interfere with an adopted emergency response plan or emergency evacuation plan?	☒	☐
Emergency response plans are maintained at the Federal, State and local level for all types of disasters, including human-made and natural. Emergency response plans for existing and new facilities would be the responsibility of the operation and management at the RBC; however, the EIR will analyze development of the RBC, including Phase 1, in consultation with all applicable emergency response providers and identify if any impacts to their adopted response plans would occur.		
h) Expose people or structures to a significant risk of loss, injury or death involving wildland fires, including where wildlands are adjacent to urbanized areas or where residences are intermixed with wildlands?	☐	☒
The RBC is not near wildlands and the risk of wildland fires is low. There are numerous open space and wetland areas at the site, but these are not considered moderate or high-risk for wildland fires due to their limited and non-contiguous setting away from large open or natural areas that are susceptible to wildland fires. Further analysis in the EIR is not required.		

	Will be Analyzed in EIR	No Additional Analysis Required
9. HYDROLOGY AND WATER QUALITY -- Would the project:		
a) Violate any water quality standards or waste discharge requirements?	☒	☐
Development of the RBC could increase the impermeable surface area, which could produce additional volume and pollutant loading of urban runoff. Increased water use from the RBC could cause increases in wastewater discharges that could exceed waste discharge requirements for water quality or quantity. The EIR will evaluate impacts to water quality from runoff and characterize current waste discharge volumes of the site and wastewater treatment capacity at the City of Richmond's wastewater treatment plant, and evaluate whether development of the RBC, including Phase 1, would cause a violation of applicable standards or waste discharge requirements.		
b) Substantially deplete groundwater supplies or interfere substantially with groundwater recharge such that there would be a net deficit in aquifer volume or a lowering of the local groundwater table level (e.g., the production rate of pre-existing nearby wells would drop to a level which would not support existing land uses or planned uses for which permits have been granted)?	☒	☐
Potable water at the site and in Richmond is supplied by EBMUD, and not from groundwater wells; groundwater in the area does not support existing or planned land uses. Groundwater contamination has been detected on portions of the site. Shallow groundwater is expected to be encountered during construction of the RBC. While additional site development may somewhat reduce percolation of stormwater into the shallow groundwater due to the addition of impervious surface area, the project would not substantially deplete supplies or interfere with groundwater recharge. However, given the size of the LRDP area and the scale of development anticipated at the horizon year, standard best practices and mitigations will be discussed in the EIR to address groundwater recharge.		
c) Substantially alter the existing drainage pattern of the site or area, including through the alteration of the course of a stream or river, in a manner which would result in substantial erosion or siltation on- or off-site?	☒	☐
The project site includes a channelized storm drain that flows into the bay and directly affects the existing drainage pattern of the site. Development of the RBC will increase the impervious area of the site and could increase the rate of site runoff. The EIR will include analysis of the proposed site and development pattern of the project to ascertain how the siting of buildings and facilities could further affect the drainage patterns of the site, and the potential impacts pertaining to drainage, erosion, and on- and off-site siltation from campus development under the proposed LRDP, including Phase 1.		
d) Substantially alter the existing drainage pattern of the site or area, including through the alteration of the course of a stream or river, or substantially increase the rate or amount of surface runoff in a manner which would result in flooding on- or off-site?	☒	☐
There are no natural streams or rivers on the site and the site has existing stormwater and drainage systems, including the channelized storm drain, that address flooding concerns. Development of the RBC, including Phase 1, would increase the area of impervious surface that could increase the volume of surface water; systems would, however, be sized and improvements planned to reduce the risk of flooding or increase in levels of urban contaminants in stormwater runoff, as part of the 2013 LRDP improvements. However, given the size of the LRDP area and the scale of development anticipated at the horizon year, standard best practices and mitigations will be discussed in the EIR to address drainage and risks of flooding.		
e) Create or contribute runoff water which would exceed the capacity of existing or planned stormwater drainage systems or provide substantial additional sources of polluted runoff?	☒	☐

	Will be Analyzed in EIR	No Additional Analysis Required
In the short term, the project will likely increase the amount of impervious surface at the site that could increase the volume of surface water runoff. The EIR will evaluate if the existing and planned drainage system could accommodate increased runoff from campus development under the proposed LRDP, including Phase 1; the analysis will include potential impacts associated with stormwater runoff.		
f) Otherwise substantially degrade water quality?	☒	☐
Expansion of research operations associated with development of the RBC, including Phase 1, could result in activities that could impact water quality. Improvements would, however, be planned to reduce the risk of water quality degradation, including bioswales and other stormwater filtration and retention measures. However, given the size of the LRDP area and the scale of development anticipated at the horizon year, standard best practices and mitigations will be discussed in the EIR to address water quality.		
g) Place housing within a 100-year flood hazard area as mapped on a federal Flood Hazard Boundary or Flood Insurance Rate Map or other flood hazard delineation map?	☐	☒
While the RBC could include temporary lodging, it would not include temporary or permanent housing within the 100-year flood hazard area; therefore, this topic will not be discussed further in the EIR.		
h) Place within a 100-year flood hazard area structures which would impede or redirect flood flows?	☒	☐
A portion of the site is within a Federal Emergency Management Agency VE Zone. This designation denotes coastal areas with a one percent or greater chance of flooding and an additional hazard associated with storm waves; these areas have a 26 percent chance of flooding over a 30-year period. Given the size of the LRDP area and the scale of development anticipated at the horizon year, the EIR will consider existing flood control structures on the site and the adequacy of these structures and the possible need for additional flood control components.		
i) Expose people or structures to a significant risk of loss, injury or death involving flooding, including flooding as a result of the failure of a levee or dam?	☒	☐
The RBC site is not downstream of or near a levee or dam. As described in response to item d) above, systems would be sized and improvements planned to reduce the risk of flooding due to stormwater flows and risk from other sources of flooding (see item h) above). A flood control channel on the site addresses current water flows, including those related to stormwater. Given the size of the LRDP area and the scale of development anticipated at the horizon year, standard best practices and mitigations will be discussed in the EIR to address drainage and risks of flooding due to campus development under the proposed LRDP, including Phase 1.		
j) Inundation by seiche, tsunami, or mudflow?	☒	☐
Portions of the RBC site are within a mapped tsunami inundation zone; however, these locations are not proposed for development. According to the City of Richmond General Plan 2030 EIR, portions of the site along the Bay could be subject to projected sea level rise as a result of global warming. The EIR will examine potential impacts due to rising sea levels and discuss any mitigations, if necessary, to address sea level rise.		
10. LAND USE AND PLANNING -- Would the project:		
a) Physically divide an established community?	☒	☐
The RBC would be located on the existing Richmond properties. The site is currently somewhat disconnected from the Richmond community, by the barriers of I-580 freeway and railroad lines north and east of the properties. The RBC LRDP would not expand the campus site into the surrounding community and would not physically divide any established communities; the project may instead improve linkages with the community. The EIR will include a discussion of adjacent and nearby land uses and land use patterns and applicable land use and zoning ordinances and policies.		

	Will be Analyzed in EIR	No Additional Analysis Required
b) Conflict with any applicable land use plan, policy, or regulation of an agency with jurisdiction over the project (including, but not limited to the LRDP, general plan, specific plan, local coastal program, or zoning ordinance) adopted for the purpose of avoiding or mitigating an environmental effect?	☒	☐
The RBC would be located on land owned by the University of California which has land use jurisdiction over the site, as prescribed by Article IX Section 9 of the California Constitution, As such, the project is not subject to local land use planning jurisdiction, but rather, the Long Range Development Plan acts as a general plan for the site. The EIR will include as context a discussion of local land use ordinances and policies, including the recently adopted City of Richmond General Plan 2030, as the University seeks to be a good neighbor. The parcels of the RBC site closest to San Francisco Bay are within the jurisdiction of the San Francisco Bay Conservation and Development Commission (BCDC) and would be subject to the policies and development guidelines of the San Francisco Bay Plan. The jurisdictional boundary of BCDC was amended in October 2011 to reflect climate change issues and projected sea level rise. Development of the RBC, including Phase 1, would include infrastructure components within the BCDC's jurisdictional area; therefore, the EIR will include a discussion of the LRDP's conformance with BCDC development policies and guidelines as directed by the San Francisco Bay Plan.		
c) Conflict with any applicable habitat conservation plan or natural community conservation plan?	☐	☒
The RBC site is not located within any adopted federal, state or local habitat conservation plan or natural community conservation plan. Therefore, no additional analysis in the EIR is required.		
11. MINERAL RESOURCES -- Would the project:		
a) Result in the loss of availability of a known mineral resource that would be of value to the region and the residents of the state?	☐	☒
Because the site is in an area where there are no significant mineral or aggregate deposits and there are no known mineral resources that would present major issues for development of the RBC, no further discussion is required in the EIR.		
b) Result in the loss of availability of a locally-important mineral resource recovery site delineated on a local general plan, specific plan or other land use plan?	☐	☒
The RBC site does not include any locally-important mineral resource recovery sites as delineated on a local general plan, specific plan or land use plan, so no further discussion is required in the EIR.		
12. NOISE -- Would the project result in:		
a) Exposure of persons to or generation of noise levels in excess of standards established in any applicable plan or noise ordinance, or applicable standards of other agencies?	☒	☐
The RBC would cause increases in traffic volumes, mechanical equipment associated with new building and related structures, and increases in daily site populations that could cause potential long-term increases in noise levels. Operation of construction equipment could cause substantial short-term noise increases that might include short-term, temporary exceedances of noise ordinances in nearby areas. The EIR will analyze the anticipated magnitude of these noise increases, and will evaluate whether the increased noise levels associated with campus development under the proposed LRDP, including Phase 1, would exceed applicable ambient noise standards.		
b) Exposure of persons to or generation of excessive groundborne vibration or groundborne noise levels?	☒	☐

	Will be Analyzed in EIR	No Additional Analysis Required
Operational activities associated with the RBC are not likely to result in activities that generate excessive groundborne vibration or noise levels. Construction of buildings or other support structures under the LRDP, including Phase 1, might require the use of pile drivers or other heavy construction machinery that could generate excessive groundborne vibration or groundborne noise levels noticeable to both on- and off-site receptors. The EIR will address vibration and groundborne noise levels from anticipated construction activities, and discuss potential impacts and mitigation measures.		
c) A substantial permanent increase in ambient noise levels in the project vicinity above levels existing without the project?	☒	☐
Activities at the RBC, including Phase 1, would cause increases of on-site population and general operations that could produce permanent ambient noise level increases. The EIR will evaluate whether any increased permanent noise levels would exceed applicable ambient noise standards.		
d) A substantial temporary or periodic increase in ambient noise levels in the project vicinity above levels existing without the project?	☒	☐
Operation of construction or other equipment could cause substantial temporary or short-term noise increases. The EIR will use current noise modeling methods to predict their magnitude, and will evaluate whether the increased temporary noise levels associated with implementation of the RBC would exceed applicable noise standards.		
e) For a project located within an airport land use plan or, where such a plan has not been adopted, within two miles of a public airport or public use airport, would the project expose people residing or working in the project area to excessive noise levels?	☐	☒
The RBC site is not in a current or proposed airport land use plan or Airport Influence Area, as defined by Assembly Bill 2776 and is not within two miles of a public airport. Therefore, no further discussion is required in the EIR.		
f) For a project within the vicinity of a private airstrip, would the project expose people residing or working in the project area to excessive noise levels?	☐	☒
The RBC site is not near a current or planned private airstrip. Therefore, no further discussion is required in the EIR.		
13. POPULATION AND HOUSING -- Would the project:		
a) Induce substantial population growth in an area, either directly (for example, by proposing new homes and businesses) or indirectly (for example, through extension of roads or other infrastructure)?	☒	☐
No housing is proposed at the RBC. Employment growth and housing demand attributable to the RBC would occur over several decades and, based on current commute patterns of existing employees at the site and LBNL and UC Berkeley employees, demand would be dispersed over a broad area of the East Bay and the greater Bay Area. Further, a portion of employees at the new RBC would be existing LBNL or UC Berkeley employees whose work is moved to a new location, and those employees would not be new employees contributing to population growth. The EIR will analyze the anticipated increase in jobs in relation to the population and housing policies and projections for the City of Richmond, as well as neighboring jurisdictions, to determine whether the level of impact that would occur with development of the RBC, including Phase 1.		
b) Displace substantial numbers of existing housing, necessitating the construction of replacement housing elsewhere?	☐	☒
The RBC site does not include housing or any related residential uses, and no housing would be displaced, so further discussion is not required in the EIR.		

	Will be Analyzed in EIR	No Additional Analysis Required
c) Displace substantial numbers of people, necessitating the construction of replacement housing elsewhere?	☐	☒
The RBC site does not include housing or any related residential uses, and no housing would be displaced, so further discussion is not required in the EIR.		
14. PUBLIC SERVICES --		
a) Would the project result in substantial adverse physical impacts associated with the provision of new or physically altered governmental facilities, need for new or physically altered governmental facilities, the construction of which could cause significant environmental impacts, in order to maintain acceptable service ratios, response times or other performance objectives for any of the public services:		
Fire protection?	☒	☐
Development of the RBC, including the permanent increase in on-site personnel, would increase the potential need for emergency fire protection services, including hazardous materials response units. The EIR will analyze the site's fire response equipment, water storage and distribution, and firefighting response capability to address any increases in demand at full implementation of the proposed LRDP as well as upon completion of Phase 1. In addition, the EIR will evaluate whether significant impacts would occur should the project result in the need for new or physically altered facilities.		
Police protection?	☒	☐
RBC-related increases in development and on-site personnel would increase the potential need for police services, which are provided by the UC Police Department. The site's on-site security forces likely would be expanded as needed to accommodate the increases in demand at full implementation of the proposed LRDP as well as upon completion of Phase 1. The EIR will evaluate the anticipated demand on police services and whether significant impacts would arise from any new or physically altered police facilities.		
Schools?	☒	☐
RBC-related increases in personnel could draw more families with school-aged children to the vicinity of the site. The EIR will analyze the potential impacts of this population to nearby primary and secondary schools. This analysis will include data and projections from the City of Richmond General Plan 2030 and projections from local school districts to determine potential impacts and the need for expanded school facilities.		
Parks?	☒	☐
RBC-related increases in personnel will draw more people into the area and increase demand for parks and recreational facilities. There are several existing parks and recreational facilities nearby. The EIR will analyze impacts to parks and recreational facilities.		
Other public facilities?	☒	☐
RBC-related increases in personnel could draw more people into the area and increase demand for additional public facilities. The EIR will analyze potential impacts to public facilities, including libraries and planned facilities identified in the City of Richmond General Plan 2030.		

	Will be Analyzed in EIR	No Additional Analysis Required
15. RECREATION --		
a) Would the project increase the use of existing neighborhood and regional parks or other recreational facilities such that substantial physical deterioration of the facility would occur or be accelerated?	☒	☐
There are several parks within one mile of the RBC site. These include Shimada Friendship Park, Rosie the Riveter Park, Laurel Park, Booker T. Anderson Community Center, and the Point Isabel Regional Shoreline. The Bay Trail is adjacent to the site, and provides a pedestrian and bicycle link along the shoreline that ultimately will provide a continuous link around San Francisco Bay. RBC related growth, including Phase 1, could increase demand for parks and recreational facilities in the area. The EIR will evaluate this issue in the context of current and proposed parkland and open space facilities in the area.		
b) Does the project include recreational facilities or require the construction or expansion of recreational facilities which might have an adverse physical effect on the environment?	☒	☐
Recreational facilities may be developed at the RBC. The EIR will discuss the existing and proposed inventory of recreational facilities in the vicinity and identify any potential impacts to these facilities by the increased daily population resulting from campus development under the proposed LRDP, including Phase 1.		
16. TRANSPORTATION/TRAFFIC -- Would the project:		
a) Conflict with an applicable plan, ordinance or policy establishing measures of effectiveness for the performance of the circulation system, taking into account all modes of transportation including mass transit and relevant components of the circulation system, including, but not limited to intersections, streets, highways, and freeways, pedestrian and bicycle paths, and mass transit?	☒	☐
The EIR will analyze the impact of the development of the RBC, including Phase 1, on the local and regional road and highway network, including Routes of Regional Significance as defined for the vicinity of the RBC. Impacts analyzed for transit will include impacts to local bus service and BART lines and connectors. The EIR will also examine potential impacts to pedestrian and bicycle facilities such as the Bay Trail and the local and regional bicycle and pedestrian network.		
b) Exceed, either individually or cumulatively, a level of service standard established by the county congestion management agency for designated roads or highways?	☒	☐
Campus development under the proposed LRDP, including Phase 1, is expected to generate increased vehicular traffic that could result in impacts to the local and regional road network. The EIR will analyze local streets and regional highway corridors to determine whether level of service standards would be impacted due to the project. The analysis will utilize the City of Richmond General Plan 2030 to identify proposed and planned changes to the circulation network in and around the RBC. Traffic modeling and forecasting for AM and PM peak hours will be conducted using the most recent version of the Countywide Travel Demand Model developed by the Contra Costa Transportation Authority, the designated congestion management agency.		
c) Result in a change in air traffic patterns, including either an increase in traffic levels or a change in location that result in substantial safety risks?	☐	☒
Development of the RBC would not alter existing air traffic patterns; therefore, this does not require further study in the EIR.		

	Will be Analyzed in EIR	No Additional Analysis Required
d) Substantially increase hazards due to a design feature (e.g., sharp curves or dangerous intersections) or incompatible uses (e.g., farm equipment)? Create unsafe conditions for pedestrians or bicycles?	☒	☐
The EIR will analyze the circulation features for access to and within the site with development of the RBC. This analysis will include location and site clearance for signalized and unsignalized intersections, traffic calming features, and related circulation elements. The EIR will discuss the proposed traffic circulation network as it relates to bicycle and pedestrian circulation and access to determine if any potential safety impacts would occur.		
e) Result in inadequate emergency access?	☒	☐
The EIR will analyze existing and proposed access and circulation for emergency vehicles in coordination and consultation with emergency service providers.		
f) Conflict with adopted policies, plans, or programs regarding public transit, bicycle or pedestrian facilities, or otherwise decrease the performance or safety of such facilities?	☒	☐
Both LBNL and UC Berkeley have robust transportation demand management programs to encourage use of alternative commute modes. As described in item a), above, the EIR would examine potential impacts to alternative commute systems and facilities due to implementation of the LRDP.		
17. UTILITIES AND SERVICE SYSTEMS -- Would the project:		
a) Exceed wastewater treatment requirements of the applicable Regional Water Quality Control Board?	☒	☐
No wastewater treatment requirements are directly applicable to the proposed project because the wastewater generated on the RBC will not be treated on-site. Wastewater generated on the campus will discharge to the City of Richmond wastewater treatment plant. The EIR will analyze the wastewater output anticipated due to development of the RBC, to determine the ability of the project to comply with the wastewater treatment requirements imposed on the City's wastewater treatment plant by the Regional Water Quality Control Board.		
b) Require or result in the construction of new water or wastewater treatment facilities or expansion of existing facilities, the construction of which could cause significant environmental effects?	☒	☐
The EIR will evaluate the increased demand on wastewater treatment and conveyance facilities under the proposed LRDP, including Phase 1, and evaluate potential impacts associated with any new or expanded facilities, if any would be required to meet this demand.		
c) Require or result in the construction of new storm water drainage facilities or expansion of existing facilities, the construction of which could cause significant environmental effects?	☒	☐
Development of the RBC, including Phase 1, would increase impervious surface coverage of the Richmond properties; this in turn may increase the volume of stormwater flow. The EIR will examine and describe the existing site-wide drainage patterns and infrastructure, analyze the increased demand for stormwater drainage facilities with the RBC, and the potential impacts associated with any new or altered drainage facilities required to meet this demand.		
d) Have sufficient water supplies available to serve the project from existing entitlements and resources, or are new or expanded entitlements needed?	☒	☐

	Will be Analyzed in EIR	No Additional Analysis Required
Development of the RBC would include up to 5.4 million square feet of buildings and approximately 10,000 adp. Development of Phase 1 would involve up to 600,000 gsf of new building space and increase the on-site population to 1,300 persons. This would increase the water use on the site; therefore, the EIR will evaluate the projected water demand for the campus relative to the planned water supply and delivery entitlements from EBMUD. The EIR will evaluate potential environmental impacts from expanded or new entitlements.		
e) Result in a determination by the wastewater treatment provider which serves or may serve the project that it has adequate capacity to serve the project's projected demand in addition to the provider's existing commitments?	☒	☐
The EIR will evaluate whether projected wastewater increases generated at the full implementation of the proposed LRDP, including Phase 1, would be served by existing capacity and identify any environmental impacts should additional wastewater entitlements be required.		
f) Be served by a landfill with sufficient permitted capacity to accommodate the project's solid waste disposal needs?	☒	☐
The EIR will discuss the current solid waste generation at the project site and the volume of waste that would be generated at Phase 1 and at full implementation of the proposed LRDP, including Phase 1. The analysis will include projected solid waste disposal needs—including wastes generated from the demolition of existing buildings and structures—and determine whether or not existing landfill capacity would be able to accommodate the waste disposal needs of the RBC. The EIR will discuss the solid waste demands in context of solid waste recycling and composting requirements and guidelines, including the UC Sustainable Practices Policy.		
g) Comply with applicable federal, state, and local statutes and regulations related to solid waste?	☒	☐
The EIR will discuss compliance of the proposed project with applicable statutes and regulations regarding solid waste, including the UC Sustainable Practices Policy.		
18. MANDATORY FINDINGS OF SIGNIFICANCE --		
a) Does the project have the potential to degrade the quality of the environment, substantially reduce the habitat of a fish or wildlife species, cause a fish or wildlife population to drop below self-sustaining levels, threaten to eliminate a plant or animal community, reduce the number or restrict the range of a rare or endangered plant or animal or eliminate important examples of the major periods of California history or prehistory?	☒	☐
Implementation of the 2013 LRDP, including Phase 1, has the potential to have significant impacts that could degrade the quality of the environment. The LRDP EIR will evaluate the potential for campus development under the 2013 LRDP to result in significant impacts that could degrade the quality of the environment, as described in the above checklist.		
b) Does the project have impacts that are individually limited, but cumulatively considerable? ("Cumulatively considerable" means that the incremental effects of a project are considerable when viewed in connection with the effects of past projects, the effects of other current projects, and the effects of probable future projects)?	☒	☐

	Will be Analyzed in EIR	No Additional Analysis Required
Development of the RBC pursuant to the proposed LRDP, including Phase 1, could cause impacts to several resource areas that will be fully analyzed in the EIR. The project will be evaluated in the cumulative setting. The City of Richmond recently adopted its General Plan 2030 that anticipates new growth and development in the area. This plan, along with other applicable plans and polices from Richmond and other neighboring communities, could contribute to a range of cumulative impacts in the area. The EIR will evaluate whether impacts associated with growth under the 2013 LRDP, in combination with past, current, and reasonably foreseeable future projects, have the potential to be cumulatively considerable.		
c) Does the project have environmental effects which will cause substantial adverse effects on human beings, either directly or indirectly?	☒	☐
The proposed 2013 LRDP has the potential to cause significant impacts. The EIR will evaluate whether these impacts have the potential to result in substantial adverse effects on human beings, either directly or indirectly.		

List of Acronyms and Abbreviations

AC Transit	Alameda-Contra Cost Transit District
adp	average daily population
ABPDU	Advanced Biofuels Process Development Unit
BART	Bay Area Rapid Transit
BCDC	Bay Conservation and Development Commission
BMP	best management practice
CEQA	California Environmental Quality Act
EBMUD	East Bay Municipal Utility District
EIR	Environmental Impact Report
GHG	greenhouse gas emissions
gsf	gross square feet
I	Interstate
JBEI	Joint Bio Energy Institute
JGI	Joint Genome Institute
KBase	Knowledge Base
LBNL	Lawrence Berkeley National Laboratory
LEED	Leadership in Energy and Environmental Design
LRDP	Long Range Development Plan
NEPA	National Environmental Policy Act
PCB	Polychlorinated Biphenyls
PG&E	Pacific Gas and Electric
PM_{10}	inhalable particulate matter
$PM_{2.5}$	fine particulate matter
RBC	Richmond Bay Campus
SFBAAB	San Francisco Bay Area Air Basin
UC	University of California
US EPA	US Environmental Protection Agency

Comments

University of California
Lawrence Berkeley National Laboratory

JAN 15 2013

Facilities Capital Projects

January 15, 2013

Jeff Philliber, Environmental Planner
Lawrence Berkeley National Laboratory
One Cyclotron Road, MS 76-225
Berkeley, CA 94720

Subject: Comments on the Notice of Preparation (NOP) for the Draft Environmental Impact Report (DEIR) for the Richmond Bay Campus 2013 Long Range Development Plan and Phase 1 Development Project

Dear Mr. Philliber:

On behalf of the San Francisco Bay Trail Project, I am writing to submit comments on the NOP for the DEIR for the Richmond Bay Campus 2013 Long Range Development Plan and Phase 1 Development Project (LRDP Project) located in the City of Richmond. The Bay Trail Project is a nonprofit organization administered by the Association of Bay Area Governments (ABAG) that plans, promotes, and advocates for the implementation of the Bay Trail. The Bay Trail is a planned 500-mile continuous network of multi-use bicycling and hiking paths that, when complete, will encircle San Francisco and San Pablo Bays in their entirety. It will link the shoreline of all nine Bay Area counties, as well as 47 cities. To date, 333 miles of the proposed Bay Trail system has been developed.

When the LRDP Project is fully built, it is expected to generate a significant number of daily vehicular trips to and from the Richmond Bay Campus (RBC) by both employees of the Lawrence Berkeley National Laboratory (LBNL) and visitors to the campus. These daily vehicular trips will result in significant impacts to parking demand, transportation infrastructures, greenhouse gas emissions, and air quality that will need to be addressed and mitigated in the DEIR. We also expect an increased demand in the use of the Bay Trail as both an alternative transportation corridor and recreational opportunity for RBC employees and visitors. As a result, the DEIR needs to evaluate the impacts of the LRDP project on demand for the Bay Trail and provide mitigation for those impacts.

Due to the LRDP Project's proximity to the significant stretch of completed Bay Trail alignments in the City of Richmond, the LRDP Project is in a unique position to mitigate its impacts resulting from the high levels of vehicular trips that it is expected to generate. The LRDP Project can mitigate the parking, traffic, greenhouse gas, and air quality impacts that it will generate by improving the existing Bay Trail and the connections to the Bay Trail between Central Avenue and Garrard Boulevard in order to encourage RBC employees and visitors to shift travel modes and use the Bay Trail as a non-motorized mode of travel to and from the RBC.

The existing Bay Trail in Richmond already has a high level of use for both transportation and recreation purposes, and the LRDP Project would need to mitigate the increase in demand for use of the Bay Trail for both transportation and recreational purposes by widening the existing Bay Trail in order to increase the volume of bicycle and pedestrian traffic that the Bay Trail is capable of carrying. In addition, for the Bay Trail to be effectively utilized as a non-motorized transportation option, the LRDP Project must improve the connections to the Bay Trail from the RBC and from the streets connecting the surrounding communities to the Bay Trail. Of particular importance are the street connections from the Bay Trail to the communities across the Interstate 80 and 580 corridors. As a result, we request that the LRDP Project either incorporate the improvements to the Bay Trail and the connections to the Bay Trail described above as part of the LRDP Project or require these improvements as mitigation for the parking, traffic, greenhouse gas, air quality, and recreational impacts that will be generated by the LRDP Project.

The Bay Trail Project appreciates the opportunity to comment on the NOP for the LRDP DEIR and looks forward to working with the Lawrence Berkeley National Laboratory to improve the Bay Trail in Richmond for LBNL employees and the public. Please do not hesitate to call me at (510) 464-7915 if you have any questions regarding the above comments or the Bay Trail.

Sincerely,

Lee Chien Huo
Bay Trail Planner

University of California
Lawrence Berkeley National Laboratory
JAN 17 2013
Facilities Capital Projects

From: **John Taylor** <jtaylor@berkeley.edu>
Date: Wed, Jan 16, 2013 at 4:23 PM
Subject: Richmond Bay Campus Comment, invasive plants
To: LRDP-EIR@lbl.gov
Cc: "Tom Kelly (KyotoUSA)" <kyotousa@sbcglobal.net>, Delia Taylor <deliataylor@mac.com>

LRDP-EIR@lbl.gov
Jeff Philliber
Chief Environmental Planner
Lawrence Berkeley National Laboratory
One Cyclotron Road MS 76-225
Berkeley CA 94720

Dear Chief Environmental Planner Philliber:

I have a specific comment regarding the Notice of Preparation and Initial Study for the Richmond Bay Campus project.

It concerns Biological Resources Sections 4a-species, 4b-riparian habitat and 4c-wetlands in Meeker Slough and the Western Stege Marsh.

Noxious and invasive plants (Italian fennel and pampas grass) that are invading the newly rehabilitated slough and marsh pose a threat to biological resources that easily could be solved *now* but will be a headache later for the new Richmond Bay Campus.

My wife, Delia, and I saw the problem on a bike ride and then contacted one of two key persons in invasive plant control along the Bay Trail, Tom Kelly. Kelly has close contacts with the East Bay Regional Park District, who own and manage the trail, which is a prime source of the invasive plants at the RFS. Given that the marsh and slough abut EBRPD trails, a logical partner in weed control would be Scott Possin, the Supervisor at Miller-Knox, the park that covers that part of the Bay Trail, spossin@ebparks.org.

Tom took us on a tour and I snapped some photos which show the problem in the attached pdf.

Sincerely,

John

Professor John Taylor
Plant and Microbial Biology
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University of California
Berkeley, CA 94720-3102
jtaylor@berkeley.edu
http://nature.berkeley.edu/taylorlab/

Invasive plants threatening the beautifully remediated marsh at the Richmond Bay Campus.

Given that remediation cost $18 million, and that, "Examples of the research that will be housed at the Richmond site include developing low-cost malaria drugs, enhanced urban runoff strategies, wetlands restoration, polluted lands remediation and genetics research to fight cancer [1]," it seems prudent to prevent a massive return of the invasive plants.

The invasive plants have returned on the Richmond Field Station, on the property of the neighbors on either side, and on the right-of-way of the East Bay Regional Parks District trail. This right-of-way extends a few meters past the fences that border either side of the trail.

A relatively small effort could check this threat. If unchecked, the invasive plants will take over much of the Richmond Field Station land and require a massive effort to remove. Note that once checked, maintenance will be needed to keep the invasive plants in check. Looks like a great opportunity for UC and the East Bay Parks to join forces.

-- John Taylor, Delia Taylor and Tom Kelly's survey of the site on September 6, 2012 on the SF Bay side of the Richmond Field Station

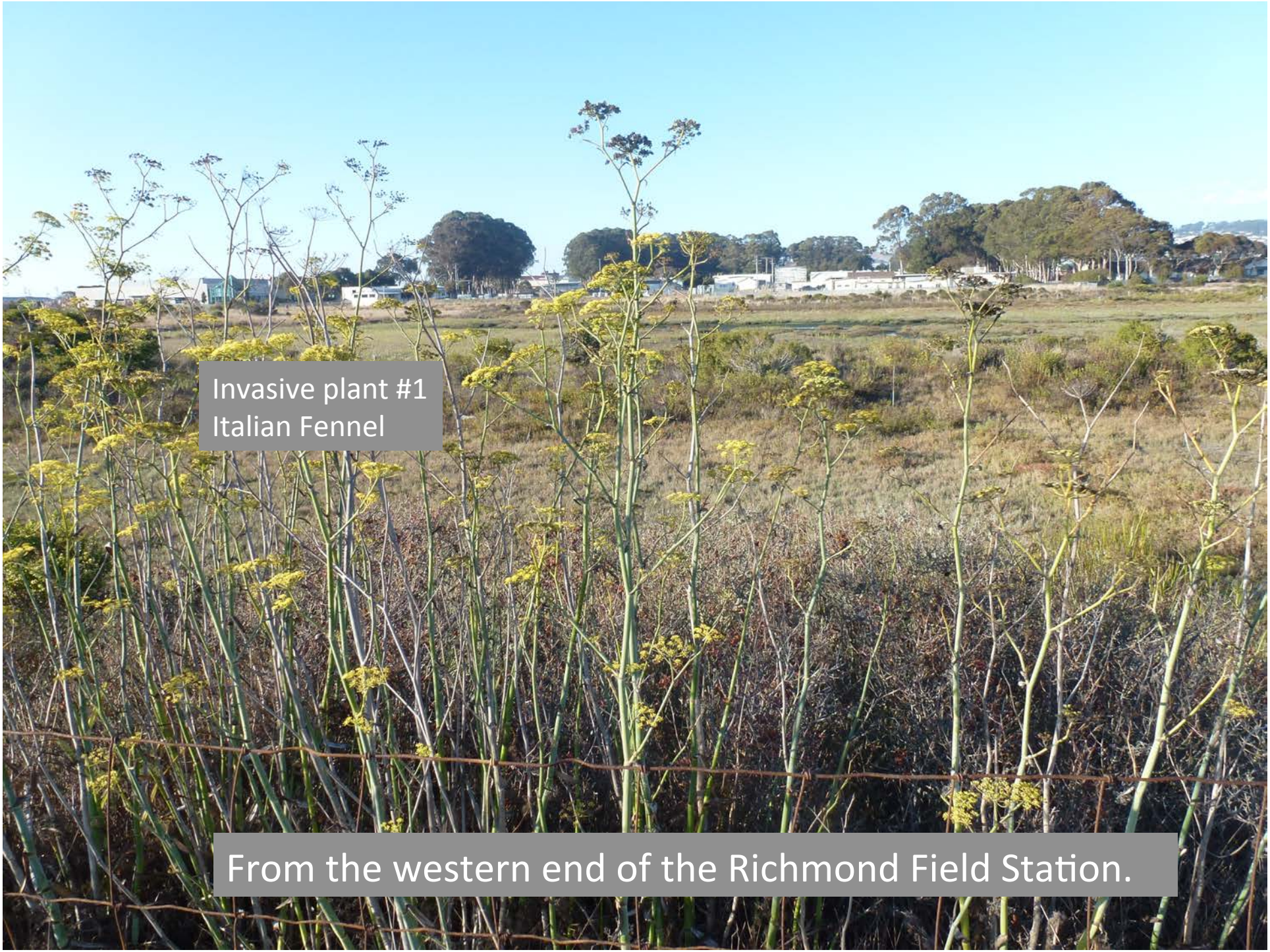
[1]Robert Rogers, Contra Costa Times, September 6, 2012, rrogers@bayareanewsgroup.com.

From the trail connecting Channel Avenue and the East Bay Parks District bay trail.

From the southeast trail to the Richmond Field Station.

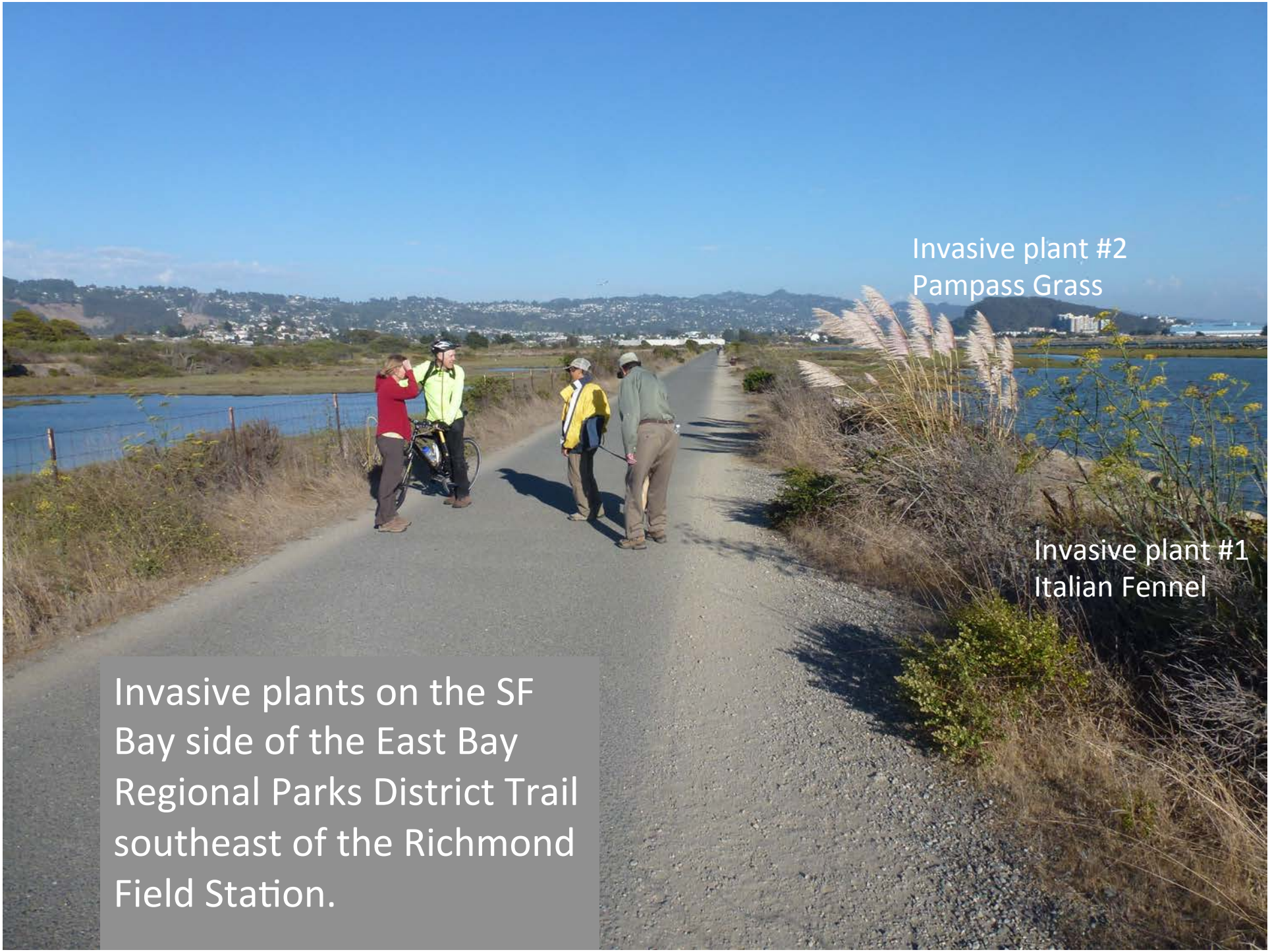
Invasive plant #1
Italian Fennell
From the southeast trail to the Richmond Field Station.

From the western end of the Richmond Field Station.


Invasive plant #1
Italian Fennel
From the western end of the Richmond Field Station.

Invasive plant #2
Pampass Grass
From the western end of the Richmond Field Station.

Invasive plant #2
Pampass Grass
From the western end of the Richmond Field Station.



Invasive plants on the SF Bay side of the East Bay Regional Parks District Trail southeast of the Richmond Field Station.

Invasive plants on the SF Bay side of the East Bay Regional Parks District Trail southeast of the Richmond Field Station.

Invasive plants on both sides of Meeker Slough, west of the Richmond Field Station.

Invasive plants threatening the beautifully remediated marsh at the Richmond Bay Campus.

John Taylor, jtaylor@berkeley.edu Professor, Plant and Microbial Biology, UC Berkeley

Delia Taylor, deliataylor@mac.com California Native Plant Society, East Bay Chapter

Tom Kelly, kyotousa@sbcglobal.net Restoration volunteer with experience at invasive plant removal on the Bay Trail and other EBRPD properties

University of California
Lawrence Berkeley National Laboratory
JAN 17 2013
Facilities Capital Projects

January 15, 2013

Jeff Philliber, Environmental Planner
Lawrence Berkeley National Laboratory
One Cyclotron Road, MS 76-225
Berkeley, CA 94720

Subject: Comments on the Notice of Preparation (NOP) for the Draft Environmental Impact Report (DEIR) for the Richmond Bay Campus 2013 Long Range Development Plan and Phase 1 Development Project

Dear Mr. Philliber:

On behalf of the San Francisco Bay Trail Project, I am writing to submit comments on the NOP for the DEIR for the Richmond Bay Campus 2013 Long Range Development Plan and Phase 1 Development Project (LRDP Project) located in the City of Richmond. The Bay Trail Project is a nonprofit organization administered by the Association of Bay Area Governments (ABAG) that plans, promotes, and advocates for the implementation of the Bay Trail. The Bay Trail is a planned 500-mile continuous network of multi-use bicycling and hiking paths that, when complete, will encircle San Francisco and San Pablo Bays in their entirety. It will link the shoreline of all nine Bay Area counties, as well as 47 cities. To date, 333 miles of the proposed Bay Trail system has been developed.

When the LRDP Project is fully built, it is expected to generate a significant number of daily vehicular trips to and from the Richmond Bay Campus (RBC) by both employees of the Lawrence Berkeley National Laboratory (LBNL) and visitors to the campus. These daily vehicular trips will result in significant impacts to parking demand, transportation infrastructures, greenhouse gas emissions, and air quality that will need to be addressed and mitigated in the DEIR. We also expect an increased demand in the use of the Bay Trail as both an alternative transportation corridor and recreational opportunity for RBC employees and visitors. As a result, the DEIR needs to evaluate the impacts of the LRDP project on demand for the Bay Trail and provide mitigation for those impacts.

Due to the LRDP Project's proximity to the significant stretch of completed Bay Trail alignments in the City of Richmond, the LRDP Project is in a unique position to mitigate its impacts resulting from the high levels of vehicular trips that it is expected to generate. The LRDP Project can mitigate the parking, traffic, greenhouse gas, and air quality impacts that it will generate by improving the existing Bay Trail and the connections to the Bay Trail between Central Avenue and Garrard Boulevard in order to encourage RBC employees and visitors to shift travel modes and use the Bay Trail as a non-motorized mode of travel to and from the RBC.

The existing Bay Trail in Richmond already has a high level of use for both transportation and recreation purposes, and the LRDP Project would need to mitigate the increase in demand for use of the Bay Trail for both transportation and recreational purposes by widening the existing Bay Trail in order to increase the volume of bicycle and pedestrian traffic that the Bay Trail is capable of carrying. In addition, for the Bay Trail to be effectively utilized as a non-motorized transportation option, the LRDP Project must improve the connections to the Bay Trail from the RBC and from the streets connecting the surrounding communities to the Bay Trail. Of particular importance are the street connections from the Bay Trail to the communities across the Interstate 80 and 580 corridors. As a result, we request that the LRDP Project either incorporate the improvements to the Bay Trail and the connections to the Bay Trail described above as part of the LRDP Project or require these improvements as mitigation for the parking, traffic, greenhouse gas, air quality, and recreational impacts that will be generated by the LRDP Project.

The Bay Trail Project appreciates the opportunity to comment on the NOP for the LRDP DEIR and looks forward to working with the Lawrence Berkeley National Laboratory to improve the Bay Trail in Richmond for LBNL employees and the public. Please do not hesitate to call me at (510) 464-7915 if you have any questions regarding the above comments or the Bay Trail.

Sincerely,

Lee Chien Huo
Bay Trail Planner

University of California
Lawrence Berkeley National Laboratory

JAN 22 2013

Facilities Capital Projects

TRAC
Trails for Richmond Action Committee

73 Belvedere Avenue
Richmond, CA 94801
Phone/Fax 510-235-2835
tracbaytrail@earthlink.net

January 17, 2013

Mr. Jeff Philliber, Environmental Planner
Lawrence Berkeley National Laboratory
One Cyclotron Road, MS 76-225
Berkeley, CA 94720

Dear Mr. Philliber:

TRAC, the Trails for Richmond Action Committee, appreciates the opportunity to comment in response to the Notice of Preparation and Initial Study for the Proposed Richmond Bay Campus (RBC) 2013 Long Range Development Plan and Phase I Development. Our comments focus on the San Francisco Bay Trail and related multi-use trails.

Overall, the EIR must undertake a comprehensive and detailed evaluation of the project's potential environmental impacts, identification of mitigation measures for those impacts, and formulation of alternatives to the project that would involve fewer and less severe environmental impacts. Project definition will be critical for assessing environmental effects of the project. To the extent that the EIR is programmatic in nature without clear project definition, it will be necessary to formulate and adopt mitigation measures to avoid significant effects where feasible. It will be especially important to evaluate the growth-inducing and cumulative impacts of this project, especially in terms of increased traffic on roads & trails, recreational impacts and the need for improving Bay Trail safety, utility, connectivity and enjoyment in the area.

Land Use & Planning

Consistency with adopted plans is a major factor for CEQA review. For example, CEQA requires the DEIR to discuss inconsistencies with general and regional plans (Guidelines §15125(d)).

Area-specific requirements of Richmond's General Plan 2030, Pedestrian Plan and Bicycle & Pedestrian Plan are cited below under Transportation, Traffic, Air Quality & Greenhouse Gas Impacts. In addition, the General Plan contains numerous citywide provisions requiring that new projects incorporate the Bay Trail and maximum feasible public access to the shoreline, e.g.:

> Policy CR1.5: "... require new development and redevelopment projects to provide pedestrian and bicycle amenities, streetscape improvements and linkages to planned and completed City and regional multi-use trails ...."
> Action CR1.D: "Require new development and redevelopment projects to be pedestrian and bicycle-friendly, and to provide adequate connections to the existing and proposed bicycle and and pedestrian network." "Include provisions that require owners of property along the shoreline to provide maximum feasible access to the shoreline and to complete the Bay Trail as part of any project approval process."

Action CR1.E: "Expand multi-use trails and greenways in the City. Provide connector trails and linkages to improve access from neighborhoods in Central Richmond to the regional open space in the hills and along the shoreline."
Action CN2.H: "Initiate and carry through on coordinated planning to provide public access at points along Richmond's southern shoreline, from Point Isabel to and including the Marina Bay."

TRAC Recommendation: The EIR should demonstrate that **Phase I** of the RBC project will fully implement the above General Plan 2030 policy and actions for the entirety of the Long Range Development Plan, as well as the specific trail and staging area provisions described below from the General Plan, Bicycle Master Plan and Pedestrian Plan. If it is not feasible to fully incorporate these plan requirements in Phase 1, enforceable mitigation measures should be formulated and adopted to ensure that they are implemented as soon as possible in subsequent phases.

Transportation, Traffic, Air Quality & Greenhouse Gas Impacts

Motor vehicle traffic and congestion on roads with associated air pollutant and greenhouse gas emissions has the potential for very significant impacts, because Phase I development "would add approximately 1,000 to the average daily population of the site" growing to an estimated 10,000 as the site is fully developed per LBNL's presentation during the October 4 community workshop. Thus, it is very important that the project be designed to facilitate and encourage bicycling and walking for commuting, errands and recreation by both employees and visitors.

An important consideration is that Richmond's over 31 miles of San Francisco Bay Trail shown on the attached map will allow RBC employees and visitors to walk and bike to/from the campus, thus reducing motor vehicle congestion and air pollution as well as parking needs. Many already use the Bay Trail to commute by bicycle to/from locations between Point Richmond and Emeryville. Connectivity improvements will be important to facilitate non-motorized transportation for both employees and visitors.

To illustrate, TRAC's Feb. 18, 2011 letter of support for RBC stated:
•"... employees at a satellite campus .... would be able to use the Bay Trail to walk or bicycle and enjoy virtually all sites in Rosie the Riveter WWII Home Front National Historical Park, Eastshore State Park, Point Isabel and Miller/Knox Regional Shorelines and five City of Richmond shoreline parks":
•"... the planned multi-use trail along the Stege Marsh frontage of these properties could connect with the existing Meeker Tidal Creek Trail offering LBNL employees a convenient walking and bicycling route to five cafes and other services near the intersection of Marina Bay Parkway and Meeker Ave., as well as to Amini's By the Bay and Salute Ristorante in Marina Bay"; and
•".... the multi-use Meeker Tidal Creek Trail connects with a large vacant lot at the intersection of Regatta Blvd. and Marina Bay Parkway on the north side of Meeker Tidal Creek ... might be considered as a complimentary site for cafes, restaurants and other services."

Richmond's General Plan 2030, Bicycle Master Plan and Pedestrian Plan provide important guidance as to the needed improvements for safe, convenient pedestrian and bicyclist access. The project should include the following Class I multi-use trails and trail staging areas in the vicinity as specified in the General Plan:

a. Trail staging areas at the southern ends of both S. 32nd and S. 46th streets with multi-use trails providing access to the San Francisco Bay Trail spine between Pt. Isabel and Marina Bay and

b. A Class I multi-use trail inland of Stege Marsh between S. 46 St. and the existing Meeker Tidal Creek Trail.

These trails are shown on the attached General Plan Map 4.1 Planned Pedestrian and Bicycle Improvements and also specified as follows:

Action CR1.E: "Create a Class I multi-use trail loop north of Meeker Tidal Creek and Stege Marsh as a transportation and scenic route. Also provide trailhead staging areas at the south end of 32nd and 46th streets with bridges across Meeker Tidal Creek and the unnamed creek east of South 32nd Street."

Action CN2.H: " Require the dedication of trailheads at the ends of South 46th and South 32nd Streets as part of any plans to redevelop the lands adjacent to the existing University of California Field Station."

The following additional trail improvements surrounding the campus are specified in the Bicycle Master Plan and Pedestrian Plan:

1. Remedy the unduly wide and dangerous Bay Trail crossing of Central Ave. at Rydin Rd., which will be used by RBC bicycle commuters, per Pedestrian Plan page 98 last bullet;
2. Provide pedestrian and bicycle improvements at I-580 interchanges with Harbour Way, Marina Way, Marina Bay Parkway, Bay View Ave., Regatta Blvd. & Central Ave., e.g. see Pedestrian Plan pp. 104 - 106 and Bicycle Master Plan p. 72; and
3. Improve Key Corridors as "complete streets" for bicyclist and pedestrian safety, e.g. see Bicycle Master Plan pp. 59 - 60 and Pedestrian Plan pp. 47, 50, 55 - 56, 59 - 60, 98 & 104 - 108.

TRAC Recommendation: Mitigate impacts related to traffic, automotive air pollution, greenhouse gases and land use for parking by designing **Phase 1** of the project to implement the 2030 General Plan, Bicycle Master Plan and Pedestrian Plan improvements listed above. Each phase of the Long Range Development Plan also should include the following mitigation measures:

1. mesh RBC's bicycle/pedestrian network seamlessly with the Bay Trail and other surrounding access points and

2. emulate SunPower Corporation's Richmond facility in providing secure, indoor bicycle storage for employees who commute by bicycle and bike-sharing facilities at convenient locations so that visitors and employees may borrow RBC bicycles for running errands, visiting nearby retail stores and restaurants, and/or recreating during breaks from work.

Recreational Impacts

The EIR should evaluate and mitigate for impacts on shoreline parks, as well as recreational and transportation usage of the Bay Trail between Central Avenue and Garrard Blvd., including growth-inducing and cumulative effects. For example, Bay Trail sections between Central Ave. and Harbour Way are popular with bicyclists, hikers, joggers, dog walkers, baby strollers, skaters with and without poles, bird watchers, etc. After establishing baseline usage, the EIR should predict future traffic for recreation and transportation and evaluate the potential need for mitigating improvements to allow safe, enjoyable use of the Bay Trail. For example, existing Class I trail sections at best only satisfy Bay Trail minimum width standards for a two-way multi-use trail.

TRAC Recommendation: Determine existing bicycle and pedestrian level of service on the Bay Trail, analyze impacts on the trail system of additional users generated by the RBC project and provide mitigations for these impacts to eliminate or bring them to a less than significant level.

Growth-Inducing & Cumulative Impacts

It will be especially important to evaluate the growth-inducing impacts for the entire phased project cumulatively with all other new developments it is likely to stimulate, especially in terms of increased traffic, recreational usage and transportation needs for improving Bay Trail connectivity with the site (CEQA Guidelines §§15126(d) & 15126.2(d)). An EIR also must discuss the cumulative impacts of a project when the incremental effects of a project are considerable viewed in connection with the effects of other past, current, and probable future projects (CEQA Guidelines §§15130(a) & 15130(b)). All probable future projects should be considered. Projects anticipated beyond the near future should be analyzed for their cumulative effect if they are reasonably foreseeable (See *Bozung v. Local Agency Formation Comm'n*, 13 Cal. 3d 263, 284 (1975)).

The analysis of cumulative impacts is particularly important in the context of long-range planning or programmatic documents because the growth allowed under such plans is often substantial and because they set forth the policies that will guide the development of future individual projects for many years. As noted in the CEQA Guidelines, one requirement of an EIR for planning documents is that they provide a more thorough analysis of cumulative impacts than is required for individual projects (CEQA Guidelines §15168).

TRAC Recommendation: Evaluate and mitigate for growth-inducing and cumulative impacts of the long range development plan, including but not limited to satellite R&D enterprises, supply and manufacturing facilities, hotels, restaurants and service businesses such as convenience stores.

TRAC hopes that these comments will be helpful and would appreciate receiving a copy of the DEIR.

Sincerely,

Bruce Beyaert, TRAC Chair

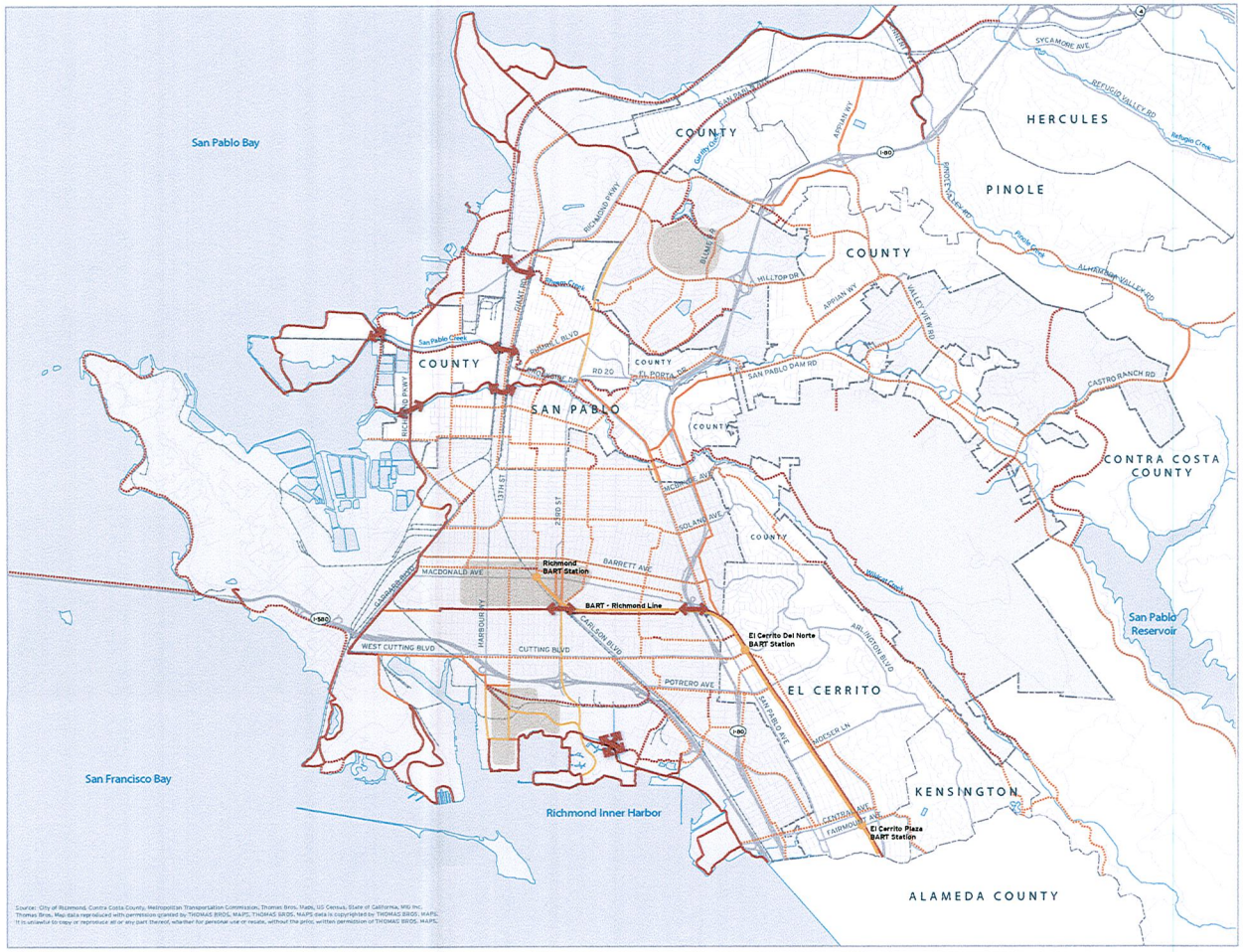
Attachments:

Richmond Bay Trail Map

General Plan 2030 Map 4.1 Planned Pedestrian and Bicycle Improvements

cc: Richard Mitchell, Lina Velasco, Brad McCrae & Greg Haet

SAN FRANCISCO
BAY TRAIL PROJECT
Richmond
Bay Trail
Complete
Incomplete
Connector trails
Complete
Incomplete
P Parking
Parks/Open Space
Water Bodies
Point Wilson
Point Pinole Regional Shoreline
UP rail corridor
Atlas Road
San Pablo Avenue
Richmond Parkway
Goodrick Ave
Point San Pablo
Point San Pablo Yacht Harbor
Terminal 4
West County Landfill
Parr
San Pablo Creek
SAN PABLO
Wildcat Creek Trail
Davis Park
Wildcat Creek Viewpoint
Gertrude
Hensley St
23rd Street
San Pablo Avenue
Point Molate NFD
Point Molate
Western Drive
Pennsylvania
Castro Point
Richmond-San Rafael Bridge
Castro Street
Garrard Blvd
Richmond BART Station
West Macdonald
RICHMOND
Ohio Ave
Richmond Greenway
El Cerrito del Norte BART Station
Ohlone Greenway Trail
Chevron Long Wharf
Cutting Blvd
Hoffman
580
Marina Bay Pkwy
Keller Beach
Canal
Regatta
Marina Bay Park
Miller-Knox Regional Shoreline
Doman Dr
Seacliff Dr
Brickyard Cove
Harbour Wy South
Marina Wy
Hall
Marina Bay
Meeker Tidal Creek
80
S 51st St
Ferry Point
Lucretia Edwards Park
Vincent Park
Shimada Park
Eastshore State Park
Shipyard 3
Central
Point Isabel Regional Shoreline
Brooks Island Regional Preserve
N
0 0.3 0.6 0.9 1.2 Miles
April 9, 2012



Map 4.1

Planned Pedestrian and Bicycle Improvements

Existing Bicycle Routes
- Class I
- Class II
- Class III

Planned Pedestrian Improvements and Bicycle Routes
- Class I Bicycle Route
- Class II and III Bicycle Route
- Bicycle and Pedestrian Connector
- Pedestrian Improvement District

50 / 10 ACRES

N

0 0.5 1 2 MILES

Note: Larger format maps are available for view or purchase at the Planning and Building Services Department.

University of California
Lawrence Berkeley National Laboratory
JAN 20 2013
Facilities Capital Projects

Subject: Qs re comments to Notice of Preparation
From: Ellen Sasaki <ejsasaki@comcast.net>
Date: 1/20/2013 6:58 PM
To: LRDP-EIR@lbl.gov

Greetings -- I am not clear on the EIR process.

Does "public comments" mean comments from individuals residing in Richmond? Or only from agencies?

I live in Richmond and am concerned about the impact on wildlife during demolition, tree removal, construction and restoration activities to restore "natural habitat" activities in developing the new LBNL campus. I don't see that "Wildlife" as an area of proposed study in the Notice document. Is this the appropriate stage of EIR development for submitting my comments?

Thanks, Ellen Sasaki

STATE OF CALIFORNIA

Governor's Office of Planning and Research

State Clearinghouse and Planning Unit

Edmund G. Brown Jr.
Governor

Ken Alex
Director

University of California
Lawrence Berkeley National Laboratory

JAN 08 2013

Facilities Capital Projects

Notice of Preparation

January 3, 2013

To: Reviewing Agencies

Re: Richmond Bay Campus 2013 Long Range Development Plan and Phase 1 Development
SCH# 2013012007

Attached for your review and comment is the Notice of Preparation (NOP) for the Richmond Bay Campus 2013 Long Range Development Plan and Phase 1 Development draft Environmental Impact Report (EIR).

Responsible agencies must transmit their comments on the scope and content of the NOP, focusing on specific information related to their own statutory responsibility, within 30 days of receipt of the NOP from the Lead Agency. This is a courtesy notice provided by the State Clearinghouse with a reminder for you to comment in a timely manner. We encourage other agencies to also respond to this notice and express their concerns early in the environmental review process.

Please direct your comments to:

Jeff Philliber
University of California
One Cyclotron Road, MS 76-225
Berkeley, CA 94720

with a copy to the State Clearinghouse in the Office of Planning and Research. Please refer to the SCH number noted above in all correspondence concerning this project.

If you have any questions about the environmental document review process, please call the State Clearinghouse at (916) 445-0613.

Sincerely,

Scott Morgan
Director, State Clearinghouse

Attachments
cc: Lead Agency

1400 TENTH STREET P.O. BOX 3044 SACRAMENTO, CALIFORNIA 95812-3044
TEL (916) 445-0613 FAX (916) 323-3018 www.opr.ca.gov

Document Details Report
State Clearinghouse Data Base

SCH# 2013012007
Project Title Richmond Bay Campus 2013 Long Range Development Plan and Phase 1 Development
Lead Agency University of California

Type NOP Notice of Preparation

Description The University of California (UC) proposes to establish a new major research campus at properties it owns in Richmond, California, for the consolidation of biosciences programs of the Lawerence Berkeley National Laboratory (LBNL) and for development of additional research-related facilities for both LBNL and UC Berkeley. This campus would jointly serve UC LBNL and UC Berkeley. The proposed 2013 Long Range Development Plan (LRDP) for the Richmond Bay Campus (RBC) would guide campus development through 2050. Initial development under Phase 1 would occur through 2018.

Lead Agency Contact

Name Jeff Philliber
Agency University of California
Phone 510 486-5257 **Fax**
email
Address One Cyclotron Road, MS 76-225
City Berkeley **State** CA **Zip** 94720

Project Location

County Contra Costa
City Richmond
Region
Cross Streets S. 46th Street and Seaver Avenue
Lat / Long 37° 54' 58" N / 122° 19' 49" W
Parcel No. 5600600008
Township **Range** **Section** **Base**

Proximity to:

Highways I-580, I-80, SR 123
Airports
Railways UPRR, Bart
Waterways San Francisco Bay
Schools Kennedy, Coronado
Land Use 1 million gsf research/dev. Zoning-Specific Plan. GP- Business/Light Industrial

Project Issues Aesthetic/Visual; Agricultural Land; Air Quality; Archaeologic-Historic; Biological Resources; Coastal Zone; Drainage/Absorption; Economics/Jobs; Flood Plain/Flooding; Forest Land/Fire Hazard; Geologic/Seismic; Minerals; Noise; Public Services; Recreation/Parks; Schools/Universities; Septic System; Sewer Capacity; Soil Erosion/Compaction/Grading; Solid Waste; Toxic/Hazardous; Traffic/Circulation; Vegetation; Water Quality; Water Supply; Wetland/Riparian; Growth Inducing; Landuse; Cumulative Effects

Reviewing Agencies Resources Agency; Office of Historic Preservation; Department of Parks and Recreation; San Francisco Bay Conservation and Development Commission; Department of Water Resources; Department of Fish and Game, Region 3; Native American Heritage Commission; California Highway Patrol; Caltrans, District 4; Department of Toxic Substances Control; Regional Water Quality Control Board, Region 2

Date Received 01/03/2013 **Start of Review** 01/03/2013 **End of Review** 02/01/2013

Note: Blanks in data fields result from insufficient information provided by lead agency.

NOP Distribution List

County: Contra Costa

SCH# 2013012007

Resources Agency

- [x] Resources Agency
  Nadell Gayou
- [ ] Dept. of Boating & Waterways
  Nicole Wong
- [ ] California Coastal Commission
  Elizabeth A. Fuchs
- [ ] Colorado River Board
  Gerald R. Zimmerman
- [ ] Dept. of Conservation
  Elizabeth Carpenter
- [ ] California Energy Commission
  Eric Knight
- [ ] Cal Fire
  Dan Foster
- [ ] Central Valley Flood Protection Board
  James Herota
- [x] Office of Historic Preservation
  Ron Parsons
- [x] Dept of Parks & Recreation
  Environmental Stewardship Section
- [ ] California Department of Resources, Recycling & Recovery
  Sue O'Leary
- [x] S.F. Bay Conservation & Dev't. Comm.
  Steve McAdam
- [x] Dept. of Water Resources Resources Agency
  Nadell Gayou

Fish and Game

- [ ] Depart. of Fish & Game
  Scott Flint
  Environmental Services Division
- [ ] Fish & Game Region 1
  Donald Koch
- [ ] Fish & Game Region 1E
  Laurie Harnsberger
- [ ] Fish & Game Region 2
  Jeff Drongesen
- [x] Fish & Game Region 3
  Charles Armor
- [ ] Fish & Game Region 4
  Julie Vance
- [ ] Fish & Game Region 5
  Leslie Newton-Reed
  Habitat Conservation Program
- [ ] Fish & Game Region 6
  Gabrina Gatchel
  Habitat Conservation Program
- [ ] Fish & Game Region 6 I/M
  Brad Henderson
  Inyo/Mono, Habitat Conservation Program
- [ ] Dept. of Fish & Game M
  George Isaac
  Marine Region

Other Departments

- [ ] Food & Agriculture
  Sandra Schubert
  Dept. of Food and Agriculture
- [ ] Depart. of General Services
  Public School Construction
- [ ] Dept. of General Services
  Anna Garbeff
  Environmental Services Section
- [ ] Dept. of Public Health
  Jeffery Worth
  Dept. of Health/Drinking Water
- [ ] Delta Stewardship Council
  Kevan Samsam

Independent Commissions,Boards

- [ ] Delta Protection Commission
  Michael Machado
- [ ] Cal EMA (Emergency Management Agency)
  Dennis Castrillo
- [x] Native American Heritage Comm.
  Debbie Treadway
- [ ] Public Utilities Commission
  Leo Wong
- [ ] Santa Monica Bay Restoration
  Guangyu Wang
- [ ] State Lands Commission
  Jennifer Deleong
- [ ] Tahoe Regional Planning Agency (TRPA)
  Cherry Jacques

Business, Trans & Housing

- [ ] Caltrans - Division of Aeronautics
  Philip Crimmins
- [ ] Caltrans - Planning
  Terri Pencovic
- [x] California Highway Patrol
  Suzann Ikeuchi
  Office of Special Projects
- [ ] Housing & Community Development
  CEQA Coordinator
  Housing Policy Division

Dept. of Transportation

- [ ] Caltrans, District 1
  Rex Jackman
- [ ] Caltrans, District 2
  Marcelino Gonzalez
- [ ] Caltrans, District 3
  Gary Arnold
- [x] Caltrans, District 4
  Erik Alm
- [ ] Caltrans, District 5
  David Murray
- [ ] Caltrans, District 6
  Michael Navarro
- [ ] Caltrans, District 7
  Dianna Watson
- [ ] Caltrans, District 8
  Dan Kopulsky
- [ ] Caltrans, District 9
  Gayle Rosander
- [ ] Caltrans, District 10
  Tom Dumas
- [ ] Caltrans, District 11
  Jacob Armstrong
- [ ] Caltrans, District 12
  Marlon Regisford

Cal EPA

Air Resources Board

- [ ] Airport/Energy Projects
  Jim Lerner
- [ ] Transportation Projects
  Douglas Ito
- [ ] Industrial Projects
  Mike Tollstrup
- [ ] State Water Resources Control Board
  Regional Programs Unit
  Division of Financial Assistance
- [ ] State Water Resources Control Board
  Student Intern, 401 Water Quality Certification Unit
  Division of Water Quality
- [ ] State Water Resouces Control Board
  Phil Crader
  Division of Water Rights
- [x] Dept. of Toxic Substances Control
  CEQA Tracking Center
- [ ] Department of Pesticide Regulation
  CEQA Coordinator

Regional Water Quality Control Board (RWQCB)

- [ ] RWQCB 1
  Cathleen Hudson
  North Coast Region (1)
- [x] RWQCB 2
  Environmental Document Coordinator
  San Francisco Bay Region (2)
- [ ] RWQCB 3
  Central Coast Region (3)
- [ ] RWQCB 4
  Teresa Rodgers
  Los Angeles Region (4)
- [ ] RWQCB 5S
  Central Valley Region (5)
- [ ] RWQCB 5F
  Central Valley Region (5)
  Fresno Branch Office
- [ ] RWQCB 5R
  Central Valley Region (5)
  Redding Branch Office
- [ ] RWQCB 6
  Lahontan Region (6)
- [ ] RWQCB 6V
  Lahontan Region (6)
  Victorville Branch Office
- [ ] RWQCB 7
  Colorado River Basin Region (7)
- [ ] RWQCB 8
  Santa Ana Region (8)
- [ ] RWQCB 9
  San Diego Region (9)

- [ ] Other _____
  _____
  _____

- [ ] _____
  Conservancy

Last Updated 8/14/2012

University of California
Lawrence Berkeley National Laboratory

JAN 28 2013

Facilities Capital Projects

January 22, 2013

Jeff Philliber
Environmental Planner
Lawrence Berkeley National Laboratory
One Cyclotron Road, MS 76-225
Berkeley, CA 94720
LRDP-EIR@lbl.gov

Dear Mr. Philliber,

We are writing to raise concerns about the proposed second campus of the Lawrence Berkeley National Laboratory (LBNL) and the U. C. Berkeley Synthetic Biology Institute (SBI) that is being considered. Much of the research that will be conducted in this laboratory will be on the emerging technology called synthetic biology. Synthetic biology is an extreme form of genetic engineering that is attempting to create novel, potentially self-replicating artificial life forms from synthesized DNA. The risks this research poses to worker safety, public health and the environment are currently being ignored.

While some find promise in synthetic biology for manufacturing new products and helping us to better understand biological processes, it is an inherently risky technology. Synthetic biology research could result in enhanced virulence in existing hosts, heightened ability to infect a wider range of hosts, and resistance to antimicrobials, antivirals, vaccines and other treatment or containment modalities.

Laboratory accidents are much more common in the U.S. than most people realize and often go unreported. If there were an accidental release of engineered organisms in this lab, the health of workers, the environment and entire communities could be put at risk. Already, the current lack of adequate safety protocols and biocontainment within rDNA labs has caused serious illness and death. Since synthetic biology's objective lies in engineering novel life forms and products with the potential to interact with human biology and other cellular processes, we believe this research poses dangers (both from accidental and deliberate uses) unforeseen in the regulatory framework of standard rDNA research.

Therefore, before any decisions are made on a specific site for this new lab, we believe a comprehensive, independent and transparent safety and risk analysis capable of assessing these threats must be completed. It is simply unacceptable to allow the laboratory to self-regulate. Moreover, it must be ascertained whether such research is even appropriate near urban centers. Safety regulations and procedures must be created and tailored to address the novel aspects of this new science, including whistleblower protections and forums for workers to raise concerns, and the costs to any municipality of an appropriate public safety infrastructure must be identified.

Finally, independent regulatory oversight must be assured, particularly because both public and private entities will be operating at the lab. Every stage of this process must be open to and involve the public, including town hall meetings to discuss and address health and safety issues.

The Lawrence Berkeley National Laboratory and the U. C. Berkeley Synthetic Biology Institute must undertake the burden of proof as to whether their laboratory will be safe before any community can make an informed decision about inviting it to break ground in their backyard.

Sincerely,

Alliance for Humane Biotechnology

BioFuel Watch

California Coalition for Worker's Memorial Day

Center for Food Safety

Center for Genetics and Society

Council for Responsible Genetics

Friends of the Earth

Global Justice Ecology Project

International Center for Technology Assessment

Movement Generation Justice and Ecology Project

National Injured Worker's Network

National Workrights Institute

Pesticide Action Network of North America

*If you have any questions or need any additional information, please do not hesitate to contact:

M. L. Tina Stevens, Ph.D.
Executive Director
Alliance for Humane Biotechnology

and

Jeremy E. Gruber, J.D.
President
Council for Responsible Genetics

at 609-610-1602 or jeeg@concentric.net

BERKELEY PATH WANDERERS ASSOCIATION

Dedicated to the creation, preservation and restoration of public paths, steps and walkways in Berkeley for the use and enjoyment of all.

1442A Walnut St. #269
Berkeley, CA 94709
info@berkeleypaths.org
www.berkeleypaths.org

University of California
Lawrence Berkeley National Laboratory

JAN 25 2013

Facilities Capital Projects

January 22, 2013

Mr. Jeff Philliber
Environmental Planner
Lawrence Berkeley National Laboratory
One Cyclotron Road, MS 76-225
Berkeley, CA 94720

Dear Mr. Philliber,

The Berkeley Path Wanderers Association (BPWA) is a volunteer organization that builds and maintains pedestrian paths as well as promotes a variety of pedestrian activities both in Berkeley and the greater Bay Area. We would like to offer our comments in response to the Notice of Preparation and Initial Study for the Proposed Richmond Bay Campus (RBC) 2013 Long Range Development Plan.

Since our concerns center around pedestrian access and safety, we would like to focus primarily on those parts of the proposed plan. However, we have also reviewed TRAC's comments on this matter as reflected in their January 10, 2013 letter to you and completely agree with "Recommended Bicycle & Pedestrian Access Improvements" beginning on page 3 of the letter. For your convenience, I've included those recommendations below.

In addition to the TRAC recommendations, BPWA offers the following comments:

Since pedestrians are generally traveling at slower speeds than bicyclists, their needs are often more pronounced. This is particularly true at the busy and dangers intersections identified in the TRAC letter. A intersection like Central and Rydin is hazardous for a bicycle but even more treacherous for someone on foot. I am attaching a letter from TRAC's Bruce Brubaker to the Contra Costa Transportation Agency in which he makes a sound recommendation for mitigating the safety issues at this intersection. BPWA supports this recommendation.

One of the most pervasive threats to pedestrians at intersections such as the I-580 exchange at Central is from cars turning right on red. Whenever possible, right turns of that nature should either be prohibited or controlled by a pedestrian-activated flashing light.

Thank you for your consideration,

Keith Skinner, President, Berkeley Path Wanderers Association

TRAC
Trails for Richmond Action Committee

Amin AbuAmara
Contra Costa Transportation Authority
3478 Buskirk Avenue, Suite #100
Pleasant Hill, CA 94523

May 30, 2010

RE: Central Avenue / I80 Interchange Improvement Project

Amin,

The Central Avenue / I80 project site occupies a strategic location in regards to the San Francisco Bay Trail in Richmond. As advocates for the Bay Trail in Richmond, TRAC respectfully submits the following comments regarding plans for this important site. Please review the attached Richmond Bay Trail map.

Bay Trail access thorough this area currently runs up from Berkeley on Class I off-street trail to the southwest corner of Central and Rydin Road. From there it crosses Central across to the northwest corner, crosses Rydin Road to the northeast corner, and then proceeds north along Rydin Road approximately 100 feet to a Class I off-street developed trail heading north to Point Isabel and points north. Bay trail use in this area is heavy, with families and bicycle commuters alike enjoying the trail.

Currently intersection improvements at Central Avenue and Rydin Road are being considered. The project proposes a new traffic signal at this intersection. As part of the design of the signalization the following measures should be provided at the intersection:

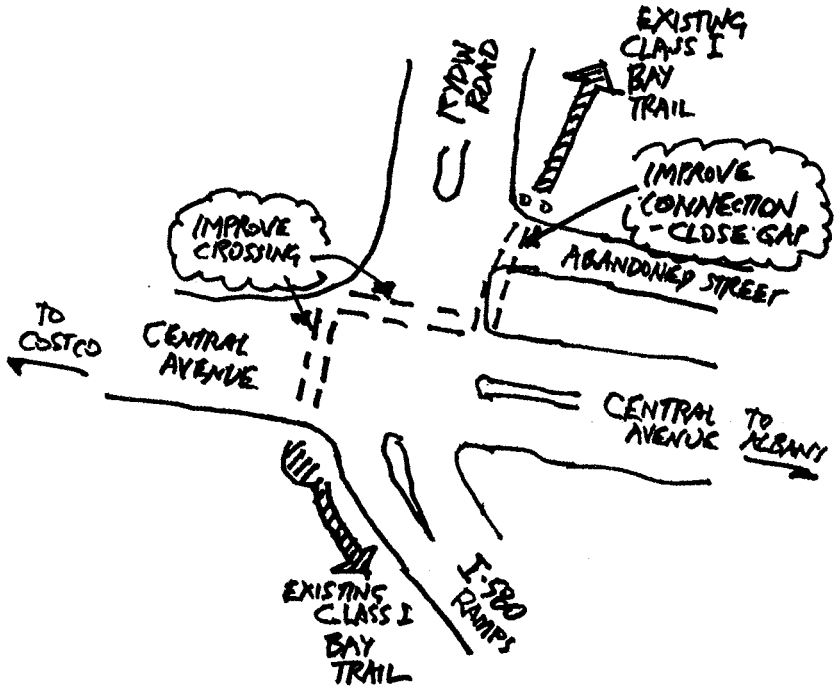
A) Crosswallks should be highly visible and should incorporate pedestrian refuges in the middle if medians will be provided.

B) Pedestrian and bicycle friendly signal activation should also be provided at the three corners where Bay Trail passes through.

C) Improvements should include wayfinding signage.

D) Improvements at the east side of Rydin. There is currently an unclear route to proceed from the northwest corner of Central and Rydin to the Class I trail 100' to the north. Most bicyclists cut diagonally across Rydin to access the Class I trail. With the new signal it will be dangerous or impossible to cut diagonally. For this reason the Class I Bay Trail should be

extended from the northeast corner of Central and Rydin northward about 100 feet to the beginning of Class I trail. See the attached Sketch below for details.



Thank you for taking into account maintaining and improving this important segment of Bay Trail while developing the plans for the Central Avenue / 180 Interchange project. Please do not hesitate to call if you have any questions.

Sincerely,

Bruce Brubaker
TRAC Steering Committee
Associate Principal
Design, Community & Environment
1625 Shattuck Avenue
Berkeley CA 94709
510.848.3815

State of California – The Natural Resources Agency
DEPARTMENT OF FISH AND WILDLIFE
Bay Delta Region
7329 Silverado Trail
Napa, CA 94558
(707) 944-5500
www.wildlife.ca.gov

EDMUND G. BROWN JR., Governor
CHARLTON H. BONHAM, Director

University of California
Lawrence Berkeley National Laboratory
JAN 25 2013
Facilities Capital Projects

January 24, 2013

Mr. Jeff Philliber
University of California
One Clyclotron Road, MS 76-225
Berkeley, CA 94720

Dear Mr. Philliber:

Subject: Richmond Bay Campus 2013 Long Range Development Plan and Phase I Development, Notice of Preparation of Draft Environmental Impact Report, SCH #2013012007, City of Richmond, Contra Costa County

The California Department of Fish and Game (CDFW) has reviewed the documents provided for the subject project, and we have the following comments.

Please provide a complete assessment (including but not limited to type, quantity and locations) of the habitats, flora and fauna within and adjacent to the project area, including endangered, threatened, and locally unique species and sensitive habitats. The assessment should include the reasonably foreseeable direct and indirect changes (temporary and permanent) that may occur with implementation of the project. Rare, threatened and endangered species to be addressed should include all those which meet the California Environmental Quality Act (CEQA) definition (see CEQA Guidelines, Section 15380). CDFW recommended survey and monitoring protocols and guidelines are available at http://www.dfg.ca.gov/biogeodata/cnddb/pdfs/Protocols_for_Surveying_and_Evaluating_Impacts.pdf.

Please be advised that a California Endangered Species Act (CESA) Permit must be obtained if the project has the potential to result in take of species of plants or animals listed under CESA, either during construction or over the life of the project. Issuance of a CESA Permit is subject to CEQA documentation; therefore, the CEQA document must specify impacts, mitigation measures, and a mitigation monitoring and reporting program. If the project will impact CESA listed species, early consultation is encouraged, as significant modification to the project and mitigation measures may be required in order to obtain a CESA Permit.

For any activity that will divert or obstruct the natural flow, or change the bed, channel, or bank (which may include associated riparian resources) of a river or stream, or use material from a streambed, CDFW may require a Lake and Streambed Alteration Agreement (LSAA), pursuant to Section 1600 et seq. of the Fish and Game Code, with the applicant. Issuance of an LSAA is subject to CEQA. CDFW, as a responsible agency under CEQA,

will consider the CEQA document for the project. The CEQA document should fully identify the potential impacts to the stream or riparian resources and provide adequate avoidance, mitigation, monitoring and reporting commitments for completion of the agreement. To obtain information about the LSAA notification process, please access our website at http://www.dfg.ca.gov/habcon/1600/; or to request a notification package, contact the Lake and Streambed Alteration Program at (707) 944-5520.

If you have any questions, please contact Ms. Randi Adair, Senior Environmental Scientist, at (707) 944-5596; or Mr. Craig Weightman, Acting Environmental Program Manager, at (707) 944-5577.

Sincerely,

Scott Wilson

Scott Wilson
Acting Regional Manager
Bay Delta Region

cc: State Clearinghouse

Department of Toxic Substances Control

Matthew Rodriquez
Secretary for
Environmental Protection

Deborah O. Raphael, Director
700 Heinz Avenue
Berkeley, California 94710-2721

Edmund G. Brown Jr.
Governor

University of California
Lawrence Berkeley National Laboratory
JAN 28 2013
Facilities Capital Projects

January 24, 2013

Mr. Jeff Philliber
Environmental Planner
Lawrence Berkeley National Laboratory
One Cyclotron Road, MS 76-225
Berkeley, CA 94720

RE: RICHMOND BAY CAMPUS 2013 LONG RANGE DEVELOPMENT PLAN AND PHASE 1 DEVELOPMENT NOTICE OF PREPARATION, DRAFT ENVIRONMENTAL IMPACT REPORT; SCH #2013-012007

Dear Mr. Philliber:

Thank you for the opportunity to review and comment on the Notice of Preparation (NOP) for the Richmond Bay Campus 2013 Long Range Development Plan and Phase 1 Development (LRDP). As proposed, the University of California (UC) would establish a new major research campus at properties it owns in the City of Richmond, California, for consolidation of biosciences programs of the Lawrence Berkeley National Laboratory (LBNL) and for development of additional research related facilities for both LBNL and UC Berkeley. The Richmond Bay Campus (RBC) would jointly serve UC LBNL and UC Berkeley. The proposed LRDP for the RBC would guide campus development through 2050.

The California Department of Toxic Substances Control (DTSC) oversees the cleanup of hazardous substances sites pursuant to the California Health and Safety Code, Division 20, Chapter 6.8. As a Responsible Agency, DTSC is submitting comments to ensure that the environmental documentation prepared under the California Environmental Quality Act (CEQA) for this Project adequately addresses the remediation of hazardous substance releases that would be required as part of the Project.

DTSC's Abandoned Site Program discovered the Project site in 1980. The Project site was a former explosive facility which produced mercury fulminate used for blasting caps and detonators. UC currently owns the property and uses the existing structures as administrative offices and research/analytical labs. The San Francisco Regional Water Quality Control Board had oversight until May 2005 when oversight was then

transferred to DTSC. DTSC's Site Investigation and Remediation Order, issued September 15, 2006 (Docket Number I/SE-RAO 06/07-004), requires the investigation and remediation of the RBC. The NOP identified that a remedy document will be prepared concurrently with the Draft Environmental Impact Report (DEIR) for the RCB. DTSC intends to utilize the EIR to fulfill its requirements under CEQA in making its determination on a remedy document.

DTSC submits the following comments to be addressed in the Draft Environmental Impact Report:

1. Site Characterization: The Site Investigation and Remediation Order describes the project site as 152 acres and the NOP states 133 acres. The DEIR project boundary description should be explain why the description is not consistent with the Remediation Order. In addition, if previously unidentified hazardous substances are encountered, they would also need to be addressed as part of the Project.

2. Site Background: Identify the current and historic uses at the Project site that may have resulted in a release of hazardous wastes/substances, and any known or potentially contaminated sites within the proposed project area.

3. Greenhouse Gasses: A discussion of all aspects of remediation, including on-site construction equipment and emissions from trucks hauling hazardous materials away from the Project site consistent with the San Francisco Bay Area Air Basin requirements.

4. Hazards and Hazardous Materials: The extent of known contamination that may be present at the Project site should be identified and proposed alternative remedies which may be contemplated for inclusion in the remedy document subject to DTSC approval. In addition, if it is determined that hazardous wastes are, or will be, generated by the proposed project, the wastes must be managed in accordance with the California Hazardous Waste Control Law (California Health and Safety Code, Division 20, Chapter 6.5) and the Hazardous Waste Control Regulations (California Code of Regulations, Title 22, Division 4.5). If it is determined that hazardous wastes will be generated as a result of the Project, discussion should be included describing the requirements for the facility in obtaining a United States Environmental Protection Agency Identification Number. In addition, a discussion of worker health and safety risks and proposed mitigation measures should be included.

5. Hydrology and Water Quality/Soils: The extent of known groundwater and soil contamination that may be present at the Project site should be identified, as well as proposed alternative remedies which may be contemplated for inclusion in the remedy document subject to DTSC approval.

6. Transportation/Traffic: A discussion should be included regarding the estimated number of truck trips associated with the removal of hazardous materials from the Project site pursuant to a remedy document. In addition, figures depicting the proposed truck transportation route to the proposed treatment or disposal facility should be included.

If you have any questions or would like to discuss these comments please contact me at (510) 540-3839 or email lynn.nakashima@dtsc.ca.gov.

Sincerely,

Lynn Nakashima
Senior Hazardous Substances Scientist
Cleanup Program
Berkeley Office

cc: Ms. Candace Hill
Department of Toxic Substances Control
Office of Environmental Planning & Analysis
OPEA/CEQA/MS 11A
1001 "I" Street
P.O. Box 806
Sacramento, CA 95182-0806

University of California
Lawrence Berkeley National Laboratory

JAN 28 2013

Facilities Capital Projects

TRAC
Trails for Richmond Action Committee

73 Belvedere Avenue
Richmond, CA 94801
Phone/Fax 510-235-2835
tracbaytrail@earthlink.net

January 28, 2013

Mr. Jeff Philliber, Environmental Planner
Lawrence Berkeley National Laboratory
One Cyclotron Road, MS 76-225
Berkeley, CA 94720

Dear Mr. Philliber:

TRAC's January 17 letter responding to the Notice of Preparation and Initial Study for the Proposed Richmond Bay Campus 2013 Long Range Development Plan and Phase I Development focused on impacts related to Land Use, Planning, Recreation, Transportation, Traffic, Air Quality and Greenhouse Gas Emissions. In doing so, it highlighted the importance of the City of Richmond's General Plan, Bicycle Master Plan and Pedestrian Plan in providing guidance for safe, convenient and enjoyable bicycle and pedestrian trails, which will reduce impacts on transportation, traffic, air quality and greenhouse gases.

TRAC is concerned about the statement in Section 10.b of the IS that "the project is not subject to local land use planning jurisdiction" because it is "located on land owned by the University." We can't find such an exemption in the cited Article IX, Section 9 of the California Constitution. Therefore, we ask that the DEIR explain the basis for this exemption from local plans and cite the relevant legal authority.

If the Constitution does exempt from City plans those facilities "located on land owned by the University", the DEIR should discuss with cited legal authority whether the project is subject to the requirement of State CEQA law to avoid significant conflicts with local plans with regard to **both** "lands owned by the University" **and** surrounding lands owned by others. Recognizing that the bulk of the recreation, traffic, congestion, air quality and greenhouse gas impacts will occur off site, it would seem irresponsible to flout provisions of the City's General Plan, Bicycle Master Plan and Pedestrian Plan designed to reduce those impacts.

TRAC requests that the DEIR recognize the importance of the City's adopted plans and commit to comply with their letter and spirit. This will lead to a better project with reduced environmental impacts and increased public support

Sincerely,

Bruce Beyaert

Bruce Beyaert, TRAC Chair

cc: Bruce Reed Goodmiller, Richard Mitchell & Lina Velasco

Subject: Added TRAC Comments on NOP/IS for LBNL's RBC 2013 LRDP & Phase I Development
From: Sandra Beyaert <sbeyaert@earthlink.net>
Date: 1/28/2013 10:06 PM
To: Jeff Philliber <lrdp-eir@lbl.gov>
CC: Bruce Goodmiller <Bruce_Goodmiller@ci.richmond.ca.us>, Richard Mitchell <richard_mitchell@ci.richmond.ca.us>, Lina Velasco <lina_velasco@ci.richmond.ca.us>, Doug Lockhart <delockhart@lbl.gov>, Jennifer McDougall <jmcdougall@berkeley.edu>, Barbara Maloney <Maloney@bmsdesigngroup.com>, Joy Glasier <glasier@bmsdesigngroup.com>, Elizabeth Foster <Foster@bmsdesigngroup.com>, Armando Viramontes <AViramontes@lbl.gov>

Jeff,
Please find attached TRAC's Jan. 28 letter following up the earlier Jan. 17 letter commenting on the Notice of Preparation and Initial Study for LBNL's Proposed Richmond Bay Campus 2013 Long Range Development Plan and Phase I Development. This new letter raises issues concerning compliance with the City of Richmond's General Plan, Bicycle Master Plan and Pedestrian Plan. TRAC hopes that these comments in preparing the DEIR.

Bruce

Bruce Beyaert, TRAC Chair
tracbaytrail@earthlink.net
phone/fax 510-235-2835

Websites >>
TRAC: http://www.pointrichmond.com/baytrail/
City of Richmond Bay Trail: http://www.ci.richmond.ca.us/TRAC
Richmond Bay Trail Slideshows:
http://sfbaytrailinrichmond.shutterfly.com/pictures/5
Richmond Convention & Visitors Bureau:
http://www.explorerichmondca.com/baytrail.htm

Attachments:

LBNL_RBC_NOP_TRAC012413.pdf 55.1 KB

Richmond Southeast Shoreline Area Community Advisory Group

EXECUTIVE COMMITTEE

University of California
Lawrence Berkeley National Laboratory

FEB 04 2013

Facilities Capital Projects

February 4, 2013

Jeff Philliber
Environmental Planner
Lawrence Berkeley National Laboratory
One Cyclotron Road, MS 76-225
Berkeley, CA 94720 via email: LRDP-EIR@lbl.gov

Re: Richmond Bay Campus 2013 Long Range Development Plan & Phase 1 Development, Richmond Bay Campus, NOP

Dear Mr. Philliber:

The Richmond Southeast Shoreline Area Community Advisory Group brings the California Department of Toxic Substances Control, property owners, and community members together to ensure that the interests of the entire community are included in plans for cleanup of this shoreline area. Our goal is to ensure that current and future users of this area (human as well as wildlife), are protected from site pollution, preferably through cleanup that removes the need for long term institutional controls and deed restrictions.

Richmond's new comprehensive General Plan identifies the southeast shoreline as a community gateway, and the community looks forward to the implementation of a LBNL project that reflects the values of livability, sustainability, and balance, especially as this is one of the more spectacular East Bay sites, drawing large numbers of visitors from both inside and outside the community for recreational purposes.

The RSSA CAG and participating community members have a continuity with this area and an expertise in its challenges; we look to the long term, and encourage this project's decision makers to consider the following points:

- Prior cleanups that left toxics in place have proven mostly ineffective. Research continues to support lower screening levels, causing earlier cleanups to fall out of compliance. In addition, a number of pollutants left in the southeast shoreline soils and water move and mix via plumes, and remediation short of complete source removal has proven ineffective.
- The pollutants on the Zeneca-Stauffer Chemical Plant property significantly impact neighboring properties. Past waste handling practices, including toxins brought from the UC Field Station have left the property highly toxic. And since some of these toxins are showing up in plumes migrating off-site adjacent properties may need to use a more aggressive discovery process than would be typical for a cleaner, less complicated area.
- The most recent, and more comprehensive, sea-level study is Sea Level Rise for the Coasts of California, Oregon and Washington: Past, Present and Future by the National Research Council of the National Academies. The report concludes that for the Bay Area, sea level rise (relative to the year 2000) will range from 1.5 - 12 inches by 2030, 5 - 24 inches by 2050, and 17 - 66 inches (i.e. up to five and a half feet) by 2100. The high figures are twenty percent higher than the previous high projections of 16 inches by 2050 and 55 inches by 2100 in the report cited by the Bay Conservation and Development Commission (BCDC) in its 2009 draft staff report entitled Living with a Rising Bay: Vulnerability and Adaptation in San Francisco Bay and on its Shoreline. Sea-level rise based on either report will cover areas impacted by the many toxics left from past historical industrial use.

This will increase the movement of toxics into Bay waters via solubility and/or motion, and increase the mixing of the toxins, which can magnify risks.

In addition, we support the comments provided to you by the following organizations:

- TRAC, January 13, 2013
- TRAC January 28, 2013
- Sierra Club, January 30, 2013
- California Native Plant Society, East Bay Chapter, February 4, 2013
- Citizens for Eastshore Parks, February 4, 2013

The RSSA CAG shares the view that while the scoping document Section 10.b states "the project is not subject to local land use planning jurisdiction because it is located on land owned by the University" the project would gain community support if the goals of Richmond's General Plan 2030 were acknowledged and implemented to a greater extent than currently indicated. To this point, we support the suggestion for a joint EIR/EIS process and compliance with NEPA.

We urge you to work with the us and the groups noted above to address the issues we have raised. We hope these comments help this project meet the longterm goals of LNBL, the University, and the community.

Sincerely,

Eric Blum
Chair
Richmond Southeast Shoreline Area Community Advisory Group

SAN FRANCISCO BAY AREA RAPID TRANSIT DISTRICT
300 Lakeside Drive, P.O. Box 12688
Oakland, CA 94604-2688
(510) 464-6000

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9TH DISTRICT

February 1, 2013

Jeff Philliber
Environmental Planner
Lawrence Berkeley National Laboratory
One Cyclotron Road, MS 76-225
Berkeley, CA 94720

Re: BART District Comments on Notice of Preparation for the Draft Environmental Impact Report for the Richmond Bay Campus 2013 Long Range Development Plan and Phase 1 Development

Dear Mr. Philliber:

We have reviewed the Notice of Preparation (NOP) for the Draft Environmental Impact Report (DEIR) for the Richmond Bay Campus 2013 Long Range Development Plan and Phase 1 Development (LRDP). We are submitting the following comments for your consideration in proceeding with the LRDP DEIR.

Overall Comments

- Recognizing that UC's prior ownership of the site was undoubtedly a factor in the decision to locate the Lawrence Berkeley National Lab (LBNL) lab expansion at the Richmond Field Station (RFS), we note that this location is a difficult location to serve with public transit, and has a number of sustainable transportation challenges. This location is isolated from the regional transit network by the I-580 freeway and the Union Pacific Railroad right-of-way, and is not directly served by any AC Transit lines or within walking distance of any BART stations. Locating a major employment center in a location that is so inaccessible by existing public transit means that the bulk of access will undoubtedly be by single-occupant auto.

  We note that, at build-out in 2050, UC is planning for a minimum of a 60% mode share for autos to this campus (6000 parking spaces anticipated, with 10,000 employees onsite anticipated). If the lab expansion were to occur in a location better served by public transit, a lower auto mode share could be anticipated and actively facilitated. As it is, the location will contribute to the generation of a significant number of VMTs in the region, with the resulting emissions. Running shuttles and providing bike facilities may ameliorate somewhat the transit-inaccessibility of the location, but a job center at this isolated location will have a significant challenge to achieve mode splits comparable with locations that are adjacent to existing, high capacity and frequent transit services.

BART 40TH ANNIVERSARY

www.bart.gov

Specific Comments

Shuttle bus services

- There is currently an hourly shuttle bus from Berkeley to RFS from approximately 730am-6pm. The NOP notes that an additional shuttle will be provided to El Cerrito Plaza BART with the project for access to AC Transit and BART. We suggest that UC consider running the new shuttle to El Cerrito del Norte Station instead of El Cerrito Plaza. At El Cerrito del Norte Station, in addition to BART and AC Transit, the shuttles could connect directly with buses operated by three additional agencies - WestCAT, Golden Gate Transit and Vallejo (SolTrans) buses. This would be much more convenient for any employees at RFS commuting from the north or west by bus, and would offer employees more transit options with fewer transfers, and would save paying an additional fare to connect between El Cerrito del Norte and El Cerrito Plaza. El Cerrito del Norte Station is also actually closer to RFS than El Cerrito Plaza is - 2.1 miles versus 2.9 miles, so the travel time would be shorter, and UC could potentially offer more frequent service with the same number of vehicles due to the faster cycle times.
- The new shuttle should start as part of Phase 1 of the project.
- The NOP notes that 10,000 employees will be onsite by 2050 (up from 300 today). The frequencies and span of service will likely have to increase dramatically on the shuttles by then to handle additional riders. As part of this EIR, UC will need to estimate future ridership demand and the frequencies needed to serve that demand. UC should meet with both BART and AC Transit to look at El Cerrito del Norte Station and/or El Cerrito Plaza Station and work out with the two agencies where the shuttles would stop and how the riders would be handled at the station. Any layover needs at the station should also be described.

Transit services

- The EIR should estimate future ridership demand generated by the project on all existing and future transit services (BART, AC Transit, and other regional and local carriers), and assess if there are any capacity issues created by the additional riders.
- The EIR should assess how walk access to the closest AC Transit route to the site could be improved. The 74-line serves a location approximately 1/4 mile away, at Regatta and Marina Bay Parkway.
- The Metropolitan Transportation Commission (MTC) published the *San Francisco Bay Area Regional Rail Plan* (2007) that identified a long-term concept for a Diesel Multiple Unit (DMU)-light rail overlay transit service on, or adjacent to, the existing Union Pacific/Capitol Corridor rail alignment. This alignment is directly across I-580 from the RFS site. BART is preparing a conceptual look at potential long-term improvements in this corridor, which is also known as the Eastshore Corridor, or wBART. Capacity improvements would need to be made to the Union Pacific alignment in order to implement the project. Station sites have not been picked and no planning, design or environmental work has been done on this corridor yet, but a station in the vicinity of the RFS would be a logical station location for the local service, given the number of jobs at the site. If this project were to move forward, it would require a new pedestrian bridge across I-580 for access to the RFS site.

Bikes

- The EIR should analyze the need to improve bicycle access to the site, including a robust and safe bicycle connection to and from BART. The path will need to get past two freeways to access the site.
- The project should include onsite facilities for bike riders such as showers and locker rooms, and secure bike parking.

- BART supports the suggestion for intra-campus bike sharing on the campus, similar to the Lawrence Livermore National Labs.
- BART supports the suggestion to offer transit discounts, guaranteed ride home services, car sharing services, and other Transportation System Management (TSM) /Transportation Demand Management (TDM) measures for employees at the site.

Transportation Demand Management

- Consistent with the mission of the Lawrence Berkeley National Labs, the EIR should consider a robust Transportation System Management (TSM) and Transportation Demand Management (TDM) program to reduce auto emissions. The program should incentivize and prioritize the use of sustainable transportation options, such as public transit. Onsite parking should be paid parking for employees and visitors, as part of a comprehensive TSM/TDM program. This would allow UC to offer a parking cash-out for employees who use transit or bike to work.

Sea-Level Adaptation

- The EIR should consider how the site and critical infrastructure can adapt and respond to sea-level / bay rise and storm surges.

Thank you for the opportunity to comment on this NOP. Please call Duncan Watry in BART Planning at (510) 287-4840 if you have any questions, or to arrange any meetings with BART or site visits during the EIR process.

Sincerely,

Val Menotti
Planning Department Manager

cc: Nathan Landau, AC Transit
Doug Johnson, MTC
Bob Franklin, BART Customer Access
Duncan Watry, BART Planning

Making San Francisco Bay Better

University of California
Lawrence Berkeley National Laboratory
FEB 04 2013
Facilities Capital Projects

February 4, 2013

Jeff Philliber
University of California
One Cyclotron Road, MS 76-225
Berkeley, CA 94720

SUBJECT: Notice of Preparation for the Richmond Bay Campus 2013 Long Range Development Plan and Phase 1 Development (SCH No. 2013012007)

Dear Mr. Philliber:

We have received a copy of the Notice of Preparation for the Richmond Bay Campus 2013 Long Range Development Plan and Phase 1 Development, dated January 3, 2013, and prepared pursuant to the California Environmental Quality Act (CEQA). The document describes a proposed new research campus at properties located at 1301 South 46th Street in the South Shoreline area of the City of Richmond, Contra Costa County.

The San Francisco Bay Conservation and Development Commission ("Commission" or "BCDC") staff reviews such documents on behalf of its Commission to assess, among other things, the project's consistency with the McAteer-Petris Act, the Commission's *San Francisco Bay Plan*, the Commission's federally-approved management plan for the San Francisco Bay, and the federal Coastal Zone Management Act (CZMA), and the project's relationship to the Commission's jurisdiction.

At this site, the Commission has permit jurisdiction over all tidal areas of the Bay up to the mean high tide line or to the inland edge of wetland vegetation in marshlands up to five feet above Mean Sea Level; all areas formerly subject to tidal action that have been filled since September 17, 1965; and a 100-foot shoreline band extending 100 feet inland from and parallel to the Bay jurisdiction.

Commission permits are required for placing and grading fill, construction, dredging, dredged material disposal, and substantial changes in use within its jurisdiction. Permits are issued when the Commission finds proposed activities to be consistent with its laws and policies. In addition to any needed permits under its state authority, federal actions, permits, and grants affecting the coastal zone are subject to review by the Commission, pursuant to the federal CZMA, for their consistency with the Commission's federally-approved management program for the Bay.

From reviewing the subject document, it appears that the proposed project would be located partially within the Commission's jurisdiction and, thus, would require

authorization via a Commission permit. Please visit our website at www.bcdc.ca.gov for the relevant laws and policies that should be considered when evaluating your project under CEQA. It is likely that a primary issue for the Commission in reviewing this project will be an evaluation of the public access to and along the shoreline of the Bay provided as part of the project. The Commission's law and policies require that proposed development provide the maximum feasible public access consistent with the project. Furthermore, public access should be sited, designed, managed and maintained to avoid significant adverse effects to wildlife as well as to be designed to be able to adapt or be resilient to sea level rise and shoreline flooding. Please feel free to contact us at your earliest convenience to discuss the type of approval necessary for the proposed project, the process for obtaining Commission authorization, and whether, as proposed, the project would be consistent with the Commission's laws and policies.

If you have any questions, please contact me at the Commission's office at 415-352-3668 or elliek@bcdc.ca.gov.

Sincerely,

Ellie Knecht
Coastal Analyst

EK

University of California
Lawrence Berkeley National Laboratory
FEB 04 2013
Facilities Capital Projects

February 4, 2013

Comments on Notice of Preparation of Draft Environmental Impact Report for LBNL proposed Richmond Bay Campus

Mr. Philliber,

We (Golden Gate Audubon Society) are writing with regard to the Notice of Preparation (NOP) for the Draft Environmental Impact Report (DEIR) on LBNL's second campus (the Campus).

Our organization's mission includes helping to preserve and improve the habitat and populations of Bay Area birds and other wildlife. Several aspects of LBNL's proposed Richmond development are therefore of concern to us.

We note that the NOP mentions the California Clapper Rail, a federally listed endangered species, which has bred recently in the marsh adjacent to the project. The NOP also mentions a portion of coastal prairie that is present on the development site. We will be especially interested in how thoroughly the DEIR assesses impacts or potential impacts to these resources.

In addition to impacts to the natural environment, we have an organizational interest in the aesthetic values of the site. The Bay Trail and its tributary walking paths adjacent to the Campus are often visited by birders, and we have docent programs that use these areas to teach people about birds and wildlife. The Bay Trail between Point Isabel and the Marina Bay development is one of the few nearby bay-front areas that is not heavily developed, and LBNL's new buildings may have a significant aesthetic impact if they are not carefully designed and integrated into the landscape.

Below we list development issues that are of special concern to our organization, as well as suggestions for mitigation:

1. Lighting. Outdoor lighting disturbs bird and wildlife sleep cycles; it also allows predators (including cats and raccoons) to hunt at night. Outdoor lighting should be avoided as much as possible; when it cannot be avoided all of the light should be directed downwards by "full cut-off" light fixtures, and fixtures should be as low to the ground as possible.
2. Raptor perches. Light poles, utility poles, some types of building roofs, and certain types of trees provide attractive perches for hawks and owls. These birds, though a natural and indeed desirable part of the ecosystem in many areas, would not naturally be common in a shoreline marsh due to lack of perching spots. Having such species in abundance along the shoreline is undesirable because they prey upon ground-nesting birds such as Clapper Rail, so potential perches should not be used. When light poles and other perches are necessary they should be designed so as to discourage perching birds, and they should be as far from marsh and shoreline areas as possible.

3. Human presence. Human presence disturbs many types of birds and wildlife, with some types more impacted than others. Human-tolerant species such as crows, ravens, opossum, and raccoon are thereby promoted relative to other species. To the extent possible, human presence should be restricted near sensitive areas such as marshland. For example, in the context of the site it would be desirable to have employees use the existing Bay Trail for recreation rather than to create an additional walking path on the LBNL property adjacent to the marsh.
4. Trash, especially edible trash. Edible trash attracts predators such as cats, raccoons, and ravens that prey on other species. Cafeteria trash control is important, and all trash cans should be scavenger-safe.
5. Noise. Construction noise and operating noises (including ventilation fans and fume hood fans) should be reduced as far as possible, and should be shielded from natural areas.
6. Bird strike. We understand that LBNL is already committed to using "bird-safe building" standards to reduce deaths due to collisions with windows. We encourage this mitigation and others to reduce the risk to birds.

We intend to participate attentively in the EIR process and look forward to reviewing the DEIR.

Sincerely,
Phillip Price
Chair, Golden Gate Audubon Society East Bay Conservation Committee

Subject: RBC 2013 LRDP EIR
From: Mary Selva <maryspond@sbcglobal.net>
Date: 2/4/2013 4:51 PM
To: LRDP-EIR@lbl.gov

University of California
Lawrence Berkeley National Laboratory
FEB 04 2013
Facilities Capital Projects

February 4, 2013

Jeff Philliber

Environmental Planner
Lawrence Berkeley National Laboratory
One Cyclotron Road, MS 76-225
Berkeley, CA 94720

RE RBC 2013 LRDP EIR

Dear Mr. Philliber:

The Richmond Annex Neighborhood Council is submitting comments to above titled project:

Climate Change and Sea Level Rise
The LBNL must analyze what will happen to their project area and adjacent to the South Shoreline area with regards to sea level rise. The LBNL should take a very conservative approach and by that we mean the LBNL should not assume that sea level rise will be the lowest that is projected, but should assume higher sea level rise figures in order to ensure that it properly analyzes the impact of sea level rise on any LBNL proposed development. Included in any such analysis must be impact of sea level rise on LBNL's toxic nature of substances found on the site. Any impact or inundation from sea level rise, the amount, if any, of any leakage of the toxics from the site due to sea level rise, and the impacts of such leakage on the Bay and the flora and fauna of the Bay.

The LBNL must also analyze whether if it approves development of that site, sea level rise will require later construction of levees or dikes to protect that development from sea level rise inundation. Again, the LBNL must use the most conservative numbers for sea level rise, i..e., the highest level that is reasonably projected and not some rosy figure that currently floats around. The reasonably projected highest number the Sierra Club has seen is around 2 meters or over 6 feet over the course of the next 100 years. The EIR for the general plan must take this potential rise into account.

Second, the LBNL must analyze the impact of any development on the adjacent wetlands. We know that large developments close to wetlands can have a devastating impact on wetland wildlife due to human intrusion, domestic pet intrusion, and the intrusion from vermin creatures such as rats that are attracted to any human development. The entire area of the shoreline of Richmond must be analyzed for these impacts from any proposed development.
Third, impacts to birds and other wildlife from lighting must be analyzed. We know that night time lighting from development near wetlands and other protected habitat can have a secondary impact on wildlife by enabling nocturnal predators to better hunt and capture prey. These impacts must be analyzed.

Fourth, the LBNL must analyze the impact to birds smashing into buildings. This impact has long been ignored, but more and more we are now realizing that many birds are unable to distinguish the glass of a building from the environment around them and fly into buildings and die. These impacts must also be analyzed.

Fifth, the LBNL should provide setbacks from the shoreline of at least 500 feet from the mean high tide mark for any development in order to ensure the full protection of wetland flora and fauna from any development impacts.

Sixth, the LBNL should provide for setbacks from creeks of at least 500 feet on each bank of a creek to protect the creek habitat and flora and fauna from any impacts from development.

Liquefaction

A magnitude 6.7 earthquake has a 99.7% chance of striking somewhere in California over the next 30 years.
In San Francisco, the probability is 63%; in Los Angeles it's 67%.
In the Bay Area, the biggest threat is the Hayward Fault and its northern extension, the Rodgers Creek Fault. The probability went from 27% in 2003 to 31% in 2008.
The probability of a 7.5 earthquake in California is 15% in the north and 37% in the south.

Threat to Shoreline and LBNL Project— A team of geologists at the USGS in Menlo Park found that much of the East Bay fill would turn into soup if a 1906-sized quake were to reoccur today. Much of the East Bay shoreline is made up of the worst possible kind of artificial fill—loose sandy soil primarily dredged from the Bay. Treasure Island and the East Bay are the fill capitals of the Bay Area. It's estimated that a magnitude 6.6 quake or greater on the Hayward fault, which runs along the East Bay hills from San Pablo to Fremont, could subject more than half of the fill land to liquefaction. But it is the San Andreas fault, 10-15 miles away on the San Francisco peninsula that poses the greatest threat to the East Bay filled land. This is because that fault is capable of much larger earthquakes, such as the magnitude 7.8 quake of 1906, than the Hayward fault.
The U.S. Geological Survey findings basically guarantee a large earthquake is going to happen.
The Hayward fault is in close proximity to the Richmond South Shoreline area—approximately 3 miles away. The Hayward fault runs along the Arlington and through the Mira Vista Golf Course in the El Cerrito Hills.

Synthetic Biology

Special Guests:
Ø Jeff Conant, Global Justice Ecology Project (www.globaljusticeecology.org);
Ø M. L. Tina Stevens, PH.D., Alliance for Humane Biotechnology (www.humanebiotech.com);
Ø Gopal Dayaneni, Movement Generation Justice & Ecology Project (www.movementgeneration.org) **. . .**
gave informative presentation on Synthetic Biology, Health, Justice, and Communities at Risk. The LBNL 2nd campus on Richmond's South Shoreline will be the world's largest synthetic biology lab. It will be made up of three different divisions, including the Joint BioEnergy Institute (JBEI), a Department of Energy lab working on development of fuels from plant crops. Research at the new facility would focus heavily on creating genetically modified organisms, with the labs to be brought onto the new campus focusing in three related areas: "Genomics, Life Sciences, and Physical Biosciences." In addition to the Emeryville-based JBEI, other projects to be relocated on the new site include the Joint Genome Institute, currently located in Walnut Creek, the National Energy Research Scientific Computing Center in downtown Oakland and "much of the Life Sciences Division in West Berkeley." Nanotechnology, the study of manipulating matter on an atomic and molecular scale, may also be built on the site. The following are some of the issues discussed and major concerns**:**
-4 according to the risks of harm they pose, with levels of increasing danger. BL1 labs perform research on non-human infectious agents; BL2 labs use biological agents that could infect humans, but are assumed to cause only "moderate harm," BL3 labs experiment with bio-agents capable of killing humans, which there are known antidotes; BL4 labs conduct research using agents that could kill humans for which there are no known antidotes.
Ø Bio-releases can spread through the air.
Ø Synthetic Biology and Nanotechnology are not properly regulated and lack adequate oversight, transparency or protections.
Ø One of the facilities did not report leak—eventually the employees did. 3 employees were infected with deadly virus.
Ø Involves a lot of people in many fields not familiar with bio-safety.
Ø LBNL – Environmental reviews are historically limited.
Ø Cal Osha requirements under Chemical Hazards Regulations are lacking biological hazards regulations.
Ø The City of Berkeley's Planning Commission and Design Review Board are exempt from reviewing the Lawrence Berkeley National Laboratory (LBNL) main campus, which is located at Strawberry Canyon. The LBNL is also exempt from Berkeley's Zoning Ordinance—Development Standards (height, setbacks, parking requirements, etc.). Likewise, the City of Richmond's Planning Commission and Design Review Board and Richmond City Council are exempt from reviewing and approving the architectural and project plans of any LBNL development in Richmond. Because it's a **"National"** Lab, it is only required to follow the National Environmental Policy Act (NEPA), which is outdated and does not include regulations for Synthetic Biology or Nanotechnology. Revisions to NEPA are done by the federal government and must get approved by Congress, which hasn't happened yet.

Other organizations involved in the movement for **responsible** synthetic biology and nanotechnology are**:**
Ø Council for Responsible Genetics (www.councilforresponsiblegenetics.org - **see Worker Safety in Biological**

Laboratories—Limitations of Osha Regulations Governing Bio-Laboratory Safety);
Ø Friends of the Earth, Center for Ecological Agriculture (www.foe.org - **see The Principles for the Oversight of Synthetic Biology**);
Ø Center for Environmental Health;
Ø Center for Food Safety, ETC Group;
Ø Injured Workers national Network;
Ø International Center for Technology Assessment;
Ø California Coalition for Workers Memorial Day;
Ø ETC Group, Global Justice Ecology Project;
Ø West County Toxic Coalition in Richmond, CA
Note: www.synbiowatch.org should include all of the above organizations regarding efforts to get regulation in place for synthetic biology and nanotechnology. The "wait and see" approach is increasingly becoming a dangerous way to determine the risks. Potential hazards to humans are inhalation, ingestion, absorption through the skin, and airborne particulates. Hazards to fish and wildlife are through contaminated creeks, soil, and potential leaks into the bay.

Wetlands and Marshlands Impacts

The Meeker Slough Wetland area and the restoration of both East and West Stege Marsh will be affected or impacted by development of the LBNL. Currently, this area is quiet solitude and has very little human activity. It is much further north than the Pt. Isabel area and people rarely go down there and know to keep out of these sensitive areas. This is where the California Clapper Rail lives and other wild habitat.

LBNL development and urban growth will account for significant historical losses of wetlands.

Degradation of wetlands is less obvious than outright loss, and can occur as a direct or indirect consequence of many human activities and dramatically increased human foot traffic as a result of the LBNL project. Large LBNL developments, for example, can result in wetlands degradation by increasing the volume of runoff and the amount of pollutants that the runoff carries. Hydrologic disruptions, such as the diversion of surface water or the withdrawal of groundwater, are major causes of wetlands degradation in urban areas.

Losing Ground: The sad irony in all this is that our human activities would create the environmental need for more wetland resources even if they did not damage or destroy our existing wetlands. Our roads, houses, commercial buildings, parking lots – essentially all of our development – cause some disruption in the functioning of our watersheds.

The hard surfaces prevent water from infiltrating into the soil, **and one result is more faster runoff**. If there were more rather than fewer wetlands to handle these consequences of our development, we might be able to maintain the original hydrologic balance. As it is, we not only create the need for more of the environmental functions of wetlands, **we also destroy or damage the resources that provide those functions.**

Other Important Issues that the RBC 2013 LRDP EIR must address:

Traffic Impacts

Infrastructure—Sewer, water, new roads, etc.

Grand Size of the Overall LBNL Project—The building plans proposed for the Lawrence Berkeley Lab on the South Richmond Shoreline have been changed. The new plan more than doubles the density of their building project, from 2-million sqft (square feet) floor area worth of buildings for 5,000 employees **to 5.4-million sqft floor area worth of buildings for 10,000 employees**. The original proposal of 2-million sf ft was considered massive. But 5.4-million sf ft would be considered overdeveloped and create major impacts.

Thank you for opportunity to submit comments,

Mary Selva, President

Richmond Annex Neighborhood Council

University of California
Lawrence Berkeley National Laboratory
FEB 04 2013
Facilities Capital Projects

Comments on: 30 JANUARY 2013

NOTICE OF PREPARATION
DRAFT ENVIRONMENTAL IMPACT REPORT

This title is subsequently referred to as 'EIR'. Are not the Draft Environmental Impact Report and the Final Environmental Impact Report separate documents? It is difficult to follow the sequence of documents that will be forthcoming when 2013 LRDP and Final LRDP EIR are mentioned in the same sentence, without explanation. Is this a NOP or a DEIR or a LRDP... is it an EIR for a LRDP? Please be consistant. Also helpful would be a graph or time-table that explains when new documents will be issued.

You could add a section explaining CEQA, NEPA, EIRs, NOP, LRDP and so forth. People newly affected by the Universitys' plans need to know what is being planned, in order to respond to your documents and at your meetings. Also, please explain the difference between a "Program" and a "Project". there are important differences that will affect people, but the words are often used interchangeably in every day speech. Be clear about this. "Tiering" is also very important to understand. It can come as a shock to find out that a benevolent-sounding Long Range Development Plan can be tiered off into a totally unexpected result.

How many of these Notice of Preparation documents were circulated among the concerned public? Giving copies to the Agencies such as PG and E, EBMUD and others just requires that an administrator says "Yes, we can provide that service".

An Initial Study was prepared because of CEQA requirements, and even a legal reporter was present, but the question remains: did that satisfy the concerns of the community, or did it merely satisfy the legal requirements. How many affected entities figured out when and where the meeting was to be held (no address given, just Civic Center Plaza) and attended, and gained anything from their time. Posters, with a goal of informing the public, were surrounded by paid employees before the meeting, and inaccessible. At the beginning of the speakers, all posters were removed. Why was that?

Section 1.0 says "the University proposes to rename the properties as the "Richmond Bay Campus". Renaming from what? the former name is not mentioned. Spell out the former name in full, with some history, so that people will know what you're talking about. the name "Richmond Field Station" is mentioned in footnote #3 on page 5 but you should be clear and open about things, and not play hide-and-seek with your readers.

POTENIAL EFFECTS, page 18.
The report contains a helpful section with sub-sections. this is nicely arranged with the Question in white color, and the Answer on light gray, with a line to separate the topics. This easy-to-read plan falls apart later, for example e) on page 20, c) on page 22, a) on page 24 and it continues to deteriorate all the way to the end. Let's fix this.

Copies of all subsequent documents for this project should be more widely distributed. Certainly copies should be readily available at Marina Bay residential neighborhood.

LAND USE.

Even though the Richmond Bay Campus is somewhat isolated from neighbors, going from a million square feet of building space to 5 million square feet seems extreme, especially when one considers the height of the buildings with their extra-high ceilings. A vague term like "iconic buildings" does little to inform the public what might be planned.

Your report needs to examine the possibility of putting 100 foot-tall buildings on marshy or filled land. In order to not sink into the bay mud, substantial footings will need to be provided, raising the cost of construction. Since this will likely fall to tax-payers, costs cannot be ignored. Please provide a detailed engineering report on building foundations, and costs.

LBNL seems to have gone from earthquake-prone sites on the hills, complete with landslide problems etc., to a site on the Bay with encroaching water problems. Much more attention needs to be paid to this in your forthcoming documents. Also worrysome is the fact that U.C. plans to add so much fill to raise the area above the tides, storms, sea-level rise and so forth. It is surprising to read about U.C.s plans for parking, water-efficient landscaping and other projects which really don't affect us all, that much, while giving so little attention to quite important issues such as toxics, building heights, earth-fill, water table and so forth. It would be a good plan to add a map or diagram to show the height above mean sea level of this property. Calling part of the Field Station "up-lands" does not give readers a clear picture of what is involved.

Legacy Pollutants.
How does the University propose to deal with the pollutants currenty on the property? Will "clean-up" involve disturbing the soil and releasing toxics into the air? Will toxics be transported on the public roads, and taken to some other locale and deposited there? Please give details about this, and also whether, like at the Lab's Hill Site, pollutants will be generated anew. This is probably the most worrisome part of U.C.'s plans, as research nowadays involves unknown particles and combinations and inventions.
The Precautionary Principal should be observed very rigorously. Unfortunately it seems clear that a competition is on between scientific organizations to carry out their science, and to publish and develop their innovations before the next group, to gain market-edge. Much more important than that is to proceed safely and cautiously. Some science projects are going to turn out to be detrimental in the long run. History proves that.

As a side issue, is U.C. worried at all about the legacy pollution at the Stauffer-Zeneca site? That would certainly enter into the ground water, and if it too was 'cleaned-up' how would that affect R.B.C.

TREES and LANDSCAPING:
In general, trees are natural and they help to regulate the earth eco-systems. Try to keep as many mature trees as possible. In the case of the Marina Bay residential area, a substantial tree-screen is necessary. A child tossing a ball in his backyard could easily land the ball in the R.B.C.- it is that close. The housing is already established in Marina Bay. Please be respectful of that.

To end these comments on a positive note, I should say thank you for sending me a paper copy of the document. I would also like to receive paper copies of other documents to come, that the public needs to comment upon.

Your colored maps are nice, I might add.

the list of acronyms and abbreviations is helpful. (though some are missing, for example C.F.R., D.O.E, N.R.L.F., R.A.O., R.F.S.)

Barbara Robben
1964 El Dorado
Berkeley CA 94707
510-524-2383

University of California
Lawrence Berkeley National Laboratory
FEB 04 2013
Facilities Capital Projects

Subject: re: EIR for Richmond LBNL campus
From: Margot Cunningham <cunningham.margot@gmail.com>
Date: 2/4/2013 3:19 PM
To: LRDP-EIR@lbl.gov

Please consider the following comments regarding biological resources in the EIR for the Richmond campus of Lawrence Berkeley Nat'l. Laboratory.

1)The Richmond Field Station contains remnant native coastal prairie grasslands. This habitat exists in very few places today and should be preserved in its entirety.

2) Another remnant field exists at the entrance to the current RFS at Meade St. and S. 46th St. Remnant populations of California poppies (*Eschscholzia californica)*, a perennial, and rancheria clover (*Trifolium albopurpureum*), an annual, grow in the grassy area along the west side of Mead St at the entrance. The rancheria clover also grows along the eastern boundary of the RFS up to the railroad crossing along the western side of Meade. These flowers should be preserved in any landscaping plans for this area. Seed can also be collected from them and used in landscaping projects throughout the new lab construction.

Thank you,
Margot Cunningham
1727 Santa Clara St
Richmond, CA 94804

California Native Plant Society
East Bay Chapter P O Box 5597, Elmwood Station, Berkeley, CA 94705

February 4, 2013

University of California
Lawrence Berkeley National Laboratory
FEB 04 2013
Facilities Capital Projects

Jeff Philliber
Environmental Planner
Lawrence Berkeley National Laboratory
One Cyclotron Road, MS 76-225
Berkeley, CA 94720

RE: Notice of Preparation for Richmond Bay Campus 2013 Long Range Development Plan and Phase 1 Development Environmental Impact Report

Dear Mr. Philliber:

The California Native Plant Society's East Bay Chapter (EBCNPS) appreciates the opportunity to comment on the *Notice of Preparation for Richmond Bay Campus 2013 Long Range Development Plan and Phase 1 Development Environmental Impact Report.*

The California Native Plant Society (CNPS) is a statewide non-profit organization that works to protect California's native plant heritage and preserve it for future generations. The Society's mission is to increase the understanding and appreciation of California's native plants and to preserve them in their natural habitat. We promote native plant appreciation, research, education, and conservation through our 5 statewide programs and 33 regional chapters in California. The East Bay Chapter covers Alameda and Contra Costa Counties and represents some 1100 members.

Pursuant to the mission of protecting California's native plant species and habitats, CNPS submits the following comments and recommendations for the NOP and General Plan/EIR:

General Considerations:

In 2010, the East Bay Chapter of CNPS published a Guidebook to the Botanical Priority Protection Areas of the East Bay. These fifteen protection areas (BPPAs) have been selected as those areas within Alameda and Contra Costa Counties that contain high value botanical resources that should be protected. The guidebook was created with the expert advice of many professional botanists to aid city and county planners in locating important native plant species and communities. The proposed project at the Richmond Field Station falls within the "Richmond Shoreline" BPPA and is thus of major concern to EBCNPS. The Richmond Field Station is recognized by CNPS for priority protection because it contains what is believed to be the last undisturbed native coastal prairie grassland adjacent to the San Francisco Bay Shoreline. This native grassland is an intact remnant stand that functions as a reference assemblage - invaluable for the study of how this threatened ecosystem functions and as an example of its community type for restoration ecologists. Today, less than one percent of California's original native grassland ecosystems remain intact.

Due to the rarity of this native plant community, EBCNPS recommends complete avoidance of the native coastal prairie grassland at the project site. It is critical that areas of native prairie be avoided during any/all construction projects. These “projects” include using the native prairie as a "construction materials staging area", as a "drive on / drive through" area, as an area where accidental spilling or spraying of harmful materials could occur, or where any other access which would create soil compaction, and/or killing of characteristic plant species could occur. Figure 2 of the NOP shows a proposed soccer field abutting the northwest edge of the known coastal prairie. Please note that building a sports field (regardless of whether it contains natural or artificial turf) will likely result in significant impacts to the coastal prairie adjacent to it, both in potential damage during construction and as a result of runoff/irrigation after completion. Any constructed area needs to be adequately set back from areas of native prairie so as to ensure the continued viability of this rare plant community during construction and after the Lab is completed.

Since the proposed environmental review process will involve completion of both a program and project level EIR, the EIR must explicitly state that it is only analyzing the initial phase of the Long Range Development Plan and that further project EIRs need to be prepared for later development phases. Also, since the proposed campus is a joint project of both a State and Federal agency, the University of California and Lawrence Berkeley National Laboratory must analyze the project and alternatives in a Joint EIS/EIR process and comply with NEPA.

Specific Comments:

Need for Thorough Botanical Surveys of Project Site

In order to ensure that the areas of native grassland are properly considered and planned around, updated botanical surveys need to be completed. The most recent botanical surveys of the Richmond Field Station were completed in 2007 by URS. While the results of these surveys will no doubt be a helpful starting point, they can not substitute for updated surveys completed over several years. ECNPS requests that plant population densities and distributions at the site be surveyed for and compiled as part of this effort. Complete botanical surveys for the entire project site need to be carried out as part of the EIR for Phase 1 of this project and to inform the Long Range Development Plan. These surveys will help create a contemporary environmental baseline. Such an environmental baseline for plant species would be accomplished through well timed botanical surveys at the appropriate time of year for several consecutive years. A reference list of target species, including their population densities and distributions across the site, that are known to occur or have the potential to occur on site will allow future land managers at the site to ensure the native grassland in not being harmed as a result of the development and ongoing activities at the proposed new lab site.

Transition Zone Between Construction and Building Areas and Coastal Prairie

It is imperative that any plans for building location and design near areas of native coastal prairie grassland include transition zones between, but outside the areas that are to be

preserved for their natural resource value and areas that are to be developed. These zones will help minimize the potential for unforeseen impacts to the prairie such as the transportation of invasive species and will help create a buffer between project landscaping and the natural environment.

Weed Management Plan

Besides the construction and ongoing use of the proposed buildings at the site, the main threat to the native grasslands is the invasion and potential site conversion of the native grasslands by invasive grasses and other invasive weedy species. Hardinggrass (*Phalaris aquatica*) is already invading areas of coastal prairie at the site, and the EIR for this project needs to specify a weed management plan to ensure this imminent threat to the native grassland is prevented. Furthermore, such a plan would help mitigate the potential for construction and building activities to spread weeds around the site including into the areas of native grassland. Such a plan must be accompanied by an endowment in perpetuity to ensure the grassland remains free from weed invasion and other damage associated with this project.

Surface drainage

A "Draft Concept Plan" rendering from October 2012 showed the cement drainage on the Western side of the Field Station as being "restored" to a meandering creek at surface level. EBCNPS has since heard from project planners that the drawing was purely conceptual and that there are currently no plans to create a waterway on the project site. However, if such an action is considered, it is critical that the construction of a natural-style waterway not affect the intact coastal prairie which could be irreparably harmed by creek construction activities and increased ground water supply. The present roadway, Regatta Blvd, parallels the canal immediately adjacent to the west. If the canal is restored to a more natural meandering state, locating it there, away from any sensitive natural resources could be a solution that EBCNPS would support.

Landscaping Considerations

Section 4.5.6 of the NOP reads:

4.5.6 Landscape

The RBC would support bio-diversity and habitat conservation through the use of native plant materials wherever possible. In addition, the RBC would utilize low-impact development design techniques and Bay-Friendly landscape design (see www.stopwaste.org) and make storm water management a site feature. As described below, natural open spaces would also be maintained.

EBCNPS recommends that local-endemic ecotypes be used wherever native plant material is called for in the landscape design of this project. Such local ecotypes are best suited for this particular location and they will prevent contaminating the gene-pool of other native plants on the site. In the case that non-native ornamental plants are used in the landscape design, we recommend the plants be non-invasive and drought tolerant. Any irrigation for landscaped areas on the site must be planned so as to avoid impacts to the native coastal prairie and any other rare plant resources at the site.

We look forward to continuing to follow this project and commenting in the future. If you have any questions, please contact me at conservation@ebcnps.org .

Sincerely,

Mack Casterman
Conservation Analyst
California Native Plant Society, East Bay Chapter

Citizens for East Shore Parks

Mail: PO Box 6087, Albany, Ca 94706 Office: 520 El Cerrito Plaza, El Cerrito CA 94530
Ph: 510. 524.5000 Fax: 510.524.5008 eastshorepark@hotmail.com www.eastshorepark.org

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Patricia V. Jones

February 4, 2013

University of California
Lawrence Berkeley National Laboratory
FEB 04 2013
Facilities Capital Projects

Jeff Philliber
Environmental Planner
Lawrence Berkeley National Laboratory
One Cyclotron Road, MS 76-225
Berkeley, CA 94720 ***via email: LRDP-EIR@lbl.gov***

Re: Richmond Bay Campus 2013 Long Range Development Plan & Phase 1 Development, Richmond Bay Campus, NOP

Dear Mr. Philliber:

Citizens for East Shore Parks (CESP) is an environmental non-profit organization that was instrumental in creating McLaughlin Eastshore State Park which is on the west side of the Second Campus project. Because this property is adjacent to what little is left of our undeveloped San Francisco Bay shoreline, it is important that you strive to see that this project sets a high standard as a public and natural resource for generations to come. While past generations thought nothing of trashing our Bay and shoreline, we now know that we can do better. We look forward to a project that respects the Park and the shoreline in terms of habitat conservation, public access and community health.

Our supporting organizations have already submitted thoughtful comments on this project, so we ask that you give those letters careful consideration as you move forward. The letters we support include:

- TRAC, January 13, 2013
- TRAC January 28, 2013
- Sierra Club, January 30, 2013
- California Native Plant Society, East Bay Chapter, February 4, 2013

We urge you to work with the environmental community to address the various issues pointed out in the above comments. In particular, we would like to highlight the following areas of concern which are explained in more detail in the above letters and should be addressed in the EIR:

- Three spheres of potential impacts (Sierra Club)
- Addressing toxic contamination (Sierra Club)
- Impacts on wetlands, birds, fauna, creek (Sierra Club)
- Impacts of sea level rise (Sierra Club)

- Protection and restoration of the "last undisturbed native coastal prairie grassland adjacent to the San Francisco Bay Shoreline... Today, less than one percent of California's original native grassland ecosystems remain intact." (CNPS)
- To conduct a complete study of the impacts of your project requires: thorough botanical surveys of project site; alternatives for transition zone between development and coastal prairie; weed management plan. (CNPS)
- Conduct meaningful alternatives to protect the coastal prairie (Sierra Club)
- Recreational impacts, such as: "...evaluate and mitigate for impacts on shoreline parks, as well as recreational and transportation usage of the Bay Trail between Central Avenue and Garrard Blvd., including growth-inducing and cumulative effects." (TRAC)
- Transportation, trail and air quality impacts: the project should make non-vehicular connectivity improvements to, from and through the facility; address how the project will implement the recommendations of Richmond's General Plan 2030 and Bicycle Master Plan and Pedestrian Plan. (TRAC)

In addition, CESP shares the concern raised in TRAC's January 28, 2013 letter which quotes the scoping document Section 10.b that "the project is not subject to local land use planning jurisdiction because it is located on land owned by the University." Further, CESP echoes the Sierra Club's call for a joint EIR/EIS process and to comply with NEPA.

CESP looks for this project to be a welcome addition to Richmond and the surrounding community. CESP hopes that our comments will be helpful and lead to a respectful project with reduced negative impacts and increased public support.

Sincerely,

Patricia V. Jones

Patricia Vaughan Jones
Executive Director

CC: CESP Board, Sierra Club, CNPS, TRAC, RANC, RSSA CAG, GGAS
Mayor Gayle McLaughlin, Richmond City Council, Richard Miller & Lina Velasco, Armando Viramontes

EAST BAY BICYCLE COALITION

Working for safe, convenient and enjoyable bicycling for all people in the East Bay

University of California
Lawrence Berkeley National Laboratory
JAN 29 2013
Facilities Capital Projects

January 29, 2013

Jeff Philliber
Environmental Planner
Lawrence Berkeley National Laboratory
One Cyclotron Road MS 76-225
Berkeley CA 94720

To Whom it May Concern:

The East Bay Bicycle Coalition has reviewed your Notice of Preparation of Environmental Impact Report for the Richmond Bay Campus 2013 Long Range Development Plan and Phase 1 Development Project. Thank you for keeping us on your mailing list. We want to first acknowledge the comment letters submitted by our partner organizations TRAC and the Association of Bay Area Governments and incorporate by reference their comments and concerns herein.

We provide the following comments to help direct your environmental review:

1. Please ensure that your EIR team reviews the new Richmond Bicycle Master Plan, the Bay Trail Plan and the Contra Costa Countywide Bicycle Plan for conformance of your project to these plans. We are particularly concerned about ensuring safe, comfortable and inviting bike access to and from the new campus for people of all ages and bicycling abilities. The new campus should be a model for the world to follow in terms of encouraging its staff and visitors to bicycle to the facility;
2. The Bay Area and the State of California have a goal of reducing greenhouse gases to 1990 levels by 2020. Since vehicle emissions contribute anywhere from 30%-40% of the greenhouse gases in the Bay Area, it is imperative that the new Richmond Bay Campus reduce its vehicle miles traveled per capita as much as possible. The Metropolitan Transportation Commission and the Contra Costa Transportation Authority are already realizing that in order to achieve the GHG reduction targets of AB 32, the Bay Area is going to have to make a significant shift from single occupant driving to public transit, walking and bicycling. Given the remote location of the new Richmond Bay Campus from transit, bicycling is going to play an even greater role. We look forward to your team developing a plan and strategies that reduce GHG's as a result of transportation to and from the new campus;
3. To the extent there are vehicle trips to and from the campus, we specifically request that your team closely study the *safety impacts* to people bicycling from these additional vehicle trips. Specifically, we want to know more about how bicyclists of all ages and abilities will safely navigate the roadways and intersections around the campus given the future vehicle trips

added. This is our most important concern. We want to know how the East Bay is going to encourage more people to bicycle to the new campus, and to bicycle more in general, if there are going to be added vehicle trips due to this project. You should take a close look at turning movement conflicts at major intersections around the campus, how bicyclists will safety make left turns into and out of roadways on key bike routes, what are the transitions like from pathways to roadways, and what level of awareness, slow traffic speeds and courtesy can be expected of roadway users of the new transportation network of the campus and the immediately adjacent roadway network of the type will promote more bicycling;

4. Access to and from the Bay Trail should be maximized, including providing lighting of main pathways at night so that bike commuters can make commute trips after work and during the limited daylight hours of Winter. Good directional signage to and from the campus for bike commuters is also needed;

5. Bike access from BART, AC Transit Rapid Bus Service, and future ferry service should also be world class, in terms of safety, design, inviting nature, and low-stress bikeway designs that will encourage a significant mode shift from driving to bicycling. No potential employee, staff member, faculty member or visitor should have the excuse of not bicycling to the campus because a nearby roadway is too dangerous and unviting;

We look forward to this project setting an example for the world to follow when it comes to eliminating the need for any employees, staff and visitors to regularly drive to the new campus.

Thank you for your consideration of these important concerns about bike safety and the promotion of bicycling in the East Bay.

Cordially yours,

Program Director
East Bay Bicycle Coalition

Subject: EIR Scoping Comments from East Bay Bicycle Coalition
From: Dave Campbell <dave@ebbc.org>
Date: 1/29/2013 3:54 PM
To: LRDP-EIR@lbl.gov
CC: TRAC <tracbaytrail@earthlink.net>, alan_wolken@ci.richmond.ca.us

Jeff,

Attached as a pdf is the comment letter from the East Bay Bicycle Coalition on the Notice of Preparation of Environmental Impact Report for the Richmond Bay Campus 2013 Long Range Development Plan and Phase 1 Development Project. Thank you in advance for taking these comments and concerns into account in your environmental work for this important project. Please let me know if you have any questions about our comments and we will look forward to the start of the environmental process and subsequently to a walkable, bikeable and transit-friendly new Richmond Research Facility.

Dave Campbell
Program Director
East Bay Bicycle Coalition
email: dave@ebbc.org
office: 510.845.7433
cell: 510.701.5971

Bikeway innovation comes back to the East Bay in 2013, as several cities are planning new types of bikeways that are innovative and designed to significantly improve your bike commute by making it much safer, more comfortable and much more attractive to new riders. You can help bring this modern bikeway network to the East Bay by supporting our work. Join the EBBC at www.ebbc.org/join

Attachments:

EBBCcomments_RichmondLBNL.pdf 82.4 KB

EAST BAY
MUNICIPAL UTILITY DISTRICT

University of California
Lawrence Berkeley National Laboratory

FEB 04 2013

Facilities Capital Projects

February 4, 2013

Jeff Philliber, Environmental Planner
Lawrence Berkeley National Laboratory
One Cyclotron Road, MS 76-225
Berkeley, CA 94720

Re: Notice of Preparation of a Draft Environmental Impact Report for the Richmond Bay Campus 2013 Long Range Development Plan and Phase 1 Development, Richmond

Dear Mr. Philliber:

East Bay Municipal Utility District (EBMUD) appreciates the opportunity to comment on the Notice of Preparation of a Draft Environmental Impact Report (EIR) for the Richmond Bay Campus (RBC) 2013 Long Range Development Plan (LRDP) and Phase 1 Development Project (Project) located in the City of Richmond that will serve the University of California (UC) and the Lawrence Berkeley National Laboratory (LBNL). EBMUD has the following comments.

WATER SERVICE

Pursuant to Section 15155 of the California Environmental Quality Act Guidelines, and Section 10910-10915 of the California Water Code, a Water Supply Assessment (WSA) will be required for the project. The project sponsor should submit a written request to EBMUD to prepare a WSA for all planned development within the entire RBC site. Preparation of the WSA will require EBMUD contacting the project sponsor to gather data and estimates of future water demands for the project area. Please be aware that the WSA can take up to 90 days to complete from the day the request was received.

EBMUD's Central Pressure Zone with a service elevation between 0 and 100 feet serves the existing LRDP project site. Main extensions, at the project sponsor's expense, will be required to serve the Phase 1 Development and may be required to serve future development phases. In addition, off-site pipeline improvements, also at the project sponsor's expense, may be required to meet domestic demands and fire flow requirements set by the local fire department. Off-site pipeline improvements include, but are not limited to, replacement of existing water mains to the project site. When the development plans are finalized, the project sponsor should contact EBMUD's New Business Office and request a water service estimate to determine costs and conditions for providing water service to the proposed development. Engineering and installation of water mains and services requires substantial lead-time, which should be provided for in the project sponsor's development schedule.

The project sponsor should be aware that EBMUD will not inspect, install or maintain pipeline in contaminated soil or groundwater (if groundwater is present at any time during the year at the depth piping is to be installed) that must be handled as a hazardous waste or that may pose a health and safety risk to construction or maintenance personnel wearing Level D personal protective equipment. Nor will EBMUD install piping in areas where groundwater contaminant concentrations exceed specified limits for discharge to sanitary sewer systems or sewage treatment plants. Project sponsors for EBMUD services requiring excavation in contaminated areas must submit copies of existing information regarding soil and groundwater quality within or adjacent to the project boundary.

In addition, the project sponsor must provide a legally sufficient, complete and specific written remedial plan establishing the methodology, planning and design of all necessary systems for the removal, treatment, and disposal of all identified contaminated soil and/or groundwater. EBMUD will not design the installation of pipelines until such time as soil and groundwater quality data and remediation plans are received and reviewed and will not install pipelines until remediation has been carried out and documentation of the effectiveness of the remediation has been received and reviewed. If no soil or groundwater quality data exists or the information supplied by the project sponsor is insufficient, EBMUD may require the project sponsor to perform sampling and analysis to characterize the soil being excavated and groundwater that may be encountered during excavation or perform such sampling and analysis itself at the project sponsor's expense.

WATER RECYCLING

EBMUD's Policy 9.05 requires that customers use non-potable water, including recycled water, for non-domestic purposes when it is of adequate quality and quantity, available at reasonable cost, not detrimental to public health and not injurious to plant, fish and wildlife to offset demand on EBMUD's limited potable water supply.

The size and nature of the proposed development along with the thousands of people that will be employed within the RBC present several opportunities for the use of recycled water for landscape irrigation, commercial and industrial process uses, toilet and urinal flushing in non-residential buildings and other applications. EBMUD's current recycled water transmission pipeline terminates approximately 3 miles from the project site at the intersection of Buchanan Street and Highway 580 in the City of Albany. As part of the long-term water supply planning, EBMUD may investigate expanding the existing recycled water infrastructure or constructing a localized satellite facility that utilizes onsite waste and rain water treatment to provide recycled water to the RBC site. Other sources of local waste water delivery and related treatment could also become available to serve future development. EBMUD recommends that the UC and LBNL as well as their developers maintain continued coordination and consultation with EBMUD as they plan and implement the various projects as they get identified within the LRDP, regarding the feasibility of providing recycled water for appropriate non-potable uses.

WATER CONSERVATION

The proposed project presents present opportunities to incorporate water conservation measures. EBMUD would request that LBNL include requirements for the project to incorporate WaterSmart technology and design standards in the landscape and building design. At a minimum the landscape design should be designed to a water budget as described in the California Model Water Efficient Landscape Ordinance (Division 2, Title 23, California Code of Regulations, Chapter 2.7, Sections 490 through 495). Provisions should be established to monitor the water budget for compliance after project completion. EBMUD reviews applications for new standard water services and applications for expanded service for compliance with EBMUD Water Service Regulation Section 31, Water Efficiency Requirements. Section 31 requirements identify specifications for toilets, urinals, showerheads, lavatory and kitchen faucets, cooling towers, commercial refrigeration, outdoor landscaping and irrigation.

EBMUD recommends that LBNL coordinate the development of this project closely with EBMUD to incorporate the most water efficient appliances and fixtures practical, even if not specifically noted in Section 31. Note that some of EBMUD's Section 31 requirements exceed the Uniform Plumbing Code requirements. EBMUD staff would appreciate the opportunity to meet with applicant's staff. A key objective of this discussion will be to explore timely opportunities to expand water conservation via early consideration of EBMUD's conservation programs and best management practices applicable to the project.

If you have any questions concerning this response, please contact David J. Rehnstrom, Senior Civil Engineer, Water Service Planning at (510) 287-1365.

Sincerely,

William R. Kirkpatrick
Manager of Water Distribution Planning

WRK:AMW:sb
sb13_021.doc

Subject: NoP Richmond Bay Campus Public Comment
From: Peter Rauch <peterar@berkeley.edu>
Date: 2/4/2013 6:09 PM
To: lrdp-eir@lbl.gov

University of California
Lawrence Berkeley National Laboratory
FEB 04 2013
Facilities Capital Projects

Jeff Philliber
Environmental Planner
Lawrence Berkeley National Laboratory
One Cyclotron Road, MS 76-225
Berkeley, CA 94720

RE: Notice of Preparation for Richmond Bay Campus 2013 Long Range Development Plan and Phase 1 Development Environmental Impact Report

Dear Mr. Philliber:

I would like to bring attention to three features shown in the NoP for the LBNL Richmond Bay Campus plan.

1. The basketball court that intrudes upon the coastal prairie site. This recreation feature should be sited elsewhere, where it will not consume space of, nor cause impacts to, the coastal prairie.

2. The section of coastal prairie --still with remnant characteristic native prairie species-- which runs parallel and adjacent to the concrete/channelized drainage creek, should be included as part of the coastal prairie conservation site, and not be designated as a planted/tree-populated alternative open space. The coastal prairie habitat at the Richmond Field Station is a very small remnant, deserving of the utmost respect for what it is, with no requirement or need to transform it into a different, non-native "mall-like" cultural element of the Plan, as shown in the figure attached to the NoP.

3. The channelized creek paralleling Regatta Blvd --a road which the Plan indicates will be removed and apparently planted to a landscaped open space-- should be elevated to ground surface level, put into a meander, and spread out over the existing canal and boulevard (not, as had been depicted in one earlier rendering, on top of the also-adjacent coastal prairie). This treatment would create a biological filter for the channel waters flowing in large part from urban runoff directly into the Bay; and, it would present an opportunity to provide for a typical Bayside ecological habitat of willows and other native vegetation. The recreational value provided by bird-watching, the educational value derived from exemplary water quality treatment, and the sound- and view-scapes all promote a more friendly, welcoming campus surrounding, and complement the coastal prairie setting as well.

Peter Rauch
105 Ardmore Road
Kensington, CA
510-526-8155

Subject: Comments on Richmond Bay Campus draft EIR
From: Marla Miyashiro <pido.editor@gmail.com>
Date: 2/4/2013 2:05 PM
To: LRDP-EIR@lbl.gov
CC: pido.editor@gmail.com

University of California
Lawrence Berkeley National Laboratory
FEB 04 2013
Facilities Capital Projects

Jeff Philliber
Environmental Planner
Lawrence Berkeley National Laboratory
One Cyclotron Road, MS 76-225
Berkeley, CA 94720
LRDP-EIR@lbl.gov

Feb. 4, 2013

Dear Mr. Philliber,

I am the vice chair of Point Isabel Dog Owners (PIDO), a nonprofit group that has been working to keep Point Isabel Regional Shoreline clean and off-leash since 1985. We have approximately 5,000 members.

My group would like to submit a few comments regarding UC's draft environmental impact report on the Richmond Bay Campus 2013 Long Range Development Plan and Phase 1 development. The RBC site lies a short distance north of Point Isabel Regional Shoreline. Point Isabel is heavily used; the East Bay Regional Park District has estimated that the park is visited by more than 1 million people per year.

Major issues that we think should be addressed:

The prevention of, and planned response to, any possible release of pollutants and biohazards into the environment in the event of a disaster such as an earthquake, fire, or flood.

The impact of development on the nearby marshes and wildlife. Many visitors to Point Isabel also walk along the adjacent Bay Trail. Concerns include adverse effects from windblown litter as well as lighting and noise that can disturb wildlife.

Thank you for taking the time to consider our comments.

Sincerely,

Marla Miyashiro
Vice Chair
Point Isabel Dog Owners
P.O. Box 8282
Berkeley, CA 94707
pido.editor@gmail.com

Subject: Comments on the Richmond Bay Campus 2013 Long Range Development Plan and Phase One
From: Loulena Miles <loulena@gmail.com>
Date: 2/4/2013 2:49 PM
To: LRDP-EIR@lbl.gov
CC: cdchas@att.net, "johnny12@comcast.net" <johnny12@comcast.net>

University of California
Lawrence Berkeley National Laboratory
FEB 04 2013
Facilities Capital Projects

Richmond Residents for Responsible Development

February 4, 2013

Jeff Philliber

Environmental Planner

Lawrence Berkeley National Laboratory

One Cyclotron Road, MS 76-225

Berkeley, CA 94720

LRDP-EIR@lbl.gov

The University of California (UC) proposes to establish a new major research campus at properties it owns in Richmond, California, for consolidation of biosciences programs of the Lawrence Berkeley National Laboratory (LBNL) and for development of additional research related facilities for both LBNL and UC Berkeley. This campus would jointly serve UC LBNL and UC Berkeley. The proposed 2013 Long Range Development Plan (LRDP) for the Richmond Bay Campus (RBC) would guide campus development through 2050.

On behalf of Richmond Residents for Responsible Land Use, we are writing to express concerns about the proposed RBC complex. We are local residents living in the City of Richmond that are concerned about the health, safety and environmental impacts of the proposed project. We are neighbors that are proud of our City's resolution to make all decisions guided by the precautionary principle. We care deeply about promoting sustainable growth to improve the economic and social outlook for the City while ensuring that we do

not jeopardize our future with dangerous or poorly planned projects. We have several serious concerns that need to be addressed in the Environmental Impact Report, including:

The EIR must adequately consider sea-level rise

The 2013-2050 Long Range Development Plan (LRDP) names the Joint Genome Institute (JGI), the Advanced Biofuels Process Demonstration Unit (ABPDU), and the Systems Biology Knowledgebase (Kbase) as facilities that comprise Phase I Development at the Richmond Bay Campus (RBC) complex. The LRDP proposes earthworks that raise the height of the RBC complex from 10 feet above sea level (asl) to 15 feet asl. News reports and climate models indicate that sea level rises of greater than 5 feet are expected in the coming decades and century; the proposed earthworks are therefore inadequate and the RBC complex needs to be at least 20 feet asl.[1]

Given these considerations, the EIR needs to analyze the individual and cumulative impacts of raising the height of the RBC complex to 20 feet asl, 25 feet asl, and 30 feet asl on communities (residents and workers) and the environment (air, water, soil and land) in Richmond, in the San Francisco Bay Area, and within a 200-mile radius of the RBC complex.

The EIR must carefully consider toxic, radioactive and bio-hazardous releases

Much of the research that will take place at the RBC will be on a suite of emerging technologies referred to as synthetic biology. Given that synthetic biology's objective is to engineer novel life forms and products with the potential to interact with human biology and other cellular processes, this research poses unforeseen dangers (both from accidental and deliberate uses). The rapidly developing nature of this laboratory research and its applications are largely beyond the existing regulatory framework of standard rDNA research and biotechnology generally.

An accidental release of engineered organisms could result in extreme and unmanageable risks to the health of workers, the environment and the neighboring community. Therefore, the EIR needs to analyze the individual and cumulative impacts of the following scenarios on communities (residents and workers) and the environment (air, water, soil, and land) in Richmond, in the San Francisco Bay Area, and within a 200-mile radius of the RBC complex:

- Release of biological materials from named and potential facilities at the RBC complex – especially engineered organisms and/or their embedded genetic material from the ABPDU and the JGI;

- Release of chemicals (including nanomaterials) from named and potential facilities at the RBC complex;

- Containment failures of named and potential facilities at the ABPDU and the entire RBC complex.

The EIR should also disclose and study the accidental or intentional release of nuclear materials. The EIR should contain a description of the type and reason for radionuclides at the site and the EIR should provide the building quantity limits for these materials. Further, the EIR should explain why the Initial Study anticipates potential airborne radionuclide releases. The EIR should also provide the type and quantity of potential toxic airborne contaminants.

Releases and failures may be a direct result of incidents – accidental, deliberate, or otherwise – at the RBC complex, or an indirect result of incidents at other research and development laboratories (public and private) and companies in Richmond. For example, given the fire that occurred at the Richmond Chevron Refinery complex in August, 2012, the EIR should pay particular attention to the impacts of fires and subsequent releases of biological, chemical and other materials. Moreover, the EIR should study the pathways and potential consequences for insiders to intentionally remove dangerous materials from the facilities.

The EIR must consider the Institutional Biosafety Committee

The Project operations will require the establishment of an institutional committee created under the National Institute of Health Guidelines to review research involving recombinant DNA and other biohazardous research. The Institutional Biosafety Committee (IBC) is one body that ensures that the operation of the Project does not result in dangerous environmental impacts and are therefore should be considered in the environmental review of the Project. The EIR should specify that the IBC meetings will be open to the public to the greatest extent possible and that meeting times and minutes be available on a publically available designated webpage. We request that the IBC's public member be appointed with input from the City Council and local residents (at a City Council meeting) to ensure transparency and accountability.

The EIR must adequately study the traffic impact

The approximately 133-acre RBC site is located at 1301 South 46th Street in the South Shoreline area of the City of Richmond, approximately 5 miles northwest of the UC Berkeley campus. Development of Phase I would add approximately 1,000 to the average daily population (adp) of the site, increasing the adp from 300 to 1,300. The University expects the campus population to increase incrementally over time as the RBC is developed over the approximately 40-year horizon of the 2013 LRDP, from approximately 300 persons in 2012 to approximately 10,000 persons in 2050. The Initial Study projects that 6,000 vehicle parking spaces will be needed in the long term. This number of added vehicles on the 580 and 80 corridors would cripple these already clogged major arteries key to the economic viability of the region. The draft EIR must propose additional transit options including a system of low emission high occupancy buses that would transport persons from major metropolitan areas. Both Google and Genentech have similar systems of buses in the Bay Area. Their systems should be studied as models for this project. Bus networks should be studied as a way to facilitate reduction of traffic on major highways and to reduce pollution.

The EIR should discuss fiscal impact

Finally, the RBC needs to analyze the fiscal impacts of construction, operation and maintenance (including insurance) of the RBC complex on residents of Richmond, Alameda County, and the State of California. What are the financial costs of the project? What funding mechanisms will be used (taxation, bonds issued by the State, bonds issued by the University of California, and so on)?

The Project should be governed by the Precautionary Principle

On May 17, 2011, the City Council of the City of Richmond passed Resolution No. 38-11, declaring that the City of Richmond adopted the precautionary principle as a policy to which it will adhere. This Resolution requires the City to undertake careful analysis of available alternatives and strongly encourages the selection of the alternative product or action, including no action, that presents the least threat to human health, the natural environment and overall quality of life; and requires democratic transparent and public engagement in the decision making process. We request that the EIR consider and describe how the Project will adhere to the precautionary principle to inform decisions during construction and operation.

Thank you.

On behalf of Richmond Residents for Responsible Development

/s/ 2/4/2012

_____ _____

Loulena Miles Date

/s/ 2/4/2012

_____ _____

Trudy Chastain Date

/s/ 2/4/2012

_____ _____

Chuck Chastain Date

/s/ 2/4/2012

_____ _____

John Chastain Date

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[1] http://www.planning.org/planning/2012/jan/waterwarriorsside2.htm

http://www.eenews.net/public/climatewire/2012/12/20/1

http://www.eenews.net/public/climatewire/2012/09/10/1

http://www.sfgate.com/bayarea/place/article/Rising-seas-shift-bay-agency-s-mission-4227915.php

http://dels.nas.edu/resources/static-assets/materials-based-on-reports/reports-in-brief/sea-level-rise-brief-final.pdf

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Serving Alameda, Contra Costa, Marin and San Francisco Counties

University of California
Lawrence Berkeley National Laboratory
FEB 04 2013
Facilities Capital Projects

REPLY TO: 802 Balra Drive
El Cerrito, CA 94530

January 30, 2013

Jeff Philliber
Environmental Planner
Lawrence Berkeley National Laboratory
One Cyclotron Road, MS 76-225
Berkeley, CA 94720

Re: Richmond Bay Campus 2013 Long Range Development Plan & Phase 1 Development
Richmond Bay Campus, NOP

Dear Mr. Philliber:

The Sierra Club makes the following comments regarding the NOP for the Richmond Bay Campus EIR.

General Concerns in Regard to Three Spheres of Potential Impact

The EIR needs to address these three "spheres" of potential general negative and positive impacts: A. the proposed site itself; B. its surrounding community; and, C. the entire East Bay region.

A. The Specific Site and its Immediate Borders

We expect that LBNL will play a positive conservation role in both avoiding degradation of existing natural resources and improving and expanding them.

To these ends, LBNL's Development plan needs to analyze alternatives that:

A1. Do not require unacceptable or unmitigated degradation

of existing site habitat and natural resources.

A2. Minimize negative impacts upon abutting natural areas and wildlife habitats from both buildings and potential increased human access.

A3. Integrate newly-built natural or park-like areas into the overall site design, with special attention to fragile wetlands.

A4. Include a credible plan to eliminate any remaining toxic hazards.

A5. Feature buildings that do not dominate or overwhelm their immediate surroundings in such respects as: height, massing/FAR, facing materials, night illumination, view corridors, noise, etc.

A6. Conform to emerging "bird safe" design standards.

A7. Conform to local zoning and approved local land-use policies to the maximum degree feasible.

A8. Accommodate the potential impact of future sea-level rise.

B. The Surrounding Community

The second campus cannot be an isolated island but rather must be part of an urban community and an existing community. That community can benefit both as the recipient of new LBNL amenities and as the provider of nearby housing and services to LBNL employees—a potential mutual win.

To these ends, LBNL's Development plan should analyze those alternatives that:

B1. Implement, with the active help of the host city or cities, SB375's preferred "complete communities" approach to fostering livable and walkable neighborhoods nearby.

B2. Analyze and plan so as to minimize local housing and commuting impacts resulting from the expected concentration of employment.

B3. Provide access to and help create a range of nearby retail and service businesses emphasizing "daily needs" of both workers and residents.

B4. Provide access to an existing or committed network of safe bicycle and pedestrian routes linking the site and the community.

B5. Increase local-community access to natural/park areas and to recreational opportunities.

B6. Provide shuttle or other shared-transportation to nearby transit hubs and retail zones.

C. The Regional Environment

While we could elaborate upon multiple potential regional environmental impacts from a second LBNL campus, one is so predominant that we will mention it alone: The impact on greenhouse gases, transit and traffic from concentrating more than 1000 employees in a single location. SB375 and all the local Climate Action Plans agree that minimizing work-related vehicle miles traveled (VMT) is the single most important means of meeting our GHG-reduction goals.

To these ends, LBNL's Development plan should analyze those alternatives that:

C1. Have carefully analyzed the host city's Climate Action Plan and respect it in their design.

C2. Minimize total VMT generated by inter-campus travel, especially by private automobile.

C3. Minimize total VMT generated by worker commuting in private vehicles, especially via solo driving along freeway corridors.

C4. Provide significant access to both regional and local transit as well as contribute to general improvements in local and regional transit infrastructure to offset any increase in VMT due to the second campus.

C5. Recommend affirmative ideas and effective programs to generate dense worker housing near new LBNL jobs, and ensure that the host city or cities have an adequately supportive certified Housing Element in their general plans.

C6. Have the potential to support meaningful LBNL "traffic demand management" programs such as car share and vanpooling.

C7. Reduce the predominance of free employee parking by under-sizing parking facilities compared to traditional office-park standards.

C8. Avoid the collateral construction of "attractor" shopping malls or similar developments that encourage more regional VMT.

Increasing the Bottom-up Engagement

Most of the potential host cities have a long history of citizen engagement in local planning and development issues, and most have received ballot approval for existing environmental policies and land-use plans. We hope that these vigorous local commitments will prove to be one of the starting-points for your deliberations, and not just receive a "communications opportunity" at the end of the road. Front-loading meaningful citizen participation will make the rest of the process go much more smoothly.

Transparency

An inclusive and transparent process for a large development like the LBNL second campus can build public understanding and support for a project and maintain that support for the long-term. Therefore, LBNL needs to make sure its process is fully transparent.

The Richmond Field Station Site:

For 20 years the Sierra club has been involved with issues related to the south Richmond shoreline area and worked to protect habitat and open space. The Richmond Field Station includes a large area of coastal prairie that is one of the last remaining expanses of such prairie in the Bay Area.

This prairie habitat must be protected. Therefore, LBNL, the University, and any private developer need to agree to relocate buildings and landscaping to ensure that this coastal prairie is protected and preserved to a standard acceptable to CESP, the Sierra Club, and the California Native Plant Society (CNPS). Those organizations must be third party beneficiaries to any development agreement and thus retain the right to enforce any agreement as to the preservation, restoration, enhancement, and protection of the coastal prairie. Working with the environmental community can ensure the preservation of the coastal prairie habitat as an important asset for the site, one which would be extremely beneficial to LBNL.

Agreement to Comply with Local Zoning and Measures Governing Land Use

The following elements need to be in a development agreement with the host city:

1. LBNL/UC will agree to comply with the Climate Action Plans that all of the potential host cities have separately been implementing; and incorporating

the goals and policies of California programs intended to reduce greenhouse gas contributions and encourage "complete communities," as part of SB375 and AB32.

2. LBNL/UC will agree to pay the equivalent of all property and parcel taxes on any private parcels that it should take ownership of or purchase the stock or controlling interest in any company that owns those parcels at the same values and rates as a private landowner.

3. LBNL/UC will agree to be bound by any local ordinances that require votes of the people for any changes to zoning or other reasons as if they were a private property owner.

4. LBNL/UC will agree to comply with all local zoning ordinances as if it were a private property owner for any future development of the site should it desire to initiate any changes to the zoning for the site that is selected.

Sea Level Rise

The NOP does not appear to adequately address the issues of sea level rise. While the NOP discusses adding 10 feet of soil to 12 acres, it does not address the longer range impacts of sea level rise as they relate to the Long Range Development Plan. Nor does it appear that the NOP will address the impacts that adding 10 feet of soil to 12 acres will have in regard to visual impacts, storm water run-off, impacts on the coastal prairie, traffic, to name a few.

Most particularly, the NOP does not address the impact of sea level rise on the potential release and spread of contaminants that are known to exist at the Richmond Field Station site.

Toxic Contamination

The NOP does not address the issue of the impact of sea level rise on the areas of known to contain hazardous and toxic materials. Inundation of contaminated lands will mean that water will cover areas that contain toxics. The EIR must address the ability of caps and seals to withstand complete and continued inundation due to sea level rise, the amount, if any, of any seepage or discharge of the toxics from the site due to sea level rise, and the impacts of such seepage on the Bay and the flora and fauna of the Bay.

Creek Restoration

UC/LBL should analyze the creation of a meandering creek which is now in the concrete channel and how it can provide for setbacks from creeks of at least 200 feet on each bank of a creek to protect the creek habitat and flora and fauna from any impacts from development.

Protection of Flora and Fauna

The EIR should provide for a transition zone between the protected zone and development in order to ensure full protection of habitat.

Compliance with the City, County, and Regional Land Use Laws and Regulations

Sierra Club maintains that UC and LBNL must comply with all local and regional land use laws and regulations. If UC/LBNL maintains that it does not have to comply, then it must include an analysis of the preferred project assuming it did comply in order for the decision maker and public to understand the significant adverse environmental impacts that result from such non-compliance and the mitigation measures that will be necessary to avoid those adverse impacts.

Limits to the EIR

The EIR should also make it explicit that it is only analyzing the initial phase of the Long Range Development Plana and that full Project EIRs need to be and will be prepared for later phases of development.

Alternatives

The proposed alternatives are not adequate for analyzing the impacts from the project and whether they can or cannot be mitigated. The reduced growth alternative is not adequately described and more than one reduced growth alternative should be included in the EIR. Similarly, the alternate Development program is not adequately described. Moreover, purpose of the off-site alternative is unclear. This alternative is not realistic because it will not be carried out and the proposed site is too distant from the Richmond Field to be useful and meaningful as an alternative. Indeed, the fact that UC and LBNL did not select the Alameda site makes it an infeasible alternative.

Meaningful alternatives would address issues of coastal prairie preservation and maximizing protection of the existing open space and also analyze the impacts of major

population increase to Richmond and the surrounding communities that will have to deal with the impacts of any development of the size and scale that is proposed for the Richmond Field Station site.

Joint EIS

The proposed second campus is a joint project of both a State and Federal agency. Therefore, the UC/LBNL must analyze the project and alternatives in a Joint EIS/EIR process and comply with NEPA.

Sincerely yours,

Norman La Force

Norman La Force, Chair
West County Group and
Chair Chapter Legal Committee

SPRAWLDEF

Sustainability, Parks, Recycling
And Wildlife Legal Defense Fund

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University of California
Lawrence Berkeley National Laboratory
FEB 04 2013
Facilities Capital Projects

January 30, 2013

Jeff Philliber

Environmental Planner

Lawrence Berkeley National Laboratory

One Cyclotron Road, MS 76-225

Berkeley, CA 94720

Re: Richmond Bay Campus 2013 Long Range Development Plan &

Phase 1 Development

Richmond Bay Campus, NOP

Dear Mr. Philliber:

SPRAWLDEF makes the following comments regarding the NOP for the Richmond Bay Campus EIR.

General Concerns in Regard to Three Spheres of Potential Impact

The EIR needs to address these three "spheres" of potential general negative and positive impacts: A. the proposed site itself; B. its surrounding community; and, C. the entire East Bay region.

A. The Specific Site and its Immediate Borders

We expect that LBNL will play a positive conservation role in both avoiding degradation of existing natural resources and improving and expanding them.

To these ends, LBNL's Development plan needs to analyze alternatives that:

A1. Do not require unacceptable or unmitigated degradation of existing site habitat and natural resources.

A2. Minimize negative impacts upon abutting natural areas and wildlife habitats from both buildings and potential increased human access.

A3. Integrate newly-built natural or park-like areas into the overall site design, with special attention to fragile wetlands.

A4. Include a credible plan to eliminate any remaining toxic hazards.

A5. Feature buildings that do not dominate or overwhelm their immediate surroundings in such respects as: height, massing/FAR, facing materials, night illumination, view corridors, noise, etc.

A6. Conform to emerging "bird safe" design standards.

A7. Conform to local zoning and approved local land-use policies to the maximum degree feasible.

A8. Accommodate the potential impact of future sea-level rise.

B. The Surrounding Community

The second campus cannot be an isolated island but rather must be part of an urban community and an existing community. That community can benefit both as the recipient of new LBNL amenities and as the provider of nearby housing and services to LBNL employees—a potential mutual win.

To these ends, LBNL's Development plan should analyze those alternatives that:

B1. Implement, with the active help of the host city or cities, SB375's preferred "complete communities" approach to fostering livable and walkable neighborhoods nearby.

B2. Analyze and plan so as to minimize local housing and commuting impacts resulting from the expected concentration of employment.

B3. Provide access to and help create a range of nearby retail and service businesses emphasizing "daily needs" of both workers and residents.

B4. Provide access to an existing or committed network of safe bicycle and pedestrian routes linking the site and the community.

B5. Increase local-community access to natural/park areas and to recreational opportunities.

B6. Provide shuttle or other shared-transportation to nearby transit hubs and retail zones.

C. The Regional Environment

While we could elaborate upon multiple potential regional environmental impacts from a second LBNL campus, one is so predominant that we will mention it alone: The impact on greenhouse gases, transit and traffic from concentrating more than 1000 employees in a single location. SB375 and all the local Climate Action Plans agree that minimizing work-related vehicle miles traveled (VMT) is the single most important means of meeting our GHG-reduction goals.

To these ends, LBNL's Development plan should analyze those alternatives that:

C1. Have carefully analyzed the host city's Climate Action Plan and respect it in their design.

C2. Minimize total VMT generated by inter-campus travel, especially by private automobile.

C3. Minimize total VMT generated by worker commuting in private vehicles, especially via solo driving along freeway corridors.

C4. Provide significant access to both regional and local transit as well as contribute to general improvements in local and regional transit infrastructure to offset any increase in VMT due to the second campus.

C5. Recommend affirmative ideas and effective programs to generate dense worker housing near new LBNL jobs, and ensure that the host city or cities have an adequately supportive certified Housing Element in their general plans.

C6. Have the potential to support meaningful LBNL "traffic demand management" programs such as car share and vanpooling.

C7. Reduce the predominance of free employee parking by under-sizing parking facilities compared to traditional office-park standards.

C8. Avoid the collateral construction of "attractor" shopping malls or similar developments that encourage more regional VMT.

Increasing the Bottom-up Engagement

Most of the potential host cities have a long history of citizen engagement in local planning and development issues, and most have received ballot approval for existing environmental policies and land-use plans. We hope that these vigorous local commitments will prove to be one of the starting-points for your deliberations, and not just receive a "communications opportunity" at the end of the road. Front-loading meaningful citizen participation will make the rest of the process go much more smoothly.

Transparency

An inclusive and transparent process for a large development like the LBNL second campus can build public understanding and support for a project and maintain that support for the long-term. Therefore, LBNL needs to make sure its process is fully transparent.

The Richmond Field Station Site:

SPRAWLDEF has been involved with issues related to the Richmond shoreline area and

worked to protect habitat and open space. It successfully sued the City of Richmond, the proposed developer of the Indian Casino and the tribe over that project. The Richmond Field Station includes a large area of coastal prairie that is one of the last remaining expanses of such prairie in the Bay Area.

This prairie habitat must be protected. Therefore, LBNL, the University, and any private developer need to agree to relocate buildings and landscaping to ensure that this coastal prairie is protected and preserved to a standard acceptable to CESP, the Sierra Club, and the California Native Plant Society (CNPS). Those organizations must be third party beneficiaries to any development agreement and thus retain the right to enforce any agreement as to the preservation, restoration, enhancement, and protection of the coastal prairie. Working with the environmental community can ensure the preservation of the coastal prairie habitat as an important asset for the site, one which would be extremely beneficial to LBNL.

Agreement to Comply with Local Zoning and Measures Governing Land Use

The following elements need to be in a development agreement with the host city:

1. UC/LBNL will agree to comply with the Climate Action Plans that all of the potential host cities have separately been implementing; and incorporating the goals and policies of California programs intended to reduce greenhouse gas contributions and encourage "complete communities," as part of SB375 and AB32.

2. LBNL/UC will agree to pay the equivalent of all property and parcel taxes on any private parcels that it should take ownership of or purchase the stock or controlling interest in any company that owns those parcels at the same values and rates as a private landowner.

3. LBNL/UC will agree to be bound by any local ordinances that require votes of the people for any changes to zoning or other reasons as if they were a private property owner.

4. LBNL/UCwill agree to comply with all local zoning ordinances as if it were a private property owner for any future development of the site should it desire to initiate any changes to the zoning for the site that is selected.

Sea Level Rise

The NOP does not appear to adequately address the issues of sea level rise. While the NOP discusses adding 10 feet of soil to 12 acres, it does not address the longer range impacts of sea level

rise as they relate to the Long Range Development Plan. Nor does it appear that the NOP will address the impacts that adding 10 feet of soil to 12 acres will have in regard to visual impacts, storm water run-off, impacts on the coastal prairie, traffic, to name a few.

Most particularly, the NOP does not address the impact of sea level rise on the potential release and spread of contaminants that are known to exist at the Richmond Field Station site.

Toxic Contamination

The NOP does not address the issue of the impact of sea level rise on the areas of known to contain hazardous and toxic materials. Inundation of contaminated lands will mean that water will cover areas that contain toxics. The EIR must address the ability of caps and seals to withstand complete and continued inundation due to sea level rise, the amount, if any, of any seepage or discharge of the toxics from the site due to sea level rise, and the impacts of such seepage on the Bay and the flora and fauna of the Bay.

Diking

The UC/LBL must also analyze whether the sea level rise will require later construction of levees or dikes to protect that development from sea level rise inundation. Again, the UC must use the most conservative numbers for sea level rise, i.e., the highest level that is reasonably projected and not some rosy figure that currently floats around. The reasonably projected highest number the Sierra Club has seen is around 2 meters or over 6 feet over the course of the next 100 years. The EIR for the Long Range Development Plan must take this potential rise into account.

The EIR also needs to address the potential impacts on Field Station workers of the continuing toxic contamination on the Zeneca site and how UC and LBNL propose to protect their workers from the toxic impacts from that site.

Impacts on Wetlands

The EIR must also analyze the impact of any development on the adjacent wetlands. Development close to wetlands can have a devastating impact on wetland wildlife due to human intrusion, domestic pet intrusion, and the intrusion from vermin creatures such as rats that are attracted to any human development. The entire area of the shoreline of Richmond must be analyzed for these impacts from any proposed development.

UC/LBL should provide setbacks from the shoreline of at least 500 feet from the mean high tide mark for any development in order to ensure the full protection of wetland flora and fauna from any development impacts.

Impacts on Birds

Impacts to birds and other wildlife from lighting must be analyzed. We know that night time lighting from human development near wetlands and other protected habitat can have a secondary impact on wildlife by enabling nocturnal predators to better hunt and capture prey. These impacts must be analyzed.

UC/LBL must analyze the impact to birds smashing into buildings. This impact has long been ignored, but more and more we are now realizing that many birds are unable to distinguish the glass of a building from the environment around them and fly into buildings and die. These impacts must also be analyzed

Creek Restoration

UC/LBL should analyze the creation of a meandering creek which is now in the concrete channel and how it can provide for setbacks from creeks of at least 200 feet on each bank of a creek to protect the creek habitat and flora and fauna from any impacts from development.

Protection of Flora and Fauna

The EIR should provide for a transition zone between the protected zone and development in order to ensure full protection of habitat.

Compliance with the City, County, and Regional Land Use Laws and Regulations

SPRAWLDEF maintains that UC and LBNL must comply with all local and regional land use laws and regulations. If UC/LBNL maintains that it does not have to comply, then it must include an analysis of the preferred project assuming it did comply in order for the decision maker and public to understand the significant adverse environmental impacts that result from such non-compliance and the mitigation measures that will be necessary to avoid those adverse impacts.

Limits to the EIR

The EIR should also make it explicit that it is only analyzing the initial phase of the Long Range Development Plana and that further Project EIRs need to be prepared for later phases of development. Statements to the effect that Supplemental EIRs or Tiered EIRs or other environmental reviews less than full project EIRs are insufficient.

Alternatives

The proposed alternatives are not adequate for analyzing the impacts from the project and whether they can or cannot be mitigated. The reduced growth alternative is not adequately described and more than one reduced growth alternative should be included in the EIR. Similarly,

the alternate Development program is not adequately described. Moreover, purpose of the off-site alternative is unclear. This alternative is not realistic because it will not be carried out and the proposed site is too distant from the Richmond Field to be useful and meaningful as an alternative. Indeed, the fact that UC and LBNL did not select the Alameda site makes it an infeasible alternative.

Meaningful alternatives would address issues of coastal prairie preservation and maximizing protection of the existing open space and also analyze the impacts of major population increase to Richmond and the surrounding communities that will have to deal with the impacts of any development of the size and scale that is proposed for the Richmond Field Station site.

Joint EIS

The proposed second campus is a joint project of both a State and Federal agency. Therefore, the UC/LBNL must analyze the project and alternatives in a Joint EIS/EIR process and comply with NEPA.

Sincerely yours,

Norman La Force

Norman La Force,

President & General Counsel

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FEB 01 2013
Facilities Capital Projects

February 1, 2013

Jeff Philliber
Environmental Planner
Lawrence Berkeley National Laboratory
One Cyclotron Road, MS 76-225
Berkeley, CA 94720
LRDP-EIR@lbl.gov

Dear Mr. Philliber,

We are writing to raise concerns about the proposed Richmond Bay Campus, which includes a second campus of the Lawrence Berkeley National Laboratory (LBNL) and the UC Berkeley Synthetic Biology Institute (SBI), which will conduct experimentation, research and development in the field of synthetic biology in Richmond, California.

Conspicuously absent from the proposed research lab's environmental impact report is a discussion of the synthetic biology research that will be conducted at the lab or a consideration of the unique risks that this research poses to public health, the environment, worker safety, biological resources, recreation and a host of other societal dimensions.

Synthetic biology is an extreme form of genetic engineering that is attempting to create novel, potentially self-replicating artificial life forms from synthesized DNA. The substantial risks this research poses to worker safety, public health and the environment have not been adequately addressed by federal or state regulators or appropriately studied by experts in the field of risk assessment. Proceeding with the development of these research facilities without a substantial review of the risks posed to workers and the surrounding community is irresponsible.

While some find promise in synthetic biology for manufacturing new products and helping us to better understand biological processes, this research could also result in enhanced virulence in existing hosts, heightened ability to infect a wider range of hosts, and resistance to antimicrobials, antivirals, vaccines and other treatment or containment modalities.

Laboratory accidents are relatively common in the United States and an unknown, but likely substantial, number of these accidents go unreported, as sickened or injured workers may fear reprisals for reporting problems. One example of this is the case of Becky McClain, who claimed she was fired for raising safety concerns to her employer Pfizer. McClain won $1.37 million in damages from Pfizer in a 2010 whistle-blower case.

McLain, who says she was sickened by the biotechnology materials in her lab, noted widespread safety problems. These and other accounts have prompted OSHA to promise to expand biotechnology worker protections, but such regulations have been slow to come into effect or inadequate.

Clearly regulations have not kept pace with the risks of modern biotechnology experimentation. Because synthetic biology's objective lies in engineering novel life forms and products with the potential to interact with human biology and other cellular processes, we believe this research poses dangers (both from accidental and deliberate uses) unforeseen in the regulatory framework of standard rDNA research.

Safety regulations and procedures must be created and tailored to address the novel aspects of this new science, including whistleblower protections and forums for workers to raise concerns. Additionally, the costs to any municipality of an appropriate public safety infrastructure must be identified. Until these steps are complete, expanding the use of synthetic biology in any setting is irresponsible.

Before any decisions are made on a specific site for this new lab, we believe a comprehensive, independent and transparent safety and risk analysis capable of assessing these threats must be completed. This should include an assessment of whether existing occupational safety guidelines are sufficient for research on synthetic biology and also an assessment of the appropriateness of conducting this kind of research next to an urban center, where the impact of an accident on public health and human lives can be greatly magnified. The proposed lab is located in the San Francisco metro area, one of the country's most populous urban centers, home to more than seven million people.

These assessments should include ample public participation, including stakeholder outreach, extensive consultation with nearby communities, and continuous opportunities for public comment. There should also be significant measures of independent regulatory oversight, particularly because both public and private entities will be operating at the lab. Every stage of this process must be open to and involve the public, including town hall meetings to discuss and address health and safety issues.

The Lawrence Berkeley National Laboratory and the UC Berkeley Synthetic Biology Institute must meet the burden of proof as to whether their laboratory will be safe before any community can make an informed decision about inviting it to break ground in their backyard.

Sincerely,

Wenonah Hauter
Executive Director

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February 1, 2013

CCVAR015

SCH#2013012007

Mr. Jeff Philliber
University of California
One Cyclotron Road, MS 76-225
Berkeley, CA 94720

Dear Mr. Philliber:

Richmond Bay Campus 2013 Long Range Development Plan and Phase 1 Development – Notice of Preparation (NOP)

Thank you for including the California Department of Transportation (Caltrans) in the environmental document (ED) review process for the project referenced above. We have reviewed the NOP and have the following comments to offer.

Traffic Impact Study (TIS)
One of Caltrans' ongoing responsibilities is to collaborate with local agencies to avoid, eliminate, or reduce to insignificance potential adverse impacts by local development on State highways. We recommend using the Caltrans *Guide for the Preparation of Traffic Impact Studies* (TIS Guide) for determining which scenarios and methodologies to use in the analysis. The TIS Guide is a starting point for collaboration between the lead agency and Caltrans in determining when a TIS is needed. The appropriate level of study is determined by the particulars of a project, the prevailing highway conditions, and the forecasted traffic. The TIS Guide is available at the following website address: http://dot.ca.gov/hq/tpp/offices/ocp/igr_ceqa_files/tisguide.pdf.

The TIS should include:

1. Vicinity map, regional location map, and a site plan clearly showing project access in relation to nearby State roadways. Ingress and egress for all project components should be clearly identified. The State right-of-way (ROW) should be clearly identified. The maps should also include project driveways, local roads and intersections, parking, and transit facilities.

2. Project-related trip generation, distribution, and assignment. The assumptions and methodologies used to develop this information should be detailed in the study, and should be supported with appropriate documentation.

3. Average Daily Traffic, AM and PM peak hour volumes and levels of service (LOS) on all roadways where potentially significant impacts may occur, including crossroads and controlled intersections for existing, existing plus project, 2035 cumulative, 2035 cumulative plus project, **and, particularly, 2050 (complete development) scenarios for the 2013 Long Range Development Plan**.

   Calculation of cumulative traffic volumes should consider all traffic-generating developments, both existing and future, that would affect study area roadways and intersections. The analysis should include turning traffic diagrams under project only, 2035 cumulative conditions, and 2035 cumulative plus project conditions. Furthermore, the analysis should clearly identify the project's contribution to area traffic and any degradation to existing and cumulative LOS including. Caltrans' LOS threshold, which is the transition between LOS C and D, and is explained in detail in the TIS Guide, should be applied to all State facilities.

4. Schematic illustration of traffic conditions including the project site and study area roadways, trip distribution percentages and volumes as well as intersection geometrics (i.e., lane configurations) for the scenarios described above.

5. The project site building potential as identified in the General Plan. The project's consistency with both the Circulation Element of the General Plan and the Congestion Management Agency's Congestion Management Plan should be evaluated.

6. Identification of mitigation for any roadway mainline section or intersection with insufficient capacity to maintain an acceptable LOS with the addition of project-related and/or cumulative traffic. As noted above, the project's fair share contribution, financing, scheduling, implementation responsibilities and lead agency monitoring should also be fully discussed for all proposed mitigation measures.

Caltrans is particularly concerned about traffic impacts to: (1) Interstate (I-)580; (2) the I-580/Meade/Regatta Interchange and its intersections; and (2) the I-580/Marina Bay Parkway Interchange and its intersections.

Traffic Impact Fees

Interstate 580, I-80 and State Route 123 are critical to regional and interregional traffic in the San Francisco Bay region. Interstate 580, in particular, is vital to commuting, freight, and recreational traffic and is of the most congested regional freeway facilities. The traffic generated by this proposed project, together with other projects in the vicinity, will have a significant cumulative regional impact to the already congested State Highway System. Therefore, Caltrans invites the University of California (UC) to work with the West Contra Costa Transportation Advisory Committee on the sub-regional transportation mitigation fee program to mitigate and plan for the impact of future growth on the regional transportation system.

Please identify traffic impact fees to be used for project mitigation. Development plans should require traffic impact fees based on projected traffic and/or based on associated cost estimates for

public transportation facilities necessitated by development. Scheduling and costs associated with planned improvements on the State ROW should be listed, in addition to identifying viable funding sources correlated to the pace of improvements for roadway improvements, if any.

Lead Agency
As the lead agency, UC is responsible for all project mitigation, including any needed improvements to State highways. The project's fair share contribution, financing, scheduling, implementation responsibilities and lead agency monitoring should be fully discussed for all proposed mitigation measures.

This information should also be presented in the Mitigation Monitoring and Reporting Plan of the ED. Required roadway improvements should be completed prior to issuance of the Certificate of Occupancy. Since an encroachment permit is required for work in the State ROW, and Caltrans will not issue a permit until our concerns are adequately addressed, we strongly recommend that UC work with Caltrans to ensure that our concerns are resolved during the environmental process, and in any case prior to submittal of an encroachment permit application. Further comments will be provided during the encroachment permit process; see the end of this letter for more information regarding encroachment permits.

Transportation Management Plan (TMP)
If it is determined that traffic restrictions and detours are needed on or affecting State highways, a TMP or construction TIS may be required of the developer for approval by Caltrans prior to construction. Traffic Management Plans must be prepared in accordance with Caltrans' *Manual on Uniform Traffic Control Devices.* Further information is available for download at the following web address: http://www.dot.ca.gov/hq/traffops/signtech/mutcdsupp/pdf/camutcd2012/Part6.pdf.

Please ensure that such plans are also prepared in accordance with the transportation management plan requirements of the corresponding jurisdictions. For further TMP assistance, please contact the Office of Traffic Management Plans at (510) 286-4647.

Vehicle Trip Reduction
Caltrans encourages you to locate any needed housing, jobs and neighborhood services near major mass transit centers, with connecting streets configured to facilitate walking and biking, as a means of promoting mass transit use and reducing regional vehicle miles traveled and traffic impacts on the State highways. Caltrans requests that all transit options be reviewed and considered, not just the proposed traffic shuttle connection to El Cerrito Plaza, but also to other BART stations in the vicinity (i.e., Richmond BART and El Cerrito Del Norte BART stations). The proposed shuttle to El Cerrito Plaza is not go the nearest BART station, nor is it the one with the most AC Transit and other regional connections.

We also encourage you to develop Travel Demand Management (TDM) policies to promote usage of nearby public transit lines and reduce vehicle trips on the State Highway System. These policies could include lower parking ratios, car-sharing programs, bicycle parking and showers for employees, and providing transit passes to residents and employees, among others. For information about parking ratios, see the Metropolitan Transportation Commission (MTC) report *Reforming*

Parking Policies to Support Smart Growth or visit the MTC parking webpage: http://www.mtc.ca.gov/planning/smart_growth/parking.

In addition, secondary impacts on pedestrians and bicyclists resulting from any traffic impact mitigation measures should be analyzed. The analysis should describe any pedestrian and bicycle mitigation measures and safety countermeasures that would in turn be needed as a means of maintaining and improving access to transit facilities and reducing vehicle trips and traffic impacts on State highways.

Cultural Resources
Caltrans requires that a project ED include documentation of a current archaeological record search from the Northwest Information Center of the California Historical Resources Information System if construction activities are proposed within State ROW. Current record searches must be no more than five years old. Caltrans requires the records search, and if warranted, a cultural resource study by a qualified, professional archaeologist, and evidence of Native American consultation to ensure compliance with California Environmental Quality Act (CEQA), Section 5024.5 and 5097 of the California Public Resources Code, and Volume 2 of Caltrans' Standard Environmental Reference (http://www.dot.ca.gov/ser/vol2/vol2.htm).

These requirements, including applicable mitigation, must be fulfilled before an encroachment permit can be issued for project-related work in State ROW; these requirements also apply to National Environmental Policy Act (NEPA) documents when there is a federal action on a project. Work subject to these requirements includes, but is not limited to: lane widening, channelization, auxiliary lanes, and/or modification of existing features such as slopes, drainage features, curbs, sidewalks and driveways within or adjacent to State ROW.

Hazardous Materials
All motor carriers and drivers involved in transportation of hazardous materials must comply with the requirements contained in federal and State regulations, and must apply for and obtain a hazardous materials transportation license from the California Highway Patrol (CHP). When transporting certain types of hazardous materials including inhalation hazards, safe routing and safe stopping places are required. A route map must be carried in the vehicle. More information is available on the CHP website: http://www.chp.ca.gov/publications/#hazmat.

Habitat Restoration and Management
Project level activities related to habitat restoration and management should be done in coordination with local and regional Habitat Conservation Plans and with Caltrans, where our programs share stewardship responsibilities for habitats, species and migration routes.

Sea Level Rise
The effects of sea level rise may have impacts on transportation facilities located in the project area. Executive Order (EO) S-13-08 directs State agencies planning construction projects in areas vulnerable to sea level rise to begin planning for potential impacts by considering a range of sea level rise scenarios for the years 2050 and 2100. According to the Association of Bay Area Governments (ABAG), portions of the Richmond Bay Campus may be vulnerable to sea level rise.

Please discuss in the upcoming Draft Environmental Impact Report how the project would address this potential hazard.

Higher water levels may increase erosion rates, change environmental characteristics that affect material durability, lead to increased groundwater levels and change sediment movement along shores and at estuaries and river mouths, as well as affect soil pore pressure at dikes and levees on which transportation facilities are constructed. All these factors must be addressed through geotechnical and hydrological studies conducted in coordination with Caltrans, if State ROW might be affected.

Bridges, Trestles, Culverts and Other Structures in Riparian or Tidal Environments
Some project level activities, including but not limited to earthworks, may affect riparian or tidal flow patterns upstream of bridges, trestles, culverts or other structures for which Caltrans holds responsibility. Please ensure your project level EDs include hydrological studies to determine whether such impacts will occur, and to identify appropriate mitigation measures.

Berm, Dike and Levee Maintenance, Repair, Upgrade and Removal
Activities involving demolition, reinforcement or rehabilitation of berms, dikes or levees on which transportation facilities are built or which are adjacent or near to such facilities may potentially affect those State facilities. Also, built features on top of berms, dikes and levees may contribute additional engineering considerations related to weight loading or compaction. These factors must be addressed through geotechnical and hydrological studies conducted in coordination with Caltrans at the project level.

Mitigation Reporting Guidelines
The California Environmental Quality Act requires the adoption of reporting or monitoring programs when public agencies include environmental impact mitigation as a condition of project approval. Reporting or monitoring takes place after project approval to ensure implementation of the project in accordance with mitigation adopted during the CEQA review process.

Some of the information requirements detailed in the attached Guidelines for Submitting Transportation Information from a Reporting Program include the following:

- Name, address, and telephone number of the CEQA lead agency contact responsible for mitigation reporting;

- Type of mitigation, specific location, and implementation schedule for each transportation impact mitigation measure; and

- Certification section to be signed and dated by the lead agency certifying that the mitigation measures agreed upon and identified in the checklist have been implemented, and all other reporting requirements have been adhered to, in accordance with Public Resources Code Sections 21081.6 and 21081.7.

Further information is available on the following website:
http://www.dot.ca.gov/hq/tpp/offices/ocp/igr_ceqa.html.

Transportation Permit
Project work that requires movement of oversized or excessive load vehicles on State roadways requires a transportation permit that is issued by Caltrans. To apply, a completed transportation permit application with the determined specific route(s) for the shipper to follow from origin to destination must be submitted to: Caltrans Transportation Permits Office, 1823 14th Street, Sacramento, CA 95811-7119. See the following website for more information:
http://www.dot.ca.gov/hq/traffops/permits.

Encroachment Permit
Please be advised that any work or traffic control that encroaches onto the State ROW requires an encroachment permit that is issued by Caltrans. To apply, a completed encroachment permit application, environmental documentation, and five (5) sets of plans clearly indicating State ROW must be submitted to the address below. David Salladay, District Office Chief, Office of Permits, California Department of Transportation, District 4, P.O. Box 23660, Oakland, CA 94623-0660. Traffic-related mitigation measures should be incorporated into the construction plans prior to the encroachment permit process. See the website linked below for more information:
http://www.dot.ca.gov/hq/traffops/developserv/permits.

Should you have any questions regarding this letter, please call Brian Brandert of my staff at (510) 286-5505.

Sincerely,

ERIK ALM, AICP
District Branch Chief
Local Development - Intergovernmental Review

c: Scott Morgan (State Clearinghouse)

Bicycle Trails Council of the East Bay

PO Box 9583, Berkeley, California 94709-0583
510-466-5123
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FEB 01 2013
Facilities Capital Projects

January 31, 2013

Jeff Philliber
Environmental Planner
Lawrence Berkeley National Laboratory
One Cyclotron Road MS 76-225
Berkeley CA 94720

To Whom It May Concern:

The Bicycle Trails Council of the East Bay is interested in the development effect of the Richmond Bay Campus. Our membership considers placement of the campus in old Seaport a thoughtful reclamation of an abused ecological jewel renewing access in concert with other ongoing civic efforts.

Part of our support is a recognition of the potential campus's bicycle communication with the Bay Trail. The positive health effects for people and the environment are well known, as are the special economies of parking accommodation and automobile operation. What is seldom appreciated is the ad hoc nature of extant infrastructure to support bicycles, including the support of bicycling at the terminus, in this case your campus. These aspects deserve an attention designed to support the specific needs for cyclists.

While reclaimed rail and industrial lands beside the Bay have provided a safe, beautiful communication for bicycles from Emeryville to Richmond, access to the Bay Trail is problematic. Excepting Berkeley's I-80 Bicycle/Pedestrian Bridge, access to the Trail for bicycles is an blithe relegation to rebate margins of hazardous auto routes serving I-80. South, accesses via Powell, Gilman, Buchannan, and Central, are mazes confounded by multiple on/off ramps and frontage roads. North, surfaces are challenged by industrial use. Nearby, access from the Bayview direction has incumbent cultural stresses. Each of these accesses need to appreciated for mitigation though signage, lighting, and traffic flow.

Consideration must be given to surface conditions, weather extremes, limited hours of daylight, fatigue, consequent perspiration, chill/overheating, and damp clothing, all deserve support at the terminus. Areas for showering facilities, clothes changing and the privacy associated with such behaviors, secure bike parking and cleaning, out of weather pre-/post-ride staging, storage of associated gear/clothing, deserve our best attention as they directly effect the probabilities of cycling performance. Attention to such factors will promote frequent, secure travel in a decent, humane fashion. It will foster an inviting experience delivering a variety of energized people safely to the campus, assuring their safe return home.

We welcome your participation in the cycling community and your support for these factors.

Michael Mejia

Michael Mejia , President, Bicycle Trails Council of the East Bay

EDWARD C. MOORE
ATTORNEY AT LAW[1]

2436 Ninth Street
Berkeley, California 94710

Tele: (510) 531-7272
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February 1, 2013

University of California
Lawrence Berkeley National Laboratory
FEB 01 2013
Facilities Capital Projects

Jeff Philliber
Environmental Planner
Lawrence Berkeley National Laboratory
One Cyclotron Road MS 76-225
Berkeley, California 94720

RE: Scope of CEQA/NEPA Environmental Review Pertaining to 2d LBNL Campus

Dear Mr. Philliber:

I am writing on behalf of myself as a member of the public to insist that if any aspect of the proposed second campus for Lawrence Berkeley National Laboratory (2d campus LBNL) is proposed to be sited on any part of Golden Gate Fields in Albany and/or Berkeley as an "off-site alternative" to the preferred Richmond site (see Notice of Preparation, par. 6.0, pp. 16-17), that a Section 106 inquiry within the meaning of the federal Historic Preservation Law, 16 U.S.C. § 470f be undertaken as the investigatory protocol specifies (e.g., see 36 CFR 800 et seq.) In short I contend the Waterfront in Berkeley and Albany as a unified whole is "eligible for inclusion in the National Register" because it satisfies on several independent grounds for National Criteria for listing (see 36 CFR 800.16).

Because I am a long-time public proponent of the waterfront in Berkeley and Albany as a Cultural Landscape *currently eligible* under federal criteria for listing on the National Register of Historic Places, I ask to be put on a your list of people to notify of significant events pertaining to the environmental-impact analysis and reporting regarding the proposed 2d campus for LBNL. I was assured this would be done many months ago by LBNL personnel and they dropped the ball. I only learned of your Notice of Preparation and its deadline for input through lately discovered other sources.

Thank you for your anticipated attention to my requests.

Very truly yours,

EDWARD C. MOORE

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[1]Voluntarily inactive as of March 1, 2010

DEPT. OF PLANNING AND BUILDING SERVICES

City of Richmond

University of California
Lawrence Berkeley National Laboratory
FEB 05 2013
Facilities Capital Projects

February 5, 2013

Jeff Philliber
Environmental Planner
Lawrence Berkeley National Laboratory
One Cyclotron Road, MS 76-225
Berkeley, CA 94720

VIA MAIL and EMAIL

RE: COMMENTS ON THE NOP FOR THE RICHMOND BAY CAMPUS 2013 LRDP AND PHASE 1 DEVELOPMENT

Dear Mr. Philliber:

The City of Richmond ("City") is undertaking a community planning effort to develop a Specific Plan around the proposed Richmond Bay Campus. We look forward to the University of California Berkeley's and Lawrence Berkeley National Laboratory's continued participation in this effort. Moreover, we believe that many of the comments contained in this letter will be addressed through the development of the Specific Plan to enable the Richmond Bay Campus and surrounding development to occur in a mutually beneficial and coordinated manner. A key opportunity afforded to the City during the development of the Specific Plan is to explore the feasibility of infrastructure financing districts for the Southern Gateway Area. This approach could expedite the transformation of the Richmond Bay Campus and surrounding areas.

The City appreciates the opportunity to comment on the Notice of Preparation of a Draft Environmental Impact Report (EIR) for the Richmond Bay Campus 2013 Long Range Development Plan and Phase 1 Development proposed in Richmond, CA.

The City has the following comments:

1. The EIR should identify all proposed improvements located within the City's right of way including roadways, lighting, landscaping, etc., and confirm that proposed campus infrastructure improvements can be designed to meet or exceed City standards.
2. The EIR should confirm that the project's transportation system will complement the City's Bicycle Master Plan, Pedestrian Plan and other applicable City standards.
3. On-going project construction including site demolition, remediation, and grading, will increase truck traffic on streets maintained by the City of Richmond. The EIR should evaluate the total impact of long-term construction on City streets and identify possible mitigations.
4. The proposed project could increase demand on the City's sanitary sewage collection and treatment systems. The EIR should analyze both dry weather flows and peak wet weather flows and confirm that the City's collection and treatment system has sufficient capacity to

450 Civic Center Plaza, Richmond, CA 94804-1630
Telephone: (510) 620-6706 Fax: (510) 620-6858 www.ci.richmond.ca.us

meet future demand. The EIR should evaluate the effects on City infrastructure due to the expansion of demand for public utilities such as water, natural gas, and telecommunications.

5. The City's municipal fiber network is currently located along Regatta Boulevard and Meade Street. The EIR should evaluate potential impact of the project and its construction on the network's operation.
6. If the project plans to discharge storm water runoff into the City drainage system, the EIR should determine whether the site will need to comply with State Water Resources Control Board requirements.
7. The EIR should evaluate the need for additional City fire apparatus or services required to support the Richmond Bay Campus development.
8. The Richmond Bay Campus site is the home of the University of California, Berkeley Richmond Field Station, and the grounds fall within the police service jurisdiction of the University of California Police Department. The Richmond Police Department stands ready to honor mutual aid agreements already in place between the agencies and anticipates expansion of those agreements as the campus evolves. The EIR should address the need to establish new or modify existing partnerships that promote public safety as part of the Richmond Bay Campus development that could include:
   - University of California and Richmond police joint substation or work stop on the project premises
   - Establishing a police substation in close proximity to the project site
9. The EIR should identify mitigation measures for potentially significant impacts that promote sustainability and conservation of resources such as the use of alternative energy systems, water conservation and recycling, complete streets, natural ventilation and other methods that take full advantage of the local climate, transportation network, and recreation facilities.

We appreciate your consideration of the comments contained herein and we look forward to meeting with you to continue our ongoing planning efforts in the Southern Gateway Area. Please feel free to contact Senior Planner/Project Manager Lina Velasco or me at (510) 620-6706.

Sincerely,

Richard Mitchell
Director of Planning and Building Services

cc: Bill Lindsay, Richmond City Manager
Shasa Curl, Richmond Administrative Chief
Michael Banks, Richmond Fire Chief
Allwyn Brown, Richmond Deputy Police Chief
Alan Wolken, Richmond City Engineer

Scoping Meeting Transcript

In The Matter Of:

RICHMOND BAY CAMPUS DEVELOPMENT SCOPING MEETING

Error getting date

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Richmond Bay Campus Long Range Development Plan and Phase One Scoping Meeting for Environmental Impact Report

Richmond City Council Chambers

403 Civic Center Plaza, Richmond, CA

January 23, 2013

7:00 p.m.

REPORTER'S TRANSCRIPT OF PROCEEDINGS
BY: JUDY LARRABEE, SHORTHAND REPORTER

CLARK REPORTING AND VIDEOCONFERENCING

2140 SHATTUCK AVENUE, SUITE 405

BERKELEY, CALIFORNIA 94704

(510) 486-0700

PROCEEDINGS

JEFF MILLER: Good evening, everyone. Thank you for coming. My name is Jeff Miller. I am head of Public Affairs at Berkeley Lab. Tonight I'm here on behalf of the University of California to introduce the Public Scoping Meeting for the Richmond Bay Campus. Now because there are rules and protocols about meetings such as this, I'm going to have to read my remarks, which is really difficult for me because people who know me know that I like to be extemporaneous. But I'm not going to do so. I'm going to read these verbatim. So I apologize if it sounds a little rote, but that's just the way it has to be.

Tonight we are here to focus on the Environmental Review under the state CEQA process of the proposed Long Range Development Plan for the Richmond Bay Campus site and the proposed first phase of development under the LRDP. LRDP meaning Long Range Development Plan.

The purpose of tonight's meeting is to gather your comments as to the scope and content of the forthcoming Environmental Impact Report. A Notice of Preparation of the Draft Environmental Impact Report was issued on January 4th, which began the public

comment period that runs through February 4th. So tonight's public meeting is an integral part of this scoping process.

At the end of the scoping period on February 4th, we will review all the comments we receive tonight, plus any we receive through e-mail or hard copy or in any other form, and we will consider them in refining the scope of the Environmental Impact Report. We will then prepare a Draft Environmental Impact Report which will be publicly circulated for review and for which we will hold a public hearing in late spring.

Now while we do not intend to directly respond to your scoping comments, we will carefully review and consider each and every one of them in preparation of the Draft EIR.

Now, we have two types of cards available. if you would like to speak tonight, please fill out a green card and pass it to Ross who is standing up right here. If you would like to give us a written comment, you can please fill out a blue card. And if you wish to send a comment by e-mail or in writing before February 4th, the addresses are on the comment card. So for example, our e-mail address is LRDP-EIR@lbl.gov, and then mail will go to Jeff Philliber at Berkeley Lab, and his address is on this

card. Is everyone with me so far?

The next public meeting in the process will be to receive comments on the Draft EIR. We don't have a date for that yet, but that should probably occur sometime in June. Okay.

We also intend to present to the community a draft of the Long Range Development Plan when it is ready for review. We expect that to be in late March or April. We will hold a public meeting at the time and present and discuss a Draft Plan with you. That meeting would not be part of this CEQA environmental review process.

So I know I've thrown a lot of dates at you. So we do have a calendar available on the RichmondBayCampus.lbl.gov Web site. If you're confused as some are -- I certainly am -- you might want to check that calendar and that should fix the problems around the dates.

The proposed LRDP is a partnership between UC Berkeley and Lawrence Berkeley National Lab. The proposed first phase of development of the LRDP is being undertaken by the Lab and UC. It will be undertaken in order to relocate and consolidate a number of Lawrence Berkeley National Laboratory programs currently located offsite from the main LBNL

site.

Tonight you will hear from Cathy Koshland from University of California Berkeley who will describe the proposed LRDP and Horst Simon from Berkeley Lab who will describe the proposed first phase of development. You will then hear from Jeff Philliber from Berkeley Lab who will describe in more detail the CEQA process. Then we will begin the official public comment period.

Please note that we have a legal reporter present who is transcribing tonight's proceedings for an official record which we've made available to the public. We also have an interpreter here for those who might need such a service. To give as many people as possible a chance to speak, we ask that speakers hold their comments to three minutes each.

When you came in, you may have seen also these posters that are now taken down. But they provided an overview of the proposed site and also described steps in the NEPA, which is the National Environmental Policy Act process, for the first phase of the Richmond Bay Campus development.

The federal environmental review process, NEPA, for the first phase of the development at the proposed Richmond Bay Campus, is being conducted simultaneously

with the state California Environmental Policy Act, the CEQA process. Two things going on simultaneously. If you would like to comment on the federal review, you can send an e-mail to Kim Abbott at Kim.abbott@bso.science.doe.gov. You will never remember that, so I'm sure Ross and others here can help you if you would like to comment via that process.

Finally I would like to emphasize that we're here tonight to conduct the process prescribed by the California Environmental Quality Act and state law. We welcome your comments on the scope of the environmental review for these projects.

And now I would like to introduce Cathy Koshland, Vice Provost for Teaching, Learning, Academic Planning & Facilities at UC Berkeley. She will then be followed by Horst Simon, who is Deputy Director at Berkeley Lab. Thank you.

CATHY KOSHLAND: Welcome to this meeting this evening. I'm going to talk briefly about our long-range plans for the Richmond Bay Campus, especially to brief those of you who haven't been able to participate in our three public meetings that we have held over the last year.

It's a pleasure to be here again in the city of

Richmond and to know that our project has reached this important milestone.

The UC Berkeley campus has long wanted its Richmond properties to contribute more to the University's core mission, and we want to contribute and be part of a vital, healthy city of Richmond. And I appreciate your support and partnership in this process.

The Richmond Bay Campus is part of a broader network of innovation centers that are part of the University of California. In this case, you see the center of the core campus of Berkeley as well as the main campus of the Berkeley Lab. And then the Richmond Bay Campus, and we also note UCSF's Mission Bay Campus where we also have ties on for both the Berkeley Campus and LBNL. So three centers of innovation. It's particularly important that the Richmond campus is part of the Green Corridor, and we see that as a critical investment in the future of our region, building economic vitality, leadership and innovation for the East Bay.

More specifically, here is the site. It includes the Richmond Field Station. The Field Station has been owned by the University of California and managed by UC Berkeley since 1950. More recently we acquired

the Regatta property next door which currently has warehouses, part of which are occupied by third parties and part of which are occupied by several of our collections, the Hearst Museum, the Berkeley Art Museum. Many of the others have critical storage facilities in that building. And then the College of Engineering has active research on the site at the present time.

The site we're discussing is the site marked "uplands" as well as the bottom portion to the north. The outboard site is submerged, and although we own it we obviously can't develop it.

The whole site that we're talking about for development that is surrounded by the yellow portion that is designated "uplands" is 133 acres. And just to give you a sense of proportionality of that, here's an overlay of that 133 acres on top of the core Berkeley campus which is about 180 acres, and you see that they are really relatively comparable.

And then we're also not so incomparable from the LBNL site. Though it's 202 acres, much of that is on a slope and therefore one can't build on. And then you can see the relationship between the Richmond Bay Campus site and the scale of the UCSF Mission Bay Project.

There's an interesting article in the Chronicle today about the ten-year anniversary of the development of the Mission Bay site and its success over this ten-year period. And we certainly aspire to something along those lines.

We've been in conversation with LBNL about a vision for this campus. We've narrowed it down to this, a state of the art, inspirational and sustainable place for this world-class, collaborative science for healthy living and sustainable communities.

At a meeting last year, some of you heard from a panel of scientists affiliated with LBNL and UC Berkeley talking about the research and the research we hope to pursue at the Richmond Bay Campus. We want to discover 21st-century solutions to 2lst-century challenges in the areas of energy, the environment, human health, and the global economy. And already research in Richmond includes research under sustainable transportation with commercial applications. And in a moment, my colleague Horst Simon will discuss the first phase of research at the Richmond Bay Campus focused on the biosciences. But you can see the additional things that we're dreaming of at the moment.

Getting back down to earth, we've completed a number of studies for this site, and we think it can comfortably house about five million square feet of development. We expect that site to be a place for research labs, obviously offices and conference space, dining and cafés to support a population that we hope will grow to about 10,000, and other support space.

The expectation is that we will have active basic research there, but we also very much want to engage in translational research that would allow the ideas that are developed in the basic research enterprise to move into being spun off in companies and in ways that enrich the economic development of the East Bay and of California.

And finally, here is a view of how one might lay out the buildings and infrastructure, roadways, connecting pathways on this site. This is strictly a concept. This is not a Master Plan; it is not a design. But it's to give you a sense of how we might do it. You'll note the wide open green spaces. That's the native prairie grasses that we seek to preserve. But we wanted to give you a sense of how we're developing, how we're thinking about this site, how we want it to interact with its neighbors in the city of Richmond, that there will be access and entry

points into the campus. We anticipate, of course, that this site will be developed in phases over 30 or 40 years, and eventually reach that total infrastructure and total population that I mentioned earlier.

This is just a general overview of the project. We'll host a community meeting on the actual Long-Range Development Plan itself this spring where we can also discuss the research programs, partnerships and economic development that can emerge with this plan. But information gathered today will help inform our study on the possible environmental impacts of that plan.

So now I want to introduce Horst Simon who will describe the actual Phase One Development that we anticipate.

HORST SIMON: Thank you, Cathy. It is again a pleasure to be back in Richmond and to talk to the city neighbors -- future neighbors -- about our plans for a Second Campus, the Richmond Bay Campus. It's always a pleasure to work with Cathy and the team at UC Berkeley on this joint development. So as you've noticed, we have developed a very strong partnership over the last year also with UC Berkeley and look at this great project jointly with great enthusiasm.

So what I would like to talk about is what is called the Phase One Development. That is the first set of new buildings that Lawrence Berkeley National Labs would like to place on the Richmond Field Station.

And just to bring you back to the beginning of this process that is now more than two years ago is that we started out with the challenge of having about 25 percent of our Lab facilities and almost 25 percent of our staff scattered over seven different sites in the East Bay that are marked here with these little yellow dots, ranging from JJI in Walnut Creek to NERSC in Oakland and then several sites in West Berkeley and in Emeryville. And it is obvious to you and it was obvious to us that this is very suboptimal. There's a lot of scientific synergy that is lost by having people in separate sites in addition to being, or course, very inefficient in terms of commuting between so many different places.

We were looking for a Second Campus and went through an RFQ process, and the City of Richmond emerged as the leading site with the Richmond Field Station. And so our vision for the future is to consolidate down to two sites -- and you saw how these dots are moving -- some of the dots are moving back to

the hill, but a large number of dots consolidate on the Richmond Bay Campus site that we're discussing today.

So specifically what we're trying to accomplish is to consolidate some of the existing facilities that are listed on this slide on the left here, the Joint Genome Institute, the Joint BioEnergy Institute, Advanced Biofuels, KBASE, and elements of the Life Science and Earth Sciences division in this Phase One Development which would be in the southeast corner of this conceptual plan that Cathy has shown you.

We expect that this first phase would be about 16 acres, and we hope to find about 800 gross square of development capability there, which over the first couple of years would be the target for building out hopefully the Richmond Bay Campus site.

I want to describe the three first buildings that we envision to happen there. The very first building there is the so-called BioIntegration facility. The notion behind this building is to take biological facilities, that as I said are currently scattered across the East Bay -- you see them listed here on this slide -- and bring them together in a building. It makes perfect sense to consolidate these facilities because they serve the scientist and the users, not

just at the Lab but in the nation. And by bringing them together in one building -- we have already done the analysis -- we will save space; we will get out of leased buildings, and we will produce a more productive facility that will serve the researchers that will not only join us on the Richmond Bay Campus site but, as I said, come from UC Berkeley, from the Bay Area, from the state of California, and from all over the world.

Just to explain -- and you will hear this in Jeff Philliber's presentation -- why we have also a NEPA process. This is going to be, as we hope, a federal building that will be financed by the Department of Energy. We are also engaging you in parallel with the CEQA process here with the NEPA process, specifically on this building.

We envisioned to have as a second building a building that is dedicated to the energy sciences. Just as a background, you are all aware of the environmental challenges that we face, not just as a community here but as a nation and the world in terms of the Increased carbon in the atmosphere. And our Lab is engaging in a number of research projects that look at the future of energy in the world and finding technologies that reduce carbon or are carbon neutral.

One of those technologies is the production of biofuels. The Joint BioEnergy Institute that's about five years old was started in a leased facility in Emeryville. That would be the anchor tenant for the second building, the energy building. Activities there would be augmented by other projects that are currently funded by DOE under the Biological Environmental Research Program.

Our third building would be our health building, health sciences. There's a large number of activities currently happening at the Lab that are currently mostly in a facility in West Berkeley on Potter Street that focus on health sciences. The notion here is that LBNL -- and you have probably heard some of the research stories when we had our young researchers here, but just to remind you -- we have a very active program which looks at physical technologies such as imaging, for example, and applies these technologies to the problems related to health.

We have a large core, for example, in breast cancer research. And so out of this combination of physically-based technology that we have developed at the Lab and the application of the health sciences, we have found a lot of important applications really benefiting the health of the population, in particular

as we consider environmental impacts on health. That's the big focus for this third building.

Here's a very short highlight, a little overview of what will happen next. Of course, we've just started the CEQA and NEPA process, and we will engage you, as you've heard, about the Long-Range Development Plan.

These are the activities that will happen throughout 2013. If the LRDP and the project funding is approved, we envision to start the project in 2014, and then expect design construction happening from 14, 15 onward through 17. And hopefully we'll be able to move into the new buildings, that's our goal, in late 17 and early 18. And then, of course, start thinking about other phases -- perhaps you've seen our long-term vision for the Richmond Bay Campus for future phases.

So with that, I would like to turn it over to Jeff Philliber, who will tell you the details of the CEQA process.

JEFF PHILLIBER: Thank you very much. Hi. My name is Jeff Philliber. I'm the Berkeley Lab environmental planner. I'll be speaking today on behalf of the University of California to present to you the CEQA process for the Richmond Bay Campus

Project.

So CEQA has a couple of main purposes. The foremost purpose is to inform governmental decision makers as to the environmental consequences of their actions or their decisions. It also allows them to choose between alternatives. It provides mitigation and ways to avoid impacts.

Another thing that CEQA allows for is public information. It informs the public. Not only does it inform the public, but it allows the public to participate in the process. The public can help inform decision makers as to what the public thinks are issues of concern. And so all of you who are here tonight are participating in our process, and we thank you for showing up.

The University's CEQA process is outlined here for an Environmental impact Report. The Environmental Impact Report is the most extensive process that CEQA provides for analyzing impacts. It starts with a scoping, typically 30 days. We're in that period right now. The scoping period is initiated by the distribution or the public circulation of a Notice of Preparation. If you haven't received that, and you want one, please contact Ross. We have them here as well. There will also be typically a public scoping

meeting which is what we're engaged in tonight.

The comments that the University receives during a scoping period are then used to help inform the report preparers as they prepare a Draft Environmental Impact Report. The Draft EIR, when its ready, is publicly circulated, typically for 45 days. The public and agencies and any interested parties may then review the report and provide comments back to the University. There will also be, as Jeff Miller pointed out, a similar meeting to this one where we would listen to your comments as to the adequacy of that Draft EIR.

At the close of that period, all of the comments received would then be responded to in a Response to Comments document that would be part of a Final Environmental Impact Report. That report would also include any refinements to the EIR as well as any mitigation plan that needs to be put together and other items that are required by the Regents or by CEQA. That would be then submitted to the Regents or the University's decision-making body, and they would then decide whether to approve or certify the EIR or not. Only after certification of an EIR can the Regents then approve the project that's the subject of the EIR.

Our process we're projecting is we'll follow this rough timeline. We open the scoping period on January 4th. It closes February 4th. The Draft EIR we're hoping will come out in the May/June timeframe of this year. The Final EIR we're projecting for sometime around October, and we are projecting or shooting for the Regents meeting in November. The Regents meet approximately once every other month.

There are different kinds of EIRs. This particular EIR comes as two different types. Program EIRs analyze general programs and master plans and proposals that are general and wide and broad in scope. Project-specific EIRs look at specific projects. This project as it's been described has both components. The LRDP will be analyzed programmatically in the EIR, and the Phase One portion of the project will be analyzed at a specific level of detail in the EIR.

Currently the University is considering a range of alternatives that would include what you see here: A reduced growth alternative on the site; an alternative development arrangement on the Richmond site that would allow for more flexibility in siting scientific facilities in the future; an off-site alternative that considers moving the entire campus to a different site

-- Alameda in particular has been looked at, but we were looking at all of the major sites that were considered in the planning process -- and a No Project Alternative which is required under CEQA which would have us analyze what would happen in the future if this project did not happen at all.

This includes most of the areas that would be analyzed in the Environmental Impact Report. You can see here -- if you want any details on any of these, just grab the NOP. We go into quite a bit of detail on our current assessment, our preliminary assessment of these areas.

As Jeff Miller mentioned, you probably noticed that the Department of Energy was answering some questions and had an informal poster session out here earlier this evening. And as Jeff pointed out, and Horst, both processes are occurring simultaneously, the CEQA process and the NEPA process.

One thing that's really important to note about these two processes, despite their many similarities, is that they're both independent of each other. That is, the University of California is conducting the CEQA process independently from the Department of Energy which is conducting the NEPA process. Therefore, if you have comments that are pertinent to

one or the other, you should make it as clear as you can when you communicate with us who you want these comments to go to. We'll definitely try to accommodate you every way we can. But if I receive comments, I'll typically assume they're for the CEQA document. And Mr. Kim Abbott, who is in the back, he's the document manager for the NEPA document, and he will be receiving all the NEPA comments. If I receive comments that reference the NEPA document, I'll make sure Kim gets those, and he will do the same for me for CEQA.

So finally as we enter into the public comment portion of this meeting, I just want to say one thing. Folks who have done this before know this already, but one frustrating thing to some folks about a public scoping meeting under CEQA, and a bit frustrating to us too, is how we have to conduct the meeting.

Those of us who work at the University are very excited about this project, and we actually love to talk about it. But we won't be able to talk about it with you tonight. That would be at odds with the purpose of the CEQA scoping meeting which is for us, the University, to be good listeners.

So we will sit quietly, and we will record everything that you say or ask or comment upon. We're

going to particularly focus on anything you have to say that's pertinent to the scope or content of the forthcoming Environmental Impact Report. But we will certainly not turn off the microphone if you talk about the project or something else.

So with that, again, I want to thank you for coming. I'm going to turn this back to Jeff. Or we can just dive right in?

JEFF MILLER: Dive right in.

JENNIFER McDOUGALL: I'm Jennifer McDougall. I'm a planner with UC Berkeley, and Jeff and I will jointly facilitate the speaker comment portion of the meeting. We will start with Carole Schemmerlinig and then after that will be Patricia Jones.

Start with three minutes. Please come to the microphone there, and give your comments. We'll do three minutes. At two minutes I'll show the fact that there's one minute left, and then we'll do 30 seconds and then we'll ask you to wrap up your comments.

CAROLE SCHEMMERLINIG: My name is Carole Schemmerlinig. I'm a member of the LBNL CAG. I have pointed out to some of the people at the Lab that this is one of the better NOPs that I've seen and had to read. I'm pleased to say that it was more comprehensive in its answers and fewer boxes checked

saying no problem. We don't have to look any further.

I am, as a member of the LBNL CAG, concerned about several issues that will be part of this project too. Water -- and there is water on the site, although the NOP says it's not a natural stream -- it was a natural stream until it was put into a concrete ditch. And so the water, and the way it's treated in the Plan, is questionable. I would like to see it restored in a natural fashion.

I'm concerned also about, in general, contamination. The present site on the hill is heavily contaminated. I know that the one in Richmond has suffered great contamination because of the Seneca buildings -- or rather properties -- and it continues to be contaminated. I need to be reassured as much as possible that the contamination will not be increased by whatever goes on at the Richmond Field Station, although I'm not sure that I can be easily reassured. But I would like to be.

The contamination of the water and the air are two things that Richmond doesn't need more of. With Chevron and the Seneca site and several other sites in Richmond, I think Richmond deserves to have everything as clean as can be.

So that's my major concern. I think it could be a

very good site for some of the expansion of the Lab. But I think in the long run, the benefits to the citizens of Richmond are more important.

JENNIFER McDOUGALL: Thank you. Our next speaker is Patricia Jones.

PATRICIA JONES: Good evening. My name is Patricia Jones. I'm the Executive Director of Citizens for East Shore Parks. So thank you for giving me an opportunity to speak this evening.

CESP, Citizens for East Shore Parks, is an environmental nonprofit group that was instrumental in creating what is now called McLaughlin East Shore State Park. And the northern tip of this park is adjacent to your project.

Our mission is to create parks and open space along the East Bay shoreline. And so to that end, we're very interested to confirm that this shoreline property along Richmond's beautiful 32-mile shoreline, is respected in terms of habitat conservation and restoration and public access.

I see that you do have appropriated boxes checked for biological resources. I just urge you to evaluate these impacts completely. There is less -- and somebody else will speak more to this; I'm not the expert -- but I understand there's less than one

percent of coastal prairie left in California, and you have a large chunk of it on your property. And I would say that having an open lawn surrounded by buildings may not make for a healthy coastal prairie.

Also, as mentioned by Carole, there is a creek running through the property that we hope restoration will be explored on that creek.

So we look forward to seeing a compete EIR and EIS, and that this project can become a community asset to the region. And CESP will be submitting comments in writing. Thank you.

JENNIFER McDOUGALL: Our next speaker is John Shively, and then after John Shively is Bruce Beyaert.

JOHN SHIVELY: I'm John Shively. I got the news of this meeting wrong. I was told that it would start at 7:30, and so I just breezed in the door. Forgive me for that.

Anyhow, I am very interested in this project. Years ago, from 1976 to 1982, I was the manager of the University's Richmond Field Station, which was a misnomer. Field stations are associated with agricultural projects. At the time I was here, there were about 13 separate totally independent research activities going on at the Field Station. And it was a delightful time.

But there was a program back then that fortunately failed. They were going to quietly -- the College of Engineering was going to sell off the Field Station for commercial development. What spoiled it is I accepted the President's office desire to build a northern region library facility, and that slipped through the radar and dropped a huge anchor which spoiled the grand plan to sell off the Field Station for commercial development.

And frankly I'm delighted. I think you can use a better name. Richmond Bay Campus doesn't ring right. I prefer to see the Richmond Research Center of the University of California. Thank you.

BRUCE BEYAERT: Good evening. My name is Bruce Beyaert. I'm a Richmond resident and chair of TRAC, the Trails for Richmond Action Committee. As you know, the citizens of Richmond are very delighted to have LBNL and UCB coming to our community, becoming a part of it.

I'd just like to address one thing tonight, and that is that the Draft EIR clearly identify the role of adopted local plans. The city of Richmond last year adopted a new General Plan, a Bicycle Master Plan, and a Pedestrian Plan. The Draft -- the initial study states on page 28 that "projects on University

property are exempt from local land use planning jurisdiction."

However, CEQA apparently does apply to the project. That's why we're here tonight. And CEQA does require addressing inconsistencies with local plans and mitigating them to a less than significant level. And, of course, most of the project's impacts occur off-site, so I would assume that that would involve consistency with the local plans I mentioned. It would be very helpful to have that clarified and addressed in the Draft EIR citing appropriate legal authorities.

But aside the legal issues and the niceties of CEQA that do a great deal in cementing the emerging great relationships between LBNL and UCB, if the Draft EIR and the institutions would commit to complying with the letter and the spirit of the City's adopted plans.

Those are my only comments. TRAC has already submitted more specific written comments. Thank you.

JENNIFER McDOUGALL: Our next speaker is Mack Casterman, and after him will be Bill Pinkham.

MACK CASTERMAN: Hello. My name is Mack Casterman, and I am the conservation analyst for the East Bay Chapter of the California Native Plant

Society.

The California Native Plant Society's East Bay Chapter has published a list of 15 Botanical Priority Protection Areas in Alameda and Contra Costa County, and the Richmond Field Station is one of those areas. Our interest in the Station is in its rare remnant coastal prairie grassland, which as Patricia Jones stated, is exceedingly rare in the state. There is very little left at this point, and so we're hopeful that the EIR will make sure to plan for any impacts to that grassland community.

Obviously, avoidance is always the best mitigation, and in the case of native grassland it is often the only feasible mitigation option. So we will be looking forward to the EIR and how it addresses the potential impacts to the native grassland at the site.

Also, it's vitally important to begin floristic surveys now, not only for this Phase One of development, but for the other phases down the line here so that appropriate data is available for this and future Environmental Impact Reports.

Also in October of 2012 I recall seeing a picture of the Plan that has the drainage that is on the west side of the property put up and possibly restored to what looked like a meandering creek. The new updated

pictures don't show that. They just show the existing drainage as it is. So I would like more information on that, or maybe some updated photos.

And we will be submitting more detailed comments for the NOP, and we'll look forward to commenting on the EIR as well. Thank you.

JENNIFER McDOUGALL: Bill Pinkham.

BILL PINKHAM: Good evening. I'm Bill Pinkham. I'm on the board of the East Bay Bicycle Coalition and on the steering committee of our local' 350.org group.

Very briefly, I hope that the EIR and the Plan will account for sea level rise in the Bay. It's pretty clear that we're going to have two or three feet already. There is 50 percent less ice on the planet than there was when we had those first pictures of earthrise that John Glenn and the other astronauts took. The seas are 30 percent more acidic, and it's much harder for them to absorb carbon. If the energy companies burn the stored energy they have right now, we'll pass a rise in two degrees Centigrade by 2015. Very scary. We're already up .8 degrees Centigrade. Especially because this project is going to be developed over 30 years or so, I think it's very important that that be a consideration. Thank you.

JENNIFER McDOUGALL: Do we have any other speaker cards tonight? Pamela Sihvola.

PAMELA SIHVOLA: My name is Pamela Sihvola, and I'm the co-chair of the Committee to Minimize Toxic Waste in Berkeley.

It is curious how little the association of this project with the Department of Energy has been mentioned. The Lawrence Berkeley National Laboratory, the Lawrence Livermore National Laboratory, the Los Alamos National Laboratory and this proposed Richmond National Laboratory are and will be all owned and operated by the Department of Energy, previously known as the Atomic Energy Commission, and managed by the University of California under contracts which generally are negotiated for five year terms.

Half of the Lawrence Berkeley National Laboratory's 72-year life span was operated without any environmental laws. Even after the Clean Air Act and the Clean Water Act, radioactive pollution continued in Berkeley next to the Lawrence Hall of Science, the Children's Museum, as tritium, a radioactive isotope of hydrogen, was released into the air and waters of the Strawberry Creek Watershed.

Regarding the proposed Richmond Field Station facility, it is critical that UC, LBNL, and the

Department of Energy prepare individual EIRs on the CEQA and full-blown Environmental Impact Statements under the National Environmental Policy Act for each of the proposed individual buildings, and analyze not only the impacts from construction but also the impacts from operations for the entire projected life span of each of these buildings.

If we had had a chance in Berkeley to comment on the National Tritium Labeling Facility Project during its planning phase, we would have learned that almost 30 percent larger inventories, 30 times larger inventories for radioactive tritium were allowed at the LBNL's site, compared, for instance, to just the central campus of UC Berkeley. And there would have been a chance to prevent radioactive emissions which reached all the way to Lake Anza in Tilden Park but may have impacted the children at Lawrence Hall of Science just 110 meters downwind from the tritium stack.

This in mind, the Richmond community must be vigilant regarding, for instance, synthetic biology, the potential impacts and risks associated with UC Berkeley's Synthetic Biology Institute being considered for the Richmond site.

Since the Richmond Lab is a federal facility, the

proposed programmatic EIR under CEQA must be accompanied by a full-blown EIS under NEPA. And the documents I have received in the mail and what was presented tonight really have no reference to the comment period for the Department of Energy's portion of this project. There are no addresses where to send these comments. There's a reference to somebody in Oakridge.

So I am urging that the EIR be accompanied with a full-blown EIS, and again, each building that is constructed should have an EIR and an EIS for both operations and the construction to fully analyze the health risks and the environmental impacts for the entire projected life span of each building. Thank you.

JENNIFER McDOUGALL: Thank you very much. Are there any other speakers tonight? Thank you very much for attending tonight and for sharing your thoughts about the project with us.

(The meeting adjourned at 7:52 p.m.)

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Appendix B

Air Quality

REPORT

AIR QUALITY AND HUMAN HEALTH RISK IMPACT ASSESSMENT

University of California/Lawrence Berkeley National Laboratory – Proposed Richmond Bay Campus Long Range Development Plan

Submitted To: Tetra Tech
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November 14, 2013 **Project No. 123-99773-02**

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1.0 INTRODUCTION

1.1 Purpose and Assessments Conducted

This report documents the quantitative air quality, human health, and greenhouse gas (GHG) impact assessments conducted for the proposed Long Range Development Plan (LRDP) for the University of California's proposed Richmond Bay Campus (RBC) in Richmond, California. This assessment is based on the project components of the proposed LRDP and additional information provided by The University of California, Berkeley (UCB) and the Lawrence Berkeley National Laboratory (LBNL); collectively referred to as The University in this report. These impact assessments have been conducted using approaches consistent with the California Environmental Quality Act (CEQA) in support of the development of a draft environmental impact report (DEIR) for the proposed LRDP.

The LRDP is intended to cover potential development at the RBC out to the year 2050. Therefore, this study estimates the potential air quality, human health, and GHG impacts from potential RBC development out to the year 2050. Additionally, a separate impact assessment was completed for the first phase of the potential development (Phase 1); Phase 1 development is assumed to occur over four years.[1]

In order to assess potential air quality, human health, and GHG impacts, the following quantitative assessments were performed for both the full LRDP and the Phase 1 portion:

Air Quality

- Estimate emissions of criteria pollutants (nitrogen oxides [NO_x], carbon monoxide [CO], particulate matter less than 10 microns in diameter [PM_{10}], particulate matter less than 2.5 microns in diameter [$PM_{2.5}$], sulfur dioxide [SO_2], and volatile organic compounds [VOC]/reactive organic compounds [ROG]) from activities associated with project construction/demolition and project operation.
- Summarize criteria pollutant emissions for easy comparison to emissions-based significance thresholds.

Human Health

- Estimate emissions of toxic air contaminants (TACs) from activities associated with project construction/demolition and project operation.

[1] This risk assessment includes consideration of a previously proposed project under the proposed LRDP, called "Phase 1 Development." Although that project is no longer proposed, the information on Phase 1 in this report could potentially provide preliminary information to inform a future proposal; accordingly, information on Phase 1 has been included in this report.

- Perform AERMOD dispersion modeling to generate dispersion factors for both onsite and offsite receptor locations representative of general public (for acute assessments), occupational workers (for chronic/cancer assessments), and residents (for chronic/cancer assessments).
- Use the Hotspots Assessment Reporting Program (HARP) On-Ramp and risk assessment software to estimate human health risk assessment impacts.
- Apply age sensitivity factors to lifetime excess cancer risk (LECR) estimates for residential receptors in accordance with Bay Area Air Quality Management District (BAAQMD) guidance.

Greenhouse Gases

- Estimate emissions of GHGs from direct and indirect activities associated with project construction/demolition and project operation.
- Summarize GHG emissions for easy comparison to emissions-based significance thresholds.

Assessment methodologies were based on BAAQMD guidance where available, or guidance from other agencies such as other California air quality districts or the U.S. Environmental Protection Agency (EPA) as appropriate (any non-BAAQMD guidance used will be noted). Many of the assessments performed in this report were conducted to be consistent with assessments recommended by the BAAQMD in a CEQA guidance document published in 2011 (BAAQMD 2011), even though this guidance is currently withdrawn based on legal challenge; this was deemed appropriate since the suite of assessments recommended in the BAAQMD 2011 CEQA guidance encompass assessments typically required in other California air Districts for similar CEQA projects and represent a wide range of different types of potential air quality impacts.

1.2 Proposed Project Description

The University proposes to establish a new major research campus, at properties it owns in Richmond, California, to provide opportunities to consolidate biosciences programs of LBNL and for development of additional facilities for use by both LBNL and UCB and synergistic institutional or industry counterparts for research and development focused on energy, environment, and health. The University proposes to rename the properties as the Richmond Bay Campus (or RBC, as defined previously).

The University is preparing an LRDP in support of the research and academic goals for this proposed new research campus. An LRDP is defined by statute (Public Resources Code [PRC] 21080.09) as a "physical development and land use plan to meet the academic and institutional objectives for a particular

campus or medical center of public higher education." The proposed 2014 LRDP addresses sustainability, land use, access and circulation, utilities and infrastructure, and open space and landscaping, and provides a policy and design framework to guide the development of up to 5.4 million gross square feet (gsf) of new research, development and support space at the site (this does not include square footage of parking structures). Design principles in the proposed LRDP feature preservation of the site's important natural open spaces, which include marsh and coastal grasslands. The proposed 2014 LRDP would guide the growth and development of the campus through year 2050.

The University is also preparing an initial development plan that would construct the first three new buildings on the RBC site, referred to hereafter as the Phase 1 development.[2] Two of these buildings would be approximately 110,000 to 150,000 gsf each, and the third building would be up to 300,000 gsf for a total of up to 600,000 gsf. These new buildings would house the LBNL's Joint Genome Institute (JGI), the Joint BioEnergy Institute (JBEI), the Advanced Biofuels Process Development Unit (ABPDU), Knowledge Base (KBase), Life Sciences programs, conference facility, a dining facility, and various support facilities. Construction of Phase 1 facilities would commence in 2014, and the new buildings would be occupied starting in 2018.

The analysis in this report, as reflected in the LRDP EIR, may be used by the state Department of Toxic Substances Control regarding approval of workplans for addressing historic contamination at portions of the RBC site proposed for development.

The approximately 133-acre RBC site is located at 1301 South 46th Street in the South Shoreline area of the City of Richmond, approximately 5 miles northwest of the UCB campus and the LBNL site in Berkeley (see Figure 1-1 in the Figures section at the end of this report). The RBC site is comprised of two parcels: the Richmond Field Station (RFS) and a recently acquired parcel along Regatta Boulevard.

The properties are bounded on the west by a Pacific Gas and Electric (PG&E) service station, on the northwest by Regatta Boulevard, on the northeast by Meade Street, on the east by South 46th Street, and on the south by the San Francisco Bay. Interstate 580 (I-580) runs parallel to Meade Street (separated by only about 25 feet) along the northeastern boundary of the RBC site.

Land uses surrounding the RBC site include industrial/office uses and a major interstate freeway, with low-/medium-density residential neighborhoods. Regatta Boulevard, along the northwestern boundary of the RBC site, is adjacent to a railroad spur and a business complex developed with one- to two-story

[2] This risk assessment includes consideration of a previously proposed project under the proposed LRDP, called "Phase 1 Development." Although that project is no longer proposed, the information on Phase 1 in this report could potentially provide preliminary information to inform a future proposal; accordingly, information on Phase 1 has been included in this report.

buildings. Bio-Rad Laboratories, a private research equipment manufacturing company, is located immediately west of the RBC site. The adjacent property to the east is the location of former chemical production operations previously owned by several entities, including Stauffer and Zeneca, and is currently owned by Cherokee Simeon Venture I, LLC.

The Marina Bay residential neighborhood, across Meeker Slough, and southwest of the RBC site, consists of a mix of multi- and single-family residences. Low- and medium-density residential uses are also located across I-580, north of the Meade Street boundary of the RBC site.

1.2.1 LRDP Illustrative Development Scenario

To provide greater detail and more complete public disclosure of potential project impacts, and also to provide a basis for some of the quantified modeling that is being completed for this LRDP, the University has developed an Illustrative Development Scenario, which is shown in Figure 1-2.

This Illustrative Development Scenario is a conceptual portrayal of potential development under the LRDP that would be consistent with the proposed 2014 LRDP goals and objectives, the proposed 2014 LRDP Land Use Diagram, and the LRDP's proposed development uses and square footages. The Illustrative Development Scenario is intended to provide a conservative, but reasonable and realistic, basis for the analysis of environmental impacts.

The actual locations of buildings, configurations, uses may vary as specific projects are considered for approval in the future. The University's needs and opportunities may change over time at any particular site and the Illustrative Development Scenario is not intended to be a precise representation of the actual development program that would take place over the nearly 40-year planning horizon of the 2014 LRDP (out to 2050).[3]

The Illustrative Development Scenario shows possible siting and dimensions of new buildings, parking garages, and roadway changes, and demolition of existing buildings. Consistent with the proposed 2014 LRDP Land Use Diagram, the Illustrative Development Scenario indicates that development of major new buildings would take place within the Research, Education, and Support zone of the RBC site. Parking structures would be sited to support a pedestrian-friendly, vehicle-free environment.

While actual development at the RBC site under the term of the 2014 LRDP would likely not be precisely what is presented in this Illustrative Development Scenario, at the time of additional development the University would consider how each individual project conforms to the assumptions and impact analyses presented in the 2014 LRDP environmental impact documents to determine what, if any, further CEQA

[3] It is not possible to forecast accurately the complex series of development opportunities and decisions, including future building locations, sizes, configurations, uses, construction schedules, etc., that would comprise full implementation of the LRDP program.

documentation is necessary at that time. In particular, any development in excess of a net total of 5,400,000 gsf of occupiable (research, education, and support) space would require an amendment of the LRDP and accompanying environmental review.

1.2.1.1 Demolition Activities

In addition to construction of new building space, the Illustrative Development Scenario considers for purposes of analysis the possible demolition of up to 750,000 gsf of outdated facilities at the RBC. Demolition is considered for buildings and structures that are not cost-effective to upgrade, no longer suitable for modern science, costly to maintain, and to more efficiently use the building sites at the RBC. Most of the existing buildings are more than 40 years old, beyond the effective age of a typical laboratory building, and are relatively small, averaging about 9,600 gsf.

Demolition equipment would include large vehicles, stationary equipment, and hand-held power equipment typical to that involved in construction.

Table 1-1 identifies the major phases of demolition of an average-sized project. The table compares anticipated average and peak annual average levels of demolition activity, broken out into principal demolition parameters for analysis. The annual average is derived by dividing the total demolition gsf by a 40-year planning period. The anticipated peak demolition activity is assumed to be demolition of the majority of the existing Regatta property within a 12-month period. The calculation of truck trips assumes 10-ton haul trucks.

Table 1-1: LRDP Demolition Activity Levels

Activity	Anticipated Average Individual Demolition Project (12-month peak activity)	Anticipated Site-wide Average Annual Demolition Activity (all projects)	Anticipated Peak Demolition Activity (12-month period)
Facilities Demolition	9,600 gsf	18,750 gsf	250,000 gsf
Weight (125 lbs./gsf)	600 tons	1,172 tons	15,625 tons
Truck Trips	60 truckloads	117 truckloads	1,563 truckloads

Additional quantitative components of the demolition activities associated with the LRDP build-out are discussed further in Section 2 of this report.

1.2.1.2 Construction Activities

Construction planning for large projects includes consideration of environmental and regulatory elements of each project. Construction activities usually include the need for adjacent lay-down areas for equipment, supplies, and fabrication activities, as well as construction-worker parking, typically on or near

a job site. Under the 2014 LRDP, it is expected that large construction projects would not often occur simultaneously, although such projects may have some degree of overlap in schedules.

Construction would typically begin with demolition of existing facilities at a site, if necessary, followed by site clearing and excavation work. At the RBC site, preliminary steps include determination of any special site or building conditions due to historic site contamination that should inform site work. If excavation is involved, soil that is certified clean may be shipped off site during this phase unless the project is a balanced cut-fill excavation. Foundation work, building frame erection, and building finishing are the three major phases to follow. Under optimal conditions, site work for large projects at the RBC would typically be scheduled to occur between the months of April through September for optimal weather conditions, although it may occur in any month of the year, and the remaining phases may also take place at any time during any season.

Construction equipment would typically include large vehicles, stationary equipment, and hand-held power equipment used on the building site and at nearby staging areas, and would be powered by diesel or gasoline engines or electricity. Such equipment would include cranes, scraper/dozers, spreader/compactors, loaders, drill rigs, haul trucks, cement trucks, bore drillers, rough terrain forklifts, pavers, rollers, and other rigs. All equipment would comply with applicable regulatory standards, including required noise, air emissions, safety, and energy efficiency standards.

For the purposes of this study, the term “construction,” unless specifically indicated otherwise, includes activities that involve construction of new facilities, major rehabilitation or modification of existing facilities, and demolition of existing facilities. The maximum total new construction and renovation under the Illustrative Development Scenario is 7,300,000 gsf. This includes approximately 300,000 gsf of existing space, 5,100,000 gsf of new occupiable building space construction, and 1,900,000 gsf of new parking structures. While parking structures are not considered part of the occupiable space totals identified in the 2014 LRDP, they account for potential construction-related impacts and are thus considered in this analysis. Table 1-2 identifies the construction activity level for a typical construction project, divided into the major phases of construction. A project with 175,000 gsf is used to represent the average size of new buildings at the RBC. Table 1-2 also compares anticipated average and peak annual levels of construction activity, by major phases of construction.

The annual averages are approximately equivalent to one typical construction project being underway at all times at the RBC and are derived by combining total construction elements of the projects identified in the Illustrative Development Scenario (e.g., total square footage, footprint square footages, etc.), and then dividing these aggregates evenly over the 40-year planning period. Additionally, an annual peak average is analyzed, which is equivalent to the proposed Phase 1 construction of up to 600,000 gross square feet over a 30-month period. In this way, the peak annual average construction activity level is over three

times the annual average, or the equivalent of 3.4 typical construction projects being underway simultaneously. This level is intended to represent the maximum anticipated construction activity level for analytical purposes.

Table 1-2: LRDP Construction Activity Levels

Activity	Anticipated Average Construction Project (30 months total)	Anticipated Site-wide Average Annual Construction Activity	Anticipated Peak Construction Annual Average
Construction	175,00 gsf	175,000 gsf	600,000 gsf
Excavation & Replacement Volume	15,700 cubic yards (yd^3)	15,700 yd^3	53,800 yd^3
Soil Hauling	1,570 truckloads	1,570 truckloads	5,380 truckloads
Foundation	650 truckloads	650 truckloads	2,740 truckloads
Construction	3,400 truckloads	3,400 truckloads	14,380 truckloads
Total Truckloads	***5,620 truckloads***	***5,620 truckloads***	***22,500 truckloads***
Average Daily Truckloads	***9 truckloads/day***	***9 truckloads/day***	***36 truckloads/day***
Peak Daily Truckloads	***25 truckloads***	***25 truckloads***	***100 truckloads***

The calculation of excavation-related truck trips assumes the use of 10 yd^3 haul trucks. Excavation for these projects is assumed to be five feet deep underneath, and to five feet outside of, the footprint of each building or parking structure identified in the Illustrative Development Scenario. The structures were assumed to be an average of 4.5 stories high. While this volume is likely to be exceeded with some projects, others would require less excavation or would be balanced cut-fill excavations. Foundations are assumed to be approximately the length of the building footprint perimeter identified in the Illustrative Development Scenario. Foundations are assumed to be approximately up to 10 feet in depth and the excavated soil would be hauled in trucks, each assumed to hold 10 yd^3. An average building project is estimated to require approximately 3,400 truckloads of materials, including rental equipment, concrete, structural steel, siding, building systems equipment, and interior finishing materials.

Additionally, approximately 70,000 yd^3 of soil will be brought onsite during Phase 1 of the LRDP development to increase the site elevation of the Phase 1 area. It is also anticipated that during the LRDP development some of the contaminated soil known to exist onsite would be excavated and removed via truck (in accordance with the Soil Management Plan for the site).

Additional quantitative components of the construction activities associated with the LRDP build-out are discussed further in Section 2 of this report.

1.2.1.3 Operations

At full build-out, the LRDP would result in approximately 300,000 gsf of existing space, 5,100,000 gsf of new occupiable building space construction, and 1,900,000 gsf of new parking structures. The RBC after full build-out is anticipated to have a daily total population of approximately 10,000 persons.

Occupiable building space will utilize natural gas boilers for heating and cooling towers for cooling. In addition, diesel-fueled generators will be installed for back-up emergency electrical power.

Full build-out of the RBC will generate additional vehicle traffic due to supply/delivery trucks, waste removal trucks, shuttle buses/vans, and vehicles for employees and visitors.

For those buildings with wet laboratory space, chemical usage will occur, resulting in the potential for chemical emissions to atmosphere through lab hood vents on building roofs.

Additional quantitative components of operations associated with the LRDP build-out are discussed further in Section 2 of this report.

1.2.2 Phase 1 Development

Upon the approval of the 2014 LRDP, the University proposes to demolish 25 existing structures in the southern portion of the RBC site totaling 106,999 gsf and construct three new buildings and parking lots in the cleared area. These three research and office buildings, parking lots, associated site preparation, and utilities development, potentially including a central utility plant, are collectively called the Phase 1 development. The Phase 1 project site is about 16 acres, and the facilities that would be developed under the Phase 1 development are shown in Figure 1-3. Phase 1 development activities are estimated to take place over four years, roughly from 2014 to 2018.

Three new research buildings totaling up to 600,000 gsf would be constructed to house a mix of laboratory, office, and interaction space. The facility to be constructed at the southernmost end of the RBC site and closest to the EPA building is referred to as the “Energy” building as shown on Figure 1-3 (also shown as Building 8 in Figure 1-2). The facility to be constructed to the north of the “Energy” building is referred to as the “BIF” building as shown on Figure 1-3 (also shown as Building 9 on Figure 1-2). The facility to be constructed to the east of these buildings is referred to as the “Health” building as shown on Figure 1-3 (also shown as Buildings 6 and 7 on Figure 1-3). The “BIF” building would house LBNL’s Joint Genome Institute, the Advanced Biofuels Process Development Unit (ABPDU), and Knowledge Base programs, an imaging center, and a conference facility. The “Energy” building would house LBNL’s Joint BioEnergy Institute and closely related programs as well as a dining facility. The “Health” building would house LBNL's Life Science Division, closely related programs, and synergistic research institutions. The “BIF” building would likely be a three-story facility totaling 110,000 to 150,000 gsf. The “Energy” building

would likely be a two-story facility totaling 110,000 to 150,000 gsf. The “Health” building would likely be a two- to three-story facility totaling up to 300,000 gsf. At full occupancy, the buildings will house approximately 1,000 new employees (in addition to the 300 employees in existing buildings at the site not demolished during Phase 1). Three new surface parking lots would be constructed to accommodate approximately 600 vehicles.

As with the remainder of the LRDP build-out, Phase 1 buildings will utilize natural gas boilers for heating and cooling towers for cooling. In addition, diesel-fueled generators will be installed for back-up emergency electrical power. Phase 1 operations will also generate a portion of the vehicle traffic and laboratory chemical usage that will be associated with the full LRDP build-out.

Additional quantitative components of construction, demolition, and operations associated with Phase 1 of the LRDP build-out are discussed further in Section 2 of this report.

2.0 EMISSIONS ESTIMATES

This section describes the methodologies and input assumptions used to estimate emissions from activities associated with project construction/demolition and project operation. These estimates were completed for both Phase 1 of the LRDP and the full LRDP build-out.

2.1 Construction and Demolition

Construction and demolition emissions are estimated utilizing the California Emissions Estimator Model (CalEEMod), version CalEEMod.2011.1.1. CalEEMod is a statewide land use emissions model designed to quantify potential criteria pollutant and GHG emissions associated with construction and operations from a variety of land use projects. CalEEMod quantifies direct emissions from construction and operations (including vehicle use), as well as indirect emissions, such as GHG emissions from energy use, solid waste disposal, vegetation planting and/or removal, and water use. CalEEMod incorporates Pavley standards and Low Carbon Fuel standards into the mobile source emission factors. Although CalEEMod is capable of estimating direct operational emissions, it was only used to estimate emissions due to construction and demolition, as well as indirect GHG emissions due to water usage and waste disposal for operations.

Although CalEEMod Version 2011.11.1 was the most current version of the model at the time this analysis was conducted, it was known to contain multiple software bugs. In order to correct the data produced using CalEEMod due to software deficiencies, some data were post-processed for each model run based on guidance from the South Coast Air Quality Management District (SCAQMD). When applicable, these post-processing operations are explained in the following sections.

Generally, input parameters needed to run CalEEMod for each construction and operation scenario were provided by The University. Where input parameters were not provided, CalEEMod defaults and engineering assumptions were used. These input parameters are described in the following sections.

2.1.1 General Project Parameters

The input parameters needed for execution of each CalEEMod scenario include gsf of structures being demolished and constructed, parking lot and parking structure gsf, site preparation and grading areas acreage disturbed, and the timeline for each phase.

2.1.1.1 Phase 1

The input parameters needed for the execution of the Phase 1 CalEEMod scenarios (years 2014 and 2015) are provided in Appendix A in Tables A-1 to A-3 and A-7 to A-8. Phase 1 activities will include:

- Demolition
- Site Preparation

- Site Grading
- Building Construction
- Paving
- Architectural Coating

Data for these project phases are individually represented in the CalEEMod output files. It was determined that the 12-month period with the highest level of activity would likely occur once demolition activities commenced. Within this 12-month period, multiple weeks of each of the first four activities listed above (demolition [17 weeks], site preparation [8 weeks], site grading [27 weeks], and building construction [18 weeks]) would occur, as well as the exportation of contaminated soils and the importation of soils needed to raise the overall ground elevation in certain locations. Activity levels and durations were provided by The University for Phase 1. The activity schedule also included an outline of construction levels and durations during the second year of construction for Phase 1. Year 2 activity consists of the remaining necessary construction activities (including architectural coating), and site improvements (including paving). To summarize, emissions during the Phase 1 development construction and demolition period were conservatively estimated based on the following CalEEMod runs:

- **Year 1** – CalEEMod run for all Phase 1 demolition, 300,000 gsf of building construction, and all soil import/export activities.
- **Year 2** – CalEEMod run for the remaining 300,000 gsf of building construction, and all site improvements.

Detailed summaries of the Phase 1 construction and demolition emissions estimates are shown in Appendix A. The model output files for the two CalEEMod runs conducted to generate the emissions associated with the Phase 1 development construction and demolition are provided in Appendix B

2.1.1.2 Full LRDP

The input parameters needed for the execution of the full LRDP CalEEMod scenario are provided in Appendix C in Tables C-1 to C-3. The Full LRDP activities will include:

- Demolition
- Site Preparation
- Site Grading
- Building Construction
- Paving
- Architectural Coating

Because the LRDP (excluding Phase 1) extends from 2018 to 2050, each of the aforementioned phases can occur during a single year. The annual average activity levels and schedules for each phase were

estimated based on the Phase 1 information provided by The University. The Phase 1 activity durations were adjusted using the ratio of annual average LRDP activity levels (gsf demolished or constructed) to the respective total Phase 1 activity levels.

The daily CalEEMod outputs shown in Appendix D are used as the basis for the annual average construction and demolition emissions estimates because the annual average emissions output values were small enough that the majority were rounded to zero. The maximum of either the winter or summer daily emissions for each phase were multiplied by their respective phase lengths to approximate the annual emissions. GHG emissions calculated using this method were verified against the annual average emissions output, and the results were within the margin of error for rounding. Detailed tables showing these calculations are provided in Appendix D.

2.1.2 Off-Road Equipment

Off-road equipment types, quantity, sizes (horsepower), and usage schedules were provided by The University. Load factors for the various equipment types were edited using updated information from Table D-7 of Appendix D from the California Air Resources Board (CARB) Off-road Simulation Model (OSM) and Summary of Off-Road Emissions Inventory, "Original OFFROAD and New Load Factors (LF) by Equipment Type".

Fugitive dust emissions resulting from the operation of off-road equipment will be mitigated to the extent recommended in the 2011 BAAQMD CEQA guidance document. Based on the Basic Construction Mitigation Measures recommended by BAAQMD[4], a twice-daily exposed surface watering frequency was applied for all CalEEMod scenarios, which represents a fugitive dust control efficiency of approximately 55%.

2.1.2.1 Phase 1

The Phase 1 off-road equipment specifications assumptions are provided in Appendix A in Table A-2.

2.1.2.2 Full LRDP

It is assumed that in general, the same equipment types, quantities, and sizes will be used for the full LRDP as for Phase 1. As stated previously, the Phase 1 activity durations were adjusted using the ratio of annual average LRDP activity levels (gsf demolished or constructed) to the respective total Phase 1 activity levels. The full LRDP off-road equipment specifications are provided in Appendix C in Table C-2.

[4] 2011 BAAQMD CEQA guidance Section 8.1.2, Table 8-1, "Basic Construction Mitigation Measures Recommended for All Proposed Projects".

2.1.3 On-Road Vehicles

Emissions resulting from on-road vehicles are derived using CalEEMod. On-road fugitive PM_{10} emissions for the haul truck vehicle category are significantly overestimated in the CalEEMod output files on both a daily and annual basis. This results from the model inappropriately using the annual vehicle miles travelled (VMT) value for daily haul truck fugitive dust calculations, and multiplying that VMT value by the number of days per phase when generating the VMT value for annual haul truck fugitive dust calculations. Because the fugitive dust emission calculation methodology is a function of VMT, the emissions in the CalEEMod output file are post-processed according to the following equation, provided by Ian MacMillan of the SCAQMD, the agency overseeing the redevelopment of CalEEMod):

$$Corrected\ Fugitive\ PM_{10}\ Haul\ Truck\ Emissions = \frac{CalEEMod\ Fugitive\ PM_{10}\ Haul\ Truck\ Emissions}{Number\ of\ Days\ per\ Phase}\ x\ 2$$

This methodology was verified by performing the fugitive dust emission calculations independently of CalEEMod, utilizing the same input parameters, which resulting in comparable emission rates on both an hourly and annual basis.

Input data for the CalEEMod runs utilizes default trip distances and number of trips per vehicle type, with few exceptions, as explained in the following subsections.

2.1.3.1 Phase 1

For Phase 1, specific vehicle parameters were input for both soil importation and soil removal. Soil importation, occurring over a 7 month period near the beginning of Phase 1 construction, was included under the site grading portion of the model. As provided by The University, 70,000 yd^3 of soil are to be imported, which includes a total of 7,000 haul truck trips (10 yd^3 haul trucks), and a total of 500 “vendor” trips over the grading phase.

Contaminated soil removal was applied to the site grading phase, which was aligned with the building demolition timeline, as soil excavations must be completed before soil importation and building construction commence. The University provided a contaminated soil removal activity level of 275 haul truck trips, with a one-way trip length of 260 miles to reach the disposal facility. These values were applied to the site preparation line item so the appropriate trip length and phase duration could be applied.

CalEEMod default values were used for all other aspects of the Phase 1 on-road vehicle emission estimates.

2.1.3.2 Full LRDP

The University provided specific vehicle trip information for haul trucks used for the LRDP construction and demolition activities. CalEEMod defaults were used for worker and vendor trip information.

2.2 Operations

Emissions from operations were conservatively evaluated based on the level of activity at the end of the build-out period (2018 for Phase 1 and 2050 for the full LRDP), but with emission factors representative of equipment installed at the beginning of the build-out period (i.e. 2014). This approach was used to ensure that the assessments were conservative; although emission rates of equipment installed in future years are not known at this time, it is reasonable to assume that they will be less than or equal to those for equipment installed in 2014.

Only emissions from activities involving non-radiological materials were estimated. Emissions of radioactive materials from project operation activities associated with Phase 1 and full LRDP build-out were determined to have a less than significant impact for the following reason. As with other hazardous materials, the most probable potential pathway for public or environmental exposure to radioactive material would be air emissions from routine project operations. Based on historical data from operations at JGI, JBEI, ABPDU, Potter Street, and KBase, exposure to airborne radionuclides at the Richmond Bay Campus would be less than 0.1% of EPA and Department of Energy regulatory limits and less than 0.001% of the threshold below which risks of health effects are either too small to be observed or are nonexistent (http://hps.org/documents/risk_ps010-2.pdf).

2.2.1 Natural Gas Usage

Natural gas-fired boilers are projected for use in providing heat energy to occupied buildings. Annual natural gas usage was based on values provided in the project description.

The NO_X emission factor for natural gas boilers was based on the BAAQMD NO_X limit of 30 parts per million (ppm) for boilers greater than 10 MMBtu/hr heat input (BAAQMD Regulation 9, Rule 7). The remaining criteria emission factors were taken from AP-42 Chapter 1.4, and GHG emissions were estimated using the data from the EPA Mandatory Greenhouse Gas Reporting Rule, 40 CFR 98, Subpart C, Table C-1 “Default CO_2 Emission Factors and High Heat Values for Various Types of Fuel”, and Table C-2 “Default CH_4 and N_2O Emission Factors for Various Types of Fuel”.

To estimate TAC emissions from boilers, three sources of emission factors were used in order of descending preference. The first preferred source of emission factors for the boilers was the California Air Toxics Emission Factor (CATEF) database. Next, the Ventura County Air Pollution Control District (VCAPCD) emission factor database was analyzed for TAC emission factors not found in the CATEF

database. Lastly, AP-42 was consulted for TAC emission factors not found in either the CATEF or VCAPCD databases.

Emissions estimates were based on emission factors and estimated annual natural gas usage. Average daily emissions were estimated by dividing annual emissions by 260 operating days per year (5 days per week, 52 weeks per year).

2.2.1.1 Phase 1

The number and size of boilers associated with the Phase 1 occupied buildings were provided by The University. The quantitative boiler assumptions for Phase 1 are provided in Appendix E, Table E-1. Criteria pollutant and GHG emission estimates are provided in Appendix E Table E-8 and TAC emission estimates are provided in Appendix E Table E-16.

2.2.1.2 Full LRDP

Boiler sizes for the Full LRDP are provided by The University (including the Northern Regional Library Facility [NRLF] expansion). The annual natural gas consumption for each boiler was apportioned from the total facility natural gas usage based on boiler size (MMBtu/hr). The quantitative boiler assumptions for the Full LRDP are provided in Appendix F, Table F-1. Criteria pollutant and GHG emission estimates are provided in Appendix F Table F-8 and TAC emission estimates are provided in Appendix F Table F-16.

2.2.2 Emergency Generators

Emergency generators were assumed to meet EPA Tier 4 emission standards or better, except for the generator(s) at Buildings 6 and 7, which might be purchased by entities other than The University. The generator(s) at Buildings 6 and 7 were assumed to meet at least EPA Interim Tier 4 emission standards. These are reasonable assumptions for new generators given that Tier 4 standards will be in full effect around the time that Phase 1 build-out commences.

In general, the emission factors used to estimate diesel generator emissions were taken from Appendix D of the CalEEMod user's guide. The emission factor for SO_2 was derived based on the total sulfur content in ultra-low-sulfur diesel fuel, assuming 100% of the fuel sulfur content is converted to SO_2. Similarly, carbon dioxide emission rates were based on fuel usage and the estimated carbon content of diesel fuel. Methane emissions were based on a ratio to VOC emissions taken from the EPA AP-42 document.

Consistent with guidance from the CARB, since the toxicity of TACs emitted from diesel-fueled internal combustion sources is represented by the toxicity factor for DPM, this was the only TAC emission quantified for the emergency generators (equal to total particulate matter emissions).

2.2.2.1 Phase 1

The University provided estimated emergency generator sizes and locations for Phase 1 occupiable buildings.

LBNL has most recently installed generators that meet a particulate matter emission rate of 0.01 grams per horsepower-hour (g/hp-hr), so all generators, other than those for Buildings 6 and 7, were assumed to meet this particulate matter limit.

The quantitative generator assumptions are provided in Appendix E, Table E-1. Criteria pollutant and GHG emission estimates are provided in Appendix E Table E-9 and TAC emission estimates are provided in Appendix E Table E-17.

2.2.2.2 Full LRDP

The University provided estimated emergency generator sizes and locations for the LRDP occupiable buildings (including the NRLF expansion). The quantitative generator assumptions are provided in in Appendix F, Table F-1. Criteria pollutant and GHG emission estimates are provided in Appendix F Table F-9 and TAC emission estimates are provided in Appendix F Table F-17.

Aside from Buildings 6, 7, 8, and 9 which are accounted for in the previous section, all generators installed for the full LRDP are assumed to meet EPA Tier 4 final emission rates for applicable all pollutants. Sulfur dioxide, VOC, and GHG emissions are estimated as described previously.

2.2.3 Laboratory Chemicals

A potential inventory of laboratory chemicals and associated stored quantities was compiled by The University for the laboratories that could be present at the Phase 1 buildings at the RBC. The methodology described in the steps below was used for estimating emissions of chemicals from these laboratories. Note that this methodology is similar to that used to develop emissions estimates for laboratory chemicals for the 2006 LRDP Human Health Risk Assessment (HHRA) study for LBNL (SECOR, 2004). The emissions estimated using this method were applied to laboratories included in Phase 1.

Radionuclide and other radioactive materials were not considered under this methodology for the reasons discussed at the beginning of Section 2.2.

Step 1 – Identify Regulated Chemicals and Associated Quantities

The inventory of laboratory chemicals was initially screened against a list of available toxicity factors and the physical state (i.e., solid, liquid, or gas) of the chemical at room temperature. The list of toxicity factors was compiled from the CARB and California Office of Environmental Health Hazard Assessment

(OEHHA) Consolidated Table of Approved Risk Assessment Health Values (http://www.arb.ca.gov/toxics/healthval/contable.pdf).

For purposes of the remainder of this document, any chemical listed in the CARB/OEHHA Consolidated Table cited above will be considered a TAC for this study. The human health impacts of any other chemicals could not be assessed with California-approved toxicity factors and were, therefore, not assessed further.

Remaining chemicals classified as solids were also eliminated from consideration for emissions as they would generally be non-volatile and not be expected to be emitted in any appreciable quantity in a research laboratory setting.

For each remaining chemical, the next two steps in the process were used to determine a usage rate (Step 2) and an appropriate emission factor (Step 3) that could be multiplied together to obtain an emission rate.

Step 2 – Determine Chemical Usage

Usage was conservatively assumed to be equal to the quantity determined to be present in the chemical inventory multiplied by a usage factor. The usage factor was based on existing data summarizing historical chemical turnover rates (i.e., elapsed time between the purchase of a container of a chemical and the eventual disposal of the empty container).

To determine a conservative usage factor that could be applied to all chemicals, the database of historical turnover rates for all chemicals was analyzed. A single initial usage factor was determined as the 95th percentile highest turnover rate for the database. Through this analysis it was determined that the 95th percentile highest turnover rate was 311 days (i.e. each year approximately 365/311 = 1.174 times the chemical storage container quantity would be used). The data used to determine this factor is discussed in further detail in SECOR, 2004.

Although the use of the 95th percentile turnover rate in this method is likely to overestimate the usage of many of the laboratory chemicals, it greatly simplifies the initial estimates of chemical usage, and is appropriate for the initial HHRA. If during the course of performing the HHRA specific chemicals had been identified as contributing significantly to the risk estimates, these conservative usage assumptions could have been revisited on a selected subset of chemicals; however, this did not turn out to be an issue.

Step 3 – Determine Worst-Case Emission Factors for Each Chemical

For gaseous chemicals, it was conservatively assumed that 100% of the materials used were emitted to the atmosphere (i.e., an emission factor of 1.0 gram/gram was used). This discounts any potential chemical reaction or solubilization into liquids, but provides a convenient simplification that will always be conservative.

For liquid chemicals, a hybrid evaporative model was used to estimate chemical emissions to the atmosphere. This model accounts for both surface evaporation and splash loading (pouring) components of usage. Based on the required input data for these models, conservative assumptions concerning receiving vessel configuration, quantity used per event, initial vapor pressure, vapor pressure during use, event duration (usage time), and air flow were used to compute an emission factor which could be applied to each laboratory chemical (grams emitted per liter used).

The assumed vapor pressure during pouring was the vapor pressure of the chemical at approximately room temperature (295 degrees K). The vapor pressure during the surface evaporation period (30 minutes) for this worst-case use scenario was either:

1) The lesser of twice the room temperature vapor pressure or 100 mmHg for chemicals with vapor pressures less than or equal to 100 mmHg at room temperature (to account for possible heating of the material during use), or

2) The estimated vapor pressure of the chemical at 295 degrees K if it is greater than 100 mmHg (the assumption being that such a volatile compound would not be heated significantly in a vessel that is not connected to some type of condenser system as the material would otherwise evaporate completely in a relatively short period of time).

The specific details of the evaporative models used for liquid chemicals and the associated assumptions are provided in the calculation spreadsheet printouts in Appendix G.

Therefore, the following emission factors were used to calculate emissions of laboratory chemicals:

- **Gases** – 1.0 gram per gram used.
- **Liquids** – Chemical-specific emission factor based on the sum of the pouring and surface evaporation emission factors calculated from evaporative models (in units of grams per liter used).

Step 4 – Calculate Emissions

Annual emissions for each chemical were calculated by multiplying annual chemical usage by the chemical-specific emission factor.

The emission estimation approach discussed above results in estimated total annual emissions of chemicals used in laboratories at the facility. Since realistic short-term emissions from laboratory stacks could not be estimated directly from data tracked by The University, an alternate, conservative approach was devised to estimate potential worst-case acute exposure conditions. In this approach, annual facility-wide emission estimates were reduced to average hourly emission rates, which were then multiplied by a factor of 5.18, based on studies comparing maximum to average emission rates for laboratories. The data and studies used to derive this factor are presented in a preliminary human health risk assessment prepared for the University of California at Berkeley (URS, 2000).

2.2.3.1 Phase 1

A summary of the Phase 1 estimated TAC emissions from all laboratory chemicals (both liquid and gaseous) is provided in Appendix E in Table E-19.

2.2.3.2 Full LRDP

The Phase 1 chemical inventory was extrapolated to the full LRDP build-out based on the gross square footage of each research and development building. Emissions from each of the buildings in Phase 1 were summed on a chemical-by-chemical basis to calculate total individual chemical emissions. The total individual chemical emissions were then divided by the total gross square footage of the Phase 1 buildings to calculate a chemical emission factor in pounds of chemical per gross square foot of research and development space. Total gross square footage of research and development buildings in the full LRDP build-out were provided by The University.

In addition to these emission factors, The University provided a set of laboratory emission factors used previously for air quality studies for UCB laboratories for Type II (General Biological Sciences) laboratories. These emission factors varied from those estimated using the Phase 1 chemical inventories, being sometimes higher and sometimes lower. In addition, the UCB emission factors included two chemicals not found in the Phase 1 laboratories that had toxicity factors published by the CARB/OEHHA.

The University estimated that on average about 37 percent of the laboratory square footage in the illustrative LRDP would be well represented by the emission factors derived from the Phase 1 inventory and about 63 percent of the laboratory square footage would be well represented by the emission factors used previously for UCB laboratories. Therefore, for all laboratories evaluated in the illustrative LRDP,

TAC emission factors were based on a weighted (37:63) average of the emission factors from the Phase 1 inventory and those used previously for UCB laboratories. For example, the LRDP laboratory emission factor for formaldehyde was calculated as:

$$(0.37)(2.7 \times 10^{-8} \text{ tons/gsf/yr}) + (0.63)(1.7 \times 10^{-7} \text{ tons/gsf/yr}) = 1.1 \times 10^{-7} \text{ tons/gsf/yr}$$

Emissions were then based on the weighted average emission factors times the square footage of laboratories within each building.

The building square footage assumptions are provided in Appendix F in Table F-1. A summary of the LRDP estimated TAC emissions from laboratory sources are provided in Appendix F in Tables F-19.

2.2.4 Cooling Towers

The total particulate matter drift rate from the cooling towers was based on an assumed dissolved solids content, drift rate, and recirculation rate taken from data previously provided by LBNL for air quality assessments for the Computational Research and Theory building currently being constructed at the main LBNL site. The Riesemann and Frisbie method (Reisman & Frisbie, 2001) of calculating the PM_{10} fraction of total particulate matter was used; this is a mass balance method for total dissolved solids and the effect of water evaporation on aerosol particle size distribution.

Cooling tower water additives will be used to prevent scaling and biological growth in the cooling tower units. In some cases, these additives could include chemicals that are TACs, which can be emitted to the air through either volatilization or removal as a component of aerosol drift. One of the proposed biocides assumed for the Computational Research and Theory building contained sodium bromide, which is identified as a TAC (bromine compounds). In the absence of additional data, The University indicated that the same assumption would be appropriate for the current assessment. It was assumed that this bromine salt would primarily be emitted along with the aerosol drift from the cooling towers. The biocide manufacturer (ChemTreat, Inc.) indicated that the biocide would typically be used to maintain a total bromine concentration of one ppm. Therefore, bromine emissions from the cooling towers were estimated to be proportional to particulate emissions, based on the ratio of the bromine concentration (in ppm) to the total dissolved solids concentration (in ppm).

2.2.4.1 Phase 1

The number and sizes of cooling towers associated with the Phase 1 occupied buildings were provided by The University. The quantitative cooling tower assumptions are provided Appendix E, Table E-1. Criteria pollutant emission estimates are provided in Appendix E Table E-10 and TAC emission estimates are provided in Appendix E Table E-18.

2.2.4.2 Full LRDP

The number and sizes of cooling towers associated with the LRDP occupied buildings, including the NRLF expansion, were provided by The University. The quantitative cooling tower assumptions are provided in in Appendix F, Table F-1. Criteria pollutant emission estimates are provided in Appendix F Table F-10 and TAC emission estimates are provided in Appendix F Table F-18.

2.2.5 Delivery Trucks

Emission factors for delivery trucks anticipated during operation of the RBC were taken from EMFAC 2011 for the T6 Instate Small Diesel Truck (GVWR <= 26,000 lbs) for both on-road truck travel (in pounds of pollutant per vehicle mile travelled, or lbs/VMT) and stationary truck idling (in pounds per vehicle idle hour, or lbs/idle-hr). The vehicle weight class was chosen to be representative of a large UPS delivery truck size. A T6 Instate Small Diesel Truck is considered to be a conservative “average” delivery truck class representative of all delivery trucks at the RBC as it represents the upper end of the weight range anticipated for institutional facility deliveries. The on-road truck travel emission factor was multiplied by the number of trips and the miles per trip determined for each scenario. Although delivery trucks will likely turn off their engines when reaching their destination at the RBC, onsite delivery truck idling emissions are conservatively estimated for a maximum of 5 minutes of idling per trip (consistent with California’s Air Toxic Control Measure to limit diesel-fueled commercial motor vehicle idling).

Emission calculations were separated into onsite and offsite to facilitate the use of the emission estimates for modeling. Offsite vehicle trip distance of 7.3 miles per trip for the delivery trucks was taken from CalEEMod Appendix D Table 4.2 "Mobile Trip Characteristics Dependent on Location", for the Bay Area AQMD region. Delivery truck route is based on the urban commercial-NW category.

Trip lengths in CalEEMod are one way, so the value was doubled to account for round-trips. The onsite roundtrip distances discussed in the following subsections were subtracted from the offsite vehicle trip distance, which includes the onsite distance.

2.2.5.1 Phase 1

Onsite roundtrip distances for delivery trucks were based on the assumption that the trucks would enter on Seaver Avenue, and proceed onsite along 47th Street on the east side of the RBC properties to either of the two Phase 1 parking lots. Idling emissions were assumed to occur in or near the parking lots. Criteria pollutants and GHG emission estimates are provided in Appendix E Tables E-2 to E-4 for exhaust emissions and Tables E-6 to E-7 for road dust emissions, and TAC emission estimates are also provided in Appendix E Tables E-2 to E-4.

2.2.5.2 Full LRDP

Onsite routes were chosen based on the assumption that approximately one third of the total delivery trucks would service the western portion of campus, one third of the total delivery trucks would travel along the north-south campus service access round, and one third of the total delivery trucks would travel along the east campus access road. An average onsite trip length was calculated by averaging the onsite road segment lengths travelled by delivery trucks. Criteria pollutant and GHG emission estimates are provided in Appendix F Tables F-2 to F-4 for exhaust emissions and Tables F-6 to F-7 for road dust emissions, and TAC emission estimates (PM_{10} Exhaust = DPM) are also provided in Appendix F Tables F-2 to F-4.

2.2.6 Employee/Visitor Vehicles

Criteria pollutant emissions from employee and visitor vehicles travelling to the RBC site were estimated using emission factors (emissions per vehicle mile travelled) taken from the CARB EMFAC2011 emissions model for the LDA vehicle class.

Criteria pollutant emissions associated with cold starts, diurnal evaporative, hot soak evaporative, and resting losses were estimated using emission factors (emissions per vehicle per day) were also taken from the CARB EMFAC2011 emissions model for the LDA vehicle class.

Similar to delivery trucks, emission calculations were separated into onsite and offsite to facilitate the use of the emission estimates for modeling. The employee offsite vehicle trip distance was calculated according to the methodology outlined in CalEEMod Appendix A Section 5.1, Vehicle Trips, which states "The average VMT associated with a trip is adjusted by modifying the primary trip length to account for the reductions from pass-by and diverted trips". The primary trip length of 12.4 miles was taken from CalEEMod Appendix D Table 4.2 "Mobile Trip Characteristics Dependent on Location", for the Bay Area AQMD region. Employee vehicle route is based on the Home to Work (H-W) category. The primary trip percentage, diverted trip percentage, and pass-by trip percentage values were taken from CalEEMod Appendix D Table 4.3 "Mobile Trip Rates, Trip Purpose, Trip Type by Land Use" for the Commercial Land Use Type, and Research and Development Land Use Sub Type. The calculated modified trip length is 10.6 miles.

Trip lengths in CalEEMod are one way, so the value was doubled to account for round-trips. The onsite roundtrip distances discussed in the following subsections were subtracted from the offsite vehicle trip distance, which includes the onsite distance.

2.2.6.1 Phase 1

The onsite portion of the employee vehicle trips (for assignment to onsite source representations in the dispersion modeling) for Phase 1 was based on a conservative estimate of potential trip lengths on the

RBC site (0.7 miles round-trip) coming in on 47th Street along the eastern boundary of the RBC property, then into the RBC site just north of the Phase 1 parking lots. Criteria pollutant and GHG emission estimates are provided in Appendix E Tables E-2 to E-5 for exhaust emissions and Tables E-7 to E-8 for dust emissions, and TAC emission estimates are provided in Appendix E Tables E-12 to E-13.

2.2.6.2 Full LRDP

The onsite average trip distance used to estimate onsite employee vehicle emissions for the full LRDP was calculated by apportioning traffic to each road segment based on the number of parking spaces available in the parking structures being served by the onsite roads. A detailed accounting of the allocation is provided in Table F-26. The fraction of traffic for each road segment is multiplied by the road segment length, resulting in a "length fraction" for each road segment. The sum of the individual length fractions is the average onsite distance used to estimate onsite employee vehicle emissions. This distance represents the distance travelled by 100% of the employee vehicles while onsite. Criteria pollutant and GHG emission estimates are provided in Appendix F Tables F-2 to F-5 for exhaust emissions and Tables F-6 to F-7 for road dust emissions, and TAC emission estimates are provided in Appendix F Tables F-12 to F-13.

2.2.7 Shuttles

Information on shuttle routes and schedules was provided by The University. Two shuttle routes will service the RBC. One route will travel between the main LBNL campus and the RBC. The other route will travel between the El Cerrito Plaza Bay Area Rapid Transit (BART) station and the RBC. Shuttles will be equivalent to a Ford E150 XLT 15 passenger van. Based on the vehicle specifications, the EMFAC vehicle class chosen to represent the shuttles is Medium-Duty Trucks (5,751 – 8,500 lbs, gasoline fueled), or MDV.

2.2.7.1 Phase 1

Shuttle route and schedule information for Phase 1 are provided by The University. The quantitative shuttle assumptions are provided in Appendix E, Table E-1. Criteria pollutants and GHG emission estimates are provided in Appendix E Tables E-2 to E-4 for exhaust emissions and Tables E-6 to E-7 for road dust emissions, and TAC emission estimates are provided in Appendix E Tables E-14 to E-15.

2.2.7.2 Full LRDP

The shuttle route and schedule information remains unchanged from Phase 1. Criteria pollutant and GHG emission estimates are provided in Appendix F Tables F-2 to F-4 for exhaust emissions and Tables F-6 to F-7 for road dust emissions, and TAC emission estimates are provided in Appendix F Tables F-14 to F-15.

2.2.8 Indirect Greenhouse Gas Emission Sources

Indirect GHG emissions were estimated utilizing multiple methodologies. Emissions due to the generation of electricity used by the facility were estimated by multiplying the electricity demand of the project when constructed (provided by The University) by a CO_2 intensity factor, published by PG&E, the local utility. The intensity factor is for the year 2018, which is the first year of operation for Phase 1. Indirect emissions due to water use, wastewater treatment, and solid waste disposal, were generated using CalEEMod, which estimates the emissions based on region-specific emissions data. Where available, project-specific water usages provided by The University were used as inputs into the model. The remaining indirect GHG emissions generated were estimated using CalEEMod default values. Appendix H contains the Phase 1 indirect GHG emission data. Full LRDP indirect GHG emission data is provided in Appendix I.

2.2.8.1 Phase 1

Indirect GHG emissions estimated using CalEEMod for Phase 1 are based on a RBC population of 1,000 employees and Phase 1 building space of 600,000 gsf, as outlined in the project description.

2.2.8.2 Full LRDP

Indirect GHG emissions estimated using CalEEMod for the Full LRDP are based on a RBC population of 10,000 employees and occupiable building space of 5,100,000 gsf, as outlined in the project description.

In order to compare these emissions to the BAAQMD GHG thresholds, credit was taken for the reduction in natural gas usage by the 667 employees that will transfer to the RBC from the hill campus. It is assumed that these employees will not be replaced at the hill campus, so the GHG emissions attributable to the transferring employees will “offset” their portion of the emissions occurring due to the operation of the proposed facilities at the RBC. Offsets were similarly accounted for in comparing indirect GHG emissions due to electricity usage and employee vehicle trips. Offsets are assumed for employee vehicle trips because the transferring employees would already be making their commute and trips, so these emissions are not attributable to the project. It is estimated that over 2,000 trips per day will occur at RBC at an estimated population increase of 1,000 employees, so it is assumed that there are two trips per employee. Offsets from stationary sources (direct GHG emissions) were also accounted for by multiplying the total stationary GHG emissions by the ratio of offset fuel usage to total fuel usage. A detailed accounting of the GHG offsets is shown in Appendix J.

2.3 Cumulative Sources

Emissions of $PM_{2.5}$ and TACs were also needed for the cumulative impact assessments for ambient $PM_{2.5}$, excess cancer risk, and chronic hazard. Impacts from other existing cumulative sources were provided by the BAAQMD as discussed further in Section 4.4; calculation of emission rates was not necessary for inclusion of these sources in the cumulative impact assessments.

2.3.1 Existing Richmond Field Station Sources

Data were provided by the University for existing $PM_{2.5}$ and/or TAC emission sources at the Richmond Field Station that would likely still be present after completion of the Phase 1 and/or illustrative LRDP development. These sources can be summarized as follows:

- Existing standby generator and diesel fire pump engine at Building 400
- Existing standby generator at Building 194 (not in full LRDP build-out)
- Laboratory emissions at Buildings 154, 158, 167, 450, 473, 474, 478, and 480 (not in full LRDP build-out except at Building 400)
- Natural gas boilers at Buildings 400, 451, 452, 454, 472, 477, 478, 480, and 484 (not in full LRDP build-out)
- Emissions from off-road mobile diesel vehicles used for site maintenance (level of activity doubled for full LRDP build-out)
- Gasoline dispensing from on-site storage tank (throughput doubled for full LRDP build-out)

Emissions for these sources were estimated using the same methods discussed in Section 2.2 above. The only new source type was gasoline dispensing; emissions for this source were estimated using methods developed by the South Coast Air Quality Management District.[5]

The emission calculations for these sources are provided in Appendix K (non-laboratory emission sources) and Appendix L (laboratory emissions).

2.3.2 Next-Phase Sources

In order to include potential cumulative impacts from all reasonably foreseeable emission sources, The University also provided information on potential development beyond Phase 1 (i.e. additional development under the Illustrative Development Scenario). This development included:

- Adding two additional office/research and development buildings in the Illustrative Development Scenario (Buildings 10 and 11).
- Adding one parking garage in the Illustrative Development Scenario (P1).
- Increasing the assumed onsite population from 1,300 to 1,700.

[5] Currently published at http://www.aqmd.gov/aer/Updates/GuideExManuallyRptTankEmis.pdf.

Since Phase 1 construction/demolition represents the highest level of such activity in the LRDP, construction/demolition was not considered for the development of the next-phase sources (called Phase 2 development for purposes of this report).

Phase 2 source emissions were most easily estimated by adding to the Phase 1 emissions inventory. Additionally, dispersion modeling of Phase 2 sources was accomplished by adding them to the cumulative models for Phase 1. As a result, the emissions estimates for Phase 2 sources are included in the emissions inventory tables provided in Appendix M, which includes both Phase 1 and Phase 2 emission sources for operations.

3.0 DISPERSION MODELING METHODOLOGY

3.1 General

Dispersion modeling was performed as part of the air quality impact analysis for the Project in order to perform HHRA estimates. The dispersion modeling was used along with TAC emission estimates in the CARB HotSpots Analysis and Reporting Program (HARP) On-Ramp software to produce annual and hourly TAC concentrations at specified model receptor locations as input to the HARP risk assessment model.

3.1.1 Dispersion Model Used

The EPA AERMOD dispersion model (version 12345) was used for this analysis using the regulatory default options. The model was executed using source representations, meteorological data, terrain data, and building dimensions as described in following sections.

3.1.2 Source Representations

Numerical source representations were used to model the release of TACs from one or more emission points. These source representations are summarized for Phase 1 in Table 3-1 (construction and demolition) and Table 3-2 (operations), for the LRDP in Table 3-3 (construction and demolition) and Table 3-4 (operations), and for cumulative sources in Table 3-5 ("Phase 2" operations) and Table 3-6 (existing Richmond Field Station operations), and are discussed in the following sections.

3.1.2.1 Construction and Demolition

Source locations for modeling emissions from construction and demolition activities in Phase 1 are presented in Figure 3-1. Source locations for modeling emissions from construction and demolition activities in the LRDP are presented in Figure 3-2 (for annual maximum impacts) and Figure 3-3 (for lifetime cancer risk impacts). The following subsections describe the parameters used to represent sources of emissions in the dispersion modeling for construction and demolition activities.

3.1.2.1.1 Onsite Off-Road Mobile Sources

Emissions from off-road mobile equipment associated with construction and demolition activities (e.g. excavators, graders, loaders, dozers, etc.) will consist of both $PM_{2.5}$ emissions associated with fugitive dust and DPM emissions from engine tailpipes. For purposes of dispersion modeling, consistent with 2011 BAAQMD CEQA guidance, only engine tailpipe emissions were modeled.

Because emissions from mobile equipment would occur over a given area travelled by the equipment over the averaging period being assessed, an area polygon source representation was used in the model. The area polygon source was set with a release height of 1.5 meters and an initial vertical dispersion of one meter to account for the initial velocity and turbulence associated with the release.

For Phase 1, the area polygon source representing exhaust emissions from construction and demolition activities (source ID P1_EXHST) was placed on the southern edge of the developed area at the site (see Figure 3-1). The area polygon source included areas of demolished buildings, newly constructed buildings, and newly constructed roads.

Three different source representations were used to represent construction and demolition activities in the full LRDP scenario. Dispersion modeling conducted for resident chronic hazard and annual $PM_{2.5}$ assessments assumed a single area source (source ID AREA7). The area source represents the construction and demolition activities that could possibly occur in one year since these assessments are based on a "worst case" annual simulation. This size of the area source was based on the total area of construction and demolition activities over the entire LRDP period, divided by the number of years that construction and demolition would occur. Several different locations within the facility property were assessed in order to determine the worst-case location of the area source. Of the 11 locations assessed, AREA7 was determined to result in the highest offsite concentrations at resident receptor locations. The locations of sources used for resident chronic hazard assessments are presented in Figure 3-2.

Similarly, for worker chronic hazard assessments, a different area source was used to represent emissions form construction and demolition activities (source ID AREA3). Of the 11 locations assessed, AREA3 resulted in the highest offsite concentrations at worker receptor locations. The locations of sources used for offsite worker chronic hazard assessments are presented in Figure 3-3.

To assess excess cancer risk, the entire area over which construction and demolition activities would occur during the full LRDP were modeled using three area sources. The roads included in this model were all the perimeter roads in the full LRDP as it was assumed that all of the roads would be used to access areas of construction and demolition at some point within the full LRDP period. The locations of the area sources are presented in Figure 3-4.

3.1.2.1.2 Offsite/Onsite On-Road Mobile Sources

Emissions from offsite and onsite on-road vehicles will consist of both $PM_{2.5}$ emissions associated with fugitive dust and DPM emissions from engine tailpipes. For purposes of dispersion modeling, consistent with 2011 BAAQMD CEQA guidance, only engine tailpipe emissions were modeled. Emissions will occur along both on-site and off-site roads.

To represent emissions occurring during vehicle travel along roads, line sources consisting of a series of volume sources placed along the road were used. Line sources were defined consistent with the methodology presented in the EPA memo dated March 2, 2012, titled "Haul Road Workgroup Final Report Submission to EPA-OAQPS" (Haul Road Memo), a conservative approach to representing tailpipe emissions. An assumed average vehicle height of 2 meters was used in defining the line sources. Roads

were either defined as being 7 meters wide (narrow roads) or 15 meters wide (wide roads). All roads were assumed to be two lane roads.

Lines source lengths were consistent with the methodology used to estimate emissions from haul truck travel over roads (see Section 2.1.3).

For Phase 1 and the full LRDP, wide road line sources were placed along Meade Street from both the north and south approach to Seaver Avenue. Narrow road line sources were then used along all other roads (see Figure 3-1 for Phase 1 source locations, and Figures 3-2, 3-3, and 3-4 for full LRDP source locations).

Source parameters for the volume line sources used to represent emissions from on-road mobile sources are presented in Table 3-1 (Phase 1 source parameters) and Table 3-3 (full LRDP source parameters).

3.1.2.2 Operations

Source locations for modeling emissions from operation of Phase 1 sources are presented in Figure 3-5 Source locations for modeling emissions from operation of sources in the full build-out of the LRDP are presented in Figure 3-6. The following subsections describe the parameters used to represent sources of emissions in the air dispersion model.

3.1.2.2.1 Boilers

Natural gas boiler emissions were simulated as point sources. Boiler emissions are described above in Section 2.2.1 and were associated with individual buildings. Conservative stack parameters were compiled based on previous studies conducted by Golder as follows:

Parameter	Value
Height	3.05 meters (10 feet) above building height
Diameter	Adjusted to maintain exit velocity at 4.95 meters per second
Velocity	4.95 meters per second (16.2 feet per second)
Temperature	366.5 °K (200 °F)

The diameter adjustment made to each boiler was based on data acquired for a 12 MMBtu per hour natural gas boiler with a 0.46 meter stack diameter achieving a 4.95 meter per second exhaust velocity. The adjusted diameter for other boilers assumed that the exhaust stack cross-sectional area was proportional to maximum boiler heat input.

3.1.2.2.2 Emergency Generators

Emergency generator exhaust emissions were simulated as point sources. Emergency generator emissions are described above in Section 2.2.2 and were associated with individual buildings. Each building was assigned one or two emergency generators. Since actual emergency generator stack parameters were not available, conservative stack parameters were used for all emergency generators, and were based on the projected size of the emergency generator

The release parameters for all emergency generators are included in Table 3-2 for Phase 1 and Table 3-4 for the LRDP. Emergency generator source locations are shown in Figure 3-5 for Phase 1 and in Figure 3-6 for the LRDP.

3.1.2.2.3 Laboratory Fume Hood Exhausts

Laboratory fume hood exhaust emissions were simulated as point sources. Laboratory emissions are described above in Section 2.2.3 and were associated with individual buildings. Each building was assigned one laboratory stack, and all TAC emissions for that building were allocated to the associated stack. Since actual laboratory stack parameters were not available, conservative parameters were used for all laboratory stacks as follows:

Parameter	Value
Height	3.05 meters (10 feet) above building height
Diameter	1.0 meters (3.28 feet)
Velocity	10 meters per second (32.8 feet per second)
Temperature	293.15 °K (68 °F)

The release parameters for all laboratory stacks are included in Table 3-2 for Phase 1 and Table 3-4 for the LRDP. Laboratory stack source representation locations are shown in Figure 3-5 for Phase 1 and in Figure 3-6 for the LRDP.

3.1.2.2.4 Cooling Towers

Cooling tower exhaust emissions were simulated as point sources. Cooling tower emissions are described above in Section 2.2.4 and were associated with individual buildings. Each building was assigned a number of cooling tower sources depending on the size of the building. All TAC and $PM_{2.5}$ emissions for that building were divided equally among the associated cooling tower stacks. Since actual cooling tower stack parameters were not available, conservative parameters were used for all cooling tower stacks as follows:

Parameter	Value
Height	6.10 meters (20 feet) above building height
Diameter	2.5 meters (8.2 feet)
Velocity	10 meters per second (32.8 feet per second)
Temperature	10 °C (18 °F) above ambient

The release parameters for all cooling tower stacks are included in Table 3-2 for Phase 1 and Table 3-4 for the LRDP. Cooling tower source locations are shown in Figure 3-5 for Phase 1 and in Figure 3-6 for the LRDP.

3.1.2.2.5 Offsite/Onsite On-Road Mobile Sources

Emissions from offsite and onsite on-road mobile sources were represented using a series of volume sources along the road. The source representations were developed using the same methodology discussed previously in Section 3.1.2.1.2.

Source parameters for the volume line sources used to represent emissions from on-road mobile sources are presented in Table 3-2 (Phase 1 source parameters) and Table 3-4 (full LRDP source parameters). Source locations are presented in Figure 3-5 for Phase 1 and Figure 3-6 for full LRDP.

3.1.2.3 Cumulative Source Operations

Dispersion model source representations for existing emission sources at the Richmond Field Station described in Section 2.3.1 above are provided in Table 3-5.

Dispersion model source representations for emission sources included in the “Phase 2” development described in Section 2.3.2 above are provided in Table 3-6.

3.1.3 Meteorological Data

Meteorological data for use in the AERMOD dispersion model were obtained by processing data provided by the BAAQMD, which include on-site, surface, and upper air meteorological data as well as surface characterization data from the EPA AERSURFACE model. The meteorological data provided by BAAQMD covered the period beginning on January 1, 2003 through December 31, 2006 and all of the 2008 calendar year (meteorological period). Data were not provided for the 2007 calendar year due to low data quality.

The latest version of AERMET (version 12345) was used to process the data provided by the BAAQMD and generate AERMOD-ready meteorological files (both *.SFC and *.PFL files). The meteorological data processing was conducted in accordance with the guidance provided by the BAAQMD[6].

A wind rose for the meteorological period is provided in Figure 3-7.

3.1.3.1 On-site Meteorological Data

On-site data were collected at the "UC Richmond" meteorological station operated by the BAAQMD. These data were provided in space-delimited text files for the meteorological period. The BAAQMD provided the necessary FORTRAN "read" and "format" statements required by AERMET to process on-site data. The on-site data included the following:

- Station atmospheric pressure,
- Solar radiation (insolation),
- Temperature,
- Wind speed,
- Wind direction,
- Relative humidity,
- Dew point temperature, and
- Standard deviation of the horizontal wind direction (sigma theta).

3.1.3.2 Surface Meteorological Data

Surface meteorological data from the Oakland International Airport were provided by the BAAQMD for the meteorological period. Data were provided in the Integrated Surface Hourly Data (ISHD) format. Additional surface data were needed since the on-site data did not include cloud cover readings, required by AERMET to process the parameters in the on-site data set.

Consistent with BAAQMD guidance, missing on-site data (other than cloud cover) were not substituted with surface data from Oakland.

3.1.3.3 Upper Air Meteorological Data

Upper air meteorological data from the Oakland International Airport were provided by the BAAQMD for the meteorological period. Upper air data are used to determine temperature gradients and wind data governing plume dispersion in the AERMOD model at higher elevations above ground level. Data were provided in the Forecast Systems Laboratory (FSL) format. Consistent with BAAQMD guidance, the "MODIFY" keyword was not used when processing upper air data; this use of this keyword would otherwise have AERMET make certain modifications to the upper air data related to soundings at specific

[6] BAAQMD Guidance for meteorological data processing provided by James Cordova via email on January 28, 2013.

heights, wind directions during hours with zero wind speed, and interpolation of missing ambient and dew point temperatures as the data are read in.

3.1.3.4 AERSURFACE

The land use characteristics surrounding the UC Richmond meteorological station were provided by the BAAQMD. The BAAQMD executed the EPA AERSURFACE program (version 08009) for each year of the meteorological period. AERSURFACE was used to generate monthly values for albedo, Bowen ratio, and surface roughness heights. The BAAQMD provided AERSURFACE output files which were used by AERMET directly. There were no changes to the AERSURFACE output files provided by the BAAQMD.

3.1.4 Modeling Domain Terrain Data

Terrain elevation data was taken from Digital Elevation Model (DEM) data produced by the U.S. Geological Survey. DEM files with a 7.5 minute (30 meters) resolution were used to determine elevations of receptors and base elevations of downwash structures and sources.

3.1.5 Building Downwash

Building downwash affecting point source emissions was accounted for using the EPA Building Profile Input Program (BPIP) software (version 04274). Building structures within 5L of any point source representation in the model (where L is the lesser of the building height or maximum projected width) were included in the BPIP analysis. The BPIP program generates direction-specific downwash parameters for each point source that are then input to the AERMOD model (AERMOD only accounts for building downwash for point source representations).

Dispersion modeling of construction and demolition emissions for both the Phase 1 and LRDP scenarios did not include any point sources. Since AERMOD only accounts for building downwash for point sources, downwash was not assumed in construction and demolition dispersion modeling.

Downwash structures defined for the dispersion modeling of the Phase 1 operations scenario are presented in Figure 3-8, with the height of each structure detailed in Table 3-5. Downwash structures defined for the dispersion modeling of the LRDP Operations scenario are presented in Figure 3-9, with the height of each structure detailed in Table 3-6.

3.2 Human Health Risk Assessment Modeling

Potential human health risk assessment impacts were evaluated for the construction and operation phases of the Phase 1 and full LRDP build-out using the methodologies detailed below.

3.2.1 Assessments Performed

The following receptor-based human health impact assessments were performed based on exposure point concentrations determined by air pollutant dispersion modeling:

Construction/Demolition Activities

- LECR (for offsite residential receptors)
- LECR (for offsite occupational worker receptors)
- LECR (for onsite occupational worker receptors [Phase 1 only[7]])
- Chronic hazard (for offsite residential receptors)
- Chronic hazard (for offsite occupational worker receptors)
- Chronic hazard (for onsite occupational worker receptors [Phase 1 only[8]])
- $PM_{2.5}$ annual average (offsite residential receptors)

Acute impacts were not assessed for construction/demolition activities since the primary TAC emitted is DPM, and CARB has indicated that the majority of the potential toxicity from DPM is captured in the chronic assessments (CARB 2003).

These assessments included all TAC emission sources discussed in this section.

Operation Activities

- LECR (for offsite residential receptors)
- LECR (for offsite occupational worker receptors)
- LECR (for onsite occupational worker receptors)
- Chronic hazard (for offsite residential receptors)
- Chronic hazard (for offsite occupational worker receptors)
- Chronic hazard (for onsite occupational worker receptors)
- Acute hazard (for offsite receptors)
- Acute hazard (for onsite receptors)
- $PM_{2.5}$ annual average (offsite residential receptors)

These assessments were conducted for the site configuration evaluated after completion of either the Phase 1 or full LRDP build-out.

[7] For the full LRDP build-out, it was not possible to represent the full range of locations where construction might be occurring overlaid with the range of locations where occupational workers in onsite buildings might be present. Onsite source-receptor geometries will change during every year of development in ways not currently known with any certainty.

[8] Ibid.

These assessments included all TAC emission sources discussed in this section.

3.2.2 Receptor Grids

The receptors in the AERMOD model were placed in locations representing the types of human receptors identified in the previous section. The locations of these receptors were determined as follows:

3.2.2.1 Offsite Residential Receptors

Offsite residential receptors were located based on data purchased from the Contra Costa County Assessor's Office. Parcel Point data were extracted by County staff, and included X-Y data elements with associated land use codes. The land use codes were used to define each element. Based on the land use codes, school parcels that were play areas or open spaces, and vacant lots were removed from the data array. An example of the offsite residential is presented in Figure 3-10.

3.2.2.2 Offsite Occupational Worker Receptors

The offsite occupation receptor grid was generated by first constructing a tiered Cartesian grid, centered on the facility, with the following dimensions:

- 1,800 by 1,800 meters with receptors spaced 25 meters apart,
- 3,000 by 3,000 meters with receptors spaced 150 meters apart, and
- 5,000 by 5,000 meters with receptors spaced 250 meters apart.

Receptors were removed from within the RBC property line, including the area extending out to the opposite side of adjacent roads to the facility property. Where sources were used to simulate emissions from vehicles traveling on roadways extending out from the property, receptors were removed from the roadways and adjacent areas that did not include structures (parking lots, freeway medians, sidewalks, tidal marshlands, etc…). Based on the difference in modeled roadways between the Phase 1 and LRDP scenarios, two different offsite occupational worker receptors grids were generated using the same methodology as just described. An example offsite occupational worker receptor grid is presented in Figure 3-11.

3.2.2.3 Onsite Occupational Worker Receptors

The onsite occupation receptor grid was generated by first constructing a Cartesian grid of discrete receptors spaced 10 meters apart. Receptors were removed from areas that would not be occupied by occupational workers.

For Phase 1, receptors were left on buildings immediately adjacent to the Phase 1 area. These buildings are existing, would not be part of the Phase 1 development, and would be occupied during both the construction/demolition and operation scenarios for Phase 1. The onsite occupational receptor grid used for Phase 1 modeling scenarios is presented in Figure 3-12

For the full LRDP operations scenario, receptors were placed on occupied downwash structures (buildings) that will be constructed in the future. Receptors were not placed on downwash structures that will not be occupied, such as parking garages. Figure 3-13 presents the onsite occupational receptor grid used for LRDP modeling. The blue outlines define the downwash structures.

Onsite occupational worker receptors were not evaluated for construction/demolition activities for the post-Phase 1 portion of the LRDP because the exact timing of building construction and demolition is unknown, so it's not possible to know what buildings might be present near construction/demolition activities after the completion of Phase 1.

3.2.2.4 Offsite Acute Receptors

The offsite acute receptor grid was generated using the same general methodology used to generate the offsite occupational worker receptor girds, previously discussed in Section 3.2.2.2. First a tiered Cartesian grid was constructed, centered on the facility, with the following dimensions:

- 1,800 by 1,800 meters with receptors spaced 25 meters apart,
- 3,000 by 3,000 meters with receptors spaced 150 meters apart, and
- 5,000 by 5,000 meters with receptors spaced 250 meters apart.

Receptors were removed from within the facility property line. Receptors were not removed from areas that the public could be reasonably expected to access. In Phase 1, a public road bisected the facility property. Rectors were retained along this roadway since the public could be reasonably expected to access it. The offsite acute receptor grid used in the Phase 1 modeling is presented in Figure 3-14.

In the full LRDP scenario, the road bisecting the facility property will be removed as part of the site development plan. The receptors used in the Phase 1 modeling along this road have been removed from the receptor grid used in the LRDP modeling. This acute offsite receptor grid used in the full LRDP modeling is presented in Figure 3-15.

3.2.2.5 Onsite Acute Receptors

The onsite acute receptor grid was generated using the same general methodology used to generate the onsite occupational worker receptor girds, previously discussed in Section 3.2.2.3. A Cartesian grid of discrete receptors spaced 10 meters apart was constructed. Receptors were removed from areas outside of the facility property boundary and areas where the public could reasonably access. The onsite acute receptor grid used in Phase 1 modeling is presented in Figure 3-16. The onsite acute receptor grid used in the full LRDP modeling is presented in Figure 3-17.

3.2.2.6 $PM_{2.5}$ Sensitive Receptors

The receptor grid used in dispersion modeling of $PM_{2.5}$ emissions was the same grid previously discussed in Section 3.2.2.1 for offsite residential receptors.

3.2.3 HARP Model

AERMOD dispersion modeling was conducted using unit emission rates for each source adjusted consistent with guidance provided with the CARB HARP On-Ramp software. The HARP On-Ramp program generated a matrix of unit emission rate ground level concentrations for each emission source included in the AERMOD model.

The CARB HARP software (Version 1.4f) then multiplied actual estimated annual or hourly emission rates for each source and TAC by the unit emission rate value in the HARP On-Ramp matrix to produce source- and TAC-specific modeled concentrations (exposure point concentrations) for use in the risk assessment calculations. The HARP software accessed the most recent HARP health database (database of dose-response factors provided by CARB) to convert TAC concentrations to estimated LECR or chronic/acute health hazard.

3.2.3.1 Breathing Rate

For LECR calculations for residential receptors, the "*Derived (Adjusted)*" method based on the 80th percentile breathing rate was used as recommended by CARB and OEHHA.[9] All other assessments used the default HARP assessment methodology for breathing rate.

3.2.3.2 GLC Adjustment Factor

For chronic assessments, the HARP model by default will assume that the receptors are exposed to the annual average concentration resulting from source emissions, even if those emissions are periodic throughout the day. As discussed in the HARP user's guide, a ground level concentration (GLC) adjustment factor should be used for chronic assessments of occupational worker exposure when the source emissions are not constant during each hour of each day of the year. Since construction/demolition and operation activities are not expected to occur 24 hours per day or 7 days per week, such an adjustment factor should be used.

A conservative factor was based on an assumption of 12 hours of operation per day and 5 days per week (note that for activities occurring over more than 12 hours per day or 5 days per week, the GLC adjustment factor would actually be lower). If exposed occupational workers are conservatively estimated to work only 8 hours per day and 5 days per week (overlapping with the 5 days that the Project could be operating), a worst-case GLC adjustment factor can be estimated as follows:

[9] Interim Policy: http://www.arb.ca.gov/toxics/harp/rmpolicyfaq.htm.

(24 hrs/day)/(12 hrs/day) x (7 days/week)/(5 days/week) = 2.8

This GLC adjustment factor was used for all chronic HARP assessments for occupational worker exposure.

3.2.3.3 Exposure Pathways

In all HARP model runs, the inhalation exposure pathway was assessed. In addition, the following non-inhalation exposure pathways were allowed with default parameters:

- Ingestion of home-grown produce (residents only)
- Dermal absorption from soil
- Ingestion of soil
- Ingestion of mother's milk

These were estimated to be the only significant non-inhalation exposure pathways that might be influenced by the maximum ambient air impacts from Project TAC emissions, and would only be applicable to those TACs considered by the HARP model to be multipathway pollutants.

3.2.4 Application of Age Sensitivity Factors

Consistent with BAAQMD risk assessment guidance (BAAQMD 2012), age sensitivity factors were considered when estimating LECR for residential receptors. These factors represent multiplicative coefficients to the carcinogenic effect due to exposure to TACs assumed to be human carcinogens. These factors are applied as follows:

- Factor of 10 for exposure during the third trimester of pregnancy to two years of age.
- Factor of 3 for exposure occurring from age two through age 15.

All subsequent years of exposure have presumed cancer risk effects that are unmodified from that suggested by the unit risk factor associated with the carcinogen.

For the assumed 70 year exposure duration used for estimating LECR for project operations, this simply results in applying a weighted age sensitivity factor of 1.7 to the LECR value determined by the HARP model.

In the case of construction/demolition activities, the age sensitivity factors were applied year-by-year to the weighted contributions to LECR predicted by the HARP model based on emissions for that year. For example, Phase 1 construction/demolition activities were estimated to occur over a period of two years; emissions for each of these years were estimated separately. However, the HARP model output for each

of these two years' emissions assumes 70 years of exposure, so LECR is over-predicted by a factor of 70 for each year. Therefore, the contribution to LECR from each year of exposure is calculated as:

[Age Sensitivity Factor (Year i)] x [HARP LECR (Year i]) / 70

The calculated values from each year of exposure were then summed to obtain the total LECR.

For each of the two years of Phase 1 construction/demolition, the age sensitivity factor was 10. For purposes of the LECR estimates, it was estimated that full implementation of Phase 1 would take four years.

In the case of construction/demolition activities for the full LRDP build-out, it was estimated that there would be an additional 32 years of construction/demolition emissions (years 5 through 36). This results in a total age sensitivity factor of (56.5/70) = 0.81 applied to the HARP LECR value (which is based on 70 years of exposure to the LRDP emission level and includes no age sensitivity factors). Unlike Phase 1, emissions from construction/demolition activities for the remainder of the LRDP build-out were assumed to be the same for each year.

Because Phase 1 is part of the full LRDP build-out, the LECR for the full LRDP was calculated as the sum of the LECR from Phase 1 and the LECR for the remainder of the LRDP.

4.0 ASSESSMENT RESULTS

This section presents the results of the assessments performed for this report. Although this section does not compare the results to any specific thresholds of significance that might be applicable under CEQA (leaving these comparisons to the overall impact reports prepared for this program), the results are presented in formats that are likely to be comparable to such thresholds that might be used. In particular, an effort has been made to present results in formats that would be comparable to CEQA significance thresholds published by the BAAQMD in 2011, which may be used for this project.

4.1 Criteria Pollutant Impacts

Criteria pollutant emissions from the construction and operation phases of the Phase 1 and full LRDP build-out were estimated as described in Section 2.0 above. These emissions are summarized in this section for ease of comparison to potential thresholds of significance.

4.1.1 Phase 1 Construction

Criteria pollutant emissions from Phase 1 construction activities are summarized in Table 4-1 by source category for the single year estimated to have the highest emissions. Emissions are provided on an annual total tonnage and average pound per day basis. PM_{10} and $PM_{2.5}$ average pounds per day include only exhaust emissions, consistent with thresholds of significance provided by the BAAQMD in 2011.

Emissions in this table are associated with tailpipe emissions from on-road vehicles and off-road equipment.

4.1.2 Phase 1 Operations

Criteria pollutant emissions from Phase 1 operations are summarized in Table 4-2 by source category for operations anticipated after completion of Phase 1. Emissions are provided on an annual total tonnage and average pound per day basis.

The majority of the criteria pollutant emissions in this table are from onsite boilers, onsite/offsite on-road vehicle tailpipe emissions, and onsite/offsite fugitive road dust.

4.1.3 LRDP Construction

Criteria pollutant emissions from full LRDP build-out construction activities are summarized in Table 4-3 by source category for a typical year. Emissions are provided on an annual total tonnage and average pound per day basis. PM_{10} and $PM_{2.5}$ average pounds per day include only exhaust emissions, consistent with thresholds of significance provided by the BAAQMD in 2011.

Emissions in this table are associated with tailpipe emissions from on-road vehicles and off-road equipment.

4.1.4 LRDP Operations

Criteria pollutant emissions from full LRDP build-out operations are summarized in Table 4-4 by source category for operations anticipated after completion of the LRDP. Emissions are provided on an annual total tonnage and average pound per day basis.

The majority of the criteria pollutant emissions in this table are from onsite boilers, onsite/offsite on-road vehicle tailpipe emissions, and onsite/offsite fugitive road dust.

4.2 Human Health Impacts

TAC and maximum annual average $PM_{2.5}$ emissions from the construction and operation phases of the Phase 1 and full LRDP build-out were estimated as described in Section 2.0 above. These emissions were used to complete air quality dispersion modeling assessments as described in Section 2.0 above to estimate maximum potential ambient concentrations at appropriate sensitive receptor sites. In the case of TACs, these concentrations were used in the CARB HARP model to estimate maximum LECR, chronic hazard, and acute hazard where appropriate.

4.2.1 Phase 1 Construction

Modeled maximum annual $PM_{2.5}$ concentrations, LECR, and chronic hazard from Phase 1 construction activities are summarized in Table 4-5 for the single year estimated to have the highest emissions (except for LECR, which was based on total exposures over the multi-year Phase 1 construction period). Acute hazard impacts were not estimated, as the primary source of TAC emissions for this scenario come from diesel engines, the toxicity of which is adequately represented through the LECR and chronic hazard assessments (CARB, 2003).

The primary contributor to LECR, chronic hazard, and $PM_{2.5}$ results in this table is from DPM from onsite off-road diesel equipment tailpipe emissions.

4.2.2 Phase 1 Operations

Modeled maximum annual $PM_{2.5}$ concentrations, LECR, chronic hazard, and acute hazard from operations anticipated after completion of Phase 1 are summarized in Table 4-5.

The primary contributors to LECR in this table are from small quantities of 7,12-dimethylbenz[a]anthracene and hexavalent chromium emissions from natural gas boilers, and DPM emissions from diesel generators and on-road delivery trucks.

The primary contributors to chronic hazard in this table are from small quantities of arsenic and nickel from onsite boilers and on-road vehicle exhaust.

The primary contributor to acute hazard in this table is from nitrogen dioxide emissions from onsite boilers.

The primary contributor to $PM_{2.5}$ concentrations in this table are from onsite/offsite on-road vehicle travel.

4.2.3 LRDP Construction

Modeled maximum annual $PM_{2.5}$ concentrations, LECR, and chronic hazard from full LRDP build-out construction activities are summarized in Table 4-7 for a typical year (except for LECR, which was based on total exposures over the multi-year LRDP construction period, including Phase 1. Acute hazard impacts were not estimated, as the primary source of TAC emissions for this scenario come from diesel engines, the toxicity of which is adequately represented through the LECR and chronic hazard assessments (CARB, 2003).

The primary contributor to LECR, chronic hazard, and $PM_{2.5}$ results in this table is from DPM emissions from onsite off-road diesel equipment tailpipe emissions.

4.2.4 LRDP Operations

Modeled maximum annual $PM_{2.5}$ concentrations, LECR, chronic hazard, and acute hazard from operations anticipated after completion of Phase 1 are summarized in Table 4-8. Because some of these assessments were predicted to have relatively high ambient impacts, the locations of a few of these impacts are shown in Figure 4-1 as described below.

The primary contributors to LECR in this table are from small quantities of 7,12-dimethylbenz[a]anthracene and hexavalent chromium emissions from natural gas boilers, and DPM emissions from diesel generators and on-road delivery trucks. For reference, the maximum modeled LRDP LECR for an offsite resident occurred at Offsite Location 1 in Figure 4-1.

The primary contributors to chronic hazard in this table are from gluteraldehyde and hydrogen chloride emissions from laboratory fume hood stacks.

The primary contributors to acute hazard in this table are from formaldehyde and chloroform emissions from laboratory fume hoods and nitrogen dioxide emissions from onsite boilers. For reference, the maximum modeled onsite acute hazard occurred at Onsite Location 1 and the maximum modeled offsite acute hazard occurred at Offsite Location 2 in Figure 4-1.

The primary contributors to $PM_{2.5}$ concentrations in this table are from road dust in onsite parking garages and onsite/offsite on-road vehicle travel. For reference, the maximum modeled $PM_{2.5}$ for an offsite resident occurred at Offsite Location 1 in Figure 4-1.

4.3 Greenhouse Gas Impacts

GHG impacts are provided in Table 4-9 in units of metric tons (MT) of carbon dioxide (CO_2) equivalent (CO_2e) per year (MT CO_2e/yr). Maximum annual emission rates are provided for both the construction and operation phases of the Phase 1 and full LRDP build-out scenarios. CO_2e emissions are based on the following formula:

$$\text{MT } CO_2e/\text{yr} = (\text{MT } CO_2/\text{yr}) + (21 \times \text{MT Methane/yr}) + (310 \times \text{MT Nitrous Oxide/yr})$$

The factors of 21 and 310 in the formula above are the global warming potentials associated with methane and nitrous oxide, respectively, and are published as part of the EPA GHG reporting program codified in 40 CFR Part 98.

Emissions are provided in Table 4-9 for subsets of emission sources consistent with those provided in the BAAQMD 2011 CEQA guidance document. For example, sources classified as Stationary include only those on-site emission sources that are stationary; this would include natural gas boilers (by far the largest GHG contributor in this category) and diesel generators. Sources classified as Not Stationary cover all other sources associated with the project emitting GHGs; this would include direct emission sources (i.e. on-site and off-site mobile sources) and indirect emission sources associated with on-site utility usage such as electricity, potable water, and wastewater.

GHG emissions on a per-employee basis assume the addition of up to 1,000 new employees to the RBC site by the end of Phase 1 and up to 10,000 new employees to the RBC site by the end of the full LRDP build-out.

4.4 Cumulative Impacts

Under CEQA, a cumulative impact is described as an impact which is created as a result of the combination of the project together with other projects causing related impacts. This typically includes potential impacts from known past, present, and probable future projects.

For this project, cumulative impacts were assessed for LECR, chronic hazard, and annual $PM_{2.5}$ concentrations consistent with the approach provided in 2011 BAAQMD CEQA guidance (BAAQMD 2011). In general, this guidance provides that emissions from known existing or probable future emission sources which are within 1,000 feet of the project boundary be included in an assessment of combined impacts at the maximally exposed individual (MEI) identified in the equivalent assessment for the project only.

The BAAQMD provides tools to aid with the assessment of cumulative impacts.[10] In particular, the Stationary Source Screening Analysis Tool provides estimated maximum LECR, chronic hazard, and annual $PM_{2.5}$ impacts from permitted stationary sources. This tool provides facility locations based on mailing addresses, so facility locations were confirmed and adjusted as necessary to reflect the actual locations of cumulative emission sources.

Additionally, the Highway Screening Analysis Tool provides similar impact data from freeways and highways (which is important in this case as the I-580 freeway is just north of the project area).

In this case, a very conservative approach to estimating the cumulative impacts at the MEI receptor is to simply add the maximum estimated impact at the MEI receptor from the project assessments contained in this report to 1) the maximum impacts at any location reported in the Stationary Source Screening Analysis Tool for sources within 1,000 feet of the project boundary (for Phase 1 or the full LRDP build-out) and 2) the maximum impact reported by the Highway Screening Analysis Tool for the distance from the highway/freeway being included (I-580 in this case) and the MEI receptor.

One adjustment to the maximum impacts from existing stationary sources provided by the BAAQMD is for diesel generators. Appropriate multiplicative coefficients are provided in the Diesel Internal Combustion (IC) Distance Multiplier Tool. Applicable to this project, the maximum cancer risk from two sources in the cumulative assessments are from diesel generators which are more than 918 feet from the MEI receptor, leading to a multiplier of 0.04 applicable to the maximum cancer risk value.

Although adding the maximum impacts from each individual cumulative stationary source at any location to the project impact at the MEI receptor is extremely conservative, if the combined impact is less than a significant impact, this approach is simple and sufficient.

4.4.1 Phase 1

Using the approach described above, the conservatively-estimated maximum cumulative impacts to LECR, chronic hazard, and annual $PM_{2.5}$ for Phase 1 of the project are presented in Table 4-10. The project team has indicated that these results are sufficient for demonstrating less-than-significant cumulative impacts, so no further refinement of the results was performed.

4.4.2 Full LRDP

Similarly, the conservatively-estimated maximum cumulative impacts to LECR, chronic hazard, and annual $PM_{2.5}$ for the full LRDP build-out are presented in Table 4-11. The project team has indicated that these results are sufficient for demonstrating less-than-significant cumulative impacts for LECR and chronic hazard, so no further refinement of these results was performed. However, Golder was asked to

[10] See http://www.baaqmd.gov/Divisions/Planning-and-Research/CEQA-GUIDELINES/Tools-and-Methodology.aspx.

perform a more refined dispersion modeling assessment for the cumulative $PM_{2.5}$ impacts for construction/demolition activities associated with the full LRDP build-out as explained further in Section 4.4.2.1 below.

Additionally, Golder was asked to re-assess the cumulative cancer risk for LRDP operations by applying the attenuation factor for diesel engines provided by BAAQMD to other existing sources within 1,000 feet of the project boundary to provide some means to reflect their actual distances from the MEI receptor being evaluated. This is detailed further in Section 4.4.2.2 below.

4.4.2.1 $PM_{2.5}$ Modeling for LRDP Construction/Demolition

Refined cumulative $PM_{2.5}$ modeling was performed in order to account for the various distances between the existing stationary sources and the MEI receptor for the assessment of $PM_{2.5}$ impacts for the construction/demolition activities associated with the full LRDP build-out. This provides a more realistic assessment of potential cumulative impacts as it accounts for the fact that maximum impacts from different sources will occur at different locations (not accounted for in the screening assessment discussed in Section 4.4.2 above).

The approach used was to explicitly model the existing stationary source $PM_{2.5}$ emissions along with the $PM_{2.5}$ emissions associated with the construction/demolition activities for the full LRDP build-out. Once the $PM_{2.5}$ concentration at the MEI receptor was determined for these sources, the maximum impact from the nearby I-580 freeway obtained from the Highway Screening Analysis Tool was added to calculate the total cumulative $PM_{2.5}$ concentration.

Conducting this assessment required that $PM_{2.5}$ emission rates and source representations for existing stationary sources be obtained from BAAQMD. Although BAAQMD was able to provide source-specific emission rates, associated release parameters were not available. Instead, BAAQMD provided conservative general release parameters for generators, generic stack sources, and generic volume sources. Therefore, each existing source to be modeled was assigned to one of these three source types. Only total particulate matter emission rates were available, so it was conservatively assumed that $PM_{2.5}$ emissions were equal to total particulate matter emissions.

The parameters and $PM_{2.5}$ emission rates associated with the existing stationary sources included in the cumulative source modeling are provided in Table 4-12.

The results of the cumulative dispersion modeling assessment, and the total annual $PM_{2.5}$ concentration with the inclusion of impacts from the I-580 freeway, are provided in Table 4-13. As can be seen by this result, the inclusion of the existing stationary sources in the LRDP construction/demolition modeling assessment increased the predicted $PM_{2.5}$ concentration at the MEI receptor only slightly (from 0.018

micrograms per cubic meter to 0.019 micrograms per cubic meter); this is a result of the existing sources being located well away from the MEI receptor location. The maximum impact from the I-580 freeway was then added to the modeled result for all other sources included in the cumulative impact assessment.

4.4.2.2 Re-Assessment of LRDP Cumulative Cancer Risk

The LRDP cumulative cancer risk result presented in Table 4-11 was re-assessed by applying the distance-dependent impact attenuation factor provided by BAAQMD for diesel generators. Although the actual attenuation of ambient pollutant concentrations from emission sources other than diesel generators might be expected to differ from that for diesel generators, the application of these factors to non-diesel generator sources in the manner used is still expected to be conservative.

Table 4-14 presents the revised assessment, which includes the distance from the existing sources within 1,000 feet of the project boundary to the cancer risk MEI being evaluated (located at Universal Transverse Mercator [UTM] coordinates of 558831, 4197161; zone 10). The diesel generator attenuation factors are constants less than 1.00 that are multiplied by the maximum predicted cancer risk for the source provided by BAAQMD, with lower factors being used as the distance between the existing source and the receptor being evaluated increases. The minimum attenuation factor provided by BAAQMD is 0.04, which can be used for distances of 280 meters and beyond. Since the distance between most of the existing sources and the MEI receptor are much greater than 280 meters, the use of an attenuation factor of 0.04 is expected to be very conservative.

When using this approach, the predicted cumulative LECR at the MEI receptor is reduced significantly compared to the results in Table 4-11 (64.4 vs. 102.4 in a million); i.e. when not accounting for the distance between the existing source and the MEI receptor.

5.0 CLOSING

This report provides the maximum predicted impacts due to estimated emissions of criteria pollutants, TACs, and GHGs for both construction/demolition and operational activities associated with the initial Phase 1 development and the full LRDP build-out. These assessments are based on a single hypothetical configuration for Phase 1 and the Illustrative Development configuration for the full LRDP build-out; the actual configuration of these projects could vary somewhat from what was assessed. However, it is believed that the air quality and human health risk assessments provided in this report conservatively represent the maximum impacts from any alternative configurations as long as they don't deviate significantly from the assumed building square footage and assumed site populations.

The results from this report will be used to support CEQA documents for the proposed project. Because these documents will determine the appropriate thresholds of significance to be used, evaluations of the potential significance of the impacts reported are not made here. As such, no conclusions are being drawn from the magnitude of the results.

Any questions on this report can be directed to Dr. Brian Patterson by phone at 503-607-1820 or by email at bpatterson@golder.com.

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6.0 REFERENCES

BAAQMD 2011, *California Environmental Quality Act Air Quality Guidelines, updated May 2011*, Bay Area Air Quality Management District, May 2011.

BAAQMD 2012, *Recommended Methods for Screening and Modeling Local Risks and Hazards*, Bay Area Air Quality Management District, May 2012.

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SECOR 2004. *Baseline Air Emissions Inventory Toxic Compound Emissions – Lawrence Berkeley National Laboratory*, SECOR International Incorporated, January 16.

URS 2000. *Central Campus Human Health Risk Assessment*, prepared by URS Corporation, June 28, 2000.

Tables

Table 3-1
Model Source Representations - Phase 1 Construction/Demolition

Area_Poly Sources						
Model ID	**Source Description**	**Base Height (m)**	**Release Height (m)**	**Initial Vert. Dimension (σZ, m)**	**Area of Source (m^2)**	**Number of Sides**
P1_EXHST	Phase 1 Construction and Demolition Area Source - Exhaust	4	1.5	1	61516.6	6

Line Source - Adjacent Volume Sources						
Source ID	**Source Description**	**Initial Lateral Dimension (m)**	**Initial Vertical Dimension (m)**	**Release Height (m)**	**Total Road Length (m)**	**Adjacent Vol. Sources**
OFS_R1	Off Site (OFS) Road Segment 1	6.05	1.58	1.7	245.9	19
OFS_R2	Off Site (OFS) Road Segment 2	9.77	1.58	0	109.7	5
OFS_R3	Off Site (OFS) Road Segment 3	9.77	1.58	1.7	532.6	25
ONS_R1	Onsite Road Segment 1	6.05	1.58	0	284.7	22

Table 3-2
Model Source Representations - Phase 1 Operations

Point Sources						
Model ID	**Source Description**	**Base Height (m)**	**Release Height (m)**	**Stack Diameter (m)**	**Exit Velocity (m/s)**	**Exit Temperature (K)**
DG_B6	Diesel Generator - Buliding 6	3	3.05	0.1524	94.56	760.85
DG_B7	Diesel Generator - Buliding 7	3.32	3.05	0.1524	94.56	760.85
DG_B8	Diesel Generator - Building 8	3	3.05	0.152	94.56	760.85
DG_B9	Diesel Generator - Building 9	3.54	3.05	0.152	94.56	760.85
NGB_B6_7	Natural Gas Boiler - Buildings 6 and 7	3	25.60	0.65	4.95	366.5
NGB_B9	Natural Gas Boiler - Building 9	3	20.12	0.46	4.95	366.5
NGB_B8	Natural Gas Boiler - Building 8	3	14.63	0.46	4.95	366.5
CTB6_7C1	Cooling Tower - Buildings 6 and 7, Cell 1	3	28.65	2.5	10	-10
CTB6_7C2	Cooling Tower - Buildings 6 and 7, Cell 2	3	28.65	2.5	10	-10
CTB6_7C3	Cooling Tower - Buildings 6 and 7, Cell 3	3	28.65	2.5	10	-10
CTB6_7C4	Cooling Tower - Buildings 6 and 7, Cell 4	3	28.65	2.5	10	-10
CTB6_7C5	Cooling Tower - Buildings 6 and 7, Cell 5	3	28.65	2.5	10	-10
CTB6_7C6	Cooling Tower - Buildings 6 and 7, Cell 6	3	28.65	2.5	10	-10
CTB8C1	Cooling Tower - Building 8, Cell 1	3	17.68	2.5	10	-10
CTB8C2	Cooling Tower - Building 8, Cell 2	3	17.68	2.5	10	-10
CTB8C3	Cooling Tower - Building 8, Cell 3	3	17.68	2.5	10	-10
CTB9C1	Cooling Tower - Building 9, Cell 1	3	23.17	2.5	10	-10
CTB9C2	Cooling Tower - Building 9, Cell 2	3	23.17	2.5	10	-10
CTB9C3	Cooling Tower - Building 9, Cell 3	3	23.17	2.5	10	-10
LAB_B6_7	Lab Hood Exhaust Stack - Building 6 and 7	3	25.60	1	10	293.15
LAB_B8	Lab Hood Exhaust Stack - Building 8	3	14.63	1	10	293.15
LAB_B9	Lab Hood Exhuast Stack - Building 9	3	20.12	1	10	293.15

Area_Poly Sources						
Model ID	**Source Description**	**Base Height (m)**	**Effective Height (m)**	**Initial Vert. Dimension (σZ, m)**	**Area of Source (m^2)**	**Number of Sides**
ONROAD1	West Onsite Onroad Vehicle Area Source	3.78	0	1	10837.9	15
ONROAD2	East Onsite Onroad Vehicle Area Source	3	0	1	13533.7	8

Line Source - Adjacent Volume Sources						
Source ID	**Source Description**	**Initial Lateral Dimension (m)**	**Initial Vertical Dimension (m)**	**Release Height (m)**	**Total Road Length (m)**	**Adjacent Vol. Sources**
ONS_R1	Onsite Road Segment 1	6.05	1.58	0	284.6	22
ONS_R2	Onsite Road Segment 2	6.05	1.58	1.7	277.4	21
OFS_R1	Off Site (OFS) Road Segment 1	6.05	1.58	1.7	245.9	19
OFS_R2	Off Site (OFS) Road Segment 2	9.77	1.58	0	109.7	5
OFS_R3	Off Site (OFS) Road Segment 3	9.77	1.58	1.7	532.6	25

Table 3-3
Model Source Representations - Full LRDP Construction/Demolition

Area Sources							
Model ID	**Source Description**	**Base Height (m)**	**Release Height (m)**	**Initial Vert. Dimension (σZ, m)**	**Area of Source (m^2)**	**Rotation (deg)**	**Assessment (1)**
AREA1	Western Construction/Demolition Activity Area	2	1.5	1	72000	0	C
AREA3	Worker Hazard Assessment Activity Area	3.73	1.5	1	8100	0	WH
AREA7	Resident Hazard Assessment Activity Area	7	1.5	1	8100	0	RH

Area_Poly Sources							
Model ID	**Source Description**	**Base Height (m)**	**Release Height (m)**	**Initial Vert. Dimension (σZ, m)**	**Area of Source (m^2)**	**Number of Sides**	**Assessment (1)**
AREA2	North-east Construction/Demolition Activity Area	9	1.5	1	96570.4	6	C
AREA3	Eastern Construction/Demolition Activity Area	6	1.5	1	48637.9	7	C
AREA4	Southern Construction/Demolition Activity Area	5	1.5	1	37054.3	6	C

Line Source - Adjacent Volume Sources							
Source ID	**Source Description**	**Initial Lateral Dimension (m)**	**Initial Vertical Dimension (m)**	**Release Height (m)**	**Total Road Length (m)**	**Adjacent Vol. Sources**	**Assessment (1)**
T2_R2	T2 to R2	6.05	1.58	1.7	164.5	13	C
R2_R3	R2 to R3	6.05	1.58	1.7	112.1	9	C
R3_R6	R3 to R6	6.05	1.58	1.7	524.9	40	C
T1_R1	T1 to R1	6.05	1.58	1.7	127.1	10	C
R1_T2	R1 to T2	6.05	1.58	1.7	98.6	8	C
R8_T3	R8 to T3	6.05	1.58	1.7	110.9	9	C
R7_R8	R7 to R8	6.05	1.58	1.7	55.3	4	C
R6_R7	R6 to R7	6.05	1.58	1.7	71.5	5	C
R14_R15	R14 to R15	9.77	1.58	1.7	180.7	9	C, RH
R15_T1	R15 to T1	9.77	1.58	1.7	153.5	7	C, RH
T1_EH	T1 to East Highway	9.77	1.58	1.7	191.5	9	C, RH
R14_NH	R14 to North Highway	9.77	1.58	1.7	99.8	5	C, RH, WH
T3_WH	T3 to West Highway	6.05	1.58	1.7	220.9	17	C, WH
T3_R11	T3 to R11	6.05	1.58	1.7	445.2	34	C, WH
R11_R12	R11 to R12	6.05	1.58	1.7	59.7	5	C, WH
R12_R13	R12 to R13	6.05	1.58	1.7	427	33	C, WH
R13_R14	R13 to R14	6.05	1.58	1.7	207.4	16	C, WH
T1_R1C	T1 to R1(C?)	6.05	1.58	1.7	99.1	8	RH

References:

(1) C = Cancer Risk Assessment, RH = Resident Hazard Assessment, WH = Worker Hazard Assessment.
Cancer Risk Assessment sources are shown in Figure 3-4, Resident Hazard Assessment sources are shown in Figure 3-2, and Worker Hazard Assessment sources are shown in Figure 3-3.

Table 3-4
Model Source Representations - Full LRDP Operations

Point Sources						
Model ID	**Source Description**	**Base Height (m)**	**Release Height (m)**	**Stack Diameter (m)**	**Exit Velocity (m/s)**	**Exit Temperature (K)**
CT_NRLF1	Cooling Tower - NRLF Expansion, Cell 1	6	10.7	2.5	10	-10
CT_NRLF2	Cooling Tower - NRLF Expansion, Cell 2	6	10.7	2.5	10	-10
CT_NRLF3	Cooling Tower - NRLF Expansion, Cell 3	6	10.7	2.5	10	-10
CT_NRLF4	Cooling Tower - NRLF Expansion, Cell 4	6	10.7	2.5	10	-10
CT_NRLF5	Cooling Tower - NRLF Expansion, Cell 5	6	10.7	2.5	10	-10
CT_NRLF6	Cooling Tower - NRLF Expansion, Cell 6	6	10.7	2.5	10	-10
CT_NRLF7	Cooling Tower - NRLF Expansion, Cell 7	6	10.7	2.5	10	-10
CT_NRLF8	Cooling Tower - NRLF Expansion, Cell 8	6	10.7	2.5	10	-10
CTB10C1	Cooling Tower - Building 10, Cell 1	4	28.7	2.5	10	-10
CTB10C2	Cooling Tower - Building 10, Cell 2	4	28.7	2.5	10	-10
CTB10C3	Cooling Tower - Building 10, Cell 3	4	28.7	2.5	10	-10
CTB11C1	Cooling Tower - Building 11, Cell 1	4.12	28.7	2.5	10	-10
CTB11C2	Cooling Tower - Building 11, Cell 2	4.1	28.7	2.5	10	-10
CTB12C1	Cooling Tower - Building 12, Cell 1	4.33	28.7	2.5	10	-10
CTB12C2	Cooling Tower - Building 12, Cell 2	4.2	28.7	2.5	10	-10
CTB12C3	Cooling Tower - Building 12, Cell 3	4.09	28.7	2.5	10	-10
CTB13C1	Cooling Tower - Building 13, Cell 1	5	23.2	2.5	10	-10
CTB13C2	Cooling Tower - Building 13, Cell 2	5	23.2	2.5	10	-10
CTB14C1	Cooling Tower - Building 14, Cell 1	5	28.7	2.5	10	-10
CTB14C2	Cooling Tower - Building 14, Cell 2	5	28.7	2.5	10	-10
CTB15C1	Cooling Tower - Building 15, Cell 1	5	28.7	2.5	10	-10
CTB15C2	Cooling Tower - Building 15, Cell 2	5	28.7	2.5	10	-10
CTB15C3	Cooling Tower - Building 15, Cell 3	5	28.7	2.5	10	-10
CTB16C1	Cooling Tower - Building 16, Cell 1	5	28.7	2.5	10	-10
CTB16C2	Cooling Tower - Building 16, Cell 2	5	28.7	2.5	10	-10
CTB16C3	Cooling Tower - Building 16, Cell 3	5	28.7	2.5	10	-10
CTB16C4	Cooling Tower - Building 16, Cell 4	5	28.7	2.5	10	-10
CTB17C1	Cooling Tower - Building 17, Cell 1	5	34.1	2.5	10	-10
CTB17C2	Cooling Tower - Building 17, Cell 2	5	34.1	2.5	10	-10
CTB17C3	Cooling Tower - Building 17, Cell 3	5	34.1	2.5	10	-10
CTB17C4	Cooling Tower - Building 17, Cell 4	5	34.1	2.5	10	-10
CTB18C1	Cooling Tower - Building 18, Cell 1	6	34.1	2.5	10	-10
CTB18C2	Cooling Tower - Building 18, Cell 2	6	34.1	2.5	10	-10
CTB18C3	Cooling Tower - Building 18, Cell 3	6	34.1	2.5	10	-10
CTB19C1	Cooling Tower - Building 19, Cell 1	6	34.1	2.5	10	-10
CTB19C2	Cooling Tower - Building 19, Cell 2	6	34.1	2.5	10	-10
CTB19C3	Cooling Tower - Building 19, Cell 3	6	34.1	2.5	10	-10
CTB20C1	Cooling Tower - Building 20, Cell 1	6	34.1	2.5	10	-10
CTB20C2	Cooling Tower - Building 20, Cell 2	6	34.1	2.5	10	-10
CTB20C3	Cooling Tower - Building 20, Cell 3	6	34.1	2.5	10	-10
CTB21C1	Cooling Tower - Building 21, Cell 1	6.05	34.1	2.5	10	-10
CTB21C2	Cooling Tower - Building 21, Cell 2	6.04	34.1	2.5	10	-10
CTB21C3	Cooling Tower - Building 21, Cell 3	6.03	34.1	2.5	10	-10
CTB21C4	Cooling Tower - Building 21, Cell 4	6.23	34.1	2.5	10	-10
CTB21C5	Cooling Tower - Building 21, Cell 5	6.19	34.1	2.5	10	-10
CTB21C6	Cooling Tower - Building 21, Cell 6	6.14	34.1	2.5	10	-10
CTB21C7	Cooling Tower - Building 21, Cell 7	6.06	34.1	2.5	10	-10
CTB22C1	Cooling Tower - Building 22, Cell 1	6	34.1	2.5	10	-10
CTB22C2	Cooling Tower - Building 22, Cell 2	6	34.1	2.5	10	-10
CTB22C3	Cooling Tower - Building 22, Cell 3	6	34.1	2.5	10	-10
CTB22C4	Cooling Tower - Building 22, Cell 4	6	34.1	2.5	10	-10
CTB22C5	Cooling Tower - Building 22, Cell 5	6	34.1	2.5	10	-10

Table 3-4 Continued
Model Source Representations - Full LRDP Operations

Point Sources (continued)						
Model ID	**Source Description**	**Base Height (m)**	**Release Height (m)**	**Stack Diameter (m)**	**Exit Velocity (m/s)**	**Exit Temperature (K)**
CTB23C1	Cooling Tower - Building 23, Cell 1	7	34.1	2.5	10	-10
CTB23C2	Cooling Tower - Building 23, Cell 2	6.93	34.1	2.5	10	-10
CTB23C3	Cooling Tower - Building 23, Cell 3	7	34.1	2.5	10	-10
CTB23C4	Cooling Tower - Building 23, Cell 4	6.96	34.1	2.5	10	-10
CTB24C1	Cooling Tower - Building 24, Cell 1	7	34.1	2.5	10	-10
CTB24C2	Cooling Tower - Building 24, Cell 2	7	34.1	2.5	10	-10
CTB24C3	Cooling Tower - Building 24, Cell 3	7	34.1	2.5	10	-10
CTB25C1	Cooling Tower - Building 25, Cell 1	6.14	34.1	2.5	10	-10
CTB25C2	Cooling Tower - Building 25, Cell 2	6.1	34.1	2.5	10	-10
CTB25C3	Cooling Tower - Building 25, Cell 3	6.26	34.1	2.5	10	-10
CTB25C4	Cooling Tower - Building 25, Cell 4	6.18	34.1	2.5	10	-10
CTB26C1	Cooling Tower - Building 26, Cell 1	7	34.1	2.5	10	-10
CTB26C2	Cooling Tower - Building 26, Cell 2	7	34.1	2.5	10	-10
CTB26C3	Cooling Tower - Building 26, Cell 3	7	34.1	2.5	10	-10
CTB26C4	Cooling Tower - Building 26, Cell 4	7	34.1	2.5	10	-10
CTB27C1	Cooling Tower - Building 27, Cell 1	7.31	28.7	2.5	10	-10
CTB27C2	Cooling Tower - Building 27, Cell 2	7.13	28.7	2.5	10	-10
CTB27C3	Cooling Tower - Building 27, Cell 3	7.44	28.7	2.5	10	-10
CTB27C4	Cooling Tower - Building 27, Cell 4	7.3	28.7	2.5	10	-10
CTB28C1	Cooling Tower - Building 28, Cell 1	7	28.7	2.5	10	-10
CTB28C2	Cooling Tower - Building 28, Cell 2	7.02	28.7	2.5	10	-10
CTB29C1	Cooling Tower - Building 29, Cell 1	7	23.2	2.5	10	-10
CTB29C2	Cooling Tower - Building 29, Cell 2	6.94	23.2	2.5	10	-10
CTB30C1	Cooling Tower - Building 30, Cell 1	7.8	28.7	2.5	10	-10
CTB30C2	Cooling Tower - Building 30, Cell 2	7.62	28.7	2.5	10	-10
CTB30C3	Cooling Tower - Building 30, Cell 3	7.84	28.7	2.5	10	-10
CTB30C4	Cooling Tower - Building 30, Cell 4	7.69	28.7	2.5	10	-10
CTB31C1	Cooling Tower - Building 31, Cell 1	4	23.2	2.5	10	-10
CTB31C2	Cooling Tower - Building 31, Cell 2	3.81	23.2	2.5	10	-10
CTB32C1	Cooling Tower - Building 32, Cell 1	3.04	34.1	2.5	10	-10
CTB32C2	Cooling Tower - Building 32, Cell 2	3.01	34.1	2.5	10	-10
CTB32C3	Cooling Tower - Building 32, Cell 3	3	34.1	2.5	10	-10
CTB33C1	Cooling Tower - Building 33, Cell 1	3.8	34.1	2.5	10	-10
CTB33C2	Cooling Tower - Building 33, Cell 2	3.75	34.1	2.5	10	-10
CTB33C3	Cooling Tower - Building 33, Cell 3	3.94	34.1	2.5	10	-10
CTB33C4	Cooling Tower - Building 33, Cell 4	3.94	34.1	2.5	10	-10
CTB34C1	Cooling Tower - Building 34, Cell 1	3	34.1	2.5	10	-10
CTB34C2	Cooling Tower - Building 34, Cell 2	3	34.1	2.5	10	-10
CTB34C3	Cooling Tower - Building 34, Cell 3	3	34.1	2.5	10	-10
CTB34C4	Cooling Tower - Building 34, Cell 4	3	34.1	2.5	10	-10
CTB35C1	Cooling Tower - Building 35, Cell 1	3	34.1	2.5	10	-10
CTB35C2	Cooling Tower - Building 35, Cell 2	3	34.1	2.5	10	-10
CTB35C3	Cooling Tower - Building 35, Cell 3	3	34.1	2.5	10	-10
CTB35C4	Cooling Tower - Building 35, Cell 4	3	34.1	2.5	10	-10
CTB35C5	Cooling Tower - Building 35, Cell 5	3	34.1	2.5	10	-10
CTB36C1	Cooling Tower - Building 36, Cell 1	2.52	34.1	2.5	10	-10
CTB36C2	Cooling Tower - Building 36, Cell 2	2.52	34.1	2.5	10	-10
CTB36C3	Cooling Tower - Building 36, Cell 3	2.71	34.1	2.5	10	-10
CTB36C4	Cooling Tower - Building 36, Cell 4	2.71	34.1	2.5	10	-10
CTB36C5	Cooling Tower - Building 36, Cell 5	2.62	34.1	2.5	10	-10
CTB37C1	Cooling Tower - Building 37, Cell 1	3	34.1	2.5	10	-10
CTB37C2	Cooling Tower - Building 37, Cell 2	3	34.1	2.5	10	-10
CTB37C3	Cooling Tower - Building 37, Cell 3	3	34.1	2.5	10	-10
CTB37C4	Cooling Tower - Building 37, Cell 4	3	34.1	2.5	10	-10
CTB37C5	Cooling Tower - Building 37, Cell 5	3	34.1	2.5	10	-10
CTB38C1	Cooling Tower - Building 38, Cell 1	2.72	23.2	2.5	10	-10

Table 3-4 Continued
Model Source Representations - Full LRDP Operations

Point Sources (continued)						
Model ID	**Source Description**	**Base Height (m)**	**Release Height (m)**	**Stack Diameter (m)**	**Exit Velocity (m/s)**	**Exit Temperature (K)**
CTB38C2	Cooling Tower - Building 38, Cell 2	2.72	23.2	2.5	10	-10
CTB6_7C1	Cooling Tower - Buildings 6 and 7, Cell 1	3	28.7	2.5	10	-10
CTB6_7C2	Cooling Tower - Buildings 6 and 7, Cell 2	3	28.7	2.5	10	-10
CTB6_7C3	Cooling Tower - Buildings 6 and 7, Cell 3	3	28.7	2.5	10	-10
CTB6_7C4	Cooling Tower - Buildings 6 and 7, Cell 4	3	28.7	2.5	10	-10
CTB6_7C5	Cooling Tower - Buildings 6 and 7, Cell 5	3	28.7	2.5	10	-10
CTB6_7C6	Cooling Tower - Buildings 6 and 7, Cell 6	3	28.7	2.5	10	-10
CTB8C1	Cooling Tower - Building 8, Cell 1	3	17.7	2.5	10	-10
CTB8C2	Cooling Tower - Building 8, Cell 2	3	17.7	2.5	10	-10
CTB8C3	Cooling Tower - Building 8, Cell 3	3	17.7	2.5	10	-10
CTB9C1	Cooling Tower - Building 9, Cell 1	3	23.2	2.5	10	-10
CTB9C2	Cooling Tower - Building 9, Cell 2	3	23.2	2.5	10	-10
CTB9C3	Cooling Tower - Building 9, Cell 3	3	23.2	2.5	10	-10
DG_B10	Diesel Generator - Buliding 10	4	3.0	0.1524	94.56	760.85
DG_B11	Diesel Generator - Buliding 11	4.82	3.0	0.1524	94.56	760.85
DG_B12	Diesel Generator - Buliding 12	4	3.0	0.1524	94.56	760.85
DG_B13	Diesel Generator - Buliding 13	5	3.0	0.1524	94.56	760.85
DG_B14	Diesel Generator - Buliding 14	5	3.0	0.1524	94.56	760.85
DG_B15	Diesel Generator - Buliding 15	5	3.0	0.1524	94.56	760.85
DG_B16	Diesel Generator - Buliding 16	5	3.0	0.1524	94.56	760.85
DG_B17	Diesel Generator - Buliding 17	5	3.0	0.1524	94.56	760.85
DG_B18	Diesel Generator - Buliding 18	6	3.0	0.1524	94.56	760.85
DG_B19	Diesel Generator - Buliding 19	6	3.0	0.1524	94.56	760.85
DG_B20	Diesel Generator - Buliding 20	6	3.0	0.1524	94.56	760.85
DG_B21A	Diesel Generator A - Building 21	6	3.0	0.1524	94.56	760.85
DG_B21B	Diesel Generator B - Building 21	6	3.0	0.1524	94.56	760.85
DG_B22	Diesel Generator - Buliding 22	6	3.0	0.203	71.01	738.15
DG_B23	Diesel Generator - Buliding 23	7	3.0	0.1524	94.56	760.85
DG_B24	Diesel Generator - Buliding 24	7	3.0	0.1524	94.56	760.85
DG_B25	Diesel Generator - Buliding 25	6	3.0	0.203	71.01	738.15
DG_B26	Diesel Generator - Buliding 26	7	3.0	0.203	71.01	738.15
DG_B27	Diesel Generator - Buliding 27	8	3.0	0.1524	94.56	760.85
DG_B28	Diesel Generator - Buliding 28	7	3.0	0.1524	94.56	760.85
DG_B29	Diesel Generator - Buliding 29	7	3.0	0.1524	94.56	760.85
DG_B30	Diesel Generator - Buliding 30	7.22	3.0	0.1524	94.56	760.85
DG_B31	Diesel Generator - Buliding 31	4	3.0	0.1524	94.56	760.85
DG_B32	Diesel Generator - Buliding 32	3	3.0	0.1524	94.56	760.85
DG_B33	Diesel Generator - Buliding 33	3.11	3.0	0.1524	94.56	760.85
DG_B34	Diesel Generator - Buliding 34	3	3.0	0.203	71.01	738.15
DG_B35	Diesel Generator - Buliding 35	3	3.0	0.203	71.01	738.15
DG_B36	Diesel Generator - Buliding 36	3	3.0	0.203	71.01	738.15
DG_B37	Diesel Generator - Buliding 27	3	3.0	0.203	71.01	738.15
DG_B38	Diesel Generator - Buliding 38	3	3.0	0.1524	94.56	760.85
DG_B6	Diesel Generator - Bulidings 6	3.32	3.0	0.1524	94.56	760.85
DG_B7	Diesel Generator - Bulidings 7	3.32	3.0	0.1524	94.56	760.85
DG_B8	Diesel Generator - Building 8	3	3.0	0.1524	94.56	760.85
DG_B9	Diesel Generator - Building 9	3.54	3.0	0.1524	94.56	760.85
DG_NRLF	Diesel Generator - NRLF Expansion	5.85	3.0	0.203	71.01	738.15
LAB_B10	Lab Stack - Building 10	4	25.6	1	10	293.15
LAB_B11	Lab Stack - Building 11	4	25.6	1	10	293.15
LAB_B12	Lab Stack - Building 12	4.16	25.6	1	10	293.15
LAB_B14	Lab Stack - Building 14	5	25.6	1	10	293.15
LAB_B15	Lab Stack - Building 15	5	25.6	1	10	293.15
LAB_B16	Lab Stack - Building 16	5	25.6	1	10	293.15
LAB_B17	Lab Stack - Building 17	5	31.1	1	10	293.15
LAB_B18	Lab Stack - Building 18	6	31.1	1	10	293.15

Table 3-4 Continued
Model Source Representations - Full LRDP Operations

Point Sources (continued)						
Model ID	**Source Description**	**Base Height (m)**	**Release Height (m)**	**Stack Diameter (m)**	**Exit Velocity (m/s)**	**Exit Temperature (K)**
LAB_B19	Lab Stack - Building 19	6	31.1	1	10	293.15
LAB_B20	Lab Stack - Building 20	6	31.1	1	10	293.15
LAB_B21	Lab Stack - Building 21	6	31.1	1	10	293.15
LAB_B22	Lab Stack - Building 22	6	31.1	1	10	293.15
LAB_B23	Lab Stack - Building 23	6.92	31.1	1	10	293.15
LAB_B24	Lab Stack - Building 24	7	31.1	1	10	293.15
LAB_B25	Lab Stack - Building 25	6.48	31.1	1	10	293.15
LAB_B26	Lab Stack - Building 26	7	31.1	1	10	293.15
LAB_B27	Lab Stack - Building 27	7	25.6	1	10	293.15
LAB_B28	Lab Stack - Building 28	7.19	25.6	1	10	293.15
LAB_B30	Lab Stack - Building 30	7.05	25.6	1	10	293.15
LAB_B32	Lab Stack - Building 32	3	31.1	1	10	293.15
LAB_B33	Lab Stack - Building 33	4	31.1	1	10	293.15
LAB_B34	Lab Stack - Building 34	2.82	31.1	1	10	293.15
LAB_B35	Lab Stack - Building 35	3.21	31.1	1	10	293.15
LAB_B36	Lab Stack - Building 36	2	31.1	1	10	293.15
LAB_B37	Lab Stack - Building 37	3	31.1	1	10	293.15
LAB_B6_7	Lab Hood Exhaust Stack - Building 6 and 7	3	25.6	1	10	293.15
LAB_B8	Lab Hood Exhaust Stack - Building 8	3	14.6	1	10	293.15
LAB_B9	Lab Hood Exhuast Stack - Building 9	3	20.1	1	10	293.15
NGB_B10	Natural Gas Boiler - Building 10	4	25.6	0.44	4.95	366.5
NGB_B11	Natural Gas Boiler - Building 11	4.58	25.6	0.33	4.95	366.5
NGB_B12	Natural Gas Boiler - Building 12	4.06	25.6	0.44	4.95	366.5
NGB_B13	Natural Gas Boiler - Building 13	4.97	20.1	0.33	4.95	366.5
NGB_B14	Natural Gas Boiler - Building 14	5	25.6	0.38	4.95	366.5
NGB_B15	Natural Gas Boiler - Building 15	5	25.6	0.48	4.95	366.5
NGB_B16	Natural Gas Boiler - Building 16	5	25.6	0.51	4.95	366.5
NGB_B17	Natural Gas Boiler - Building 17	5	31.1	0.53	4.95	366.5
NGB_B18	Natural Gas Boiler - Building 18	6	31.1	0.5	4.95	366.5
NGB_B19	Natural Gas Boiler - Building 19	6	31.1	0.46	4.95	366.5
NGB_B20	Natural Gas Boiler - Building 20	6	31.1	0.46	4.95	366.5
NGB_B21	Natural Gas Boiler - Building 21	6	31.1	0.7	4.95	366.5
NGB_B22	Natural Gas Boiler - Building 22	6	31.1	0.58	4.95	366.5
NGB_B23	Natural Gas Boiler - Building 23	7	31.1	0.5	4.95	366.5
NGB_B24	Natural Gas Boiler - Building 24	7	31.1	0.46	4.95	366.5
NGB_B25	Natural Gas Boiler - Building 25	6	31.1	0.55	4.95	366.5
NGB_B26	Natural Gas Boiler - Building 26	7	31.1	0.55	4.95	366.5
NGB_B27	Natural Gas Boiler - Building 27	7.8	25.6	0.53	4.95	366.5
NGB_B28	Natural Gas Boiler - Building 28	7	25.6	0.33	4.95	366.5
NGB_B29	Natural Gas Boiler - Building 29	6.96	20.1	0.33	4.95	366.5
NGB_B30	Natural Gas Boiler - Building 30	7.35	25.6	0.53	4.95	366.5
NGB_B31	Natural Gas Boiler - Building 31	3.95	20.1	0.33	4.95	366.5
NGB_B32	Natural Gas Boiler - Building 32	3.04	31.1	0.48	4.95	366.5
NGB_B33	Natural Gas Boiler - Building 33	3.26	31.1	0.53	4.95	366.5
NGB_B34	Natural Gas Boiler - Building 34	3	31.1	0.55	4.95	366.5
NGB_B35	Natural Gas Boiler - Building 35	3	31.1	0.58	4.95	366.5
NGB_B36	Natural Gas Boiler - Building 36	2.61	31.1	0.56	4.95	366.5
NGB_B37	Natural Gas Boiler - Building 37	3	31.1	0.59	4.95	366.5
NGB_B38	Natural Gas Boiler - Building 38	2.74	20.1	0.38	4.95	366.5
NGB_B6_7	Natural Gas Boiler - Buildings 6 and 7	3	25.6	0.65	4.95	366.5
NGB_B8	Natural Gas Boiler - Building 8	3	14.6	0.46	4.95	366.5
NGB_B9	Natural Gas Boiler - Building 9	3	20.1	0.46	4.95	366.5
NGB_NRLF	Natural Gas Boiler - NRLF Expansion	5.99	7.6	0.64	4.95	366.5

Table 3-4 Continued
Model Source Representations - Full LRDP Operations

Volume Sources						
Source ID	**Source Description**	**Base Height (m)**	**Release Height (meters)**	**Length of Side (meters)**	**Initial Lateral Dimension (σY, meters)**	**Initial Vert. Dimension (σZ, meters)**
IDLE_B30	Idle emissions at Building 30	8	1	2	0.465	0.930
IDLE_B28	Idle emissions at Building 28	7	1	2	0.465	0.930
IDLE_B26	Idle emissions at Building 26	7	1	2	0.465	0.930
IDLE_B29	Idle emissions at Building 29	6.97	1	2	0.465	0.930
IDLE_B25	Idle emissions at Building 25	6	1	2	0.465	0.930
IDLE_B18	Idle emissions at Building 18	6	1	2	0.465	0.930
IDLE_B19	Idle emissions at Building 19	6	1	2	0.465	0.930
IDLE_B17	Idle emissions at Building 17	5	1	2	0.465	0.930
IDLE_B7	Idle emissions at Building 7	3.33	1	2	0.465	0.930
IDLE_B9	Idle emissions at Building 9	3	1	2	0.465	0.930
IDLE_B34	Idle emissions at Building 34	3	1	2	0.465	0.930
IDLE_B36	Idle emissions at Building 36	3	1	2	0.465	0.930
P1	Parking Structure Volume Source P1	3.98	11.7	38.94	9.06	10.92
P2	Parking Structure Volume Source P2	5.17	11.7	51.76	12.04	5.46
P3	Parking Structure Volume Source P3	7	13.4	65.84	15.31	12.48
P4	Parking Structure Volume Source - P4	8	11.7	53.93	12.54	10.92
P5	Parking Structure Volume Source P5	4	10.1	36.99	8.60	4.68
P6	Parking Structure Volume Source P6	3	8.4	53.77	12.50	3.90

Line Source - Adjacent Volume Sources						
Source ID	**Source Description**	**Initial Lateral Dimension (m)**	**Initial Vertical Dimension (m)**	**Release Height (m)**	**Total Road Length (m)**	**Adjacent Vol. Sources**
T2_R2	T2 to R2	6.05	1.58	1.7	164.5	13
R2_R3	R2 to R3	6.05	1.58	1.7	112.1	9
R3_R4	R3 to R4	6.05	1.58	1.7	80.6	6
R3_R6	R3 to R6	6.05	1.58	1.7	524.9	40
R13_R5	R13 to R5	6.05	1.58	1.7	630.1	48
R8_R9	R8 to R9	6.05	1.58	1.7	117.4	9
R11_R10	R11 to R10	6.05	1.58	1.7	142.4	11
R15_R16	R15 to R16	6.05	1.58	1.7	186.7	14
T1_EH	T1 to East Highway	9.77	1.58	1.7	191.5	9
T1_R1	T1 to R1	6.05	1.58	1.7	127.1	10
R1_T2	R1 to T2	6.05	1.58	1.7	98.6	8
R14_NH	R14 to North Highway	9.77	1.58	1.7	99.8	5
R14_R15	R14 to R15	9.77	1.58	1.7	180.7	9
R15_T1	R15 to T1	9.77	1.58	1.7	153.5	7
T3_WH	T3 to West Highway	6.05	1.58	1.7	220.9	17
R8_T3	R8 to T3	6.05	1.58	1.7	110.9	9
R7_R8	R7 to R8	6.05	1.58	1.7	55.3	4
R6_R7	R6 to R7	6.05	1.58	1.7	71.5	5
T3_R11	T3 to R11	6.05	1.58	1.7	445.2	34
R11_R12	R11 to R12	6.05	1.58	1.7	59.7	5
R12_R13	R12 to R13	6.05	1.58	1.7	427	33
R13_R14	R13 to R14	6.05	1.58	1.7	207.4	16

Table 3-5
Model Source Representations - Existing Richmond Field Station Operations

Phase 1 Sources

Point Sources						
Model ID	**Source Description**	**Base Height (m)**	**Release Height (m)**	**Stack Diameter (m)**	**Exit Velocity (m/s)**	**Exit Temperature (K)**
DG_B194	Existing standby generator - B194	6.7	3.0	0.1524	94.56	760.85
DG_NRLF2	Existing standby generator - NRLF	7.55	3.0	0.1524	94.56	760.85
FP_NRLF2	Existing Fire Pump - NRLF	8.07	3.0	0.1524	94.56	760.85
NGB_400a	Natural Gas Boiler - Building 400a	7.71	14.0	0.15	4.95	366.5
NGB_400b	Natural Gas Boiler - Building 400b	7.71	14.0	0.16	4.95	366.5
NGB_400c	Natural Gas Boiler - Building 400c	7.7	14.0	0.16	4.95	366.5
NGB_400d	Natural Gas Boiler - Building 400d	8.07	17.7	0.16	4.95	366.5
NGB_451	Natural Gas Boiler - Building 451	8.86	6.7	0.11	4.95	366.5
NGB_452	Natural Gas Boiler - Building 452	9.47	6.7	0.08	4.95	366.5
NGB_454	Natural Gas Boiler - Building 454	9.56	6.7	0.09	4.95	366.5
NGB_472	Natural Gas Boiler - Building 472	7.73	7.3	0.08	4.95	366.5
NGB_477	Natural Gas Boiler - Building 477	7.97	6.7	0.1	4.95	366.5
NGB_478a	Natural Gas Boiler - Building 478a	8.43	10.7	0.09	4.95	366.5
NGB_478b	Natural Gas Boiler - Building 478b	8.42	10.7	0.09	4.95	366.5
NGB_478c	Natural Gas Boiler - Building 478c	8.39	10.7	0.19	4.95	366.5
NGB_480	Natural Gas Boiler - Building 480	7.96	7.3	0.09	4.95	366.5
NGB_484	Natural Gas Boiler - Building 484	7.53	22.3	0.13	4.95	366.5
LAB_B154	Lab Hood Exhaust Stack - Building 154	5.53	9.1	1	10	293.15
LAB_B158	Lab Hood Exhaust Stack - Building 158	5.52	10.4	1	10	293.15
LAB_B167	Lab Hood Exhaust Stack - Building 167	6.36	7.3	1	10	293.15
LAB_B450	Lab Hood Exhaust Stack - Building 450	7.42	7.3	1	10	293.15
LAB_B473	Lab Hood Exhaust Stack - Building 473	7.85	7.3	1	10	293.15
LAB_B474	Lab Hood Exhaust Stack - Building 474	7.99	7.3	1	10	293.15
LAB_B478	Lab Hood Exhaust Stack - Building 478	8.4	10.7	1	10	293.15
LAB_B480	Lab Hood Exhaust Stack - Building 480	7.9	7.3	1	10	293.15

Area Sources						
Model ID	**Source Description**	**Base Height (m)**	**Release Height (m)**	**Initial Vert. Dimension (σZ, m)**	**Area of Source (m^2)**	**Rotation (deg)**
OFFMAIN	Off-road mobile diesel vehicles	6.78	0	1	1225	0

Volume Sources						
Source ID	**Source Description**	**Base Height (m)**	**Release Height (meters)**	**Length of Side (meters)**	**Initial Lateral Dimension (σY, meters)**	**Initial Vert. Dimension (σZ, meters)**
FUEL	Existing gasoline dispensing	8	1	5.0	1.163	0.500

Table 3-5 Continued
Model Source Representations - Existing Richmond Field Station Operations

LRDP Sources

Point Sources						
Model ID	**Source Description**	**Base Height (m)**	**Release Height (m)**	**Stack Diameter (m)**	**Exit Velocity (m/s)**	**Exit Temperature (K)**
DG_NRLF2	Existing standby generator - NRLF	7.55	3.0	0.1524	94.56	760.85
FP_NRLF2	Existing Fire Pump - NRLF	8.07	3.0	0.1524	94.56	760.85
NGB_400a	Natural Gas Boiler - Building 400a	7.71	14.0	0.15	4.95	366.5
NGB_400b	Natural Gas Boiler - Building 400b	7.71	14.0	0.16	4.95	366.5
NGB_400c	Natural Gas Boiler - Building 400c	7.7	14.0	0.16	4.95	366.5
NGB_400d	Natural Gas Boiler - Building 400d	8.07	17.7	0.16	4.95	366.5

Area Sources						
Model ID	**Source Description**	**Base Height (m)**	**Release Height (m)**	**Initial Vert. Dimension (σZ, m)**	**Area of Source (m^2)**	**Rotation (deg)**
OFFMAIN1	Off-road mobile diesel vehicles	3.69	0	1	1225	0
OFFMAIN2	Off-road mobile diesel vehicles	6.24	0	1	1225	0

Volume Sources						
Source ID	**Source Description**	**Base Height (m)**	**Release Height (meters)**	**Length of Side (meters)**	**Initial Lateral Dimension (σY, meters)**	**Initial Vert. Dimension (σZ, meters)**
FUEL	Existing gasoline dispensing	8	1	5.0	1.163	0.500

Table 3-6
Model Source Representations - Phase 2 Operations

Point Sources						
Model ID	**Source Description**	**Base Height (m)**	**Release Height (m)**	**Stack Diameter (m)**	**Exit Velocity (m/s)**	**Exit Temperature (K)**
CTB10C1	Cooling Tower - Building 10, Cell 1	4	28.7	2.5	10	-10
CTB10C2	Cooling Tower - Building 10, Cell 2	4	28.7	2.5	10	-10
CTB10C3	Cooling Tower - Building 10, Cell 3	4	28.7	2.5	10	-10
CTB11C1	Cooling Tower - Building 11, Cell 1	4.12	28.7	2.5	10	-10
CTB11C2	Cooling Tower - Building 11, Cell 2	4.1	28.7	2.5	10	-10
DG_B10	Diesel Generator - Buliding 10	4	3.0	0.15	94.6	760.9
DG_B11	Diesel Generator - Buliding 11	4.82	3.0	0.15	94.6	760.9
LAB_B10	Lab Stack - Building 10	4	25.6	1	10	293.2
LAB_B11	Lab Stack - Building 11	4	25.6	1	10	293.2
NGB_B10	Natural Gas Boiler - Building 10	4	25.6	0.44	4.95	366.5
NGB_B11	Natural Gas Boiler - Building 11	4.58	25.6	0.33	4.95	366.5

Volume Sources						
Source ID	**Source Description**	**Base Height (m)**	**Release Height (meters)**	**Length of Side (meters)**	**Initial Lateral Dimension (σY, meters)**	**Initial Vert. Dimension (σZ, meters)**
P1	Parking Structure Volume Source P1	3.98	11.7	38.94	9.06	10.92

Line Source - Adjacent Volume Sources						
Source ID	**Source Description**	**Initial Lateral Dimension (m)**	**Initial Vertical Dimension (m)**	**Release Height (m)**	**Total Road Length (m)**	**Adjacent Vol. Sources**
ONS_R1	Onsite main entry road	6.05	1.58	0	284.6	22
R3_R4	Onsite road to P1	6.05	1.58	1.7	80.6	6
ONS_R2	Onsite Shuttle only road	6.05	1.58	1.7	277.4	21
OFS_R2	Offsite East Highway road	9.77	1.58	0	109.7	5
OFS_R1	Offsite main entry road	6.05	1.58	1.7	245.9	19
OFS_R3	Offsite North Highway road	9.77	1.58	1.7	532.6	25

Table 3-7
Phase 1 Downwash Structure Heights

Building ID	Number of Tiers	Tier Height (m)
BLDG1	1	7.6
BLD_6	1	17.1
BLD_7	1	22.6
BLD_8	1	11.6
BLD_9	1	17.1

Table 3-8
Full LRDP Downwash Structure Heights

Building ID	Number of Tiers	Tier Height (m)
B1_EPA_EX	1	7.6
B10	1	22.6
B11	1	22.6
B12	1	22.6
B13	1	17.1
B14	1	22.6
B15	1	22.6
B16	1	22.6
B17	1	28.0
B18	1	28.0
B19	1	28.0
B20	1	28.0
B21	1	28.0
B22	1	28.0
B23	1	28.0
B24	1	28.0
B25	1	28.0
B26	1	28.0
B27	1	22.6
B28	1	22.6
B29	1	17.1
B3	1	16.8
B30	1	22.6
B31	1	17.1
B32	1	28.0
B33	1	28.0
B34	1	28.0
B35	1	28.0
B36	1	28.0
B37	1	28.0
B38	1	17.1
B6	1	17.1
B7	1	22.6
B8	1	11.6
B9	1	17.1
ES1	1	4.6
NRLF_EX_2	1	12.2
P1	1	23.5
P2	1	23.5
P3	1	26.8
P4	1	23.5
P5	1	20.1
P6	1	16.8

Table 4-1. Phase 1 Construction - Maximum Criteria Pollutant Emissions Estimates

Assessment	Annual Tons per Year					
	Onsite Stationary (Exhaust)	Onsite Mobile (Exhaust)	Onsite Fugitive Dust	Offsite Mobile (Exhaust)	Offsite Fugitive Dust	Total (1)
ROG/VOC Emissions	--	0.25	--	0.52	--	0.77
NO_x Emissions	--	1.97	--	4.69	--	6.65
CO Emissions	--	1.17	--	3.83	--	5.00
PM_{10} Emissions	--	0.11	N/A	0.14	N/A	0.25
$PM_{2.5}$ Emissions	--	0.11	N/A	0.13	N/A	0.24

Assessment	Average Pounds per Day					
	Onsite Stationary (Exhaust)	Onsite Mobile (Exhaust)	Onsite Fugitive Dust	Offsite Mobile (Exhaust)	Offsite Fugitive Dust	Total (1)
ROG/VOC Emissions	--	1.38	--	2.85	--	4.23
NO_x Emissions	--	10.77	--	25.69	--	36.46
CO Emissions	--	6.38	--	21.00	--	27.38
PM_{10} Emissions	--	0.62	N/A	0.77	N/A	1.38
$PM_{2.5}$ Emissions	--	0.62	N/A	0.69	N/A	1.31

Notes:

(1) Sum of all emission categories for ROG/VOC and NO_x; sum of Exhaust emission categories only for PM_{10}/$PM_{2.5}$.

Table 4-2. Phase 1 Operations - Maximum Criteria Pollutant Emissions Estimates

Assessment	Annual Tons per Year					
	Onsite Stationary (Exhaust)	Onsite Mobile (Exhaust)	Onsite Fugitive Dust	Offsite Mobile (Exhaust)	Offsite Fugitive Dust	Total (1)
ROG/VOC Emissions	0.77	0.31	--	1.15	--	2.23
NO_x Emissions	1.13	0.22	--	1.65	--	3.00
CO Emissions	4.98	2.56	--	14.95	--	22.48
PM_{10} Emissions	1.40	0.01	0.500	0.80	1.88	4.59
$PM_{2.5}$ Emissions	1.02	0.01	0.123	0.34	0.46	1.94

Assessment	Average Pounds per Day					
	Onsite Stationary (Exhaust)	Onsite Mobile (Exhaust)	Onsite Fugitive Dust	Offsite Mobile (Exhaust)	Offsite Fugitive Dust	Total (1)
ROG/VOC Emissions	4.23	1.72	--	6.28	--	12.23
NO_x Emissions	6.18	1.19	--	9.06	--	16.44
CO Emissions	27.30	14.00	--	81.90	--	123.20
PM_{10} Emissions	7.67	0.04	2.74	4.39	10.31	25.15
$PM_{2.5}$ Emissions	5.56	0.04	0.67	1.84	2.53	10.65

Notes:

(1) Sum of all emission categories for ROG/VOC, NO_x, PM_{10}, and $PM_{2.5}$.

Table 4-3. LRDP Construction - Maximum Criteria Pollutant Emissions Estimates (1)

Assessment	Annual Tons per Year					
	Onsite Stationary (Exhaust)	Onsite Mobile (Exhaust)	Onsite Fugitive Dust	Offsite Mobile (Exhaust)	Offsite Fugitive Dust	Total (2)
ROG/VOC Emissions	--	0.09	N/A	0.20	N/A	0.29
NO_x Emissions	--	0.62	N/A	1.68	N/A	2.30
CO Emissions	--	0.47	N/A	1.49	N/A	1.95
PM_{10} Emissions	--	0.03	N/A	0.05	N/A	0.08
$PM_{2.5}$ Emissions	--	0.03	N/A	0.05	N/A	0.08

Assessment	Average Pounds per Day					
	Onsite Stationary (Exhaust)	Onsite Mobile (Exhaust)	Onsite Fugitive Dust	Offsite Mobile (Exhaust)	Offsite Fugitive Dust	Total (2)
ROG/VOC Emissions	--	0.48	N/A	1.12	N/A	1.59
NO_x Emissions	--	3.42	N/A	9.18	N/A	12.60
CO Emissions	--	2.56	N/A	8.14	N/A	10.70
PM_{10} Emissions	--	0.16	N/A	0.29	N/A	0.45
$PM_{2.5}$ Emissions	--	0.16	N/A	0.27	N/A	0.42

Notes:

(1) Excludes Phase 1 period, which was evaluated separately.

(2) Sum of all emission categories for ROG/VOC and NO_x; sum of Exhaust emission categories only for PM_{10}/$PM_{2.5}$.

Table 4-4. LRDP Operations - Maximum Criteria Pollutant Emissions Estimates

Assessment	Annual Tons per Year					
	Onsite Stationary (Exhaust)	Onsite Mobile (Exhaust)	Onsite Fugitive Dust	Offsite Mobile (Exhaust)	Offsite Fugitive Dust	Total (1)
ROG/VOC Emissions	16.44	1.71	--	6.60	--	24.75
NO_x Emissions	8.61	1.92	--	9.65	--	20.18
CO Emissions	38.91	20.18	--	88.28	--	147.37
PM_{10} Emissions	13.00	0.16	4.764	7.89	18.45	44.27
$PM_{2.5}$ Emissions	9.16	0.15	1.168	3.32	4.53	18.33

Assessment	Average Pounds per Day					
	Onsite Stationary (Exhaust)	Onsite Mobile (Exhaust)	Onsite Fugitive Dust	Offsite Mobile (Exhaust)	Offsite Fugitive Dust	Total (1)
ROG/VOC Emissions	90.10	9.38	--	36.14	--	135.62
NO_x Emissions	47.20	10.50	--	52.90	--	110.60
CO Emissions	213.20	110.60	--	483.70	--	807.50
PM_{10} Emissions	71.21	0.90	26.102	43.24	101.10	242.56
$PM_{2.5}$ Emissions	50.20	0.83	6.400	18.21	24.82	100.46

Notes:

(1) Sum of all emission categories for ROG/VOC, NO_x, PM_{10}, and $PM_{2.5}$.

Table 4-5. Phase 1 Construction - Maximum Estimated Human Health Impacts

Assessment	Assessment Metric	Maximum Result
Cancer Risk - Offsite Resident	Lifetime Excess Cancer Risk	1.1-in-a-million
Cancer Risk - Offsite Worker	Lifetime Excess Cancer Risk	0.6-in-a-million
Cancer Risk - Onsite Worker	Lifetime Excess Cancer Risk	1.7-in-a-million
Chronic Hazard - Offsite Resident	Hazard Index	0.003
Chronic Hazard - Offsite Worker	Hazard Index	0.05
Chronic Hazard - Onsite Worker	Hazard Index	0.14
Acute Hazard - Onsite Worker	Hazard Index	(1)
Acute Hazard - Offsite Worker	Hazard Index	(1)
$PM_{2.5}$ Annual Concentration	Annual Average Concentration ($\mu g/m^3$)	0.020

Notes:

(1) Not assessed for this scenario - see report text.

Table 4-6. Phase 1 Operations - Maximum Estimated Human Health Impacts

Assessment	Assessment Metric	Maximum Result
Cancer Risk - Offsite Resident	Lifetime Excess Cancer Risk	0.9-in-a-million
Cancer Risk - Offsite Worker	Lifetime Excess Cancer Risk	2.4-in-a-million
Cancer Risk - Onsite Worker	Lifetime Excess Cancer Risk	2.9-in-a-million
Chronic Hazard - Offsite Resident	Hazard Index	0.005
Chronic Hazard - Offsite Worker	Hazard Index	0.04
Chronic Hazard - Onsite Worker	Hazard Index	0.05
Acute Hazard - Onsite Worker	Hazard Index	0.42
Acute Hazard - Offsite Worker	Hazard Index	0.36
$PM_{2.5}$ Annual Concentration	Annual Average Concentration ($\mu g/m^3$)	0.082

Table 4-7. LRDP Construction - Maximum Estimated Human Health Impacts

Assessment	Assessment Metric	Maximum Result
Cancer Risk - Offsite Resident	Lifetime Excess Cancer Risk	3.3-in-a-million
Cancer Risk - Offsite Worker	Lifetime Excess Cancer Risk	2.6-in-a-million
Cancer Risk - Onsite Worker	Lifetime Excess Cancer Risk	(1)
Chronic Hazard - Offsite Resident	Hazard Index	0.003
Chronic Hazard - Offsite Worker	Hazard Index	0.06
Chronic Hazard - Onsite Worker	Hazard Index	(1)
Acute Hazard - Onsite Worker	Hazard Index	(1)
Acute Hazard - Offsite Worker	Hazard Index	(1)
$PM_{2.5}$ Annual Concentration	Annual Average Concentration ($\mu g/m^3$)	0.018

Notes:

(1) Not assessed for this scenario - see report text.

Table 4-8. LRDP Operations - Maximum Estimated Human Health Impacts

Assessment	Assessment Metric	Maximum Result
Cancer Risk - Offsite Resident (1)	Lifetime Excess Cancer Risk	8.9-in-a-million
Cancer Risk - Offsite Worker	Lifetime Excess Cancer Risk	3.1-in-a-million
Cancer Risk - Onsite Worker	Lifetime Excess Cancer Risk	4.9-in-a-million
Chronic Hazard - Offsite Resident	Hazard Index	0.070
Chronic Hazard - Offsite Worker	Hazard Index	0.27
Chronic Hazard - Onsite Worker	Hazard Index	0.36
Acute Hazard - Onsite Worker (2)	Hazard Index	1.06
Acute Hazard - Offsite Worker (3)	Hazard Index	0.89
$PM_{2.5}$ Annual Concentration (4)	Annual Average Concentration ($\mu g/m^3$)	0.89

(1) Maximum modeled value occurred at Offsite Location 1 on Figure 4-1.
(2) Maximum modeled value occurred at Onsite Location 1 on Figure 4-1.
(3) Maximum modeled value occurred at Offsite Location 2 on Figure 4-1.
(4) Maximum modeled value occurred at Offsite Location 1 on Figure 4-1.

Table 4-9. Estimated Greenhouse Gas Emissions

Scenario	Assessment	Direct Emissions (MT CO_2e/yr)	Indirect Emissions (MT CO_2e/yr)	Total Emissions (MT CO_2e/yr)
Phase 1 - Construction	GHG Emissions (Not Stationary)	1,385	--	1,385

	Assessment	Direct Emissions (MT CO_2e/yr)	Indirect Emissions (MT CO_2e/yr)	Total Emissions (MT CO_2e/yr)	Total New Employees	Emissions per Employee (MT CO_2e/yr)
Phase 1 - Operations	GHG Emissions (Not Stationary)	1,155	373	1,528	1,000	1.53
Phase 1 - Operations	GHG Emissions (Stationary)	1,158	--	1,158		

Scenario	Assessment	Direct Emissions (MT CO_2e/yr)	Indirect Emissions (MT CO_2e/yr)	Total Emissions (MT CO_2e/yr)
LRDP - Construction	GHG Emissions (Not Stationary)	404	--	404

Scenario	Assessment	Direct Emissions (MT CO_2e/yr)	Indirect Emissions (MT CO_2e/yr)	Total Emissions (MT CO_2e/yr)	Total New Employees	Emissions per Employee (MT CO_2e/yr)
LRDP - Operations	GHG Emissions (Not Stationary)	25,202	20124	45,326	10,000	4.53
LRDP - Operations	GHG Emissions (Stationary)	31,880	--	31,880		

Notes:

Not Stationary - Includes onsite and offsite mobile sources and offsite indirect sources resulting from onsite utility usage.
Stationary - Includes only onsite stationary emission sources.

Table 4-10. Cumulative Cancer Risk, Chronic Hazard, and $PM_{2.5}$ Assessments for Phase 1 Project

ID	Name	Address	Cancer Risk (in a million)	Chronic Hazard Quotient	$PM_{2.5}$ ($\mu g/m^3$)
Existing Sources within 1,000 Feet of Project Boundary (1)					
5462	Bio-Rad Laboratories	3110 REGATTA BLVD	36.1	0.374	0.028
15508	Wareham Property Group - EPA Lab	1337 SO 46TH ST, BLDG 201	19	0.0067	0.34
	Phase 1 Project - Construction (2)		1.4	0.004	0.02
	Phase 1 Project - Operations (3)		3.0	0.009	0.15
	Cumulative - Construction (4,6)		**38.3**	**0.38**	**0.39**
	Cumulative - Operations (5,6)		**39.9**	**0.39**	**0.51**

Notes:

(1) As provided in the BAAQMD Stationary Source and Highway Screening Tools (*http://www.baaqmd.gov/Divisions/Planning-and-Research/CEQA-GUIDELINES/Tools-and-Methodology.aspx*). Maximum impacts at any location reported.

(2) Includes impacts from existing RFS sources.

(3) Includes impacts from existing RFS and Phase 2 sources.

(4) Sum of maximum impacts from existing sources and Phase 1 Project - Construction

(5) Sum of maximum impacts from existing sources and Phase 1 Project - Operation

(6) Source ID 15508 cancer risk result multiplied by minimum generator distance multiplier of 0.04 because 98% of the cancer risk is from a diesel generator and the facility is >> 280 m from MEI receptor.

Table 4-11. Cumulative Cancer Risk, Chronic Hazard, and $PM_{2.5}$ Assessments for Full LRDP Build-Out

ID	Name	Address	Cancer Risk (in a million)	Chronic Hazard Quotient	$PM_{2.5}$ ($\mu g/m^3$)
Existing Sources within 1,000 Feet of Project Boundary (1)					
5462	Bio-Rad Laboratories	3110 REGATTA BLVD	36.1	0.374	0.028
G9842	University of CA-Richmond Field Station	1301 So 46th Street	0	0	na
15755	Grace Baking	3200G REGATTA BLVD	0.0576	0.00002	0.53
G7543	Pacific Gas and Electric Company	1100 So 27th Street	1.1	0.0016	na
17029	Verizon Wireless (Richmond)	SO 27TH ST & PIERSON AVE	8.5	0.003	0.002
93	Safeway Stores Inc, Bakery Plant	905 SO 34TH STREET	0.03	0.00001	0.617
G7555	Stop & Shop	800 Carlson Boulevard	2.37	0.0034	na
15508	Wareham Property Group - EPA Lab	1337 SO 46TH ST, BLDG 201	19	0.0067	0.34
851	I-580 (East/North of Freeway)	300 ft from Max. Exposed Individual	50.384	0.041	0.279
	LRDP - Construction (3)		3.6	0.004	0.02
	LRDP - Operations (3)		11.3	0.07	0.89
	Cumulative - Construction (4, 6)		**94.7**	**0.42**	**1.49**
	Cumulative - Operations (5, 6)		**102.4**	**0.49**	**2.36**

Notes:

(1) As provided in the BAAQMD Stationary Source and Highway Screening Tools (*http://www.baaqmd.gov/Divisions/Planning-and-Research/CEQA-GUIDELINES/Tools-and-Methodology.aspx*). Maximum impacts at any location reported.

(2) BAAQMD database indicated zero impact from Richmond Field Station sources; however, these source emissions were explictly included in the Cumulative dispersion modeling, and were therefore accounted for in this manner.

(3) Includes impacts from existing RFS sources.

(4) Sum of maximum impacts from existing sources and LRDP - Construction.

(5) Sum of maximum impacts from existing sources and LRDP - Operations.

(6) Source ID 17029 is a diesel generator, so maximum impacts multiplied by generator distance multiplier of 0.04 (>> 280 m from MEI receptor). Source ID 15508 cancer risk result multiplied by minimum generator distance multiplier of 0.04 because 98% of the cancer risk is from a diesel generator and the facility is >> 280 m from MEI receptor.

Table 4-12. Summary of Cumulative PM Sources Modeled

Facility Number	Facility Name	Facility Address	Emission Source(s)	BAAQMD Source Representation Description	BAAQMD Source Representation Type	BAAQMD Source Parameters	UTM Coordinates (m, Zone 10)	PM Emissions (1) (lb/day)
15508	Wareham Property Group - EPA Lab	1337 South 46th St, Bldg 201	Emergency Generator	Generator	Point	Stack Height = 3.66 m (12 ft) Stack Diameter = 1.83 m (0.6 ft) Stack Temperature = 739.8 C (872 F) Stack Velocity = 45.3 m/sec (8,923 ft/min)	558296, 4196431	7.67E-04
15508	Wareham Property Group - EPA Lab	1337 South 46th St, Bldg 201	Natural Gas Cogeneration Plant	Unknown Stack	Point	Stack Height = 6.1 m (20 ft) Stack Diameter = 3.05 m (1 ft) Stack Temperature = 644 C(700 F) Stack Velocity = 17.8 m/s (3,500 ft/min)	558296, 4196431	7.83E-03
5462	Bio-Rad Laboratories	3110 Regatta Blvd	Fume Hoods/Bottling Operation	Unknown Source	Volume	Release Height = 1.8 m Initial Lateral Dimension = 10 m Initial Vertical Dimension = 1 m	558077, 4196531	1.04E-06
15755	Grace Baking	3200G Regatta Blvd	Tunnel Ovens	Unknown Stack	Point	Stack Height = 6.1 m (20 ft) Stack Diameter = 3.05 m (1 ft) Stack Temperature = 644 C(700 F) Stack Velocity = 17.8 m/s (3,500 ft/min)	557986, 4196651	1.35E-02
17029	Verizon Wireless (Richmond)	South 27th ST & Pierson Ave	Emergency Generator	Generator	Point	Stack Height = 3.66 m (12 ft) Stack Diameter = 1.83 m (0.6 ft) Stack Temperature = 739.8 C (872 F) Stack Velocity = 45.3 m/sec (8,923 ft/min)	557863, 4196931	2.42E-05
93	Safeway Stores Inc, Bakery Plant	905 South 34th Street	Ovens	Unknown Stack	Point	Stack Height = 6.1 m (20 ft) Stack Diameter = 3.05 m (1 ft) Stack Temperature = 644 C(700 F) Stack Velocity = 17.8 m/s (3,500 ft/min)	558209, 4197074	1.08E-02

Notes:
(1) Provided by BAAQMD - Annual average.

Table 4-13. Modeled Cumulative $PM_{2.5}$ Assessments for Full LRDP Build-Out Construction/Demolition

ID	Name	Address	$PM_{2.5}$ ($\mu g/m^3$)
Existing Sources within 1,000 Feet of Project Boundary			
5462	Bio-Rad Laboratories	3110 REGATTA BLVD	(1)
G9842	University of CA-Richmond Field Station	1301 So 46th Street	na
15755	Grace Baking	3200G REGATTA BLVD	(1)
G7543	Pacific Gas and Electric Company	1100 So 27th Street	na
17029	Verizon Wireless (Richmond)	SO 27TH ST & PIERSON AVE	(1)
93	Safeway Stores Inc, Bakery Plant	905 SO 34TH STREET	(1)
G7555	Stop & Shop	800 Carlson Boulevard	na
15508	Wareham Property Group - EPA Lab	1337 SO 46TH ST, BLDG 201	(1)
851	I-580 (East/North of Freeway)	300 ft from Max. Exposed Individual	0.279
	LRDP - Construction (2)		0.02
	Cumulative - Construction (3)		**0.30**

Notes:

(1) Included in LRDP - Construction model result.

(2) Modeled cumulative concentration including existing stationary sources and proposed full LRDP build-out sources.

(3) Sum of maximum impacts from I-580 freeway and LRDP - Construction model result; at MEI receptor (UTM 558899.52, 4197095.70).

Table 4-14. Cumulative Cancer Risk for Full LRDP Build-Out Operations with Attenuation Factors

ID	Name	Address	Cancer Risk (in a million)	Distance to Project MEI [3] (m)	BAAQMD Attenuation Factor [4]	Adjusted Cancer Risk (in a million)
Existing Sources within 1,000 Feet of Project Boundary [1]						
5462	Bio-Rad Laboratories	3110 REGATTA BLVD	36.1	985	0.04	1.44
G9842	University of CA-Richmond Field Station [2]	1301 So 46th Street	0	na	na	0
15755	Grace Baking	3200G REGATTA BLVD	0.0576	990	0.04	0.002
G7543	Pacific Gas and Electric Company	1100 So 27th Street	1.1	1200	0.04	0.04
17029	Verizon Wireless (Richmond)	SO 27TH ST & PIERSON AVE	8.5	1000	0.04	0.34
93	Safeway Stores Inc, Bakery Plant	905 SO 34TH STREET	0.03	630	0.04	0.001
G7555	Stop & Shop	800 Carlson Boulevard	2.37	180	0.034	0.08
15508	Wareham Property Group - EPA Lab	1337 SO 46TH ST, BLDG 201	19	900	0.04	0.76
851	I-580 (East/North of Freeway)	300 ft from Max. Exposed Individual	50.384	na	na	50.384
	LRDP - Operations [5]		11.3	na	na	11.30
	Cumulative - Operations [6]		**102.4**			**64.4**

Notes:

(1) As provided in the BAAQMD Stationary Source and Highway Screening Tools (*http://www.baaqmd.gov/Divisions/Planning-and-Research/CEQA-GUIDELINES/Tools-and-Methodology.aspx*). Maximum impacts at any location reported.

(2) BAAQMD database indicated zero impact from Richmond Field Station sources; however, these source emissions were explictly included in the Cumulative dispersion modeling, and were therefore accounted for in this manner.

(3) Cancer risk Maximumally Exposed Individual (MEI) located at UTM coordinates 558831, 4197161 (zone 10).

(4) BAAQMD attenuation factors applicable to diesel generators applied to all sources except G7555, which utilized a BAAQMD attenuation factor for service stations. Note that the BAAQMD attenuation factor of 0.04 for diesel generators applies for distances of 280 meters and beyond, and is therefore very conservatively applied to the generator and non-generator sources in this table, which are all well beyond 280 meters from the MEI. Sources 17029 and 15508 reflect impacts from diesel generators.

(5) Includes impacts from existing RFS sources.

(6) Sum of maximum impacts from existing sources and LRDP - Operations.

Figures

Figure 1-1. Regional Project Site Map

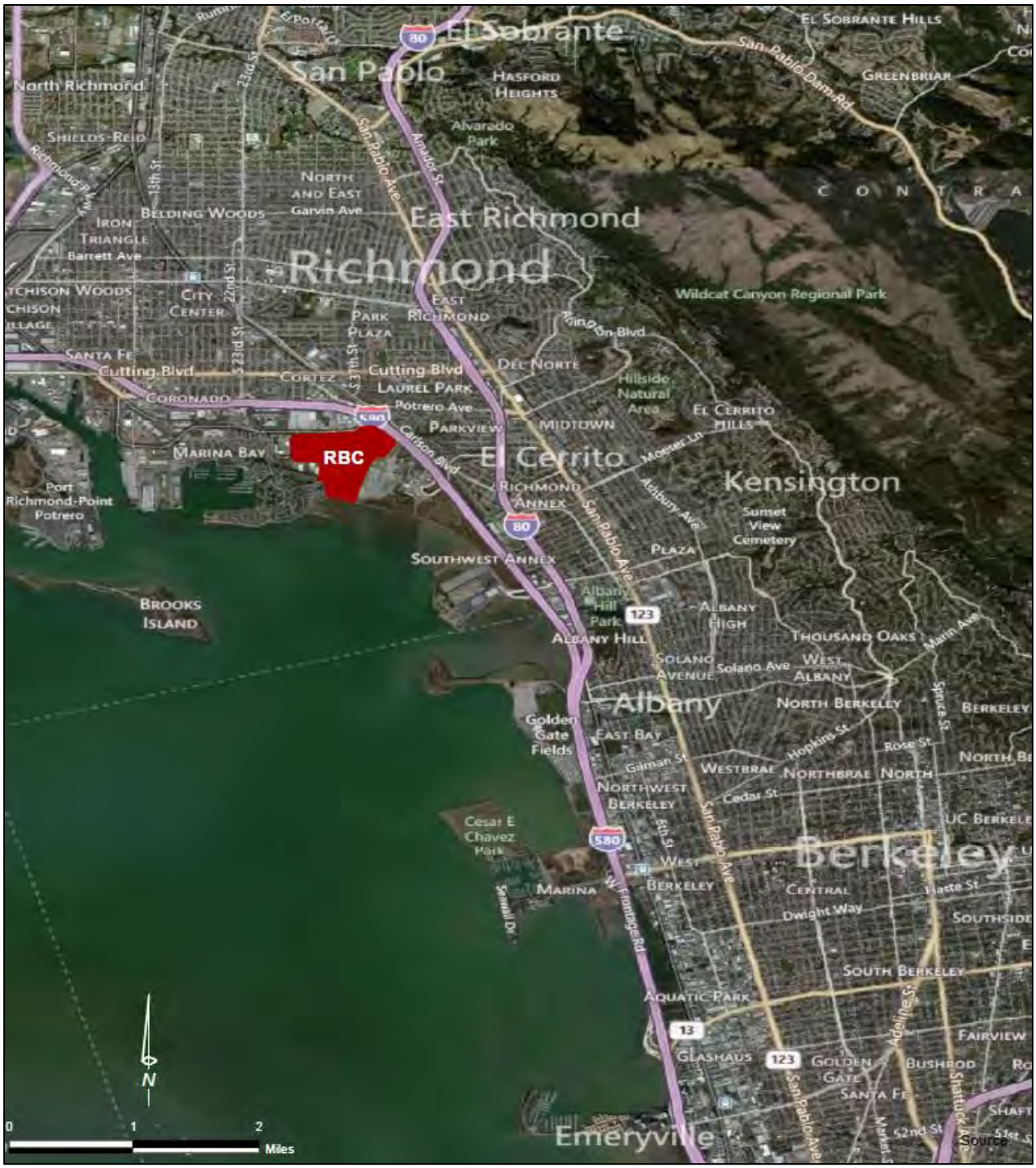


Figure provided by Tetra Tech

Figure 1-2. Long Range Development Plan Illustrative Development Scenario

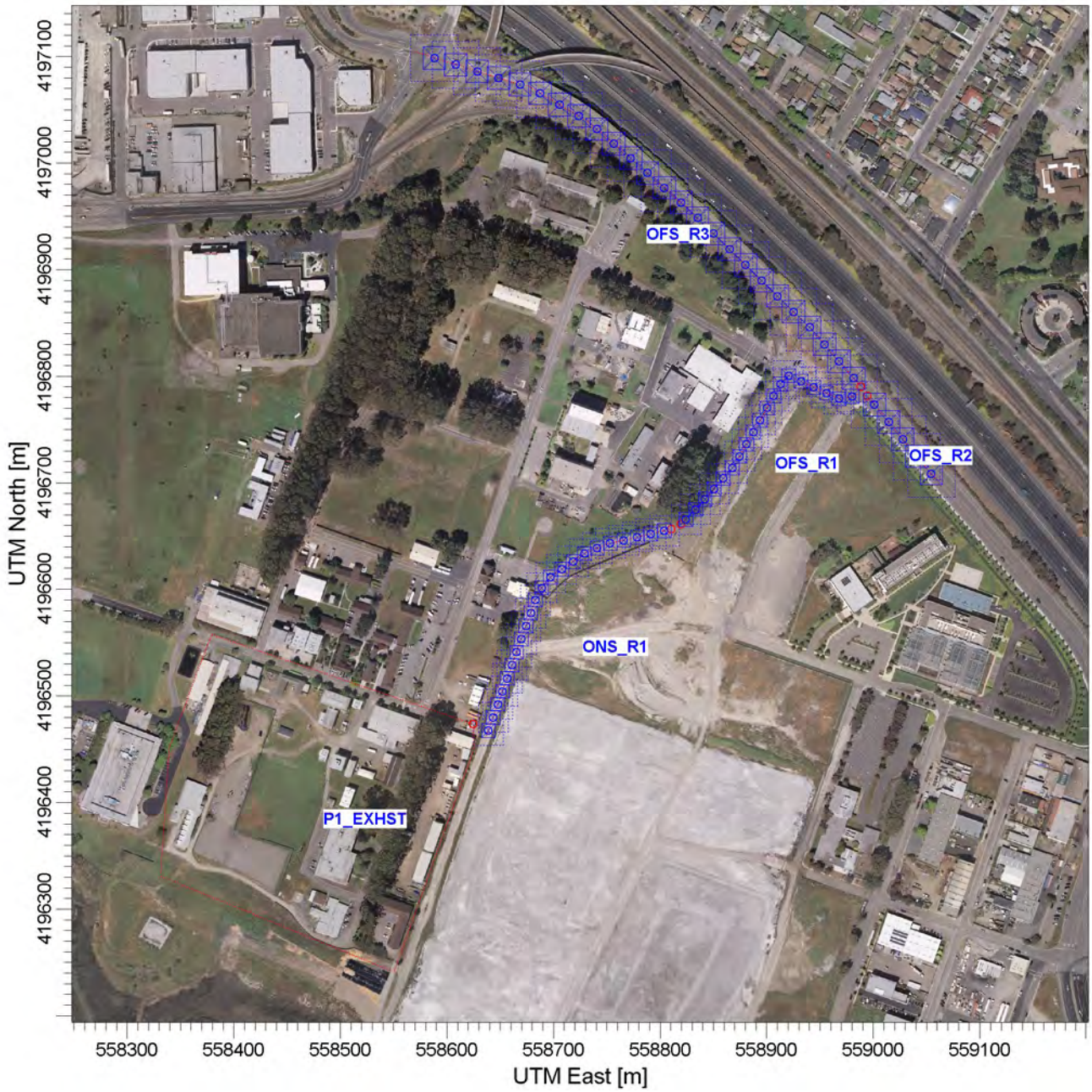
Figure provided by Tetra Tech. Represents one potential build-out scenario.

Figure 1-3. Long Range Development Plan – Phase 1

Figure provided by Tetra Tech. Represents one potential Phase 1 scenario.

PROJECT TITLE:

Figure 3-1. Source Locations - Construction/Demolition - Phase 1
Richmond Bay Campus LRDP, Richmond, California



COMMENTS:

Red dashed lines represent area source location.

Blue squares represent road line source locations.

COMPANY NAME:

Golder Associates, Inc.

MODELER:

Portland, OR

SCALE: 1:6,000

0 0.2 km

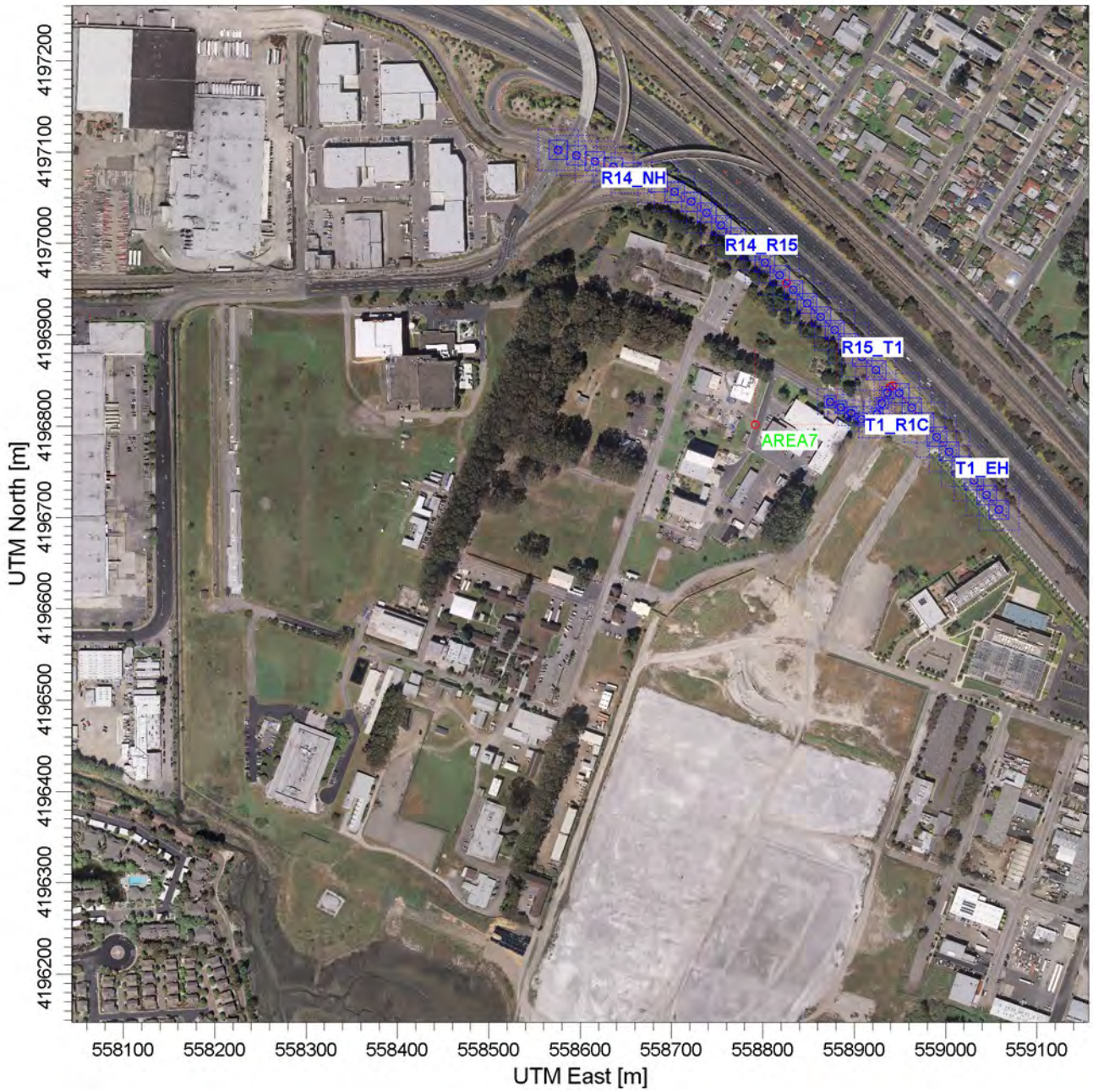
PROJECT NO.:

123-99773_02

AERMOD View - Lakes Environmental Software

PROJECT TITLE:

Figure 3-2. Source Locations - Construction/Demolition - Maximum Annual Impacts at Resident Receptors - Full LRDP
Richmond Bay Campus LRDP, Richmond, California



COMMENTS:

Red dashed lines represent area source location.

Blue squares represent road line source locations.

COMPANY NAME:

Golder Associates, Inc.

MODELER:

Portland, OR

SCALE: 1:7,000

0 0.2 km

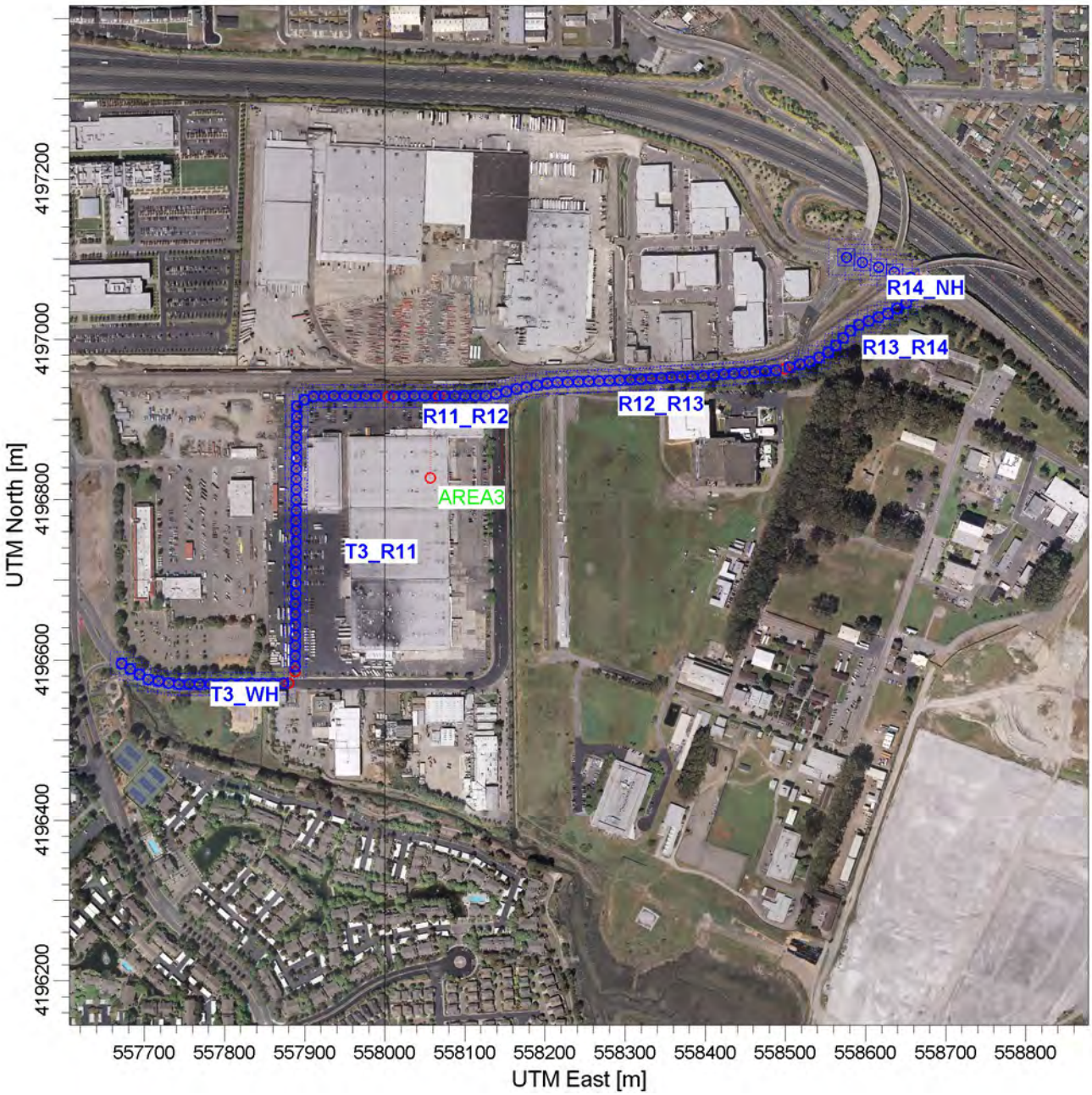
PROJECT NO.:

123-99773_02

AERMOD View - Lakes Environmental Software

PROJECT TITLE:

Figure 3-3. Source Locations - Construction/Demolition - Maximum Annual Impacts at Offsite Worker Receptors - Full LRDP Richmond Bay Campus LRDP, Richmond, California



COMMENTS:

Red dashed lines represent area source location.

Blue squares represent road line source locations.

COMPANY NAME:

Golder Associates, Inc.

MODELER:

Portland, OR

SCALE: 1:8,000

0 0.3 km

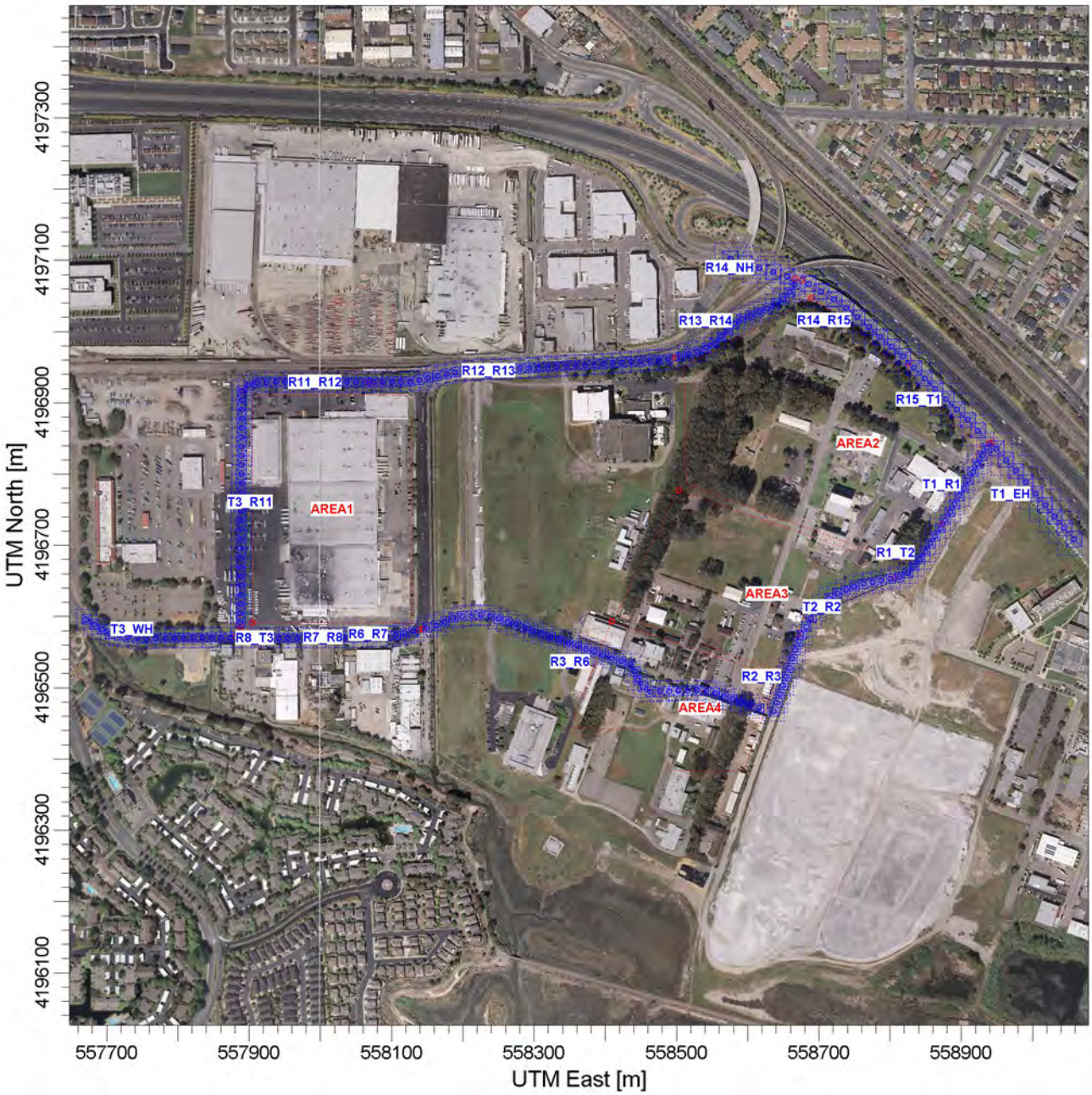
PROJECT NO.:

123-99773_02

AERMOD View - Lakes Environmental Software

PROJECT TITLE:

Figure 3-4. Source Locations - Construction/Demolition - Lifetime Cancer Risk Impacts - Full LRDP
Richmond Bay Campus LRDP, Richmond, California



COMMENTS:

Red dashed lines represent area source locations.

Blue squares represent road line source locations.

COMPANY NAME:

Golder Associates, Inc.

MODELER:

Portland, OR

SCALE: 1:9,000

0 0.3 km

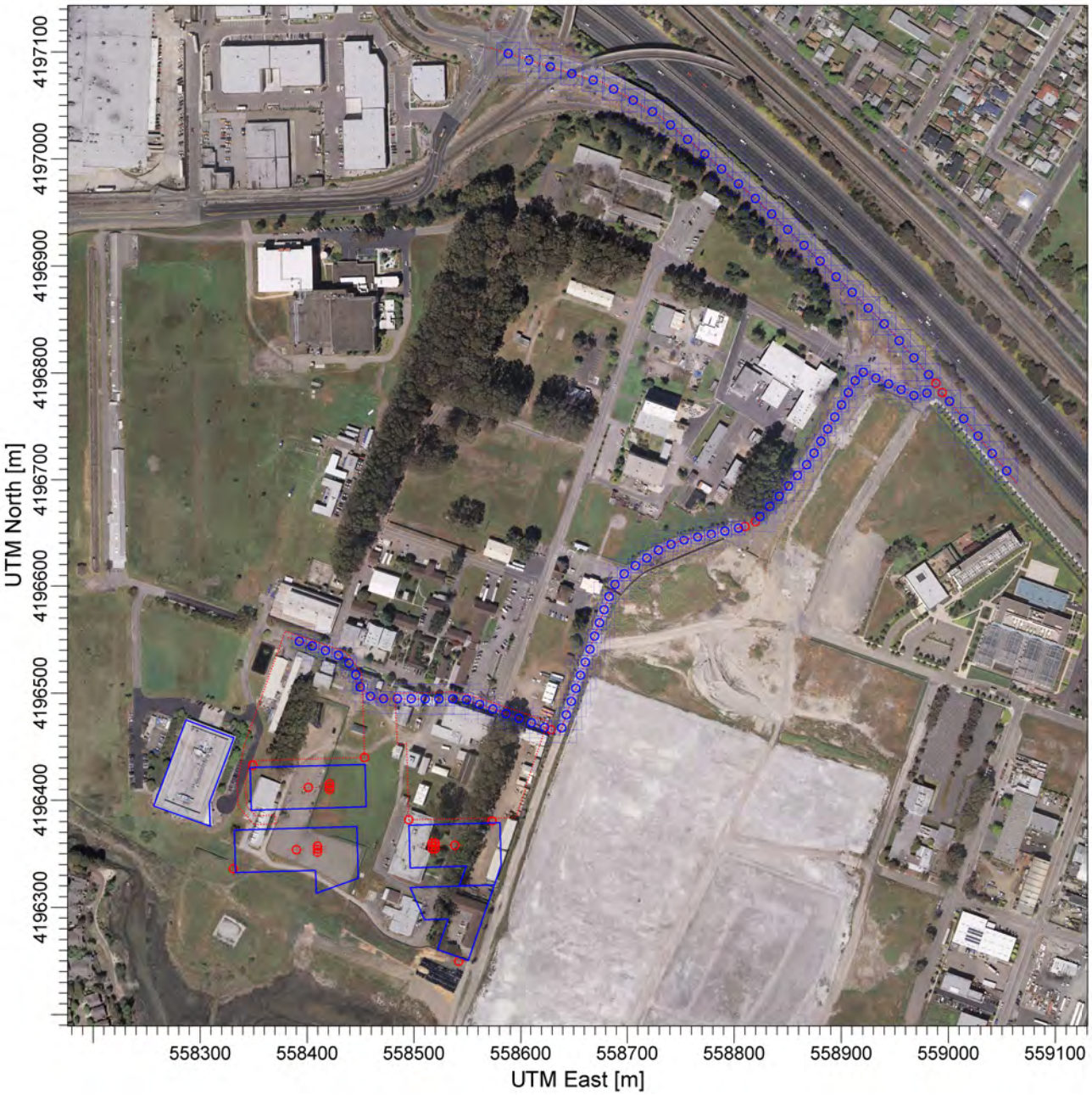
PROJECT NO.:

123-99773_02

AERMOD View - Lakes Environmental Software

PROJECT TITLE:

Figure 3-5. Source Locations - Operations - Phase 1
Richmond Bay Campus LRDP, Richmond, California

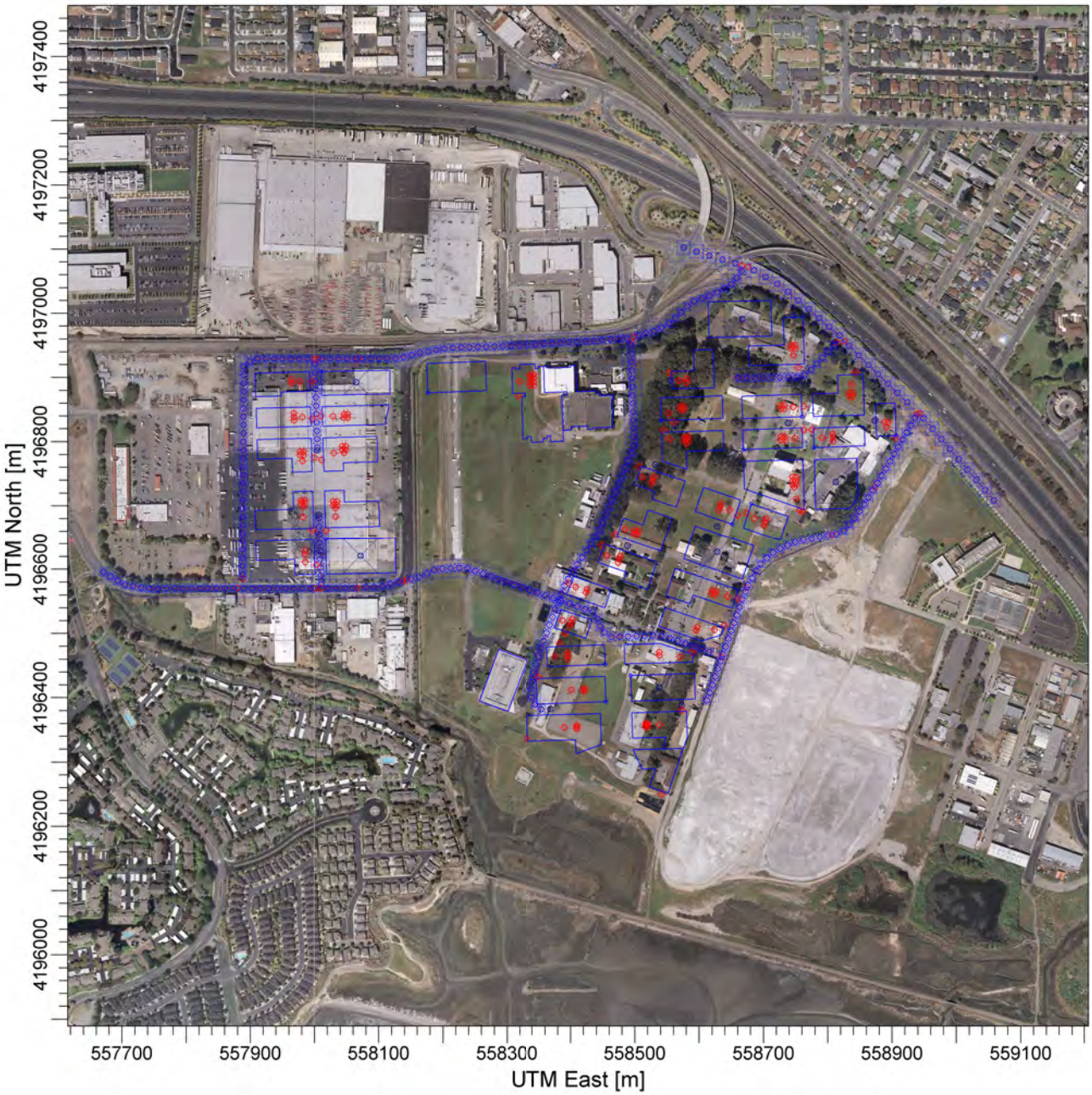


COMMENTS:	SOURCES:	COMPANY NAME:	
Red crosshairs denote point source locations. Red dashed lines represent area source locations. Adjacent blue squares represent road line source locations. Blue outlines represent downwash structure locations.	**26**	**Golder Associates, Inc.**	
		MODELER: **Portland, OR**	Golder Associates
		SCALE: 1:6,000 0 0.2 km	
			PROJECT NO.: **123-99773_02**

AERMOD View - Lakes Environmental Software

PROJECT TITLE:

Figure 3-6. Source Locations - Operations - Full LRDP
Richmond Bay Campus LRDP, Richmond, California



COMMENTS:	SOURCES:	COMPANY NAME:	
Red crosshairs denote point source locations. Red dashed lines represent area source locations. Adjacent blue squares represent road line source locations. Dashed blue squares represent volume source locations. Blue outlines represent downwash structure locations.	**229**	**Golder Associates, Inc.**	
		MODELER: **Portland, OR**	Golder Associates
		SCALE: 1:10,000 0 0.3 km	
			PROJECT NO.: **123-99773_02**

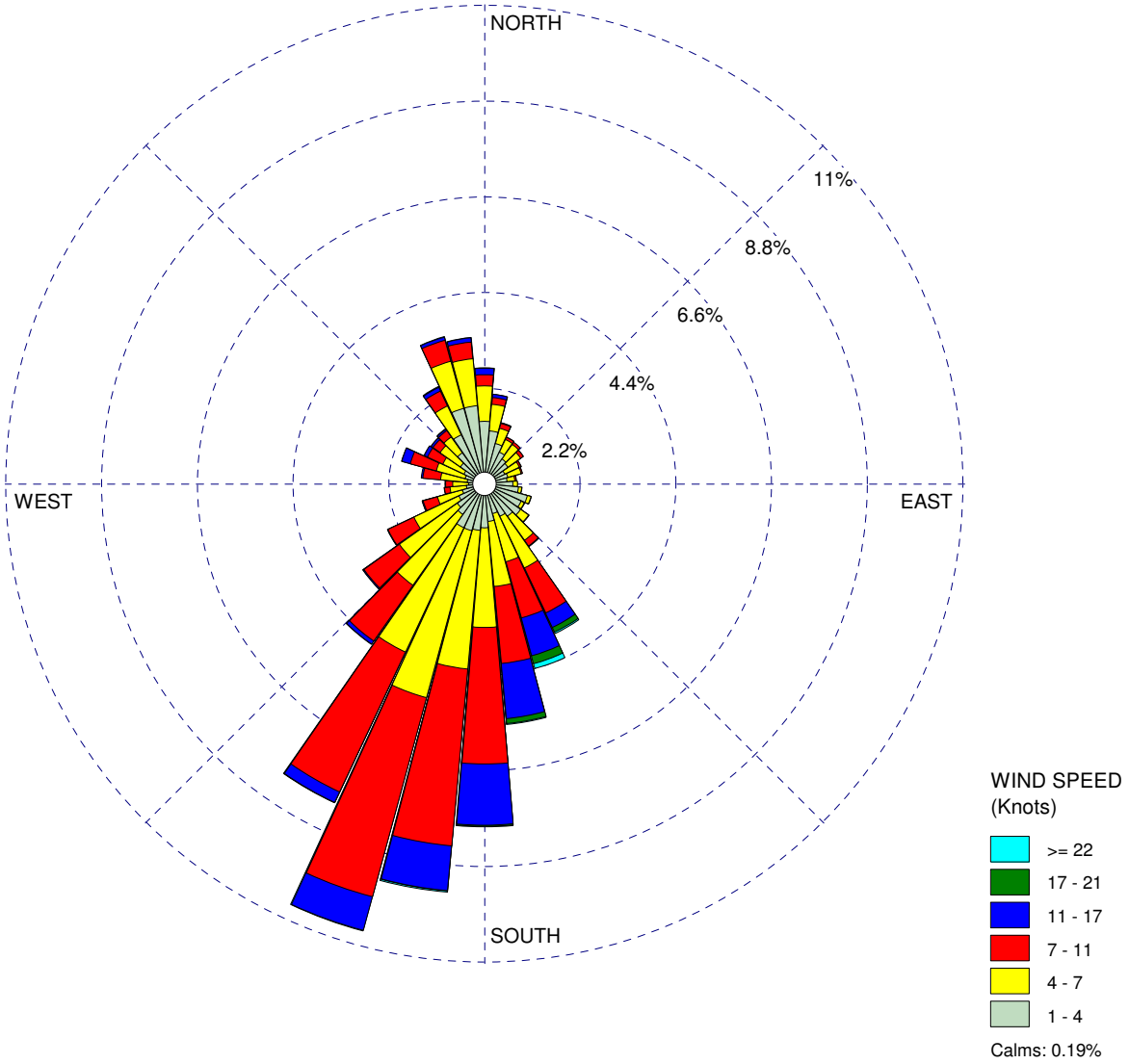
AERMOD View - Lakes Environmental Software

WIND ROSE PLOT:

Figure 3-7. Wind Rose for Modeling Period (2003-2006, and 2008)
Richmond Bay Campus LRDP, Richmond, California

DISPLAY:

Wind Speed
Direction (blowing from)



COMMENTS:

Surface meteorological data collected at the "UC Richmond" location operated by BAAQMD. Data provided by BAAQMD.

COMPANY NAME:

Golder Associates

MODELER:

Portland, OR

CALM WINDS:

0.19%

TOTAL COUNT:

43809 hrs.

AVG. WIND SPEED:

6.40 Knots

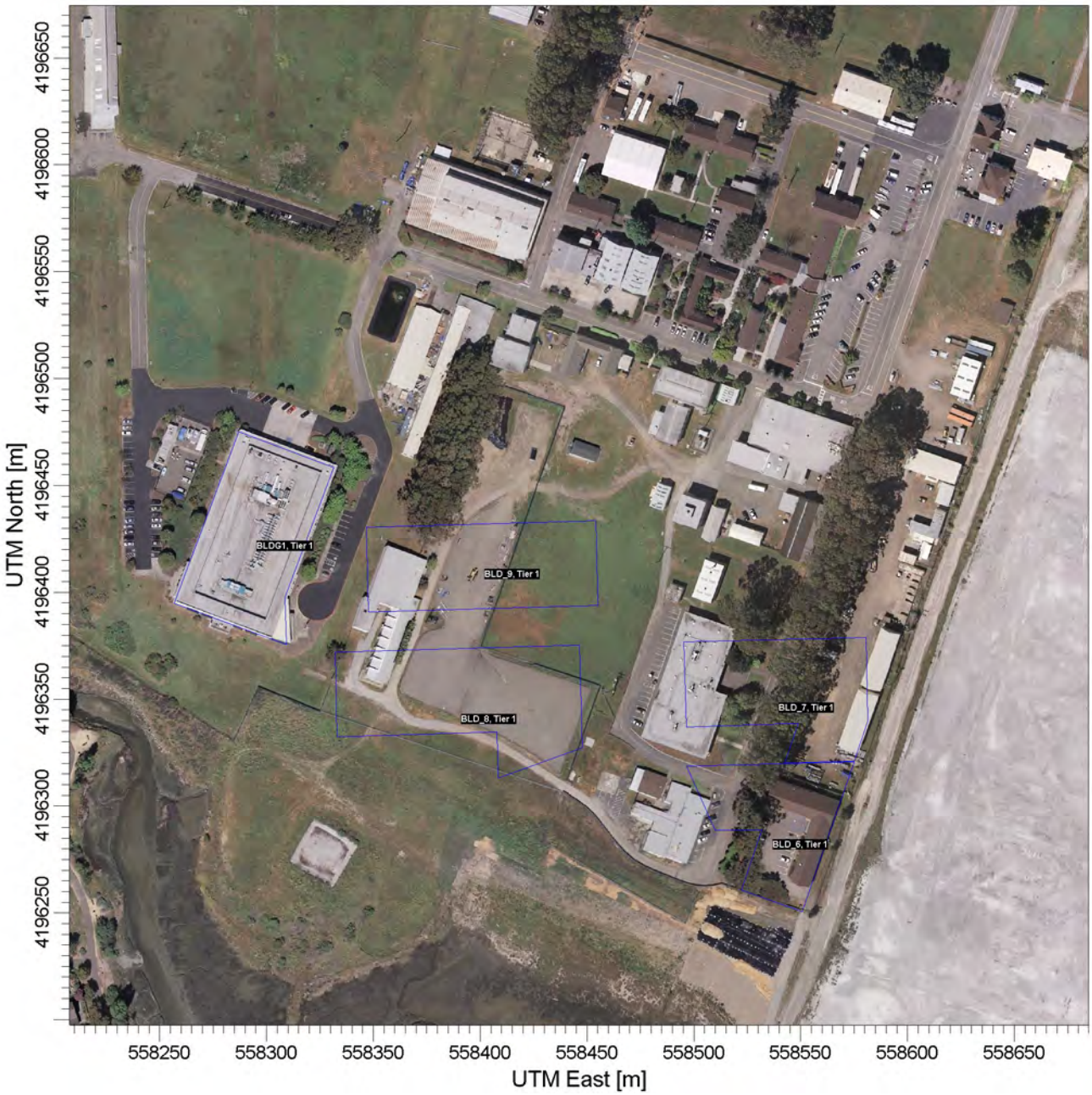
PROJECT NO.:

123-99773_02

WRPLOT View - Lakes Environmental Software

PROJECT TITLE:

Figure 3-8. Phase 1 Downwash Structure Locations
Richmond Bay Campus LRDP, Richmond, California



COMMENTS:		COMPANY NAME:	
Blue lines denote downwash structures.		**Golder Associates, Inc**	
		MODELER: **Portland, OR**	Golder Associates
		SCALE: 1:3,000 0 0.1 km	
			PROJECT NO.: **123-99773_02**

AERMOD View - Lakes Environmental Software

PROJECT TITLE:

Figure 3-9. Full LRDP Downwash Structure Locations
Richmond Bay Campus LRDP, Richmond, California

COMMENTS:		COMPANY NAME:	
Blue lines denote downwash structures.		**Golder Associates, Inc**	
		MODELER: **Portland, OR**	Golder Associates
		SCALE: 1:7,000 0 0.2 km	
			PROJECT NO.: **123-99773_02**

AERMOD View - Lakes Environmental Software

PROJECT TITLE:

Figure 3-10. Receptor Locations - Offsite Residences
Richmond Bay Campus LRDP, Richmond, California

COMMENTS:

Yellow dots represent discrete receptor locations.

COMPANY NAME:

Golder Associates, Inc

MODELER:

Portland, OR

SCALE: 1:18,000

0 0.5 km

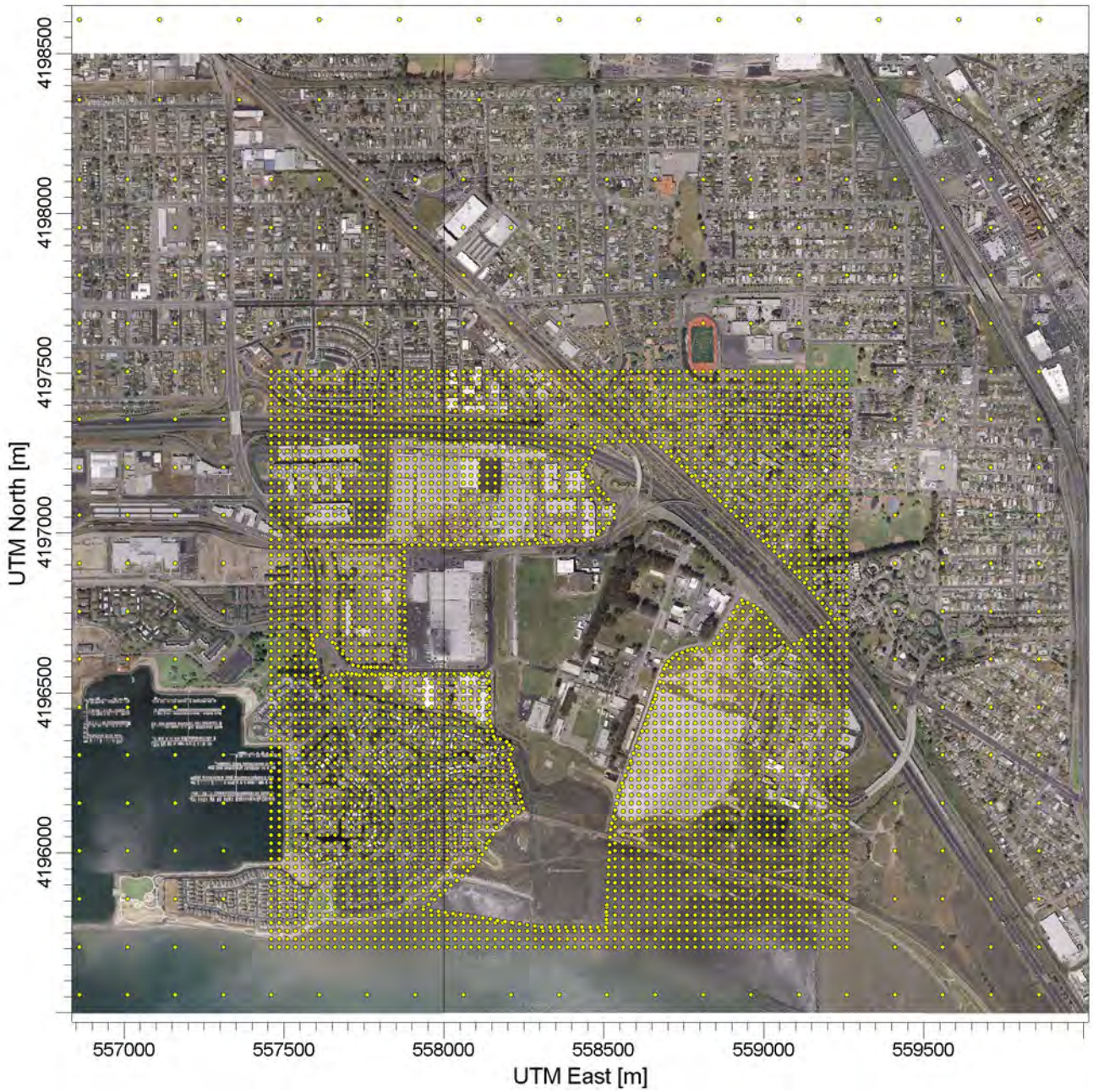
PROJECT NO.:

123-99773_02

AERMOD View - Lakes Environmental Software

PROJECT TITLE:

Figure 3-11. Receptor Locations - Offsite Occupational Workers
Richmond Bay Campus LRDP, Richmond, California



COMMENTS:

Yellow dots represent discrete receptor locations.

COMPANY NAME:

Golder Associates, Inc

MODELER:

Portland, OR

SCALE: 1:20,000

0 0.5 km

PROJECT NO.:

123-99773_02

AERMOD View - Lakes Environmental Software

PROJECT TITLE:

Figure 3-12. Receptor Locations - Onsite Occupation Workers - Phase 1
Richmond Bay Campus LRDP, Richmond, California

COMMENTS:

Yellow dots represent discrete receptor locations.

COMPANY NAME:

Golder Associates, Inc

MODELER:

Portland, OR

SCALE: 1:8,000

0 0.3 km

PROJECT NO.:

123-99773_02

AERMOD View - Lakes Environmental Software

PROJECT TITLE:

Figure 3-13. Receptor Locations - Onsite Occupational Workers - Full LRDP
Richmond Bay Campus LRDP, Richmond, California

COMMENTS:

Yellow dots represent discrete receptor locations.

Blue line represent downwash structures.

COMPANY NAME:

Golder Associates, Inc

MODELER:

Portland, OR

SCALE: 1:8,000

0 0.3 km

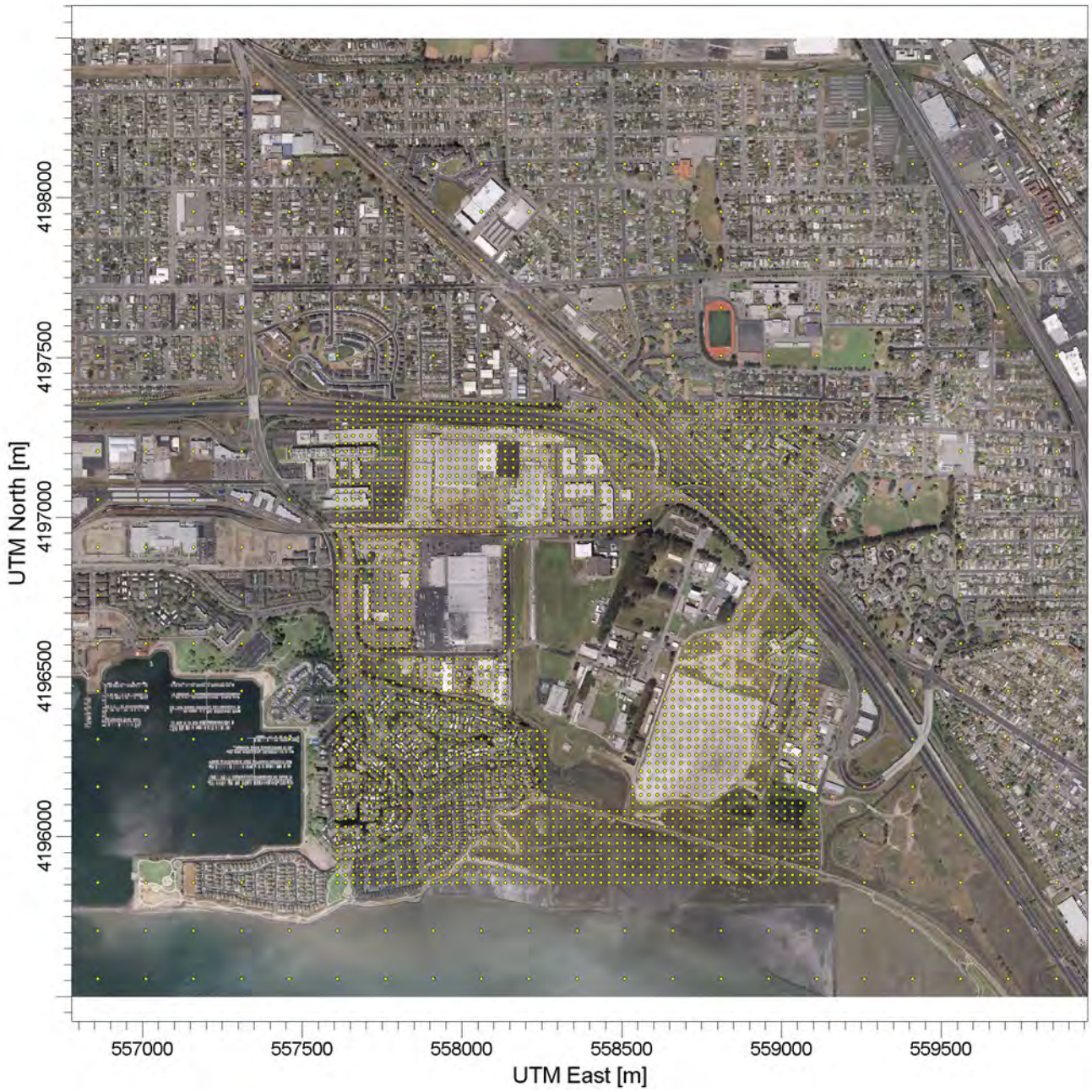
PROJECT NO.:

123-99773_02

AERMOD View - Lakes Environmental Software

PROJECT TITLE:

Figure 3-14. Receptor Locations - Offsite Acute - Phase 1
Richmond Bay Campus LRDP, Richmond, California



COMMENTS:

Yellow dots represent discrete receptor locations.

COMPANY NAME:

Golder Associates, Inc

MODELER:

Portland, OR

SCALE: 1:20,000

0 0.5 km

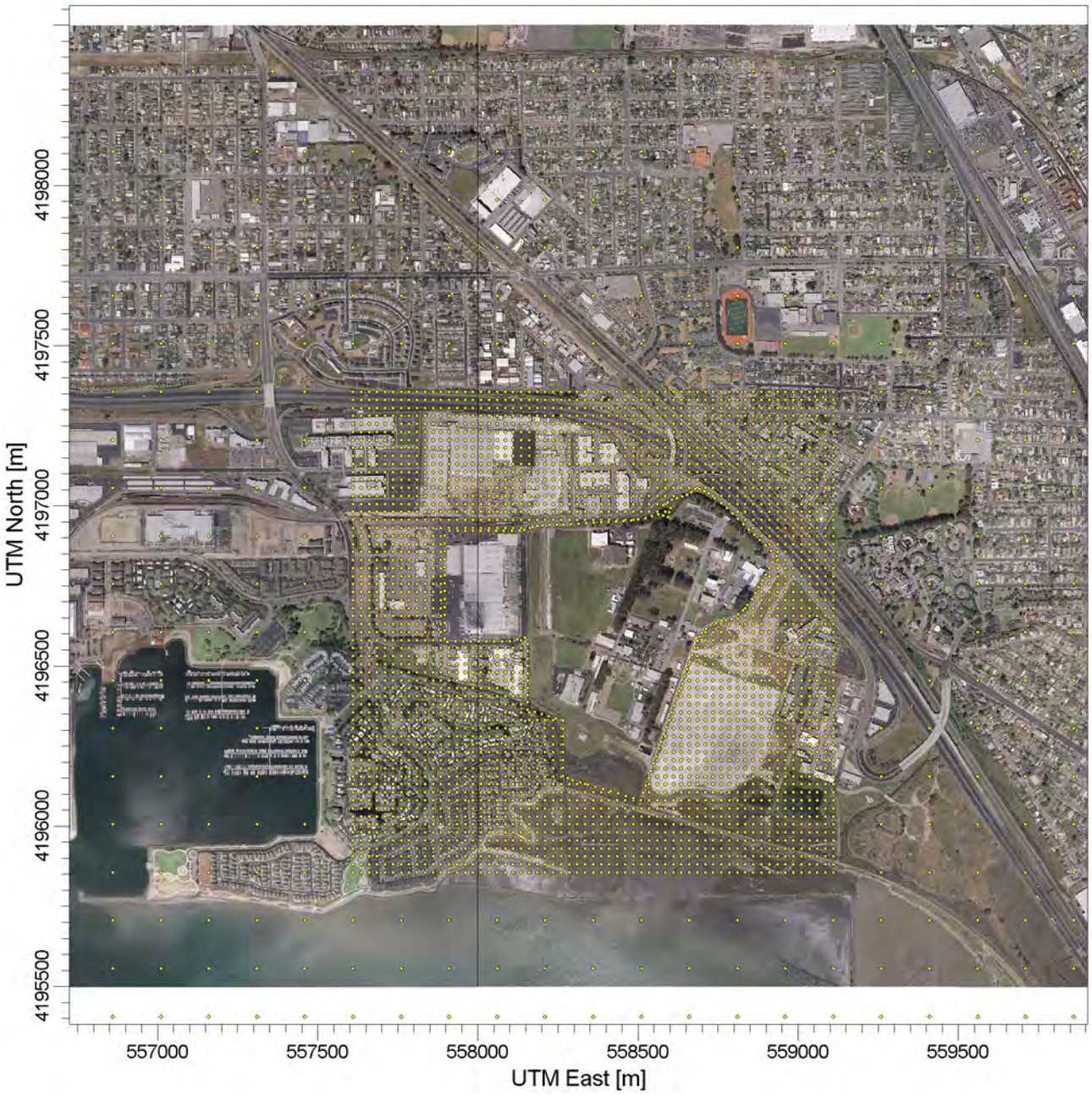
PROJECT NO.:

123-99773_02

AERMOD View - Lakes Environmental Software

PROJECT TITLE:

Figure 3-15. Receptor Locations - Offsite Acute - Full LRDP
Richmond Bay Campus LRDP, Richmond, California



COMMENTS:

Yellow dots represent discrete receptor locations.

COMPANY NAME:

Golder Associates, Inc

MODELER:

Portland, OR

SCALE: 1:20,000

0 0.5 km

PROJECT NO.:

123-99773_02

AERMOD View - Lakes Environmental Software

PROJECT TITLE:

Figure 3-16. Receptor Locations - Onsite Acute - Phase 1
Richmond Bay Campus LRDP, Richmond, California

COMMENTS:

Yellow dots represetn discrete receptor locations.

COMPANY NAME:

Golder Associates, Inc

MODELER:

Portland, OR

SCALE: 1:9,000

0 0.3 km

PROJECT NO.:

123-99773_02

AERMOD View - Lakes Environmental Software

PROJECT TITLE:

Figure 3-17. Receptor Locations - Onsite Acute - LRDP
Richmond Bay Campus LRDP, Richmond, California

COMMENTS:

Yellow dots represent discrete receptor locations.

COMPANY NAME:

Golder Associates, Inc

MODELER:

Portland, OR

SCALE: 1:9,000

0 0.3 km

PROJECT NO.:

123-99773_02

AERMOD View - Lakes Environmental Software

Figure 4-1. Maximally Exposed Individual Reference Locations

Appendix A

Emissions Estimates – Phase 1 Construction

Table A-1
CalEEMod Input Assumptions for Phase 1 Construction and Demolition Scenario - 2014

Construction Area		Dates		Total Number of Years		Project Total	(units)	Phase Amount [(a)]	(units)	Truck Trips (trips/year)		Inventory Onroad Trip Length (miles/trip)		Modeling Onroad Trip Length (miles/trip)		Total Area Disturbed (acres)	
Demolition - 2014																	
Demolition	(1)	1/20/2014	2/10/2014	1.00	(2)	106,999	gsf	106,999	gsf	Default	(3)	Default	(3)	0.6371	(4)	--	
Site Preparation (contaminated soil removal)	(1)	2/10/2014	4/7/2014	1.00	(2)	--	yd^3	--	yd^3	--	(1)	260	(1)	0.6371	(4)	--	(1)
Construction - 2014																	
Grading	(5)	2/10/2014	4/7/2014	1.00	(2)	70,000	yd^3	70,000	yd^3	7,500	(6)	Default	(3)	0.6371	(4)	12	(1)
	(7)	2/10/2014	4/7/2014	1.00	(2)	2,750	yd^3	2,750	yd^3	275	(8)	Default	(3)	0.6371	(4)	12	(1)
Building Construction (research & development)	(1)	4/28/2014	12/7/2015	2.00	(2)	600,000	gsf	300,000	gsf	Default	(3)	Default	(3)	0.6371	(4)	--	
Building Construction (parking lot)	(1)	4/28/2014	12/7/2015	2.00	(2)	600	spaces	300	spaces	Default	(3)	Default	(3)	0.6371	(4)	--	
Paving	(1)	10/5/2015	12/14/2015	1.00	(2)	--	--	--	--	Default	(3)	Default	(3)	0.6371	(4)	--	

Notes:

(a) Phase amount (units) = (Project total [units]) / (total number of years per phase)

References:

(1) Demolition and construction general project information provided by LBNL.
(2) Construction and demolition schedules provided by LBNL.
(3) CalEEMod default assumption. Onroad and off-road trips represent one-way trip lengths.
(4) Adjusted onroad one-way trip length derived from entrance to RBC. Used to estimate emissions for modeling purposes only.
(5) Grading phase imports 70,000 cubic yards of soil.
(6) Grading (soil import) trips include 7,000 haul truck trips per year and 500 vendor trips per year.
(7) Grading phase exports 2,750 cubic yards of soil.
(8) Phase amount divided by typical truck load capacity of 10 cubic yards per load.

Table A-2
CalEEMod Input Assumptions for Phase 1 Construction and Demolition Scenario Offroad Equipment

Phase	Type of Equipment	Units	Year	LBNL Daily Hours of Operation (hrs/phase)	LBNL Duration of Use (days/phase)	CalEEMod Phase Length (days/phase)	Total Hours of Use (hrs/phase)	CalEEMod Daily Hours of Operation [a] (hrs/day)	Approximate Size of Equipment (hp)	Load Fraction	CalEEMod Load Factor Used [1]
Demolition	Excavators	1	2014	8	20	20	160	8	153	75	0.38
	Backhoe Loader	1	2014	8	20	20	160	8	95	80	0.37
	Dozer	1	2014	8	16	20	128	6.40	99	75	0.40
	Asphalt Cutter	1	2014	4	10	20	40	2	6.5 [2]	65	0.73
	Water Truck	1	2014	8	20	20	160	8	360	75	0.42
Site Preparation	--	--	2014	--	--	44	--	--	--	--	--
Site Grading - Excavation	Excavators	1	2014	8	44	44	352	8	153	75	0.38
	Backhoe Loader	1	2014	8	44	44	352	8	95	80	0.37
	Dozer	1	2014	8	20	44	160	3.64	99	75	0.40
	Trenching Equipment	1	2014	8	20	44	160	3.64	185	80	0.50
	Compaction Equipment	2	2014	8	44	44	704	8	157	75	0.38
Building Construction - Foundations	Backhoe/Crawler Loaders	1	2014	8	40	70	320	4.57	110	75	0.37
	Forklifts	2	2014	4	65	70	520	4	110	75	0.20
	Concrete Pumps	1	2014	8	20	70	160	2.29	307 [3]	80	0.74
	Compaction Equipment	2	2014	8	20	70	320	2.29	14.0	80	0.43
	Small Tools	1	2014	8	66	70	528	7.54	15 kW/month	85	--
	Air Compressors	1	2014	2	70	70	140	2	60	70	0.48
Building Construction - Steel Erection	Mobile Crane	2	2014	6	45	85	540	3.18	279	90	0.29
	Front End Welders	2	2014	8	45	85	720	4	14	85	0.45
	Back End Welders	3	2014	8	45	85	1080	4.2	14	85	0.45
	Man Lifts	1	2014	8	45	85	360	4.24	80 kW/hr	80	--
	Boomlifts	1	2014	4	85	85	340	4	82	80	0.40
	Forklifts	1	2014	4	85	85	340	4	110	75	0.20
	Air Compressors	1	2014	2	85	85	170	2	60.0	70	0.48
	Small Tools	1	2014	8	85	85	680	8	15 kW/month	85	--
	Concrete Pumps	1	2014	8	10	85	80	0.94	307 [3]	80	0.74
Building Construction - Exterior Enclosure	Mobile Crane	1	2015	6	130	130	780	6	279	60	0.29
	Man Lifts	1	2015	8	130	130	1040	8	80 kW/hr	80	--
	Boomlifts	1	2015	2	130	130	260	2	82	75	0.40
	Forklifts	1	2015	2	130	130	260	2	110.0	75	0.20
	Water Truck	1	2015	2	130	130	260	2	360	80	0.42
	Small Tools	1	2015	8	130	130	1040	8	15 kW/month	85	--
Building Construction - Interior Finishes	Boomlifts	1	2015	2	140	140	280	2	82	75	0.40
	Forklifts	1	2015	2	140	140	280	2	110	80	0.20
	Small Tools	1	2015	8	140	140	1120	8	15 kW/month	85	--
	Water Truck	1	2015	2	140	140	280	2	360.0	80	0.42
Paving - Site Improvements	Water Truck	1	2015	2	45	45	90	2.0	360	75	0.42
	Asphalt Cutter	1	2015	8	10	45	80	2	7	65	0.73
	Paving Equipment	1	2015	8	10	45	80	1.78	142	65	0.36
	Forklifts	1	2015	2	45	45	90	2.0	50.0	65	0.40
	Compactor	2	2015	8	20	45	320	4	7	70	0.38
	Excavators	1	2015	8	20	45	160	3.56	54	70	0.38
	Skid Steered Loader	1	2015	6	20	45	120	3	50.0	80	0.37
	Small Tools	1	2015	8	45	45	360	8	15 kW/month	85	--
	Trenching Equipment	1	2015	4	20	45	80	1.78	6	80	0.50

Notes:

(a) CalEEMod daily hours of operation (hrs/day) = (Total hours of use [hrs/phase]) / (CalEEMod phase length [days/phase]) / (units)

References:

(1) Staff Report: Initial Statement of Reasons for Proposed Rulemaking, Appendix D - OSM and Summary of Off-Road Emissions Inventory Update, California Air Resources Board, October 2010, http://www.arb.ca.gov/regact/2010/Off-Roadlsi10/Off-Roadappd.pdf.

(2) CalEEMod load factors can only input whole numbers. Thus, rounding to nearest whole number was used.

(3) Concrete pump horsepower provided by LBNL. Represents 65% usage of truck mounted pumps (450 hp) and 35% usage of the hydraulic pump (40 hp).

Table A-3

CalEEMod Input Assumptions for Phase 1 Construction and Demolition Scenario Onroad Vehicles

Source	Source Parameter	Dates [1]		Operation [2]	(units)	Worker Trips (trips/day)	Vendor Trips (trips/day)	Total Hauling Trips	Worker Trip Length [2] (miles)	Vendor Trip Length [2] (miles)	Hauling Trip Length (miles)
Onroad Vehicle Emissions											
	Demolition	1/1/2014	1/28/2014	20	days	13 [3]	0 [3]	487 [3]	12.4	7.3	20 [3]
	Site Preparation	1/1/2014	3/3/2014	44	days	0 [3]	0 [3]	275 [3]	12.4	7.3	260 [1]
	Grading	3/4/2014	5/4/2014	44	days	15 [3]	3 [1]	7,500 [1]	12.4	7.3	20 [3]
	Building Construction - Foundations	5/5/2014	8/8/2014	70	days	146 [3]	69 [3]	0 [3]	12.4	7.3	20 [3]
	Building Construction - Steel Erection	8/9/2014	12/5/2104	85	days	146 [3]	69 [3]	0 [3]	12.4	7.3	20 [3]

References:

(1) Demolition and construction general project information provided by LBNL.

(2) See Table A-2, CalEEMod Input Assumptions for Phase 1 Construction and Demolition Scenario Offroad Equipment.

(3) All off-road equipment data taken from CalEEMod defaults.

Table A-4
Phase 1 Construction and Demoltion Annual Emission Estimates - 2014

Base Year	Phase		Pollutant (tons/yr)															
			ROG	NOx	CO	SO_2	Fugitive PM_{10}	Exhaust PM_{10} (1)	PM_{10} Total	Fugitive $PM_{2.5}$	Exhaust $PM_{2.5}$	$PM_{2.5}$ Total	Bio- CO_2 (a)	NBio- CO_2 (a)	Total CO_2 (a)	CH_4 (a)	N_2O (a)	CO_2e (a)
Off-Road Vehicle Emissions																		
2014	Demolition		2.0E-02	0.15	9.0E-02	0	2.0E-02 (3)	1.0E-02	3.0E-02	0 (3)	1.0E-02	1.0E-02	0	24.5	24.5	0	0	24.5
	Site Preparation		0	0	0	0	1.0E-02 (3)	0	1.0E-02	0 (3)	0	0	0	0	0	0	0	0
	Grading		6.0E-02	0.48	0.31	0	3.0E-02 (3)	3.0E-02	6.0E-02	2.0E-02 (3)	3.0E-02	5.0E-02	0	56.0	56.0	0	0	56.1
	Building Construction - Foundations		4.0E-02	0.31	0.18	0	0 (3)	2.0E-02	2.0E-02	0 (3)	2.0E-02	2.0E-02	0	42.5	42.5	0	0	42.6
	Building Construction - Steel Erection		6.0E-02	0.46	0.25	0	0 (3)	2.0E-02	2.0E-02	0 (3)	2.0E-02	2.0E-02	0	60.5	60.5	0	0	60.6
Total Annual Off-Road Emissions			**0.12**	**0.94**	**0.58**	**0**	**6.0E-02**	**6.0E-02**	**0.12**	**2.0E-02**	**6.0E-02**	**8.0E-02**	**0**	**123**	**123**	**0**	**0**	**123**
Onroad Vehicle Emissions																		
2014	Demolition	Hauling	1.0E-02	0.11	6.0E-02	0	9.0E-03 (b)	0	9.0E-03	0	0	0	0	19.9	19.9	0	0	19.9
		Vendor	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		Worker	0	0	1.0E-02	0	0	0	0	0	0	0	0	1.43	1.43	0	0	1.43
	Site Preparation	Hauling	6.0E-02	0.73	0.33	0	6.6E-02 (b)	3.0E-02	9.6E-02	0	2.0E-02	2.0E-02	0	141	141	0	0	142
		Vendor	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		Worker	0	0	0	0	0	0	0	0	0	0	0	0.73	0.73	0	0	0.73
	Grading	Hauling	0.15	1.61	0.93	0	0.13 (b)	5.0E-02	0.18	0	5.0E-02	5.0E-02	0	286	286	1.1E-02	0	286
		Vendor	0	4.0E-02	3.0E-02	0	0	0	0	0	0	0	0	7.10	7.10	0	0	7.10
		Worker	0	0	2.0E-02	0	0	0	0	0	0	0	0	3.63	3.63	0	0	3.64
	Building Construction - Foundations	Hauling	0	0	0	0	0 (b)	0	0	0	0	0	0	0	0	0	0	0
		Vendor	3.0E-02	0.35	0.25	0	2.0E-02	1.0E-02	3.0E-02	0	1.0E-02	1.0E-02	0	64.9	64.9	0	0	64.9
		Worker	4.0E-02	4.0E-02	0.36	0	6.0E-02	0	6.0E-02	0	0	0	0	56.2	56.2	0	0	56.3
	Building Construction - Steel Erection	Hauling	0	0	0	0	0 (b)	0	0	0	0	0	0	0	0	0	0	0
		Vendor	4.0E-02	0.42	0.31	0	2.0E-02	1.0E-02	3.0E-02	0	1.0E-02	1.0E-02	0	78.8	78.8	0	0	78.8
		Worker	4.0E-02	4.0E-02	0.43	0	7.0E-02	0	8.0E-02	0	0	0	0	68.3	68.3	0	0	68.3
Total Annual Onroad Emissions			**0.37**	**3.34**	**2.73**	**0**	**0.37**	**1.0E-01**	**0.48**	**0**	**9.0E-02**	**9.0E-02**	**0**	**729**	**729**	**1.1E-02**	**0**	**729**

Notes:

(a) Pollutant (tons/yr) = (CalEEMod GHG emission [MT/yr]) x (conversion factor [short ton/metric ton])

Conversion factor [short ton/metric ton] = 1.10231 (2)

(b) Onroad hauling fugitive PM_{10} (lb/day) = (CalEEMod fugitive PM_{10} result [lb/day]) / (number of days per phase) x 2 (4)

Number of days for demolition (days) = 20 (5)

Number of days for site preparation (days) = 44 (5)

Number of days for grading (days) = 44 (5)

Number of days for building construction - foundations (days) = 70 (5)

Number of days for building construction - steel erection (days) = 85 (5)

References:

(1) Assumes 100% of Exhaust PM_{10} equals Diesel Particulate Matter (DPM).

(2) CalEEMod greenhouse gas emission result is provided in metric tons/yr.

(3) Off-road fugitive PM_{10} and $PM_{2.5}$ emissions include a two times daily watering for fugitive emissions control, resulting in a control efficiency of 55%.

(4) Email correspondance and phone conversation with AQMD regarding CalEEMod offsite emission error on January 29th, 2013 resulting in correction equation.

(5) CalEEMod defaults for number of days per phase based on timeline information from LBNL.

Table A-5
Phase 1 Construction and Demolition Annual Onroad Vehicle Emission Estimates - Modeling Offsite Trip Length - 2014

Base Year	Phase		Pollutant (tons/yr) [(a)]															
			ROG	NOx	CO	SO_2	Fugitive PM_{10}	Exhaust PM_{10} [(2)]	PM_{10} Total	Fugitive $PM_{2.5}$	Exhaust $PM_{2.5}$	$PM_{2.5}$ Total	Bio- CO_2 [(b)]	NBio- CO_2 [(b)]	Total CO_2 [(b)]	CH_4 [(b)]	N_2O [(b)]	CO_2e [(b)]
2014	Demolition	Hauling	2.7E-04	3.2E-03	1.4E-03	1.0E-05	2.9E-04 [(c)]	1.1E-04	3.0E-03	1.0E-05	1.1E-04	1.1E-04	0	0.61	0.61	1.1E-05	0	0.61
		Vendor	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		Worker	4.0E-05	4.0E-05	4.0E-04	0	8.0E-05	0	8.0E-05	0	0	0	0	7.2E-02	7.2E-02	0	0	7.2E-02
	Site Preparation	Hauling	1.5E-04	1.8E-03	8.0E-04	0	1.6E-04 [(c)]	6.0E-05	3.6E-03	0	6.0E-05	6.0E-05	0	0.35	0.35	1.1E-05	0	0.35
		Vendor	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		Worker	2.0E-05	2.0E-05	2.0E-04	0	4.0E-05	0	4.0E-05	0	0	0	0	3.7E-02	3.7E-02	0	0	3.7E-02
	Grading	Hauling	3.8E-03	4.5E-02	2.0E-02	8.0E-05	4.1E-03 [(c)]	1.7E-03	9.2E-02	1.0E-04	1.5E-03	1.6E-03	0	8.81	8.81	1.9E-04	0	8.81
		Vendor	2.1E-04	2.6E-03	1.3E-03	1.0E-05	1.7E-04	9.0E-05	2.6E-04	1.0E-05	9.0E-05	9.0E-05	0	0.59	0.59	1.1E-05	0	0.59
		Worker	9.0E-05	1.1E-04	1.0E-03	0	2.0E-04	1.0E-05	2.1E-04	0	1.0E-05	1.0E-05	0	0.18	0.18	1.1E-05	0	0.18
	Building Construction - Foundations	Hauling	0	0	0	0	0 [(c)]	0	0	0	0	0	0	0	0	0	0	0
		Vendor	1.9E-03	2.4E-02	1.1E-02	5.0E-05	1.6E-03	8.6E-04	2.4E-03	5.0E-05	7.9E-04	8.4E-04	0	5.36	5.36	8.8E-05	0	5.37
		Worker	1.4E-03	1.7E-03	1.6E-02	3.0E-05	3.1E-03	1.2E-04	3.3E-03	5.0E-05	1.1E-04	1.6E-04	0	2.85	2.85	1.7E-04	0	2.85
	Building Construction - Steel Erection	Hauling	0	0	0	0	0 [(c)]	0	0	0	0	0	0	0	0	0	0	0
		Vendor	2.3E-03	2.9E-02	1.4E-02	6.0E-05	1.9E-03	1.0E-03	2.9E-03	6.0E-05	9.6E-04	1.0E-03	0	6.51	6.51	1.1E-04	0	6.52
		Worker	1.8E-03	2.0E-03	1.9E-02	4.0E-05	3.8E-03	1.4E-04	4.0E-03	6.0E-05	1.3E-04	1.9E-04	0	3.45	3.45	2.0E-04	0	3.46
Total Annual Onroad Emissions			**1.2E-02**	**0.11**	**8.5E-02**	**2.8E-04**	**1.5E-02**	**4.1E-03**	**0.11**	**3.4E-04**	**3.8E-03**	**4.1E-03**	**0**	**28.8**	**28.8**	**7.9E-04**	**0**	**28.8**

Notes:

(a) Actual onroad vehicle pollutant emissions (lbs/day) = (Onroad pollutant emissions [lbs/day]) / (scaling factor)
Scaling factor = 1,000 (1)

(b) Pollutant (tons/yr) = (CalEEMod GHG emission [MT/yr]) x (conversion factor [short ton/metric ton])
Conversion factor [short ton/metric ton] = 1.10231 (3)

(c) Onroad hauling fugitive PM_{10} (lb/day) = (CalEEMod fugitive PM_{10} result [lb/day]) / (number of days per phase) x 2 (4)
Number of days for demolition (days) = 20 (5)
Number of days for site preparation (days) = 44 (5)
Number of days for grading (days) = 44 (5)
Number of days for building construction - foundations (days) = 70 (5)
Number of days for building construction - steel erection (days) = 85 (5)

References:

(1) Scaling factor applied to onroad source emissions due to CalEEMod precision inaccurarcy. Demolition and construction results obtained via CalEEMod
(2) Assumes 100% of Exhaust PM_{10} equals Diesel Particulate Matter (DPM).
(3) CalEEMod greenhouse gas emission result is provided in metric tons/yr.
(4) Email correspondance and phone conversation with AQMD regarding CalEEMod offsite emission error on January 29th, 2013 resulting in correction equation.
(5) CalEEMod defaults for number of days per phase based on timeline information from LBNL.

Table A-6
Phase 1 Construction and Demolition Criteria Pollutant Emissions Summary - 2014

Source	Annual Operation [1] (days/yr)	ROG		NO_X		CO		SO_2		Fugitive PM_{10}		Exhaust PM_{10} [2]	
		(lbs/day)	(tons/yr)	(lbs/day)	(tons/yr)	(lbs/day)	(tons/yr)	(lbs/day)	(tons/yr)	(lbs/day)	(tons/yr)	(lbs/day)	(tons/yr)
2014 Off-Road Equipment Emissions													
2014 Demolition	260	0.15	2.0E-02	1.15	0.15	0.69	9.0E-02	0	0	0.15	2.0E-02	7.7E-02	1.0E-02
2014 Site Preparation	260	0	0	0	0	0	0	0	0	7.7E-02	1.0E-02	0	0
2014 Grading	260	0.46	6.0E-02	3.69	0.48	2.38	0.31	0	0	0.23	3.0E-02	0.23	3.0E-02
2014 Building Construction - Foundations	260	0.31	4.0E-02	2.38	0.31	1.38	0.18	0	0	0	0	0.15	2.0E-02
2014 Building Construction - Steel Erection	260	0.46	6.0E-02	3.54	0.46	1.92	0.25	0	0	0	0	0.15	2.0E-02
Total 2014 Off-Road Emissions		**1.38**	**0.18**	**10.8**	**1.40**	**6.38**	**0.83**	**0**	**0**	**0.46**	**6.0E-02**	**0.62**	**8.0E-02**
2014 Onroad Vehicle Emissions													
Total 2014 Onroad Demolition Source Emissions		**7.7E-02**	**1.0E-02**	**0.85**	**0.11**	**0.54**	**7.0E-02**	**0**	**0**	**6.9E-02**	**9.0E-03**	**0**	**0**
Demolition Hauling Vehicle Onroad Emissions	260	7.7E-02	1.0E-02	0.85	0.11	0.46	6.0E-02	0	0	6.9E-02	9.0E-03	0	0
Demolition Vendor Vehicle Onroad Emissions	260	0	0	0	0	0	0	0	0	0	0	0	0
Demolition Worker Vehicle Onroad Emissions	260	0	0	0	0	7.7E-02	1.0E-02	0	0	0	0	0	0
Total 2014 Onroad Site Preparation Source Emissions		**0.46**	**6.0E-02**	**5.62**	**0.73**	**2.54**	**0.33**	**0**	**0**	**0.51**	**6.6E-02**	**0.23**	**3.0E-02**
Site Preparation Hauling Vehicle Onroad Emissions	260	0.46	6.0E-02	5.62	0.73	2.54	0.33	0	0	0.51	6.6E-02	0.23	3.0E-02
Site Preparation Vendor Vehicle Onroad Emissions	260	0	0	0	0	0	0	0	0	0	0	0	0
Site Preparation Worker Vehicle Onroad Emissions	260	0	0	0	0	0	0	0	0	0	0	0	0
Total 2014 Onroad Grading Source Emissions		**1.15**	**0.15**	**12.7**	**1.65**	**7.54**	**0.98**	**0**	**0**	**0.99**	**0.13**	**0.38**	**5.0E-02**
Grading Hauling Vehicle Onroad Emissions	260	1.15	0.15	12.4	1.61	7.15	0.93	0	0	0.99	0.13	0.38	5.0E-02
Grading Vendor Vehicle Onroad Emissions	260	0	0	0.31	4.0E-02	0.23	3.0E-02	0	0	0	0	0	0
Grading Worker Vehicle Onroad Emissions	260	0	0	0	0	0.15	2.0E-02	0	0	0	0	0	0
Total 2014 Onroad Building Construction - Foundations Source Emissions		**0.54**	**7.0E-02**	**3.00**	**0.39**	**4.69**	**0.61**	**0**	**0**	**0.62**	**8.0E-02**	**7.7E-02**	**1.0E-02**
Building Construction - Foundations Hauling Vehicle Onroad Emissions	260	0	0	0	0	0	0	0	0	0	0	0	0
Building Construction - Foundations Vendor Vehicle Onroad Emissions	260	0.23	3.0E-02	2.69	0.35	1.92	0.25	0	0	0.15	2.0E-02	7.7E-02	1.0E-02
Building Construction - Foundations Worker Vehicle Onroad Emissions	260	0.31	4.0E-02	0.31	4.0E-02	2.77	0.36	0	0	0.46	6.0E-02	0	0
Total 2014 Onroad Building Construction - Steel Erection Source Emissions		**0.62**	**8.0E-02**	**3.54**	**0.46**	**5.69**	**0.74**	**0**	**0**	**0.69**	**9.0E-02**	**7.7E-02**	**1.0E-02**
Building Construction - Steel Erection Hauling Vehicle Onroad Emissions	260	0	0	0	0	0	0	0	0	0	0	0	0
Building Construction - Steel Erection Vendor Vehicle Onroad Emissions	260	0.31	4.0E-02	3.23	0.42	2.38	0.31	0	0	0.15	2.0E-02	7.7E-02	1.0E-02
Building Construction - Steel Erection Worker Vehicle Onroad Emissions	260	0.31	4.0E-02	0.31	4.0E-02	3.31	0.43	0	0	0.54	7.0E-02	0	0
Total 2014 Onroad Emissions		**2.85**	**0.37**	**25.7**	**3.34**	**21.0**	**2.73**	**0**	**0**	**2.88**	**0.37**	**0.77**	**1.0E-01**
Total 2014 Project Emissions	**--**	**4.23**	**0.55**	**36.5**	**4.74**	**27.4**	**3.56**	**0**	**0**	**3.34**	**0.43**	**1.38**	**0.18**
Onsite Stationary Exhaust	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**
Onsite Mobile Exhaust	**--**	**1.38**	**0.18**	**10.8**	**1.40**	**6.38**	**0.83**	**0**	**0**	**--**	**--**	**0.62**	**8.0E-02**
Onsite Fugitive Dust	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**0.46**	**6.0E-02**	**--**	**--**
Offsite Mobile Exhaust	**--**	**2.85**	**0.37**	**25.7**	**3.34**	**21.0**	**2.73**	**0**	**0**	**--**	**--**	**0.77**	**1.0E-01**
Offsite Fugitive Dust	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**2.88**	**0.37**	**--**	**--**
Total 2014 Project Emissions	**--**	**4.23**	**0.55**	**36.5**	**4.74**	**27.4**	**3.56**	**0**	**0**	**3.34**	**0.43**	**1.38**	**0.18**

References:

(1) Annual operation assumes a 5-day work week and 52 weeks per year.

(2) Assumes 100% of Exhaust PM_{10} equals Diesel Particulate Matter (DPM).

Table A-6
Phase 1 Construction and Demolition Criteria Pollutant Emissions Summary - 2014

Source	Annual Operation [1] (days/yr)	PM_{10} Total		Fugitive $PM_{2.5}$		Exhaust $PM_{2.5}$		$PM_{2.5}$ Total		Total CO_2	
		(lbs/day)	(tons/yr)	(lbs/day)	(tons/yr)	(lbs/day)	(tons/yr)	(lbs/day)	(tons/yr)	(lbs/day)	(tons/yr)
2014 Off-Road Equipment Emissions											
2014 Demolition	260	0.23	3.0E-02	0	0	7.7E-02	1.0E-02	7.7E-02	1.0E-02	188	24.5
2014 Site Preparation	260	7.7E-02	1.0E-02	0	0	0	0	0	0	0	0
2014 Grading	260	0.46	6.0E-02	0.15	2.0E-02	0.23	3.0E-02	0.38	5.0E-02	431	56.0
2014 Building Construction - Foundations	260	0.15	2.0E-02	0	0	0.15	2.0E-02	0.15	2.0E-02	327	42.5
2014 Building Construction - Steel Erection	260	0.15	2.0E-02	0	0	0.15	2.0E-02	0.15	2.0E-02	466	60.5
Total 2014 Off-Road Emissions		**1.08**	**0.14**	**0.15**	**2.0E-02**	**0.62**	**8.0E-02**	**0.77**	**1.0E-01**	**1,412**	**184**
2014 Onroad Vehicle Emissions											
Total 2014 Onroad Demolition Source Emissions		**6.9E-02**	**9.0E-03**	**0**	**0**	**0**	**0**	**0**	**0**	**164**	**21.3**
Demolition Hauling Vehicle Onroad Emissions	260	6.9E-02	9.0E-03	0	0	0	0	0	0	153	19.9
Demolition Vendor Vehicle Onroad Emissions	260	0	0	0	0	0	0	0	0	0	0
Demolition Worker Vehicle Onroad Emissions	260	0	0	0	0	0	0	0	0	11.0	1.43
Total 2014 Onroad Site Preparation Source Emissions		**0.74**	**9.6E-02**	**0**	**0**	**0.15**	**2.0E-02**	**0.15**	**2.0E-02**	**1,094**	**142**
Site Preparation Hauling Vehicle Onroad Emissions	260	0.74	9.6E-02	0	0	0.15	2.0E-02	0.15	2.0E-02	1,088	141
Site Preparation Vendor Vehicle Onroad Emissions	260	0	0	0	0	0	0	0	0	0	0
Site Preparation Worker Vehicle Onroad Emissions	260	0	0	0	0	0	0	0	0	5.60	0.73
Total 2014 Onroad Grading Source Emissions		**1.38**	**0.18**	**0**	**0**	**0.38**	**5.0E-02**	**0.38**	**5.0E-02**	**2,283**	**297**
Grading Hauling Vehicle Onroad Emissions	260	1.38	0.18	0	0	0.38	5.0E-02	0.38	5.0E-02	2,201	286
Grading Vendor Vehicle Onroad Emissions	260	0	0	0	0	0	0	0	0	54.6	7.10
Grading Worker Vehicle Onroad Emissions	260	0	0	0	0	0	0	0	0	27.9	3.63
Total 2014 Onroad Building Construction - Foundations Source Emissions		**0.69**	**9.0E-02**	**0**	**0**	**7.7E-02**	**1.0E-02**	**7.7E-02**	**1.0E-02**	**932**	**121**
Building Construction - Foundations Hauling Vehicle Onroad Emissions	260	0	0	0	0	0	0	0	0	0	0
Building Construction - Foundations Vendor Vehicle Onroad Emissions	260	0.23	3.0E-02	0	0	7.7E-02	1.0E-02	7.7E-02	1.0E-02	499	64.9
Building Construction - Foundations Worker Vehicle Onroad Emissions	260	0.46	6.0E-02	0	0	0	0	0	0	432	56.2
Total 2014 Onroad Building Construction - Steel Erection Source Emissions		**0.85**	**0.11**	**0**	**0**	**7.7E-02**	**1.0E-02**	**7.7E-02**	**1.0E-02**	**1,131**	**147**
Building Construction - Steel Erection Hauling Vehicle Onroad Emissions	260	0	0	0	0	0	0	0	0	0	0
Building Construction - Steel Erection Vendor Vehicle Onroad Emissions	260	0.23	3.0E-02	0	0	7.7E-02	1.0E-02	7.7E-02	1.0E-02	606	78.8
Building Construction - Steel Erection Worker Vehicle Onroad Emissions	260	0.62	8.0E-02	0	0	0	0	0	0	525	68.3
Total 2014 Onroad Emissions		**3.72**	**0.48**	**0**	**0**	**0.69**	**9.0E-02**	**0.69**	**9.0E-02**	**5,604**	**729**
Total 2014 Project Emissions	**--**	**4.80**	**0.62**	**0.15**	**2.0E-02**	**1.31**	**0.17**	**1.46**	**0.19**	**7,016**	**912**
Onsite Stationary Exhaust	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**
Onsite Mobile Exhaust	**--**	**0.62**	**8.0E-02**	**--**	**--**	**0.62**	**8.0E-02**	**0.62**	**8.0E-02**	**1,412**	**184**
Onsite Fugitive Dust	**--**	**0.46**	**6.0E-02**	**0.15**	**2.0E-02**	**--**	**--**	**0.15**	**2.0E-02**	**--**	**--**
Offsite Mobile Exhaust	**--**	**0.77**	**1.0E-01**	**--**	**--**	**0.69**	**9.0E-02**	**0.69**	**9.0E-02**	**5,604**	**729**
Offsite Fugitive Dust	**--**	**2.88**	**0.37**	**0**	**0**	**--**	**--**	**0**	**0**	**--**	**--**
Total 2014 Project Emissions	**--**	**4.80**	**0.62**	**0.15**	**2.0E-02**	**1.31**	**0.17**	**1.46**	**0.19**	**7,016**	**912**

References:

(1) Annual operation assumes a 5-day work week and 52 weeks per year.

(2) Assumes 100% of Exhaust PM_{10} equals Diesel Particulate Matter (DPM).

Table A-6
Phase 1 Construction and Demolition Criteria Pollutant Emissions Summary - 2014

Source	Annual Operation [1] (days/yr)	CH_4		N_2O		CO_2e	
		(lbs/day)	(tons/yr)	(lbs/day)	(tons/yr)	(lbs/day)	(tons/yr)
2014 Off-Road Equipment Emissions							
2014 Demolition	260	0	0	0	0	189	24.5
2014 Site Preparation	260	0	0	0	0	0	0
2014 Grading	260	0	0	0	0	432	56.1
2014 Building Construction - Foundations	260	0	0	0	0	328	42.6
2014 Building Construction - Steel Erection	260	0	0	0	0	466	60.6
Total 2014 Off-Road Emissions		**0**	**0**	**0**	**0**	**1,414**	**184**
2014 Onroad Vehicle Emissions							
Total 2014 Onroad Demolition Source Emissions		**0**	**0**	**0**	**0**	**164**	**21.4**
Demolition Hauling Vehicle Onroad Emissions	260	0	0	0	0	153	19.9
Demolition Vendor Vehicle Onroad Emissions	260	0	0	0	0	0	0
Demolition Worker Vehicle Onroad Emissions	260	0	0	0	0	11.0	1.43
Total 2014 Onroad Site Preparation Source Emissions		**0**	**0**	**0**	**0**	**1,094**	**142**
Site Preparation Hauling Vehicle Onroad Emissions	260	0	0	0	0	1,089	142
Site Preparation Vendor Vehicle Onroad Emissions	260	0	0	0	0	0	0
Site Preparation Worker Vehicle Onroad Emissions	260	0	0	0	0	5.60	0.73
Total 2014 Onroad Grading Source Emissions		**8.5E-02**	**1.1E-02**	**0**	**0**	**2,284**	**297**
Grading Hauling Vehicle Onroad Emissions	260	8.5E-02	1.1E-02	0	0	2,202	286
Grading Vendor Vehicle Onroad Emissions	260	0	0	0	0	54.6	7.10
Grading Worker Vehicle Onroad Emissions	260	0	0	0	0	28.0	3.64
Total 2014 Onroad Building Construction - Foundations Source Emissions		**0**	**0**	**0**	**0**	**932**	**121**
Building Construction - Foundations Hauling Vehicle Onroad Emissions	260	0	0	0	0	0	0
Building Construction - Foundations Vendor Vehicle Onroad Emissions	260	0	0	0	0	499	64.9
Building Construction - Foundations Worker Vehicle Onroad Emissions	260	0	0	0	0	433	56.3
Total 2014 Onroad Building Construction - Steel Erection Source Emissions		**0**	**0**	**0**	**0**	**1,132**	**147**
Building Construction - Steel Erection Hauling Vehicle Onroad Emissions	260	0	0	0	0	0	0
Building Construction - Steel Erection Vendor Vehicle Onroad Emissions	260	0	0	0	0	606	78.8
Building Construction - Steel Erection Worker Vehicle Onroad Emissions	260	0	0	0	0	526	68.3
Total 2014 Onroad Emissions		**8.5E-02**	**1.1E-02**	**0**	**0**	**5,608**	**729**
Total 2014 Project Emissions	**--**	**8.5E-02**	**1.1E-02**	**0**	**0**	**7,022**	**913**
Onsite Stationary Exhaust	**--**	**--**	**--**	**--**	**--**	**--**	**--**
Onsite Mobile Exhaust	**--**	**0**	**0**	**0**	**0**	**1,414**	**184**
Onsite Fugitive Dust	**--**	**--**	**--**	**--**	**--**	**--**	**--**
Offsite Mobile Exhaust	**--**	**8.5E-02**	**1.1E-02**	**0**	**0**	**5,608**	**729**
Offsite Fugitive Dust	**--**	**--**	**--**	**--**	**--**	**--**	**--**
Total 2014 Project Emissions	**--**	**8.5E-02**	**1.1E-02**	**0**	**0**	**7,022**	**913**

References:

(1) Annual operation assumes a 5-day work week and 52 weeks per year.

(2) Assumes 100% of Exhaust PM_{10} equals Diesel Particulate Matter (DPM).

Table A-7
CalEEMod Input Assumptions for Phase 1 Construction and Demolition Scenario - 2015

Construction Area	Dates		Total Number of Years	Project Total	(units)	Phase Amount [(a)]	(units)	Truck Trips (trips/year)	Inventory Onroad Trip Length (miles/trip)	Modeling Onroad Trip Length (miles/trip)	Total Area Disturbed (acres)
Construction - 2015											
Building. Construction (research & development) [(1)]	1/1/2015	12/31/2015	2.00 [(2)]	600,000	gsf	300,000	gsf	Default [(3)]	Default [(3)]	0.6371 [(4)]	--
Building Construction (parking lot) [(1)]	1/1/2015	12/31/2015	2.00 [(2)]	600	spaces	300	spaces	Default [(3)]	Default [(3)]	0.6371 [(4)]	--
Paving [(1)]	10/30/2015	12/31/2015	1.00 [(2)]	--	--	--	--	Default [(3)]	Default [(3)]	0.6371 [(4)]	--

Notes:

(a) Phase amount (units) = (Project total [units]) x (total number of years per phase)

References:

(1) Demolition and construction general project information provided by LBNL.
(2) Construction and demolition schedules provided by LBNL. Construction occurs over approximately 4.2 months out of a possible 20 total month period.
(3) CalEEMod default assumption. Onroad and off-road trips represent one-way trip lengths.
(4) Adjusted Onroad one-way trip length derived from entrance to RBC. Used to estimate emissions for modeling purposes only.

Table A-8

CalEEMod Input Assumptions for Phase 1 Construction and Demolition Scenario Onroad Vehicles - 2015

Source	Source Parameter	Dates [1]		Operation [2]	(units)	Worker Trips (trips/day)	Vendor Trips (trips/day)	Total Hauling Trips	Worker Trip Length (miles) [3]	Vendor Trip Length (miles) [3]	Hauling Trip Length (miles) [3]
Onroad Vehicle Emissions											
	Building Construction - Exterior Enclosure	1/1/2015	7/1/2015	130	days	146 [3]	69 [3]	0 [3]	12.4	7.3	20
	Building Construction - Interior Finishes	6/1/2015	12/11/2015	140	days	146 [3]	69 [3]	0 [3]	12.4	7.3	260
	Paving	10/30/2015	12/31/2015	45	days	23 [3]	0 [1]	0 [1]	12.4	7.3	20

References:

(1) Demolition and construction general project information provided by LBNL.

(2) See Table A-9, CalEEMod Input Assumptions for Phase 1 Construction and Demolition Scenario Offroad Equipment - 2015.

(3) All Off-Road equipment data taken from CalEEMod defaults.

Table A-9
Phase 1 Construction and Demoltion Annual Emission Estimates - 2015

Base Year	Phase		Pollutant (tons/yr)															
			ROG	NOx	CO	SO_2	Fugitive PM_{10}	Exhaust PM_{10} (1)	PM_{10} Total	Fugitive $PM_{2.5}$	Exhaust $PM_{2.5}$	$PM_{2.5}$ Total	Bio- CO_2 (a)	NBio- CO_2 (a)	Total CO_2 (a)	CH_4 (a)	N_2O (a)	CO_2e (a)
Off-Road Vehicle Emissions																		
2015	Building Construction - Exterior Enclosure		6.0E-02	0.52	0.26	0	0 (3)	2.0E-02	2.0E-02	0 (3)	2.0E-02	2.0E-02	0	88.3	88.3	1.1E-02	0	88.4
	Building Construction - Interior Finishes		3.0E-02	0.22	0.14	0	0 (3)	1.0E-02	1.0E-02	0 (3)	1.0E-02	1.0E-02	0	39.9	39.9	0	0	40.0
	Paving		2.0E-02	0.11	8.0E-02	0	0 (3)	1.0E-02	1.0E-02	0 (3)	1.0E-02	1.0E-02	0	16.6	16.6	0	0	16.6
Total Annual Off-Road Emissions			**0.11**	**0.85**	**0.48**	**0**	**0**	**4.0E-02**	**4.0E-02**	**0**	**4.0E-02**	**4.0E-02**	**0**	**145**	**145**	**1.1E-02**	**0**	**145**
Onroad Vehicle Emissions																		
2015	Building Construction - Exterior Enclosure	Hauling	0	0	0	0	0 (b)	0	0	0	0	0	0	0	0	0	0	0
		Vendor	6.0E-02	0.59	0.43	0	3.0E-02	2.0E-02	5.0E-02	0	2.0E-02	2.0E-02	0	121	121	0	0	121
		Worker	6.0E-02	6.0E-02	0.60	0	0.11	0	0.11	0	0	0	0	102	102	1.1E-02	0	102
	Building Construction - Interior Finishes	Hauling	0	0	0	0	0 (b)	0	0	0	0	0	0	0	0	0	0	0
		Vendor	6.0E-02	0.63	0.47	0	4.0E-02	2.0E-02	6.0E-02	0	2.0E-02	2.0E-02	0	130	130	0	0	130
		Worker	7.0E-02	7.0E-02	0.65	0	0.12	0	0.12	0	0	0	0	110	110	1.1E-02	0	110
	Paving	Hauling	0	0	0	0	0 (b)	0	0	0	0	0	0	0	0	0	0	0
		Vendor	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		Worker	0	0	3.0E-02	0	1.0E-02	0	1.0E-02	0	0	0	0	5.57	5.57	0	0	5.57
Total Annual Onroad Emissions			**0.25**	**1.35**	**2.18**	**0**	**0.31**	**4.0E-02**	**0.35**	**0**	**4.0E-02**	**4.0E-02**	**0**	**468**	**468**	**2.2E-02**	**0**	**469**

Notes:

(a) Pollutant (tons/yr) = (CalEEMod GHG emission [MT/yr]) x (conversion factor [short ton/metric ton])
Conversion factor [short ton/metric ton] = 1.10231 (2)

(b) Onroad hauling fugitive PM10 (lb/day) = (CalEEMod fugitive PM10 result [lb/day]) / (number of days per phase) x 2 (4)
Number of days for building construction - exterior enclosure (days) = 130 (5)
Number of days for building construction - interior finishes(days) = 140 (5)
Number of days for paving (days) = 45 (5)

References:

(1) Assumes 100% of exhaust PM_{10} equals diesel particulate matter (DPM).
(2) CalEEMod greenhouse gas emission result is provided in metric tons/yr.
(3) Off-road fugitive PM_{10} and $PM_{2.5}$ emissions include a two times daily watering for fugitive emissions control, resulting in a control efficiency of 55%.
(4) Email correspondance and phone conversation with AQMD regarding CalEEMod offsite emission error on January 29th, 2013 resulting in correction equation.
(5) CalEEMod defaults for number of days per phase based on timeline information from LBNL.

Table A-10
Phase 1 Construction and Demolition Annual Onroad Vehicle Emission Estimates - Modeling Offsite Trip Length - 2015

Base Year	Phase		Pollutant (tons/yr) [a]															
			ROG	NOx	CO	SO_2	Fugitive PM_{10}	Exhaust PM_{10} [2]	PM_{10} Total	Fugitive $PM_{2.5}$	Exhaust $PM_{2.5}$	$PM_{2.5}$ Total	Bio- CO_2 [b]	NBio- CO_2 [b]	Total CO_2 [b]	CH_4 [b]	N_2O [b]	CO_2e [b]
2015	Building Construction - Exterior Enclosure	Hauling	0	0	0	0	0 [c]	0	0	0	0	0	0	0	0	0	0	0
		Vendor	3.2E-03	4.0E-02	1.9E-02	1.0E-04	2.9E-03	1.5E-03	4.4E-03	9.0E-05	1.3E-03	1.4E-03	0	9.97	9.97	1.5E-04	0	9.97
		Worker	2.5E-03	2.8E-03	2.6E-02	5.0E-05	5.8E-03	2.2E-04	6.0E-03	1.0E-04	2.0E-04	3.0E-04	0	5.16	5.16	2.9E-04	0	5.17
	Building Construction - Interior Finishes	Hauling	0	0	0	0	0 [c]	0	0	0	0	0	0	0	0	0	0	0
		Vendor	3.4E-03	4.3E-02	2.1E-02	1.0E-04	3.1E-03	1.6E-03	4.7E-03	1.0E-04	1.4E-03	1.5E-03	0	10.7	10.7	1.7E-04	0	10.7
		Worker	2.7E-03	3.0E-03	2.8E-02	6.0E-05	6.3E-03	2.3E-04	6.5E-03	1.1E-04	2.2E-04	3.2E-04	0	5.56	5.56	3.1E-04	0	5.57
	Paving	Hauling	0	0	0	0	0 [c]	0	0	0	0	0	0	0	0	0	0	0
		Vendor	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		Worker	1.3E-04	1.5E-04	1.4E-03	0	3.2E-04	1.0E-05	3.3E-04	1.0E-05	1.0E-05	2.0E-05	0	0.28	0.28	1.1E-05	0	0.28
Total Annual Onroad Emissions			**1.2E-02**	**8.9E-02**	**9.6E-02**	**3.1E-04**	**1.8E-02**	**3.5E-03**	**2.2E-02**	**4.1E-04**	**3.2E-03**	**3.6E-03**	**0**	**31.7**	**31.7**	**9.3E-04**	**0**	**31.7**

Notes:

(a) Actual onroad vehicle pollutant emissions (lbs/day) = (Onroad pollutant emissions [lbs/day]) / (scaling factor)
Scaling factor = 1,000 (1)

(b) Pollutant (tons/yr) = (CalEEMod GHG emission [MT/yr]) x (conversion factor [short ton/metric ton])
Conversion factor [short ton/metric ton] = 1.10231 (3)

(c) Onroad hauling fugitive PM_{10} (lb/day) = (CalEEMod fugitive PM_{10} result [lb/day]) / (Number of days per phase) x 2 (4)
Number of days for building construction - exterior enclosure (days) = 130 (5)
Number of days for building construction - interior finishes (days) = 140 (5)
Number of days for paving (days) = 45 (5)

References:

(1) Scaling factor applied to Onroad source emissions due to CalEEMod precision inaccurarcy. Demolition and construction results obtained via CalEEMod
(2) Assumes 100% of Exhaust PM_{10} equals Diesel Particulate Matter (DPM).
(3) CalEEMod greenhouse gas emission result is provided in metric tons/yr.
(4) Email correspondance and phone conversation with AQMD regarding CalEEMod offsite emission error on January 29th, 2013 resulting in correction equation.
(5) CalEEMod defaults for number of days per phase based on timeline information from LBNL.

Table A-11
Phase 1 Construction and Demolition Criteria Pollutant Emissions Summary - 2015

Source	Annual Operation (days/yr)	ROG		NO_X		CO		SO_2		Fugitive PM_{10}		Exhaust PM_{10} (1)		PM_{10} Total	
		(lbs/day)	(tons/yr)	(lbs/day)	(tons/yr)	(lbs/day)	(tons/yr)	(lbs/day)	(tons/yr)	(lbs/day)	(tons/yr)	(lbs/day)	(tons/yr)	(lbs/day)	(tons/yr)
2015 Off-Road Equipment Emissions															
2015 Building Construction - Exterior Enclosure	260	0.46	6.0E-02	4.00	0.52	2.00	0.26	0	0	0	0	0.15	2.0E-02	0.15	2.0E-02
2015 Building Construction - Interior Finishes	260	0.23	3.0E-02	1.69	0.22	1.08	0.14	0	0	0	0	7.7E-02	1.0E-02	7.7E-02	1.0E-02
2015 Paving	260	0.15	2.0E-02	0.85	0.11	0.62	8.0E-02	0	0	0	0	7.7E-02	1.0E-02	7.7E-02	1.0E-02
Total 2015 Off-Road Emissions		**0.85**	**0.11**	**6.54**	**0.85**	**3.69**	**0.48**	**0**	**0**	**0**	**0**	**0.31**	**4.0E-02**	**0.31**	**4.0E-02**
2015 Onroad Vehicle Emissions															
Total 2015 Onroad Building Construction - Exterior Enclosure Source Emissions		**0.92**	**0.12**	**5.00**	**0.65**	**7.92**	**1.03**	**0**	**0**	**1.08**	**0.14**	**0.15**	**2.0E-02**	**1.23**	**0.16**
Building Construction - Exterior Enclosure Hauling Vehicle Onroad Emissions	260	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Building Construction - Exterior Enclosure Vendor Vehicle Onroad Emissions	260	0.46	6.0E-02	4.54	0.59	3.31	0.43	0	0	0.23	3.0E-02	0.15	2.0E-02	0.38	5.0E-02
Building Construction - Exterior Enclosure Worker Vehicle Onroad Emissions	260	0.46	6.0E-02	0.46	6.0E-02	4.62	0.60	0	0	0.85	0.11	0	0	0.85	0.11
Total 2015 Onroad Building Construction - Interior Finishes Source Emissions		**1.00**	**0.13**	**5.38**	**0.70**	**8.62**	**1.12**	**0**	**0**	**1.23**	**0.16**	**0.15**	**2.0E-02**	**1.38**	**0.18**
Building Construction - Interior Finishes Hauling Vehicle Onroad Emissions	260	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Building Construction - Interior Finishes Vendor Vehicle Onroad Emissions	260	0.46	6.0E-02	4.85	0.63	3.62	0.47	0	0	0.31	4.0E-02	0.15	2.0E-02	0.46	6.0E-02
Building Construction - Interior Finishes Worker Vehicle Onroad Emissions	260	0.54	7.0E-02	0.54	7.0E-02	5.00	0.65	0	0	0.92	0.12	0	0	0.92	0.12
Total 2015 Onroad Paving Source Emissions		**0**	**0**	**0**	**0**	**0.23**	**3.0E-02**	**0**	**0**	**7.7E-02**	**1.0E-02**	**0**	**0**	**7.7E-02**	**1.0E-02**
Paving Hauling Vehicle Onroad Emissions	260	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Paving Vendor Vehicle Onroad Emissions	260	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Paving Worker Vehicle Onroad Emissions	260	0	0	0	0	0.23	3.0E-02	0	0	7.7E-02	1.0E-02	0	0	7.7E-02	1.0E-02
Total 2015 Onroad Emissions		**1.92**	**0.25**	**10.4**	**1.35**	**16.8**	**2.18**	**0**	**0**	**2.38**	**0.31**	**0.31**	**4.0E-02**		**0.35**
Total 2015 Project Emissions	**--**	**2.77**	**0.36**	**16.9**	**2.20**	**20.5**	**2.66**	**0**	**0**	**2.38**	**0.31**	**0.62**	**8.0E-02**	**0.31**	**0.39**
Onsite Stationary Exhaust	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**
Onsite Mobile Exhaust	**--**	**0.85**	**0.11**	**6.54**	**0.85**	**3.69**	**0.48**	**0**	**0**	**--**	**--**	**0.31**	**4.0E-02**	**0.31**	**4.0E-02**
Onsite Fugitive Dust	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**0**	**0**	**--**	**--**	**0**	**0**
Offsite Mobile Exhaust	**--**	**1.92**	**0.25**	**10.4**	**1.35**	**16.8**	**2.18**	**0**	**0**	**--**	**--**	**0.31**	**4.0E-02**	**0.31**	**4.0E-02**
Offsite Fugitive Dust	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**2.38**	**0.31**	**--**	**--**	**2.38**	**0.31**
Total 2015 Project Emissions	**--**	**2.77**	**0.36**	**16.9**	**2.20**	**20.5**	**2.66**	**0**	**0**	**2.38**	**0.31**	**0.62**	**8.0E-02**	**0.31**	**0.39**

References:

(1) Assumes 100% of Exhaust PM_{10} equals Diesel Particulate Matter (DPM).

Table A-11
Phase 1 Construction and Demolition Criteria Pollutant Emissions Summary - 2015

Source	Annual Operation (days/yr)	Fugitive $PM_{2.5}$		Exhaust $PM_{2.5}$		$PM_{2.5}$ Total		Total CO_2		CH_4		N_2O		CO_2e	
		(lbs/day)	(tons/yr)	(lbs/day)	(tons/yr)	(lbs/day)	(tons/yr)	(lbs/day)	(tons/yr)	(lbs/day)	(tons/yr)	(lbs/day)	(tons/yr)	(lbs/day)	(tons/yr)
2015 Off-Road Equipment Emissions															
2015 Building Construction - Exterior Enclosure	260	0	0	0.15	2.0E-02	0.15	2.0E-02	679	88.3	8.5E-02	1.1E-02	0	0	680	88.4
2015 Building Construction - Interior Finishes	260	0	0	7.7E-02	1.0E-02	7.7E-02	1.0E-02	307	39.9	0	0	0	0	308	40.0
2015 Paving	260	0	0	7.7E-02	1.0E-02	7.7E-02	1.0E-02	127	16.6	0	0	0	0	128	16.6
Total 2015 Off-Road Emissions		**0**	**0**	**0.31**	**4.0E-02**	**0.31**	**4.0E-02**	**1,114**	**145**	**8.5E-02**	**1.1E-02**	**0**	**0**	**1,115**	**145**
2015 Onroad Vehicle Emissions															
Total 2015 Onroad Building Construction - Exterior Enclosure Source Emissions		**0**	**0**	**0.15**	**2.0E-02**	**0.15**	**2.0E-02**	**1,714**	**223**	**8.5E-02**	**1.1E-02**	**0**	**0**	**1,715**	**223**
Building Construction - Exterior Enclosure Hauling Vehicle Onroad Emissions	260	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Building Construction - Exterior Enclosure Vendor Vehicle Onroad Emissions	260	0	0	0.15	2.0E-02	0.15	2.0E-02	929	121	0	0	0	0	929	121
Building Construction - Exterior Enclosure Worker Vehicle Onroad Emissions	260	0	0	0	0	0	0	785	102	8.5E-02	1.1E-02	0	0	786	102
Total 2015 Onroad Building Construction - Interior Finishes Source Emissions		**0**	**0**	**0.15**	**2.0E-02**	**0.15**	**2.0E-02**	**1,846**	**240**	**8.5E-02**	**1.1E-02**	**0**	**0**	**1,847**	**240**
Building Construction - Interior Finishes Hauling Vehicle Onroad Emissions	260	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Building Construction - Interior Finishes Vendor Vehicle Onroad Emissions	260	0	0	0.15	2.0E-02	0.15	2.0E-02	1,000	130	0	0	0	0	1,001	130
Building Construction - Interior Finishes Worker Vehicle Onroad Emissions	260	0	0	0	0	0	0	845	110	8.5E-02	1.1E-02	0	0	846	110
Total 2015 Onroad Paving Source Emissions		**0**	**0**	**0**	**0**	**0**	**0**	**42.8**	**5.57**	**0**	**0**	**0**	**0**	**42.8**	**5.57**
Paving Hauling Vehicle Onroad Emissions	260	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Paving Vendor Vehicle Onroad Emissions	260	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Paving Worker Vehicle Onroad Emissions	260	0	0	0	0	0	0	42.8	5.57	0	0	0	0	42.8	5.57
Total 2015 Onroad Emissions		**0**	**0**	**0.31**	**4.0E-02**	**0.31**	**4.0E-02**	**3,602**	**468**	**0.17**	**2.2E-02**	**0**	**0**	**3,605**	**469**
Total 2015 Project Emissions	**--**	**0**	**0**	**0.62**	**8.0E-02**	**0.62**	**8.0E-02**	**4,716**	**613**	**0.25**	**3.3E-02**	**0**	**0**	**4,721**	**614**
Onsite Stationary Exhaust	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**
Onsite Mobile Exhaust	**--**	**--**	**--**	**0.31**	**4.0E-02**	**0.31**	**4.0E-02**	**1,114**	**145**	**8.5E-02**	**1.1E-02**	**0**	**0**	**1,115**	**145**
Onsite Fugitive Dust	**--**	**0**	**0**	**--**	**--**	**0**	**0**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**
Offsite Mobile Exhaust	**--**	**--**	**--**	**0.31**	**4.0E-02**	**0.31**	**4.0E-02**	**3,602**	**468**	**0.17**	**2.2E-02**	**0**	**0**	**3,605**	**469**
Offsite Fugitive Dust	**--**	**0**	**0**	**--**	**--**	**0**	**0**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**
Total 2015 Project Emissions	**--**	**0**	**0**	**0.62**	**8.0E-02**	**0.62**	**8.0E-02**	**4,716**	**613**	**0.25**	**3.3E-02**	**0**	**0**	**4,721**	**614**

References:

(1) Assumes 100% of Exhaust PM_{10} equals Diesel Particulate Matter (DPM).

Appendix B

CalEEMod Outputs – Phase 1 Construction

Phase 1 Development - Year 1 Max - 03/22/2012

Bay Area AQMD Air District, Annual

1.0 Project Characteristics

1.1 Land Usage

Land Uses	Size	Metric
Research & Development	300	1000sqft
Parking Lot	300	Space

1.2 Other Project Characteristics

Urbanization	Urban	**Wind Speed (m/s)**	2.2	**Utility Company**	Pacific Gas & Electric Company
Climate Zone	5	**Precipitation Freq (Days)**	64		

1.3 User Entered Comments

Project Characteristics -

Land Use - 300,000 gsf for R&D, 300 spaces for parking lot, and 1,300 population. Updated: 3/22/13

Construction Phase - Demolition (1/1/14 - 1/28/14); Site Prep (1/1/14 - 3/3/14); Grading (3/4/14 - 5/4/14); BC-F (5/5/14 - 8/8/14); BC-SE (8/9/14 - 12/5/14) Updated: 3/22/13

Off-road Equipment - Pumps = 307 hp. Updated: 3/22/13

Off-road Equipment - Pumps = 307 hp. Updated: 3/22/13

Off-road Equipment - Updated: 3/22/13

Off-road Equipment - Updated: 3/22/13

Off-road Equipment - Site Prep: Rubber tired dozer assigned 0 hp and 0 LF. Updated: 3/22/13

Trips and VMT - Site Prep: 275 hauling truck trips @ 260 miles
Grading: 12 vendor trips/day and 7,000 hauling truck trips
Updated: 3/22/13

Demolition - Demolition = 106,999 gsf; Updated: 3/22/13

Grading - Grading: 70,000 cyd material imported and 2,750 material exported @ 12 acres disturbed
Updated: 3/22/13

Construction Off-road Equipment Mitigation - Water Exposed Area = 2/day @ 55% reduction
Updated: 3/22/13

2.0 Emissions Summary

2.1 Overall Construction

Unmitigated Construction

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio-CO2	Total CO2	CH4	N2O	CO2e
Year	tons/yr										MT/yr					
2014	0.56	4.75	3.56	0.01	4.70	0.19	4.88	0.06	0.18	0.24	0.00	827.37	827.37	0.03	0.00	828.11
Total	**0.56**	**4.75**	**3.56**	**0.01**	**4.70**	**0.19**	**4.88**	**0.06**	**0.18**	**0.24**	**0.00**	**827.37**	**827.37**	**0.03**	**0.00**	**828.11**

Mitigated Construction

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio-CO2	Total CO2	CH4	N2O	CO2e
Year	tons/yr										MT/yr					
2014	0.56	4.75	3.56	0.01	4.62	0.19	4.81	0.03	0.18	0.21	0.00	827.37	827.37	0.03	0.00	828.11
Total	**0.56**	**4.75**	**3.56**	**0.01**	**4.62**	**0.19**	**4.81**	**0.03**	**0.18**	**0.21**	**0.00**	**827.37**	**827.37**	**0.03**	**0.00**	**828.11**

2.2 Overall Operational

Unmitigated Operational

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio-CO2	Total CO2	CH4	N2O	CO2e
Category	tons/yr										MT/yr					
Area	2.13	0.00	0.00	0.00		0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Energy	0.04	0.38	0.32	0.00		0.00	0.03		0.00	0.03	0.00	1,132.87	1,132.87	0.04	0.02	1,139.89
Mobile	1.34	2.52	11.76	0.02	2.24	0.11	2.36	0.04	0.10	0.14	0.00	1,939.17	1,939.17	0.08	0.00	1,940.95
Waste						0.00	0.00		0.00	0.00	4.63	0.00	4.63	0.27	0.00	10.37
Water						0.00	0.00		0.00	0.00	0.00	233.85	233.85	4.51	0.12	364.48
Total	**3.51**	**2.90**	**12.08**	**0.02**	**2.24**	**0.11**	**2.39**	**0.04**	**0.10**	**0.17**	**4.63**	**3,305.89**	**3,310.52**	**4.90**	**0.14**	**3,455.69**

2.2 Overall Operational

Mitigated Operational

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio-CO2	Total CO2	CH4	N2O	CO2e
Category	tons/yr										MT/yr					
Area	2.13	0.00	0.00	0.00		0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Energy	0.04	0.38	0.32	0.00		0.00	0.03		0.00	0.03	0.00	1,132.87	1,132.87	0.04	0.02	1,139.89
Mobile	1.34	2.52	11.76	0.02	2.24	0.11	2.36	0.04	0.10	0.14	0.00	1,939.17	1,939.17	0.08	0.00	1,940.95
Waste						0.00	0.00		0.00	0.00	4.63	0.00	4.63	0.27	0.00	10.37
Water						0.00	0.00		0.00	0.00	0.00	233.85	233.85	4.51	0.12	364.48
Total	**3.51**	**2.90**	**12.08**	**0.02**	**2.24**	**0.11**	**2.39**	**0.04**	**0.10**	**0.17**	**4.63**	**3,305.89**	**3,310.52**	**4.90**	**0.14**	**3,455.69**

3.0 Construction Detail

3.1 Mitigation Measures Construction

Water Exposed Area

3.2 Demolition - 2014

Unmitigated Construction On-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio-CO2	Total CO2	CH4	N2O	CO2e
Category	tons/yr										MT/yr					
Fugitive Dust					0.05	0.00	0.05	0.01	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00
Off-Road	0.02	0.15	0.09	0.00		0.01	0.01		0.01	0.01	0.00	22.20	22.20	0.00	0.00	22.24
Total	**0.02**	**0.15**	**0.09**	**0.00**	**0.05**	**0.01**	**0.06**	**0.01**	**0.01**	**0.02**	**0.00**	**22.20**	**22.20**	**0.00**	**0.00**	**22.24**

Unmitigated Construction Off-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio-CO2	Total CO2	CH4	N2O	CO2e
Category	tons/yr										MT/yr					
Hauling	0.01	0.11	0.06	0.00	0.09	0.00	0.09	0.00	0.00	0.00	0.00	18.06	18.06	0.00	0.00	18.07
Vendor	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Worker	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.30	1.30	0.00	0.00	1.30
Total	**0.01**	**0.11**	**0.07**	**0.00**	**0.09**	**0.00**	**0.09**	**0.00**	**0.00**	**0.00**	**0.00**	**19.36**	**19.36**	**0.00**	**0.00**	**19.37**

3.2 Demolition - 2014

Mitigated Construction On-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio-CO2	Total CO2	CH4	N2O	CO2e
Category	tons/yr										MT/yr					
Fugitive Dust					0.02	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Off-Road	0.02	0.15	0.09	0.00		0.01	0.01		0.01	0.01	0.00	22.20	22.20	0.00	0.00	22.24
Total	**0.02**	**0.15**	**0.09**	**0.00**	**0.02**	**0.01**	**0.03**	**0.00**	**0.01**	**0.01**	**0.00**	**22.20**	**22.20**	**0.00**	**0.00**	**22.24**

Mitigated Construction Off-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio-CO2	Total CO2	CH4	N2O	CO2e
Category	tons/yr										MT/yr					
Hauling	0.01	0.11	0.06	0.00	0.09	0.00	0.09	0.00	0.00	0.00	0.00	18.06	18.06	0.00	0.00	18.07
Vendor	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Worker	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.30	1.30	0.00	0.00	1.30
Total	**0.01**	**0.11**	**0.07**	**0.00**	**0.09**	**0.00**	**0.09**	**0.00**	**0.00**	**0.00**	**0.00**	**19.36**	**19.36**	**0.00**	**0.00**	**19.37**

3.3 Site Preparation - 2014

Unmitigated Construction On-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio-CO2	Total CO2	CH4	N2O	CO2e
Category	tons/yr										MT/yr					
Fugitive Dust					0.02	0.00	0.02	0.01	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00
Total					**0.02**	**0.00**	**0.02**	**0.01**	**0.00**	**0.01**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**

Unmitigated Construction Off-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio-CO2	Total CO2	CH4	N2O	CO2e
Category	tons/yr										MT/yr					
Hauling	0.06	0.73	0.33	0.00	1.45	0.03	1.48	0.00	0.02	0.03	0.00	128.34	128.34	0.00	0.00	128.40
Vendor	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Worker	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.66	0.66	0.00	0.00	0.66
Total	**0.06**	**0.73**	**0.33**	**0.00**	**1.45**	**0.03**	**1.48**	**0.00**	**0.02**	**0.03**	**0.00**	**129.00**	**129.00**	**0.00**	**0.00**	**129.06**

3.3 Site Preparation - 2014

Mitigated Construction On-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio-CO2	Total CO2	CH4	N2O	CO2e
Category	tons/yr										MT/yr					
Fugitive Dust					0.01	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total					**0.01**	**0.00**	**0.01**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**

Mitigated Construction Off-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio-CO2	Total CO2	CH4	N2O	CO2e
Category	tons/yr										MT/yr					
Hauling	0.06	0.73	0.33	0.00	1.45	0.03	1.48	0.00	0.02	0.03	0.00	128.34	128.34	0.00	0.00	128.40
Vendor	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Worker	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.66	0.66	0.00	0.00	0.66
Total	**0.06**	**0.73**	**0.33**	**0.00**	**1.45**	**0.03**	**1.48**	**0.00**	**0.02**	**0.03**	**0.00**	**129.00**	**129.00**	**0.00**	**0.00**	**129.06**

3.4 Grading - 2014

Unmitigated Construction On-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio-CO2	Total CO2	CH4	N2O	CO2e
Category	tons/yr										MT/yr					
Fugitive Dust					0.07	0.00	0.07	0.03	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.00
Off-Road	0.06	0.48	0.31	0.00		0.03	0.03		0.03	0.03	0.00	50.80	50.80	0.00	0.00	50.90
Total	**0.06**	**0.48**	**0.31**	**0.00**	**0.07**	**0.03**	**0.10**	**0.03**	**0.03**	**0.06**	**0.00**	**50.80**	**50.80**	**0.00**	**0.00**	**50.90**

Unmitigated Construction Off-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio-CO2	Total CO2	CH4	N2O	CO2e
Category	tons/yr										MT/yr					
Hauling	0.15	1.61	0.93	0.00	2.84	0.05	2.89	0.00	0.05	0.05	0.00	259.54	259.54	0.01	0.00	259.68
Vendor	0.00	0.04	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.44	6.44	0.00	0.00	6.44
Worker	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.29	3.29	0.00	0.00	3.30
Total	**0.15**	**1.65**	**0.98**	**0.00**	**2.84**	**0.05**	**2.89**	**0.00**	**0.05**	**0.05**	**0.00**	**269.27**	**269.27**	**0.01**	**0.00**	**269.42**

3.4 Grading - 2014

Mitigated Construction On-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio-CO2	Total CO2	CH4	N2O	CO2e
Category	tons/yr										MT/yr					
Fugitive Dust					0.03	0.00	0.03	0.02	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00
Off-Road	0.06	0.48	0.31	0.00		0.03	0.03		0.03	0.03	0.00	50.80	50.80	0.00	0.00	50.90
Total	**0.06**	**0.48**	**0.31**	**0.00**	**0.03**	**0.03**	**0.06**	**0.02**	**0.03**	**0.05**	**0.00**	**50.80**	**50.80**	**0.00**	**0.00**	**50.90**

Mitigated Construction Off-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio-CO2	Total CO2	CH4	N2O	CO2e
Category	tons/yr										MT/yr					
Hauling	0.15	1.61	0.93	0.00	2.84	0.05	2.89	0.00	0.05	0.05	0.00	259.54	259.54	0.01	0.00	259.68
Vendor	0.00	0.04	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.44	6.44	0.00	0.00	6.44
Worker	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.29	3.29	0.00	0.00	3.30
Total	**0.15**	**1.65**	**0.98**	**0.00**	**2.84**	**0.05**	**2.89**	**0.00**	**0.05**	**0.05**	**0.00**	**269.27**	**269.27**	**0.01**	**0.00**	**269.42**

3.5 Building Construction - Foundations - 2014

Unmitigated Construction On-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio-CO2	Total CO2	CH4	N2O	CO2e
Category	tons/yr										MT/yr					
Off-Road	0.04	0.31	0.18	0.00		0.02	0.02		0.02	0.02	0.00	38.58	38.58	0.00	0.00	38.64
Total	**0.04**	**0.31**	**0.18**	**0.00**		**0.02**	**0.02**		**0.02**	**0.02**	**0.00**	**38.58**	**38.58**	**0.00**	**0.00**	**38.64**

Unmitigated Construction Off-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio-CO2	Total CO2	CH4	N2O	CO2e
Category	tons/yr										MT/yr					
Hauling	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Vendor	0.03	0.35	0.25	0.00	0.02	0.01	0.03	0.00	0.01	0.01	0.00	58.87	58.87	0.00	0.00	58.90
Worker	0.04	0.04	0.36	0.00	0.06	0.00	0.06	0.00	0.00	0.00	0.00	51.00	51.00	0.00	0.00	51.06
Total	**0.07**	**0.39**	**0.61**	**0.00**	**0.08**	**0.01**	**0.09**	**0.00**	**0.01**	**0.01**	**0.00**	**109.87**	**109.87**	**0.00**	**0.00**	**109.96**

3.5 Building Construction - Foundations - 2014

Mitigated Construction On-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio-CO2	Total CO2	CH4	N2O	CO2e
Category	tons/yr										MT/yr					
Off-Road	0.04	0.31	0.18	0.00		0.02	0.02		0.02	0.02	0.00	38.58	38.58	0.00	0.00	38.64
Total	**0.04**	**0.31**	**0.18**	**0.00**		**0.02**	**0.02**		**0.02**	**0.02**	**0.00**	**38.58**	**38.58**	**0.00**	**0.00**	**38.64**

Mitigated Construction Off-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio-CO2	Total CO2	CH4	N2O	CO2e
Category	tons/yr										MT/yr					
Hauling	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Vendor	0.03	0.35	0.25	0.00	0.02	0.01	0.03	0.00	0.01	0.01	0.00	58.87	58.87	0.00	0.00	58.90
Worker	0.04	0.04	0.36	0.00	0.06	0.00	0.06	0.00	0.00	0.00	0.00	51.00	51.00	0.00	0.00	51.06
Total	**0.07**	**0.39**	**0.61**	**0.00**	**0.08**	**0.01**	**0.09**	**0.00**	**0.01**	**0.01**	**0.00**	**109.87**	**109.87**	**0.00**	**0.00**	**109.96**

3.6 Building Construction - Steel Erection - 2014

Unmitigated Construction On-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio-CO2	Total CO2	CH4	N2O	CO2e
Category	tons/yr										MT/yr					
Off-Road	0.06	0.46	0.25	0.00		0.02	0.02		0.02	0.02	0.00	54.90	54.90	0.00	0.00	55.00
Total	**0.06**	**0.46**	**0.25**	**0.00**		**0.02**	**0.02**		**0.02**	**0.02**	**0.00**	**54.90**	**54.90**	**0.00**	**0.00**	**55.00**

Unmitigated Construction Off-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio-CO2	Total CO2	CH4	N2O	CO2e
Category	tons/yr										MT/yr					
Hauling	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Vendor	0.04	0.42	0.31	0.00	0.02	0.01	0.03	0.00	0.01	0.01	0.00	71.48	71.48	0.00	0.00	71.52
Worker	0.04	0.04	0.43	0.00	0.07	0.00	0.08	0.00	0.00	0.00	0.00	61.92	61.92	0.00	0.00	62.00
Total	**0.08**	**0.46**	**0.74**	**0.00**	**0.09**	**0.01**	**0.11**	**0.00**	**0.01**	**0.01**	**0.00**	**133.40**	**133.40**	**0.00**	**0.00**	**133.52**

3.6 Building Construction - Steel Erection - 2014

Mitigated Construction On-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio-CO2	Total CO2	CH4	N2O	CO2e
Category	tons/yr										MT/yr					
Off-Road	0.06	0.46	0.25	0.00		0.02	0.02		0.02	0.02	0.00	54.90	54.90	0.00	0.00	55.00
Total	**0.06**	**0.46**	**0.25**	**0.00**		**0.02**	**0.02**		**0.02**	**0.02**	**0.00**	**54.90**	**54.90**	**0.00**	**0.00**	**55.00**

Mitigated Construction Off-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio-CO2	Total CO2	CH4	N2O	CO2e
Category	tons/yr										MT/yr					
Hauling	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Vendor	0.04	0.42	0.31	0.00	0.02	0.01	0.03	0.00	0.01	0.01	0.00	71.48	71.48	0.00	0.00	71.52
Worker	0.04	0.04	0.43	0.00	0.07	0.00	0.08	0.00	0.00	0.00	0.00	61.92	61.92	0.00	0.00	62.00
Total	**0.08**	**0.46**	**0.74**	**0.00**	**0.09**	**0.01**	**0.11**	**0.00**	**0.01**	**0.01**	**0.00**	**133.40**	**133.40**	**0.00**	**0.00**	**133.52**

4.0 Mobile Detail

4.1 Mitigation Measures Mobile

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio-CO2	Total CO2	CH4	N2O	CO2e
Category	tons/yr										MT/yr					
Mitigated	1.34	2.52	11.76	0.02	2.24	0.11	2.36	0.04	0.10	0.14	0.00	1,939.17	1,939.17	0.08	0.00	1,940.95
Unmitigated	1.34	2.52	11.76	0.02	2.24	0.11	2.36	0.04	0.10	0.14	0.00	1,939.17	1,939.17	0.08	0.00	1,940.95
Total	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**

4.2 Trip Summary Information

	Average Daily Trip Rate			Unmitigated	Mitigated
Land Use	Weekday	Saturday	Sunday	Annual VMT	Annual VMT
Parking Lot	0.00	0.00	0.00		
Research & Development	2,433.00	570.00	333.00	4,678,806	4,678,806
Total	2,433.00	570.00	333.00	4,678,806	4,678,806

4.3 Trip Type Information

	Miles			Trip %		
Land Use	H-W or C-W	H-S or C-C	H-O or C-NW	H-W or C-W	H-S or C-C	H-O or C-NW
Parking Lot	9.50	7.30	7.30	0.00	0.00	0.00
Research & Development	9.50	7.30	7.30	33.00	48.00	19.00

5.0 Energy Detail

5.1 Mitigation Measures Energy

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio-CO2	Total CO2	CH4	N2O	CO2e
Category	tons/yr										MT/yr					
Electricity Mitigated						0.00	0.00		0.00	0.00	0.00	721.75	721.75	0.03	0.01	726.27
Electricity Unmitigated						0.00	0.00		0.00	0.00	0.00	721.75	721.75	0.03	0.01	726.27
NaturalGas Mitigated	0.04	0.38	0.32	0.00		0.00	0.03		0.00	0.03	0.00	411.11	411.11	0.01	0.01	413.62
NaturalGas Unmitigated	0.04	0.38	0.32	0.00		0.00	0.03		0.00	0.03	0.00	411.11	411.11	0.01	0.01	413.62
Total	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**

5.2 Energy by Land Use - NaturalGas

Unmitigated

	NaturalGas Use	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio-CO2	Total CO2	CH4	N2O	CO2e
Land Use	kBTU	tons/yr										MT/yr					
Parking Lot	0	0.00	0.00	0.00	0.00		0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Research & Development	7.704e+006	0.04	0.38	0.32	0.00		0.00	0.03		0.00	0.03	0.00	411.11	411.11	0.01	0.01	413.62
Total		**0.04**	**0.38**	**0.32**	**0.00**		**0.00**	**0.03**		**0.00**	**0.03**	**0.00**	**411.11**	**411.11**	**0.01**	**0.01**	**413.62**

5.2 Energy by Land Use - NaturalGas

Mitigated

	NaturalGas Use	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio-CO2	Total CO2	CH4	N2O	CO2e
Land Use	kBTU	tons/yr										MT/yr					
Parking Lot	0	0.00	0.00	0.00	0.00		0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Research & Development	7.704e+006	0.04	0.38	0.32	0.00		0.00	0.03		0.00	0.03	0.00	411.11	411.11	0.01	0.01	413.62
Total		**0.04**	**0.38**	**0.32**	**0.00**		**0.00**	**0.03**		**0.00**	**0.03**	**0.00**	**411.11**	**411.11**	**0.01**	**0.01**	**413.62**

5.3 Energy by Land Use - Electricity

Unmitigated

	Electricity Use	ROG	NOx	CO	SO2	Total CO2	CH4	N2O	CO2e
Land Use	kWh	tons/yr				MT/yr			
Parking Lot	0					0.00	0.00	0.00	0.00
Research & Development	2.481e+006					721.75	0.03	0.01	726.27
Total						**721.75**	**0.03**	**0.01**	**726.27**

5.3 Energy by Land Use - Electricity

Mitigated

	Electricity Use	ROG	NOx	CO	SO2	Total CO2	CH4	N2O	CO2e
Land Use	kWh	tons/yr				MT/yr			
Parking Lot	0					0.00	0.00	0.00	0.00
Research & Development	2.481e+006					721.75	0.03	0.01	726.27
Total						**721.75**	**0.03**	**0.01**	**726.27**

6.0 Area Detail

6.1 Mitigation Measures Area

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio-CO2	Total CO2	CH4	N2O	CO2e
Category	tons/yr										MT/yr					
Mitigated	2.13	0.00	0.00	0.00		0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Unmitigated	2.13	0.00	0.00	0.00		0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**

6.2 Area by SubCategory

Unmitigated

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio-CO2	Total CO2	CH4	N2O	CO2e
SubCategory	tons/yr										MT/yr					
Architectural Coating	0.49					0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Consumer Products	1.64					0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Landscaping	0.00	0.00	0.00	0.00		0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	**2.13**	**0.00**	**0.00**	**0.00**		**0.00**	**0.00**		**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**

Mitigated

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio-CO2	Total CO2	CH4	N2O	CO2e
SubCategory	tons/yr										MT/yr					
Architectural Coating	0.49					0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Consumer Products	1.64					0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Landscaping	0.00	0.00	0.00	0.00		0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	**2.13**	**0.00**	**0.00**	**0.00**		**0.00**	**0.00**		**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**

7.0 Water Detail

7.1 Mitigation Measures Water

	ROG	NOx	CO	SO2	Total CO2	CH4	N2O	CO2e
Category	tons/yr				MT/yr			
Mitigated					233.85	4.51	0.12	364.48
Unmitigated					233.85	4.51	0.12	364.48
Total	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**

7.2 Water by Land Use

Unmitigated

	Indoor/Outdoor Use	ROG	NOx	CO	SO2	Total CO2	CH4	N2O	CO2e
Land Use	Mgal	tons/yr				MT/yr			
Parking Lot	0 / 0					0.00	0.00	0.00	0.00
Research & Development	147.508 / 0					233.85	4.51	0.12	364.48
Total						**233.85**	**4.51**	**0.12**	**364.48**

7.2 Water by Land Use

Mitigated

	Indoor/Outdoor Use	ROG	NOx	CO	SO2	Total CO2	CH4	N2O	CO2e
Land Use	Mgal	tons/yr				MT/yr			
Parking Lot	0 / 0					0.00	0.00	0.00	0.00
Research & Development	147.508 / 0					233.85	4.51	0.12	364.48
Total						**233.85**	**4.51**	**0.12**	**364.48**

8.0 Waste Detail

8.1 Mitigation Measures Waste

Category/Year

	ROG	NOx	CO	SO2	Total CO2	CH4	N2O	CO2e
	tons/yr				MT/yr			
Mitigated					4.63	0.27	0.00	10.37
Unmitigated					4.63	0.27	0.00	10.37
Total	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**

8.2 Waste by Land Use

Unmitigated

	Waste Disposed	ROG	NOx	CO	SO2	Total CO2	CH4	N2O	CO2e
Land Use	tons	tons/yr				MT/yr			
Parking Lot	0					0.00	0.00	0.00	0.00
Research & Development	22.8					4.63	0.27	0.00	10.37
Total						**4.63**	**0.27**	**0.00**	**10.37**

Mitigated

	Waste Disposed	ROG	NOx	CO	SO2	Total CO2	CH4	N2O	CO2e
Land Use	tons	tons/yr				MT/yr			
Parking Lot	0					0.00	0.00	0.00	0.00
Research & Development	22.8					4.63	0.27	0.00	10.37
Total						**4.63**	**0.27**	**0.00**	**10.37**

9.0 Vegetation

Phase 1 Development - Year 2 Max - 03/22/2012

Bay Area AQMD Air District, Annual

1.0 Project Characteristics

1.1 Land Usage

Land Uses	Size	Metric
Research & Development	300	1000sqft
Parking Lot	300	Space

1.2 Other Project Characteristics

Urbanization	Urban	**Wind Speed (m/s)**	2.2	**Utility Company**	Pacific Gas & Electric Company
Climate Zone	5	**Precipitation Freq (Days)**	64		

1.3 User Entered Comments

Construction Phase - BC-EE (1/1/15 - 7/1/15); BC-IF (6/1/15 - 12/11/15); Paving (10/30/15 - 12/31/15)
Updated: 3/22/13

Off-road Equipment - Site Prep: Rubber tired dozer assigned 0 hp and 0 LF. Updated: 3/22/13

Grading - Grading: 70,000 cyd material imported and 2,750 material exported @ 12 acres disturbed
Updated: 3/22/13

Demolition - Demolition = 106,999 gsf; Updated: 3/22/13

Trips and VMT -

Construction Off-road Equipment Mitigation - Water Exposed Area = 2/day @ 55% reduction
Updated: 3/22/13

Project Characteristics -

Land Use - 300,000 gsf of R&D, 300 spaces for the parking lot, and 1,300 population. Updated: 3/22/13

Off-road Equipment - Updated: 3/22/13

Off-road Equipment - Updated: 3/22/13 - 2 Forklifts and 1 Other Constr. Equip.

Off-road Equipment - Updated: 3/22/13

2.0 Emissions Summary

2.1 Overall Construction

Unmitigated Construction

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio-CO2	Total CO2	CH4	N2O	CO2e
Year	tons/yr										MT/yr					
2015	0.36	2.20	2.66	0.01	0.31	0.08	0.40	0.01	0.08	0.09	0.00	556.21	556.21	0.03	0.00	556.75
Total	**0.36**	**2.20**	**2.66**	**0.01**	**0.31**	**0.08**	**0.40**	**0.01**	**0.08**	**0.09**	**0.00**	**556.21**	**556.21**	**0.03**	**0.00**	**556.75**

Mitigated Construction

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio-CO2	Total CO2	CH4	N2O	CO2e
Year	tons/yr										MT/yr					
2015	0.36	2.20	2.66	0.01	0.31	0.08	0.40	0.01	0.08	0.09	0.00	556.21	556.21	0.03	0.00	556.75
Total	**0.36**	**2.20**	**2.66**	**0.01**	**0.31**	**0.08**	**0.40**	**0.01**	**0.08**	**0.09**	**0.00**	**556.21**	**556.21**	**0.03**	**0.00**	**556.75**

2.2 Overall Operational

Unmitigated Operational

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio-CO2	Total CO2	CH4	N2O	CO2e
Category	tons/yr										MT/yr					
Area	2.13	0.00	0.00	0.00		0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Energy	0.04	0.38	0.32	0.00		0.00	0.03		0.00	0.03	0.00	1,132.87	1,132.87	0.04	0.02	1,139.89
Mobile	1.34	2.52	11.76	0.02	2.24	0.11	2.36	0.04	0.10	0.14	0.00	1,939.17	1,939.17	0.08	0.00	1,940.95
Waste						0.00	0.00		0.00	0.00	4.63	0.00	4.63	0.27	0.00	10.37
Water						0.00	0.00		0.00	0.00	0.00	233.85	233.85	4.51	0.12	364.48
Total	**3.51**	**2.90**	**12.08**	**0.02**	**2.24**	**0.11**	**2.39**	**0.04**	**0.10**	**0.17**	**4.63**	**3,305.89**	**3,310.52**	**4.90**	**0.14**	**3,455.69**

2.2 Overall Operational

Mitigated Operational

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio-CO2	Total CO2	CH4	N2O	CO2e
Category	tons/yr										MT/yr					
Area	2.13	0.00	0.00	0.00		0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Energy	0.04	0.38	0.32	0.00		0.00	0.03		0.00	0.03	0.00	1,132.87	1,132.87	0.04	0.02	1,139.89
Mobile	1.34	2.52	11.76	0.02	2.24	0.11	2.36	0.04	0.10	0.14	0.00	1,939.17	1,939.17	0.08	0.00	1,940.95
Waste						0.00	0.00		0.00	0.00	4.63	0.00	4.63	0.27	0.00	10.37
Water						0.00	0.00		0.00	0.00	0.00	233.85	233.85	4.51	0.12	364.48
Total	**3.51**	**2.90**	**12.08**	**0.02**	**2.24**	**0.11**	**2.39**	**0.04**	**0.10**	**0.17**	**4.63**	**3,305.89**	**3,310.52**	**4.90**	**0.14**	**3,455.69**

3.0 Construction Detail

3.1 Mitigation Measures Construction

Water Exposed Area

3.2 Building Construction - Exterior Enclosure - 2015

Unmitigated Construction On-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio-CO2	Total CO2	CH4	N2O	CO2e
Category	tons/yr										MT/yr					
Off-Road	0.06	0.52	0.26	0.00		0.02	0.02		0.02	0.02	0.00	80.10	80.10	0.01	0.00	80.20
Total	**0.06**	**0.52**	**0.26**	**0.00**		**0.02**	**0.02**		**0.02**	**0.02**	**0.00**	**80.10**	**80.10**	**0.01**	**0.00**	**80.20**

Unmitigated Construction Off-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio-CO2	Total CO2	CH4	N2O	CO2e
Category	tons/yr										MT/yr					
Hauling	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Vendor	0.06	0.59	0.43	0.00	0.03	0.02	0.05	0.00	0.02	0.02	0.00	109.55	109.55	0.00	0.00	109.60
Worker	0.06	0.06	0.60	0.00	0.11	0.00	0.12	0.00	0.00	0.01	0.00	92.58	92.58	0.01	0.00	92.69
Total	**0.12**	**0.65**	**1.03**	**0.00**	**0.14**	**0.02**	**0.17**	**0.00**	**0.02**	**0.03**	**0.00**	**202.13**	**202.13**	**0.01**	**0.00**	**202.29**

3.2 Building Construction - Exterior Enclosure - 2015

Mitigated Construction On-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio-CO2	Total CO2	CH4	N2O	CO2e
Category	tons/yr										MT/yr					
Off-Road	0.06	0.52	0.26	0.00		0.02	0.02		0.02	0.02	0.00	80.10	80.10	0.01	0.00	80.20
Total	**0.06**	**0.52**	**0.26**	**0.00**		**0.02**	**0.02**		**0.02**	**0.02**	**0.00**	**80.10**	**80.10**	**0.01**	**0.00**	**80.20**

Mitigated Construction Off-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio-CO2	Total CO2	CH4	N2O	CO2e
Category	tons/yr										MT/yr					
Hauling	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Vendor	0.06	0.59	0.43	0.00	0.03	0.02	0.05	0.00	0.02	0.02	0.00	109.55	109.55	0.00	0.00	109.60
Worker	0.06	0.06	0.60	0.00	0.11	0.00	0.12	0.00	0.00	0.01	0.00	92.58	92.58	0.01	0.00	92.69
Total	**0.12**	**0.65**	**1.03**	**0.00**	**0.14**	**0.02**	**0.17**	**0.00**	**0.02**	**0.03**	**0.00**	**202.13**	**202.13**	**0.01**	**0.00**	**202.29**

3.3 Building Construction - Interior Finishes - 2015

Unmitigated Construction On-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio-CO2	Total CO2	CH4	N2O	CO2e
Category	tons/yr										MT/yr					
Off-Road	0.03	0.22	0.14	0.00		0.01	0.01		0.01	0.01	0.00	36.24	36.24	0.00	0.00	36.29
Total	**0.03**	**0.22**	**0.14**	**0.00**		**0.01**	**0.01**		**0.01**	**0.01**	**0.00**	**36.24**	**36.24**	**0.00**	**0.00**	**36.29**

Unmitigated Construction Off-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio-CO2	Total CO2	CH4	N2O	CO2e
Category	tons/yr										MT/yr					
Hauling	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Vendor	0.06	0.63	0.47	0.00	0.04	0.02	0.05	0.00	0.02	0.02	0.00	117.97	117.97	0.00	0.00	118.03
Worker	0.07	0.07	0.65	0.00	0.12	0.00	0.13	0.00	0.00	0.01	0.00	99.70	99.70	0.01	0.00	99.82
Total	**0.13**	**0.70**	**1.12**	**0.00**	**0.16**	**0.02**	**0.18**	**0.00**	**0.02**	**0.03**	**0.00**	**217.67**	**217.67**	**0.01**	**0.00**	**217.85**

3.3 Building Construction - Interior Finishes - 2015

Mitigated Construction On-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio-CO2	Total CO2	CH4	N2O	CO2e
Category	tons/yr										MT/yr					
Off-Road	0.03	0.22	0.14	0.00		0.01	0.01		0.01	0.01	0.00	36.24	36.24	0.00	0.00	36.29
Total	**0.03**	**0.22**	**0.14**	**0.00**		**0.01**	**0.01**		**0.01**	**0.01**	**0.00**	**36.24**	**36.24**	**0.00**	**0.00**	**36.29**

Mitigated Construction Off-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio-CO2	Total CO2	CH4	N2O	CO2e
Category	tons/yr										MT/yr					
Hauling	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Vendor	0.06	0.63	0.47	0.00	0.04	0.02	0.05	0.00	0.02	0.02	0.00	117.97	117.97	0.00	0.00	118.03
Worker	0.07	0.07	0.65	0.00	0.12	0.00	0.13	0.00	0.00	0.01	0.00	99.70	99.70	0.01	0.00	99.82
Total	**0.13**	**0.70**	**1.12**	**0.00**	**0.16**	**0.02**	**0.18**	**0.00**	**0.02**	**0.03**	**0.00**	**217.67**	**217.67**	**0.01**	**0.00**	**217.85**

3.4 Paving - 2015

Unmitigated Construction On-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio-CO2	Total CO2	CH4	N2O	CO2e
Category	tons/yr										MT/yr					
Off-Road	0.02	0.11	0.08	0.00		0.01	0.01		0.01	0.01	0.00	15.03	15.03	0.00	0.00	15.06
Paving	0.00					0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	**0.02**	**0.11**	**0.08**	**0.00**		**0.01**	**0.01**		**0.01**	**0.01**	**0.00**	**15.03**	**15.03**	**0.00**	**0.00**	**15.06**

Unmitigated Construction Off-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio-CO2	Total CO2	CH4	N2O	CO2e
Category	tons/yr										MT/yr					
Hauling	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Vendor	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Worker	0.00	0.00	0.03	0.00	0.01	0.00	0.01	0.00	0.00	0.00	0.00	5.05	5.05	0.00	0.00	5.05
Total	**0.00**	**0.00**	**0.03**	**0.00**	**0.01**	**0.00**	**0.01**	**0.00**	**0.00**	**0.00**	**0.00**	**5.05**	**5.05**	**0.00**	**0.00**	**5.05**

3.4 Paving - 2015

Mitigated Construction On-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio-CO2	Total CO2	CH4	N2O	CO2e
Category	tons/yr										MT/yr					
Off-Road	0.02	0.11	0.08	0.00		0.01	0.01		0.01	0.01	0.00	15.03	15.03	0.00	0.00	15.06
Paving	0.00					0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	**0.02**	**0.11**	**0.08**	**0.00**		**0.01**	**0.01**		**0.01**	**0.01**	**0.00**	**15.03**	**15.03**	**0.00**	**0.00**	**15.06**

Mitigated Construction Off-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio-CO2	Total CO2	CH4	N2O	CO2e
Category	tons/yr										MT/yr					
Hauling	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Vendor	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Worker	0.00	0.00	0.03	0.00	0.01	0.00	0.01	0.00	0.00	0.00	0.00	5.05	5.05	0.00	0.00	5.05
Total	**0.00**	**0.00**	**0.03**	**0.00**	**0.01**	**0.00**	**0.01**	**0.00**	**0.00**	**0.00**	**0.00**	**5.05**	**5.05**	**0.00**	**0.00**	**5.05**

4.0 Mobile Detail

4.1 Mitigation Measures Mobile

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio-CO2	Total CO2	CH4	N2O	CO2e
Category	tons/yr										MT/yr					
Mitigated	1.34	2.52	11.76	0.02	2.24	0.11	2.36	0.04	0.10	0.14	0.00	1,939.17	1,939.17	0.08	0.00	1,940.95
Unmitigated	1.34	2.52	11.76	0.02	2.24	0.11	2.36	0.04	0.10	0.14	0.00	1,939.17	1,939.17	0.08	0.00	1,940.95
Total	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**

4.2 Trip Summary Information

	Average Daily Trip Rate			Unmitigated	Mitigated
Land Use	Weekday	Saturday	Sunday	Annual VMT	Annual VMT
Parking Lot	0.00	0.00	0.00		
Research & Development	2,433.00	570.00	333.00	4,678,806	4,678,806
Total	2,433.00	570.00	333.00	4,678,806	4,678,806

4.3 Trip Type Information

	Miles			Trip %		
Land Use	H-W or C-W	H-S or C-C	H-O or C-NW	H-W or C-W	H-S or C-C	H-O or C-NW
Parking Lot	9.50	7.30	7.30	0.00	0.00	0.00
Research & Development	9.50	7.30	7.30	33.00	48.00	19.00

5.0 Energy Detail

5.1 Mitigation Measures Energy

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio-CO2	Total CO2	CH4	N2O	CO2e
Category	tons/yr										MT/yr					
Electricity Mitigated						0.00	0.00		0.00	0.00	0.00	721.75	721.75	0.03	0.01	726.27
Electricity Unmitigated						0.00	0.00		0.00	0.00	0.00	721.75	721.75	0.03	0.01	726.27
NaturalGas Mitigated	0.04	0.38	0.32	0.00		0.00	0.03		0.00	0.03	0.00	411.11	411.11	0.01	0.01	413.62
NaturalGas Unmitigated	0.04	0.38	0.32	0.00		0.00	0.03		0.00	0.03	0.00	411.11	411.11	0.01	0.01	413.62
Total	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**

5.2 Energy by Land Use - NaturalGas

Unmitigated

	NaturalGas Use	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio-CO2	Total CO2	CH4	N2O	CO2e
Land Use	kBTU	tons/yr										MT/yr					
Parking Lot	0	0.00	0.00	0.00	0.00		0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Research & Development	7.704e+006	0.04	0.38	0.32	0.00		0.00	0.03		0.00	0.03	0.00	411.11	411.11	0.01	0.01	413.62
Total		**0.04**	**0.38**	**0.32**	**0.00**		**0.00**	**0.03**		**0.00**	**0.03**	**0.00**	**411.11**	**411.11**	**0.01**	**0.01**	**413.62**

Mitigated

	NaturalGas Use	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio-CO2	Total CO2	CH4	N2O	CO2e
Land Use	kBTU	tons/yr										MT/yr					
Parking Lot	0	0.00	0.00	0.00	0.00		0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Research & Development	7.704e+006	0.04	0.38	0.32	0.00		0.00	0.03		0.00	0.03	0.00	411.11	411.11	0.01	0.01	413.62
Total		**0.04**	**0.38**	**0.32**	**0.00**		**0.00**	**0.03**		**0.00**	**0.03**	**0.00**	**411.11**	**411.11**	**0.01**	**0.01**	**413.62**

5.3 Energy by Land Use - Electricity

Unmitigated

	Electricity Use	ROG	NOx	CO	SO2	Total CO2	CH4	N2O	CO2e
Land Use	kWh	tons/yr				MT/yr			
Parking Lot	0					0.00	0.00	0.00	0.00
Research & Development	2.481e+006					721.75	0.03	0.01	726.27
Total						**721.75**	**0.03**	**0.01**	**726.27**

Mitigated

	Electricity Use	ROG	NOx	CO	SO2	Total CO2	CH4	N2O	CO2e
Land Use	kWh	tons/yr				MT/yr			
Parking Lot	0					0.00	0.00	0.00	0.00
Research & Development	2.481e+006					721.75	0.03	0.01	726.27
Total						**721.75**	**0.03**	**0.01**	**726.27**

6.0 Area Detail

6.1 Mitigation Measures Area

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio-CO2	Total CO2	CH4	N2O	CO2e
Category	tons/yr										MT/yr					
Mitigated	2.13	0.00	0.00	0.00		0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Unmitigated	2.13	0.00	0.00	0.00		0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**

6.2 Area by SubCategory

Unmitigated

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio-CO2	Total CO2	CH4	N2O	CO2e
SubCategory	tons/yr										MT/yr					
Architectural Coating	0.49					0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Consumer Products	1.64					0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Landscaping	0.00	0.00	0.00	0.00		0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	**2.13**	**0.00**	**0.00**	**0.00**		**0.00**	**0.00**		**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**

6.2 Area by SubCategory

Mitigated

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio-CO2	Total CO2	CH4	N2O	CO2e
SubCategory	tons/yr										MT/yr					
Architectural Coating	0.49					0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Consumer Products	1.64					0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Landscaping	0.00	0.00	0.00	0.00		0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	**2.13**	**0.00**	**0.00**	**0.00**		**0.00**	**0.00**		**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**

7.0 Water Detail

7.1 Mitigation Measures Water

	ROG	NOx	CO	SO2	Total CO2	CH4	N2O	CO2e
Category	tons/yr				MT/yr			
Mitigated					233.85	4.51	0.12	364.48
Unmitigated					233.85	4.51	0.12	364.48
Total	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**

7.2 Water by Land Use

Unmitigated

	Indoor/Outdoor Use	ROG	NOx	CO	SO2	Total CO2	CH4	N2O	CO2e
Land Use	Mgal	tons/yr				MT/yr			
Parking Lot	0 / 0					0.00	0.00	0.00	0.00
Research & Development	147.508 / 0					233.85	4.51	0.12	364.48
Total						**233.85**	**4.51**	**0.12**	**364.48**

7.2 Water by Land Use

Mitigated

	Indoor/Outdoor Use	ROG	NOx	CO	SO2	Total CO2	CH4	N2O	CO2e
Land Use	Mgal	tons/yr				MT/yr			
Parking Lot	0 / 0					0.00	0.00	0.00	0.00
Research & Development	147.508 / 0					233.85	4.51	0.12	364.48
Total						**233.85**	**4.51**	**0.12**	**364.48**

8.0 Waste Detail

8.1 Mitigation Measures Waste

Category/Year

	ROG	NOx	CO	SO2	Total CO2	CH4	N2O	CO2e
	tons/yr				MT/yr			
Mitigated					4.63	0.27	0.00	10.37
Unmitigated					4.63	0.27	0.00	10.37
Total	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**

8.2 Waste by Land Use

Unmitigated

	Waste Disposed	ROG	NOx	CO	SO2	Total CO2	CH4	N2O	CO2e
Land Use	tons	tons/yr				MT/yr			
Parking Lot	0					0.00	0.00	0.00	0.00
Research & Development	22.8					4.63	0.27	0.00	10.37
Total						**4.63**	**0.27**	**0.00**	**10.37**

Mitigated

	Waste Disposed	ROG	NOx	CO	SO2	Total CO2	CH4	N2O	CO2e
Land Use	tons	tons/yr				MT/yr			
Parking Lot	0					0.00	0.00	0.00	0.00
Research & Development	22.8					4.63	0.27	0.00	10.37
Total						**4.63**	**0.27**	**0.00**	**10.37**

9.0 Vegetation

Phase 1 Development - Year 1 Max - 03/22/2012

Bay Area AQMD Air District, Annual

1.0 Project Characteristics

1.1 Land Usage

Land Uses	Size	Metric
Research & Development	300	1000sqft
Parking Lot	300	Space

1.2 Other Project Characteristics

Urbanization	Urban	**Wind Speed (m/s)**	2.2	**Utility Company**	Pacific Gas & Electric Company
Climate Zone	5	**Precipitation Freq (Days)**	64		

1.3 User Entered Comments

Project Characteristics -

Land Use - 300,000 gsf for R&D, 300 spaces for parking lot, and 1,300 population. Updated: 3/22/13

Construction Phase - Demolition (1/1/14 - 1/28/14); Site Prep (1/1/14 - 3/3/14); Grading (3/4/14 - 5/4/14); BC-F (5/5/14 - 8/8/14); BC-SE (8/9/14 - 12/5/14) Updated: 3/22/13

Off-road Equipment - Pumps = 307 hp. Updated: 3/22/13

Off-road Equipment - Pumps = 307 hp. Updated: 3/22/13

Off-road Equipment - Updated: 3/22/13

Off-road Equipment - Updated: 3/22/13

Off-road Equipment - Site Prep: Rubber tired dozer assigned 0 hp and 0 LF. Updated: 3/22/13

Trips and VMT - Site Prep: 275 hauling truck trips @ 260 miles
Grading: 12 vendor trips/day and 7,000 hauling truck trips
Modeling Length = 637.1 miles
Updated: 3/22/13

Demolition - Demolition = 106,999 gsf; Updated: 3/22/13

Grading - Grading: 70,000 cyd material imported and 2,750 material exported @ 12 acres disturbed
Updated: 3/22/13

Construction Off-road Equipment Mitigation - Water Exposed Area = 2/day @ 55% reduction
Updated: 3/22/13

2.0 Emissions Summary

2.1 Overall Construction

Unmitigated Construction

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio-CO2	Total CO2	CH4	N2O	CO2e
Year	tons/yr										MT/yr					
2014	12.14	111.72	86.10	0.28	107.90	4.16	112.06	0.40	3.84	4.24	0.00	26,316.46	26,316.46	0.74	0.00	26,332.04
Total	**12.14**	**111.72**	**86.10**	**0.28**	**107.90**	**4.16**	**112.06**	**0.40**	**3.84**	**4.24**	**0.00**	**26,316.46**	**26,316.46**	**0.74**	**0.00**	**26,332.04**

Mitigated Construction

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio-CO2	Total CO2	CH4	N2O	CO2e
Year	tons/yr										MT/yr					
2014	12.14	111.72	86.10	0.28	107.82	4.16	111.99	0.37	3.84	4.21	0.00	26,316.46	26,316.46	0.74	0.00	26,332.04
Total	**12.14**	**111.72**	**86.10**	**0.28**	**107.82**	**4.16**	**111.99**	**0.37**	**3.84**	**4.21**	**0.00**	**26,316.46**	**26,316.46**	**0.74**	**0.00**	**26,332.04**

2.2 Overall Operational

Unmitigated Operational

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio-CO2	Total CO2	CH4	N2O	CO2e
Category	tons/yr										MT/yr					
Area	2.13	0.00	0.00	0.00		0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Energy	0.04	0.38	0.32	0.00		0.00	0.03		0.00	0.03	0.00	1,132.87	1,132.87	0.04	0.02	1,139.89
Mobile	1.34	2.52	11.76	0.02	2.24	0.11	2.36	0.04	0.10	0.14	0.00	1,939.17	1,939.17	0.08	0.00	1,940.95
Waste						0.00	0.00		0.00	0.00	4.63	0.00	4.63	0.27	0.00	10.37
Water						0.00	0.00		0.00	0.00	0.00	233.85	233.85	4.51	0.12	364.48
Total	**3.51**	**2.90**	**12.08**	**0.02**	**2.24**	**0.11**	**2.39**	**0.04**	**0.10**	**0.17**	**4.63**	**3,305.89**	**3,310.52**	**4.90**	**0.14**	**3,455.69**

2.2 Overall Operational

Mitigated Operational

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio-CO2	Total CO2	CH4	N2O	CO2e
Category	tons/yr										MT/yr					
Area	2.13	0.00	0.00	0.00		0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Energy	0.04	0.38	0.32	0.00		0.00	0.03		0.00	0.03	0.00	1,132.87	1,132.87	0.04	0.02	1,139.89
Mobile	1.34	2.52	11.76	0.02	2.24	0.11	2.36	0.04	0.10	0.14	0.00	1,939.17	1,939.17	0.08	0.00	1,940.95
Waste						0.00	0.00		0.00	0.00	4.63	0.00	4.63	0.27	0.00	10.37
Water						0.00	0.00		0.00	0.00	0.00	233.85	233.85	4.51	0.12	364.48
Total	**3.51**	**2.90**	**12.08**	**0.02**	**2.24**	**0.11**	**2.39**	**0.04**	**0.10**	**0.17**	**4.63**	**3,305.89**	**3,310.52**	**4.90**	**0.14**	**3,455.69**

3.0 Construction Detail

3.1 Mitigation Measures Construction

Water Exposed Area

3.2 Demolition - 2014

Unmitigated Construction On-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio-CO2	Total CO2	CH4	N2O	CO2e
Category	tons/yr										MT/yr					
Fugitive Dust					0.05	0.00	0.05	0.01	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00
Off-Road	0.02	0.15	0.09	0.00		0.01	0.01		0.01	0.01	0.00	22.20	22.20	0.00	0.00	22.24
Total	**0.02**	**0.15**	**0.09**	**0.00**	**0.05**	**0.01**	**0.06**	**0.01**	**0.01**	**0.02**	**0.00**	**22.20**	**22.20**	**0.00**	**0.00**	**22.24**

Unmitigated Construction Off-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio-CO2	Total CO2	CH4	N2O	CO2e
Category	tons/yr										MT/yr					
Hauling	0.27	3.16	1.42	0.01	2.87	0.11	2.99	0.01	0.11	0.11	0.00	556.02	556.02	0.01	0.00	556.27
Vendor	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Worker	0.04	0.04	0.40	0.00	0.08	0.00	0.08	0.00	0.00	0.00	0.00	65.66	65.66	0.00	0.00	65.74
Total	**0.31**	**3.20**	**1.82**	**0.01**	**2.95**	**0.11**	**3.07**	**0.01**	**0.11**	**0.11**	**0.00**	**621.68**	**621.68**	**0.01**	**0.00**	**622.01**

3.2 Demolition - 2014

Mitigated Construction On-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio-CO2	Total CO2	CH4	N2O	CO2e
Category	tons/yr										MT/yr					
Fugitive Dust					0.02	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Off-Road	0.02	0.15	0.09	0.00		0.01	0.01		0.01	0.01	0.00	22.20	22.20	0.00	0.00	22.24
Total	**0.02**	**0.15**	**0.09**	**0.00**	**0.02**	**0.01**	**0.03**	**0.00**	**0.01**	**0.01**	**0.00**	**22.20**	**22.20**	**0.00**	**0.00**	**22.24**

Mitigated Construction Off-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio-CO2	Total CO2	CH4	N2O	CO2e
Category	tons/yr										MT/yr					
Hauling	0.27	3.16	1.42	0.01	2.87	0.11	2.99	0.01	0.11	0.11	0.00	556.02	556.02	0.01	0.00	556.27
Vendor	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Worker	0.04	0.04	0.40	0.00	0.08	0.00	0.08	0.00	0.00	0.00	0.00	65.66	65.66	0.00	0.00	65.74
Total	**0.31**	**3.20**	**1.82**	**0.01**	**2.95**	**0.11**	**3.07**	**0.01**	**0.11**	**0.11**	**0.00**	**621.68**	**621.68**	**0.01**	**0.00**	**622.01**

3.3 Site Preparation - 2014

Unmitigated Construction On-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio-CO2	Total CO2	CH4	N2O	CO2e
Category	tons/yr										MT/yr					
Fugitive Dust					0.02	0.00	0.02	0.01	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00
Total					**0.02**	**0.00**	**0.02**	**0.01**	**0.00**	**0.01**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**

Unmitigated Construction Off-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio-CO2	Total CO2	CH4	N2O	CO2e
Category	tons/yr										MT/yr					
Hauling	0.15	1.78	0.80	0.00	3.55	0.06	3.62	0.00	0.06	0.06	0.00	313.97	313.97	0.01	0.00	314.11
Vendor	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Worker	0.02	0.02	0.20	0.00	0.04	0.00	0.04	0.00	0.00	0.00	0.00	33.34	33.34	0.00	0.00	33.38
Total	**0.17**	**1.80**	**1.00**	**0.00**	**3.59**	**0.06**	**3.66**	**0.00**	**0.06**	**0.06**	**0.00**	**347.31**	**347.31**	**0.01**	**0.00**	**347.49**

3.3 Site Preparation - 2014

Mitigated Construction On-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio-CO2	Total CO2	CH4	N2O	CO2e
Category	tons/yr										MT/yr					
Fugitive Dust					0.01	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total					**0.01**	**0.00**	**0.01**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**

Mitigated Construction Off-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio-CO2	Total CO2	CH4	N2O	CO2e
Category	tons/yr										MT/yr					
Hauling	0.15	1.78	0.80	0.00	3.55	0.06	3.62	0.00	0.06	0.06	0.00	313.97	313.97	0.01	0.00	314.11
Vendor	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Worker	0.02	0.02	0.20	0.00	0.04	0.00	0.04	0.00	0.00	0.00	0.00	33.34	33.34	0.00	0.00	33.38
Total	**0.17**	**1.80**	**1.00**	**0.00**	**3.59**	**0.06**	**3.66**	**0.00**	**0.06**	**0.06**	**0.00**	**347.31**	**347.31**	**0.01**	**0.00**	**347.49**

3.4 Grading - 2014

Unmitigated Construction On-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio-CO2	Total CO2	CH4	N2O	CO2e
Category	tons/yr										MT/yr					
Fugitive Dust					0.07	0.00	0.07	0.03	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.00
Off-Road	0.06	0.48	0.31	0.00		0.03	0.03		0.03	0.03	0.00	50.80	50.80	0.00	0.00	50.90
Total	**0.06**	**0.48**	**0.31**	**0.00**	**0.07**	**0.03**	**0.10**	**0.03**	**0.03**	**0.06**	**0.00**	**50.80**	**50.80**	**0.00**	**0.00**	**50.90**

Unmitigated Construction Off-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio-CO2	Total CO2	CH4	N2O	CO2e
Category	tons/yr										MT/yr					
Hauling	3.83	45.38	20.40	0.08	90.44	1.65	92.08	0.10	1.51	1.62	0.00	7,992.08	7,992.08	0.17	0.00	7,995.62
Vendor	0.21	2.64	1.25	0.01	0.17	0.09	0.26	0.01	0.09	0.09	0.00	531.98	531.98	0.01	0.00	532.16
Worker	0.09	0.11	1.00	0.00	0.20	0.01	0.21	0.00	0.01	0.01	0.00	166.68	166.68	0.01	0.00	166.89
Total	**4.13**	**48.13**	**22.65**	**0.09**	**90.81**	**1.75**	**92.55**	**0.11**	**1.61**	**1.72**	**0.00**	**8,690.74**	**8,690.74**	**0.19**	**0.00**	**8,694.67**

3.4 Grading - 2014

Mitigated Construction On-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio-CO2	Total CO2	CH4	N2O	CO2e
Category	tons/yr										MT/yr					
Fugitive Dust					0.03	0.00	0.03	0.02	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00
Off-Road	0.06	0.48	0.31	0.00		0.03	0.03		0.03	0.03	0.00	50.80	50.80	0.00	0.00	50.90
Total	**0.06**	**0.48**	**0.31**	**0.00**	**0.03**	**0.03**	**0.06**	**0.02**	**0.03**	**0.05**	**0.00**	**50.80**	**50.80**	**0.00**	**0.00**	**50.90**

Mitigated Construction Off-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio-CO2	Total CO2	CH4	N2O	CO2e
Category	tons/yr										MT/yr					
Hauling	3.83	45.38	20.40	0.08	90.44	1.65	92.08	0.10	1.51	1.62	0.00	7,992.08	7,992.08	0.17	0.00	7,995.62
Vendor	0.21	2.64	1.25	0.01	0.17	0.09	0.26	0.01	0.09	0.09	0.00	531.98	531.98	0.01	0.00	532.16
Worker	0.09	0.11	1.00	0.00	0.20	0.01	0.21	0.00	0.01	0.01	0.00	166.68	166.68	0.01	0.00	166.89
Total	**4.13**	**48.13**	**22.65**	**0.09**	**90.81**	**1.75**	**92.55**	**0.11**	**1.61**	**1.72**	**0.00**	**8,690.74**	**8,690.74**	**0.19**	**0.00**	**8,694.67**

3.5 Building Construction - Foundations - 2014

Unmitigated Construction On-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio-CO2	Total CO2	CH4	N2O	CO2e
Category	tons/yr										MT/yr					
Off-Road	0.04	0.31	0.18	0.00		0.02	0.02		0.02	0.02	0.00	38.58	38.58	0.00	0.00	38.64
Total	**0.04**	**0.31**	**0.18**	**0.00**		**0.02**	**0.02**		**0.02**	**0.02**	**0.00**	**38.58**	**38.58**	**0.00**	**0.00**	**38.64**

Unmitigated Construction Off-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio-CO2	Total CO2	CH4	N2O	CO2e
Category	tons/yr										MT/yr					
Hauling	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Vendor	1.88	24.16	11.45	0.05	1.56	0.86	2.42	0.05	0.79	0.84	0.00	4,866.38	4,866.38	0.08	0.00	4,868.09
Worker	1.44	1.67	15.55	0.03	3.14	0.12	3.25	0.05	0.11	0.16	0.00	2,581.03	2,581.03	0.15	0.00	2,584.22
Total	**3.32**	**25.83**	**27.00**	**0.08**	**4.70**	**0.98**	**5.67**	**0.10**	**0.90**	**1.00**	**0.00**	**7,447.41**	**7,447.41**	**0.23**	**0.00**	**7,452.31**

3.5 Building Construction - Foundations - 2014

Mitigated Construction On-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio-CO2	Total CO2	CH4	N2O	CO2e
Category	tons/yr										MT/yr					
Off-Road	0.04	0.31	0.18	0.00		0.02	0.02		0.02	0.02	0.00	38.58	38.58	0.00	0.00	38.64
Total	**0.04**	**0.31**	**0.18**	**0.00**		**0.02**	**0.02**		**0.02**	**0.02**	**0.00**	**38.58**	**38.58**	**0.00**	**0.00**	**38.64**

Mitigated Construction Off-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio-CO2	Total CO2	CH4	N2O	CO2e
Category	tons/yr										MT/yr					
Hauling	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Vendor	1.88	24.16	11.45	0.05	1.56	0.86	2.42	0.05	0.79	0.84	0.00	4,866.38	4,866.38	0.08	0.00	4,868.09
Worker	1.44	1.67	15.55	0.03	3.14	0.12	3.25	0.05	0.11	0.16	0.00	2,581.03	2,581.03	0.15	0.00	2,584.22
Total	**3.32**	**25.83**	**27.00**	**0.08**	**4.70**	**0.98**	**5.67**	**0.10**	**0.90**	**1.00**	**0.00**	**7,447.41**	**7,447.41**	**0.23**	**0.00**	**7,452.31**

3.6 Building Construction - Steel Erection - 2014

Unmitigated Construction On-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio-CO2	Total CO2	CH4	N2O	CO2e
Category	tons/yr										MT/yr					
Off-Road	0.06	0.46	0.24	0.00		0.02	0.02		0.02	0.02	0.00	54.47	54.47	0.00	0.00	54.56
Total	**0.06**	**0.46**	**0.24**	**0.00**		**0.02**	**0.02**		**0.02**	**0.02**	**0.00**	**54.47**	**54.47**	**0.00**	**0.00**	**54.56**

Unmitigated Construction Off-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio-CO2	Total CO2	CH4	N2O	CO2e
Category	tons/yr										MT/yr					
Hauling	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Vendor	2.29	29.34	13.91	0.06	1.90	1.04	2.94	0.06	0.96	1.02	0.00	5,909.17	5,909.17	0.10	0.00	5,911.25
Worker	1.75	2.03	18.88	0.04	3.81	0.14	3.95	0.06	0.13	0.19	0.00	3,134.11	3,134.11	0.18	0.00	3,137.98
Total	**4.04**	**31.37**	**32.79**	**0.10**	**5.71**	**1.18**	**6.89**	**0.12**	**1.09**	**1.21**	**0.00**	**9,043.28**	**9,043.28**	**0.28**	**0.00**	**9,049.23**

3.6 Building Construction - Steel Erection - 2014

Mitigated Construction On-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio-CO2	Total CO2	CH4	N2O	CO2e
Category	tons/yr										MT/yr					
Off-Road	0.06	0.46	0.24	0.00		0.02	0.02		0.02	0.02	0.00	54.47	54.47	0.00	0.00	54.56
Total	**0.06**	**0.46**	**0.24**	**0.00**		**0.02**	**0.02**		**0.02**	**0.02**	**0.00**	**54.47**	**54.47**	**0.00**	**0.00**	**54.56**

Mitigated Construction Off-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio-CO2	Total CO2	CH4	N2O	CO2e
Category	tons/yr										MT/yr					
Hauling	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Vendor	2.29	29.34	13.91	0.06	1.90	1.04	2.94	0.06	0.96	1.02	0.00	5,909.17	5,909.17	0.10	0.00	5,911.25
Worker	1.75	2.03	18.88	0.04	3.81	0.14	3.95	0.06	0.13	0.19	0.00	3,134.11	3,134.11	0.18	0.00	3,137.98
Total	**4.04**	**31.37**	**32.79**	**0.10**	**5.71**	**1.18**	**6.89**	**0.12**	**1.09**	**1.21**	**0.00**	**9,043.28**	**9,043.28**	**0.28**	**0.00**	**9,049.23**

4.0 Mobile Detail

4.1 Mitigation Measures Mobile

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio-CO2	Total CO2	CH4	N2O	CO2e
Category	tons/yr										MT/yr					
Mitigated	1.34	2.52	11.76	0.02	2.24	0.11	2.36	0.04	0.10	0.14	0.00	1,939.17	1,939.17	0.08	0.00	1,940.95
Unmitigated	1.34	2.52	11.76	0.02	2.24	0.11	2.36	0.04	0.10	0.14	0.00	1,939.17	1,939.17	0.08	0.00	1,940.95
Total	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**

4.2 Trip Summary Information

	Average Daily Trip Rate			Unmitigated	Mitigated
Land Use	Weekday	Saturday	Sunday	Annual VMT	Annual VMT
Parking Lot	0.00	0.00	0.00		
Research & Development	2,433.00	570.00	333.00	4,678,806	4,678,806
Total	2,433.00	570.00	333.00	4,678,806	4,678,806

4.3 Trip Type Information

	Miles			Trip %		
Land Use	H-W or C-W	H-S or C-C	H-O or C-NW	H-W or C-W	H-S or C-C	H-O or C-NW
Parking Lot	9.50	7.30	7.30	0.00	0.00	0.00
Research & Development	9.50	7.30	7.30	33.00	48.00	19.00

5.0 Energy Detail

5.1 Mitigation Measures Energy

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio-CO2	Total CO2	CH4	N2O	CO2e
Category	tons/yr										MT/yr					
Electricity Mitigated						0.00	0.00		0.00	0.00	0.00	721.75	721.75	0.03	0.01	726.27
Electricity Unmitigated						0.00	0.00		0.00	0.00	0.00	721.75	721.75	0.03	0.01	726.27
NaturalGas Mitigated	0.04	0.38	0.32	0.00		0.00	0.03		0.00	0.03	0.00	411.11	411.11	0.01	0.01	413.62
NaturalGas Unmitigated	0.04	0.38	0.32	0.00		0.00	0.03		0.00	0.03	0.00	411.11	411.11	0.01	0.01	413.62
Total	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**

5.2 Energy by Land Use - NaturalGas

Unmitigated

	NaturalGas Use	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio-CO2	Total CO2	CH4	N2O	CO2e
Land Use	kBTU	tons/yr										MT/yr					
Parking Lot	0	0.00	0.00	0.00	0.00		0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Research & Development	7.704e+006	0.04	0.38	0.32	0.00		0.00	0.03		0.00	0.03	0.00	411.11	411.11	0.01	0.01	413.62
Total		**0.04**	**0.38**	**0.32**	**0.00**		**0.00**	**0.03**		**0.00**	**0.03**	**0.00**	**411.11**	**411.11**	**0.01**	**0.01**	**413.62**

5.2 Energy by Land Use - NaturalGas

Mitigated

	NaturalGas Use	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio-CO2	Total CO2	CH4	N2O	CO2e
Land Use	kBTU	tons/yr										MT/yr					
Parking Lot	0	0.00	0.00	0.00	0.00		0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Research & Development	7.704e+006	0.04	0.38	0.32	0.00		0.00	0.03		0.00	0.03	0.00	411.11	411.11	0.01	0.01	413.62
Total		**0.04**	**0.38**	**0.32**	**0.00**		**0.00**	**0.03**		**0.00**	**0.03**	**0.00**	**411.11**	**411.11**	**0.01**	**0.01**	**413.62**

5.3 Energy by Land Use - Electricity

Unmitigated

	Electricity Use	ROG	NOx	CO	SO2	Total CO2	CH4	N2O	CO2e
Land Use	kWh	tons/yr				MT/yr			
Parking Lot	0					0.00	0.00	0.00	0.00
Research & Development	2.481e+006					721.75	0.03	0.01	726.27
Total						**721.75**	**0.03**	**0.01**	**726.27**

5.3 Energy by Land Use - Electricity

Mitigated

	Electricity Use	ROG	NOx	CO	SO2	Total CO2	CH4	N2O	CO2e
Land Use	kWh	tons/yr				MT/yr			
Parking Lot	0					0.00	0.00	0.00	0.00
Research & Development	2.481e+006					721.75	0.03	0.01	726.27
Total						**721.75**	**0.03**	**0.01**	**726.27**

6.0 Area Detail

6.1 Mitigation Measures Area

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio-CO2	Total CO2	CH4	N2O	CO2e
Category	tons/yr										MT/yr					
Mitigated	2.13	0.00	0.00	0.00		0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Unmitigated	2.13	0.00	0.00	0.00		0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**

6.2 Area by SubCategory

Unmitigated

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio-CO2	Total CO2	CH4	N2O	CO2e
SubCategory	tons/yr										MT/yr					
Architectural Coating	0.49					0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Consumer Products	1.64					0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Landscaping	0.00	0.00	0.00	0.00		0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	**2.13**	**0.00**	**0.00**	**0.00**		**0.00**	**0.00**		**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**

Mitigated

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio-CO2	Total CO2	CH4	N2O	CO2e
SubCategory	tons/yr										MT/yr					
Architectural Coating	0.49					0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Consumer Products	1.64					0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Landscaping	0.00	0.00	0.00	0.00		0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	**2.13**	**0.00**	**0.00**	**0.00**		**0.00**	**0.00**		**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**

7.0 Water Detail

7.1 Mitigation Measures Water

	ROG	NOx	CO	SO2	Total CO2	CH4	N2O	CO2e
Category	tons/yr				MT/yr			
Mitigated					233.85	4.51	0.12	364.48
Unmitigated					233.85	4.51	0.12	364.48
Total	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**

7.2 Water by Land Use

Unmitigated

	Indoor/Outdoor Use	ROG	NOx	CO	SO2	Total CO2	CH4	N2O	CO2e
Land Use	Mgal	tons/yr				MT/yr			
Parking Lot	0 / 0					0.00	0.00	0.00	0.00
Research & Development	147.508 / 0					233.85	4.51	0.12	364.48
Total						**233.85**	**4.51**	**0.12**	**364.48**

7.2 Water by Land Use

Mitigated

	Indoor/Outdoor Use	ROG	NOx	CO	SO2	Total CO2	CH4	N2O	CO2e
Land Use	Mgal	tons/yr				MT/yr			
Parking Lot	0 / 0					0.00	0.00	0.00	0.00
Research & Development	147.508 / 0					233.85	4.51	0.12	364.48
Total						**233.85**	**4.51**	**0.12**	**364.48**

8.0 Waste Detail

8.1 Mitigation Measures Waste

Category/Year

	ROG	NOx	CO	SO2	Total CO2	CH4	N2O	CO2e
	tons/yr				MT/yr			
Mitigated					4.63	0.27	0.00	10.37
Unmitigated					4.63	0.27	0.00	10.37
Total	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**

8.2 Waste by Land Use

Unmitigated

	Waste Disposed	ROG	NOx	CO	SO2	Total CO2	CH4	N2O	CO2e
Land Use	tons	tons/yr				MT/yr			
Parking Lot	0					0.00	0.00	0.00	0.00
Research & Development	22.8					4.63	0.27	0.00	10.37
Total						**4.63**	**0.27**	**0.00**	**10.37**

Mitigated

	Waste Disposed	ROG	NOx	CO	SO2	Total CO2	CH4	N2O	CO2e
Land Use	tons	tons/yr				MT/yr			
Parking Lot	0					0.00	0.00	0.00	0.00
Research & Development	22.8					4.63	0.27	0.00	10.37
Total						**4.63**	**0.27**	**0.00**	**10.37**

9.0 Vegetation

Phase 1 Development - Year 2 Max - 03/22/2012

Bay Area AQMD Air District, Annual

1.0 Project Characteristics

1.1 Land Usage

Land Uses	Size	Metric
Research & Development	300	1000sqft
Parking Lot	300	Space

1.2 Other Project Characteristics

Urbanization	Urban	**Wind Speed (m/s)**	2.2	**Utility Company**	Pacific Gas & Electric Company
Climate Zone	5	**Precipitation Freq (Days)**	64		

1.3 User Entered Comments

Construction Phase - BC-EE (1/1/15 - 7/1/15); BC-IF (6/1/15 - 12/11/15); Paving (10/30/15 - 12/31/15)
Updated: 3/22/13

Off-road Equipment - Site Prep: Rubber tired dozer assigned 0 hp and 0 LF. Updated: 3/22/13

Grading - Grading: 70,000 cyd material imported and 2,750 material exported @ 12 acres disturbed
Updated: 3/22/13

Demolition - Demolition = 106,999 gsf; Updated: 3/22/13

Trips and VMT - Modeling Length = 637.1 miles
Updated: 3/22/13

Construction Off-road Equipment Mitigation - Water Exposed Area = 2/day @ 55% reduction
Updated: 3/22/13

Project Characteristics -

Land Use - 300,000 gsf of R&D, 300 spaces for the parking lot, and 1,300 population. Updated: 3/22/13

Off-road Equipment - Updated: 3/22/13

Off-road Equipment - Updated: 3/22/13 - 2 Forklifts and 1 Other Constr. Equip.

Off-road Equipment - Updated: 3/22/13

2.0 Emissions Summary

2.1 Overall Construction

Unmitigated Construction

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio-CO2	Total CO2	CH4	N2O	CO2e
Year	tons/yr										MT/yr					
2015	12.00	89.79	96.49	0.32	18.44	3.51	21.96	0.40	3.24	3.64	0.00	28,904.12	28,904.12	0.85	0.00	28,921.95
Total	**12.00**	**89.79**	**96.49**	**0.32**	**18.44**	**3.51**	**21.96**	**0.40**	**3.24**	**3.64**	**0.00**	**28,904.12**	**28,904.12**	**0.85**	**0.00**	**28,921.95**

Mitigated Construction

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio-CO2	Total CO2	CH4	N2O	CO2e
Year	tons/yr										MT/yr					
2015	12.00	89.79	96.49	0.32	18.44	3.51	21.96	0.40	3.24	3.64	0.00	28,904.12	28,904.12	0.85	0.00	28,921.95
Total	**12.00**	**89.79**	**96.49**	**0.32**	**18.44**	**3.51**	**21.96**	**0.40**	**3.24**	**3.64**	**0.00**	**28,904.12**	**28,904.12**	**0.85**	**0.00**	**28,921.95**

2.2 Overall Operational

Unmitigated Operational

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio-CO2	Total CO2	CH4	N2O	CO2e
Category	tons/yr										MT/yr					
Area	2.13	0.00	0.00	0.00		0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Energy	0.04	0.38	0.32	0.00		0.00	0.03		0.00	0.03	0.00	1,132.87	1,132.87	0.04	0.02	1,139.89
Mobile	1.34	2.52	11.76	0.02	2.24	0.11	2.36	0.04	0.10	0.14	0.00	1,939.17	1,939.17	0.08	0.00	1,940.95
Waste						0.00	0.00		0.00	0.00	4.63	0.00	4.63	0.27	0.00	10.37
Water						0.00	0.00		0.00	0.00	0.00	233.85	233.85	4.51	0.12	364.48
Total	**3.51**	**2.90**	**12.08**	**0.02**	**2.24**	**0.11**	**2.39**	**0.04**	**0.10**	**0.17**	**4.63**	**3,305.89**	**3,310.52**	**4.90**	**0.14**	**3,455.69**

2.2 Overall Operational

Mitigated Operational

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio-CO2	Total CO2	CH4	N2O	CO2e
Category	tons/yr										MT/yr					
Area	2.13	0.00	0.00	0.00		0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Energy	0.04	0.38	0.32	0.00		0.00	0.03		0.00	0.03	0.00	1,132.87	1,132.87	0.04	0.02	1,139.89
Mobile	1.34	2.52	11.76	0.02	2.24	0.11	2.36	0.04	0.10	0.14	0.00	1,939.17	1,939.17	0.08	0.00	1,940.95
Waste						0.00	0.00		0.00	0.00	4.63	0.00	4.63	0.27	0.00	10.37
Water						0.00	0.00		0.00	0.00	0.00	233.85	233.85	4.51	0.12	364.48
Total	**3.51**	**2.90**	**12.08**	**0.02**	**2.24**	**0.11**	**2.39**	**0.04**	**0.10**	**0.17**	**4.63**	**3,305.89**	**3,310.52**	**4.90**	**0.14**	**3,455.69**

3.0 Construction Detail

3.1 Mitigation Measures Construction

Water Exposed Area

3.2 Building Construction - Exterior Enclosure - 2015

Unmitigated Construction On-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio-CO2	Total CO2	CH4	N2O	CO2e
Category	tons/yr										MT/yr					
Off-Road	0.06	0.52	0.26	0.00		0.02	0.02		0.02	0.02	0.00	80.10	80.10	0.01	0.00	80.20
Total	**0.06**	**0.52**	**0.26**	**0.00**		**0.02**	**0.02**		**0.02**	**0.02**	**0.00**	**80.10**	**80.10**	**0.01**	**0.00**	**80.20**

Unmitigated Construction Off-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio-CO2	Total CO2	CH4	N2O	CO2e
Category	tons/yr										MT/yr					
Hauling	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Vendor	3.19	39.94	19.37	0.10	2.90	1.45	4.35	0.09	1.33	1.43	0.00	9,045.14	9,045.14	0.14	0.00	9,048.03
Worker	2.47	2.81	26.17	0.05	5.83	0.22	6.04	0.10	0.20	0.30	0.00	4,685.39	4,685.39	0.26	0.00	4,690.85
Total	**5.66**	**42.75**	**45.54**	**0.15**	**8.73**	**1.67**	**10.39**	**0.19**	**1.53**	**1.73**	**0.00**	**13,730.53**	**13,730.53**	**0.40**	**0.00**	**13,738.88**

3.2 Building Construction - Exterior Enclosure - 2015

Mitigated Construction On-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio-CO2	Total CO2	CH4	N2O	CO2e
Category	tons/yr										MT/yr					
Off-Road	0.06	0.52	0.26	0.00		0.02	0.02		0.02	0.02	0.00	80.10	80.10	0.01	0.00	80.20
Total	**0.06**	**0.52**	**0.26**	**0.00**		**0.02**	**0.02**		**0.02**	**0.02**	**0.00**	**80.10**	**80.10**	**0.01**	**0.00**	**80.20**

Mitigated Construction Off-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio-CO2	Total CO2	CH4	N2O	CO2e
Category	tons/yr										MT/yr					
Hauling	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Vendor	3.19	39.94	19.37	0.10	2.90	1.45	4.35	0.09	1.33	1.43	0.00	9,045.14	9,045.14	0.14	0.00	9,048.03
Worker	2.47	2.81	26.17	0.05	5.83	0.22	6.04	0.10	0.20	0.30	0.00	4,685.39	4,685.39	0.26	0.00	4,690.85
Total	**5.66**	**42.75**	**45.54**	**0.15**	**8.73**	**1.67**	**10.39**	**0.19**	**1.53**	**1.73**	**0.00**	**13,730.53**	**13,730.53**	**0.40**	**0.00**	**13,738.88**

3.3 Building Construction - Interior Finishes - 2015

Unmitigated Construction On-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio-CO2	Total CO2	CH4	N2O	CO2e
Category	tons/yr										MT/yr					
Off-Road	0.03	0.22	0.14	0.00		0.01	0.01		0.01	0.01	0.00	36.24	36.24	0.00	0.00	36.29
Total	**0.03**	**0.22**	**0.14**	**0.00**		**0.01**	**0.01**		**0.01**	**0.01**	**0.00**	**36.24**	**36.24**	**0.00**	**0.00**	**36.29**

Unmitigated Construction Off-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio-CO2	Total CO2	CH4	N2O	CO2e
Category	tons/yr										MT/yr					
Hauling	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Vendor	3.44	43.01	20.86	0.10	3.12	1.56	4.69	0.10	1.44	1.54	0.00	9,740.92	9,740.92	0.15	0.00	9,744.03
Worker	2.66	3.02	28.18	0.06	6.28	0.23	6.51	0.11	0.22	0.32	0.00	5,045.81	5,045.81	0.28	0.00	5,051.69
Total	**6.10**	**46.03**	**49.04**	**0.16**	**9.40**	**1.79**	**11.20**	**0.21**	**1.66**	**1.86**	**0.00**	**14,786.73**	**14,786.73**	**0.43**	**0.00**	**14,795.72**

3.3 Building Construction - Interior Finishes - 2015

Mitigated Construction On-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio-CO2	Total CO2	CH4	N2O	CO2e
Category	tons/yr										MT/yr					
Off-Road	0.03	0.22	0.14	0.00		0.01	0.01		0.01	0.01	0.00	36.24	36.24	0.00	0.00	36.29
Total	**0.03**	**0.22**	**0.14**	**0.00**		**0.01**	**0.01**		**0.01**	**0.01**	**0.00**	**36.24**	**36.24**	**0.00**	**0.00**	**36.29**

Mitigated Construction Off-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio-CO2	Total CO2	CH4	N2O	CO2e
Category	tons/yr										MT/yr					
Hauling	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Vendor	3.44	43.01	20.86	0.10	3.12	1.56	4.69	0.10	1.44	1.54	0.00	9,740.92	9,740.92	0.15	0.00	9,744.03
Worker	2.66	3.02	28.18	0.06	6.28	0.23	6.51	0.11	0.22	0.32	0.00	5,045.81	5,045.81	0.28	0.00	5,051.69
Total	**6.10**	**46.03**	**49.04**	**0.16**	**9.40**	**1.79**	**11.20**	**0.21**	**1.66**	**1.86**	**0.00**	**14,786.73**	**14,786.73**	**0.43**	**0.00**	**14,795.72**

3.4 Paving - 2015

Unmitigated Construction On-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio-CO2	Total CO2	CH4	N2O	CO2e
Category	tons/yr										MT/yr					
Off-Road	0.02	0.11	0.08	0.00		0.01	0.01		0.01	0.01	0.00	15.03	15.03	0.00	0.00	15.06
Paving	0.00					0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	**0.02**	**0.11**	**0.08**	**0.00**		**0.01**	**0.01**		**0.01**	**0.01**	**0.00**	**15.03**	**15.03**	**0.00**	**0.00**	**15.06**

Unmitigated Construction Off-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio-CO2	Total CO2	CH4	N2O	CO2e
Category	tons/yr										MT/yr					
Hauling	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Vendor	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Worker	0.13	0.15	1.43	0.00	0.32	0.01	0.33	0.01	0.01	0.02	0.00	255.50	255.50	0.01	0.00	255.80
Total	**0.13**	**0.15**	**1.43**	**0.00**	**0.32**	**0.01**	**0.33**	**0.01**	**0.01**	**0.02**	**0.00**	**255.50**	**255.50**	**0.01**	**0.00**	**255.80**

3.4 Paving - 2015

Mitigated Construction On-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio-CO2	Total CO2	CH4	N2O	CO2e
Category	tons/yr										MT/yr					
Off-Road	0.02	0.11	0.08	0.00		0.01	0.01		0.01	0.01	0.00	15.03	15.03	0.00	0.00	15.06
Paving	0.00					0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	**0.02**	**0.11**	**0.08**	**0.00**		**0.01**	**0.01**		**0.01**	**0.01**	**0.00**	**15.03**	**15.03**	**0.00**	**0.00**	**15.06**

Mitigated Construction Off-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio-CO2	Total CO2	CH4	N2O	CO2e
Category	tons/yr										MT/yr					
Hauling	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Vendor	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Worker	0.13	0.15	1.43	0.00	0.32	0.01	0.33	0.01	0.01	0.02	0.00	255.50	255.50	0.01	0.00	255.80
Total	**0.13**	**0.15**	**1.43**	**0.00**	**0.32**	**0.01**	**0.33**	**0.01**	**0.01**	**0.02**	**0.00**	**255.50**	**255.50**	**0.01**	**0.00**	**255.80**

4.0 Mobile Detail

4.1 Mitigation Measures Mobile

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio-CO2	Total CO2	CH4	N2O	CO2e
Category	tons/yr										MT/yr					
Mitigated	1.34	2.52	11.76	0.02	2.24	0.11	2.36	0.04	0.10	0.14	0.00	1,939.17	1,939.17	0.08	0.00	1,940.95
Unmitigated	1.34	2.52	11.76	0.02	2.24	0.11	2.36	0.04	0.10	0.14	0.00	1,939.17	1,939.17	0.08	0.00	1,940.95
Total	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**

4.2 Trip Summary Information

	Average Daily Trip Rate			Unmitigated	Mitigated
Land Use	Weekday	Saturday	Sunday	Annual VMT	Annual VMT
Parking Lot	0.00	0.00	0.00		
Research & Development	2,433.00	570.00	333.00	4,678,806	4,678,806
Total	2,433.00	570.00	333.00	4,678,806	4,678,806

4.3 Trip Type Information

	Miles			Trip %		
Land Use	H-W or C-W	H-S or C-C	H-O or C-NW	H-W or C-W	H-S or C-C	H-O or C-NW
Parking Lot	9.50	7.30	7.30	0.00	0.00	0.00
Research & Development	9.50	7.30	7.30	33.00	48.00	19.00

5.0 Energy Detail

5.1 Mitigation Measures Energy

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio-CO2	Total CO2	CH4	N2O	CO2e
Category	tons/yr										MT/yr					
Electricity Mitigated						0.00	0.00		0.00	0.00	0.00	721.75	721.75	0.03	0.01	726.27
Electricity Unmitigated						0.00	0.00		0.00	0.00	0.00	721.75	721.75	0.03	0.01	726.27
NaturalGas Mitigated	0.04	0.38	0.32	0.00		0.00	0.03		0.00	0.03	0.00	411.11	411.11	0.01	0.01	413.62
NaturalGas Unmitigated	0.04	0.38	0.32	0.00		0.00	0.03		0.00	0.03	0.00	411.11	411.11	0.01	0.01	413.62
Total	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**

5.2 Energy by Land Use - NaturalGas

Unmitigated

	NaturalGas Use	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio-CO2	Total CO2	CH4	N2O	CO2e
Land Use	kBTU	tons/yr										MT/yr					
Parking Lot	0	0.00	0.00	0.00	0.00		0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Research & Development	7.704e+006	0.04	0.38	0.32	0.00		0.00	0.03		0.00	0.03	0.00	411.11	411.11	0.01	0.01	413.62
Total		**0.04**	**0.38**	**0.32**	**0.00**		**0.00**	**0.03**		**0.00**	**0.03**	**0.00**	**411.11**	**411.11**	**0.01**	**0.01**	**413.62**

Mitigated

	NaturalGas Use	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio-CO2	Total CO2	CH4	N2O	CO2e
Land Use	kBTU	tons/yr										MT/yr					
Parking Lot	0	0.00	0.00	0.00	0.00		0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Research & Development	7.704e+006	0.04	0.38	0.32	0.00		0.00	0.03		0.00	0.03	0.00	411.11	411.11	0.01	0.01	413.62
Total		**0.04**	**0.38**	**0.32**	**0.00**		**0.00**	**0.03**		**0.00**	**0.03**	**0.00**	**411.11**	**411.11**	**0.01**	**0.01**	**413.62**

5.3 Energy by Land Use - Electricity

Unmitigated

	Electricity Use	ROG	NOx	CO	SO2	Total CO2	CH4	N2O	CO2e
Land Use	kWh	tons/yr				MT/yr			
Parking Lot	0					0.00	0.00	0.00	0.00
Research & Development	2.481e+006					721.75	0.03	0.01	726.27
Total						**721.75**	**0.03**	**0.01**	**726.27**

Mitigated

	Electricity Use	ROG	NOx	CO	SO2	Total CO2	CH4	N2O	CO2e
Land Use	kWh	tons/yr				MT/yr			
Parking Lot	0					0.00	0.00	0.00	0.00
Research & Development	2.481e+006					721.75	0.03	0.01	726.27
Total						**721.75**	**0.03**	**0.01**	**726.27**

6.0 Area Detail

6.1 Mitigation Measures Area

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio-CO2	Total CO2	CH4	N2O	CO2e
Category	tons/yr										MT/yr					
Mitigated	2.13	0.00	0.00	0.00		0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Unmitigated	2.13	0.00	0.00	0.00		0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**

6.2 Area by SubCategory

Unmitigated

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio-CO2	Total CO2	CH4	N2O	CO2e
SubCategory	tons/yr										MT/yr					
Architectural Coating	0.49					0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Consumer Products	1.64					0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Landscaping	0.00	0.00	0.00	0.00		0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	**2.13**	**0.00**	**0.00**	**0.00**		**0.00**	**0.00**		**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**

6.2 Area by SubCategory

Mitigated

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio-CO2	Total CO2	CH4	N2O	CO2e
SubCategory	tons/yr										MT/yr					
Architectural Coating	0.49					0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Consumer Products	1.64					0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Landscaping	0.00	0.00	0.00	0.00		0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	**2.13**	**0.00**	**0.00**	**0.00**		**0.00**	**0.00**		**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**

7.0 Water Detail

7.1 Mitigation Measures Water

	ROG	NOx	CO	SO2	Total CO2	CH4	N2O	CO2e
Category	tons/yr				MT/yr			
Mitigated					233.85	4.51	0.12	364.48
Unmitigated					233.85	4.51	0.12	364.48
Total	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**

7.2 Water by Land Use

Unmitigated

	Indoor/Outdoor Use	ROG	NOx	CO	SO2	Total CO2	CH4	N2O	CO2e
Land Use	Mgal	tons/yr				MT/yr			
Parking Lot	0 / 0					0.00	0.00	0.00	0.00
Research & Development	147.508 / 0					233.85	4.51	0.12	364.48
Total						**233.85**	**4.51**	**0.12**	**364.48**

7.2 Water by Land Use

Mitigated

	Indoor/Outdoor Use	ROG	NOx	CO	SO2	Total CO2	CH4	N2O	CO2e
Land Use	Mgal	tons/yr				MT/yr			
Parking Lot	0 / 0					0.00	0.00	0.00	0.00
Research & Development	147.508 / 0					233.85	4.51	0.12	364.48
Total						**233.85**	**4.51**	**0.12**	**364.48**

8.0 Waste Detail

8.1 Mitigation Measures Waste

Category/Year

	ROG	NOx	CO	SO2	Total CO2	CH4	N2O	CO2e
	tons/yr				MT/yr			
Mitigated					4.63	0.27	0.00	10.37
Unmitigated					4.63	0.27	0.00	10.37
Total	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**

8.2 Waste by Land Use

Unmitigated

	Waste Disposed	ROG	NOx	CO	SO2	Total CO2	CH4	N2O	CO2e
Land Use	tons	tons/yr				MT/yr			
Parking Lot	0					0.00	0.00	0.00	0.00
Research & Development	22.8					4.63	0.27	0.00	10.37
Total						**4.63**	**0.27**	**0.00**	**10.37**

Mitigated

	Waste Disposed	ROG	NOx	CO	SO2	Total CO2	CH4	N2O	CO2e
Land Use	tons	tons/yr				MT/yr			
Parking Lot	0					0.00	0.00	0.00	0.00
Research & Development	22.8					4.63	0.27	0.00	10.37
Total						**4.63**	**0.27**	**0.00**	**10.37**

9.0 Vegetation

Appendix C

Emissions Estimates – Full LRDP Construction

Table C-1
CalEEMod Input Assumptions for LRDP Construction and Demolition Scenario

Construction Area		Dates		Total Number of Years		Project Total	(units)		Phase Amount	(units)		Truck Trips (trips/year)		Inventory Onroad Trip Length (miles/trip)		Modeling Onroad Trip Length (miles/trip)		Total Area Disturbed (acres)
Demolition																		
Demolition	(1)	1/1/2018	12/31/2050	32.00	(2)	643,001	gsf	(3)	20,094	gsf	(a)	125	(b)	Default	(5)	0.6371	(6)	--
Construction																		
Grading (soil import and export)	(1)	1/1/2018	12/31/2050	32.00	(2)	502,400	yd^3	(c)	15,700	yd^3	(1)	1,570	(1)	Default	(5)	0.6371	(6)	2.00 (8)
Building Construction (total)	(1)	1/1/2018	12/31/2050	32.00	(2)	6,400,000	gsf	(9)	200,000	gsf	(a)	4,050	(1)	Default	(5)	0.6371	(6)	--
Post Construction																		
Paving	(1)	1/1/2018	12/31/2050	32.00	(2)	--	--		--	--		Default	(5)	Default	(5)	0.6371	(6)	--

Notes:

(a) Phase amount (units) = (Project total [units]) / (total number of years per phase)

(b) Demolition truck trips (trips/yr) = (Average demolition truck trips [trips/yr]) / (average demolition activity [gsf]) x (phase amount [gsf])

Average demolition truck trips (trips/yr) = 117 (4)

Average demolition activity (gsf) = 18,750 (4)

(c) Project total (units) = (Phase amount [units]) x (total number of years per phase)

References:

(1) Demolition and construction general project information provided by LBNL.
(2) Construction and demolition schedules provided by LBNL. Construction occurs from the year 2018 to 2050.
(3) Total project demolition (750,000 gsf) minus Phase 1 demolition (106,999 gsf).
(4) Demolition trip informaiton provided by LBNL.
(5) CalEEMod default assumption. Onroad and off-road trips represent one-way trip lengths.
(6) Adjusted onroad trip length derived from entrance to RBC used for modeling purposes only.
(7) Assumes an additional 20% area disturbed above the average building footprint.
(8) Total area disturbed is based on the average square footage of the modeling footprint areas.
(9) Total building construction (7,000,000 gsf) minus Phase 1 building construction (600,000 gsf).

Table C-2
CalEEMod Input Assumptions for LRDP Construction and Demolition Offroad Equipment

Phase	Type of Equipment	Units	LBNL Daily Hours of Operation (hrs/phase)	Phase 1 LBNL Duration of Use (days/phase)	Phase 1 CalEEMod Phase Length (days/phase)	LRDP CalEEMod Phase Length (days/phase)	Phase 1 LBNL Phase Length (hrs/phase)	CalEEMod Daily Hours of Operation (hrs/day) [a]	Approximate Size of Equipment (hp)	Load Factor	CalEEMod Load Factor Used [1]
Demolition	Excavators	1	8	20	20	4 [b]	160	8	153	75	0.38
	Backhoe Loader	1	8	20	20	4 [b]	160	8	95	80	0.37
	Dozer	1	8	16	20	4 [b]	128	6.40	99	75	0.40
	Asphalt Cutter	1	4	10	20	4 [b]	40	2	6.5 [4]	65	0.73
	Water Truck	1	8	20	20	4 [b]	160	8	360	75	0.42
Site Grading - Excavation	Excavators	1	8	44	44	15 [c]	352	8	153	75	0.38
	Backhoe Loader	1	8	44	44	15 [c]	352	8	95	80	0.37
	Dozer	1	8	20	44	15 [c]	160	3.64	99	75	0.40
	Trenching Equipment	1	8	20	44	15 [c]	160	3.64	185	80	0.50
	Compaction Equipment	2	8	44	44	15 [c]	704	8	157	75	0.38
Building Construction - Foundations	Backhoe/Crawler Loaders	1	8	40	70	24 [c]	320	4.57	110	75	0.37
	Forklifts	2	4	65	70	24 [c]	520	4	110	75	0.20
	Concrete Pumps	1	8	20	70	24 [c]	160	2.29	307 [5]	80	0.74
	Compaction Equipment	2	8	20	70	24 [c]	320	2.29	14.0	80	0.43
	Small Tools	1	8	66	70	24 [c]	528	7.54	15 kW/month	85	--
	Air Compressors	1	2	70	70	24 [c]	140	2	60	70	0.48
Building Construction - Steel Erection	Mobile Crane	2	6	45	85	29 [c]	540	3.18	279	90	0.29
	Front End Welders	2	8	45	85	29 [c]	720	4	14	85	0.45
	Back End Welders	3	8	45	85	29 [c]	1080	4.2	14	85	0.45
	Man Lifts	1	8	45	85	29 [c]	360	4.24	80 kW/hr	80	--
	Boomlifts	1	4	85	85	29 [c]	340	4	82	80	0.40
	Forklifts	1	4	85	85	29 [c]	340	4	110	75	0.20
	Air Compressors	1	2	85	85	29 [c]	170	2	60.0	70	0.48
	Small Tools	1	8	85	85	29 [c]	680	8	15 kW/month	85	--
	Concrete Pumps	1	8	10	85	29 [c]	80	0.94	307 [5]	80	0.74
Building Construction - Exterior Enclosure	Mobile Crane	1	6	130	130	44 [c]	780	6	279	60	0.29
	Man Lifts	1	8	130	130	44 [c]	1040	8	80 kW/hr	80	--
	Boomlifts	1	2	130	130	44 [c]	260	2	82	75	0.40
	Forklifts	1	2	130	130	44 [c]	260	2	110.0	75	0.20
	Water Truck	1	2	130	130	44 [c]	260	2	360	80	0.42
	Small Tools	1	8	130	130	44 [c]	1040	8	15 kW/month	85	--
Building Construction - Interior Finishes	Boomlifts	1	2	140	140	47 [c]	280	2	82	75	0.40
	Forklifts	1	2	140	140	47 [c]	280	2	110	80	0.20
	Small Tools	1	8	140	140	47 [c]	1120	8	15 kW/month	85	--
	Water Truck	1	2	140	140	47 [c]	280	2	360.0	80	0.42
Paving - Site Improvements	Water Truck	1	2	45	45	15 [c]	90	2.0	360	75	0.42
	Asphalt Cutter	1	8	10	45	15 [c]	80	2	7	65	0.73
	Paving Equipment	1	8	10	45	15 [c]	80	1.78	142	65	0.36
	Forklifts	1	2	45	45	15 [c]	90	2.0	50.0	65	0.40
	Compactor	2	8	20	45	15 [c]	320	4	7	70	0.38
	Excavators	1	8	20	45	15 [c]	160	3.56	54	70	0.38
	Skid Steered Loader	1	6	20	45	15 [c]	120	3	50.0	80	0.37
	Small Tools	1	8	45	45	15 [c]	360	8	15 kW/month	85	--
	Trenching Equipment	1	4	20	45	15 [c]	80	1.78	6	80	0.50

Notes:

(a) CalEEMod daily hours of operation (hrs/day) = (Phase 1 LBNL phase length [hrs/phase]) / (Phase 1 CalEEMod phase length [days/phase]) / (units)

(b) LRDP demolition phase length (days/phase) = (LRDP demolition [gsf]) / (Phase 1 demolition [gsf]) x (Phase 1 CalEEMod phase length [days/phase])

LRDP demolition gross square footage (gsf) = 20,094 (2)

Phase 1 demolition gross square footage (gsf) = 106,999 (3)

(c) LRDP phase length (days/phase) = (LRDP total gross square footage [gsf]) / (Phase 1 total gross square footage [gsf]) x (Phase 1 CalEEMod phase length [days/phase])

LRDP total building construction (gsf) = 200,000 (2)

Phase 1 total building construction (gsf) = 600,000 (3)

References:

(1) Staff Report: Initial Statement of Reasons for Proposed Rulemaking, Appendix D - OSM and Summary of Off-Road Emissions Inventory Update, California Air Resources Board, October 2010, http://www.arb.ca.gov/regact/2010/Off-Roadlsi10/Off-Roadappd.pdf.

(2) See Table C-1, CalEEMod Input Assumptions for LRDP Construction and Demolition Scenario.

(3) See Phase 1 Development input assumptions provided by LBNL.

(4) CalEEMod only allows load factor input as whole numbers. Thus, rounding to nearest whole number was used.

(5) Concrete pump horsepower provided by LBNL. Represents 65% usage of truck mounted pumps (450 hp) and 35% usage of the hydraulic pump (40 hp).

Table C-3

CalEEMod Assumptions for LRDP Construction and Demolition Onroad Vehicles

Source	Phase Operation (1) (days/phase)	Worker Trips (trips/day)	Vendor Trips (trips/day)	Total Hauling Trips (trips/yr)	Worker Trip Distance (2) (miles)	Vendor Trip Distance (2) (miles)	Hauling Trip Distance (2) (miles)
Onroad Vehicle Emissions							
Demolition	4	13 (2)	0 (2)	125 (3)	12.4	7.3	20
Site Grading - Excavation	15	15 (2)	0 (2)	1,570 (3)	12.4	7.3	20
Building Construction - Foundations	24	64 (2)	33 (2)	650 (3)	12.4	7.3	20
Building Construction - Steel Erection	29	64 (2)	33 (4)	3,400 (3)	12.4	7.3	20
Building Construction - Exterior Enclosure	44	64 (2)	33 (4)	0 (2)	12.4	7.3	20
Building Construction - Interior Finishes	47	64 (2)	33 (2)	0 (2)	12.4	7.3	20
Paving - Site Improvements	15	23 (2)	0 (2)	0 (2)	12.4	7.3	20

References:

(1) See Table C-2, CalEEMod Input Assumptions for LRDP Construction and Demolition Offroad Equipment .

(2) CalEEMod default vehicle trip assumption.

(3) Demolition and construction general project information provided by LBNL.

(4) CalEEMod default assumption set vendor trips for exterior enclosure and steel erection (building construction) to zero. Value is conservatively set to 33 vendor trips per day within CalEEMod model for consistency.

Table C-4
LRDP Construction and Demolition Maximum Daily Emission Estimates

Base Year	Phase		Pollutant (lbs/day) [1]															
			ROG	NOx	CO	SO_2	Fugitive PM_{10}	Exhaust PM_{10} [2]	PM_{10} Total	Fugitive $PM_{2.5}$	Exhaust $PM_{2.5}$	$PM_{2.5}$ Total	Bio- CO_2	NBio- CO_2	Total CO_2	CH_4	N_2O	CO_2e
Off-Road Vehicle Emissions																		
2018	Demolition		1.39	9.39	8.60	2.0E-02	2.23 [3]	0.42	2.65	0 [3]	0.42	0.42	0	2,448	2,448	0.12	0	2,451
	Site Grading - Excavation		1.06	7.52	6.86	1.0E-02	1.34 [3]	0.37	1.71	0.68 [3]	0.37	1.05	0	1,351	1,351	9.0E-02	0	1,353
	Building Construction - Foundations		0.76	6.01	4.93	1.0E-02	0 [3]	0.29	0.29	0 [3]	0.29	0.29	0	1,215	1,215	7.0E-02	0	1,217
	Building Construction - Steel Erection		1.08	7.73	5.28	1.0E-02	0 [3]	0.37	0.37	0 [3]	0.37	0.37	0	1,413	1,413	1.0E-01	0	1,415
	Building Construction - Exterior Enclosure		0.70	4.97	3.01	1.0E-02	0 [3]	0.20	0.20	0 [3]	0.20	0.20	0	1,123	1,123	6.0E-02	0	1,125
	Building Construction - Interior Finishes		0.29	2.02	1.63	0	0 [3]	1.0E-01	1.0E-01	0 [3]	1.0E-01	1.0E-01	0	516	516	3.0E-02	0	516
	Paving - Site Improvements		0.56	3.74	3.26	1.0E-02	0 [3]	0.17	0.17	0 [3]	0.17	0.17	0	739	739	5.0E-02	0	740
Total Daily Off-Road Emissions			**5.84**	**41.4**	**33.6**	**7.0E-02**	**3.57**	**1.92**	**5.49**	**0.68**	**1.92**	**2.60**	**0**	**8,806**	**8,806**	**0.52**	**0**	**8,817**
Onroad Vehicle Emissions																		
2018	Demolition	Hauling	0.99	9.99	6.45	2.0E-02	1.50 [a]	0.30	1.80	3.0E-02	0.28	0.31	0	2,588	2,588	5.0E-02	0	2,589
		Vendor	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		Worker	8.0E-02	7.0E-02	0.69	0	0.19	1.0E-02	0.20	0	1.0E-02	1.0E-02	0	146	146	1.0E-02	0	146
	Site Grading - Excavation	Hauling	3.31	33.5	21.6	8.0E-02	4.91 [a]	1.02	5.93	1.0E-01	0.93	1.03	0	8,668	8,668	0.16	0	8,671
		Vendor	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		Worker	9.0E-02	8.0E-02	0.80	0	0.22	1.0E-02	0.23	0	1.0E-02	1.0E-02	0	168	168	1.0E-02	0	169
	Building Construction - Foundations	Hauling	0.86	8.66	5.59	2.0E-02	1.27 [a]	0.26	1.53	3.0E-02	0.24	0.27	0	2,243	2,243	4.0E-02	0	2,244
		Vendor	0.35	3.47	2.82	1.0E-02	0.30	1.0E-01	0.40	1.0E-02	9.0E-02	1.0E-01	0	897	897	2.0E-02	0	897
		Worker	0.38	0.33	3.41	1.0E-02	0.96	3.0E-02	0.99	1.0E-02	3.0E-02	4.0E-02	0	719	719	3.0E-02	0	719
	Building Construction - Steel Erection	Hauling	3.70	37.5	24.2	9.0E-02	5.48 [a]	1.14	6.62	0.11	1.05	1.16	0	9,709	9,709	0.18	0	9,712
		Vendor	0.35	3.47	2.82	1.0E-02	0.30	1.0E-01	0.40	1.0E-02	9.0E-02	1.0E-01	0	897	897	2.0E-02	0	897
		Worker	0.38	0.33	3.41	1.0E-02	0.96	3.0E-02	0.99	1.0E-02	3.0E-02	4.0E-02	0	719	719	3.0E-02	0	719
	Building Construction - Exterior Enclosure	Hauling	0	0	0	0	0 [a]	0	0	0	0	0	0	0	0	0	0	0
		Vendor	0.35	3.47	2.82	1.0E-02	0.30	1.0E-01	0.40	1.0E-02	9.0E-02	1.0E-01	0	897	897	2.0E-02	0	897
		Worker	0.38	0.33	3.41	1.0E-02	0.96	3.0E-02	0.99	1.0E-02	3.0E-02	4.0E-02	0	719	719	3.0E-02	0	719
	Building Construction - Interior Finishes	Hauling	0	0	0	0	0 [a]	0	0	0	0	0	0	0	0	0	0	0
		Vendor	0.35	3.47	2.82	1.0E-02	0.30	1.0E-01	0.40	1.0E-02	9.0E-02	1.0E-01	0	897	897	2.0E-02	0	897
		Worker	0.38	0.33	3.41	1.0E-02	0.96	3.0E-02	0.99	1.0E-02	3.0E-02	4.0E-02	0	719	719	3.0E-02	0	719
	Paving - Site Improvements	Hauling	0	0	0	0	0 [a]	0	0	0	0	0	0	0	0	0	0	0
		Vendor	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		Worker	0.14	0.12	1.23	0	0.34	1.0E-02	0.35	0	1.0E-02	1.0E-02	0	258	258	1.0E-02	0	259
Total Daily Onroad Emissions			**12.1**	**105**	**85.5**	**0.29**	**18.9**	**3.27**	**22.2**	**0.35**	**3.01**	**3.36**	**0**	**30,242**	**30,242**	**0.66**	**0**	**30,256**

Notes:

(a) Onroad vehicle fugitive PM_{10} (lb/day) = (CalEEMod fugitive PM_{10} result [lb/day]) / (number of days per phase) x 2 (4)

Number of days for Demolition (days/phase) =	4	(5)
Number of days for Site Grading - Excavation (days/phase) =	15	(5)
Number of days for Building Construction - Foundations (days/phase) =	24	(5)
Number of days for Building Construction - Steel Erection (days/phase) =	29	(5)
Number of days for Building Construction - Exterior Enclosure (days/phase) =	44	(5)
Number of days for Building Construction - Interior Finishes (days/phase) =	47	(5)

References:

(1) Demolition and construction daily emissions obtained via CalEEMod results.
(2) Assumes 100% of exhaust PM_{10} equals diesel particulate matter (DPM).
(3) Off-road fugitive PM_{10} and $PM_{2.5}$ emissions include a control efficiency due to watering 2 times daily.
(4) Email correspondance and phone conversation with AQMD regarding CalEEMod offsite emission error on January 29th, 2013 resulting in correction equation.
(5) See Table C-2, CalEEMod Input Assumptions for LRDP Construction and Demolition Offroad Equipment .

Table C-5
LRDP Construction and Demolition Annual Emission Estimates

Base Year	Phase		Annual Emissions (tons/yr) [(a)]															
			ROG	NOx	CO	SO_2	Fugitive PM_{10}	Exhaust PM_{10} [(3)]	PM_{10} Total	Fugitive $PM_{2.5}$	Exhaust $PM_{2.5}$	$PM_{2.5}$ Total	Bio- CO_2	NBio- CO_2	Total CO_2	CH_4	N_2O	CO_2e
Off-Road Vehicle Emissions																		
2018	Demolition		2.8E-03	1.9E-02	1.7E-02	4.0E-05	4.5E-03 [(4)]	8.4E-04	5.3E-03	0 [(4)]	8.4E-04	8.4E-04	0	4.90	4.90	2.4E-04	0	4.90
	Site Grading - Excavation		8.0E-03	5.6E-02	5.1E-02	7.5E-05	1.0E-02 [(4)]	2.8E-03	1.3E-02	5.1E-03 [(4)]	2.8E-03	7.9E-03	0	10.1	10.1	6.8E-04	0	10.1
	Building Construction - Foundations		9.1E-03	7.2E-02	5.9E-02	1.2E-04	0 [(4)]	3.5E-03	3.5E-03	0 [(4)]	3.5E-03	3.5E-03	0	14.6	14.6	8.4E-04	0	14.6
	Building Construction - Steel Erection		1.6E-02	0.11	7.7E-02	1.5E-04	0 [(4)]	5.4E-03	5.4E-03	0 [(4)]	5.4E-03	5.4E-03	0	20.5	20.5	1.5E-03	0	20.5
	Building Construction - Exterior Enclosure		1.5E-02	0.11	6.6E-02	2.2E-04	0 [(4)]	4.4E-03	4.4E-03	0 [(4)]	4.4E-03	4.4E-03	0	24.7	24.7	1.3E-03	0	24.7
	Building Construction - Interior Finishes		6.8E-03	4.7E-02	3.8E-02	0	0 [(4)]	2.4E-03	2.4E-03	0 [(4)]	2.4E-03	2.4E-03	0	12.1	12.1	7.1E-04	0	12.1
	Paving - Site Improvements		4.2E-03	2.8E-02	2.4E-02	7.5E-05	0 [(4)]	1.3E-03	1.3E-03	0 [(4)]	1.3E-03	1.3E-03	0	5.54	5.54	3.8E-04	0	5.55
Total Annual Off-Road Emissions			**6.2E-02**	**0.44**	**0.33**	**6.8E-04**	**1.5E-02**	**2.0E-02**	**3.5E-02**	**5.1E-03**	**2.0E-02**	**2.6E-02**	**0**	**92.5**	**92.5**	**5.6E-03**	**0**	**92.6**
Onroad Vehicle Emissions																		
2018	Demolition	Hauling	2.0E-03	2.0E-02	1.3E-02	4.0E-05	3.0E-03	6.0E-04	3.6E-03	6.0E-05	5.6E-04	6.2E-04	0	5.18	5.18	1.0E-04	0	5.18
		Vendor	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		Worker	1.6E-04	1.4E-04	1.4E-03	0	3.8E-04	2.0E-05	4.0E-04	0	2.0E-05	2.0E-05	0	0.29	0.29	2.0E-05	0	0.29
	Site Grading - Excavation	Hauling	2.5E-02	0.25	0.16	6.0E-04	3.7E-02	7.7E-03	4.4E-02	7.5E-04	7.0E-03	7.7E-03	0	65.0	65.0	1.2E-03	0	65.0
		Vendor	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		Worker	6.8E-04	6.0E-04	6.0E-03	0	1.7E-03	7.5E-05	1.7E-03	0	7.5E-05	7.5E-05	0	1.26	1.26	7.5E-05	0	1.26
	Building Construction - Foundations	Hauling	1.0E-02	0.10	6.7E-02	2.4E-04	1.5E-02	3.1E-03	1.8E-02	3.6E-04	2.9E-03	3.2E-03	0	26.9	26.9	4.8E-04	0	26.9
		Vendor	4.2E-03	4.2E-02	3.4E-02	1.2E-04	3.6E-03	1.2E-03	4.8E-03	1.2E-04	1.1E-03	1.2E-03	0	10.8	10.8	2.4E-04	0	10.8
		Worker	4.6E-03	4.0E-03	4.1E-02	1.2E-04	1.2E-02	3.6E-04	1.2E-02	1.2E-04	3.6E-04	4.8E-04	0	8.62	8.62	3.6E-04	0	8.63
	Building Construction - Steel Erection	Hauling	5.4E-02	0.54	0.35	1.3E-03	7.9E-02	1.7E-02	9.6E-02	1.6E-03	1.5E-02	1.7E-02	0	141	141	2.6E-03	0	141
		Vendor	5.1E-03	5.0E-02	4.1E-02	1.5E-04	4.4E-03	1.5E-03	5.8E-03	1.5E-04	1.3E-03	1.5E-03	0	13.0	13.0	2.9E-04	0	13.0
		Worker	5.5E-03	4.8E-03	4.9E-02	1.5E-04	1.4E-02	4.4E-04	1.4E-02	1.5E-04	4.4E-04	5.8E-04	0	10.4	10.4	4.4E-04	0	10.4
	Building Construction - Exterior Enclosure	Hauling	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		Vendor	7.7E-03	7.6E-02	6.2E-02	2.2E-04	6.6E-03	2.2E-03	8.8E-03	2.2E-04	2.0E-03	2.2E-03	0	19.7	19.7	4.4E-04	0	19.7
		Worker	8.4E-03	7.3E-03	7.5E-02	2.2E-04	2.1E-02	6.6E-04	2.2E-02	2.2E-04	6.6E-04	8.8E-04	0	15.8	15.8	6.6E-04	0	15.8
	Building Construction - Interior Finishes	Hauling	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		Vendor	8.2E-03	8.2E-02	6.6E-02	2.4E-04	7.1E-03	2.4E-03	9.4E-03	2.4E-04	2.1E-03	2.4E-03	0	21.1	21.1	4.7E-04	0	21.1
		Worker	8.9E-03	7.8E-03	8.0E-02	2.4E-04	2.3E-02	7.1E-04	2.3E-02	2.4E-04	7.1E-04	9.4E-04	0	16.9	16.9	7.1E-04	0	16.9
	Paving - Site Improvements	Hauling	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		Vendor	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		Worker	1.1E-03	9.0E-04	9.2E-03	0	2.6E-03	7.5E-05	2.6E-03	0	7.5E-05	7.5E-05	0	1.94	1.94	7.5E-05	0	1.94
Total Annual Onroad Emissions			**0.15**	**1.19**	**1.06**	**3.6E-03**	**0.23**	**3.7E-02**	**0.27**	**4.2E-03**	**3.4E-02**	**3.9E-02**	**0**	**358**	**358**	**8.2E-03**	**0**	**358**

Notes:

(a) Annual emissions (tons/yr) = (Daily emissions [lbs/day]) x (number of days per phase) x (ton/2,000 lbs) (1)

Number of days for Demolition (days/phase) = 4 (2)

Number of days for Site Grading - Excavation (days/phase) = 15 (2)

Number of days for Building Construction - Foundations (days/phase) = 24 (2)

Number of days for Building Construction - Steel Erection (days/phase) = 29 (2)

Number of days for Building Construction - Exterior Enclosure (days/phase) = 44 (2)

Number of days for Building Construction - Interior Finishes (days/phase) = 47 (2)

Number of days for Paving - Site Improvements (days/phase) = 15 (2)

References:

(1) Email correspondance and phone conversation with AQMD regarding CalEEMod offsite emission error on January 29th, 2013 resulting in correction equation.

(2) See Table C-2, CalEEMod Input Assumptions for LRDP Construction and Demolition Offroad Equipment .

(3) Assumes 100% of Exhaust PM_{10} equals Diesel Particulate Matter (DPM).

(4) Off-road fugitive PM_{10} and $PM_{2.5}$ emissions include a 55% control efficiency due to watering.

Table C-6
LRDP Construction and Demolition Annual Emission Estimates For Residential Hazard Modeling

Base Year	Phase		Annual Emissions (tons/yr)															
			ROG	NOx	CO	SO_2	Fugitive PM_{10}	Exhaust PM_{10} (1)	PM_{10} Total	Fugitive $PM_{2.5}$	Exhaust $PM_{2.5}$	$PM_{2.5}$ Total	Bio- CO_2	NBio- CO_2	Total CO_2	CH_4	N_2O	CO_2e
Onroad Vehicle Emissions (a)																		
2018	Demolition	Hauling	3.1E-05	3.1E-04	2.0E-04	6.2E-07	4.7E-05	9.4E-06	5.6E-05	9.4E-07	8.7E-06	9.7E-06	0	8.1E-02	8.1E-02	1.6E-06	0	8.1E-02
		Vendor	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		Worker	4.0E-06	3.5E-06	3.5E-05	0	9.6E-06	5.0E-07	1.0E-05	0	5.0E-07	5.0E-07	0	7.3E-03	7.3E-03	5.0E-07	0	7.3E-03
	Site Grading - Excavation	Hauling	3.9E-04	3.9E-03	2.5E-03	9.4E-06	5.7E-04	1.2E-04	6.9E-04	1.2E-05	1.1E-04	1.2E-04	0	1.01	1.01	1.9E-05	0	1.01
		Vendor	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		Worker	1.7E-05	1.5E-05	1.5E-04	0	4.1E-05	1.9E-06	4.3E-05	0	1.9E-06	1.9E-06	0	3.2E-02	3.2E-02	1.9E-06	0	3.2E-02
	Building Construction - Foundations	Hauling	1.6E-04	1.6E-03	1.0E-03	3.7E-06	2.4E-04	4.9E-05	2.9E-04	5.6E-06	4.5E-05	5.1E-05	0	0.42	0.42	7.5E-06	0	0.42
		Vendor	1.8E-04	1.8E-03	1.4E-03	5.1E-06	1.5E-04	5.1E-05	2.1E-04	5.1E-06	4.6E-05	5.1E-05	0	0.46	0.46	1.0E-05	0	0.46
		Worker	1.1E-04	1.0E-04	1.0E-03	3.0E-06	2.9E-04	9.1E-06	3.0E-04	3.0E-06	9.1E-06	1.2E-05	0	0.22	0.22	9.1E-06	0	0.22
	Building Construction - Steel Erection	Hauling	8.4E-04	8.5E-03	5.5E-03	2.0E-05	1.2E-03	2.6E-04	1.5E-03	2.5E-05	2.4E-04	2.6E-04	0	2.19	2.19	4.1E-05	0	2.20
		Vendor	2.2E-04	2.1E-03	1.7E-03	6.2E-06	1.9E-04	6.2E-05	2.5E-04	6.2E-06	5.6E-05	6.2E-05	0	0.56	0.56	1.2E-05	0	0.56
		Worker	1.4E-04	1.2E-04	1.2E-03	3.6E-06	3.5E-04	1.1E-05	3.6E-04	3.6E-06	1.1E-05	1.5E-05	0	0.26	0.26	1.1E-05	0	0.26
	Building Construction - Exterior Enclosure	Hauling	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		Vendor	3.3E-04	3.3E-03	2.7E-03	9.4E-06	2.8E-04	9.4E-05	3.8E-04	9.4E-06	8.5E-05	9.4E-05	0	0.84	0.84	1.9E-05	0	0.84
		Worker	2.1E-04	1.8E-04	1.9E-03	5.5E-06	5.3E-04	1.7E-05	5.5E-04	5.5E-06	1.7E-05	2.2E-05	0	0.40	0.40	1.7E-05	0	0.40
	Building Construction - Interior Finishes	Hauling	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		Vendor	3.5E-04	3.5E-03	2.8E-03	1.0E-05	3.0E-04	1.0E-04	4.0E-04	1.0E-05	9.0E-05	1.0E-04	0	0.90	0.90	2.0E-05	0	0.90
		Worker	2.2E-04	2.0E-04	2.0E-03	5.9E-06	5.7E-04	1.8E-05	5.9E-04	5.9E-06	1.8E-05	2.4E-05	0	0.42	0.42	1.8E-05	0	0.43
	Paving - Site Improvements	Hauling	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		Vendor	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		Worker	2.6E-05	2.3E-05	2.3E-04	0	6.4E-05	1.9E-06	6.6E-05	0	1.9E-06	1.9E-06	0	4.9E-02	4.9E-02	1.9E-06	0	4.9E-02
Total Annual Onroad Emissions			**3.2E-03**	**2.6E-02**	**2.5E-02**	**8.3E-05**	**4.9E-03**	**8.0E-04**	**5.7E-03**	**9.2E-05**	**7.4E-04**	**8.3E-04**	**0**	**7.86**	**7.86**	**1.9E-04**	**0**	**7.86**

Notes:

(a) Annual emissions (tons/yr) = (Daily emissions [lbs/day]) x (number of days per phase) x (ton/2,000 lbs) x (modeling road length [mi]) / (hauling, vendor, or worker CalEEMod default road length [mi]) (2)

Number of days for Demolition (days/phase) =	4	(3)
Number of days for Site Grading - Excavation (days/phase) =	15	(3)
Number of days for Building Construction - Foundations (days/phase) =	24	(3)
Number of days for Building Construction - Steel Erection (days/phase) =	29	(3)
Number of days for Building Construction - Exterior Enclosure (days/phase) =	44	(3)
Number of days for Building Construction - Interior Finishes (days/phase) =	47	(3)
Number of days for Paving - Site Improvements (days/phase) =	15	(3)
Residential modeling road length (mi) =	0.31	(4)
Hauling road length (mi) =	20	(5)
Vendor road length (mi) =	7.3	(5)
Worker road length (mi) =	12.4	(5)

References:

(1) Assumes 100% of Exhaust PM_{10} equals Diesel Particulate Matter (DPM).
(2) Email correspondance and phone conversation with AQMD regarding CalEEMod offsite emission error on January 29th, 2013 resulting in correction equation.
(3) See Table C-2, CalEEMod Input Assumptions for LRDP Construction and Demolition Offroad Equipment .
(4) Engineering judgement based on an analysis of road length data provided by LBNL.
(5) See Table C-3, CalEEMod Assumptions for LRDP Construction and Demolition Onroad Vehicles.

Table C-7
LRDP Construction and Demolition Annual Emission Estimates For Worker Hazard Modeling

Base Year	Phase		Annual Emissions (tons/yr)															
			ROG	NOx	CO	SO_2	Fugitive PM_{10}	Exhaust PM_{10} (1)	PM_{10} Total	Fugitive $PM_{2.5}$	Exhaust $PM_{2.5}$	$PM_{2.5}$ Total	Bio- CO_2	NBio- CO_2	Total CO_2	CH_4	N_2O	CO_2e
Onroad Vehicle Emissions (a)																		
2018	Demolition	Hauling	5.0E-05	5.1E-04	3.3E-04	1.0E-06	7.6E-05	1.5E-05	9.2E-05	1.5E-06	1.4E-05	1.6E-05	0	0.13	0.13	2.5E-06	0	0.13
		Vendor	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		Worker	6.6E-06	5.8E-06	5.7E-05	0	1.6E-05	8.2E-07	1.6E-05	0	8.2E-07	8.2E-07	0	1.2E-02	1.2E-02	8.2E-07	0	1.2E-02
	Site Grading - Excavation	Hauling	6.3E-04	6.4E-03	4.1E-03	1.5E-05	9.4E-04	1.9E-04	1.1E-03	1.9E-05	1.8E-04	2.0E-04	0	1.66	1.66	3.1E-05	0	1.66
		Vendor	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		Worker	2.8E-05	2.5E-05	2.5E-04	0	6.8E-05	3.1E-06	7.1E-05	0	3.1E-06	3.1E-06	0	5.2E-02	5.2E-02	3.1E-06	0	5.2E-02
	Building Construction - Foundations	Hauling	2.6E-04	2.6E-03	1.7E-03	6.1E-06	3.9E-04	7.9E-05	4.7E-04	9.2E-06	7.3E-05	8.3E-05	0	0.69	0.69	1.2E-05	0	0.69
		Vendor	2.9E-04	2.9E-03	2.4E-03	8.4E-06	2.5E-04	8.4E-05	3.4E-04	8.4E-06	7.5E-05	8.4E-05	0	0.75	0.75	1.7E-05	0	0.75
		Worker	1.9E-04	1.6E-04	1.7E-03	4.9E-06	4.7E-04	1.5E-05	4.9E-04	4.9E-06	1.5E-05	2.0E-05	0	0.35	0.35	1.5E-05	0	0.35
	Building Construction - Steel Erection	Hauling	1.4E-03	1.4E-02	8.9E-03	3.3E-05	2.0E-03	4.2E-04	2.4E-03	4.1E-05	3.9E-04	4.3E-04	0	3.59	3.59	6.6E-05	0	3.59
		Vendor	3.5E-04	3.5E-03	2.9E-03	1.0E-05	3.0E-04	1.0E-04	4.0E-04	1.0E-05	9.1E-05	1.0E-04	0	0.91	0.91	2.0E-05	0	0.91
		Worker	2.3E-04	2.0E-04	2.0E-03	6.0E-06	5.7E-04	1.8E-05	5.9E-04	6.0E-06	1.8E-05	2.4E-05	0	0.43	0.43	1.8E-05	0	0.43
	Building Construction - Exterior Enclosure	Hauling	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		Vendor	5.4E-04	5.3E-03	4.3E-03	1.5E-05	4.6E-04	1.5E-04	6.1E-04	1.5E-05	1.4E-04	1.5E-04	0	1.38	1.38	3.1E-05	0	1.38
		Worker	3.4E-04	3.0E-04	3.1E-03	9.0E-06	8.7E-04	2.7E-05	8.9E-04	9.0E-06	2.7E-05	3.6E-05	0	0.65	0.65	2.7E-05	0	0.65
	Building Construction - Interior Finishes	Hauling	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		Vendor	5.7E-04	5.7E-03	4.6E-03	1.6E-05	4.9E-04	1.6E-04	6.6E-04	1.6E-05	1.5E-04	1.6E-04	0	1.47	1.47	3.3E-05	0	1.47
		Worker	3.7E-04	3.2E-04	3.3E-03	9.7E-06	9.3E-04	2.9E-05	9.6E-04	9.7E-06	2.9E-05	3.9E-05	0	0.69	0.69	2.9E-05	0	0.69
	Paving - Site Improvements	Hauling	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		Vendor	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		Worker	4.3E-05	3.7E-05	3.8E-04	0	1.0E-04	3.1E-06	1.1E-04	0	3.1E-06	3.1E-06	0	8.0E-02	8.0E-02	3.1E-06	0	8.0E-02
Total Annual Onroad Emissions			**5.3E-03**	**4.2E-02**	**4.0E-02**	**1.4E-04**	**8.0E-03**	**1.3E-03**	**9.3E-03**	**1.5E-04**	**1.2E-03**	**1.4E-03**	**0**	**12.8**	**12.8**	**3.1E-04**	**0**	**12.8**

Notes:

(a) Annual emissions (tons/yr) = (Daily emissions [lbs/day]) x (number of days per phase) x (ton/2,000 lbs) x (modeling road length [mi]) / (Hauling, Vendor, or Worker CalEEMod default road length [mi]) (2)

Number of days for Demolition (days/phase) =	4	(3)
Number of days for Site Grading - Excavation (days/phase) =	15	(3)
Number of days for Building Construction - Foundations (days/phase) =	24	(3)
Number of days for Building Construction - Steel Erection (days/phase) =	29	(3)
Number of days for Building Construction - Exterior Enclosure (days/phase) =	44	(3)
Number of days for Building Construction - Interior Finishes (days/phase) =	47	(3)
Number of days for Paving - Site Improvements (days/phase) =	15	(3)
Worker modeling road length (mi) =	0.51	(4)
Hauling road length (mi) =	20	(5)
Vendor road length (mi) =	7.3	(5)
Worker road length (mi) =	12.4	(5)

References:

(1) Assumes 100% of Exhaust PM_{10} equals Diesel Particulate Matter (DPM).
(2) Email correspondance and phone conversation with AQMD regarding CalEEMod offsite emission error on January 29th, 2013 resulting in correction equation.
(3) See Table C-2, CalEEMod Input Assumptions for LRDP Construction and Demolition Offroad Equipment .
(4) Engineering judgement based on an analysis of road length data provided by LBNL.
(5) See Table C-3, CalEEMod Assumptions for LRDP Construction and Demolition Onroad Vehicles.

Table C-8
LRDP Construction and Demolition Annual Emission Estimates For Cancer Risk Modeling

Base Year	Phase		Annual Emissions (tons/yr)															
			ROG	NOx	CO	SO_2	Fugitive PM_{10}	Exhaust PM_{10} (1)	PM_{10} Total	Fugitive $PM_{2.5}$	Exhaust $PM_{2.5}$	$PM_{2.5}$ Total	Bio- CO_2	NBio- CO_2	Total CO_2	CH_4	N_2O	CO_2e
Onroad Vehicle Emissions (a)																		
2018	Demolition	Hauling	7.2E-05	7.3E-04	4.7E-04	1.5E-06	1.1E-04	2.2E-05	1.3E-04	2.2E-06	2.0E-05	2.3E-05	0	0.19	0.19	3.6E-06	0	0.19
		Vendor	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		Worker	9.4E-06	8.2E-06	8.1E-05	0	2.2E-05	1.2E-06	2.4E-05	0	1.2E-06	1.2E-06	0	1.7E-02	1.7E-02	1.2E-06	0	1.7E-02
	Site Grading - Excavation	Hauling	9.1E-04	9.1E-03	5.9E-03	2.2E-05	1.3E-03	2.8E-04	1.6E-03	2.7E-05	2.5E-04	2.8E-04	0	2.37	2.37	4.4E-05	0	2.37
		Vendor	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		Worker	4.0E-05	3.5E-05	3.5E-04	0	9.7E-05	4.4E-06	1.0E-04	0	4.4E-06	4.4E-06	0	7.4E-02	7.4E-02	4.4E-06	0	7.4E-02
	Building Construction - Foundations	Hauling	3.8E-04	3.8E-03	2.4E-03	8.8E-06	5.5E-04	1.1E-04	6.7E-04	1.3E-05	1.1E-04	1.2E-04	0	0.98	0.98	1.8E-05	0	0.98
		Vendor	4.2E-04	4.2E-03	3.4E-03	1.2E-05	3.6E-04	1.2E-04	4.8E-04	1.2E-05	1.1E-04	1.2E-04	0	1.08	1.08	2.4E-05	0	1.08
		Worker	2.7E-04	2.3E-04	2.4E-03	7.1E-06	6.8E-04	2.1E-05	7.0E-04	7.1E-06	2.1E-05	2.8E-05	0	0.51	0.51	2.1E-05	0	0.51
	Building Construction - Steel Erection	Hauling	2.0E-03	2.0E-02	1.3E-02	4.8E-05	2.9E-03	6.0E-04	3.5E-03	5.8E-05	5.6E-04	6.1E-04	0	5.13	5.13	9.5E-05	0	5.13
		Vendor	5.1E-04	5.0E-03	4.1E-03	1.4E-05	4.3E-04	1.4E-04	5.8E-04	1.4E-05	1.3E-04	1.4E-04	0	1.30	1.30	2.9E-05	0	1.30
		Worker	3.2E-04	2.8E-04	2.9E-03	8.5E-06	8.2E-04	2.6E-05	8.4E-04	8.5E-06	2.6E-05	3.4E-05	0	0.61	0.61	2.6E-05	0	0.61
	Building Construction - Exterior Enclosure	Hauling	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		Vendor	7.7E-04	7.6E-03	6.2E-03	2.2E-05	6.6E-04	2.2E-04	8.8E-04	2.2E-05	2.0E-04	2.2E-04	0	1.97	1.97	4.4E-05	0	1.97
		Worker	4.9E-04	4.3E-04	4.4E-03	1.3E-05	1.2E-03	3.9E-05	1.3E-03	1.3E-05	3.9E-05	5.2E-05	0	0.93	0.93	3.9E-05	0	0.93
	Building Construction - Interior Finishes	Hauling	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		Vendor	8.2E-04	8.1E-03	6.6E-03	2.3E-05	7.0E-04	2.3E-04	9.4E-04	2.3E-05	2.1E-04	2.3E-04	0	2.11	2.11	4.7E-05	0	2.11
		Worker	5.3E-04	4.6E-04	4.7E-03	1.4E-05	1.3E-03	4.1E-05	1.4E-03	1.4E-05	4.1E-05	5.5E-05	0	0.99	0.99	4.1E-05	0	0.99
	Paving - Site Improvements	Hauling	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		Vendor	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		Worker	6.2E-05	5.3E-05	5.4E-04	0	1.5E-04	4.4E-06	1.5E-04	0	4.4E-06	4.4E-06	0	0.11	0.11	4.4E-06	0	0.11
Total Annual Onroad Emissions			**7.5E-03**	**6.0E-02**	**5.7E-02**	**1.9E-04**	**1.1E-02**	**1.9E-03**	**1.3E-02**	**2.2E-04**	**1.7E-03**	**1.9E-03**	**0**	**18.4**	**18.4**	**4.4E-04**	**0**	**18.4**

Notes:

(a) Annual emissions (tons/yr) = (Daily emissions [lbs/day]) x (number of days per phase) x (ton/2,000 lbs) x (modeling road length [mi]) / (Hauling, Vendor, or Worker CalEEMod default road length [mi]) (2)

Number of days for Demolition (days/phase) =	4	(3)
Number of days for Site Grading - Excavation (days/phase) =	15	(3)
Number of days for Building Construction - Foundations (days/phase) =	24	(3)
Number of days for Building Construction - Steel Erection (days/phase) =	29	(3)
Number of days for Building Construction - Exterior Enclosure (days/phase) =	44	(3)
Number of days for Building Construction - Interior Finishes (days/phase) =	47	(3)
Number of days for Paving - Site Improvements (days/phase) =	15	(3)
Cancer risk modeling road length (mi) =	0.73	(4)
Hauling road length (mi) =	20	(5)
Vendor road length (mi) =	7.3	(5)
Worker road length (mi) =	12.4	(5)

References:

(1) Assumes 100% of Exhaust PM_{10} equals Diesel Particulate Matter (DPM).
(2) Email correspondance and phone conversation with AQMD regarding CalEEMod offsite emission error on January 29th, 2013 resulting in correction equation.
(3) See Table C-2, CalEEMod Input Assumptions for LRDP Construction and Demolition Offroad Equipment .
(4) Engineering judgement based on an analysis of road length data provided by LBNL.
(5) See Table C-3, CalEEMod Assumptions for LRDP Construction and Demolition Onroad Vehicles.

Table C-9
LRDP Construction and Demolition Criteria Pollutant Emissions Summary

Source	Annual Operation (days/yr)	ROG		NO_X		CO		SO_2		Fugitive PM_{10}		Exhaust PM_{10} (1)		PM_{10} Total		Fugitive $PM_{2.5}$		Exhaust $PM_{2.5}$		$PM_{2.5}$ Total	
		(lbs/day)	(tons/yr)	(lbs/day)	(tons/yr)	(lbs/day)	(tons/yr)	(lbs/day)	(tons/yr)	(lbs/day)	(tons/yr)	(lbs/day)	(tons/yr)	(lbs/day)	(tons/yr)	(lbs/day)	(tons/yr)	(lbs/day)	(tons/yr)	(lbs/day)	(tons/yr)
2018 Off-Road Equipment Emissions																					
Demolition	260	2.1E-02	2.8E-03	0.14	1.9E-02	0.13	1.7E-02	3.1E-04	4.0E-05	3.4E-02	4.5E-03	6.5E-03	8.4E-04	4.1E-02	5.3E-03	0	0	6.5E-03	8.4E-04	6.5E-03	8.4E-04
Site Grading - Excavation	260	6.1E-02	8.0E-03	0.43	5.6E-02	0.40	5.1E-02	5.8E-04	7.5E-05	7.7E-02	1.0E-02	2.1E-02	2.8E-03	9.9E-02	1.3E-02	3.9E-02	5.1E-03	2.1E-02	2.8E-03	6.1E-02	7.9E-03
Building Construction - Foundations	260	7.0E-02	9.1E-03	0.55	7.2E-02	0.46	5.9E-02	9.2E-04	1.2E-04	0	0	2.7E-02	3.5E-03	2.7E-02	3.5E-03	0	0	2.7E-02	3.5E-03	2.7E-02	3.5E-03
Building Construction - Steel Erection	260	0.12	1.6E-02	0.86	0.11	0.59	7.7E-02	1.1E-03	1.5E-04	0	0	4.1E-02	5.4E-03	4.1E-02	5.4E-03	0	0	4.1E-02	5.4E-03	4.1E-02	5.4E-03
Building Construction - Exterior Enclosure	260	0.12	1.5E-02	0.84	0.11	0.51	6.6E-02	1.7E-03	2.2E-04	0	0	3.4E-02	4.4E-03	3.4E-02	4.4E-03	0	0	3.4E-02	4.4E-03	3.4E-02	4.4E-03
Building Construction - Interior Finishes	260	5.2E-02	6.8E-03	0.37	4.7E-02	0.29	3.8E-02	0	0	0	0	1.8E-02	2.4E-03	1.8E-02	2.4E-03	0	0	1.8E-02	2.4E-03	1.8E-02	2.4E-03
Paving - Site Improvements	260	3.2E-02	4.2E-03	0.22	2.8E-02	0.19	2.4E-02	5.8E-04	7.5E-05	0	0	9.8E-03	1.3E-03	9.8E-03	1.3E-03	0	0	9.8E-03	1.3E-03	9.8E-03	1.3E-03
Total 2018 Off-Road Emissions		**0.48**	**5.8E-02**	**3.42**	**0.42**	**2.56**	**0.31**	**5.2E-03**	**6.0E-04**	**0.11**	**1.5E-02**	**0.16**	**1.9E-02**	**0.27**	**3.4E-02**	**3.9E-02**	**5.1E-03**	**0.16**	**1.9E-02**	**0.20**	**2.4E-02**
2018 Onroad Vehicle Emissions																					
Total Demolition		**1.6E-02**	**2.1E-03**	**0.15**	**2.0E-02**	**0.11**	**1.4E-02**	**3.1E-04**	**4.0E-05**	**2.6E-02**	**3.4E-03**	**4.8E-03**	**6.2E-04**	**3.1E-02**	**4.0E-03**	**4.6E-04**	**6.0E-05**	**4.5E-03**	**5.8E-04**	**4.9E-03**	**6.4E-04**
Hauling Vehicle Onroad Emissions	260	1.5E-02	2.0E-03	0.15	2.0E-02	9.9E-02	1.3E-02	3.1E-04	4.0E-05	2.3E-02	3.0E-03	4.6E-03	6.0E-04	2.8E-02	3.6E-03	4.6E-04	6.0E-05	4.3E-03	5.6E-04	4.8E-03	6.2E-04
Vendor Vehicle Onroad Emissions	260	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Worker Vehicle Onroad Emissions	260	1.2E-03	1.6E-04	1.1E-03	1.4E-04	1.1E-02	1.4E-03	0	0	2.9E-03	3.8E-04	1.5E-04	2.0E-05	3.1E-03	4.0E-04	0	0	1.5E-04	2.0E-05	1.5E-04	2.0E-05
Total Site Grading - Excavation		**0.20**	**2.6E-02**	**1.94**	**0.25**	**1.29**	**0.17**	**4.6E-03**	**6.0E-04**	**0.30**	**3.8E-02**	**5.9E-02**	**7.7E-03**	**0.36**	**4.6E-02**	**5.8E-03**	**7.5E-04**	**5.4E-02**	**7.1E-03**	**6.0E-02**	**7.8E-03**
Hauling Vehicle Onroad Emissions	260	0.19	2.5E-02	1.93	0.25	1.25	0.16	4.6E-03	6.0E-04	0.28	3.7E-02	5.9E-02	7.7E-03	0.34	4.4E-02	5.8E-03	7.5E-04	5.4E-02	7.0E-03	5.9E-02	7.7E-03
Vendor Vehicle Onroad Emissions	260	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Worker Vehicle Onroad Emissions	260	5.2E-03	6.8E-04	4.6E-03	6.0E-04	4.6E-02	6.0E-03	0	0	1.3E-02	1.7E-03	5.8E-04	7.5E-05	1.3E-02	1.7E-03	0	0	5.8E-04	7.5E-05	5.8E-04	7.5E-05
Total Building Construction - Foundations		**0.15**	**1.9E-02**	**1.15**	**0.15**	**1.09**	**0.14**	**3.7E-03**	**4.8E-04**	**0.23**	**3.0E-02**	**3.6E-02**	**4.7E-03**	**0.27**	**3.5E-02**	**4.6E-03**	**6.0E-04**	**3.3E-02**	**4.3E-03**	**3.8E-02**	**4.9E-03**
Hauling Vehicle Onroad Emissions	260	7.9E-02	1.0E-02	0.80	0.10	0.52	6.7E-02	1.8E-03	2.4E-04	0.12	1.5E-02	2.4E-02	3.1E-03	0.14	1.8E-02	2.8E-03	3.6E-04	2.2E-02	2.9E-03	2.5E-02	3.2E-03
Vendor Vehicle Onroad Emissions	260	3.2E-02	4.2E-03	0.32	4.2E-02	0.26	3.4E-02	9.2E-04	1.2E-04	2.8E-02	3.6E-03	9.2E-03	1.2E-03	3.7E-02	4.8E-03	9.2E-04	1.2E-04	8.3E-03	1.1E-03	9.2E-03	1.2E-03
Worker Vehicle Onroad Emissions	260	3.5E-02	4.6E-03	3.0E-02	4.0E-03	0.31	4.1E-02	9.2E-04	1.2E-04	8.9E-02	1.2E-02	2.8E-03	3.6E-04	9.1E-02	1.2E-02	9.2E-04	1.2E-04	2.8E-03	3.6E-04	3.7E-03	4.8E-04
Total Building Construction - Steel Erection		**0.49**	**6.4E-02**	**4.60**	**0.60**	**3.40**	**0.44**	**1.2E-02**	**1.6E-03**	**0.75**	**9.8E-02**	**0.14**	**1.8E-02**	**0.89**	**0.12**	**1.5E-02**	**1.9E-03**	**0.13**	**1.7E-02**	**0.15**	**1.9E-02**
Hauling Vehicle Onroad Emissions	260	0.41	5.4E-02	4.18	0.54	2.70	0.35	1.0E-02	1.3E-03	0.61	7.9E-02	0.13	1.7E-02	0.74	9.6E-02	1.2E-02	1.6E-03	0.12	1.5E-02	0.13	1.7E-02
Vendor Vehicle Onroad Emissions	260	3.9E-02	5.1E-03	0.39	5.0E-02	0.31	4.1E-02	1.1E-03	1.5E-04	3.3E-02	4.4E-03	1.1E-02	1.5E-03	4.5E-02	5.8E-03	1.1E-03	1.5E-04	1.0E-02	1.3E-03	1.1E-02	1.5E-03
Worker Vehicle Onroad Emissions	260	4.2E-02	5.5E-03	3.7E-02	4.8E-03	0.38	4.9E-02	1.1E-03	1.5E-04	0.11	1.4E-02	3.3E-03	4.4E-04	0.11	1.4E-02	1.1E-03	1.5E-04	3.3E-03	4.4E-04	4.5E-03	5.8E-04
Total Building Construction - Exterior Enclosure		**0.12**	**1.6E-02**	**0.64**	**8.4E-02**	**1.05**	**0.14**	**3.4E-03**	**4.4E-04**	**0.21**	**2.8E-02**	**2.2E-02**	**2.9E-03**	**0.24**	**3.1E-02**	**3.4E-03**	**4.4E-04**	**2.0E-02**	**2.6E-03**	**2.4E-02**	**3.1E-03**
Hauling Vehicle Onroad Emissions	260	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Vendor Vehicle Onroad Emissions	260	5.9E-02	7.7E-03	0.59	7.6E-02	0.48	6.2E-02	1.7E-03	2.2E-04	5.1E-02	6.6E-03	1.7E-02	2.2E-03	6.8E-02	8.8E-03	1.7E-03	2.2E-04	1.5E-02	2.0E-03	1.7E-02	2.2E-03
Worker Vehicle Onroad Emissions	260	6.4E-02	8.4E-03	5.6E-02	7.3E-03	0.58	7.5E-02	1.7E-03	2.2E-04	0.16	2.1E-02	5.1E-03	6.6E-04	0.17	2.2E-02	1.7E-03	2.2E-04	5.1E-03	6.6E-04	6.8E-03	8.8E-04
Total Building Construction - Interior Finishes		**0.13**	**1.7E-02**	**0.69**	**8.9E-02**	**1.13**	**0.15**	**3.6E-03**	**4.7E-04**	**0.23**	**3.0E-02**	**2.4E-02**	**3.1E-03**	**0.25**	**3.3E-02**	**3.6E-03**	**4.7E-04**	**2.2E-02**	**2.8E-03**	**2.5E-02**	**3.3E-03**
Hauling Vehicle Onroad Emissions	260	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Vendor Vehicle Onroad Emissions	260	6.3E-02	8.2E-03	0.63	8.2E-02	0.51	6.6E-02	1.8E-03	2.4E-04	5.4E-02	7.1E-03	1.8E-02	2.4E-03	7.2E-02	9.4E-03	1.8E-03	2.4E-04	1.6E-02	2.1E-03	1.8E-02	2.4E-03
Worker Vehicle Onroad Emissions	260	6.9E-02	8.9E-03	6.0E-02	7.8E-03	0.62	8.0E-02	1.8E-03	2.4E-04	0.17	2.3E-02	5.4E-03	7.1E-04	0.18	2.3E-02	1.8E-03	2.4E-04	5.4E-03	7.1E-04	7.2E-03	9.4E-04
Total Paving - Site Improvements		**8.1E-03**	**1.1E-03**	**6.9E-03**	**9.0E-04**	**7.1E-02**	**9.2E-03**	**0**	**0**	**2.0E-02**	**2.6E-03**	**5.8E-04**	**7.5E-05**	**2.0E-02**	**2.6E-03**	**0**	**0**	**5.8E-04**	**7.5E-05**	**5.8E-04**	**7.5E-05**
Hauling Vehicle Onroad Emissions	260	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Vendor Vehicle Onroad Emissions	260	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Worker Vehicle Onroad Emissions	260	8.1E-03	1.1E-03	6.9E-03	9.0E-04	7.1E-02	9.2E-03	0	0	2.0E-02	2.6E-03	5.8E-04	7.5E-05	2.0E-02	2.6E-03	0	0	5.8E-04	7.5E-05	5.8E-04	7.5E-05
Total 2018 Onroad Emissions	--	**1.12**	**0.15**	**9.18**	**1.19**	**8.14**	**1.06**	**2.8E-02**	**3.6E-03**	**1.77**	**0.23**	**0.29**	**3.7E-02**	**2.06**	**0.27**	**3.2E-02**	**4.2E-03**	**0.27**	**3.4E-02**	**0.30**	**3.9E-02**
Total 2018 Project Emissions	--	**1.59**	**0.20**	**12.6**	**1.61**	**10.7**	**1.37**	**3.3E-02**	**4.2E-03**	**1.88**	**0.24**	**0.45**	**5.7E-02**	**2.32**	**0.30**	**7.2E-02**	**9.3E-03**	**0.42**	**5.4E-02**	**0.49**	**6.3E-02**
Onsite Stationary Exhaust	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Onsite Mobile Exhaust	--	**0.48**	**5.8E-02**	**3.42**	**0.42**	**2.56**	**0.31**	**5.2E-03**	**6.0E-04**	--	--	**0.16**	**1.9E-02**	--	--	--	--	**0.16**	**1.9E-02**	--	--
Onsite Fugitive Dust	--	--	--	--	--	--	--	--	--	**0.11**	**1.5E-02**	--	--	--	--	**3.9E-02**	**5.1E-03**	--	--	--	--
Offsite Mobile Exhaust	--	**1.12**	**0.15**	**9.18**	**1.19**	**8.14**	**1.06**	**2.8E-02**	**3.6E-03**	--	--	**0.29**	**3.7E-02**	--	--	--	--	**0.27**	**3.4E-02**	--	--
Offsite Fugitive Dust	--	--	--	--	--	--	--	--	--	**1.77**	**0.23**	--	--	--	--	**3.2E-02**	**4.2E-03**	--	--	--	--
Total 2018 Project Emissions	--	**1.59**	**0.20**	**12.6**	**1.61**	**10.7**	**1.37**	**3.3E-02**	**4.2E-03**	**1.88**	**0.24**	**0.45**	**5.7E-02**	**2.32**	**0.30**	**7.2E-02**	**9.3E-03**	**0.42**	**5.4E-02**	**0.49**	**6.3E-02**

References:

(1) Assumes 100% of Exhaust PM_{10} equals Diesel Particulate Matter (DPM).

Table C-9
LRDP Construction and Demolition Criteria Pollutant Emissions Summary

Source	Annual Operation (days/yr)	Total CO_2		CH_4		N_2O		CO_2e	
		(lbs/day)	(tons/yr)	(lbs/day)	(tons/yr)	(lbs/day)	(tons/yr)	(lbs/day)	(tons/yr)
2018 Off-Road Equipment Emissions									
Demolition	260	37.7	4.90	1.8E-03	2.4E-04	0	0	37.7	4.90
Site Grading - Excavation	260	77.9	10.1	5.2E-03	6.8E-04	0	0	78.1	10.1
Building Construction - Foundations	260	112	14.6	6.5E-03	8.4E-04	0	0	112	14.6
Building Construction - Steel Erection	260	158	20.5	1.1E-02	1.5E-03	0	0	158	20.5
Building Construction - Exterior Enclosure	260	190	24.7	1.0E-02	1.3E-03	0	0	190	24.7
Building Construction - Interior Finishes	260	93.2	12.1	5.4E-03	7.1E-04	0	0	93.3	12.1
Paving - Site Improvements	260	42.6	5.54	2.9E-03	3.8E-04	0	0	42.7	5.55
Total 2018 Off-Road Emissions		**711**	**86.9**	**4.3E-02**	**5.2E-03**	**0**	**0**	**712**	**87.0**
2018 Onroad Vehicle Emissions									
Total Demolition		**42.1**	**5.47**	**9.2E-04**	**1.2E-04**	**0**	**0**	**42.1**	**5.47**
Hauling Vehicle Onroad Emissions	260	39.8	5.18	7.7E-04	1.0E-04	0	0	39.8	5.18
Vendor Vehicle Onroad Emissions	260	0	0	0	0	0	0	0	0
Worker Vehicle Onroad Emissions	260	2.25	0.29	1.5E-04	2.0E-05	0	0	2.25	0.29
Total Site Grading - Excavation		**510**	**66.3**	**9.8E-03**	**1.3E-03**	**0**	**0**	**510**	**66.3**
Hauling Vehicle Onroad Emissions	260	500	65.0	9.2E-03	1.2E-03	0	0	500	65.0
Vendor Vehicle Onroad Emissions	260	0	0	0	0	0	0	0	0
Worker Vehicle Onroad Emissions	260	9.72	1.26	5.8E-04	7.5E-05	0	0	9.73	1.26
Total Building Construction - Foundations		**356**	**46.3**	**8.3E-03**	**1.1E-03**	**0**	**0**	**356**	**46.3**
Hauling Vehicle Onroad Emissions	260	207	26.9	3.7E-03	4.8E-04	0	0	207	26.9
Vendor Vehicle Onroad Emissions	260	82.8	10.8	1.8E-03	2.4E-04	0	0	82.8	10.8
Worker Vehicle Onroad Emissions	260	66.3	8.62	2.8E-03	3.6E-04	0	0	66.4	8.63
Total Building Construction - Steel Erection		**1,263**	**164**	**2.6E-02**	**3.3E-03**	**0**	**0**	**1,264**	**164**
Hauling Vehicle Onroad Emissions	260	1,083	141	2.0E-02	2.6E-03	0	0	1,083	141
Vendor Vehicle Onroad Emissions	260	100	13.0	2.2E-03	2.9E-04	0	0	100	13.0
Worker Vehicle Onroad Emissions	260	80.2	10.4	3.3E-03	4.4E-04	0	0	80.2	10.4
Total Building Construction - Exterior Enclosure		**273**	**35.5**	**8.5E-03**	**1.1E-03**	**0**	**0**	**274**	**35.6**
Hauling Vehicle Onroad Emissions	260	0	0	0	0	0	0	0	0
Vendor Vehicle Onroad Emissions	260	152	19.7	3.4E-03	4.4E-04	0	0	152	19.7
Worker Vehicle Onroad Emissions	260	122	15.8	5.1E-03	6.6E-04	0	0	122	15.8
Total Building Construction - Interior Finishes		**292**	**38.0**	**9.0E-03**	**1.2E-03**	**0**	**0**	**292**	**38.0**
Hauling Vehicle Onroad Emissions	260	0	0	0	0	0	0	0	0
Vendor Vehicle Onroad Emissions	260	162	21.1	3.6E-03	4.7E-04	0	0	162	21.1
Worker Vehicle Onroad Emissions	260	130	16.9	5.4E-03	7.1E-04	0	0	130	16.9
Total Paving - Site Improvements		**14.9**	**1.94**	**5.8E-04**	**7.5E-05**	**0**	**0**	**14.9**	**1.94**
Hauling Vehicle Onroad Emissions	260	0	0	0	0	0	0	0	0
Vendor Vehicle Onroad Emissions	260	0	0	0	0	0	0	0	0
Worker Vehicle Onroad Emissions	260	14.9	1.94	5.8E-04	7.5E-05	0	0	14.9	1.94
Total 2018 Onroad Emissions	**--**	**2,751**	**358**	**6.3E-02**	**8.2E-03**	**0**	**0**	**2,753**	**358**
Total 2018 Project Emissions	**--**	**3,463**	**445**	**0.11**	**1.3E-02**	**0**	**0**	**3,465**	**445**
Onsite Stationary Exhaust	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**
Onsite Mobile Exhaust	**--**	**711**	**86.9**	**4.3E-02**	**5.2E-03**	**0**	**0**	**712**	**87.0**
Onsite Fugitive Dust	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**
Offsite Mobile Exhaust	**--**	**2,751**	**358**	**6.3E-02**	**8.2E-03**	**0**	**0**	**2,753**	**358**
Offsite Fugitive Dust	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**
Total 2018 Project Emissions	**--**	**3,463**	**445**	**0.11**	**1.3E-02**	**0**	**0**	**3,465**	**445**

References:

(1) Assumes 100% of Exhaust PM_{10} equals Diesel Particulate Matter (DPM).

Table C-10
LRDP Construction and Demolition Onsite and Offsite Vehicle Traffic Assumptions for Modeling

Road Segment	Offsite Road Length (m)	Onsite Road Length (m)	Area Source Length of Side (m)	Fraction of Traffic (1)	Length Fraction	Fraction of Emissions
Resident Construction/Demolition - Offsite						
R14_NH	99.8	--	--	0.50	49.9	0.099
R14_R15	181	--	--	0.50	90.4	0.18
R15_T1	154	--	--	0.50	76.8	0.15
T1_EH	192	--	--	0.50	95.8	0.19
Total Offsite Resident Length				1.00	313	0.62
Resident Construction/Demolition - Onsite						
T1_R1C	--	99.1	--	1.00	99.1	0.20
AREA7	--	--	90.0	1.00	90.0	0.18
Total Onsite Resident Length				1.00	189	0.38
Total Resident Road Length					**502**	
Worker Construction/Demolition						
R14_NH	99.8	--	--	0.50	49.9	0.061
R13_R14	207	--	--	0.50	104	0.13
R12_R13	427	--	--	0.50	214	0.26
R11_R12	59.7	--	--	0.50	29.9	0.036
T3_R11	445	--	--	0.50	223	0.27
T3_WH	221	--	--	0.50	110	0.13
Total Offsite Worker Length				1.00	730	0.89
Worker Construction/Demolition - Onsite						
AREA3	--	--	90.0	1.00	90.0	0.11
Total Onsite Worker Length				1.00	90.0	0.11
Total Worker Road Length					**820**	
Cancer Risk Construction/Demolition - Offsite						
R14_NH	99.8	--	--	0.33	33.3	0.028
R14_R15	181	--	--	0.33	60.2	0.051
R15_T1	154	--	--	0.33	51.2	0.044
T1_EH	192	--	--	0.33	63.8	0.054
T1_R1	127	--	--	0.33	42.4	0.036
R1_T2	98.6	--	--	0.33	32.9	0.028
T3_WH	221	--	--	0.33	73.6	0.063
T3_R11	445	--	--	0.33	148	0.13
R11_R12	59.7	--	--	0.33	19.9	0.017
R12_R13	427	--	--	0.33	142	0.12
R13_R14	207	--	--	0.33	69.1	0.059
R8_T3	111	--	--	0.33	37.0	0.032
R7_R8	55.3	--	--	0.33	18.4	0.016
R6_R7	71.5	--	--	0.33	23.8	0.020
Total Offsite Cancer Risk Road Length					816	0.70
Cancer Risk Construction/Demolition - Onsite						
T2_R2	--	165	--	0.33	54.8	0.047
R2_R3	--	112	--	0.33	37.4	0.032
R3_R6	--	525	--	0.33	175	0.15
AREA1	--	--	90.0	0.28	25.5	0.022
AREA2	--	--	90.0	0.38	34.2	0.029
AREA3	--	--	90.0	0.19	17.2	0.015
AREA4	--	--	90.0	0.15	13.1	0.011
Total Onsite Cancer Risk Road Length					357	0.30
Total Cancer Risk Road Length					**1,174**	

References:

(1) Vehicle traffic provided by LBNL.

Appendix D

CalEEMod Output – Full LRDP Construction

LRDP - Average Demolition - 04/04/2013

Bay Area AQMD Air District, Summer

1.0 Project Characteristics

1.1 Land Usage

Land Uses	Size	Metric
Research & Development	200	1000sqft

1.2 Other Project Characteristics

Urbanization	Urban	**Wind Speed (m/s)**	2.2	**Utility Company**	Pacific Gas & Electric Company
Climate Zone	5	**Precipitation Freq (Days)**	64		

1.3 User Entered Comments

Project Characteristics -

Land Use - Average construction of 200,000 gsf for R&D and 10,000 population. - Updated: 3/27/13

Construction Phase - Dem (1/1/18 - 1/4/18); Grading (1/5/18 - 1/25/18); BC-F (1/26/18 - 2/28/18); BC-SE (3/01/18 - 4/10/18); BC-EE (4/11/18 - 6/11/18); BC-IF (6/12/18 - 8/15/18); Paving (8/16/18 - 9/05/18)
- Updated: 4/4/18

Off-road Equipment - Cranes, Forklifts, Other construction equip., and Rough terrain forklifts. - Updated: 4/4/13

Off-road Equipment - Tractors/loaders/backhoes, Forklifts, Pumps. Plate compactors, and Air compressors. - Updated: 4/4/18

Off-road Equipment - Forklifts, Other construction equip., and Rough terrain forklifts. Updated; 4/4/13

Off-road Equipment - Air Compressors, Cranes, Forklifts, Pumps, Rough terrain forklifts, Welders, and Welders. Updated: 4/4/13

Off-road Equipment - Excavators, Tractors/Loaders/Backhoes, Rubber Tired Dozers, Concrete/Industrial Saws, and Other Construction Equipment - Updated: 4/4/18

Off-road Equipment - Concrete/Industrial saws, Excavators. Forklifts, Other construction equip., Paving equip., Plate compactors, Skid steer loaders, and Trenchers. - Updated: 4/4/13

Off-road Equipment - Excavators, Tractors/loaders/backhoes, Rubber tired dozers, Trenchers, and Plate compactors. - Updated: 4/4/13

Trips and VMT - Demolition (125 hauling trips); Site Grading (1,570 hauling trips); BC-F (650 hauling trips); BC-SE (3,400 hauling trips). - Updated: 4/4/13

Demolition - Avg demolition = 20,094 gsf - Updated: 4/4/13

Grading - Grading soil export = 15,700 CYD @ 2.00 acres disturbed. - Updated: 4/4/13

Energy Use -

Water And Wastewater - - 340,000,000 gallons/yr of potable water - Updated: 4/4/13

Construction Off-road Equipment Mitigation - Watering 2 times per day @ 55% reduction. - Updated: 4/4/13

2.0 Emissions Summary

2.1 Overall Construction (Maximum Daily Emission)

Unmitigated Construction

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio-CO2	Total CO2	CH4	N2O	CO2e
Year	lb/day										lb/day					
2018	5.29	48.97	31.22	0.12	80.70	1.62	82.32	1.61	1.52	2.91	0.00	12,737.51	0.00	0.32	0.00	12,744.22
Total	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**

Mitigated Construction

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio-CO2	Total CO2	CH4	N2O	CO2e
Year	lb/day										lb/day					
2018	5.29	48.97	31.22	0.12	80.70	1.62	82.32	0.78	1.52	2.08	0.00	12,737.51	0.00	0.32	0.00	12,744.22
Total	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**

2.2 Overall Operational

Unmitigated Operational

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio-CO2	Total CO2	CH4	N2O	CO2e
Category	lb/day										lb/day					
Area	5.55	0.00	0.00	0.00		0.00	0.00		0.00	0.00		0.00		0.00		0.00
Energy	0.15	1.38	1.16	0.01		0.00	0.10		0.00	0.10		1,655.44		0.03	0.03	1,665.51
Mobile	6.81	11.97	57.07	0.13	13.45	0.53	13.98	0.19	0.49	0.68		11,047.02		0.44		11,056.16
Total	**12.51**	**13.35**	**58.23**	**0.14**	**13.45**	**0.53**	**14.08**	**0.19**	**0.49**	**0.78**		**12,702.46**		**0.47**	**0.03**	**12,721.67**

Mitigated Operational

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio-CO2	Total CO2	CH4	N2O	CO2e
Category	lb/day										lb/day					
Area	5.55	0.00	0.00	0.00		0.00	0.00		0.00	0.00		0.00		0.00		0.00
Energy	0.15	1.38	1.16	0.01		0.00	0.10		0.00	0.10		1,655.44		0.03	0.03	1,665.51
Mobile	6.81	11.97	57.07	0.13	13.45	0.53	13.98	0.19	0.49	0.68		11,047.02		0.44		11,056.16
Total	**12.51**	**13.35**	**58.23**	**0.14**	**13.45**	**0.53**	**14.08**	**0.19**	**0.49**	**0.78**		**12,702.46**		**0.47**	**0.03**	**12,721.67**

3.0 Construction Detail

3.1 Mitigation Measures Construction

Water Exposed Area

3.2 Demolition - 2018

Unmitigated Construction On-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio-CO2	Total CO2	CH4	N2O	CO2e
Category	lb/day										lb/day					
Fugitive Dust					4.94	0.00	4.94	0.00	0.00	0.00						0.00
Off-Road	1.39	9.39	8.60	0.02		0.42	0.42		0.42	0.42		2,448.30		0.12		2,450.88
Total	**1.39**	**9.39**	**8.60**	**0.02**	**4.94**	**0.42**	**5.36**	**0.00**	**0.42**	**0.42**		**2,448.30**		**0.12**		**2,450.88**

Unmitigated Construction Off-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio-CO2	Total CO2	CH4	N2O	CO2e
Category	lb/day										lb/day					
Hauling	0.94	9.99	5.42	0.02	3.00	0.30	3.30	0.03	0.28	0.30		2,587.84		0.05		2,588.81
Vendor	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00		0.00		0.00
Worker	0.07	0.06	0.69	0.00	0.19	0.01	0.20	0.00	0.01	0.01		145.98		0.01		146.13
Total	**1.01**	**10.05**	**6.11**	**0.02**	**3.19**	**0.31**	**3.50**	**0.03**	**0.29**	**0.31**		**2,733.82**		**0.06**		**2,734.94**

3.2 Demolition - 2018

Mitigated Construction On-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio-CO2	Total CO2	CH4	N2O	CO2e
Category	lb/day										lb/day					
Fugitive Dust					2.23	0.00	2.23	0.00	0.00	0.00						0.00
Off-Road	1.39	9.39	8.60	0.02		0.42	0.42		0.42	0.42	0.00	2,448.30		0.12		2,450.88
Total	**1.39**	**9.39**	**8.60**	**0.02**	**2.23**	**0.42**	**2.65**	**0.00**	**0.42**	**0.42**	**0.00**	**2,448.30**		**0.12**		**2,450.88**

Mitigated Construction Off-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio-CO2	Total CO2	CH4	N2O	CO2e
Category	lb/day										lb/day					
Hauling	0.94	9.99	5.42	0.02	3.00	0.30	3.30	0.03	0.28	0.30		2,587.84		0.05		2,588.81
Vendor	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00		0.00		0.00
Worker	0.07	0.06	0.69	0.00	0.19	0.01	0.20	0.00	0.01	0.01		145.98		0.01		146.13
Total	**1.01**	**10.05**	**6.11**	**0.02**	**3.19**	**0.31**	**3.50**	**0.03**	**0.29**	**0.31**		**2,733.82**		**0.06**		**2,734.94**

3.3 Site Grading - Excavation - 2018

Unmitigated Construction On-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio-CO2	Total CO2	CH4	N2O	CO2e
Category	lb/day										lb/day					
Fugitive Dust					2.97	0.00	2.97	1.51	0.00	1.51						0.00
Off-Road	1.06	7.52	6.86	0.01		0.37	0.37		0.37	0.37		1,351.02		0.09		1,353.01
Total	**1.06**	**7.52**	**6.86**	**0.01**	**2.97**	**0.37**	**3.34**	**1.51**	**0.37**	**1.88**		**1,351.02**		**0.09**		**1,353.01**

Unmitigated Construction Off-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio-CO2	Total CO2	CH4	N2O	CO2e
Category	lb/day										lb/day					
Hauling	3.15	33.45	18.16	0.08	36.82	1.00	37.83	0.10	0.92	1.02		8,667.54		0.15		8,670.77
Vendor	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00		0.00		0.00
Worker	0.08	0.07	0.80	0.00	0.22	0.01	0.23	0.00	0.01	0.01		168.44		0.01		168.61
Total	**3.23**	**33.52**	**18.96**	**0.08**	**37.04**	**1.01**	**38.06**	**0.10**	**0.93**	**1.03**		**8,835.98**		**0.16**		**8,839.38**

3.3 Site Grading - Excavation - 2018

Mitigated Construction On-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio-CO2	Total CO2	CH4	N2O	CO2e
Category	lb/day										lb/day					
Fugitive Dust					1.34	0.00	1.34	0.68	0.00	0.68						0.00
Off-Road	1.06	7.52	6.86	0.01		0.37	0.37		0.37	0.37	0.00	1,351.02		0.09		1,353.01
Total	**1.06**	**7.52**	**6.86**	**0.01**	**1.34**	**0.37**	**1.71**	**0.68**	**0.37**	**1.05**	**0.00**	**1,351.02**		**0.09**		**1,353.01**

Mitigated Construction Off-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio-CO2	Total CO2	CH4	N2O	CO2e
Category	lb/day										lb/day					
Hauling	3.15	33.45	18.16	0.08	36.82	1.00	37.83	0.10	0.92	1.02		8,667.54		0.15		8,670.77
Vendor	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00		0.00		0.00
Worker	0.08	0.07	0.80	0.00	0.22	0.01	0.23	0.00	0.01	0.01		168.44		0.01		168.61
Total	**3.23**	**33.52**	**18.96**	**0.08**	**37.04**	**1.01**	**38.06**	**0.10**	**0.93**	**1.03**		**8,835.98**		**0.16**		**8,839.38**

3.4 Building Construction - Foundations - 2018

Unmitigated Construction On-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio-CO2	Total CO2	CH4	N2O	CO2e
Category	lb/day										lb/day					
Off-Road	0.76	6.01	4.93	0.01		0.29	0.29		0.29	0.29		1,215.47		0.07		1,216.89
Total	**0.76**	**6.01**	**4.93**	**0.01**		**0.29**	**0.29**		**0.29**	**0.29**		**1,215.47**		**0.07**		**1,216.89**

Unmitigated Construction Off-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio-CO2	Total CO2	CH4	N2O	CO2e
Category	lb/day										lb/day					
Hauling	0.82	8.66	4.70	0.02	15.20	0.26	15.46	0.03	0.24	0.26		2,242.80		0.04		2,243.63
Vendor	0.32	3.47	2.19	0.01	0.30	0.10	0.40	0.01	0.09	0.10		896.92		0.02		897.25
Worker	0.36	0.30	3.41	0.01	0.96	0.03	0.99	0.01	0.03	0.04		718.68		0.03		719.41
Total	**1.50**	**12.43**	**10.30**	**0.04**	**16.46**	**0.39**	**16.85**	**0.05**	**0.36**	**0.40**		**3,858.40**		**0.09**		**3,860.29**

3.4 Building Construction - Foundations - 2018

Mitigated Construction On-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio-CO2	Total CO2	CH4	N2O	CO2e
Category	lb/day										lb/day					
Off-Road	0.76	6.01	4.93	0.01		0.29	0.29		0.29	0.29	0.00	1,215.47		0.07		1,216.89
Total	**0.76**	**6.01**	**4.93**	**0.01**		**0.29**	**0.29**		**0.29**	**0.29**	**0.00**	**1,215.47**		**0.07**		**1,216.89**

Mitigated Construction Off-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio-CO2	Total CO2	CH4	N2O	CO2e
Category	lb/day										lb/day					
Hauling	0.82	8.66	4.70	0.02	15.20	0.26	15.46	0.03	0.24	0.26		2,242.80		0.04		2,243.63
Vendor	0.32	3.47	2.19	0.01	0.30	0.10	0.40	0.01	0.09	0.10		896.92		0.02		897.25
Worker	0.36	0.30	3.41	0.01	0.96	0.03	0.99	0.01	0.03	0.04		718.68		0.03		719.41
Total	**1.50**	**12.43**	**10.30**	**0.04**	**16.46**	**0.39**	**16.85**	**0.05**	**0.36**	**0.40**		**3,858.40**		**0.09**		**3,860.29**

3.5 Building Construction - Steel Erection - 2018

Unmitigated Construction On-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio-CO2	Total CO2	CH4	N2O	CO2e
Category	lb/day										lb/day					
Off-Road	1.08	7.73	5.28	0.01		0.37	0.37		0.37	0.37		1,413.04		0.10		1,415.07
Total	**1.08**	**7.73**	**5.28**	**0.01**		**0.37**	**0.37**		**0.37**	**0.37**		**1,413.04**		**0.10**		**1,415.07**

Unmitigated Construction Off-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio-CO2	Total CO2	CH4	N2O	CO2e
Category	lb/day										lb/day					
Hauling	3.53	37.47	20.34	0.09	79.44	1.12	80.56	0.11	1.03	1.14		9,708.87		0.17		9,712.49
Vendor	0.32	3.47	2.19	0.01	0.30	0.10	0.40	0.01	0.09	0.10		896.92		0.02		897.25
Worker	0.36	0.30	3.41	0.01	0.96	0.03	0.99	0.01	0.03	0.04		718.68		0.03		719.41
Total	**4.21**	**41.24**	**25.94**	**0.11**	**80.70**	**1.25**	**81.95**	**0.13**	**1.15**	**1.28**		**11,324.47**		**0.22**		**11,329.15**

3.5 Building Construction - Steel Erection - 2018

Mitigated Construction On-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio-CO2	Total CO2	CH4	N2O	CO2e
Category	lb/day										lb/day					
Off-Road	1.08	7.73	5.28	0.01		0.37	0.37		0.37	0.37	0.00	1,413.04		0.10		1,415.07
Total	**1.08**	**7.73**	**5.28**	**0.01**		**0.37**	**0.37**		**0.37**	**0.37**	**0.00**	**1,413.04**		**0.10**		**1,415.07**

Mitigated Construction Off-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio-CO2	Total CO2	CH4	N2O	CO2e
Category	lb/day										lb/day					
Hauling	3.53	37.47	20.34	0.09	79.44	1.12	80.56	0.11	1.03	1.14		9,708.87		0.17		9,712.49
Vendor	0.32	3.47	2.19	0.01	0.30	0.10	0.40	0.01	0.09	0.10		896.92		0.02		897.25
Worker	0.36	0.30	3.41	0.01	0.96	0.03	0.99	0.01	0.03	0.04		718.68		0.03		719.41
Total	**4.21**	**41.24**	**25.94**	**0.11**	**80.70**	**1.25**	**81.95**	**0.13**	**1.15**	**1.28**		**11,324.47**		**0.22**		**11,329.15**

3.6 Building Construction - Exterior Enclosure - 2018

Unmitigated Construction On-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio-CO2	Total CO2	CH4	N2O	CO2e
Category	lb/day										lb/day					
Off-Road	0.70	4.97	3.01	0.01		0.20	0.20		0.20	0.20		1,123.38		0.06		1,124.69
Total	**0.70**	**4.97**	**3.01**	**0.01**		**0.20**	**0.20**		**0.20**	**0.20**		**1,123.38**		**0.06**		**1,124.69**

Unmitigated Construction Off-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio-CO2	Total CO2	CH4	N2O	CO2e
Category	lb/day										lb/day					
Hauling	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00		0.00		0.00
Vendor	0.32	3.47	2.19	0.01	0.30	0.10	0.40	0.01	0.09	0.10		896.92		0.02		897.25
Worker	0.36	0.30	3.41	0.01	0.96	0.03	0.99	0.01	0.03	0.04		718.68		0.03		719.41
Total	**0.68**	**3.77**	**5.60**	**0.02**	**1.26**	**0.13**	**1.39**	**0.02**	**0.12**	**0.14**		**1,615.60**		**0.05**		**1,616.66**

3.6 Building Construction - Exterior Enclosure - 2018

Mitigated Construction On-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio-CO2	Total CO2	CH4	N2O	CO2e
Category	lb/day										lb/day					
Off-Road	0.70	4.97	3.01	0.01		0.20	0.20		0.20	0.20	0.00	1,123.38		0.06		1,124.69
Total	**0.70**	**4.97**	**3.01**	**0.01**		**0.20**	**0.20**		**0.20**	**0.20**	**0.00**	**1,123.38**		**0.06**		**1,124.69**

Mitigated Construction Off-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio-CO2	Total CO2	CH4	N2O	CO2e
Category	lb/day										lb/day					
Hauling	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00		0.00		0.00
Vendor	0.32	3.47	2.19	0.01	0.30	0.10	0.40	0.01	0.09	0.10		896.92		0.02		897.25
Worker	0.36	0.30	3.41	0.01	0.96	0.03	0.99	0.01	0.03	0.04		718.68		0.03		719.41
Total	**0.68**	**3.77**	**5.60**	**0.02**	**1.26**	**0.13**	**1.39**	**0.02**	**0.12**	**0.14**		**1,615.60**		**0.05**		**1,616.66**

3.7 Building Construction - Interior Finishes - 2018

Unmitigated Construction On-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio-CO2	Total CO2	CH4	N2O	CO2e
Category	lb/day										lb/day					
Off-Road	0.29	2.02	1.63	0.00		0.10	0.10		0.10	0.10		515.71		0.03		516.26
Total	**0.29**	**2.02**	**1.63**	**0.00**		**0.10**	**0.10**		**0.10**	**0.10**		**515.71**		**0.03**		**516.26**

Unmitigated Construction Off-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio-CO2	Total CO2	CH4	N2O	CO2e
Category	lb/day										lb/day					
Hauling	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00		0.00		0.00
Vendor	0.32	3.47	2.19	0.01	0.30	0.10	0.40	0.01	0.09	0.10		896.92		0.02		897.25
Worker	0.36	0.30	3.41	0.01	0.96	0.03	0.99	0.01	0.03	0.04		718.68		0.03		719.41
Total	**0.68**	**3.77**	**5.60**	**0.02**	**1.26**	**0.13**	**1.39**	**0.02**	**0.12**	**0.14**		**1,615.60**		**0.05**		**1,616.66**

3.7 Building Construction - Interior Finishes - 2018

Mitigated Construction On-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio-CO2	Total CO2	CH4	N2O	CO2e
Category	lb/day										lb/day					
Off-Road	0.29	2.02	1.63	0.00		0.10	0.10		0.10	0.10	0.00	515.71		0.03		516.26
Total	**0.29**	**2.02**	**1.63**	**0.00**		**0.10**	**0.10**		**0.10**	**0.10**	**0.00**	**515.71**		**0.03**		**516.26**

Mitigated Construction Off-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio-CO2	Total CO2	CH4	N2O	CO2e
Category	lb/day										lb/day					
Hauling	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00		0.00		0.00
Vendor	0.32	3.47	2.19	0.01	0.30	0.10	0.40	0.01	0.09	0.10		896.92		0.02		897.25
Worker	0.36	0.30	3.41	0.01	0.96	0.03	0.99	0.01	0.03	0.04		718.68		0.03		719.41
Total	**0.68**	**3.77**	**5.60**	**0.02**	**1.26**	**0.13**	**1.39**	**0.02**	**0.12**	**0.14**		**1,615.60**		**0.05**		**1,616.66**

3.8 Paving - Site Improvements - 2018

Unmitigated Construction On-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio-CO2	Total CO2	CH4	N2O	CO2e
Category	lb/day										lb/day					
Off-Road	0.56	3.74	3.26	0.01		0.17	0.17		0.17	0.17		739.11		0.05		740.16
Paving	0.00					0.00	0.00		0.00	0.00						0.00
Total	**0.56**	**3.74**	**3.26**	**0.01**		**0.17**	**0.17**		**0.17**	**0.17**		**739.11**		**0.05**		**740.16**

Unmitigated Construction Off-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio-CO2	Total CO2	CH4	N2O	CO2e
Category	lb/day										lb/day					
Hauling	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00		0.00		0.00
Vendor	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00		0.00		0.00
Worker	0.13	0.11	1.23	0.00	0.34	0.01	0.36	0.00	0.01	0.01		258.28		0.01		258.54
Total	**0.13**	**0.11**	**1.23**	**0.00**	**0.34**	**0.01**	**0.36**	**0.00**	**0.01**	**0.01**		**258.28**		**0.01**		**258.54**

3.8 Paving - Site Improvements - 2018

Mitigated Construction On-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio-CO2	Total CO2	CH4	N2O	CO2e
Category	lb/day										lb/day					
Off-Road	0.56	3.74	3.26	0.01		0.17	0.17		0.17	0.17	0.00	739.11		0.05		740.16
Paving	0.00					0.00	0.00		0.00	0.00						0.00
Total	**0.56**	**3.74**	**3.26**	**0.01**		**0.17**	**0.17**		**0.17**	**0.17**	**0.00**	**739.11**		**0.05**		**740.16**

Mitigated Construction Off-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio-CO2	Total CO2	CH4	N2O	CO2e
Category	lb/day										lb/day					
Hauling	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00		0.00		0.00
Vendor	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00		0.00		0.00
Worker	0.13	0.11	1.23	0.00	0.34	0.01	0.36	0.00	0.01	0.01		258.28		0.01		258.54
Total	**0.13**	**0.11**	**1.23**	**0.00**	**0.34**	**0.01**	**0.36**	**0.00**	**0.01**	**0.01**		**258.28**		**0.01**		**258.54**

4.0 Mobile Detail

4.1 Mitigation Measures Mobile

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio-CO2	Total CO2	CH4	N2O	CO2e
Category	lb/day										lb/day					
Mitigated	6.81	11.97	57.07	0.13	13.45	0.53	13.98	0.19	0.49	0.68		11,047.02		0.44		11,056.16
Unmitigated	6.81	11.97	57.07	0.13	13.45	0.53	13.98	0.19	0.49	0.68		11,047.02		0.44		11,056.16
Total	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**

4.2 Trip Summary Information

	Average Daily Trip Rate			Unmitigated	Mitigated
Land Use	Weekday	Saturday	Sunday	Annual VMT	Annual VMT
Research & Development	1,622.00	380.00	222.00	3,119,204	3,119,204
Total	1,622.00	380.00	222.00	3,119,204	3,119,204

4.3 Trip Type Information

	Miles			Trip %		
Land Use	H-W or C-W	H-S or C-C	H-O or C-NW	H-W or C-W	H-S or C-C	H-O or C-NW
Research & Development	9.50	7.30	7.30	33.00	48.00	19.00

5.0 Energy Detail

5.1 Mitigation Measures Energy

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio-CO2	Total CO2	CH4	N2O	CO2e
Category	lb/day										lb/day					
NaturalGas Mitigated	0.15	1.38	1.16	0.01		0.00	0.10		0.00	0.10		1,655.44		0.03	0.03	1,665.51
NaturalGas Unmitigated	0.15	1.38	1.16	0.01		0.00	0.10		0.00	0.10		1,655.44		0.03	0.03	1,665.51
Total	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**

5.2 Energy by Land Use - NaturalGas

Unmitigated

	NaturalGas Use	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio-CO2	Total CO2	CH4	N2O	CO2e
Land Use	kBTU	lb/day										lb/day					
Research & Development	14071.2	0.15	1.38	1.16	0.01		0.00	0.10		0.00	0.10		1,655.44		0.03	0.03	1,665.51
Total		**0.15**	**1.38**	**1.16**	**0.01**		**0.00**	**0.10**		**0.00**	**0.10**		**1,655.44**		**0.03**	**0.03**	**1,665.51**

5.2 Energy by Land Use - NaturalGas

Mitigated

	NaturalGas Use	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio-CO2	Total CO2	CH4	N2O	CO2e
Land Use	kBTU	lb/day										lb/day					
Research & Development	14.0712	0.15	1.38	1.16	0.01		0.00	0.10		0.00	0.10		1,655.44		0.03	0.03	1,665.51
Total		**0.15**	**1.38**	**1.16**	**0.01**		**0.00**	**0.10**		**0.00**	**0.10**		**1,655.44**		**0.03**	**0.03**	**1,665.51**

6.0 Area Detail

6.1 Mitigation Measures Area

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio-CO2	Total CO2	CH4	N2O	CO2e
Category	lb/day										lb/day					
Mitigated	5.55	0.00	0.00	0.00		0.00	0.00		0.00	0.00		0.00		0.00		0.00
Unmitigated	5.55	0.00	0.00	0.00		0.00	0.00		0.00	0.00		0.00		0.00		0.00
Total	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**

6.2 Area by SubCategory

Unmitigated

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio-CO2	Total CO2	CH4	N2O	CO2e
SubCategory	lb/day										lb/day					
Architectural Coating	1.27					0.00	0.00		0.00	0.00						0.00
Consumer Products	4.28					0.00	0.00		0.00	0.00						0.00
Landscaping	0.00	0.00	0.00	0.00		0.00	0.00		0.00	0.00		0.00		0.00		0.00
Total	**5.55**	**0.00**	**0.00**	**0.00**		**0.00**	**0.00**		**0.00**	**0.00**		**0.00**		**0.00**		**0.00**

Mitigated

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio-CO2	Total CO2	CH4	N2O	CO2e
SubCategory	lb/day										lb/day					
Architectural Coating	1.27					0.00	0.00		0.00	0.00						0.00
Consumer Products	4.28					0.00	0.00		0.00	0.00						0.00
Landscaping	0.00	0.00	0.00	0.00		0.00	0.00		0.00	0.00		0.00		0.00		0.00
Total	**5.55**	**0.00**	**0.00**	**0.00**		**0.00**	**0.00**		**0.00**	**0.00**		**0.00**		**0.00**		**0.00**

7.0 Water Detail

7.1 Mitigation Measures Water

8.0 Waste Detail

8.1 Mitigation Measures Waste

9.0 Vegetation

LRDP - Average Demolition - 04/04/2013

Bay Area AQMD Air District, Winter

1.0 Project Characteristics

1.1 Land Usage

Land Uses	Size	Metric
Research & Development	200	1000sqft

1.2 Other Project Characteristics

Urbanization	Urban	**Wind Speed (m/s)**	2.2	**Utility Company**	Pacific Gas & Electric Company
Climate Zone	5	**Precipitation Freq (Days)**	64		

1.3 User Entered Comments

Project Characteristics -

Land Use - Average construction of 200,000 gsf for R&D and 10,000 population. - Updated: 3/27/13

Construction Phase - Dem (1/1/18 - 1/4/18); Grading (1/5/18 - 1/25/18); BC-F (1/26/18 - 2/28/18); BC-SE (3/01/18 - 4/10/18); BC-EE (4/11/18 - 6/11/18); BC-IF (6/12/18 - 8/15/18); Paving (8/16/18 - 9/05/18)
- Updated: 4/4/18

Off-road Equipment - Cranes, Forklifts, Other construction equip., and Rough terrain forklifts. - Updated: 4/4/13

Off-road Equipment - Tractors/loaders/backhoes, Forklifts, Pumps. Plate compactors, and Air compressors. - Updated: 4/4/18

Off-road Equipment - Forklifts, Other construction equip., and Rough terrain forklifts. Updated; 4/4/13

Off-road Equipment - Air Compressors, Cranes, Forklifts, Pumps, Rough terrain forklifts, Welders, and Welders. Updated: 4/4/13

Off-road Equipment - Excavators, Tractors/Loaders/Backhoes, Rubber Tired Dozers, Concrete/Industrial Saws, and Other Construction Equipment - Updated: 4/4/18

Off-road Equipment - Concrete/Industrial saws, Excavators. Forklifts, Other construction equip., Paving equip., Plate compactors, Skid steer loaders, and Trenchers. - Updated: 4/4/13

Off-road Equipment - Excavators, Tractors/loaders/backhoes, Rubber tired dozers, Trenchers, and Plate compactors. - Updated: 4/4/13

Trips and VMT - Demolition (125 hauling trips); Site Grading (1,570 hauling trips); BC-F (650 hauling trips); BC-SE (3,400 hauling trips). - Updated: 4/4/13

Demolition - Avg demolition = 20,094 gsf - Updated: 4/4/13

Grading - Grading soil export = 15,700 CYD @ 2.00 acres disturbed. - Updated: 4/4/13

Energy Use -

Water And Wastewater - - 340,000,000 gallons/yr of potable water - Updated: 4/4/13

Construction Off-road Equipment Mitigation - Watering 2 times per day @ 55% reduction. - Updated: 4/4/13

2.0 Emissions Summary

2.1 Overall Construction (Maximum Daily Emission)

Unmitigated Construction

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio-CO2	Total CO2	CH4	N2O	CO2e
Year	lb/day										lb/day					
2018	5.52	48.99	35.45	0.12	80.70	1.64	82.34	1.61	1.53	2.92	0.00	12,604.85	0.00	0.33	0.00	12,611.73
Total	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**

Mitigated Construction

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio-CO2	Total CO2	CH4	N2O	CO2e
Year	lb/day										lb/day					
2018	5.52	48.99	35.45	0.12	80.70	1.64	82.34	0.78	1.53	2.09	0.00	12,604.85	0.00	0.33	0.00	12,611.73
Total	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**

2.2 Overall Operational

Unmitigated Operational

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio-CO2	Total CO2	CH4	N2O	CO2e
Category	lb/day										lb/day					
Area	5.55	0.00	0.00	0.00		0.00	0.00		0.00	0.00		0.00		0.00		0.00
Energy	0.15	1.38	1.16	0.01		0.00	0.10		0.00	0.10		1,655.44		0.03	0.03	1,665.51
Mobile	6.99	12.50	57.57	0.11	13.45	0.53	13.98	0.19	0.50	0.68		10,079.71		0.45		10,089.08
Total	**12.69**	**13.88**	**58.73**	**0.12**	**13.45**	**0.53**	**14.08**	**0.19**	**0.50**	**0.78**		**11,735.15**		**0.48**	**0.03**	**11,754.59**

Mitigated Operational

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio-CO2	Total CO2	CH4	N2O	CO2e
Category	lb/day										lb/day					
Area	5.55	0.00	0.00	0.00		0.00	0.00		0.00	0.00		0.00		0.00		0.00
Energy	0.15	1.38	1.16	0.01		0.00	0.10		0.00	0.10		1,655.44		0.03	0.03	1,665.51
Mobile	6.99	12.50	57.57	0.11	13.45	0.53	13.98	0.19	0.50	0.68		10,079.71		0.45		10,089.08
Total	**12.69**	**13.88**	**58.73**	**0.12**	**13.45**	**0.53**	**14.08**	**0.19**	**0.50**	**0.78**		**11,735.15**		**0.48**	**0.03**	**11,754.59**

3.0 Construction Detail

3.1 Mitigation Measures Construction

Water Exposed Area

3.2 Demolition - 2018

Unmitigated Construction On-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio-CO2	Total CO2	CH4	N2O	CO2e
Category	lb/day										lb/day					
Fugitive Dust					4.94	0.00	4.94	0.00	0.00	0.00						0.00
Off-Road	1.39	9.39	8.60	0.02		0.42	0.42		0.42	0.42		2,448.30		0.12		2,450.88
Total	**1.39**	**9.39**	**8.60**	**0.02**	**4.94**	**0.42**	**5.36**	**0.00**	**0.42**	**0.42**		**2,448.30**		**0.12**		**2,450.88**

Unmitigated Construction Off-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio-CO2	Total CO2	CH4	N2O	CO2e
Category	lb/day										lb/day					
Hauling	0.99	9.99	6.45	0.02	3.00	0.30	3.30	0.03	0.28	0.31		2,574.61		0.05		2,575.62
Vendor	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00		0.00		0.00
Worker	0.08	0.07	0.64	0.00	0.19	0.01	0.20	0.00	0.01	0.01		130.54		0.01		130.68
Total	**1.07**	**10.06**	**7.09**	**0.02**	**3.19**	**0.31**	**3.50**	**0.03**	**0.29**	**0.32**		**2,705.15**		**0.06**		**2,706.30**

3.2 Demolition - 2018

Mitigated Construction On-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio-CO2	Total CO2	CH4	N2O	CO2e
Category	lb/day										lb/day					
Fugitive Dust					2.23	0.00	2.23	0.00	0.00	0.00						0.00
Off-Road	1.39	9.39	8.60	0.02		0.42	0.42		0.42	0.42	0.00	2,448.30		0.12		2,450.88
Total	**1.39**	**9.39**	**8.60**	**0.02**	**2.23**	**0.42**	**2.65**	**0.00**	**0.42**	**0.42**	**0.00**	**2,448.30**		**0.12**		**2,450.88**

Mitigated Construction Off-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio-CO2	Total CO2	CH4	N2O	CO2e
Category	lb/day										lb/day					
Hauling	0.99	9.99	6.45	0.02	3.00	0.30	3.30	0.03	0.28	0.31		2,574.61		0.05		2,575.62
Vendor	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00		0.00		0.00
Worker	0.08	0.07	0.64	0.00	0.19	0.01	0.20	0.00	0.01	0.01		130.54		0.01		130.68
Total	**1.07**	**10.06**	**7.09**	**0.02**	**3.19**	**0.31**	**3.50**	**0.03**	**0.29**	**0.32**		**2,705.15**		**0.06**		**2,706.30**

3.3 Site Grading - Excavation - 2018

Unmitigated Construction On-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio-CO2	Total CO2	CH4	N2O	CO2e
Category	lb/day										lb/day					
Fugitive Dust					2.97	0.00	2.97	1.51	0.00	1.51						0.00
Off-Road	1.06	7.52	6.86	0.01		0.37	0.37		0.37	0.37		1,351.02		0.09		1,353.01
Total	**1.06**	**7.52**	**6.86**	**0.01**	**2.97**	**0.37**	**3.34**	**1.51**	**0.37**	**1.88**		**1,351.02**		**0.09**		**1,353.01**

Unmitigated Construction Off-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio-CO2	Total CO2	CH4	N2O	CO2e
Category	lb/day										lb/day					
Hauling	3.31	33.46	21.61	0.08	36.82	1.02	37.84	0.10	0.93	1.03		8,623.22		0.16		8,626.62
Vendor	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00		0.00		0.00
Worker	0.09	0.08	0.74	0.00	0.22	0.01	0.23	0.00	0.01	0.01		150.62		0.01		150.78
Total	**3.40**	**33.54**	**22.35**	**0.08**	**37.04**	**1.03**	**38.07**	**0.10**	**0.94**	**1.04**		**8,773.84**		**0.17**		**8,777.40**

3.3 Site Grading - Excavation - 2018

Mitigated Construction On-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio-CO2	Total CO2	CH4	N2O	CO2e
Category	lb/day										lb/day					
Fugitive Dust					1.34	0.00	1.34	0.68	0.00	0.68						0.00
Off-Road	1.06	7.52	6.86	0.01		0.37	0.37		0.37	0.37	0.00	1,351.02		0.09		1,353.01
Total	**1.06**	**7.52**	**6.86**	**0.01**	**1.34**	**0.37**	**1.71**	**0.68**	**0.37**	**1.05**	**0.00**	**1,351.02**		**0.09**		**1,353.01**

Mitigated Construction Off-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio-CO2	Total CO2	CH4	N2O	CO2e
Category	lb/day										lb/day					
Hauling	3.31	33.46	21.61	0.08	36.82	1.02	37.84	0.10	0.93	1.03		8,623.22		0.16		8,626.62
Vendor	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00		0.00		0.00
Worker	0.09	0.08	0.74	0.00	0.22	0.01	0.23	0.00	0.01	0.01		150.62		0.01		150.78
Total	**3.40**	**33.54**	**22.35**	**0.08**	**37.04**	**1.03**	**38.07**	**0.10**	**0.94**	**1.04**		**8,773.84**		**0.17**		**8,777.40**

3.4 Building Construction - Foundations - 2018

Unmitigated Construction On-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio-CO2	Total CO2	CH4	N2O	CO2e
Category	lb/day										lb/day					
Off-Road	0.76	6.01	4.93	0.01		0.29	0.29		0.29	0.29		1,215.47		0.07		1,216.89
Total	**0.76**	**6.01**	**4.93**	**0.01**		**0.29**	**0.29**		**0.29**	**0.29**		**1,215.47**		**0.07**		**1,216.89**

Unmitigated Construction Off-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio-CO2	Total CO2	CH4	N2O	CO2e
Category	lb/day										lb/day					
Hauling	0.86	8.66	5.59	0.02	15.20	0.26	15.46	0.03	0.24	0.27		2,231.33		0.04		2,232.21
Vendor	0.35	3.44	2.82	0.01	0.30	0.10	0.40	0.01	0.09	0.10		889.93		0.02		890.29
Worker	0.38	0.33	3.14	0.01	0.96	0.03	0.99	0.01	0.03	0.04		642.66		0.03		643.34
Total	**1.59**	**12.43**	**11.55**	**0.04**	**16.46**	**0.39**	**16.85**	**0.05**	**0.36**	**0.41**		**3,763.92**		**0.09**		**3,765.84**

3.4 Building Construction - Foundations - 2018

Mitigated Construction On-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio-CO2	Total CO2	CH4	N2O	CO2e
Category	lb/day										lb/day					
Off-Road	0.76	6.01	4.93	0.01		0.29	0.29		0.29	0.29	0.00	1,215.47		0.07		1,216.89
Total	**0.76**	**6.01**	**4.93**	**0.01**		**0.29**	**0.29**		**0.29**	**0.29**	**0.00**	**1,215.47**		**0.07**		**1,216.89**

Mitigated Construction Off-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio-CO2	Total CO2	CH4	N2O	CO2e
Category	lb/day										lb/day					
Hauling	0.86	8.66	5.59	0.02	15.20	0.26	15.46	0.03	0.24	0.27		2,231.33		0.04		2,232.21
Vendor	0.35	3.44	2.82	0.01	0.30	0.10	0.40	0.01	0.09	0.10		889.93		0.02		890.29
Worker	0.38	0.33	3.14	0.01	0.96	0.03	0.99	0.01	0.03	0.04		642.66		0.03		643.34
Total	**1.59**	**12.43**	**11.55**	**0.04**	**16.46**	**0.39**	**16.85**	**0.05**	**0.36**	**0.41**		**3,763.92**		**0.09**		**3,765.84**

3.5 Building Construction - Steel Erection - 2018

Unmitigated Construction On-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio-CO2	Total CO2	CH4	N2O	CO2e
Category	lb/day										lb/day					
Off-Road	1.08	7.73	5.28	0.01		0.37	0.37		0.37	0.37		1,413.04		0.10		1,415.07
Total	**1.08**	**7.73**	**5.28**	**0.01**		**0.37**	**0.37**		**0.37**	**0.37**		**1,413.04**		**0.10**		**1,415.07**

Unmitigated Construction Off-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio-CO2	Total CO2	CH4	N2O	CO2e
Category	lb/day										lb/day					
Hauling	3.70	37.48	24.21	0.09	79.44	1.14	80.58	0.11	1.05	1.16		9,659.22		0.18		9,663.03
Vendor	0.35	3.44	2.82	0.01	0.30	0.10	0.40	0.01	0.09	0.10		889.93		0.02		890.29
Worker	0.38	0.33	3.14	0.01	0.96	0.03	0.99	0.01	0.03	0.04		642.66		0.03		643.34
Total	**4.43**	**41.25**	**30.17**	**0.11**	**80.70**	**1.27**	**81.97**	**0.13**	**1.17**	**1.30**		**11,191.81**		**0.23**		**11,196.66**

3.5 Building Construction - Steel Erection - 2018

Mitigated Construction On-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio-CO2	Total CO2	CH4	N2O	CO2e
Category	lb/day										lb/day					
Off-Road	1.08	7.73	5.28	0.01		0.37	0.37		0.37	0.37	0.00	1,413.04		0.10		1,415.07
Total	**1.08**	**7.73**	**5.28**	**0.01**		**0.37**	**0.37**		**0.37**	**0.37**	**0.00**	**1,413.04**		**0.10**		**1,415.07**

Mitigated Construction Off-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio-CO2	Total CO2	CH4	N2O	CO2e
Category	lb/day										lb/day					
Hauling	3.70	37.48	24.21	0.09	79.44	1.14	80.58	0.11	1.05	1.16		9,659.22		0.18		9,663.03
Vendor	0.35	3.44	2.82	0.01	0.30	0.10	0.40	0.01	0.09	0.10		889.93		0.02		890.29
Worker	0.38	0.33	3.14	0.01	0.96	0.03	0.99	0.01	0.03	0.04		642.66		0.03		643.34
Total	**4.43**	**41.25**	**30.17**	**0.11**	**80.70**	**1.27**	**81.97**	**0.13**	**1.17**	**1.30**		**11,191.81**		**0.23**		**11,196.66**

3.6 Building Construction - Exterior Enclosure - 2018

Unmitigated Construction On-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio-CO2	Total CO2	CH4	N2O	CO2e
Category	lb/day										lb/day					
Off-Road	0.70	4.97	3.01	0.01		0.20	0.20		0.20	0.20		1,123.38		0.06		1,124.69
Total	**0.70**	**4.97**	**3.01**	**0.01**		**0.20**	**0.20**		**0.20**	**0.20**		**1,123.38**		**0.06**		**1,124.69**

Unmitigated Construction Off-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio-CO2	Total CO2	CH4	N2O	CO2e
Category	lb/day										lb/day					
Hauling	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00		0.00		0.00
Vendor	0.35	3.44	2.82	0.01	0.30	0.10	0.40	0.01	0.09	0.10		889.93		0.02		890.29
Worker	0.38	0.33	3.14	0.01	0.96	0.03	0.99	0.01	0.03	0.04		642.66		0.03		643.34
Total	**0.73**	**3.77**	**5.96**	**0.02**	**1.26**	**0.13**	**1.39**	**0.02**	**0.12**	**0.14**		**1,532.59**		**0.05**		**1,533.63**

3.6 Building Construction - Exterior Enclosure - 2018

Mitigated Construction On-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio-CO2	Total CO2	CH4	N2O	CO2e
Category	lb/day										lb/day					
Off-Road	0.70	4.97	3.01	0.01		0.20	0.20		0.20	0.20	0.00	1,123.38		0.06		1,124.69
Total	**0.70**	**4.97**	**3.01**	**0.01**		**0.20**	**0.20**		**0.20**	**0.20**	**0.00**	**1,123.38**		**0.06**		**1,124.69**

Mitigated Construction Off-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio-CO2	Total CO2	CH4	N2O	CO2e
Category	lb/day										lb/day					
Hauling	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00		0.00		0.00
Vendor	0.35	3.44	2.82	0.01	0.30	0.10	0.40	0.01	0.09	0.10		889.93		0.02		890.29
Worker	0.38	0.33	3.14	0.01	0.96	0.03	0.99	0.01	0.03	0.04		642.66		0.03		643.34
Total	**0.73**	**3.77**	**5.96**	**0.02**	**1.26**	**0.13**	**1.39**	**0.02**	**0.12**	**0.14**		**1,532.59**		**0.05**		**1,533.63**

3.7 Building Construction - Interior Finishes - 2018

Unmitigated Construction On-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio-CO2	Total CO2	CH4	N2O	CO2e
Category	lb/day										lb/day					
Off-Road	0.29	2.02	1.63	0.00		0.10	0.10		0.10	0.10		515.71		0.03		516.26
Total	**0.29**	**2.02**	**1.63**	**0.00**		**0.10**	**0.10**		**0.10**	**0.10**		**515.71**		**0.03**		**516.26**

Unmitigated Construction Off-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio-CO2	Total CO2	CH4	N2O	CO2e
Category	lb/day										lb/day					
Hauling	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00		0.00		0.00
Vendor	0.35	3.44	2.82	0.01	0.30	0.10	0.40	0.01	0.09	0.10		889.93		0.02		890.29
Worker	0.38	0.33	3.14	0.01	0.96	0.03	0.99	0.01	0.03	0.04		642.66		0.03		643.34
Total	**0.73**	**3.77**	**5.96**	**0.02**	**1.26**	**0.13**	**1.39**	**0.02**	**0.12**	**0.14**		**1,532.59**		**0.05**		**1,533.63**

3.7 Building Construction - Interior Finishes - 2018

Mitigated Construction On-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio-CO2	Total CO2	CH4	N2O	CO2e
Category	lb/day										lb/day					
Off-Road	0.29	2.02	1.63	0.00		0.10	0.10		0.10	0.10	0.00	515.71		0.03		516.26
Total	**0.29**	**2.02**	**1.63**	**0.00**		**0.10**	**0.10**		**0.10**	**0.10**	**0.00**	**515.71**		**0.03**		**516.26**

Mitigated Construction Off-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio-CO2	Total CO2	CH4	N2O	CO2e
Category	lb/day										lb/day					
Hauling	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00		0.00		0.00
Vendor	0.35	3.44	2.82	0.01	0.30	0.10	0.40	0.01	0.09	0.10		889.93		0.02		890.29
Worker	0.38	0.33	3.14	0.01	0.96	0.03	0.99	0.01	0.03	0.04		642.66		0.03		643.34
Total	**0.73**	**3.77**	**5.96**	**0.02**	**1.26**	**0.13**	**1.39**	**0.02**	**0.12**	**0.14**		**1,532.59**		**0.05**		**1,533.63**

3.8 Paving - Site Improvements - 2018

Unmitigated Construction On-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio-CO2	Total CO2	CH4	N2O	CO2e
Category	lb/day										lb/day					
Off-Road	0.56	3.74	3.26	0.01		0.17	0.17		0.17	0.17		739.11		0.05		740.16
Paving	0.00					0.00	0.00		0.00	0.00						0.00
Total	**0.56**	**3.74**	**3.26**	**0.01**		**0.17**	**0.17**		**0.17**	**0.17**		**739.11**		**0.05**		**740.16**

Unmitigated Construction Off-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio-CO2	Total CO2	CH4	N2O	CO2e
Category	lb/day										lb/day					
Hauling	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00		0.00		0.00
Vendor	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00		0.00		0.00
Worker	0.14	0.12	1.13	0.00	0.34	0.01	0.36	0.00	0.01	0.01		230.96		0.01		231.20
Total	**0.14**	**0.12**	**1.13**	**0.00**	**0.34**	**0.01**	**0.36**	**0.00**	**0.01**	**0.01**		**230.96**		**0.01**		**231.20**

3.8 Paving - Site Improvements - 2018

Mitigated Construction On-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio-CO2	Total CO2	CH4	N2O	CO2e
Category	lb/day										lb/day					
Off-Road	0.56	3.74	3.26	0.01		0.17	0.17		0.17	0.17	0.00	739.11		0.05		740.16
Paving	0.00					0.00	0.00		0.00	0.00						0.00
Total	**0.56**	**3.74**	**3.26**	**0.01**		**0.17**	**0.17**		**0.17**	**0.17**	**0.00**	**739.11**		**0.05**		**740.16**

Mitigated Construction Off-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio-CO2	Total CO2	CH4	N2O	CO2e
Category	lb/day										lb/day					
Hauling	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00		0.00		0.00
Vendor	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00		0.00		0.00
Worker	0.14	0.12	1.13	0.00	0.34	0.01	0.36	0.00	0.01	0.01		230.96		0.01		231.20
Total	**0.14**	**0.12**	**1.13**	**0.00**	**0.34**	**0.01**	**0.36**	**0.00**	**0.01**	**0.01**		**230.96**		**0.01**		**231.20**

4.0 Mobile Detail

4.1 Mitigation Measures Mobile

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio-CO2	Total CO2	CH4	N2O	CO2e
Category	lb/day										lb/day					
Mitigated	6.99	12.50	57.57	0.11	13.45	0.53	13.98	0.19	0.50	0.68		10,079.71		0.45		10,089.08
Unmitigated	6.99	12.50	57.57	0.11	13.45	0.53	13.98	0.19	0.50	0.68		10,079.71		0.45		10,089.08
Total	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**

4.2 Trip Summary Information

	Average Daily Trip Rate			Unmitigated	Mitigated
Land Use	Weekday	Saturday	Sunday	Annual VMT	Annual VMT
Research & Development	1,622.00	380.00	222.00	3,119,204	3,119,204
Total	1,622.00	380.00	222.00	3,119,204	3,119,204

4.3 Trip Type Information

	Miles			Trip %		
Land Use	H-W or C-W	H-S or C-C	H-O or C-NW	H-W or C-W	H-S or C-C	H-O or C-NW
Research & Development	9.50	7.30	7.30	33.00	48.00	19.00

5.0 Energy Detail

5.1 Mitigation Measures Energy

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio-CO2	Total CO2	CH4	N2O	CO2e
Category	lb/day										lb/day					
NaturalGas Mitigated	0.15	1.38	1.16	0.01		0.00	0.10		0.00	0.10		1,655.44		0.03	0.03	1,665.51
NaturalGas Unmitigated	0.15	1.38	1.16	0.01		0.00	0.10		0.00	0.10		1,655.44		0.03	0.03	1,665.51
Total	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**

5.2 Energy by Land Use - NaturalGas

Unmitigated

	NaturalGas Use	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio-CO2	Total CO2	CH4	N2O	CO2e
Land Use	kBTU	lb/day										lb/day					
Research & Development	14071.2	0.15	1.38	1.16	0.01		0.00	0.10		0.00	0.10		1,655.44		0.03	0.03	1,665.51
Total		**0.15**	**1.38**	**1.16**	**0.01**		**0.00**	**0.10**		**0.00**	**0.10**		**1,655.44**		**0.03**	**0.03**	**1,665.51**

5.2 Energy by Land Use - NaturalGas

Mitigated

	NaturalGas Use	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio-CO2	Total CO2	CH4	N2O	CO2e
Land Use	kBTU	lb/day										lb/day					
Research & Development	14.0712	0.15	1.38	1.16	0.01		0.00	0.10		0.00	0.10		1,655.44		0.03	0.03	1,665.51
Total		**0.15**	**1.38**	**1.16**	**0.01**		**0.00**	**0.10**		**0.00**	**0.10**		**1,655.44**		**0.03**	**0.03**	**1,665.51**

6.0 Area Detail

6.1 Mitigation Measures Area

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio-CO2	Total CO2	CH4	N2O	CO2e
Category	lb/day										lb/day					
Mitigated	5.55	0.00	0.00	0.00		0.00	0.00		0.00	0.00		0.00		0.00		0.00
Unmitigated	5.55	0.00	0.00	0.00		0.00	0.00		0.00	0.00		0.00		0.00		0.00
Total	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**

6.2 Area by SubCategory

Unmitigated

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio-CO2	Total CO2	CH4	N2O	CO2e
SubCategory	lb/day										lb/day					
Architectural Coating	1.27					0.00	0.00		0.00	0.00						0.00
Consumer Products	4.28					0.00	0.00		0.00	0.00						0.00
Landscaping	0.00	0.00	0.00	0.00		0.00	0.00		0.00	0.00		0.00		0.00		0.00
Total	**5.55**	**0.00**	**0.00**	**0.00**		**0.00**	**0.00**		**0.00**	**0.00**		**0.00**		**0.00**		**0.00**

Mitigated

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio-CO2	Total CO2	CH4	N2O	CO2e
SubCategory	lb/day										lb/day					
Architectural Coating	1.27					0.00	0.00		0.00	0.00						0.00
Consumer Products	4.28					0.00	0.00		0.00	0.00						0.00
Landscaping	0.00	0.00	0.00	0.00		0.00	0.00		0.00	0.00		0.00		0.00		0.00
Total	**5.55**	**0.00**	**0.00**	**0.00**		**0.00**	**0.00**		**0.00**	**0.00**		**0.00**		**0.00**		**0.00**

7.0 Water Detail

7.1 Mitigation Measures Water

8.0 Waste Detail

8.1 Mitigation Measures Waste

9.0 Vegetation

Appendix E

Emissions Estimates – Phase 1 Operations

Table E-1
Phase 1 Operations Input Assumptions for Emission Rate Calculations

Source	Source Parameter	Unit Size (units)	Short Term Input (units)	Annual Input (units)
Employee and Facility Data				
	Number of Employees	--	1,300 (1)	--
	Average Occupancy (for vehicle trip calculation)	--	16 (hrs/day)	260 (days/yr) (2)
Diesel Emergency Generators				
	Emergency Generator Usage	--	2 (hrs/day) (3)	25.15 (hrs/yr) (3)
	Building 9 Emergency Generator	440 (BHP) (4)	22.3 (gal/hr) (a)	--
	Building 8 Emergency Generator	440 (BHP) (4)	22.3 (gal/hr) (a)	--
	Building 6 Emergency Generator	440 (BHP) (4)	22.3 (gal/hr) (a)	--
	Building 7 Emergency Generator	440 (BHP) (4)	22.3 (gal/hr) (a)	--
Natural Gas Boilers				
	Building 9 Natural Gas Boiler	12 (MMBtu/hr) (4)	24 (hrs/day)	21,000 (MMBtu/yr) (4)
	Building 8 Natural Gas Boiler	12 (MMBtu/hr) (4)	24 (hrs/day)	21,000 (MMBtu/yr) (4)
	Building 6 & 7 Natural Gas Boiler	24 (MMBtu/hr) (4)	24 (hrs/day)	42,000 (MMBtu/yr) (4)
Cooling Towers				
	Cooling Tower Usage		24 (hrs/day)	6,360 (hrs/yr) (7)
	Cooling Tower Design	**Number of Cells**	**Cell Size**	**Total Recirculation Rate**
	Building 9 Cooling Tower	3 (cells) (4)	500 (tons/cell) (4)	4,500 (gpm) (b)
	Building 8 Cooling Tower	3 (cells) (4)	500 (tons/cell) (4)	4,500 (gpm) (b)
	Building 6 & 7 Cooling Tower	6 (cells) (4)	500 (tons/cell) (4)	9,000 (gpm) (b)
Laboratory Chemicals				
	Lab Hood Exhaust Stack - Building 9	--	10 (hrs/day) (8)	260 (days/yr) (2)
	Lab Hood Exhaust Stack - Building 8	--	10 (hrs/day) (8)	260 (days/yr) (2)
	Lab Hood Exhaust Stack - Buildings 6 & 7	--	10 (hrs/day) (8)	260 (days/yr) (2)
Vehicle Data				
	Vehicle Trips		**Maximum Daily (trips/day)**	**Average Annual (trips/yr)**
	Employee Trips		2,031 (9)	528,060 (10)
	Delivery Truck Trips		10 (11)	2,600 (11)
	LBNL - RBC Shuttle Trips		13 (12)	3,380 (12)
	BART - RBC Shuttle Trips		25 (12)	6,500 (12)
	Total trips		2,079	540,540
	Vehicle Idling Times and Round Trip Distances	**Onsite Idling Time (min/trip)**	**Onsite Round Trip Distance (mi/trip)**	**Offsite Round Trip Distance (mi/trip)**
	Employee Vehicles	0 (13)	0.697 (14)	20.6 (c)
	Delivery Trucks	0.08 (18)	0.697 (14)	13.9 (19)
	LBNL - RBC Shuttle	0.08 (20)	0.695 (14)	15.5 (21)
	BART - RBC Shuttle	0.08 (20)	0.695 (14)	8 (21)
	Employee Offsite Round Trip Distance - Modeling (mi/trip)			0.706 (14)
	Delivery Truck Offsite Round Trip Distance - Modeling (mi/trip)			0.706 (14)
	LBNL - RBC Shuttle Round Trip Distance - Modeling (mi/trip)			0.706 (14)
	BART - RBC Shuttle Round Trip Distance (mi/trip)			0.706 (14)
	Average Vehicle Weights			**Average Weight (tons)**
	Employee Vehicles			2.4 (22)
	Delivery Trucks			13 (23)
	LBNL - RBC Shuttle			4.2 (24)
	BART - RBC Shuttle			4.2 (24)
	Mean Vehicle Weight Calculation		**Daily Basis (tons)**	**Annual Basis (tons)**
	Employee Mean Vehicle Weight portion (ton)		2.34 (d)	2.34 (d)
	Delivery Truck Mean Vehicle Weight Portion (ton)		0.06 (d)	0.063 (d)
	LBNL - RBC Shuttle Mean Vehicle Weight Portion (ton)		0.026 (d)	0.026 (d)
	BART - RBC Shuttle Mean Vehicle Weight Portion (ton)		0.051 (d)	0.051 (d)
	Mean Vehicle Weight - sum of weight portions (ton)		2.48	2.48
Additional Site-Specific Data and Constants Used for Emission Calculations				
	Cooling Towers - Equivalent Ton Water Usage (gpm/ton)		3 (e)	
	Cooling Towers - Total Dissolved Solids Concentration (ppm)		536 (25)	
	Roads - P = No. of Days with Precip. > 0.01 in. (days/yr)		62 (26)	

Notes:

(a) Engine fuel consumption (gal/hr) = (Engine size [hp]) x (average brake-specific fuel consumption [Btu/hp-hr]) / (liquid fuel higher heating value [Btu/gal])

Average brake-specific fuel consumption (Btu/hp-hr) =	7,000	(5)
Liquid fuel higher heating value (Btu/gal) =	138,000	(6)

(b) Recirculation rate (gpm) = (Number of cooling tower cells) x (heat removal equivalent tons per cell [tons/cell]) x (equivalent ton water usage [gpm/ton])

(c) Offsite round trip distance (mi/trip) = {(Primary trip length [mi]) x (primary trip percentage [%]) + (primary trip length [mi]) x (diverted trip percentage [%]) x (diverted trip percentage of primary trip length [%]) + (pass-by trip percentage [%]) x (pass-by trip length [mi])} x 2 - (onsite round trip distance [mi/trip])

Primary trip length (mi) =	12.4	(15)
Primary trip percentage (%) =	82	(16)
Diverted trip percentage of primary trip length (%) =	25	(17)
Diverted trip percentage (%) =	15	(16)
Pass-by trip length (mi) =	0.1	(17)
Pass-by trip percentage (%) =	3	(16)

(d) Mean vehicle weight portions (tons) = (Individual vehicle trips [trips/day or trips/yr]) / (total vehicle trips [trips/day or trips/yr]) x (individual vehicle average weight [tons])

(e) Equivalent ton water usage (gpm/ton) = (15,000 Btu/hr/ton) x (hr/60 min) x (gal/8.337 lbs) / (1 Btu/lb-°F) / (10 °F temperature differential)

References:

(1) January 17, 2013 LBNL response - population increase by approx. 1,000 over the current 300. Assume 1,300 trips per day.
(2) Assumes employees will generally be visiting the site 5 days per week, 52 weeks per year. This provides a conservative value to calculate the annual employee vehicle trips.
(3) Hourly value conservatively assumes a maximum of 2 hours per day of operation for maintenance and testing. Annual value is based on the average historical emergency engine usage from the LBNL LRDP.
(4) January 17, 2013 LBNL responses.
(5) AP-42 Chapter 3.3 (October 1996), Footnote to Table 3.3-1, "Emission Factors for Uncontrolled Gasoline and Diesel Industrial Engines".
(6) ULSD higher heating value.
(7) January 31, 2013 I.R. responses. Assumes cooling tower fans are off 2,400 hours per year, and only operate at full speed 260 hours per year.
(8) Assumes laboratory work is conducted over 10 hours per day. This conservatively estimates hourly emissions .
(9) Updated traffic information provided by LBNL (RBC LRDP TIA 20130301.pdf)
(10) Assumes daily worker trips will occur 5 days per week, 52 weeks per year.
(11) January 31, 2013 I.R. responses. Assumes that the 10 weekly trips will occur over 5 days per week, 52 weeks per year.
(12) Shuttle schedule provided by LBNL. Assumes shuttle trips occur 5 days per week, 52 weeks per year.
(13) It is assumed that employee vehicles will have negligible idling time.
(14) Onsite and offsite modeling trip distances approximated using the AERMOD modeling software.
(15) CalEEMod Appendix D Table 4.2 "Mobile Trip Characteristics Dependent on Location", Bay Area AQMD. Light duty employee vehicle route is based on the urban home to work (H-W) trip length. Trip lengths in CalEEMod are one way.
(16) CalEEMod Appendix D Table 4.3 "Mobile Trip Rates, Trip Purpose, Trip Type by Land Use", Commercial Land Use Type, Research and Development Land Use Sub Type.
(17) CalEEMod Appendix A Section 5.1, Vehicle Trips. "For pass-by trip links the trip length will be 0.1 miles and diverted trip links the trip length will be 25% of the primary trip length".
(18) Assumes 5 minutes of idle time consistent with California Code of Regulations Section 2485, Airborne Toxic Control Measure to Limit Diesel-Fueled Commercial Motor Vehicle Idling.
(19) CalEEMod Appendix D Table 4.2 "Mobile Trip Characteristics Dependent on Location", Bay Area AQMD. Delivery truck route is based on the urban commercial-NW route. Trip lengths in CalEEMod are one way.
(20) Conservative estimate of idling time for each shuttle drop-off event.
(21) Shuttle bus routes and schedules provided by LBNL.
(22) CalEEMod Appendix D Table 4.1 "Road Characteristics". Average vehicle weight for Bay Area AQMD.
(23) Based on the EMFAC vehicle class used for estimating emissions: T6 instate small, which has the higher VMT of all comparable categories, and is representative of delivery trucks. Max GVWR = 26,000 lbs. Also assumes that LBNL would not be the final destination for deliveries, so only a nominal difference between loaded and unloaded weights is used.
(24) Ford E150 XLT - 5,700 lb curb weight, plus 15 passengers at ~180 lbs/person.
(25) From CRT project emissions calculations, provided by Impact Sciences.
(26) Comparative Climatic Data, National Climatic Data Center, NOAA, 2011. 84 year average for San Francisco AP, CA.

Table E-2
Summary of Offsite On-Road Exhaust Criteria Pollutant Emission Estimates

Pollutant	Vehicle Type	EMFAC Vehicle Class	Maximum Daily Round-Trips [1] (trips/day)	Total Annual Round-Trips [1] (trips/yr)	Round-Trip Distance [1] (miles)	Emission Factors [2] (lbs/VMT)	Maximum Daily Emissions Estimate [a] (lbs/day)	Annual Average Emissions Estimate [b] (tons/yr)
ROG	Delivery Trucks	T6 Instate Small	10.0	2,600	14	3.9E-04	5.4E-02	7.1E-03
	LBNL - RBC Shuttle	MDV	13	3,380	16	3.7E-04	7.5E-02	9.8E-03
	BART - RBC Shuttle	MDV	25	6,500	8.0	3.7E-04	7.5E-02	9.7E-03
	Employees	LDA	2,031	528,060	21	1.5E-04	6.1	0.79
	Total ROG Emissions						**6.3**	**0.82**
NO_X	Delivery Trucks	T6 Instate Small	10	2,600	14	5.1E-03	0.71	9.2E-02
	LBNL - RBC Shuttle	MDV	13	3,380	16	6.6E-04	0.13	1.7E-02
	BART - RBC Shuttle	MDV	25	6,500	8.0	6.6E-04	0.13	1.7E-02
	Employees	LDA	2,031	528,060	21	1.9E-04	8.1	1.1
	Total NO_X Emissions						**9.1**	**1.2**
CO	Delivery Trucks	T6 Instate Small	10.0	2,600	14	1.3E-03	0.19	2.4E-02
	LBNL - RBC Shuttle	MDV	13	3,380	16	4.6E-03	0.92	0.12
	BART - RBC Shuttle	MDV	25	6,500	8.0	4.6E-03	0.92	0.12
	Employees	LDA	2,031	528,060	21	1.9E-03	80	10
	Total CO Emissions						**82**	**11**
SO_2	Delivery Trucks	T6 Instate Small	10.0	2,600	14	2.5E-05	3.4E-03	4.5E-04
	LBNL - RBC Shuttle	MDV	13	3,380	16	1.3E-05	2.6E-03	3.4E-04
	BART - RBC Shuttle	MDV	25	6,500	8.0	1.3E-05	2.6E-03	3.4E-04
	Employees	LDA	2,031	528,060	21	7.5E-06	0.31	4.1E-02
	Total SO_2 Emissions						**0.32**	**4.2E-02**
PM_{10} Exhaust	Delivery Trucks	T6 Instate Small	10.0	2,600	14	1.9E-04	2.7E-02	3.5E-03
	LBNL - RBC Shuttle	MDV	13	3,380	16	4.7E-06	9.4E-04	1.2E-04
	BART - RBC Shuttle	MDV	25	6,500	8.0	4.7E-06	9.3E-04	1.2E-04
	Employees	LDA	2,031	528,060	21	3.8E-06	0.16	2.1E-02
	Total PM_{10} Emissions						**0.19**	**2.4E-02**
PM_{10} Tire/Brake	Delivery Trucks	T6 Instate Small	10.0	2,600	14	3.1E-04	4.4E-02	5.7E-03
	LBNL - RBC Shuttle	MDV	13	3,380	16	9.9E-05	2.0E-02	2.6E-03
	BART - RBC Shuttle	MDV	25	6,500	8.0	9.9E-05	2.0E-02	2.6E-03
	Employees	LDA	2,031	528,060	21	9.9E-05	4.1	0.54
	Total PM_{10} Emissions						**4.2**	**0.55**
$PM_{2.5}$ Exhaust	Delivery Trucks	T6 Instate Small	10.0	2,600	14	1.8E-04	2.5E-02	3.2E-03
	LBNL - RBC Shuttle	MDV	13	3,380	16	4.3E-06	8.7E-04	1.1E-04
	BART - RBC Shuttle	MDV	25	6,500	8.0	4.3E-06	8.6E-04	1.1E-04
	Employees	LDA	2,031	528,060	21	3.5E-06	0.15	1.9E-02
	Total $PM_{2.5}$ Emissions						**0.17**	**2.3E-02**
$PM_{2.5}$ Tire/Brake	Delivery Trucks	T6 Instate Small	10.0	2,600	14	1.3E-04	1.8E-02	2.3E-03
	LBNL - RBC Shuttle	MDV	13	3,380	16	3.9E-05	7.9E-03	1.0E-03
	BART - RBC Shuttle	MDV	25	6,500	8.0	3.9E-05	7.8E-03	1.0E-03
	Employees	LDA	2,031	528,060	21	3.9E-05	1.6	0.21
	Total $PM_{2.5}$ Emissions						**1.7**	**0.22**
CO_2	Delivery Trucks	T6 Instate Small	10.0	2,600	14	2.4	337	44
	LBNL - RBC Shuttle	MDV	13	3,380	16	1.1	221	29
	BART - RBC Shuttle	MDV	25	6,500	8.0	1.1	219	28
	Employees	LDA	2,031	528,060	21	0.56	23,569	3,064
	Total CO_2 Emissions						**24,345**	**3,165**

Notes:
(a) Maximum daily emissions estimate (lbs/day) = (Maximum daily round-trips [trips/day]) x (round-trip distance [miles]) x (emission factor [lbs/VMT])
(b) Annual average emissions estimate (tons/yr) = (Annual round-trips [trips/yr]) x (round-trip distance [miles]) x (emission factor [lbs/VMT]) x (ton/2,000 lbs)

References:
(1) See Table E-1, Phase 1 Operations Input Assumptions for Emission Rate Calculations.
(2) Emission Factors source: Emfac 2011 (Model Years to 2018), typical speed distribution. Carbon dioxide emission factors are representative of post-Low Carbon Fuel Standard implementation.

Table E-3
Summary of Onsite On-Road Exhaust Criteria Pollutant Emission Estimates

Pollutant	Vehicle Type	EMFAC Vehicle Class	Maximum Daily Round-Trips [1] (trips/day)	Total Annual Round-Trips [1] (trips/yr)	Round-Trip Distance [1] (miles)	Emission Factor [2] (lbs/VMT)	Maximum Daily Emissions Estimate [a] (lbs/day)	Annual Average Emissions Estimate [b] (tons/yr)
ROG	Delivery Trucks	T6 Instate Small	10.0	2,600	0.70	2.1E-03	1.5E-02	1.9E-03
	LBNL - RBC Shuttle	MDV	13	3,380	0.70	4.7E-04	4.2E-03	5.5E-04
	BART - RBC Shuttle	MDV	25	6,500	0.70	4.7E-04	8.1E-03	1.1E-03
	Employees	LDA	2,031	528,060	0.70	1.6E-04	0.23	2.9E-02
	Total ROG Emissions						**0.25**	**3.3E-02**
NO_X	Delivery Trucks	T6 Instate Small	10.0	2,600	0.70	1.1E-02	7.8E-02	1.0E-02
	LBNL - RBC Shuttle	MDV	13	3,380	0.70	1.0E-03	9.3E-03	1.2E-03
	BART - RBC Shuttle	MDV	25	6,500	0.70	1.0E-03	1.8E-02	2.3E-03
	Employees	LDA	2,031	528,060	0.70	2.9E-04	0.41	5.4E-02
	Total NO_X Emissions						**0.52**	**6.8E-02**
CO	Delivery Trucks	T6 Instate Small	10.0	2,600	0.70	3.9E-03	2.7E-02	3.6E-03
	LBNL - RBC Shuttle	MDV	13	3,380	0.70	8.0E-03	7.2E-02	9.4E-03
	BART - RBC Shuttle	MDV	25	6,500	0.70	8.0E-03	0.14	1.8E-02
	Employees	LDA	2,031	528,060	0.70	3.3E-03	4.7	0.61
	Total CO Emissions						**4.9**	**0.64**
SO_2	Delivery Trucks	T6 Instate Small	10.0	2,600	0.70	0	0	0
	LBNL - RBC Shuttle	MDV	13	3,380	0.70	0	0	0
	BART - RBC Shuttle	MDV	25	6,500	0.70	0	0	0
	Employees	LDA	2,031	528,060	0.70	0	0	0
	Total SO_2 Emissions						**0**	**0**
PM_{10} Exhaust	Delivery Trucks	T6 Instate Small	10.0	2,600	0.70	2.8E-04	2.0E-03	2.5E-04
	LBNL - RBC Shuttle	MDV	13	3,380	0.70	1.9E-05	1.7E-04	2.2E-05
	BART - RBC Shuttle	MDV	25	6,500	0.70	1.9E-05	3.3E-04	4.2E-05
	Employees	LDA	2,031	528,060	0.70	1.6E-05	2.2E-02	2.9E-03
	Total PM_{10} Emissions						**2.5E-02**	**3.2E-03**
PM_{10} Tire/Brake	Delivery Trucks	T6 Instate Small	10.0	2,600	0.70	0	0	0
	LBNL - RBC Shuttle	MDV	13	3,380	0.70	0	0	0
	BART - RBC Shuttle	MDV	25	6,500	0.70	0	0	0
	Employees	LDA	2,031	528,060	0.70	0	0	0
	Total PM_{10} Emissions						**0**	**0**
$PM_{2.5}$ Exhaust	Delivery Trucks	T6 Instate Small	10.0	2,600	0.70	2.6E-04	1.8E-03	2.3E-04
	LBNL - RBC Shuttle	MDV	13	3,380	0.70	1.7E-05	1.6E-04	2.0E-05
	BART - RBC Shuttle	MDV	25	6,500	0.70	1.7E-05	3.0E-04	3.9E-05
	Employees	LDA	2,031	528,060	0.70	1.4E-05	2.0E-02	2.7E-03
	Total $PM_{2.5}$ Emissions						**2.3E-02**	**3.0E-03**
$PM_{2.5}$ Tire/Brake	Delivery Trucks	T6 Instate Small	10.0	2,600	0.70	0	0	0
	LBNL - RBC Shuttle	MDV	13	3,380	0.70	0	0	0
	BART - RBC Shuttle	MDV	25	6,500	0.70	0	0	0
	Employees	LDA	2,031	528,060	0.70	0	0	0
	Total $PM_{2.5}$ Emissions						**0**	**0**
CO_2	Delivery Trucks	T6 Instate Small	10.0	2,600	0.70	4.4	31	4.0
	LBNL - RBC Shuttle	MDV	13	3,380	0.70	2.6	24	3.1
	BART - RBC Shuttle	MDV	25	6,500	0.70	2.6	45	5.9
	Employees	LDA	2,031	528,060	0.70	1.3	1,888	245
	Total CO_2 Emissions						**1,988**	**258**

Notes:
(a) Maximum daily emissions estimate (lbs/day) = (Maximum daily round-trips [trips/day]) x (round-trip distance [miles]) x (emission factor [lbs/VMT])
(b) Annual average emissions estimate (tons/yr) = (Annual round-trips [trips/yr]) x (round-trip distance [miles]) x (emission factor [lbs/VMT]) x (ton/2,000 lbs)

References:
(1) See Table E-1, Phase 1 Operations Input Assumptions for Emission Rate Calculations.
(2) Emission Factors source: EMFAC 2011 (Model Years to 2018), 30 mph speed. Carbon dioxide emission factors are representative of post-Low Carbon Fuel Standard implementation.

Table E-4
Summary of Onsite Idling Exhaust Criteria Pollutant Emission Estimates

Pollutant	Vehicle Type	EMFAC Vehicle Class	Maximum Daily Round-Trips [1] (trips/day)	Total Annual Round-Trips [1] (trips/yr)	Idle Time per Trip [1] (hrs/trip)	Idle Emission Factor [2] (lbs/idle-hour)	Maximum Daily Emissions Estimate [a] (lbs/day)	Annual Average Emissions Estimate [b] (tons/yr)
ROG	Delivery Trucks	T6 Instate Small	10.0	2,600	8.3E-02	4.3E-03	3.6E-03	4.6E-04
	LBNL - RBC Shuttle	MDV	13	3,380	8.3E-02	3.6E-03	3.9E-03	5.1E-04
	BART - RBC Shuttle	MDV	25	6,500	8.3E-02	3.6E-03	7.5E-03	9.7E-04
	Employees	LDA	2,031	528,060	0	1.2E-03	0	0
	Total ROG Emissions						**1.5E-02**	**1.9E-03**
NO_X	Delivery Trucks	T6 Instate Small	10.0	2,600	8.3E-02	0.15	0.12	1.6E-02
	LBNL - RBC Shuttle	MDV	13	3,380	8.3E-02	6.0E-03	6.5E-03	8.4E-04
	BART - RBC Shuttle	MDV	25	6,500	8.3E-02	6.0E-03	1.2E-02	1.6E-03
	Employees	LDA	2,031	528,060	0	1.7E-03	0	0
	Total NO_X Emissions						**0.14**	**1.8E-02**
CO	Delivery Trucks	T6 Instate Small	10.0	2,600	8.3E-02	4.9E-02	4.1E-02	5.3E-03
	LBNL - RBC Shuttle	MDV	13	3,380	8.3E-02	4.7E-02	5.1E-02	6.6E-03
	BART - RBC Shuttle	MDV	25	6,500	8.3E-02	4.7E-02	9.8E-02	1.3E-02
	Employees	LDA	2,031	528,060	0	1.9E-02	0	0
	Total CO Emissions						**0.19**	**2.5E-02**
SO_2	Delivery Trucks	T6 Instate Small	10.0	2,600	8.3E-02	1.6E-04	1.3E-04	1.7E-05
	LBNL - RBC Shuttle	MDV	13	3,380	8.3E-02	0	0	0
	BART - RBC Shuttle	MDV	25	6,500	8.3E-02	0	0	0
	Employees	LDA	2,031	528,060	0	0	0	0
	Total SO_2 Emissions						**1.3E-04**	**1.7E-05**
PM_{10} Exhaust	Delivery Trucks	T6 Instate Small	10.0	2,600	8.3E-02	4.8E-04	4.0E-04	5.2E-05
	LBNL - RBC Shuttle	MDV	13	3,380	8.3E-02	1.5E-04	1.6E-04	2.1E-05
	BART - RBC Shuttle	MDV	25	6,500	8.3E-02	1.5E-04	3.1E-04	4.1E-05
	Employees	LDA	2,031	528,060	0	1.2E-04	0	0
	Total PM_{10} Emissions						**8.7E-04**	**1.1E-04**
$PM_{2.5}$ Exhaust	Delivery Trucks	T6 Instate Small	10.0	2,600	8.3E-02	4.4E-04	3.6E-04	4.7E-05
	LBNL - RBC Shuttle	MDV	13	3,380	8.3E-02	1.4E-04	1.5E-04	2.0E-05
	BART - RBC Shuttle	MDV	25	6,500	8.3E-02	1.4E-04	2.9E-04	3.8E-05
	Employees	LDA	2,031	528,060	0	1.1E-04	0	0
	Total $PM_{2.5}$ Emissions						**8.0E-04**	**1.0E-04**
CO_2	Delivery Trucks	T6 Instate Small	10.0	2,600	8.3E-02	16	13	1.7
	LBNL - RBC Shuttle	MDV	13	3,380	8.3E-02	18	19	2.5
	BART - RBC Shuttle	MDV	25	6,500	8.3E-02	18	37	4.8
	Employees	LDA	2,031	528,060	0	9.1	0	0
	Total CO_2 Emissions						**69**	**9.0**

Notes:
(a) Maximum daily emissions estimate (lbs/day) = (Maximum daily round-trips [trips/day]) x (idle time per trip [hrs/trip]) x (emission factor [lbs/idle-hr])
(b) Annual average emissions estimate (tons/yr) = (Annual round-trips [trips/yr]) x (idle time per trip [hrs/trip]) x (emission factor [lbs/idle-hr]) x (ton/2,000 lbs)

References:
(1) See Table E-1, Phase 1 Operations Input Assumptions for Emission Rate Calculations.
(2) Emission Factors source: EMFAC 2011 (Model Years to 2018). Emissions for Light Duty Vehicle Idling assumed to be negligible, and thus not quantified. Carbon dioxide emission factors are representative of post-Low Carbon Fuel Standard implementation.

Table E-5

Onsite Parking Lot Emission Estimates

Source		Parking Lot (total)
EMFAC Vehicle Class	(1)	LDA
Number of Vehicle Trips per Day	(2)	2,031
Number of Vehicle Trips per Year	(2)	528,060
Modeling ID		LOT_EX

Pollutant	Emission Factor (3) (lbs/trip)	Maximum Daily Emissions Estimate (a) (lbs/day)	Annual Average Emissions Estimate (b) (tons/yr)
PM_{10}	6.97E-06	0.014	1.8E-03
$PM_{2.5}$	6.45E-06	0.013	1.7E-03
NO_X	2.62E-04	0.53	0.069
CO	4.37E-03	8.88	1.15
SO_2	1.70E-06	3.5E-03	4.5E-04
ROG	7.14E-04	1.45	0.19
CO_2	0.16	330	42.9

Notes:

(a) Daily emissions estimate (lbs/day) = (Emission factor [lbs/trip]) x (number of vehicle trips per day)

(b) Annual emissions estimate (lbs/day) = (Emission factor [lbs/trip]) x (number of vehicle trips per year) x (ton/2,000 lbs)

References:

(1) LDA represents light-duty employee vehicles.

(2) See Table E-1, Phase 1 Operations Input Assumptions for Emission Rate Calculations.

(3) EMFAC 2011. Emission factors are based on the stationary starting exhaust, diurnal, hot soak, and resting loss vehicle portions of the LDA class emissions, on a per trip basis.

Table E-6
Onsite Paved Road Dust Emission Estimates

Parameter		Employee Vehicles	Delivery Trucks	LBNL - RBC Shuttle	BART - RBC Shuttle	Total
Onsite Roundtrip Distance (mi/trip)	(1)	0.7	0.7	0.7	0.7	
Maximum Daily Trips (trips/day)	(1)	2,031	10	13	25	
Annual Trips (trips/yr)	(1)	528,060	2,600	3,380	6,500	

Pollutant	Daily Emission Factor [a] (lbs/VMT)	Annual Emission Factor [b] (lbs/VMT)	Maximum Daily Emissions Estimate [c] (lbs/day)	Annual Average Emissions Estimate [d] (tons/yr)	Maximum Daily Emissions Estimate [c] (lbs/day)	Annual Average Emissions Estimate [d] (tons/yr)	Maximum Daily Emissions Estimate [c] (lbs/day)	Annual Average Emissions Estimate [d] (tons/yr)	Maximum Daily Emissions Estimate [c] (lbs/day)	Annual Average Emissions Estimate [d] (tons/yr)	Maximum Daily Emissions Estimate (lbs/day)	Annual Average Emissions Estimate (tons/yr)
PM	9.9E-03	9.4E-03	14.0	1.74	0.069	8.6E-03	0.089	0.011	0.17	0.021	14.3	1.78
PM_{10}	2.0E-03	1.9E-03	2.79	0.35	0.014	1.7E-03	0.018	2.2E-03	0.034	4.3E-03	2.86	0.36
$PM_{2.5}$	4.8E-04	4.6E-04	0.69	0.085	3.4E-03	4.2E-04	4.4E-03	5.4E-04	8.4E-03	1.0E-03	0.70	0.087

Notes:

(a) Maximum daily emission factor (lbs/VMT) = $(k \times (sL)^{0.91} \times (W)^{1.02})$

k = aerodynamic particle size multiplier (PM) = 0.011 (2)
k = aerodynamic particle size multiplier (PM_{10}) = 0.0022 (2)
k = aerodynamic particle size multiplier ($PM_{2.5}$) = 0.00054 (2)
sL = surface material silt content (g/m^2) = 0.32 (3)
W = mean vehicle weight (tons) = 2.5 (4)

(b) Annual emission factor (lbs/VMT) = $(k \times (sL)^{0.91} \times (W)^{1.02}) \times ((1-P)/4N)$

k = aerodynamic particle size multiplier (PM) = 0.011 (2)
k = aerodynamic particle size multiplier (PM_{10}) = 0.0022 (2)
k = aerodynamic particle size multiplier ($PM_{2.5}$) = 0.00054 (2)
sL = surface material silt content (g/m^2) = 0.32 (3)
W = mean vehicle weight (tons) = 2.5 (4)
P = number of wet days (0.01 inches of precip.) = 62 (1)
N = number of days in averaging period = 365

(c) Maximum daily emissions estimate (lbs/day) = (Emission factor [lbs/VMT]) x (maximum daily vehicle trips [trips/day]) x (onsite roundtrip distance [mi/trip]) x (1 - [control efficiency {%}] / 100)

Control efficiency (%) = 0% (5)

(d) Annual emissions estimate (tons/yr) = (Emission factor [lbs/VMT]) x (annual vehicle trips [trips/yr]) x (onsite roundtrip distance [mi/trip]) x (ton/2,000 lbs) x (1 - [control efficiency {%}] / 100)

Control efficiency (%) = 0% (5)

References:

(1) See Table E-1, Phase 1 Operations Input Assumptions for Emission Rate Calculations.
(2) AP-42 Chapter 13.2.1 (January, 2011), Table 13.2.1-1 "Particle Size Multipliers for Paved Road Equation".
(3) Section 7.9 of the CARB Emission Inventory Methodology. Assumes offsite roads are equivalent to local roads as shown in Table 3 (silt loading of 0.32 g/m^2).
(4) Mean vehicle weight is calculated as the weighted average of the individual vehicle weights (average of unloaded and loaded weight), weighted based on the individual annual truck trips divided by total annual truck trips.
(5) Engineering estimate.

Table E-7
Offsite Paved Road Dust Emission Estimates

Parameter		Employee Vehicles	Delivery Trucks	LBNL - RBC Shuttle	BART - RBC Shuttle	Total
Offsite Roundtrip Distance (mi/trip)	(1)	21	14	16	8	
Maximum Daily Trips (trips/day)	(1)	2,031	10	13	25	
Annual Trips (trips/yr)	(1)	528,060	2,600	3,380	6,500	

Pollutant	Daily Emission Factor (a) (lbs/VMT)	Annual Emission Factor (b) (lbs/VMT)	Maximum Daily Emissions Estimate (c) (lbs/day)	Annual Average Emissions Estimate (d) (tons/yr)	Maximum Daily Emissions Estimate (c) (lbs/day)	Annual Average Emissions Estimate (d) (tons/yr)	Maximum Daily Emissions Estimate (c) (lbs/day)	Annual Average Emissions Estimate (d) (tons/yr)	Maximum Daily Emissions Estimate (c) (lbs/day)	Annual Average Emissions Estimate (d) (tons/yr)	Maximum Daily Emissions Estimate (lbs/day)	Annual Average Emissions Estimate (tons/yr)
PM	1.3E-03	1.2E-03	53.1	6.61	0.18	0.022	0.26	0.032	0.25	0.032	53.8	6.70
PM_{10}	2.5E-04	2.4E-04	10.6	1.32	0.035	4.4E-03	0.051	6.4E-03	0.051	6.3E-03	10.8	1.34
$PM_{2.5}$	6.2E-05	6.0E-05	2.61	0.32	8.7E-03	1.1E-03	0.013	1.6E-03	0.012	1.6E-03	2.64	0.33

Notes:

(a) Maximum daily emission factor (lbs/VMT) = $(k \times (sL)^{0.91} \times (W)^{1.02})$

k = aerodynamic particle size multiplier (PM) =	0.011	(2)
k = aerodynamic particle size multiplier (PM_{10}) =	0.0022	(2)
k = aerodynamic particle size multiplier ($PM_{2.5}$) =	0.00054	(2)
sL = surface material silt content (g/m^2) =	0.035	(3)
W = mean vehicle weight (tons) =	2.4	(3)

(b) Annual emission factor (lbs/VMT) = $(k \times (sL)^{0.91} \times (W)^{1.02}) \times ((1-P)/4N)$

k = aerodynamic particle size multiplier (PM) =	0.011	(2)
k = aerodynamic particle size multiplier (PM_{10}) =	0.0022	(2)
k = aerodynamic particle size multiplier ($PM_{2.5}$) =	0.00054	(2)
sL = surface material silt content (g/m^2) =	0.035	(3)
W = mean vehicle weight (tons) =	2.4	(3)
P = number of wet days (0.01 inches of precip.) =	62	(1)
N = number of days in averaging period =	365	

(c) Maximum daily emissions estimate (lbs/day) = (Emission factor [lbs/VMT]) x (maximum daily vehicle trips [trips/day]) x (offsite roundtrip distance [mi/trip]) x (1 - [control efficiency {%}] / 100)

Control efficiency (%) = 0% (4)

(d) Annual emissions estimate (tons/yr) = (Emission factor [lbs/VMT]) x (annual vehicle trips [trips/yr]) x (offsite roundtrip distance [mi/trip]) x (ton/2,000 lbs) x (1 - [control efficiency {%}] / 100)

Control efficiency (%) = 0% (4)

References:

(1) See Table E-1, Phase 1 Operations Input Assumptions for Emission Rate Calculations.
(2) AP-42 Chapter 13.2.1 (January, 2011), Table 13.2.1-1 "Particle Size Multipliers for Paved Road Equation".
(3) Section 7.9 of the CARB Emission Inventory Methodology. Assumes offsite roads are equivalent to major/collector roads as shown in Table 3 (silt loading of 0.035 g/m^2).
(4) Engineering estimate.

Table E-8
Natural Gas Boiler Criteria Emission Estimates

Source		Natural Gas Boiler - Building 9	Natural Gas Boiler - Building 8	Natural Gas Boiler - Buildings 6 and 7	Total
Maximum Hourly Fuel Usage (MMBtu/hr)	(1)	12	12	24	
Daily Hours of Operation (hrs/day)	(1)	24	24	24	
Annual Fuel Usage (MMBtu/yr)	(1)	21,000	21,000	42,000	
Modeling ID		NGB_B9	NGB_B8	NGB_B6_7	

Pollutant	Emission Factor (lbs/MMscf)		Maximum Daily Emissions Estimate [(a)] (lbs/day)	Annual Average Emissions Estimate [(b)] (tons/yr)	Maximum Daily Emissions Estimate [(a)] (lbs/day)	Annual Average Emissions Estimate [(b)] (tons/yr)	Maximum Daily Emissions Estimate [(a)] (lbs/day)	Annual Average Emissions Estimate [(b)] (tons/yr)	Maximum Daily Emissions Estimate (lbs/day)	Annual Average Emissions Estimate (tons/yr)
PM	7.60	(2)	2.15	0.078	2.15	0.078	4.29	0.16	8.58	0.31
PM_{10}	7.60	(3)	2.15	0.078	2.15	0.078	4.29	0.16	8.58	0.31
$PM_{2.5}$	7.60	(3)	2.15	0.078	2.15	0.078	4.29	0.16	8.58	0.31
NO_X	18.72	(c)	5.28	0.19	5.28	0.19	10.6	0.39	21.1	0.77
CO	84	(5)	23.7	0.86	23.7	0.86	47.4	1.73	94.9	3.46
SO_2	0.6	(2)	0.17	6.2E-03	0.17	6.2E-03	0.34	0.012	0.68	0.025
VOC	5.5	(2)	1.55	0.057	1.55	0.057	3.11	0.11	6.21	0.23
CO_2	120,162	(d)	33,928	1,237	33,928	1,237	67,856	2,474	135,712	4,948
CH_4	2.27	(e)	0.64	0.023	0.64	0.023	1.28	0.047	2.56	0.093
N_2O	0.23	(e)	0.064	2.3E-03	0.064	2.3E-03	0.13	4.7E-03	0.26	9.3E-03
CO_2e	120,280	(f)	33,961	1,238	33,961	1,238	67,923	2,476	135,846	4,953

Notes:

(a) Daily emissions estimate (lbs/day) = (Emission factor [lbs/MMscf]) x (maximum hourly heat input [MMBtu/hr]) x (daily hours of operation [hrs/day]) / (natural gas heat content [Btu/scf])
Natural gas heat content (Btu/scf) = 1,020 (2)

(b) Annual emissions estimate (tons/yr) = (emission factor [lbs/MMscf]) x (annual heat input [MMBtu/yr]) / (natural gas heat content [Btu/scf]) x (tons/2,000 lbs)
Natural gas heat content (Btu/scf) = 1,020 (2)

(c) Emission factor (lbs/MMscf) = (NO_2 or CO emission limit [ppmv @ 3% O_2]) x (10^{-6}) x (NO_2 or CO molecular weight [lbs/lb-mol]) x (lb-mol/385.44 ft^3) x (natural gas f-factor [8,710 dscf/MMBtu]) x (20.9% O_2/[20.9% O_2 - 3% O_2]) x (heat content [Btu/scf])
BAAQMD NO_X emission limit (ppmv @ 3% O_2) = 15 (4)
BAAQMD CO emission limit (ppmv @ 3% O_2) = 400 (4)
NO_2 molecular weight (lbs/lb-mol) = 46
CO molecular weight (lbs/lb-mol) = 28.01
Natural gas heat content (Btu/scf) = 1,028 (6)

(d) CO_2 emission factor [lbs/MMscf] = (CO_2 emission factor [kg CO_2/MMBtu]) x (default high heat value (MMBtu/scf)) x (10^6 scf/MMscf) x (lb/0.453592 kg)
CO_2 emission factor (kg/MMBtu) = 53.02 (6)
Default high heat value (MMBtu/scf) = 1.028E-03 (6)

(e) CH_4 or N_2O emission factor (lbs/MMscf) = (CH_4 or N_2O emission factor [kg/MMBtu]) x (lb/0.453592 kg) x (natural gas heat content [Btu/scf])
CH_4 emission factor (kg/MMBtu) = 1.0E-03 (7)
N_2O emission factor (kg/MMBtu) = 1.0E-04 (7)
Natural gas heat content (Btu/scf) = 1,028 (6)

(f) CO_2e emission factor (lbs/MMscf) = (CO_2 emission factor [lbs/MMscf]) + (CH_4 emission factor [lbs/MMscf] x CH_4 global warming potential) + (N_2O emission factor [lbs/MMscf] x N_2O global warming potential)
Global warming potential of CH_4 = 21 (8)
Global warming potential of N_2O = 310 (8)

References:

(1) See Table E-1, Phase 1 Operations Input Assumptions for Emission Rate Calculations.
(2) AP-42 Chapter 1.4 (July 1998), Table 1.4-2 "Emission Factors for Criteria Pollutants and Greenhouse Gases from Natural Gas Combustion".
(3) Assumes that 100% of PM is $PM_{2.5}$. Therefore, 100% of PM_{10} is $PM_{2.5}$.
(4) BAAQMD Emission Limits 307.2, 307.3, and 307.4 from Section 9-7-307.
(5) AP-42 Chapter 1.4 (July 1998), Table 1.4-1 "Emission Factors for NO_X and CO from Natural Gas Combustion".
(6) 40 CFR Part 98 Subpart C, Table C-1, Default CO_2 Emission Factors and High Heat Values for Various Types of Fuel.
(7) 40 CFR Part 98 Subpart C, Table C-2, Default CH_4 and N_2O Emission Factors for Various Types of Fuel.
(8) 40 CFR Part 98 Subpart A, Table A-1, Global Warming Potentials.

Table E-9

Emergency Diesel Generator Criteria Emission Estimates

Source		Diesel Generator - Building 9	Diesel Generator - Building 8	Diesel Generator - Building 6	Diesel Generator - Building 7	Total
Generator Power Rating (BHP)	(1)	440	440	440	440	
Diesel Fuel Usage (gal/hr)	(1)	22.3	22.3	22.3	22.3	
Load Factor	(2)	0.74	0.74	0.74	0.74	
Annual Operation (hrs/yr)	(1)	25.15	25.15	25.15	25.15	
Modeling ID		DG_B9	DG_B8	DG_B6	DG_B7	

Pollutant	Small Engine Emission Factor (g/hp-hr)	Maximum Daily Emissions Estimate (lbs/day)	Annual Average Emissions Estimate [a] (tons/yr)	Maximum Daily Emissions Estimate (lbs/day)	Annual Average Emissions Estimate [a] (tons/yr)	Large Engine Emission Factor (g/hp-hr)	Maximum Daily Emissions Estimate (lbs/day)	Annual Average Emissions Estimate [a] (tons/yr)	Maximum Daily Emissions Estimate (lbs/day)	Annual Average Emissions Estimate [a] (tons/yr)	Maximum Daily Emissions Estimate (lbs/day)	Annual Average Emissions Estimate (tons/yr)
PM	0.01 [3]	0.014 [b]	9.0E-05	0.014 [b]	9.0E-05	0.015 [4]	0.022 [b]	1.4E-04	0.022 [b]	1.4E-04	0.072	4.5E-04
PM_{10}	0.01 [3]	0.014 [b]	9.0E-05	0.014 [b]	9.0E-05	0.015 [4]	0.022 [b]	1.4E-04	0.022 [b]	1.4E-04	0.072	4.5E-04
$PM_{2.5}$	0.01 [3]	0.014 [b]	9.0E-05	0.014 [b]	9.0E-05	0.015 [4]	0.022 [b]	1.4E-04	0.022 [b]	1.4E-04	0.072	4.5E-04
NO_X	0.3 [4]	0.43 [b]	2.7E-03	0.43 [b]	2.7E-03	1.50 [4]	2.15 [b]	0.014	2.15 [b]	0.014	5.17	0.032
CO	2.2 [4]	3.16 [b]	0.020	3.16 [b]	0.020	2.60 [4]	3.73 [b]	0.023	3.73 [b]	0.023	13.8	0.087
SO_2	-- [5]	9.4E-03 [c]	5.9E-05	9.4E-03 [c]	5.9E-05	-- [5]	9.4E-03 [c]	5.9E-05	9.4E-03 [c]	5.9E-05	0.037	2.4E-04
VOC	0.14 [4]	0.20 [b]	1.3E-03	0.20 [b]	1.3E-03	0.14 [4]	0.20 [b]	1.3E-03	0.20 [b]	1.3E-03	0.80	5.1E-03
CO_2	-- [7]	996 [d]	6.26	996 [d]	6.26	-- [7]	996 [d]	6.26	996 [d]	6.26	3,984	25.1
CH_4	--	0.018 [9]	1.1E-04	0.018 [9]	1.1E-04	--	0.018 [9]	1.1E-04	0.018 [9]	1.1E-04	0.072	4.5E-04
CO_2e	--	996 [e]	6.27	996 [e]	6.27	--	996 [e]	6.27	996 [e]	6.27	3,986	25.1

Notes:

(a) Annual average emission estimate (tons/yr) = (Daily emissions [lbs/day]) / (daily hours of operation [hrs/day]) x (annual hours of operation [hrs/yr]) x (ton/2,000 lbs)

Daily hours of operation (hrs/day) = 2 (1)

(b) Maximum daily emission estimate (lbs/day) = (Emission factor [g/hp-hr]) x (generator power [hp]) x (load factor) x (maximum hours per day [hrs/day]) x (lb/453.59g)

Daily hours of operation (hrs/day) = 2 (1)

(c) Maximum daily emissions estimate (lbs/day) = (Fuel sulfur content [ppmw] / 10^6) x (generator fuel consumption [gal/hr]) x (generator usage [hrs/day]) x (diesel density [lbs/gal) x ([SO_2 molecular weight {lbs/lb-mol}] / [sulfur molecular weight {lbs/lb-mol}])

Fuel sulfur content (ppmw) = 15 (6)
Diesel density (lbs/gal) = 7
SO_2 molecular weight (lbs/lb-mol) = 64
Sulfur molecular weight (lbs/lb-mol) = 32

(d) Maximum daily emissions estimate (lbs/day) = (Fuel carbon content [%] / 100) x (generator fuel consumption [gal/hr]) x (generator usage [hrs/day]) x (diesel density [lbs/gal) x ([CO_2 molecular weight {lbs/lb-mol}] / [carbon molecular weight {lbs/lb-mol}])

Fuel carbon content (%) = 87 (8)
Diesel density (lbs/gal) = 7
CO_2 molecular weight (lbs/lb-mol) = 44.0
Carbon molecular weight (lbs/lb-mol) = 12.0

(e) CO_2e emissions (lbs/day) = (CO_2 emissions [lbs/day]) + (CH_4 emissions [lbs/day] x CH_4 global warming potential)

CH_4 Global Warming Potential (GWP) = 21 (10)

References:

(1) See Table E-1, Phase 1 Operations Input Assumptions for Emission Rate Calculations.
(2) Default load factor for generators in URBEMIS emissions model.
(3) LBNL has committed to purchasing engines that achieve 0.01 g/hp-hr particulate matter emissions. Assumes all PM is $PM_{2.5}$.
(4) CalEEMod Appendix D, Default Data Tables. Table 3.5, OFFROAD Emission Factor Based on Engine Tier. Assumes Tier 4 Final for LBNL-owned small engines (Buildings 9 and 8), and Tier 4 Interim for the Building 6&7 engine.
(5) Sulfur dioxide emissions calculated on a sulfur mass balance basis, assuming 100% of the fuel sulfur content is emitted as SO_2.
(6) California Code of Regulations Title 13, Division 3, Chapter 5, Article 2, Standards for Diesel Fuel.
(7) Carbon dioxide emissions calculated on a carbon mass balance basis, conservatively assuming 100% of the fuel carbon content is emitted as CO_2.
(8) AP-42 Chapter 3.3 (October 1996) and 3.4 (October 1996), Footnote to criteria emission factor table.
(9) Assumes methane is 9% of VOC, based on footnote f of Table 3.4-1 in AP-42, Chapter 3.4. VOC emission factor is shown as ROG/TOG in CalEEMod Appendix D ,Table 3.5.
(10) 40 CFR Part 98 Subpart A, Table A-1, Global Warming Potentials.

Table E-10

Cooling Tower Particulate Emission Estimates

Source		Cooling Tower - Building 9	Cooling Tower - Building 8	Cooling Tower - Buildings 6 and 7	Total
Total Circulation Water Rate (gpm)	(1)	4,500	4,500	9,000	
Drift Loss of Circulating Water (%)	(2)	0.005	0.005	0.005	
Annual Operation (hrs/yr)	(1)	6,360	6,360	6,360	
Modeling ID		CTB9C#	CTB8C#	CTB6_7C#	

Pollutant	Maximum Daily Emissions Estimate (lbs/day)		Annual Average Emissions Estimate [(a)] (tons/yr)	Maximum Daily Emissions Estimate (lbs/day)		Annual Average Emissions Estimate [(a)] (tons/yr)	Maximum Daily Emissions Estimate (lbs/day)		Annual Average Emissions Estimate [(a)] (tons/yr)	Maximum Daily Emissions Estimate (lbs/day)	Annual Average Emissions Estimate (tons/yr)
PM	1.45	(b)	0.19	1.45	(b)	0.19	2.90	(b)	0.38	5.79	0.77
PM_{10}	1.29	(c)	0.17	1.29	(c)	0.17	2.58	(c)	0.34	5.16	0.68
$PM_{2.5}$	0.77	(d)	0.10	0.77	(d)	0.10	1.55	(d)	0.21	3.09	0.41

Notes:

(a) Annual emissions estimate (tons/yr) = (Daily emissions [lbs/day]) / (daily hours of operation [hrs/day]) x (annual hours of operation [hrs/yr]) x (ton/2,000 lbs)

Daily hours of operation (hrs/day) = 24 (1)

(b) Maximum daily emissions estimate (lbs/day) = (Circulation water rate [gpm]) x (density of water [lbs/gal]) x (total dissolved solids concentration [ppmw]) x (10^{-6}) x (drift loss of circulating water [%] / 100) x (60 min/hr) x (daily hours of operation [hrs/day])

Total dissolved solids concentration (ppmw) = 536 (1)

Density of water (lbs/gal) = 8.34

Daily hours of operation (hrs/day) = 24 (1)

(c) Maximum daily emissions estimate (lbs/day) = (PM emissions estimate [lbs/day]) x (percent of PM_{10} emissions [%] / 100)

Percent of PM_{10} emissions (%) = 89.0 (3)

(d) Maximum daily emissions estimate (lbs/day) = (PM_{10} emissions estimate [lbs/day]) x ($PM_{2.5}$ fraction of PM_{10})

$PM_{2.5}$ fraction of PM_{10} = 0.6 (4)

References:

(1) See Table E-1, Phase 1 Operations Input Assumptions for Emission Rate Calculations.

(2) Engineering judgment based on past work with industrial cooling towers.

(3) From the technical paper "Calculating Realistic PM10 Emissions from Cooling Towers", by Joel Reisman and Gordon Frisbie. The percent PM_{10} is based on total dissolved content.

(4) From Appendix A - Updated CEIDARS Table with PM2.5 Fractions to the CEQA handbook, supplemental information.

Table E-11
Phase 1 Operations Criteria Pollutant Emissions Summary

Source	Annual Days of Operation	TAC		Criteria												Greenhouse Gases							
		DPM		PM_{10}		$PM_{2.5}$		NO_X		CO		SO_2		VOC		CO_2		CH_4		N_2O		CO_2e	
		(lbs/day) (1)	(tons/yr)	(lbs/day) (1)	(tons/yr)	(lbs/day) (1)	(tons/yr)	(lbs/day) (1)	(tons/yr)	(lbs/day) (1)	(tons/yr)	(lbs/day) (1)	(tons/yr)	(lbs/day) (1)	(tons/yr)	(lbs/day) (1)	(tons/yr)	(lbs/day) (1)	(tons/yr)	(lbs/day) (1)	(tons/yr)	(lbs/day) (1)	(tons/yr)
Stationary Sources																							
Diesel generators	**260**	**3.5E-03**	**4.5E-04**	**3.5E-03**	**4.5E-04**	**3.5E-03**	**4.5E-04**	**0.25**	**3.2E-02**	**0.67**	**8.7E-02**	**1.8E-03**	**2.4E-04**	**3.9E-02**	**5.1E-03**	**193**	**25.1**	**3.5E-03**	**4.5E-04**	**--**	**--**	**193**	**25.1**
Natural Gas Boilers	**260**	**--**	**--**	**2.41**	**0.31**	**2.41**	**0.31**	**5.93**	**0.77**	**26.6**	**3.46**	**0.19**	**2.5E-02**	**1.74**	**0.23**	**38,060**	**4,948**	**0.72**	**9.3E-02**	**7.2E-02**	**9.3E-03**	**38,098**	**4,953**
Cooling Towers	**260**	**--**	**--**	**5.26**	**0.68**	**3.15**	**0.41**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**
Lab Chemicals	260	--	--	--	--	--	--	--	--	--	--	--	--	2.45	0.32	--	--	--	--	--	--	--	--
Total Onsite Stationary Source Emissions	**--**	**3.5E-03**	**4.5E-04**	**7.67**	**1.00**	**5.56**	**0.72**	**6.18**	**0.80**	**27.3**	**3.55**	**0.19**	**2.5E-02**	**4.23**	**0.55**	**38,253**	**4,973**	**0.72**	**9.4E-02**	**7.2E-02**	**9.3E-03**	**38,290**	**4,978**
Onsite On-Road Vehicle Emission Sources																							
Onsite On-Road Exhaust - Delivery Trucks	260	2.0E-03	2.5E-04	2.0E-03	2.5E-04	1.8E-03	2.3E-04	7.8E-02	1.0E-02	2.7E-02	3.6E-03	0	0	1.5E-02	1.9E-03	30.5	3.97	--	--	--	--	30.5	3.97
Onsite On-Road Exhaust - LBNL-RBC Shuttle	260	--	--	1.7E-04	2.2E-05	1.6E-04	2.0E-05	9.3E-03	1.2E-03	7.2E-02	9.4E-03	0	0	4.2E-03	5.5E-04	23.6	3.07	--	--	--	--	23.6	3.07
Onsite On-Road Exhaust - BART-RBC Shuttle	260	--	--	3.3E-04	4.2E-05	3.0E-04	3.9E-05	1.8E-02	2.3E-03	0.14	1.8E-02	0	0	8.1E-03	1.1E-03	45.4	5.90	--	--	--	--	45.4	5.90
Onsite On-Road Exhaust - Employee Vehicles	260	--	--	2.2E-02	2.9E-03	2.0E-02	2.7E-03	0.41	5.4E-02	4.67	0.61	0	0	0.23	2.9E-02	1,888	245	--	--	--	--	1,888	245
Onsite On-Road Dust - Delivery Trucks	260	--	--	1.3E-02	1.7E-03	3.2E-03	4.2E-04	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Onsite On-Road Dust - LBNL-RBC Shuttle	260	--	--	1.7E-02	2.2E-03	4.2E-03	5.4E-04	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Onsite On-Road Dust - BART-RBC Shuttle	260	--	--	3.3E-02	4.3E-03	8.1E-03	1.0E-03	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Onsite On-Road Dust - Employee Vehicles	260	--	--	2.68	0.35	0.66	8.5E-02	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Onsite Idling Exhaust - Delivery Trucks	260	4.0E-04	5.2E-05	4.0E-04	5.2E-05	3.6E-04	4.7E-05	0.12	1.6E-02	4.1E-02	5.3E-03	1.3E-04	1.7E-05	3.6E-03	4.6E-04	13.0	1.69	--	--	--	--	13.0	1.69
Onsite Idling Exhaust - LBNL-RBC Shuttle	260	--	--	1.6E-04	2.1E-05	1.5E-04	2.0E-05	6.5E-03	8.4E-04	5.1E-02	6.6E-03	0	0	3.9E-03	5.1E-04	19.1	2.49	--	--	--	--	19.1	2.49
Onsite Idling Exhaust - BART-RBC Shuttle	260	--	--	3.1E-04	4.1E-05	2.9E-04	3.8E-05	1.2E-02	1.6E-03	9.8E-02	1.3E-02	0	0	7.5E-03	9.7E-04	36.8	4.79	--	--	--	--	36.8	4.79
Total Onsite Vehicle Parking Lot Emissions	260	--	--	1.4E-02	1.8E-03	1.3E-02	1.7E-03	0.53	6.9E-02	8.88	1.15	3.5E-03	4.5E-04	1.45	0.19	330	42.9	--	--	--	--	330	42.9
Total Onsite On-Road Vehicle Emissions	**--**	**2.4E-03**	**3.1E-04**	**2.78**	**0.36**	**0.71**	**9.2E-02**	**1.19**	**0.16**	**14.0**	**1.82**	**3.6E-03**	**4.7E-04**	**1.72**	**0.22**	**2,387**	**310**	**--**	**--**	**--**	**--**	**2,387**	**310**
Offsite On-Road Emissions																							
Offsite On-Road Exhaust - Delivery Trucks	260	2.7E-02	3.5E-03	7.0E-02	9.1E-03	4.3E-02	5.5E-03	0.71	9.2E-02	0.19	2.4E-02	3.4E-03	4.5E-04	5.4E-02	7.1E-03	337	43.8	--	--	--	--	337	43.8
Offsite On-Road Exhaust - LBNL-RBC Shuttle	260	--	--	2.1E-02	2.7E-03	8.8E-03	1.1E-03	0.13	1.7E-02	0.92	0.12	2.6E-03	3.4E-04	7.5E-02	9.8E-03	221	28.7	--	--	--	--	221	28.7
Offsite On-Road Exhaust - BART-RBC Shuttle	260	--	--	2.1E-02	2.7E-03	8.7E-03	1.1E-03	0.13	1.7E-02	0.92	0.12	2.6E-03	3.4E-04	7.5E-02	9.7E-03	219	28.5	--	--	--	--	219	28.5
Offsite On-Road Exhaust - Employee Vehicles	260	--	--	4.28	0.56	1.78	0.23	8.09	1.05	79.8	10.4	0.31	4.1E-02	6.07	0.79	23,569	3,064	--	--	--	--	23,569	3,064
Offsite On-Road Dust - Delivery Trucks	260	--	--	3.4E-02	4.4E-03	8.3E-03	1.1E-03	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Offsite On-Road Dust - LBNL-RBC Shuttle	260	--	--	4.9E-02	6.4E-03	1.2E-02	1.6E-03	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Offsite On-Road Dust - BART-RBC Shuttle	260	--	--	4.9E-02	6.3E-03	1.2E-02	1.6E-03	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Offsite On-Road Dust - Employee Vehicles	260	--	--	10.2	1.32	2.50	0.32	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Total Offsite On-Road Vehicle Emissions	**--**	**2.7E-02**	**3.5E-03**	**14.7**	**1.91**	**4.37**	**0.57**	**9.06**	**1.18**	**81.9**	**10.6**	**0.32**	**4.2E-02**	**6.28**	**0.82**	**24,345**	**3,165**	**--**	**--**	**--**	**--**	**24,345**	**3,165**
Total Phase 1 Project Summary	**--**	**3.2E-02**	**4.2E-03**	**25.1**	**3.27**	**10.6**	**1.38**	**16.4**	**2.14**	**123**	**16.0**	**0.52**	**6.7E-02**	**12.2**	**1.59**	**64,985**	**8,448**	**0.72**	**9.4E-02**	**7.2E-02**	**9.3E-03**	**65,023**	**8,453**
Onsite Stationary Exhaust		**3.5E-03**	**4.5E-04**	**7.67**	**1.00**	**5.56**	**0.72**	**6.18**	**0.80**	**27.3**	**3.55**	**0.19**	**2.5E-02**	**4.23**	**0.55**	**38,253**	**4,973**	**0.72**	**9.4E-02**	**7.2E-02**	**9.3E-03**	**38,290**	**4,978**
Onsite Mobile Exhaust		**2.4E-03**	**3.1E-04**	**4.0E-02**	**5.1E-03**	**3.7E-02**	**4.8E-03**	**1.19**	**0.16**	**14.0**	**1.82**	**3.6E-03**	**4.7E-04**	**1.72**	**0.22**	**2,387**	**310**	**0**	**0**	**0**	**0**	**2,387**	**310**
Onsite Fugitive Dust		**0**	**0**	**2.74**	**0.36**	**0.67**	**8.7E-02**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**
Offsite Mobile Exhaust		**2.7E-02**	**3.5E-03**	**4.39**	**0.57**	**1.84**	**0.24**	**9.06**	**1.18**	**81.9**	**10.6**	**0.32**	**4.2E-02**	**6.28**	**0.82**	**24,345**	**3,165**	**0**	**0**	**0**	**0**	**24,345**	**3,165**
Offsite Fugitive Dust		**0**	**0**	**10.3**	**1.34**	**2.53**	**0.33**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**

References:

(1) Daily average emissions calculated by dividing the annual emissions by the annual days of operation and converting tons to lbs.

Table E-12
Onsite Employee Vehicle TAC Emission Estimates

Parameter		Parking Lot Emissions					Onroad Emissions
		Hot Soak / Running Evaporative	Resting Evaporative / Diurnal	Starting	Idling	Total	Running
Organic Speciation Profile	(1)	660	661	664	2105		2105
LDA TOG Emission Factor	(2)	8.19E-04 (lbs/trip)	1.52E-04 (lbs/trip)	3.33E-04 (lbs/trip)	1.99E-03 (lbs/hr)		1.74E-04 (lbs/VMT)
Maximum Daily Vehicle Trips (trips/day)	(3)	2,031	2,031	2,031	2,031		2,031
Annual Vehicle Trips (trips/yr)	(3)	528,060	528,060	528,060	528,060		528,060

TAC	CAS	TAC Emission Fraction of TOG (1)	Maximum Daily Emissions Estimate (a) (lbs/day)	Annual Average Emissions Estimate (b) (tons/yr)	TAC Emission Fraction of TOG (1)	Maximum Daily Emissions Estimate (a) (lbs/day)	Annual Average Emissions Estimate (b) (tons/yr)	TAC Emission Fraction of TOG (1)	Maximum Daily Emissions Estimate (a) (lbs/day)	Annual Average Emissions Estimate (b) (tons/yr)	TAC Emission Fraction of TOG (1)	Maximum Daily Emissions Estimate (c) (lbs/day)	Annual Average Emissions Estimate (d) (tons/yr)	Maximum Daily Emissions Estimate (lbs/day)	Annual Average Emissions Estimate (tons/yr)	TAC Emission Fraction of TOG (1)	Maximum Daily Emissions Estimate (e) (lbs/day)	Annual Average Emissions Estimate (f) (tons/yr)
1,3-Butadiene	106-99-0	No Data	--	--	No Data	--	--	7.0E-03	4.7E-03	6.2E-04	5.5E-03	0	0	4.7E-03	6.2E-04	5.5E-03	1.4E-03	1.8E-04
2-Butanone	78-93-3	No Data	--	--	No Data	--	--	6.0E-04	4.1E-04	5.3E-05	2.0E-04	0	0	4.1E-04	5.3E-05	2.0E-04	4.9E-05	6.4E-06
Acetaldehyde	75-07-0	No Data	--	--	No Data	--	--	5.2E-03	3.5E-03	4.6E-04	2.8E-03	0	0	3.5E-03	4.6E-04	2.8E-03	6.9E-04	9.0E-05
Acrolein	107-02-8	No Data	--	--	No Data	--	--	1.1E-03	7.4E-04	9.7E-05	1.3E-03	0	0	7.4E-04	9.7E-05	1.3E-03	3.2E-04	4.2E-05
Benzene	71-43-2	0.010	0.017	2.2E-03	3.6E-03	1.1E-03	1.4E-04	0.024	0.016	2.1E-03	0.025	0	0	0.034	4.4E-03	0.025	6.1E-03	7.9E-04
Ethylbenzene	100-41-4	0.016	0.027	3.5E-03	1.2E-03	3.7E-04	4.8E-05	0.016	0.011	1.4E-03	0.011	0	0	0.038	5.0E-03	0.011	2.6E-03	3.4E-04
Formaldehyde	50-00-0	No Data	--	--	No Data	--	--	0.013	8.5E-03	1.1E-03	0.016	0	0	8.5E-03	1.1E-03	0.016	3.9E-03	5.1E-04
Methanol	67-56-1	1.0E-04	1.7E-04	2.2E-05	No Data	--	--	2.9E-03	2.0E-03	2.5E-04	1.2E-03	0	0	2.1E-03	2.8E-04	1.2E-03	3.0E-04	3.8E-05
Naphthalene	91-20-3	1.4E-03	2.3E-03	3.0E-04	No Data	--	--	7.0E-04	4.7E-04	6.2E-05	5.0E-04	0	0	2.8E-03	3.6E-04	5.0E-04	1.2E-04	1.6E-05
n-Hexane	110-54-3	7.6E-03	0.013	1.6E-03	0.015	4.8E-03	6.2E-04	0.018	0.012	1.6E-03	0.016	0	0	0.029	3.8E-03	0.016	3.9E-03	5.1E-04
Propylene	115-07-1	No Data	--	--	No Data	--	--	0.033	0.023	2.9E-03	0.031	0	0	0.023	2.9E-03	0.031	7.5E-03	9.8E-04
Styrene	100-42-5	No Data	--	--	No Data	--	--	2.6E-03	1.8E-03	2.3E-04	1.2E-03	0	0	1.8E-03	2.3E-04	1.2E-03	3.0E-04	3.8E-05
Toluene	108-88-3	0.051	0.085	0.011	0.017	5.3E-03	6.8E-04	0.074	0.050	6.5E-03	0.058	0	0	0.14	0.018	0.058	0.014	1.8E-03
m-Xylene	108-38-3	0.027	0.045	5.8E-03	3.4E-03	1.1E-03	1.4E-04	0.053	0.036	4.7E-03	0.036	0	0	0.082	0.011	0.036	8.8E-03	1.1E-03
o-Xylene	95-47-6	0.016	0.027	3.5E-03	1.3E-03	4.0E-04	5.2E-05	0.018	0.012	1.6E-03	0.012	0	0	0.039	5.1E-03	0.012	3.1E-03	4.0E-04
p-Xylene	106-42-3	0.014	0.023	3.0E-03	1.1E-03	3.4E-04	4.4E-05	No Data	--	--	No Data	--	--	0.023	3.0E-03	No Data	--	--

Notes:

(a) Maximum daily emissions estimate (lbs/day) = (Emission factor [lbs/trip]) x (maximum daily vehicle trips [trips/day]) x (TAC emission fraction)

(b) Annual emissions estimate (tons/yr) = (Emission factor [lbs/trip]) x (annual vehicle trips [trips/yr]) x (ton/2,000 lbs) x (TAC emission fraction)

(c) Maximum daily emissions estimate (lbs/day) = (Emission factor [lbs/hr]) x (maximum daily vehicle trips [trips/day]) x (idling time per trip [hrs/trip]) x (TAC emission fraction)

Idling time per trip (hrs/trip) = 0 (3)

(d) Annual emissions estimate (tons/yr) = (Emission factor [lbs/hr]) x (annual vehicle trips [trips/yr]) x (idling time per trip [hrs/trip]) x (ton/2,000 lbs) x (TAC emission fraction)

Idling time per trip (hrs/trip) = 0 (3)

(e) Maximum daily emissions estimate (lbs/day) = (Emission factor [lbs/VMT]) x (maximum daily vehicle trips [trips/day]) x (onsite roundtrip distance [mi/trip]) x (TAC emission fraction)

Onsite roundtrip distance (mi/trip) = 0.70 (3)

(f) Annual emissions estimate (tons/yr) = (Emission factor [lbs/VMT]) x (annual vehicle trips [trips/yr]) x (onsite roundtrip distance [mi/trip]) x (ton/2,000 lbs) x (TAC emission fraction)

Onsite roundtrip distance (mi/trip) = 0.70 (3)

References:

(1) California Air Resources Board Speciation Database. TAC emission fractions are derived from the individual speciation profiles listed. Profiles chosen to best represent the project vehicle fleet and existing gasoline formulation.

(2) Emission Factors source: EMFAC 2011 (model years to 2018). Onsite speed set to 15 mile per hour to conservatively estimate onsite emissions.

(3) See Table E-1, Phase 1 Operations Input Assumptions for Emission Rate Calculations.

Table E-13
Offsite Employee Vehicle TAC Emission Estimates

Parameter		Onroad Emissions						Total
		Running		Tire Wear		Brake Wear		
Speciation Profile	(1)	2105	(organic)	472	(particulate)	473	(particulate)	
LDA Emission Factor (lbs/VMT)	(2)	6.64E-05	(TOG)	1.8E-05	(PM_{10})	8.1E-05	(PM_{10})	
Maximum Daily Vehicle Trips (trips/day)	(3)	2,031		2,031		2,031		
Annual Vehicle Trips (trips/yr)	(3)	528,060		528,060		528,060		

TAC	CAS	TAC Emission Fraction of TOG (1)	Maximum Daily Emissions Estimate (a) (lbs/day)	Annual Average Emissions Estimate (b) (tons/yr)	TAC Emission Fraction of PM_{10} (1)	Maximum Daily Emissions Estimate (a) (lbs/day)	Annual Average Emissions Estimate (b) (tons/yr)	TAC Emission Fraction of PM_{10} (1)	Maximum Daily Emissions Estimate (a) (lbs/day)	Annual Average Emissions Estimate (b) (tons/yr)	Maximum Daily Emissions Estimate (lbs/day)	Annual Average Emissions Estimate (tons/yr)
1,3-Butadiene	106-99-0	5.5E-03	0.015	2.0E-03	--	--	--	--	--	--	0.015	2.0E-03
2-Butanone	78-93-3	2.0E-04	5.5E-04	7.2E-05	--	--	--	--	--	--	5.5E-04	7.2E-05
Acetaldehyde	75-07-0	2.8E-03	7.8E-03	1.0E-03	--	--	--	--	--	--	7.8E-03	1.0E-03
Acrolein	107-02-8	1.3E-03	3.6E-03	4.7E-04	--	--	--	--	--	--	3.6E-03	4.7E-04
Benzene	71-43-2	0.025	0.069	8.9E-03	--	--	--	--	--	--	0.069	8.9E-03
Ethylbenzene	100-41-4	0.011	0.029	3.8E-03	--	--	--	--	--	--	0.029	3.8E-03
Formaldehyde	50-00-0	0.016	0.044	5.7E-03	--	--	--	--	--	--	0.044	5.7E-03
Methanol	67-56-1	1.2E-03	3.3E-03	4.3E-04	--	--	--	--	--	--	3.3E-03	4.3E-04
Naphthalene	91-20-3	5.0E-04	1.4E-03	1.8E-04	--	--	--	--	--	--	1.4E-03	1.8E-04
n-Hexane	110-54-3	0.016	0.044	5.8E-03	--	--	--	--	--	--	0.044	5.8E-03
Propylene	115-07-1	0.031	0.085	0.011	--	--	--	--	--	--	0.085	0.011
Styrene	100-42-5	1.2E-03	3.3E-03	4.3E-04	--	--	--	--	--	--	3.3E-03	4.3E-04
Toluene	108-88-3	0.058	0.16	0.021	--	--	--	--	--	--	0.16	0.021
m-Xylene	108-38-3	0.036	0.099	0.013	--	--	--	--	--	--	0.099	0.013
o-Xylene	95-47-6	0.012	0.034	4.5E-03	--	--	--	--	--	--	0.034	4.5E-03
Lead	7439-92-1	--	--	--	1.6E-04	1.2E-04	1.5E-05	5.0E-05	1.7E-04	2.2E-05	2.9E-04	3.7E-05
Manganese	7439-96-5	--	--	--	1.0E-04	7.4E-05	9.6E-06	1.7E-03	5.8E-03	7.5E-04	5.8E-03	7.6E-04
Nickel	7440-02-0	--	--	--	5.0E-05	3.7E-05	4.8E-06	6.6E-04	2.2E-03	2.9E-04	2.3E-03	3.0E-04
Arsenic	7440-38-2	--	--	--	No Data	--	--	1.0E-05	3.4E-05	4.4E-06	3.4E-05	4.4E-06
Copper	7440-50-8	--	--	--	4.9E-04	3.6E-04	4.7E-05	0.011	0.039	5.1E-03	0.039	5.1E-03
Vanadium	7440-62-2	--	--	--	No Data	--	--	6.6E-04	2.2E-03	2.9E-04	2.2E-03	2.9E-04
Bromine	7726-95-6	--	--	--	1.5E-05	1.1E-05	1.4E-06	4.0E-05	1.4E-04	1.8E-05	1.5E-04	1.9E-05
Selenium	7782-49-2	--	--	--	2.0E-05	1.5E-05	1.9E-06	2.0E-05	6.8E-05	8.8E-06	8.2E-05	1.1E-05
Chlorine	7782-50-5	--	--	--	7.8E-03	5.7E-03	7.5E-04	1.5E-03	5.1E-03	6.6E-04	0.011	1.4E-03

Notes:

(a) Maximum daily emissions estimate (lbs/day) = (Emission factor [lbs/VMT]) x (maximum daily vehicle trips [trips/day]) x (offsite roundtrip distance [mi/trip]) x (TAC emission fraction)
Offsite roundtrip distance (mi/trip) = 20.6 (3)

(b) Annual emissions estimate (tons/yr) = (Emission factor [lbs/VMT]) x (annual vehicle trips [trips/yr]) x (offsite roundtrip distance [mi/trip]) x (ton/2,000 lbs) x (TAC emission fraction)
Offsite roundtrip distance (mi/trip) = 20.6 (3)

References:

(1) California Air Resources Board Speciation Database. TAC emission fractions are derived from the individual speciation profiles listed. Profiles chosen to best represent the project vehicle fleet and existing gasoline formulation.
(2) Emission Factors source: EMFAC 2011 (model years to 2018).
(3) See Table E-1, Phase 1 Operations Input Assumptions for Emission Rate Calculations.

Table E-14
Onsite Shuttle TAC Emission Estimates

Parameter		LBNL - RBC Shuttle		BART - RBC Shuttle		Total
		Idling	Running	Idling	Running	
Organic Speciation Profile	(1)	2105	2105	2105	2105	
MDV TOG Emission Factor	(2)	5.47E-03 (lbs/hr)	4.75E-04 (lbs/VMT)	5.47E-03 (lbs/hr)	4.75E-04 (lbs/VMT)	
Maximum Daily Vehicle Trips (trips/day)	(3)	13	13	25	25	
Annual Vehicle Trips (trips/yr)	(3)	3,380	3,380	6,500	6,500	
Idling Time per Trip (hrs/trip)	(3)	0.083	--	0.083	--	
Onsite Roundtrip Distance (mi/trip)	(3)	--	0.695	--	0.695	

TAC	CAS	TAC Emission Fraction of TOG (1)	Maximum Daily Emissions Estimate (a) (lbs/day)	Annual Average Emissions Estimate (b) (tons/yr)	TAC Emission Fraction of TOG (1)	Maximum Daily Emissions Estimate (c) (lbs/day)	Annual Average Emissions Estimate (d) (tons/yr)	TAC Emission Fraction of TOG (1)	Maximum Daily Emissions Estimate (a) (lbs/day)	Annual Average Emissions Estimate (b) (tons/yr)	TAC Emission Fraction of TOG (1)	Maximum Daily Emissions Estimate (c) (lbs/day)	Annual Average Emissions Estimate (d) (tons/yr)	Maximum Daily Emissions Estimate (lbs/day)	Annual Average Emissions Estimate (tons/yr)
1,3-Butadiene	106-99-0	5.5E-03	3.3E-05	4.2E-06	5.5E-03	2.4E-05	3.1E-06	5.5E-03	6.3E-05	8.2E-06	5.5E-03	4.5E-05	5.9E-06	1.6E-04	2.1E-05
2-Butanone	78-93-3	2.0E-04	1.2E-06	1.5E-07	2.0E-04	8.6E-07	1.1E-07	2.0E-04	2.3E-06	3.0E-07	2.0E-04	1.7E-06	2.1E-07	6.0E-06	7.8E-07
Acetaldehyde	75-07-0	2.8E-03	1.7E-05	2.2E-06	2.8E-03	1.2E-05	1.6E-06	2.8E-03	3.2E-05	4.1E-06	2.8E-03	2.3E-05	3.0E-06	8.4E-05	1.1E-05
Acrolein	107-02-8	1.3E-03	7.7E-06	1.0E-06	1.3E-03	5.6E-06	7.3E-07	1.3E-03	1.5E-05	1.9E-06	1.3E-03	1.1E-05	1.4E-06	3.9E-05	5.1E-06
Benzene	71-43-2	0.025	1.5E-04	1.9E-05	0.025	1.1E-04	1.4E-05	0.025	2.8E-04	3.7E-05	0.025	2.0E-04	2.7E-05	7.4E-04	9.6E-05
Ethylbenzene	100-41-4	0.011	6.2E-05	8.1E-06	0.011	4.5E-05	5.9E-06	0.011	1.2E-04	1.6E-05	0.011	8.7E-05	1.1E-05	3.1E-04	4.1E-05
Formaldehyde	50-00-0	0.016	9.4E-05	1.2E-05	0.016	6.8E-05	8.8E-06	0.016	1.8E-04	2.3E-05	0.016	1.3E-04	1.7E-05	4.7E-04	6.1E-05
Methanol	67-56-1	1.2E-03	7.1E-06	9.2E-07	1.2E-03	5.2E-06	6.7E-07	1.2E-03	1.4E-05	1.8E-06	1.2E-03	9.9E-06	1.3E-06	3.6E-05	4.7E-06
Naphthalene	91-20-3	5.0E-04	3.0E-06	3.9E-07	5.0E-04	2.1E-06	2.8E-07	5.0E-04	5.7E-06	7.4E-07	5.0E-04	4.1E-06	5.4E-07	1.5E-05	1.9E-06
n-Hexane	110-54-3	0.016	9.5E-05	1.2E-05	0.016	6.9E-05	8.9E-06	0.016	1.8E-04	2.4E-05	0.016	1.3E-04	1.7E-05	4.8E-04	6.2E-05
Propylene	115-07-1	0.031	1.8E-04	2.4E-05	0.031	1.3E-04	1.7E-05	0.031	3.5E-04	4.5E-05	0.031	2.5E-04	3.3E-05	9.1E-04	1.2E-04
Styrene	100-42-5	1.2E-03	7.1E-06	9.2E-07	1.2E-03	5.2E-06	6.7E-07	1.2E-03	1.4E-05	1.8E-06	1.2E-03	9.9E-06	1.3E-06	3.6E-05	4.7E-06
Toluene	108-88-3	0.058	3.4E-04	4.4E-05	0.058	2.5E-04	3.2E-05	0.058	6.6E-04	8.5E-05	0.058	4.8E-04	6.2E-05	1.7E-03	2.2E-04
m-Xylene	108-38-3	0.036	2.1E-04	2.7E-05	0.036	1.5E-04	2.0E-05	0.036	4.1E-04	5.3E-05	0.036	2.9E-04	3.8E-05	1.1E-03	1.4E-04
o-Xylene	95-47-6	0.012	7.4E-05	9.6E-06	0.012	5.3E-05	6.9E-06	0.012	1.4E-04	1.8E-05	0.012	1.0E-04	1.3E-05	3.7E-04	4.8E-05

Notes:

(a) Maximum daily emissions estimate (lbs/day) = (Emission factor [lbs/hr]) x (maximum daily vehicle trips [trips/day]) x (idling time per trip [hrs/trip]) x (TAC emission fraction)

(b) Annual emissions estimate (tons/yr) = (Emission factor [lbs/hr]) x (annual vehicle trips [trips/yr]) x (idling time per trip [hrs/trip]) x (ton/2,000 lbs) x (TAC emission fraction)

(c) Maximum daily emissions estimate (lbs/day) = (Emission factor [lbs/VMT]) x (maximum daily vehicle trips [trips/day]) x (onsite roundtrip distance [mi/trip]) x (TAC emission fraction)

(d) Annual emissions estimate (tons/yr) = (Emission factor [lbs/VMT]) x (annual vehicle trips [trips/yr]) x (onsite roundtrip distance [mi/trip]) x (ton/2,000 lbs) x (TAC emission fraction)

References:

(1) California Air Resources Board Speciation Database. TAC emission fractions are derived from the individual speciation profiles listed. Profiles chosen to best represent the project vehicle fleet and existing gasoline formulation.

(2) Emission Factors source: EMFAC 2011 (model years to 2018). Onsite speed set to 15 mile per hour to conservatively estimate onsite emissions. No tire and brake wear emission factors are provided at 15 miles per hour.

(3) See Table E-1, Phase 1 Operations Input Assumptions for Emission Rate Calculations.

Table E-15
Offsite Shuttle TAC Emission Estimates

Parameter		LBNL - RBC Shuttle						BART - RBC Shuttle						Total
		Running		Tire Wear		Brake Wear		Running		Tire Wear		Brake Wear		
Speciation Profile	(1)	2105	(organic)	472	(particulate)	473	(particulate)	2105	(organic)	472	(particulate)	473	(particulate)	
MDV Emission Factor (lbs/VMT)	(2)	1.79E-04	(TOG)	1.8E-05	(PM_{10})	8.1E-05	(PM_{10})	1.79E-04	(TOG)	1.8E-05	(PM_{10})	8.1E-05	(PM_{10})	
Maximum Daily Vehicle Trips (trips/day)	(3)	13		13		13		25		25		25		
Annual Vehicle Trips (trips/yr)	(3)	3,380		3,380		3,380		6,500		6,500		6,500		
Offsite Roundtrip Distance (mi/trip)	(3)	15.5		15.5		15.5		8.0		8.0		8.0		

TAC	CAS	TAC Emission Fraction of TOG (1)	Maximum Daily Emissions Estimate (a) (lbs/day)	Annual Average Emissions Estimate (b) (tons/yr)	TAC Emission Fraction of PM_{10} (1)	Maximum Daily Emissions Estimate (a) (lbs/day)	Annual Average Emissions Estimate (b) (tons/yr)	TAC Emission Fraction of PM_{10} (1)	Maximum Daily Emissions Estimate (a) (lbs/day)	Annual Average Emissions Estimate (b) (tons/yr)	Maximum Daily Emissions Estimate (lbs/day)	Annual Average Emissions Estimate (tons/yr)	TAC Emission Fraction of TOG (1)	Maximum Daily Emissions Estimate (a) (lbs/day)	Annual Average Emissions Estimate (b) (tons/yr)	TAC Emission Fraction of PM_{10} (1)	Maximum Daily Emissions Estimate (a) (lbs/day)	Annual Average Emissions Estimate (b) (tons/yr)	TAC Emission Fraction of PM_{10} (1)	Maximum Daily Emissions Estimate (a) (lbs/day)	Annual Average Emissions Estimate (b) (tons/yr)	Maximum Daily Emissions Estimate (lbs/day)	Annual Average Emissions Estimate (tons/yr)
1,3-Butadiene	106-99-0	5.5E-03	2.0E-04	2.6E-05	--	--	--	--	--	--	2.0E-04	2.6E-05	5.5E-03	2.0E-04	2.6E-05	--	--	--	--	--	--	2.0E-04	2.6E-05
2-Butanone	78-93-3	2.0E-04	7.2E-06	9.4E-07	--	--	--	--	--	--	7.2E-06	9.4E-07	2.0E-04	7.2E-06	9.3E-07	--	--	--	--	--	--	7.2E-06	9.3E-07
Acetaldehyde	75-07-0	2.8E-03	1.0E-04	1.3E-05	--	--	--	--	--	--	1.0E-04	1.3E-05	2.8E-03	1.0E-04	1.3E-05	--	--	--	--	--	--	1.0E-04	1.3E-05
Acrolein	107-02-8	1.3E-03	4.7E-05	6.1E-06	--	--	--	--	--	--	4.7E-05	6.1E-06	1.3E-03	4.7E-05	6.1E-06	--	--	--	--	--	--	4.7E-05	6.1E-06
Benzene	71-43-2	0.025	8.9E-04	1.2E-04	--	--	--	--	--	--	8.9E-04	1.2E-04	0.025	8.8E-04	1.2E-04	--	--	--	--	--	--	8.8E-04	1.2E-04
Ethylbenzene	100-41-4	0.011	3.8E-04	4.9E-05	--	--	--	--	--	--	3.8E-04	4.9E-05	0.011	3.8E-04	4.9E-05	--	--	--	--	--	--	3.8E-04	4.9E-05
Formaldehyde	50-00-0	0.016	5.7E-04	7.4E-05	--	--	--	--	--	--	5.7E-04	7.4E-05	0.016	5.7E-04	7.4E-05	--	--	--	--	--	--	5.7E-04	7.4E-05
Methanol	67-56-1	1.2E-03	4.3E-05	5.6E-06	--	--	--	--	--	--	4.3E-05	5.6E-06	1.2E-03	4.3E-05	5.6E-06	--	--	--	--	--	--	4.3E-05	5.6E-06
Naphthalene	91-20-3	5.0E-04	1.8E-05	2.3E-06	--	--	--	--	--	--	1.8E-05	2.3E-06	5.0E-04	1.8E-05	2.3E-06	--	--	--	--	--	--	1.8E-05	2.3E-06
n-Hexane	110-54-3	0.016	5.8E-04	7.5E-05	--	--	--	--	--	--	5.8E-04	7.5E-05	0.016	5.7E-04	7.5E-05	--	--	--	--	--	--	5.7E-04	7.5E-05
Propylene	115-07-1	0.031	1.1E-03	1.4E-04	--	--	--	--	--	--	1.1E-03	1.4E-04	0.031	1.1E-03	1.4E-04	--	--	--	--	--	--	1.1E-03	1.4E-04
Styrene	100-42-5	1.2E-03	4.3E-05	5.6E-06	--	--	--	--	--	--	4.3E-05	5.6E-06	1.2E-03	4.3E-05	5.6E-06	--	--	--	--	--	--	4.3E-05	5.6E-06
Toluene	108-88-3	0.058	2.1E-03	2.7E-04	--	--	--	--	--	--	2.1E-03	2.7E-04	0.058	2.1E-03	2.7E-04	--	--	--	--	--	--	2.1E-03	2.7E-04
m-Xylene	108-38-3	0.036	1.3E-03	1.7E-04	--	--	--	--	--	--	1.3E-03	1.7E-04	0.036	1.3E-03	1.7E-04	--	--	--	--	--	--	1.3E-03	1.7E-04
o-Xylene	95-47-6	0.012	4.5E-04	5.8E-05	--	--	--	--	--	--	4.5E-04	5.8E-05	0.012	4.4E-04	5.8E-05	--	--	--	--	--	--	4.4E-04	5.8E-05
Lead	7439-92-1	--	--	--	1.6E-04	5.7E-07	7.4E-08	5.0E-05	8.2E-07	1.1E-07	1.4E-06	1.8E-07	--	--	--	1.6E-04	5.6E-07	7.3E-08	5.0E-05	8.1E-07	1.1E-07	1.4E-06	1.8E-07
Manganese	7439-96-5	--	--	--	1.0E-04	3.6E-07	4.6E-08	1.7E-03	2.8E-05	3.6E-06	2.8E-05	3.7E-06	--	--	--	1.0E-04	3.5E-07	4.6E-08	1.7E-03	2.8E-05	3.6E-06	2.8E-05	3.6E-06
Nickel	7440-02-0	--	--	--	5.0E-05	1.8E-07	2.3E-08	6.6E-04	1.1E-05	1.4E-06	1.1E-05	1.4E-06	--	--	--	5.0E-05	1.8E-07	2.3E-08	6.6E-04	1.1E-05	1.4E-06	1.1E-05	1.4E-06
Arsenic	7440-38-2	--	--	--	No Data	--	--	1.0E-05	1.6E-07	2.1E-08	1.6E-07	2.1E-08	--	--	--	No Data	--	--	1.0E-05	1.6E-07	2.1E-08	1.6E-07	2.1E-08
Copper	7440-50-8	--	--	--	4.9E-04	1.7E-06	2.3E-07	0.011	1.9E-04	2.4E-05	1.9E-04	2.5E-05	--	--	--	4.9E-04	1.7E-06	2.2E-07	0.011	1.9E-04	2.4E-05	1.9E-04	2.4E-05
Vanadium	7440-62-2	--	--	--	No Data	--	--	6.6E-04	1.1E-05	1.4E-06	1.1E-05	1.4E-06	--	--	--	No Data	--	--	6.6E-04	1.1E-05	1.4E-06	1.1E-05	1.4E-06
Bromine	7726-95-6	--	--	--	1.5E-05	5.3E-08	6.9E-09	4.0E-05	6.5E-07	8.5E-08	7.1E-07	9.2E-08	--	--	--	1.5E-05	5.3E-08	6.9E-09	4.0E-05	6.5E-07	8.4E-08	7.0E-07	9.1E-08
Selenium	7782-49-2	--	--	--	2.0E-05	7.1E-08	9.2E-09	2.0E-05	3.3E-07	4.2E-08	4.0E-07	5.2E-08	--	--	--	2.0E-05	7.1E-08	9.2E-09	2.0E-05	3.2E-07	4.2E-08	3.9E-07	5.1E-08
Chlorine	7782-50-5	--	--	--	7.8E-03	2.8E-05	3.6E-06	1.5E-03	2.4E-05	3.2E-06	5.2E-05	6.8E-06	--	--	--	7.8E-03	2.8E-05	3.6E-06	1.5E-03	2.4E-05	3.2E-06	5.2E-05	6.7E-06

Notes:

(a) Maximum daily emissions estimate (lbs/day) = (Emission factor [lbs/VMT]) x (maximum daily vehicle trips [trips/day]) x (offsite roundtrip distance [mi/trip]) x (TAC emission fraction)

(b) Annual emissions estimate (tons/yr) = (Emission factor [lbs/VMT]) x (annual vehicle trips [trips/yr]) x (offsite roundtrip distance [mi/trip]) x (ton/2,000 lbs) x (TAC emission fraction)

References:

(1) California Air Resources Board Speciation Database. TAC emission fractions are derived from the individual speciation profiles listed. Profiles chosen to best represent the project vehicle fleet and existing gasoline formulation.

(2) Emission Factors source: EMFAC 2011 (model years to 2018).

(3) See Table E-1, Phase 1 Operations Input Assumptions for Emission Rate Calculations.

Table E-16
Natural Gas Boiler TAC Emission Estimates

Source		Natural Gas Boiler - Building 9	Natural Gas Boiler - Building 8	Natural Gas Boiler - Buildings 6 and 7	Total
Maximum Hourly Fuel Usage (MMBtu/hr)	(1)	12	12	24	
Daily Hours of Operation (hrs/day)	(1)	24	24	24	
Annual Fuel Usage (MMBtu/yr)	(1)	21,000	21,000	42,000	
Modeling ID		NGB_B9	NGB_B8	NGB_B6_7	

TAC	CAS	Emission Factor (lbs/MMscf)		Maximum Daily Emissions Estimate [a] (lbs/day)	Annual Average Emissions Estimate [b] (tons/yr)	Maximum Daily Emissions Estimate [a] (lbs/day)	Annual Average Emissions Estimate [b] (tons/yr)	Maximum Daily Emissions Estimate [a] (lbs/day)	Annual Average Emissions Estimate [b] (tons/yr)	Maximum Daily Emissions Estimate (lbs/day)	Annual Average Emissions Estimate (tons/yr)
7,12-Dimethylbenz(a)anthracene	57-97-6	1.6E-05	(2)	4.5E-06	1.6E-07	4.5E-06	1.6E-07	9.0E-06	3.3E-07	1.8E-05	6.6E-07
Acetaldehyde	75-07-0	8.9E-03	(3)	2.5E-03	9.1E-05	2.5E-03	9.1E-05	5.0E-03	1.8E-04	0.010	3.7E-04
Benzene	71-43-2	4.3E-03	(3)	1.2E-03	4.4E-05	1.2E-03	4.4E-05	2.4E-03	8.9E-05	4.9E-03	1.8E-04
Dichlorobenzene	25321-22-6	1.2E-03	(2)	3.4E-04	1.2E-05	3.4E-04	1.2E-05	6.8E-04	2.5E-05	1.4E-03	4.9E-05
Ethylbenzene	100-41-4	6.9E-03	(5)	1.9E-03	7.1E-05	1.9E-03	7.1E-05	3.9E-03	1.4E-04	7.8E-03	2.8E-04
Fluoranthene	206-44-0	3.0E-06	(2)	8.5E-07	3.1E-08	8.5E-07	3.1E-08	1.7E-06	6.2E-08	3.4E-06	1.2E-07
Formaldehyde	50-00-0	2.2E-01	(3)	0.062	2.3E-03	0.062	2.3E-03	0.12	4.6E-03	0.25	9.1E-03
n-Hexane	110-54-3	4.6E-03	(5)	1.3E-03	4.7E-05	1.3E-03	4.7E-05	2.6E-03	9.5E-05	5.2E-03	1.9E-04
Naphthalene	91-20-3	3.0E-04	(5)	8.5E-05	3.1E-06	8.5E-05	3.1E-06	1.7E-04	6.2E-06	3.4E-04	1.2E-05
Propylene	115-07-1	5.3E-01	(5)	0.15	5.5E-03	0.15	5.5E-03	0.30	0.011	0.60	0.022
Toluene	108-88-3	2.7E-02	(5)	7.5E-03	2.7E-04	7.5E-03	2.7E-04	0.015	5.5E-04	0.030	1.1E-03
Xylenes	1330-20-7	2.0E-02	(5)	5.6E-03	2.0E-04	5.6E-03	2.0E-04	0.011	4.1E-04	0.022	8.1E-04
Arsenic	7440-38-2	2.0E-04	(4)	5.6E-05	2.1E-06	5.6E-05	2.1E-06	1.1E-04	4.1E-06	2.3E-04	8.2E-06
Beryllium	7440-41-7	1.2E-05	(4)	3.4E-06	1.2E-07	3.4E-06	1.2E-07	6.8E-06	2.5E-07	1.4E-05	4.9E-07
Cadmium	7440-43-9	1.1E-03	(4)	3.1E-04	1.1E-05	3.1E-04	1.1E-05	6.2E-04	2.3E-05	1.2E-03	4.5E-05
Chromium VI	18540-29-9	2.4E-04	(6)	6.7E-05	2.5E-06	6.7E-05	2.5E-06	1.3E-04	4.9E-06	2.7E-04	9.8E-06
Cobalt	7440-48-4	8.4E-05	(4)	2.4E-05	8.6E-07	2.4E-05	8.6E-07	4.7E-05	1.7E-06	9.5E-05	3.5E-06
Copper	7440-50-8	8.5E-04	(4)	2.4E-04	8.8E-06	2.4E-04	8.8E-06	4.8E-04	1.8E-05	9.6E-04	3.5E-05
Lead	7439-92-1	5.0E-04	(7)	1.4E-04	5.1E-06	1.4E-04	5.1E-06	2.8E-04	1.0E-05	5.6E-04	2.1E-05
Manganese	7439-96-5	3.8E-04	(4)	1.1E-04	3.9E-06	1.1E-04	3.9E-06	2.1E-04	7.8E-06	4.3E-04	1.6E-05
Mercury	7439-97-6	2.6E-04	(4)	7.3E-05	2.7E-06	7.3E-05	2.7E-06	1.5E-04	5.4E-06	2.9E-04	1.1E-05
Nickel	7440-02-0	2.1E-03	(4)	5.9E-04	2.2E-05	5.9E-04	2.2E-05	1.2E-03	4.3E-05	2.4E-03	8.6E-05
Selenium	7782-49-2	2.4E-05	(4)	6.8E-06	2.5E-07	6.8E-06	2.5E-07	1.4E-05	4.9E-07	2.7E-05	9.9E-07

Notes:

(a) Daily emissions estimate (lbs/day) = (Emission factor [lbs/MMscf]) x (maximum hourly heat input [MMBtu/hr]) x (daily hours of operation [hrs/day]) / (natural gas heat content [Btu/scf])

Natural gas heat content (Btu/scf) = 1,020 (2)

(b) Annual emissions estimate (tons/yr) = (Emission factor [lbs/MMscf]) x (annual heat input [MMBtu/yr]) / (natural gas heat content [Btu/scf]) x (tons/2,000 lbs)

Natural gas heat content (Btu/scf) = 1,020 (2)

References:

(1) See Table E-1, Phase 1 Operations Input Assumptions for Emission Rate Calculations.
(2) AP-42 Chapter 1.4 (July 1998), Table 1.4-3 "Emission Factors For Speciated Organic Compounds from Natural Gas Combustion".
(3) California Air Toxics Emission Factor (CATEF) Database under Natural Gas Boilers.
(4) AP-42 Chapter 1.4 (July 1998), Table 1.4-4 "Emission Factors For Metals from Natural Gas Combustion".
(5) Ventura Air Quality Management District emission factor database.
(6) The AP-42 total chromium emission factor was multiplied by 17% to correct for emissions of hexavalent chromium per EPA assumptions when regulating combustion sources under 40 CFR Part 63 Subpart DDDD.
(7) AP-42 Chapter 1.4 (July 1998), Table 1.4-2 "Emission Factors for Criteria Pollutants and Greenhouse Gases from Natural Gas Combustion".

Table E-17
Emergency Diesel Generator TAC Emission Estimates

Source		Diesel Generator - Building 9	Diesel Generator - Building 8	Diesel Generator - Building 6	Diesel Generator - Building 7	Total
Generator Power Rating (BHP)	(1)	440	440	440	440	
Diesel Fuel Usage (gal/hr)	(1)	22.3	22.3	22.3	22.3	
Load Factor	(2)	0.74	0.74	0.74	0.74	
Annual Operation (hrs/yr)	(1)	25.15	25.15	25.15	25.15	
Modeling ID		DG_B9	DG_B8	DG_B6	DG_B7	

TAC	CAS	Emission Factor ($lbs/10^3$ gal)		Maximum Daily Emissions Estimate (lbs/day)		Annual Average Emissions Estimate [a] (tons/yr)	Maximum Daily Emissions Estimate (lbs/day)		Annual Average Emissions Estimate [a] (tons/yr)	Maximum Daily Emissions Estimate (lbs/day)		Annual Average Emissions Estimate [a] (tons/yr)	Maximum Daily Emissions Estimate (lbs/day)		Annual Average Emissions Estimate [a] (tons/yr)	Maximum Daily Emissions Estimate (lbs/day)	Annual Average Emissions Estimate (tons/yr)
DPM	9901	--	(3)	0.014	(b)	9.0E-05	0.014	(b)	9.0E-05	0.022	(b)	1.4E-04	0.022	(b)	1.4E-04	0.072	4.5E-04
1,3-Butadiene	106-99-0	2.17E-01	(4)	7.2E-03	(c)	4.5E-05	7.2E-03	(c)	4.5E-05	7.2E-03	(c)	4.5E-05	7.2E-03	(c)	4.5E-05	0.029	1.8E-04
Acetaldehyde	75-07-0	3.47E-03	(5)	1.1E-04	(c)	7.2E-07	1.1E-04	(c)	7.2E-07	1.1E-04	(c)	7.2E-07	1.1E-04	(c)	7.2E-07	4.6E-04	2.9E-06
Benzene	71-43-2	1.93E-01	(5)	6.4E-03	(c)	4.0E-05	6.4E-03	(c)	4.0E-05	6.4E-03	(c)	4.0E-05	6.4E-03	(c)	4.0E-05	0.026	1.6E-04
Benzo(a)anthracene	56-55-3	--	(6)	--		--	--		--	--		--	--		--	--	0
Benzo(b)fluoranthene	205-99-2	--	(6)	--		--	--		--	--		--	--		--	--	0
Benzo(k)fluoranthene	207-08-9	--	(6)	--		--	--		--	--		--	--		--	--	0
Chlorobenzene	108-90-7	2.00E-04	(4)	6.6E-06	(c)	4.2E-08	6.6E-06	(c)	4.2E-08	6.6E-06	(c)	4.2E-08	6.6E-06	(c)	4.2E-08	2.6E-05	1.7E-07
Chrysene	218-01-9	--	(6)	--		--	--		--	--		--	--		--	--	0
Dibenz(a,h)anthracene	53-70-3	--	(6)	--		--	--		--	--		--	--		--	--	0
Ethylbenzene	100-41-4	6.76E-03	(5)	2.2E-04	(c)	1.4E-06	2.2E-04	(c)	1.4E-06	2.2E-04	(c)	1.4E-06	2.2E-04	(c)	1.4E-06	8.9E-04	5.6E-06
Formaldehyde	50-00-0	5.06E-02	(5)	1.7E-03	(c)	1.0E-05	1.7E-03	(c)	1.0E-05	1.7E-03	(c)	1.0E-05	1.7E-03	(c)	1.0E-05	6.7E-03	4.2E-05
n-Hexane	110-54-3	1.39E-03	(5)	4.6E-05	(c)	2.9E-07	4.6E-05	(c)	2.9E-07	4.6E-05	(c)	2.9E-07	4.6E-05	(c)	2.9E-07	1.8E-04	1.2E-06
Hydrogen Chloride	7647-01-0	1.86E-01	(4)	6.2E-03	(c)	3.9E-05	6.2E-03	(c)	3.9E-05	6.2E-03	(c)	3.9E-05	6.2E-03	(c)	3.9E-05	0.025	1.5E-04
Indeno(1,2,3-cd)pyrene	193-39-5	--	(6)	--		--	--		--	--		--	--		--	--	0
Naphthalene	91-20-3	1.60E-02	(5)	5.3E-04	(c)	3.3E-06	5.3E-04	(c)	3.3E-06	5.3E-04	(c)	3.3E-06	5.3E-04	(c)	3.3E-06	2.1E-03	1.3E-05
Propylene	115-07-1	3.41E-01	(5)	0.011	(c)	7.1E-05	0.011	(c)	7.1E-05	0.011	(c)	7.1E-05	0.011	(c)	7.1E-05	0.045	2.8E-04
Toluene	108-88-3	6.12E-02	(5)	2.0E-03	(c)	1.3E-05	2.0E-03	(c)	1.3E-05	2.0E-03	(c)	1.3E-05	2.0E-03	(c)	1.3E-05	8.1E-03	5.1E-05
Xylenes	1330-20-7	4.24E-02	(4)	1.4E-03	(c)	8.8E-06	1.4E-03	(c)	8.8E-06	1.4E-03	(c)	8.8E-06	1.4E-03	(c)	8.8E-06	5.6E-03	3.5E-05
Arsenic	7440-38-2	1.60E-03	(4)	5.3E-05	(c)	3.3E-07	5.3E-05	(c)	3.3E-07	5.3E-05	(c)	3.3E-07	5.3E-05	(c)	3.3E-07	2.1E-04	1.3E-06
Cadmium	7440-43-9	1.50E-03	(4)	5.0E-05	(c)	3.1E-07	5.0E-05	(c)	3.1E-07	5.0E-05	(c)	3.1E-07	5.0E-05	(c)	3.1E-07	2.0E-04	1.2E-06
Chromium VI	18540-29-9	1.00E-04	(7)	3.3E-06	(c)	2.1E-08	3.3E-06	(c)	2.1E-08	3.3E-06	(c)	2.1E-08	3.3E-06	(c)	2.1E-08	1.3E-05	8.3E-08
Copper	7440-50-8	4.10E-03	(4)	1.4E-04	(c)	8.5E-07	1.4E-04	(c)	8.5E-07	1.4E-04	(c)	8.5E-07	1.4E-04	(c)	8.5E-07	5.4E-04	3.4E-06
Lead	7439-92-1	8.30E-03	(4)	2.7E-04	(c)	1.7E-06	2.7E-04	(c)	1.7E-06	2.7E-04	(c)	1.7E-06	2.7E-04	(c)	1.7E-06	1.1E-03	6.9E-06
Manganese	7439-96-5	3.10E-03	(4)	1.0E-04	(c)	6.4E-07	1.0E-04	(c)	6.4E-07	1.0E-04	(c)	6.4E-07	1.0E-04	(c)	6.4E-07	4.1E-04	2.6E-06
Mercury	7439-97-6	2.00E-03	(4)	6.6E-05	(c)	4.2E-07	6.6E-05	(c)	4.2E-07	6.6E-05	(c)	4.2E-07	6.6E-05	(c)	4.2E-07	2.6E-04	1.7E-06
Nickel	7440-02-0	3.90E-03	(4)	1.3E-04	(c)	8.1E-07	1.3E-04	(c)	8.1E-07	1.3E-04	(c)	8.1E-07	1.3E-04	(c)	8.1E-07	5.2E-04	3.2E-06
Selenium	7782-49-2	2.20E-03	(4)	7.3E-05	(c)	4.6E-07	7.3E-05	(c)	4.6E-07	7.3E-05	(c)	4.6E-07	7.3E-05	(c)	4.6E-07	2.9E-04	1.8E-06

Modeling ID		DG_B9	DG_B8	DG_B6	DG_B7
Diesel Particulate Emission Factor (g/hp-hr)	(6)	0.01	0.01	0.015	0.015

Notes:

(a) Annual average emission estimate (tons/yr) = (Maximum daily emissions estimate [lbs/day]) / (maximum daily hours of operation [hrs/day]) x (annual hours of operation [hrs/yr]) x (ton/2,000 lbs)
Maximum daily hours of operation (hrs/day) = 2 (1)

(b) Daily diesel particulate emissions estimate (lbs/day) = (Emission factor [g/hp-hr]) x (engine horsepower [hp]) x (load factor) / (453.59 [g/lb]) x (maximum daily hours of operation [hrs/day])
Maximum daily hours of operation (hrs/day) = 2 (1)

(c) Daily emissions estimate (lbs/day) = (Emission factor [$lbs/10^3$ gal]) x (load factor) x (fuel usage [gal/hr]) x (0.001 [gal/10^3 gal]) x (maximum daily hours of operation [hrs/day])
Maximum daily hours of operation (hrs/day) = 2 (1)

References:

(1) See Table E-1, Phase 1 Operations Input Assumptions for Emission Rate Calculations.
(2) Default load factor for generators in URBEMIS emission model.
(3) See diesel particulate matter emission factors at the bottom of the table.
(4) Ventura County Air Pollution Control District AB 2588 Combustion Emission Factors Database, May 2001.
(5) California Toxic Emission Factor (CATEF) Database, except for Diesel PM. The emission factors for each TAC are averaged for diesel internal combustion engines operating at less than 13% oxygen in the exhaust. Per vendor information, the percent oxygen in the exhaust is less than 13% at loads greater than 50%. It is assumed that the generator would be run at 50% load or greater.
(6) Polycyclic Aromatic Hydrocarbons (PAHs) are assumed to be included in the particulate matter emission factor. PAHs that are not specifically listed in this table, but may be included in the particulate matter emission factor, include Acenaphthylene, Anthracene, Acenaphthene, Benzo(a)anthracene, Benzo(a)pyrene, Benzo(b)fluoranthene, Benzo(k)fluoranthene, Benzo(g,h,i)perylene, Chrysene, Dibenz(a,h)anthracene, Fluoranthene, Fluorene, Indeno(1,2,3-cd)pyrene, Phenanthrene, and Pyrene. For purposes of this inventory, it is assumed that all particulate is represented as Diesel Particulate Matter (DPM).
(7) The AP-42 total chromium emission factor was multiplied by 17% to correct for emissions of hexavalent chromium per EPA assumptions when regulating combustion sources under 40 CFR Part 63 Subpart DDDD.

Table E-18
Cooling Tower TAC Emission Estimates

Source		Cooling Tower - Building 9	Cooling Tower - Building 8	Cooling Tower - Buildings 6 and 7	Total
PM_{10} Emission Rate (lbs/day)	(1)	1.29	1.29	2.58	
Annual Operation (hrs/yr)	(2)	6,360	6,360	6,360	
Modeling ID		CTB9C#	CTB8C#	CTB6_7C#	

Pollutant	CAS	Maximum Daily Emissions Estimate [a] (lbs/day)	Annual Average Emissions Estimate [b] (tons/yr)	Maximum Daily Emissions Estimate [a] (lbs/day)	Annual Average Emissions Estimate [b] (tons/yr)	Maximum Daily Emissions Estimate [a] (lbs/day)	Annual Average Emissions Estimate [b] (tons/yr)	Maximum Daily Emissions Estimate (lbs/day)	Annual Average Emissions Estimate (tons/yr)
Bromine	7726-95-6	2.4E-03	3.2E-04	2.4E-03	3.2E-04	4.8E-03	6.4E-04	9.6E-03	1.3E-03

Notes:

(a) Maximum daily emissions estimate (lbs/day) = (PM_{10} emission rate [lbs/day]) x (ChemTreat CL-4910 bromine concentration [ppm]) / (total dissolved solids concentration [ppm])

ChemTreat CL-4910 bromine concentration (ppm) = 1 (3)

Total dissolved solids concentration (ppmw) = 536 (2)

(b) Annual emissions estimate (tons/yr) = (Daily emissions [lbs/day]) / (daily hours of operation [hrs/day]) x (annual hours of operation [hrs/yr]) x (ton/2,000 lbs)

Daily hours of operation (hrs/day) = 24 (2)

References:

(1) See Table E-10, Cooling Tower Particulate Emission Estimates.
(2) See Table E-1, Phase 1 Operations Input Assumptions for Emission Rate Calculations.
(3) Provided by ChemTreat.

Table E-19

Total Estimated Air Emissions of Laboratory Non-Radionuclide Liquid Chemicals [1]

TAC	CAS Number	Building 9 LAB_B9			Building 8 LAB_B8			Building 6 & 7 LAB_B6_7			Total	
		Estimated Emissions (grams/yr)	Daily Emissions Estimate (lbs/day) [a]	Annual Emissions Estimate (tons/yr) [b]	Estimated Emissions (grams/yr)	Daily Emissions Estimate (lbs/day) [a]	Annual Emissions Estimate (tons/yr) [b]	Estimated Emissions (grams/yr)	Daily Emissions Estimate (lbs/day) [a]	Annual Emissions Estimate (tons/yr) [b]	Daily Emissions Estimate (lbs/day)	Annual Emissions Estimate (tons/yr)
1,3-Butadiene	106-99-0	--	--	--	286	2.4E-03	3.2E-04	--	--	--	2.4E-03	3.2E-04
1,4-Dioxane	123-91-1	322	2.7E-03	3.5E-04	2,773	0.024	3.1E-03	--	--	--	0.026	3.4E-03
Acetaldehyde	75-07-0	--	--	--	144	1.2E-03	1.6E-04	--	--	--	1.2E-03	1.6E-04
Acrolein	107-02-8	--	--	--	--	--	--	70.1	5.9E-04	7.7E-05	5.9E-04	7.7E-05
Acrylic acid	79-10-7	--	--	--	9.99	8.5E-05	1.1E-05	--	--	--	8.5E-05	1.1E-05
Aniline	62-53-3	--	--	--	2.22	1.9E-05	2.4E-06	0.22	1.9E-06	2.4E-07	2.1E-05	2.7E-06
Benzene	71-43-2	467	4.0E-03	5.1E-04	1,005	8.5E-03	1.1E-03	467	4.0E-03	5.1E-04	0.016	2.1E-03
Benzyl chloride	100-44-7	--	--	--	5.16	4.4E-05	5.7E-06	--	--	--	4.4E-05	5.7E-06
Bromine	7726-95-6	--	--	--	1.13	9.5E-06	1.2E-06	--	--	--	9.5E-06	1.2E-06
Carbon tetrachloride	56-23-5	--	--	--	--	--	--	295	2.5E-03	3.2E-04	2.5E-03	3.2E-04
Chloroform	67-66-3	11255	0.095	0.012	16,775	0.14	0.018	18,574	0.16	0.020	0.40	0.051
Diethanolamine	111-42-2	8.6E-04	7.3E-09	9.5E-10	4.3E-04	3.7E-09	4.7E-10	1.7E-03	1.5E-08	1.9E-09	2.6E-08	3.3E-09
Dimethyl formamide	68-12-2	11.56	9.8E-05	1.3E-05	179	1.5E-03	2.0E-04	325	2.8E-03	3.6E-04	4.4E-03	5.7E-04
Epichlorohydrin	106-89-8	--	--	--	14.8	1.3E-04	1.6E-05	--	--	--	1.3E-04	1.6E-05
Ethylbenzene	100-41-4	--	--	--	90.7	7.7E-04	1.0E-04	--	--	--	7.7E-04	1.0E-04
Ethylene dichloride [EDC]	107-06-2	--	--	--	2,083	0.018	2.3E-03	--	--	--	0.018	2.3E-03
Ethylene glycol	107-21-1	1.59	1.3E-05	1.8E-06	1.06	9.0E-06	1.2E-06	2.76	2.3E-05	3.0E-06	4.6E-05	6.0E-06
Ethylene glycol monomethyl ether	109-86-4	--	--	--	76.9	6.5E-04	8.5E-05	--	--	--	6.5E-04	8.5E-05
Formaldehyde	50-00-0	1707	0.014	1.9E-03	788	6.7E-03	8.7E-04	9897	0.084	0.011	1.1E-01	0.014
Glutaraldehyde	111-30-8	9	7.6E-05	9.8E-06	3	2.5E-05	3.3E-06	33	2.8E-04	3.6E-05	3.8E-04	4.9E-05
n-Hexane	110-54-3	1975	0.017	2.2E-03	31772	0.27	0.035	6258	0.053	6.9E-03	3.4E-01	0.044
Hydrogen Chloride	7647-01-0	6332	0.054	7.0E-03	11097	0.094	0.012	20562	0.17	0.023	3.2E-01	0.042
Hydrogen fluoride	7664-39-3	--	--	--	--	--	--	37	3.2E-04	4.1E-05	3.2E-04	4.1E-05
Isopropyl alcohol	67-63-0	10455	0.089	0.012	10594	0.090	0.012	14334	0.12	0.016	3.0E-01	0.039
Lindane [gamma-Hexachlorocyclohexane]	58-89-9	--	--	--	--	--	--	1.2E-04	1.0E-09	1.3E-10	1.0E-09	1.3E-10
m-Cresol	108-39-4	--	--	--	5.9E-01	5.0E-06	6.5E-07	5.9E-01	5.0E-06	6.5E-07	1.0E-05	1.3E-06
Methanol	67-56-1	1910	0.016	2.1E-03	29593	0.25	0.033	13839	0.12	0.015	3.8E-01	0.050
2-Butanone	78-93-3	--	--	--	974	8.3E-03	1.1E-03	--	--	--	8.3E-03	1.1E-03
Methyl tert-butyl ether	1634-04-4	--	--	--	612	5.2E-03	6.7E-04	70	5.9E-04	7.7E-05	5.8E-03	7.5E-04
Methylene chloride [Dichloromethane]	75-09-2	70.3	6.0E-04	7.7E-05	49576	0.42	0.055	1054	8.9E-03	1.2E-03	4.3E-01	0.056
Nitric acid	7697-37-2	389	3.3E-03	4.3E-04	1477	0.013	1.6E-03	--	--	--	1.6E-02	2.1E-03
Tetrachloroehtene	127-18-4	--	--	--	236	2.0E-03	2.6E-04	--	--	--	2.0E-03	2.6E-04
Phosphoric acid	7664-38-2	1.4	1.2E-05	1.5E-06	2.29	1.9E-05	2.5E-06	2	1.4E-05	1.9E-06	4.6E-05	5.9E-06
Propylene glycol monomethyl ether	107-98-2	4.8	4.1E-05	5.3E-06	4.85	4.1E-05	5.3E-06	--	--	--	8.2E-05	1.1E-05
Propylene oxide	75-56-9	--	--	--	--	--	--	4.2E-01	3.6E-06	4.7E-07	3.6E-06	4.7E-07
Styrene	100-42-5	--	--	--	27.3	2.3E-04	3.0E-05	--	--	--	2.3E-04	3.0E-05
Sulfuric acid	7664-93-9	15.23	1.3E-04	1.7E-05	93.6	7.9E-04	1.0E-04	78	6.6E-04	8.6E-05	1.6E-03	2.1E-04
Toluene	108-88-3	70.0	5.9E-04	7.7E-05	2685	0.023	3.0E-03	1881	0.016	2.1E-03	3.9E-02	5.1E-03
Trichloroethylene	79-01-6	--	--	--	794	6.7E-03	8.8E-04	265	2.2E-03	2.9E-04	9.0E-03	1.2E-03
Triethylamine	121-44-8	--	--	--	992	8.4E-03	1.1E-03	285	2.4E-03	3.1E-04	1.1E-02	1.4E-03
Xylenes	1330-20-7	--	--	--	--	--	--	869	7.4E-03	9.6E-04	7.4E-03	9.6E-04
Total - All Chemicals Listed		**34,995**	**0.30**	**0.039**	**164,769**	**1.40**	**0.18**	**89,198**	**0.76**	**0.098**	**2.45**	**0.32**

Notes:

(a) Estimated emissions (lbs/day) = (Estimated emissions [grams/year]) x (lbs/453.59 grams) / (annual operation [days/year])

Annual operation for all buildings (days/year) = 260 (2)

(b) Estimated emissions (tons/yr) = (Estimated emissions [grams/yr]) x (lbs/453.59 g) x (tons/2,000 lbs)

References:

(1) See emission estimation methods in Appendix G.

(2) See Table E-1, Phase 1 Operations Input Assumptions for Emission Rate Calculations.

Table E-20
Phase 1 Operations TAC Emissions Summary

TAC	CAS	Natural Gas Boilers		Diesel Generators		Cooling Towers		Laboratory Buildings		Onsite Onroad Exhaust		Offsite Onroad Exhaust		Total	
		(lbs/day)	(tons/yr)	(lbs/day)	(tons/yr)	(lbs/day)	(tons/yr)	(lbs/day)	(tons/yr)	(lbs/day)	(tons/yr)	(lbs/day)	(tons/yr)	(lbs/day)	(tons/yr)
DPM (1)	9-90-1	--	--	0.072	4.5E-04	--	--	--	--	2.4E-03	3.1E-04	0.027	3.5E-03	0.10	4.2E-03
1,3-Butadiene	106-99-0	--	--	0.029	1.8E-04	--	--	2.4E-03	3.2E-04	6.2E-03	8.1E-04	0.015	2.0E-03	0.053	3.3E-03
1,4-Dioxane	123-91-1	--	--	--	--	--	--	0.026	3.4E-03	--	--	--	--	0.026	3.4E-03
2-Butanone	78-93-3	--	--	--	--	--	--	8.3E-03	1.1E-03	4.6E-04	6.0E-05	5.6E-04	7.3E-05	9.3E-03	1.2E-03
7,12-Dimethylbenz(a)anthracene	57-97-6	1.8E-05	6.6E-07	--	--	--	--	--	--	--	--	--	--	1.8E-05	6.6E-07
Acetaldehyde	75-07-0	0.010	3.7E-04	4.6E-04	2.9E-06	--	--	1.2E-03	1.6E-04	4.3E-03	5.6E-04	7.9E-03	1.0E-03	0.024	2.1E-03
Acrolein	107-02-8	--	--	--	--	--	--	5.9E-04	7.7E-05	1.1E-03	1.4E-04	3.7E-03	4.7E-04	5.3E-03	7.0E-04
Acrylic acid	79-10-7	--	--	--	--	--	--	8.5E-05	1.1E-05	--	--	--	--	8.5E-05	1.1E-05
Aniline	62-53-3	--	--	--	--	--	--	2.1E-05	2.7E-06	--	--	--	--	2.1E-05	2.7E-06
Arsenic	7440-38-2	2.3E-04	8.2E-06	2.1E-04	1.3E-06	--	--	--	--	--	--	3.4E-05	4.4E-06	4.7E-04	1.4E-05
Benzene	71-43-2	4.9E-03	1.8E-04	0.026	1.6E-04	--	--	0.016	2.1E-03	0.041	5.3E-03	0.069	9.0E-03	0.16	0.017
Benzyl chloride	100-44-7	--	--	--	--	--	--	4.4E-05	5.7E-06	--	--	--	--	4.4E-05	5.7E-06
Beryllium	7440-41-7	1.4E-05	4.9E-07	--	--	--	--	--	--	--	--	--	--	1.4E-05	4.9E-07
Bromine	7726-95-6	--	--	--	--	9.6E-03	1.3E-03	9.5E-06	1.2E-06	--	--	1.5E-04	1.9E-05	9.8E-03	1.3E-03
Cadmium	7440-43-9	1.2E-03	4.5E-05	2.0E-04	1.2E-06	--	--	--	--	--	--	--	--	1.4E-03	4.7E-05
Carbon tetrachloride	56-23-5	--	--	--	--	--	--	2.5E-03	3.2E-04	--	--	--	--	2.5E-03	3.2E-04
Chlorine	7782-50-5	--	--	--	--	--	--	--	--	--	--	0.011	1.4E-03	0.011	1.4E-03
Chlorobenzene	108-90-7	--	--	2.6E-05	1.7E-07	--	--	--	--	--	--	--	--	2.6E-05	1.7E-07
Chloroform	67-66-3	--	--	--	--	--	--	0.40	0.051	--	--	--	--	0.40	0.051
Chromium VI	18540-29-9	2.7E-04	9.8E-06	1.3E-05	8.3E-08	--	--	--	--	--	--	--	--	2.8E-04	9.9E-06
Cobalt	7440-48-4	9.5E-05	3.5E-06	--	--	--	--	--	--	--	--	--	--	9.5E-05	3.5E-06
Copper	7440-50-8	9.6E-04	3.5E-05	5.4E-04	3.4E-06	--	--	--	--	--	--	0.039	5.1E-03	0.041	5.2E-03
Dichlorobenzene	25321-22-6	1.4E-03	4.9E-05	--	--	--	--	--	--	--	--	--	--	1.4E-03	4.9E-05
Diethanolamine	111-42-2	--	--	--	--	--	--	2.6E-08	3.3E-09	--	--	--	--	2.6E-08	3.3E-09
Dimethyl formamide	68-12-2	--	--	--	--	--	--	4.4E-03	5.7E-04	--	--	--	--	4.4E-03	5.7E-04
Epichlorohydrin	106-89-8	--	--	--	--	--	--	1.3E-04	1.6E-05	--	--	--	--	1.3E-04	1.6E-05
Ethylbenzene	100-41-4	7.8E-03	2.8E-04	8.9E-04	5.6E-06	--	--	7.7E-04	1.0E-04	0.041	5.4E-03	0.030	3.8E-03	0.080	9.6E-03
Ethylene dichloride [EDC]	107-06-2	--	--	--	--	--	--	0.018	2.3E-03	--	--	--	--	0.018	2.3E-03
Ethylene glycol	107-21-1	--	--	--	--	--	--	4.6E-05	6.0E-06	--	--	--	--	4.6E-05	6.0E-06
Ethylene glycol monomethyl ether	109-86-4	--	--	--	--	--	--	6.5E-04	8.5E-05	--	--	--	--	6.5E-04	8.5E-05
Fluoranthene	206-44-0	3.4E-06	1.2E-07	--	--	--	--	--	--	--	--	--	--	3.4E-06	1.2E-07
Formaldehyde	50-00-0	0.25	9.1E-03	6.7E-03	4.2E-05	--	--	0.11	0.014	0.013	1.7E-03	0.044	5.8E-03	0.42	0.030
Glutaraldehyde	111-30-8	--	--	--	--	--	--	3.8E-04	4.9E-05	--	--	--	--	3.8E-04	4.9E-05
Hydrogen Chloride	7647-01-0	--	--	0.025	1.5E-04	--	--	0.32	0.042	--	--	--	--	0.35	0.042
Hydrogen fluoride	7664-39-3	--	--	--	--	--	--	3.2E-04	4.1E-05	--	--	--	--	3.2E-04	4.1E-05
Isopropyl alcohol	67-63-0	--	--	--	--	--	--	0.30	0.039	--	--	--	--	0.30	0.039
Lead	7439-92-1	5.6E-04	2.1E-05	1.1E-03	6.9E-06	--	--	--	--	--	--	2.9E-04	3.8E-05	1.9E-03	6.5E-05
Lindane [gamma-Hexachlorocyclohexane]	58-89-9	--	--	--	--	--	--	1.0E-09	1.3E-10	--	--	--	--	1.0E-09	1.3E-10
Manganese	7439-96-5	4.3E-04	1.6E-05	4.1E-04	2.6E-06	--	--	--	--	--	--	5.9E-03	7.6E-04	6.7E-03	7.8E-04
m-Cresol	108-39-4	--	--	--	--	--	--	1.0E-05	1.3E-06	--	--	--	--	1.0E-05	1.3E-06
Mercury	7439-97-6	2.9E-04	1.1E-05	2.6E-04	1.7E-06	--	--	--	--	--	--	--	--	5.6E-04	1.2E-05
Methanol	67-56-1	--	--	--	--	--	--	0.38	0.050	2.5E-03	3.2E-04	3.4E-03	4.4E-04	0.39	0.051
Methyl tert-butyl ether	1634-04-4	--	--	--	--	--	--	5.8E-03	7.5E-04	--	--	--	--	5.8E-03	7.5E-04
Methylene chloride [Dichloromethane]	75-09-2	--	--	--	--	--	--	0.43	0.056	--	--	--	--	0.43	0.056
Naphthalene	91-20-3	3.4E-04	1.2E-05	2.1E-03	1.3E-05	--	--	--	--	2.9E-03	3.8E-04	1.4E-03	1.8E-04	6.8E-03	5.9E-04
n-Hexane	110-54-3	5.2E-03	1.9E-04	1.8E-04	1.2E-06	--	--	0.34	0.044	0.034	4.4E-03	0.045	5.8E-03	0.42	0.055
Nickel	7440-02-0	2.4E-03	8.6E-05	5.2E-04	3.2E-06	--	--	--	--	--	--	2.3E-03	3.0E-04	5.2E-03	3.9E-04
Nitric acid	7697-37-2	--	--	--	--	--	--	0.016	2.1E-03	--	--	--	--	0.016	2.1E-03
Phosphoric acid	7664-38-2	--	--	--	--	--	--	4.6E-05	5.9E-06	--	--	--	--	4.6E-05	5.9E-06
Propylene	115-07-1	0.60	0.022	0.045	2.8E-04	--	--	--	--	0.031	4.0E-03	0.086	0.011	0.76	0.037
Propylene glycol monomethyl ether	107-98-2	--	--	--	--	--	--	8.2E-05	1.1E-05	--	--	--	--	8.2E-05	1.1E-05
Propylene oxide	75-56-9	--	--	--	--	--	--	3.6E-06	4.7E-07	--	--	--	--	3.6E-06	4.7E-07
Selenium	7782-49-2	2.7E-05	9.9E-07	2.9E-04	1.8E-06	--	--	--	--	--	--	8.3E-05	1.1E-05	4.0E-04	1.4E-05
Styrene	100-42-5	--	--	--	--	--	--	2.3E-04	3.0E-05	2.1E-03	2.7E-04	3.4E-03	4.4E-04	5.7E-03	7.4E-04
Sulfuric acid	7664-93-9	--	--	--	--	--	--	1.6E-03	2.1E-04	--	--	--	--	1.6E-03	2.1E-04
Tetrachloroehtene	127-18-4	--	--	--	--	--	--	2.0E-03	2.6E-04	--	--	--	--	2.0E-03	2.6E-04
Toluene	108-88-3	0.030	1.1E-03	8.1E-03	5.1E-05	--	--	0.039	5.1E-03	0.16	0.020	0.16	0.021	0.40	0.048
Trichloroethylene	79-01-6	--	--	--	--	--	--	9.0E-03	1.2E-03	--	--	--	--	9.0E-03	1.2E-03
Triethylamine	121-44-8	--	--	--	--	--	--	0.011	1.4E-03	--	--	--	--	0.011	1.4E-03
Vanadium	7440-62-2	--	--	--	--	--	--	--	--	--	--	2.2E-03	2.9E-04	2.2E-03	2.9E-04
m-Xylene	108-38-3	--	--	--	--	--	--	--	--	0.092	0.012	0.10	0.013	0.19	0.025
o-Xylene	95-47-6	--	--	--	--	--	--	--	--	0.043	5.6E-03	0.035	4.5E-03	0.078	0.010
p-Xylene	106-42-3	--	--	--	--	--	--	--	--	0.023	3.0E-03	--	--	0.023	3.0E-03
Xylenes	1330-20-7	0.022	8.1E-04	5.6E-03	3.5E-05	--	--	7.4E-03	9.6E-04	--	--	--	--	0.035	1.8E-03
NO_2	10102-44-0	21.1	0.77	5.17	0.032	--	--	--	--	1.19	0.16	9.06	1.18	36.6	2.14
SO_2	7446-09-5	0.68	0.025	0.037	2.4E-04	--	--	--	--	3.6E-03	4.7E-04	0.32	0.042	1.04	0.067
CO	630-08-0	94.9	3.46	13.8	0.087	--	--	--	--	14.0	1.82	81.9	10.6	204	16.0

References:

(1) On-site DPM emissions. Assumes all PM10 emissions from mobile source combustion equals diesel particulate matter (DPM). See Table E-11, Criteria Pollutant Emissions Summary, for DPM emissions from onsite onroad sources.

Appendix F

Emissions Estimates – Full LRDP Operations

Table F-1
LRDP Operations Input Assumptions for Emission Rate Calculations

Source	*Building Size (gsf)*	*Diesel Emergency Generators*		*Natural Gas Boilers*			*Cooling Towers*		
		Engine Size (BHP)	Fuel Usage (gal/hr)	Maximum Heat Input (MMBtu/hr)	Daily Operation (hrs/day)	Annual Fuel Usage (MMBtu/yr)	Number of Cells	Cell Size (tons/cell)	Total Recirc. Rate (gpm)
Building NRLF	352,000	700	35.5 [a]	23	24	31,923	8	500	12,000 [b]
Buildings 6 and 7	253,954	--	--	24 [4]	24	42,000 [4]	6 [4]	500 [4]	9,000 [b]
Building 6	--	440 [3]	22.3 [a]	--	--	--	--	--	--
Building 7	--	440 [3]	22.3 [a]	--	--	--	--	--	--
Building 8	110,510	440 [4]	22.3 [a]	12 [4]	24	21,000 [4]	3 [4]	500 [4]	4,500 [b]
Building 9	137,451	440 [4]	22.3 [a]	12 [4]	24	21,000 [4]	3 [4]	500 [4]	4,500 [b]
Building 10	117,700	410	20.8 [a]	11	24	15,267	3	500	4,500 [b]
Building 11	67,280	240	12.2 [a]	6	24	8,328	2	400	2,400 [b]
Building 12	119,504	420	21.3 [a]	11	24	15,267	3	500	4,500 [b]
Building 13	84,894	170	8.6 [a]	6	24	8,328	2	400	2,400 [b]
Building 14	81,472	290	14.7 [a]	8	24	11,104	2	500	3,000 [b]
Building 15	137,820	480	24.3 [a]	13	24	18,043	3	500	4,500 [b]
Building 16	160,604	560	28.4 [a]	15	24	20,819	4	500	6,000 [b]
Building 17	170,085	600	30.4 [a]	16	24	22,207	4	500	6,000 [b]
Building 18	144,805	510	25.9 [a]	14	24	19,431	3	600	5,400 [b]
Building 19	129,795	460	23.3 [a]	12	24	16,655	3	500	4,500 [b]
Building 20	128,560	450	22.8 [a]	12	24	16,655	3	500	4,500 [b]
Building 21	290,240	510 [3]	25.9 [a]	28	24	38,863	7	500	10,500 [b]
Building 21 (Generator B)	--	510 [3]	25.9 [a]	--	--	--	--	--	--
Building 22	200,645	700	35.5 [a]	19	24	26,371	5	500	7,500 [b]
Building 23	151,650	530	26.9 [a]	14	24	19,431	4	500	6,000 [b]
Building 24	130,000	460	23.3 [a]	12	24	16,655	3	500	4,500 [b]
Building 25	180,770	630	32.0 [a]	17	24	23,595	4	500	6,000 [b]
Building 26	174,400	610	30.9 [a]	17	24	23,595	4	500	6,000 [b]
Building 27	167,612	590	29.9 [a]	16	24	22,207	4	500	6,000 [b]
Building 28	66,808	230	11.7 [a]	6	24	8,328	2	400	2,400 [b]
Building 29	90,216	180	9.1 [a]	6	24	8,328	2	400	2,400 [b]
Building 30	169,768	600	30.4 [a]	16	24	22,207	4	500	6,000 [b]
Building 31	90,927	180	9.1 [a]	6	24	8,328	2	400	2,400 [b]
Building 32	138,545	490	24.9 [a]	13	24	18,043	3	500	4,500 [b]
Building 33	165,490	580	29.4 [a]	16	24	22,207	4	500	6,000 [b]
Building 34	173,790	610	30.9 [a]	17	24	23,595	4	500	6,000 [b]
Building 35	199,630	700	35.5 [a]	19	24	26,371	5	500	7,500 [b]
Building 36	193,275	680	34.5 [a]	18	24	24,983	5	500	7,500 [b]
Building 37	209,615	740	37.5 [a]	20	24	27,759	5	500	7,500 [b]
Building 38	112,761	230	11.7 [a]	8	24	11,104	2	500	3,000 [b]
Total	5,102,576	16810	852.7	463	--	660,000 [5]	--	--	179,400

Table F-1 (continued)
LRDP Operations Input Assumptions for Emission Rate Calculations

Source	Source Parameter		Short Term Input (units)		Annual Input (units)	
Employee and Facility Data						
	Number of Employees		10,000	(4)	--	
	Average Building Occupancy		10 (hrs/day)	(6)	260 (days/yr)	(7)
	Emergency Generator Usage		2 (hrs/day)	(8)	25.15 (hrs/yr)	(8)
	Cooling Tower Usage		24 (hrs/day)		6,360 (hrs/yr)	(9)
Vehicle Data						
	Vehicle Trips	**Daily Operation (hrs/day)**	**Maximum Daily (trips/day)**		**Average Annual (trips/yr)**	
	Employee Trips	16	20,081	(10)	5,221,060	(11)
	Delivery Truck Trips	16	102	(12)	26,432	(13)
	LBNL - RBC Shuttle Trips	13 (14)	13	(14)	3,380	(14)
	BART - RBC Shuttle Trips	13 (14)	25	(14)	6,500	(14)
	Total trips		20,221		5,257,372	
	Vehicle Idling Times and Round Trip Distances	**Onsite Idling Time (min/trip)**	**Onsite Round Trip Distance (mi/trip)**		**Offsite Round Trip Distance (mi/trip)**	
	Employee Vehicles	0 (15)	0.685	(16)	20.6	(c)
	Delivery Trucks	0.08 (20)	1.680	(16)	12.9	(21)
	LBNL - RBC Shuttle	0.08 (22)	0.730	(16)	15.5	(23)
	BART - RBC Shuttle	0.08 (22)	0.730	(16)	8	(23)
	Employee Offsite Round Trip Distance - Modeling (mi/trip)				0.685	(16)
	Delivery Truck Offsite Round Trip Distance - Modeling (mi/trip)				2.434	(16)
	LBNL - RBC Shuttle Round Trip Distance - Modeling (mi/trip)				1.770	(16)
	BART - RBC Shuttle Round Trip Distance (mi/trip)				1.770	(16)
	Average Vehicle Weights				**Average Weight (tons)**	
	Employee Vehicles				2.4	(24)
	Delivery Trucks				13	(25)
	LBNL - RBC Shuttle				4.2	(26)
	BART - RBC Shuttle				4.2	(26)
	Mean Vehicle Weight Calculation		**Daily Basis (tons)**		**Annual Basis (tons)**	
	Employee Mean Vehicle Weight portion (ton)		2.38	(d)	2.38	(d)
	Delivery Truck Mean Vehicle Weight Portion (ton)		0.065	(d)	0.065	(d)
	LBNL - RBC Shuttle Mean Vehicle Weight Portion (ton)		0.003	(d)	0.003	(d)
	BART - RBC Shuttle Mean Vehicle Weight Portion (ton)		0.005	(d)	0.005	(d)
	Mean Vehicle Weight - sum of weight portions (ton)		2.46		2.46	
Additional Site-Specific Data and Constants Used for Emission Calculations						
	Cooling Towers - Equivalent Ton Water Usage (gpm/ton)		3			(e)
	Cooling Towers - Total Dissolved Solids Concentration (ppm)		536			(27)
	Roads - P = No. of Days with Precip. > 0.01 in. (days/yr)		62			(28)

Table F-1 (continued)
LRDP Operations Input Assumptions for Emission Rate Calculations

Notes:

(a) Engine fuel consumption (gal/hr) = (Engine size [hp]) x (average brake-specific fuel consumption [Btu/hp-hr]) / (liquid fuel higher heating value [Btu/gal])

Average brake-specific fuel consumption (Btu/hp-hr) =	7,000	(1)
Liquid fuel higher heating value (Btu/gal) =	138,000	(2)

(b) Recirculation rate (gpm) = (Number of cooling tower cells) x (heat removal equivalent tons per cell [tons/cell]) x (equivalent ton water usage [gpm/ton])

(c) Offsite round trip distance (mi/trip) = {(Primary trip length [mi]) x (primary trip percentage [%]) + (primary trip length [mi]) x (diverted trip percentage [%]) x (diverted trip percentage of primary trip length [%]) + (pass-by trip percentage [%]) x (pass-by trip length [mi])} x 2 - (onsite round trip distance [mi/trip])

Primary trip length (mi) =	12.4	(17)
Primary trip percentage (%) =	82	(18)
Diverted trip percentage of primary trip length (%) =	25	(19)
Diverted trip percentage (%) =	15	(18)
Pass-by trip length (mi) =	0.1	(19)
Pass-by trip percentage (%) =	3	(18)

(d) Mean vehicle weight portions (tons) = (Individual vehicle trips [trips/day or trips/yr]) / (total vehicle trips [trips/day or trips/yr]) x (individual vehicle average weight [tons])

(e) Equivalent ton water usage (gpm/ton) = (15,000 Btu/hr/ton) x (hr/60 min) x (gal/8.337 lbs) / (1 Btu/lb-°F) / (10 °F temperature differential)

References:

(1) AP-42 Chapter 3.3 (October 1996), Footnote to Table 3.3-1, "Emission Factors for Uncontrolled Gasoline and Diesel Industrial Engines".
(2) ULSD higher heating value.
(3) Buildings 6 & 7 and Building 21 will each have two generators. For Buildings 6 & 7, the generators will total 880 hp and for Building 21, the generators will total 1,020 hp.
(4) January 17, 2013 LBNL responses.
(5) The annual fuel usage is described in the project description.
(6) Assumes laboratory work is conducted over 10 hours per day. This conservatively estimates hourly emissions .
(7) Assumes employees will generally be visiting the site 5 days per week, 52 weeks per year. This provides a conservative value to calculation the annual employee vehicle trips.
(8) Hourly value conservatively assumes a maximum of 2 hours per day of operation for maintenance and testing. Annual value is based on the average historical emergency engine usage from the LBNL LRDP.
(9) January 31, 2013 I.R. responses. Assumes cooling tower fans are off 2,400 hours per year, and only operate at full speed 260 hours per year.
(10) January 17, 2013 LBNL response - population increase by approx. 1,000 over the current 300. Assume 1,300 trips per day.
(11) Assumes daily worker trips will occur 5 days per week, 52 weeks per year.
(12) LRDP Daily truck trips equal to Phase 1 trips (10/day) x (LRDP gsf / Phase 1 gsf).
(13) January 31, 2013 I.R. responses. Assumes that the 10 weekly trips will occur over 5 days per week, 52 weeks per year.
(14) Shuttle schedule provided by LBNL. Assumes shuttle trips occur 5 days per week, 52 weeks per year.
(15) It is assumed that employee vehicles will have negligible idling time.
(16) Onsite and offsite modeling trip distances approximated using the AERMOD modeling software.
(17) CalEEMod Appendix D Table 4.2 "Mobile Trip Characteristics Dependent on Location", Bay Area AQMD. Light duty employee vehicle route is based on the urban home to work (H-W) trip length. Trip lengths in CalEEMod are one way.
(18) CalEEMod Appendix D Table 4.3 "Mobile Trip Rates, Trip Purpose, Trip Type by Land Use", Commercial Land Use Type, Research and Development Land Use Sub Type.
(19) CalEEMod Appendix A Section 5.1, Vehicle Trips. "For pass-by trip links the trip length will be 0.1 miles and diverted trip links the trip length will be 25% of the primary trip length".
(20) Assumes 5 minutes at idle time consistent with California Code of Regulations Section 2485, Airborne Toxic Control Measure to Limit Diesel-Fueled Commercial Motor Vehicle Idling.
(21) CalEEMod Appendix D Table 4.2 "Mobile Trip Characteristics Dependent on Location", Bay Area AQMD. Delivery truck route is based on the urban commercial-NW route. Trip lengths in CalEEMod are one way.
(22) Conservative estimate of idling time for each shuttle drop-off event.
(23) Shuttle bus routes and schedules provided by LBNL.
(24) CalEEMod Appendix D Table 4.1 "Road Characteristics". Average vehicle weight for Bay Area AQMD.
(25) Based on the EMFAC vehicle class used for estimating emissions: T6 instate small, which has the higher VMT of all comparable categories, and is representative of delivery trucks. Max GVWR = 26,000 lbs. Also assumes that LBNL would not be the final destination for deliveries, so only a nominal difference between loaded and unloaded weights is used.
(26) Ford E150 XLT - 5,700 lb curb weight, plus 15 passengers at ~180 lbs/person.
(27) From CRT project emissions calculations, provided by Impact Sciences.
(28) Comparative Climatic Data, National Climatic Data Center, NOAA, 2011. 84 year average for San Francisco AP, CA.

Table F-2
Summary of Offsite On-Road Exhaust Criteria Pollutant Emission Estimates

Pollutant	Vehicle Type	EMFAC Vehicle Class	Maximum Daily Round-Trips [1] (trips/day)	Total Annual Round-Trips [1] (trips/yr)	Round-Trip Distance [1] (miles)	Emission Factors [2] (lbs/VMT)	Maximum Daily Emissions Estimate [a] (lbs/day)	Annual Average Emissions Estimate [b] (tons/yr)
ROG	Delivery Trucks	T6 Instate Small	102	26,432	13	2.5E-04	0.33	4.3E-02
	LBNL - RBC Shuttle	MDV	13	3,380	16	2.4E-04	4.8E-02	6.3E-03
	BART - RBC Shuttle	MDV	25	6,500	8.0	2.4E-04	4.8E-02	6.2E-03
	Employees	LDA	20,081	5,221,060	21	8.6E-05	36	4.6
	Total ROG Emissions						**36**	**4.7**
NO_X	Delivery Trucks	T6 Instate Small	102	26,432	13	2.2E-03	2.9	0.38
	LBNL - RBC Shuttle	MDV	13	3,380	16	2.4E-04	4.9E-02	6.3E-03
	BART - RBC Shuttle	MDV	25	6,500	8.0	2.4E-04	4.8E-02	6.3E-03
	Employees	LDA	20,081	5,221,060	21	1.2E-04	50	6.5
	Total NO_X Emissions						**53**	**6.9**
CO	Delivery Trucks	T6 Instate Small	102	26,432	13	8.8E-04	1.2	0.15
	LBNL - RBC Shuttle	MDV	13	3,380	16	2.1E-03	0.42	5.4E-02
	BART - RBC Shuttle	MDV	25	6,500	8.0	2.1E-03	0.41	5.4E-02
	Employees	LDA	20,081	5,221,060	21	1.2E-03	482	63
	Total CO Emissions						**484**	**63**
SO_2	Delivery Trucks	T6 Instate Small	102	26,432	13	2.5E-05	3.2E-02	4.2E-03
	LBNL - RBC Shuttle	MDV	13	3,380	16	1.3E-05	2.6E-03	3.4E-04
	BART - RBC Shuttle	MDV	25	6,500	8.0	1.3E-05	2.6E-03	3.4E-04
	Employees	LDA	20,081	5,221,060	21	7.5E-06	3.1	0.40
	Total SO_2 Emissions						**3.1**	**0.41**
PM_{10} Exhaust	Delivery Trucks	T6 Instate Small	102	26,432	13	8.2E-05	0.11	1.4E-02
	LBNL - RBC Shuttle	MDV	13	3,380	16	4.3E-06	8.7E-04	1.1E-04
	BART - RBC Shuttle	MDV	25	6,500	8.0	4.3E-06	8.7E-04	1.1E-04
	Employees	LDA	20,081	5,221,060	21	4.5E-06	1.9	0.24
	Total PM_{10} Emissions						**2.0**	**0.26**
PM_{10} Tire/Brake	Delivery Trucks	T6 Instate Small	102	26,432	13	3.1E-04	0.41	5.4E-02
	LBNL - RBC Shuttle	MDV	13	3,380	16	9.9E-05	2.0E-02	2.6E-03
	BART - RBC Shuttle	MDV	25	6,500	8.0	9.9E-05	2.0E-02	2.6E-03
	Employees	LDA	20,081	5,221,060	21	9.9E-05	41	5.3
	Total PM_{10} Emissions						**41**	**5.4**
$PM_{2.5}$ Exhaust	Delivery Trucks	T6 Instate Small	102	26,432	13	7.6E-05	1.0E-01	1.3E-02
	LBNL - RBC Shuttle	MDV	13	3,380	16	4.0E-06	8.1E-04	1.1E-04
	BART - RBC Shuttle	MDV	25	6,500	8.0	4.0E-06	8.0E-04	1.0E-04
	Employees	LDA	20,081	5,221,060	21	4.2E-06	1.7	0.23
	Total $PM_{2.5}$ Emissions						**1.8**	**0.24**
$PM_{2.5}$ Tire/Brake	Delivery Trucks	T6 Instate Small	102	26,432	13	1.3E-04	0.17	2.2E-02
	LBNL - RBC Shuttle	MDV	13	3,380	16	3.9E-05	7.9E-03	1.0E-03
	BART - RBC Shuttle	MDV	25	6,500	8.0	3.9E-05	7.8E-03	1.0E-03
	Employees	LDA	20,081	5,221,060	21	3.9E-05	16	2.1
	Total $PM_{2.5}$ Emissions						**16**	**2.1**
CO_2	Delivery Trucks	T6 Instate Small	102	26,432	13	2.3	3,048	396
	LBNL - RBC Shuttle	MDV	13	3,380	16	0.92	185	24
	BART - RBC Shuttle	MDV	25	6,500	8.0	0.92	184	24
	Employees	LDA	20,081	5,221,060	21	0.45	185,182	24,074
	Total CO_2 Emissions						**188,599**	**24,518**

Notes:
(a) Maximum daily emissions estimate (lbs/day) = (Maximum daily round-trips [trips/day]) x (round-trip distance [miles]) x (emission factor [lbs/VMT])
(b) Annual average emissions estimate (tons/yr) = (Annual round-trips [trips/yr]) x (round-trip distance [miles]) x (emission factor [lbs/VMT]) x (ton/2,000 lbs)

References:
(1) See Table F-1, LRDP Operations Input Assumptions for Emission Rate Calculations.
(2) Emission Factors source: Emfac 2011 (Model Years to 2034), typical speed distribution. Carbon dioxide emission factors are representative of post-Low Carbon Fuel Standard implementation.

Table F-3
Summary of Onsite On-Road Exhaust Criteria Pollutant Emission Estimates

Pollutant	Vehicle Type	EMFAC Vehicle Class	Maximum Daily Round-Trips [1] (trips/day)	Total Annual Round-Trips [1] (trips/yr)	Round-Trip Distance [1] (miles)	Emission Factor [2] (lbs/VMT)	Maximum Daily Emissions Estimate [a] (lbs/day)	Annual Average Emissions Estimate [b] (tons/yr)
ROG	Delivery Trucks	T6 Instate Small	102	26,432	1.7	1.3E-03	0.23	3.0E-02
	LBNL - RBC Shuttle	MDV	13	3,380	0.73	1.6E-04	1.6E-03	2.0E-04
	BART - RBC Shuttle	MDV	25	6,500	0.73	1.6E-04	3.0E-03	3.9E-04
	Employees	LDA	20,081	5,221,060	1.7	8.2E-05	2.8	0.36
	Total ROG Emissions						**3.0**	**0.39**
NO_X	Delivery Trucks	T6 Instate Small	102	26,432	1.7	5.1E-03	0.87	0.11
	LBNL - RBC Shuttle	MDV	13	3,380	0.73	3.9E-04	3.7E-03	4.8E-04
	BART - RBC Shuttle	MDV	25	6,500	0.73	3.9E-04	7.1E-03	9.2E-04
	Employees	LDA	20,081	5,221,060	1.7	1.9E-04	6.4	0.84
	Total NO_X Emissions						**7.3**	**0.95**
CO	Delivery Trucks	T6 Instate Small	102	26,432	1.7	2.5E-03	0.43	5.6E-02
	LBNL - RBC Shuttle	MDV	13	3,380	0.73	3.5E-03	3.4E-02	4.4E-03
	BART - RBC Shuttle	MDV	25	6,500	0.73	3.5E-03	6.5E-02	8.4E-03
	Employees	LDA	20,081	5,221,060	1.7	2.0E-03	66	8.6
	Total CO Emissions						**66**	**8.6**
SO_2	Delivery Trucks	T6 Instate Small	102	26,432	1.7	0	0	0
	LBNL - RBC Shuttle	MDV	13	3,380	0.73	0	0	0
	BART - RBC Shuttle	MDV	25	6,500	0.73	0	0	0
	Employees	LDA	20,081	5,221,060	1.7	0	0	0
	Total SO_2 Emissions						**0**	**0**
PM_{10} Exhaust	Delivery Trucks	T6 Instate Small	102	26,432	1.7	7.8E-05	1.3E-02	1.7E-03
	LBNL - RBC Shuttle	MDV	13	3,380	0.73	1.9E-05	1.8E-04	2.3E-05
	BART - RBC Shuttle	MDV	25	6,500	0.73	1.9E-05	3.4E-04	4.4E-05
	Employees	LDA	20,081	5,221,060	1.7	1.9E-05	0.65	8.4E-02
	Total PM_{10} Emissions						**0.66**	**8.6E-02**
PM_{10} Tire/Brake	Delivery Trucks	T6 Instate Small	102	26,432	1.7	0	0	0
	LBNL - RBC Shuttle	MDV	13	3,380	0.73	0	0	0
	BART - RBC Shuttle	MDV	25	6,500	0.73	0	0	0
	Employees	LDA	20,081	5,221,060	1.7	0	0	0
	Total PM_{10} Emissions						**0**	**0**
$PM_{2.5}$ Exhaust	Delivery Trucks	T6 Instate Small	102	26,432	1.7	7.2E-05	1.2E-02	1.6E-03
	LBNL - RBC Shuttle	MDV	13	3,380	0.73	1.7E-05	1.6E-04	2.1E-05
	BART - RBC Shuttle	MDV	25	6,500	0.73	1.7E-05	3.1E-04	4.1E-05
	Employees	LDA	20,081	5,221,060	1.7	1.8E-05	0.60	7.8E-02
	Total $PM_{2.5}$ Emissions						**0.62**	**8.0E-02**
$PM_{2.5}$ Tire/Brake	Delivery Trucks	T6 Instate Small	102	26,432	1.7	0	0	0
	LBNL - RBC Shuttle	MDV	13	3,380	0.73	0	0	0
	BART - RBC Shuttle	MDV	25	6,500	0.73	0	0	0
	Employees	LDA	20,081	5,221,060	1.7	0	0	0
	Total $PM_{2.5}$ Emissions						**0**	**0**
CO_2	Delivery Trucks	T6 Instate Small	102	26,432	1.7	4.2	717	93
	LBNL - RBC Shuttle	MDV	13	3,380	0.73	2.2	21	2.7
	BART - RBC Shuttle	MDV	25	6,500	0.73	2.2	40	5.2
	Employees	LDA	20,081	5,221,060	1.7	1.1	35,750	4,647
	Total CO_2 Emissions						**36,527**	**4,749**

Notes:
(a) Maximum daily emissions estimate (lbs/day) = (Maximum daily round-trips [trips/day]) x (round-trip distance [miles]) x (emission factor [lbs/VMT])
(b) Annual average emissions estimate (tons/yr) = (Annual round-trips [trips/yr]) x (round-trip distance [miles]) x (emission factor [lbs/VMT]) x (ton/2,000 lbs)

References:
(1) See Table F-1, LRDP Operations Input Assumptions for Emission Rate Calculations.
(2) Emission Factors source: EMFAC 2011 (Model Years to 2034), 10 mph speed to represent average onsite speeds. Carbon dioxide emission factors are representative of post-Low Carbon Fuel Standard implementation.

Table F-4
Summary of Onsite Idling Exhaust Criteria Pollutant Emission Estimates

Pollutant	Vehicle Type	EMFAC Vehicle Class	Maximum Daily Round-Trips [1] (trips/day)	Total Annual Round-Trips [1] (trips/yr)	Idle Time per Trip [1] (hrs/trip)	Idle Emission Factor [2] (lbs/idle-hour)	Maximum Daily Emissions Estimate [a] (lbs/day)	Annual Average Emissions Estimate [b] (tons/yr)
ROG	Delivery Trucks	T6 Instate Small	102	26,432	8.3E-02	4.7E-03	4.0E-02	5.2E-03
	LBNL - RBC Shuttle	MDV	13	3,380	8.3E-02	1.3E-03	1.4E-03	1.8E-04
	BART - RBC Shuttle	MDV	25	6,500	8.3E-02	1.3E-03	2.7E-03	3.5E-04
	Employees	LDA	20,081	5,221,060	0	6.6E-04	0	0
	Total ROG Emissions						**4.4E-02**	**5.7E-03**
NO_X	Delivery Trucks	T6 Instate Small	102	26,432	8.3E-02	8.5E-02	0.72	9.4E-02
	LBNL - RBC Shuttle	MDV	13	3,380	8.3E-02	2.2E-03	2.4E-03	3.1E-04
	BART - RBC Shuttle	MDV	25	6,500	8.3E-02	2.2E-03	4.6E-03	6.0E-04
	Employees	LDA	20,081	5,221,060	0	1.1E-03	0	0
	Total NO_X Emissions						**0.73**	**9.5E-02**
CO	Delivery Trucks	T6 Instate Small	102	26,432	8.3E-02	5.6E-02	0.47	6.2E-02
	LBNL - RBC Shuttle	MDV	13	3,380	8.3E-02	2.0E-02	2.1E-02	2.8E-03
	BART - RBC Shuttle	MDV	25	6,500	8.3E-02	2.0E-02	4.1E-02	5.3E-03
	Employees	LDA	20,081	5,221,060	0	1.1E-02	0	0
	Total CO Emissions						**0.54**	**7.0E-02**
SO_2	Delivery Trucks	T6 Instate Small	102	26,432	8.3E-02	1.6E-04	1.4E-03	1.8E-04
	LBNL - RBC Shuttle	MDV	13	3,380	8.3E-02	0	0	0
	BART - RBC Shuttle	MDV	25	6,500	8.3E-02	0	0	0
	Employees	LDA	20,081	5,221,060	0	0	0	0
	Total SO_2 Emissions						**1.4E-03**	**1.8E-04**
PM_{10} Exhaust	Delivery Trucks	T6 Instate Small	102	26,432	8.3E-02	2.0E-04	1.7E-03	2.2E-04
	LBNL - RBC Shuttle	MDV	13	3,380	8.3E-02	1.5E-04	1.6E-04	2.1E-05
	BART - RBC Shuttle	MDV	25	6,500	8.3E-02	1.5E-04	3.1E-04	4.0E-05
	Employees	LDA	20,081	5,221,060	0	1.5E-04	0	0
	Total PM_{10} Emissions						**2.2E-03**	**2.8E-04**
$PM_{2.5}$ Exhaust	Delivery Trucks	T6 Instate Small	102	26,432	8.3E-02	1.8E-04	1.6E-03	2.0E-04
	LBNL - RBC Shuttle	MDV	13	3,380	8.3E-02	1.4E-04	1.5E-04	1.9E-05
	BART - RBC Shuttle	MDV	25	6,500	8.3E-02	1.4E-04	2.9E-04	3.7E-05
	Employees	LDA	20,081	5,221,060	0	1.4E-04	0	0
	Total $PM_{2.5}$ Emissions						**2.0E-03**	**2.6E-04**
CO_2	Delivery Trucks	T6 Instate Small	102	26,432	8.3E-02	15	128	17
	LBNL - RBC Shuttle	MDV	13	3,380	8.3E-02	15	16	2.1
	BART - RBC Shuttle	MDV	25	6,500	8.3E-02	15	31	4.0
	Employees	LDA	20,081	5,221,060	0	7.2	0	0
	Total CO_2 Emissions						**175**	**23**

Notes:
(a) Maximum daily emissions estimate (lbs/day) = (Maximum daily round-trips [trips/day]) x (idle time per trip [hrs/trip]) x (emission factor [lbs/idle-hr])
(b) Annual average emissions estimate (tons/yr) = (Annual round-trips [trips/yr]) x (idle time per trip [hrs/trip]) x (emission factor [lbs/idle-hr]) x (ton/2,000 lbs)

References:
(1) See Table F-1, LRDP Operations Input Assumptions for Emission Rate Calculations.
(2) Emission Factors source: EMFAC 2011 (Model Years to 2034). Emissions for Light Duty Vehicle Idling assumed to be negligible, and thus not quantified. Carbon dioxide emission factors are representative of post-Low Carbon Fuel Standard implementation.

Table F-5

Onsite Parking Lot Emission Estimates

Source		Parking Lot (total)
EMFAC Vehicle Class	(1)	LDA
Number of Vehicle Trips per Day	(2)	20,081
Number of Vehicle Trips per Year	(2)	5,221,060
Modeling ID		LOT_EX

Pollutant	Emission Factor (3) (lbs/trip)	Maximum Daily Emissions Estimate (a) (lbs/day)	Annual Average Emissions Estimate (b) (tons/yr)
PM_{10}	1.16E-05	0.23	0.030
$PM_{2.5}$	1.08E-05	0.22	0.028
NO_X	1.24E-04	2.49	0.32
CO	2.17E-03	43.6	5.67
SO_2	1.67E-06	0.034	4.4E-03
ROG	3.15E-04	6.32	0.82
CO_2	0.16	3,287	427

Notes:

(a) Daily emissions estimate (lbs/day) =(Emission factor [lbs/trip]) x (number of vehicle trips per day)

(b) Annual emissions estimate (lbs/day) =(Emission factor [lbs/trip]) x (number of vehicle trips per year) x (ton/2,000 lbs)

References:

(1) LDA represents light-duty employee vehicles.

(2) See Table F-1, LRDP Operations Input Assumptions for Emission Rate Calculations.

(3) EMFAC 2011. Emission factors are based on the stationary starting exhaust, diurnal, hot soak, and resting loss vehicle portions of the LDA class emissions, on a per trip basis.

Table F-6
Onsite Paved Road Dust Emission Estimates

Parameter		Employee Vehicles	Delivery Trucks	LBNL - RBC Shuttle	BART - RBC Shuttle	Total
Onsite Roundtrip Distance (mi/trip)	(1)	0.7	1.7	0.7	0.7	
Maximum Daily Trips (trips/day)	(1)	20,081	102	13	25	
Annual Trips (trips/yr)	(1)	5,221,060	26,432	3,380	6,500	

Pollutant	Daily Emission Factor [a] (lbs/VMT)	Annual Emission Factor [b] (lbs/VMT)	Maximum Daily Emissions Estimate [c] (lbs/day)	Annual Average Emissions Estimate [d] (tons/yr)	Maximum Daily Emissions Estimate [c] (lbs/day)	Annual Average Emissions Estimate [d] (tons/yr)	Maximum Daily Emissions Estimate [c] (lbs/day)	Annual Average Emissions Estimate [d] (tons/yr)	Maximum Daily Emissions Estimate [c] (lbs/day)	Annual Average Emissions Estimate [d] (tons/yr)	Maximum Daily Emissions Estimate (lbs/day)	Annual Average Emissions Estimate (tons/yr)
PM	9.8E-03	9.3E-03	134	16.7	1.67	0.21	0.093	0.012	0.18	0.022	136	16.9
PM_{10}	2.0E-03	1.9E-03	26.8	3.34	0.33	0.041	0.019	2.3E-03	0.036	4.4E-03	27.2	3.39
$PM_{2.5}$	4.8E-04	4.6E-04	6.58	0.82	0.082	0.010	4.5E-03	5.7E-04	8.7E-03	1.1E-03	6.68	0.83

Notes:

(a) Maximum daily emission factor (lbs/VMT) = $(k \times (sL)^{0.91} \times (W)^{1.02})$

k = aerodynamic particle size multiplier (PM) =	0.011	(2)
k = aerodynamic particle size multiplier (PM_{10}) =	0.0022	(2)
k = aerodynamic particle size multiplier ($PM_{2.5}$) =	0.00054	(2)
sL = surface material silt content (g/m^2) =	0.32	(3)
W = mean vehicle weight (tons) =	2.5	(4)

(b) Annual emission factor (lbs/VMT) = $(k \times (sL)^{0.91} \times (W)^{1.02}) \times ((1-P)/4N)$

k = aerodynamic particle size multiplier (PM) =	0.011	(2)
k = aerodynamic particle size multiplier (PM_{10}) =	0.0022	(2)
k = aerodynamic particle size multiplier ($PM_{2.5}$) =	0.00054	(2)
sL = surface material silt content (g/m^2) =	0.32	(3)
W = mean vehicle weight (tons) =	2.5	(4)
P = number of wet days (0.01 inches of precip.) =	62	(1)
N = number of days in averaging period =	365	

(c) Maximum daily emissions estimate (lbs/day) = (Emission factor [lbs/VMT]) x (maximum daily vehicle trips [trips/day]) x (onsite roundtrip distance [mi/trip]) x (1 - [control efficiency {%}] / 100)

Control efficiency (%) = 0% (5)

(d) Annual emissions estimate (tons/yr) = (Emission factor [lbs/VMT]) x (annual vehicle trips [trips/yr]) x (onsite roundtrip distance [mi/trip]) x (ton/2,000 lbs) x (1 - [control efficiency {%}] / 100)

Control efficiency (%) = 0% (5)

References:

(1) See Table F-1, LRDP Operations Input Assumptions for Emission Rate Calculations.
(2) AP-42 Chapter 13.2.1 (January, 2011), Table 13.2.1-1 "Particle Size Multipliers for Paved Road Equation".
(3) Section 7.9 of the CARB Emission Inventory Methodology. Assumes offsite roads are equivalent to local roads as shown in Table 3 (silt loading of 0.32 g/m^2).
(4) Mean vehicle weight is calculated as the weighted average of the individual vehicle weights (average of unloaded and loaded weight), weighted based on the individual annual truck trips divided by total annual truck trips.
(5) Engineering estimate.

Table F-7
Offsite Paved Road Dust Emission Estimates

Parameter		Employee Vehicles	Delivery Trucks	LBNL - RBC Shuttle	BART - RBC Shuttle	Total
Offsite Roundtrip Distance (mi/trip)	(1)	21	13	16	8	
Maximum Daily Trips (trips/day)	(1)	20,081	102	13	25	
Annual Trips (trips/yr)	(1)	5,221,060	26,432	3,380	6,500	

Pollutant	Daily Emission Factor [a] (lbs/VMT)	Annual Emission Factor [b] (lbs/VMT)	Maximum Daily Emissions Estimate [c] (lbs/day)	Annual Average Emissions Estimate [d] (tons/yr)	Maximum Daily Emissions Estimate [c] (lbs/day)	Annual Average Emissions Estimate [d] (tons/yr)	Maximum Daily Emissions Estimate [c] (lbs/day)	Annual Average Emissions Estimate [d] (tons/yr)	Maximum Daily Emissions Estimate [c] (lbs/day)	Annual Average Emissions Estimate [d] (tons/yr)	Maximum Daily Emissions Estimate (lbs/day)	Annual Average Emissions Estimate (tons/yr)
PM	1.3E-03	1.2E-03	526	65.4	1.67	0.21	0.26	0.032	0.25	0.032	528	65.7
PM_{10}	2.5E-04	2.4E-04	105	13.1	0.33	0.042	0.051	6.4E-03	0.051	6.3E-03	106	13.1
$PM_{2.5}$	6.2E-05	6.0E-05	25.8	3.21	0.082	0.010	0.013	1.6E-03	0.012	1.6E-03	25.9	3.23

Notes:

(a) Maximum daily emission factor (lbs/VMT) = $(k \times (sL)^{0.91} \times (W)^{1.02})$

k = aerodynamic particle size multiplier (PM) =	0.011	(2)
k = aerodynamic particle size multiplier (PM_{10}) =	0.0022	(2)
k = aerodynamic particle size multiplier ($PM_{2.5}$) =	0.00054	(2)
sL = surface material silt content (g/m^2) =	0.035	(3)
W = mean vehicle weight (tons) =	2.4	(3)

(b) Annual emission factor (lbs/VMT) = $(k \times (sL)^{0.91} \times (W)^{1.02}) \times ((1-P)/4N)$

k = aerodynamic particle size multiplier (PM) =	0.011	(2)
k = aerodynamic particle size multiplier (PM_{10}) =	0.0022	(2)
k = aerodynamic particle size multiplier ($PM_{2.5}$) =	0.00054	(2)
sL = surface material silt content (g/m^2) =	0.035	(3)
W = mean vehicle weight (tons) =	2.4	(3)
P = number of wet days (0.01 inches of precip.) =	62	(1)
N = number of days in averaging period =	365	

(c) Maximum daily emissions estimate (lbs/day) = (Emission factor [lbs/VMT]) x (maximum daily vehicle trips [trips/day]) x (offsite roundtrip distance [mi/trip]) x (1 - [control efficiency {%}] / 100)

Control efficiency (%) =	0%	(4)

(d) Annual emissions estimate (tons/yr) = (Emission factor [lbs/VMT]) x (annual vehicle trips [trips/yr]) x (offsite roundtrip distance [mi/trip]) x (ton/2,000 lbs) x (1 - [control efficiency {%}] / 100)

Control efficiency (%) =	0%	(4)

References:

(1) See Table F-1, LRDP Operations Input Assumptions for Emission Rate Calculations.
(2) AP-42 Chapter 13.2.1 (January, 2011), Table 13.2.1-1 "Particle Size Multipliers for Paved Road Equation".
(3) Section 7.9 of the CARB Emission Inventory Methodology. Assumes offsite roads are equivalent to major/collector roads as shown in Table 3 (silt loading of 0.035 g/m^2).
(4) Engineering estimate.

Table F-8
Natural Gas Boiler Criteria Emission Estimates

Pollutant					PM		PM_{10}		$PM_{2.5}$		NO_X		CO		SO_2		VOC		CO_2		CH_4		N_2O		CO_2e	
Emission Factor (lbs/MMscf)					7.60 (1)		7.60 (2)		7.60 (2)		18.72 (a)		84 (4)		0.6 (1)		5.5 (1)		120,162 (b)		2.27 (c)		0.23 (c)		120,280 (d)	
					Emission Estimates																					
Source	Modeling ID	Maximum Hourly Fuel Usage (8) (MMBtu/hr)	Daily Operation (8) (hrs/day)	Annual Fuel Usage (8) (MMBtu/yr)	Maximum Daily (e) (lbs/day)	Annual Average (f) (tons/yr)	Maximum Daily (e) (lbs/day)	Annual Average (f) (tons/yr)	Maximum Daily (e) (lbs/day)	Annual Average (f) (tons/yr)	Maximum Daily (e) (lbs/day)	Annual Average (f) (tons/yr)	Maximum Daily (e) (lbs/day)	Annual Average (f) (tons/yr)	Maximum Daily (e) (lbs/day)	Annual Average (f) (tons/yr)	Maximum Daily (e) (lbs/day)	Annual Average (f) (tons/yr)	Maximum Daily (e) (lbs/day)	Annual Average (f) (tons/yr)	Maximum Daily (e) (lbs/day)	Annual Average (f) (tons/yr)	Maximum Daily (e) (lbs/day)	Annual Average (f) (tons/yr)	Maximum Daily (e) (lbs/day)	Annual Average (f) (tons/yr)
Natural Gas Boiler - Building NRLF	NGB_NRLF	23	24	31,923	4.08	0.12	4.08	0.12	4.08	0.12	10.0	0.29	45.1	1.30	0.32	9.3E-03	2.95	0.085	64,523	1,866	1.22	0.035	0.12	3.5E-03	64,586	1,868
Natural Gas Boiler - Buildings 6 and 7	NGB_B6_7	24	24	42,000	4.26	0.16	4.26	0.16	4.26	0.16	10.5	0.38	47.1	1.72	0.34	0.012	3.08	0.11	67,328	2,455	1.27	0.046	0.13	4.6E-03	67,394	2,457
Natural Gas Boiler - Building 8	NGB_B8	12	24	21,000	2.13	0.078	2.13	0.078	2.13	0.078	5.24	0.19	23.5	0.86	0.17	6.1E-03	1.54	0.056	33,664	1,227	0.63	0.023	0.063	2.3E-03	33,697	1,229
Natural Gas Boiler - Building 9	NGB_B9	12	24	21,000	2.13	0.078	2.13	0.078	2.13	0.078	5.24	0.19	23.5	0.86	0.17	6.1E-03	1.54	0.056	33,664	1,227	0.63	0.023	0.063	2.3E-03	33,697	1,229
Natural Gas Boiler - Building 10	NGB_B10	11	24	15,267	1.95	0.056	1.95	0.056	1.95	0.056	4.81	0.14	21.6	0.62	0.15	4.5E-03	1.41	0.041	30,859	892	0.58	0.017	0.058	1.7E-03	30,889	893
Natural Gas Boiler - Building 11	NGB_B11	6	24	8,328	1.06	0.031	1.06	0.031	1.06	0.031	2.62	0.076	11.8	0.34	0.084	2.4E-03	0.77	0.022	16,832	487	0.32	9.2E-03	0.032	9.2E-04	16,849	487
Natural Gas Boiler - Building 12	NGB_B12	11	24	15,267	1.95	0.056	1.95	0.056	1.95	0.056	4.81	0.14	21.6	0.62	0.15	4.5E-03	1.41	0.041	30,859	892	0.58	0.017	0.058	1.7E-03	30,889	893
Natural Gas Boiler - Building 13	NGB_B13	6	24	8,328	1.06	0.031	1.06	0.031	1.06	0.031	2.62	0.076	11.8	0.34	0.084	2.4E-03	0.77	0.022	16,832	487	0.32	9.2E-03	0.032	9.2E-04	16,849	487
Natural Gas Boiler - Building 14	NGB_B14	8	24	11,104	1.42	0.041	1.42	0.041	1.42	0.041	3.50	0.10	15.7	0.45	0.11	3.2E-03	1.03	0.030	22,443	649	0.42	0.012	0.042	1.2E-03	22,465	650
Natural Gas Boiler - Building 15	NGB_B15	13	24	18,043	2.31	0.067	2.31	0.067	2.31	0.067	5.68	0.16	25.5	0.74	0.18	5.3E-03	1.67	0.048	36,469	1,055	0.69	0.020	0.069	2.0E-03	36,505	1,056
Natural Gas Boiler - Building 16	NGB_B16	15	24	20,819	2.66	0.077	2.66	0.077	2.66	0.077	6.55	0.19	29.4	0.85	0.21	6.1E-03	1.93	0.056	42,080	1,217	0.79	0.023	0.079	2.3E-03	42,121	1,218
Natural Gas Boiler - Building 17	NGB_B17	16	24	22,207	2.84	0.082	2.84	0.082	2.84	0.082	6.99	0.20	31.4	0.91	0.22	6.5E-03	2.05	0.059	44,885	1,298	0.85	0.024	0.085	2.4E-03	44,929	1,299
Natural Gas Boiler - Building 18	NGB_B18	14	24	19,431	2.48	0.072	2.48	0.072	2.48	0.072	6.12	0.18	27.5	0.79	0.20	5.7E-03	1.80	0.052	39,275	1,136	0.74	0.021	0.074	2.1E-03	39,313	1,137
Natural Gas Boiler - Building 19	NGB_B19	12	24	16,655	2.13	0.062	2.13	0.062	2.13	0.062	5.24	0.15	23.5	0.68	0.17	4.9E-03	1.54	0.045	33,664	973	0.63	0.018	0.063	1.8E-03	33,697	974
Natural Gas Boiler - Building 20	NGB_B20	12	24	16,655	2.13	0.062	2.13	0.062	2.13	0.062	5.24	0.15	23.5	0.68	0.17	4.9E-03	1.54	0.045	33,664	973	0.63	0.018	0.063	1.8E-03	33,697	974
Natural Gas Boiler - Building 21	NGB_B21	28	24	38,863	4.97	0.14	4.97	0.14	4.97	0.14	12.2	0.35	54.9	1.59	0.39	0.011	3.60	0.10	78,550	2,271	1.48	0.043	0.15	4.3E-03	78,627	2,274
Natural Gas Boiler - Building 22	NGB_B22	19	24	26,371	3.37	0.097	3.37	0.097	3.37	0.097	8.30	0.24	37.3	1.08	0.27	7.7E-03	2.44	0.071	53,301	1,541	1.01	0.029	0.10	2.9E-03	53,354	1,543
Natural Gas Boiler - Building 23	NGB_B23	14	24	19,431	2.48	0.072	2.48	0.072	2.48	0.072	6.12	0.18	27.5	0.79	0.20	5.7E-03	1.80	0.052	39,275	1,136	0.74	0.021	0.074	2.1E-03	39,313	1,137
Natural Gas Boiler - Building 24	NGB_B24	12	24	16,655	2.13	0.062	2.13	0.062	2.13	0.062	5.24	0.15	23.5	0.68	0.17	4.9E-03	1.54	0.045	33,664	973	0.63	0.018	0.063	1.8E-03	33,697	974
Natural Gas Boiler - Building 25	NGB_B25	17	24	23,595	3.02	0.087	3.02	0.087	3.02	0.087	7.43	0.21	33.3	0.96	0.24	6.9E-03	2.18	0.063	47,691	1,379	0.90	0.026	0.090	2.6E-03	47,738	1,380
Natural Gas Boiler - Building 26	NGB_B26	17	24	23,595	3.02	0.087	3.02	0.087	3.02	0.087	7.43	0.21	33.3	0.96	0.24	6.9E-03	2.18	0.063	47,691	1,379	0.90	0.026	0.090	2.6E-03	47,738	1,380
Natural Gas Boiler - Building 27	NGB_B27	16	24	22,207	2.84	0.082	2.84	0.082	2.84	0.082	6.99	0.20	31.4	0.91	0.22	6.5E-03	2.05	0.059	44,885	1,298	0.85	0.024	0.085	2.4E-03	44,929	1,299
Natural Gas Boiler - Building 28	NGB_B28	6	24	8,328	1.06	0.031	1.06	0.031	1.06	0.031	2.62	0.076	11.8	0.34	0.084	2.4E-03	0.77	0.022	16,832	487	0.32	9.2E-03	0.032	9.2E-04	16,849	487
Natural Gas Boiler - Building 29	NGB_B29	6	24	8,328	1.06	0.031	1.06	0.031	1.06	0.031	2.62	0.076	11.8	0.34	0.084	2.4E-03	0.77	0.022	16,832	487	0.32	9.2E-03	0.032	9.2E-04	16,849	487
Natural Gas Boiler - Building 30	NGB_B30	16	24	22,207	2.84	0.082	2.84	0.082	2.84	0.082	6.99	0.20	31.4	0.91	0.22	6.5E-03	2.05	0.059	44,885	1,298	0.85	0.024	0.085	2.4E-03	44,929	1,299
Natural Gas Boiler - Building 31	NGB_B31	6	24	8,328	1.06	0.031	1.06	0.031	1.06	0.031	2.62	0.076	11.8	0.34	0.084	2.4E-03	0.77	0.022	16,832	487	0.32	9.2E-03	0.032	9.2E-04	16,849	487
Natural Gas Boiler - Building 32	NGB_B32	13	24	18,043	2.31	0.067	2.31	0.067	2.31	0.067	5.68	0.16	25.5	0.74	0.18	5.3E-03	1.67	0.048	36,469	1,055	0.69	0.020	0.069	2.0E-03	36,505	1,056
Natural Gas Boiler - Building 33	NGB_B33	16	24	22,207	2.84	0.082	2.84	0.082	2.84	0.082	6.99	0.20	31.4	0.91	0.22	6.5E-03	2.05	0.059	44,885	1,298	0.85	0.024	0.085	2.4E-03	44,929	1,299
Natural Gas Boiler - Building 34	NGB_B34	17	24	23,595	3.02	0.087	3.02	0.087	3.02	0.087	7.43	0.21	33.3	0.96	0.24	6.9E-03	2.18	0.063	47,691	1,379	0.90	0.026	0.090	2.6E-03	47,738	1,380
Natural Gas Boiler - Building 35	NGB_B35	19	24	26,371	3.37	0.097	3.37	0.097	3.37	0.097	8.30	0.24	37.3	1.08	0.27	7.7E-03	2.44	0.071	53,301	1,541	1.01	0.029	0.10	2.9E-03	53,354	1,543
Natural Gas Boiler - Building 36	NGB_B36	18	24	24,983	3.19	0.092	3.19	0.092	3.19	0.092	7.86	0.23	35.3	1.02	0.25	7.3E-03	2.31	0.067	50,496	1,460	0.95	0.028	0.095	2.8E-03	50,546	1,462
Natural Gas Boiler - Building 37	NGB_B37	20	24	27,759	3.55	0.10	3.55	0.10	3.55	0.10	8.74	0.25	39.2	1.13	0.28	8.1E-03	2.57	0.074	56,107	1,622	1.06	0.031	0.11	3.1E-03	56,162	1,624
Natural Gas Boiler - Building 38	NGB_B38	8	24	11,104	1.42	0.041	1.42	0.041	1.42	0.041	3.50	0.10	15.7	0.45	0.11	3.2E-03	1.03	0.030	22,443	649	0.42	0.012	0.042	1.2E-03	22,465	650
Total					**82.2**	**2.44**	**82.2**	**2.44**	**82.2**	**2.44**	**202**	**6.01**	**908**	**27.0**	**6.49**	**0.19**	**59.5**	**1.77**	**1,298,873**	**38,573**	**24.5**	**0.73**	**2.45**	**0.073**	**1,300,147**	**38,611**

Notes:

(a) Emission factor (lbs/MMscf) = (NO_2 or CO emission limit [ppmv @ 3% O_2]) x (10^{-6}) x (NO_2 or CO molecular weight [lbs/lb-mol]) x (lb-mol/385.44 ft^3) x (natural gas f-factor [8,710 dscf/MMBtu]) x (20.9% O_2/[20.9% O_2 - 3% O_2]) x (heat content [Btu/scf])

BAAQMD NO_X emission limit (ppmv @ 3% O_2) =	15	(3)
BAAQMD CO emission limit (ppmv @ 3% O_2) =	400	(3)
NO_2 molecular weight (lbs/lb-mol) =	46	
CO molecular weight (lbs/lb-mol) =	28.01	
Natural gas heat content (Btu/scf) =	1,028	(5)

(b) CO_2 emission factor (lbs/MMscf) = (CO_2 emission factor [kg CO_2/MMBtu]) x (default high heat value (MMBtu/scf)) x (10^6 scf/MMscf) x (lb/0.453592 kg)

CO_2 emission factor (kg/MMBtu) =	53.02	(5)
Default high heat value (MMBtu/scf) =	1.028E-03	(5)

(c) CH_4 or N_2O emission factor (lbs/MMscf) = (CH_4 or N_2O emission factor [kg/MMBtu]) x (lb/0.453592 kg) x (natural gas heat content [Btu/scf])

CH_4 emission factor (kg/MMBtu) =	1.0E-03	(6)
N_2O emission factor (kg/MMBtu) =	1.0E-04	(6)
Natural gas heat content (Btu/scf) =	1,028	(5)

(d) CO_2e emission factor (lbs/MMscf) = (CO_2 emission factor [lbs/MMscf]) + (CH_4 emission factor [lbs/MMscf] x CH_4 global warming potential)
+ (N_2O emission factor [lbs/MMscf] x N_2O global warming potential)

Global warming potential of CH_4 =	21	(7)
Global warming potential of N_2O =	310	(7)

(e) Daily emissions estimate (lbs/day) = (Emission factor [lbs/MMscf]) x (maximum hourly heat input [MMBtu/hr]) x (daily hours of operation [hrs/day]) / (natural gas heat content [Btu/scf])

Natural gas heat content (Btu/scf) =	1,028	(5)

(f) Annual emissions estimate (tons/yr) = (emission factor [lbs/MMscf]) x (annual heat input [MMBtu/yr]) / (natural gas heat content [Btu/scf]) x (tons/2,000 lbs)

Natural gas heat content (Btu/scf) =	1,028	(5)

References:

(1) AP-42 Chapter 1.4 (July 1998), Table 1.4-2 "Emission Factors for Criteria Pollutants and Greenhouse Gases from Natural Gas Combustion".
(2) Assumes that 100% of PM is $PM_{2.5}$. Therefore, 100% of PM_{10} is $PM_{2.5}$.
(3) BAAQMD Emission Limits 307.2, 307.3, and 307.4 from Section 9-7-307..
(4) AP-42 Chapter 1.4 (July 1998), Table 1.4-1 "Emission Factors for NO_X and CO from Natural Gas Combustion".
(5) 40 CFR Part 98 Subpart C, Table C-1, Default CO_2 Emission Factors and High Heat Values for Various Types of Fuel.
(6) 40 CFR Part 98 Subpart C, Table C-2, Default CH_4 and N_2O Emission Factors for Various Types of Fuel.
(7) 40 CFR Part 98 Subpart A, Table A-1, Global Warming Potentials.
(8) See Table F-1, LRDP Operations Input Assumptions for Emission Rate Calculations.

Table F-9
Emergency Diesel Generator Criteria Emission Estimates

Pollutant				Min HP	Max HP	PM		PM_{10}		$PM_{2.5}$		NO_X		CO		SO_2		VOC		CO_2		CH_4		CO_2e	
Emission Factor - Phase 1 Tier 4 Final (g/hp-hr)			(1)	440		0.01	(1)	0.01	(1)	0.01	(1)	0.3	(2)	2.2	(2)	--	(3)	0.14	(2)	--	(4)	--		--	
Emission Factor - Tier 4 Final (g/hp-hr)			(1)	100	174	0.015	(1)	0.015	(1)	0.015	(1)	0.3	(2)	3.7	(2)	--	(3)	0.14	(2)	--	(4)	--		--	
Emission Factor - Tier 4 Final (g/hp-hr)			(1)	175	749	0.015	(1)	0.015	(1)	0.015	(1)	0.3	(2)	2.2	(2)	--	(3)	0.14	(2)	--	(4)	--		--	
Emission Factor - Tier 4 Final (g/hp-hr)			(1)	750	2,000	0.03	(1)	0.03	(1)	0.03	(1)	2.6	(2)	2.2	(2)	--	(3)	0.14	(2)	--	(4)	--		--	
Emission Factor - Phase 1 Tier 4 Interim (g/hp-hr)			(1)	440		0.015	(2)	0.015	(2)	0.015	(2)	1.5	(2)	2.6	(2)	--	(3)	0.14	(2)	--	(4)	--		--	
Source	**Modeling ID**	**Generator Power Rating (5) (BHP)**	**Diesel Fuel Usage (5) (gal/hr)**	**Load Factor (6)**	**Annual Operation (5) (hrs/yr)**	**Maximum Daily (a) (lbs/day)**	**Annual Average (b) (tons/yr)**	**Maximum Daily (a) (lbs/day)**	**Annual Average (b) (tons/yr)**	**Maximum Daily (a) (lbs/day)**	**Annual Average (b) (tons/yr)**	**Maximum Daily (a) (lbs/day)**	**Annual Average (b) (tons/yr)**	**Maximum Daily (a) (lbs/day)**	**Annual Average (b) (tons/yr)**	**Maximum Daily (c) (lbs/day)**	**Annual Average (b) (tons/yr)**	**Maximum Daily (a) (lbs/day)**	**Annual Average (b) (tons/yr)**	**Maximum Daily (d) (lbs/day)**	**Annual Average (b) (tons/yr)**	**Maximum Daily (9) (lbs/day)**	**Annual Average (b) (tons/yr)**	**Maximum Daily (e) (lbs/day)**	**Annual Average (b) (tons/yr)**
						Tier 4 Final - Emission Estimates																			
Diesel Generator - Building NRLF	DG_NRLF	700	35.5	0.74	25.15	0.034	2.2E-04	0.034	2.2E-04	0.034	2.2E-04	0.69	4.3E-03	5.02	0.032	0.015	9.4E-05	0.32	2.0E-03	1,585	9.96	0.029	1.8E-04	1,585	9.97
Diesel Generator - Building 8	DG_B8	440	22.3	0.74	25.15	0.014	9.0E-05	0.014	9.0E-05	0.014	9.0E-05	0.43	2.7E-03	3.16	0.020	9.4E-03	5.9E-05	0.20	1.3E-03	996	6.26	0.018	1.1E-04	996	6.27
Diesel Generator - Building 9	DG_B9	440	22.3	0.74	25.15	0.014	9.0E-05	0.014	9.0E-05	0.014	9.0E-05	0.43	2.7E-03	3.16	0.020	9.4E-03	5.9E-05	0.20	1.3E-03	996	6.26	0.018	1.1E-04	996	6.27
Diesel Generator - Building 10	DG_B10	410	20.8	0.74	25.15	0.020	1.3E-04	0.020	1.3E-04	0.020	1.3E-04	0.40	2.5E-03	2.94	0.019	8.7E-03	5.5E-05	0.19	1.2E-03	928	5.84	0.017	1.1E-04	929	5.84
Diesel Generator - Building 11	DG_B11	240	12.2	0.74	25.15	0.012	7.4E-05	0.012	7.4E-05	0.012	7.4E-05	0.23	1.5E-03	1.72	0.011	5.1E-03	3.2E-05	0.11	6.9E-04	543	3.42	9.9E-03	6.2E-05	544	3.42
Diesel Generator - Building 12	DG_B12	420	21.3	0.74	25.15	0.021	1.3E-04	0.021	1.3E-04	0.021	1.3E-04	0.41	2.6E-03	3.01	0.019	8.9E-03	5.6E-05	0.19	1.2E-03	951	5.98	0.017	1.1E-04	951	5.98
Diesel Generator - Building 13	DG_B13	170	8.6	0.74	25.15	8.3E-03	5.2E-05	8.3E-03	5.2E-05	8.3E-03	5.2E-05	0.17	1.0E-03	2.05	0.013	3.6E-03	2.3E-05	0.078	4.9E-04	385	2.42	7.0E-03	4.4E-05	385	2.42
Diesel Generator - Building 14	DG_B14	290	14.7	0.74	25.15	0.014	8.9E-05	0.014	8.9E-05	0.014	8.9E-05	0.28	1.8E-03	2.08	0.013	6.2E-03	3.9E-05	0.13	8.3E-04	657	4.13	0.012	7.5E-05	657	4.13
Diesel Generator - Building 15	DG_B15	480	24.3	0.74	25.15	0.023	1.5E-04	0.023	1.5E-04	0.023	1.5E-04	0.47	3.0E-03	3.45	0.022	0.010	6.4E-05	0.22	1.4E-03	1,087	6.83	0.020	1.2E-04	1,087	6.84
Diesel Generator - Building 16	DG_B16	560	28.4	0.74	25.15	0.027	1.7E-04	0.027	1.7E-04	0.027	1.7E-04	0.55	3.4E-03	4.02	0.025	0.012	7.5E-05	0.26	1.6E-03	1,268	7.97	0.023	1.4E-04	1,268	7.97
Diesel Generator - Building 17	DG_B17	600	30.4	0.74	25.15	0.029	1.8E-04	0.029	1.8E-04	0.029	1.8E-04	0.59	3.7E-03	4.31	0.027	0.013	8.0E-05	0.27	1.7E-03	1,358	8.54	0.025	1.6E-04	1,359	8.54
Diesel Generator - Building 18	DG_B18	510	25.9	0.74	25.15	0.025	1.6E-04	0.025	1.6E-04	0.025	1.6E-04	0.50	3.1E-03	3.66	0.023	0.011	6.8E-05	0.23	1.5E-03	1,155	7.26	0.021	1.3E-04	1,155	7.26
Diesel Generator - Building 19	DG_B19	460	23.3	0.74	25.15	0.023	1.4E-04	0.023	1.4E-04	0.023	1.4E-04	0.45	2.8E-03	3.30	0.021	9.8E-03	6.2E-05	0.21	1.3E-03	1,041	6.55	0.019	1.2E-04	1,042	6.55
Diesel Generator - Building 20	DG_B20	450	22.8	0.74	25.15	0.022	1.4E-04	0.022	1.4E-04	0.022	1.4E-04	0.44	2.8E-03	3.23	0.020	9.6E-03	6.0E-05	0.21	1.3E-03	1,019	6.41	0.019	1.2E-04	1,019	6.41
Diesel Generator A - Building 21	DG_B21A	510	25.9	0.74	25.15	0.025	1.6E-04	0.025	1.6E-04	0.025	1.6E-04	0.50	3.1E-03	3.66	0.023	0.011	6.8E-05	0.23	1.5E-03	1,155	7.26	0.021	1.3E-04	1,155	7.26
Diesel Generator B - Building 21	DG_B21B	510	25.9	0.74	25.15	0.025	1.6E-04	0.025	1.6E-04	0.025	1.6E-04	0.50	3.1E-03	3.66	0.023	0.011	6.8E-05	0.23	1.5E-03	1,155	7.26	0.021	1.3E-04	1,155	7.26
Diesel Generator - Building 22	DG_B22	700	35.5	0.74	25.15	0.034	2.2E-04	0.034	2.2E-04	0.034	2.2E-04	0.69	4.3E-03	5.02	0.032	0.015	9.4E-05	0.32	2.0E-03	1,585	9.96	0.029	1.8E-04	1,585	9.97
Diesel Generator - Building 23	DG_B23	530	26.9	0.74	25.15	0.026	1.6E-04	0.026	1.6E-04	0.026	1.6E-04	0.52	3.3E-03	3.80	0.024	0.011	7.1E-05	0.24	1.5E-03	1,200	7.54	0.022	1.4E-04	1,200	7.55
Diesel Generator - Building 24	DG_B24	460	23.3	0.74	25.15	0.023	1.4E-04	0.023	1.4E-04	0.023	1.4E-04	0.45	2.8E-03	3.30	0.021	9.8E-03	6.2E-05	0.21	1.3E-03	1,041	6.55	0.019	1.2E-04	1,042	6.55
Diesel Generator - Building 25	DG_B25	630	32.0	0.74	25.15	0.031	1.9E-04	0.031	1.9E-04	0.031	1.9E-04	0.62	3.9E-03	4.52	0.028	0.013	8.4E-05	0.29	1.8E-03	1,426	8.97	0.026	1.6E-04	1,427	8.97
Diesel Generator - Building 26	DG_B26	610	30.9	0.74	25.15	0.030	1.9E-04	0.030	1.9E-04	0.030	1.9E-04	0.60	3.8E-03	4.38	0.028	0.013	8.2E-05	0.28	1.8E-03	1,381	8.68	0.025	1.6E-04	1,381	8.69
Diesel Generator - Building 27	DG_B27	590	29.9	0.74	25.15	0.029	1.8E-04	0.029	1.8E-04	0.029	1.8E-04	0.58	3.6E-03	4.24	0.027	0.013	7.9E-05	0.27	1.7E-03	1,336	8.40	0.024	1.5E-04	1,336	8.40
Diesel Generator - Building 28	DG_B28	230	11.7	0.74	25.15	0.011	7.1E-05	0.011	7.1E-05	0.011	7.1E-05	0.23	1.4E-03	1.65	0.010	4.9E-03	3.1E-05	0.11	6.6E-04	521	3.27	9.5E-03	5.9E-05	521	3.28
Diesel Generator - Building 29	DG_B29	180	9.1	0.74	25.15	8.8E-03	5.5E-05	8.8E-03	5.5E-05	8.8E-03	5.5E-05	0.18	1.1E-03	1.29	8.1E-03	3.8E-03	2.4E-05	0.082	5.2E-04	407	2.56	7.4E-03	4.7E-05	408	2.56
Diesel Generator - Building 30	DG_B30	600	30.4	0.74	25.15	0.029	1.8E-04	0.029	1.8E-04	0.029	1.8E-04	0.59	3.7E-03	4.31	0.027	0.013	8.0E-05	0.27	1.7E-03	1,358	8.54	0.025	1.6E-04	1,359	8.54
Diesel Generator - Building 31	DG_B31	180	9.1	0.74	25.15	8.8E-03	5.5E-05	8.8E-03	5.5E-05	8.8E-03	5.5E-05	0.18	1.1E-03	1.29	8.1E-03	3.8E-03	2.4E-05	0.082	5.2E-04	407	2.56	7.4E-03	4.7E-05	408	2.56
Diesel Generator - Building 32	DG_B32	490	24.9	0.74	25.15	0.024	1.5E-04	0.024	1.5E-04	0.024	1.5E-04	0.48	3.0E-03	3.52	0.022	0.010	6.6E-05	0.22	1.4E-03	1,109	6.97	0.020	1.3E-04	1,110	6.98
Diesel Generator - Building 33	DG_B33	580	29.4	0.74	25.15	0.028	1.8E-04	0.028	1.8E-04	0.028	1.8E-04	0.57	3.6E-03	4.16	0.026	0.012	7.8E-05	0.26	1.7E-03	1,313	8.26	0.024	1.5E-04	1,314	8.26
Diesel Generator - Building 34	DG_B34	610	30.9	0.74	25.15	0.030	1.9E-04	0.030	1.9E-04	0.030	1.9E-04	0.60	3.8E-03	4.38	0.028	0.013	8.2E-05	0.28	1.8E-03	1,381	8.68	0.025	1.6E-04	1,381	8.69
Diesel Generator - Building 35	DG_B35	700	35.5	0.74	25.15	0.034	2.2E-04	0.034	2.2E-04	0.034	2.2E-04	0.69	4.3E-03	5.02	0.032	0.015	9.4E-05	0.32	2.0E-03	1,585	9.96	0.029	1.8E-04	1,585	9.97
Diesel Generator - Building 36	DG_B36	680	34.5	0.74	25.15	0.033	2.1E-04	0.033	2.1E-04	0.033	2.1E-04	0.67	4.2E-03	4.88	0.031	0.014	9.1E-05	0.31	2.0E-03	1,539	9.68	0.028	1.8E-04	1,540	9.68
Diesel Generator - Building 37	DG_B37	740	37.5	0.74	25.15	0.036	2.3E-04	0.036	2.3E-04	0.036	2.3E-04	0.72	4.6E-03	5.31	0.033	0.016	9.9E-05	0.34	2.1E-03	1,675	10.5	0.030	1.9E-04	1,676	10.5
Diesel Generator - Building 38	DG_B38	230	11.7	0.74	25.15	0.011	7.1E-05	0.011	7.1E-05	0.011	7.1E-05	0.23	1.4E-03	1.65	0.010	4.9E-03	3.1E-05	0.11	6.6E-04	521	3.27	9.5E-03	5.9E-05	521	3.28
						Tier 4 Interim - Emission Estimates																			
Diesel Generator - Building 6	DG_B6	440	22.3	0.74	25.15	0.022	1.4E-04	0.022	1.4E-04	0.022	1.4E-04	2.15	0.014	3.73	0.023	9.4E-03	5.9E-05	0.20	1.3E-03	996	6.26	0.018	1.1E-04	996	6.27
Diesel Generator - Building 7	DG_B7	440	22.3	0.74	25.15	0.022	1.4E-04	0.022	1.4E-04	0.022	1.4E-04	2.15	0.014	3.73	0.023	9.4E-03	5.9E-05	0.20	1.3E-03	996	6.26	0.018	1.1E-04	996	6.27
Total						**0.81**	**5.1E-03**	**0.81**	**5.1E-03**	**0.81**	**5.1E-03**	**19.9**	**0.13**	**123**	**0.77**	**0.36**	**2.3E-03**	**7.68**	**0.048**	**38,056**	**239**	**0.69**	**4.3E-03**	**38,070**	**239**

Notes:

(a) Maximum daily emission estimate (lbs/day) = (Emission factor [g/hp-hr]) x (generator power [hp]) x (load factor) x (maximum hours per day [hrs/day]) x (lb/453.59g)
Daily hours of operation (hrs/day) = 2 (5)

(b) Annual average emission estimate (tons/yr) = (Daily emissions [lbs/day]) / (daily hours of operation [hrs/day]) x (annual hours of operation [hrs/yr]) x (ton/2,000 lbs)
Daily hours of operation (hrs/day) = 2 (5)

(c) Maximum daily emissions estimate (lbs/day) = (Fuel sulfur content [ppmw] / 1,000,000) x (generator fuel consumption [gal/hr]) x (daily hours of operation [hrs/day]) x (diesel density [lbs/gal]) x ([SO_2 molecular weight {lbs/lb-mol}] / [sulfur molecular weight {lbs/lb-mol}])
Fuel sulfur content (ppmw) = 15 (7)
Daily hours of operation (hrs/day) = 2 (5)
Diesel density (lbs/gal) = 7
SO_2 molecular weight (lbs/lb-mol) = 64
Sulfur molecular weight (lbs/lb-mol) = 32

(d) Maximum daily emissions estimate (lbs/day) = (Fuel carbon content [%] / 100) x (generator fuel consumption [gal/hr]) x (daily hours of operation [hrs/day]) x (diesel density [lbs/gal]) x ([CO_2 molecular weight {lbs/lb-mol}] / [carbon molecular weight {lbs/lb-mol}])
Fuel carbon content (%) = 87 (8)
Daily hours of operation (hrs/day) = 2 (5)
Diesel density (lbs/gal) = 7
CO_2 molecular weight (lbs/lb-mol) = 44.0
Carbon molecular weight (lbs/lb-mol) = 12.0

(e) CO_2e emissions (lbs/day) = (CO_2 emissions [lbs/day]) + (CH_4 emissions [lbs/day] x CH_4 global warming potential) + (N_2O emissions [lbs/day] x N_2O global warming potential)
CH_4 Global Warming Potential (GWP) = 21 (10)
N_2O Global Warming Potential (GWP) = 310 (10)

References:

(1) LBNL has committed to purchasing engines for buildings 7 and 8 that achieve 0.01 g/hp-hr particulate matter emissions. Buildings 6 and 7 will not be under the control of LBNL, so interim Tier IV emission factors are assumed. All other engines will be based on Tier IV emission factors. Assumes all PM is PM2.5.
(2) CalEEMod Appendix D, Default Data Tables. Table 3.5, OFFROAD Emission Factor Based on Engine Tier. Assumes Tier 4 Final for LBNL-owned small engines (Buildings 9 and 8), and Tier 4 Interim for the Building 6&7 engine.
(3) Sulfur dioxide emissions calculated on a sulfur mass balance basis, assuming 100% of the fuel sulfur content is emitted as SO_2.
(4) Carbon dioxide emissions calculated on a carbon mass balance basis, conservatively assuming 100% of the fuel carbon content is emitted as CO_2.
(5) See Table F-1, LRDP Operations Input Assumptions for Emission Rate Calculations.
(6) Default load factor for generators in URBEMIS emissions model.
(7) California Code of Regulations Title 13, Division 3, Chapter 5, Article 2, Standards for Diesel Fuel.
(8) AP-42 Chapter 3.3 (October 1996) and 3.4 (October 1996), Footnote to criteria emission factor table.
(9) Assumes methane is 9% of VOC, based on footnote f of Table 3.4-1 in AP-42, Chapter 3.4. VOC emission factor is shown as ROG/TOG in CalEEMod Appendix D ,Table 3.5.
(10) 40 CFR Part 98 Subpart A, Table A-1, Global Warming Potentials.

Table F-10
Cooling Tower Particulate Emission Estimates

Pollutant					PM		PM_{10}		$PM_{2.5}$	
					Emission Estimates					
Source	Modeling ID	Total Circulation Water Rate [1] (gpm)	Drift Loss of Circulating Water [2] (%)	Annual Operation [1] (hrs/yr)	Maximum Daily [a] (lbs/day)	Annual Average [b] (tons/yr)	Maximum Daily [c] (lbs/day)	Annual Average [b] (tons/yr)	Maximum Daily [d] (lbs/day)	Annual Average [b] (tons/yr)
Cooling Tower - Building NRLF	CT_NRLF#	12,000	0.005	6,360	3.86	0.51	3.44	0.46	2.06	0.27
Cooling Tower - Building 8	CTB8C#	4,500	0.005	6,360	1.45	0.19	1.29	0.17	0.77	0.10
Cooling Tower - Building 9	CTB9C#	4,500	0.005	6,360	1.45	0.19	1.29	0.17	0.77	0.10
Cooling Tower - Building 10	CTB10C#	4,500	0.005	6,360	1.45	0.19	1.29	0.17	0.77	0.10
Cooling Tower - Building 11	CTB11C#	2,400	0.005	6,360	0.77	0.10	0.69	0.091	0.41	0.055
Cooling Tower - Building 12	CTB12C#	4,500	0.005	6,360	1.45	0.19	1.29	0.17	0.77	0.10
Cooling Tower - Building 13	CTB13C#	2,400	0.005	6,360	0.77	0.10	0.69	0.091	0.41	0.055
Cooling Tower - Building 14	CTB14C#	3,000	0.005	6,360	0.97	0.13	0.86	0.11	0.52	0.068
Cooling Tower - Building 15	CTB15C#	4,500	0.005	6,360	1.45	0.19	1.29	0.17	0.77	0.10
Cooling Tower - Building 16	CTB16C#	6,000	0.005	6,360	1.93	0.26	1.72	0.23	1.03	0.14
Cooling Tower - Building 17	CTB17C#	6,000	0.005	6,360	1.93	0.26	1.72	0.23	1.03	0.14
Cooling Tower - Building 18	CTB18C#	5,400	0.005	6,360	1.74	0.23	1.55	0.21	0.93	0.12
Cooling Tower - Building 19	CTB19C#	4,500	0.005	6,360	1.45	0.19	1.29	0.17	0.77	0.10
Cooling Tower - Building 20	CTB20C#	4,500	0.005	6,360	1.45	0.19	1.29	0.17	0.77	0.10
Cooling Tower - Building 21	CTB21C#	10,500	0.005	6,360	3.38	0.45	3.01	0.40	1.81	0.24
Cooling Tower - Building 22	CTB22C#	7,500	0.005	6,360	2.41	0.32	2.15	0.28	1.29	0.17
Cooling Tower - Building 23	CTB23C#	6,000	0.005	6,360	1.93	0.26	1.72	0.23	1.03	0.14
Cooling Tower - Building 24	CTB24C#	4,500	0.005	6,360	1.45	0.19	1.29	0.17	0.77	0.10
Cooling Tower - Building 25	CTB25C#	6,000	0.005	6,360	1.93	0.26	1.72	0.23	1.03	0.14
Cooling Tower - Building 26	CTB26C#	6,000	0.005	6,360	1.93	0.26	1.72	0.23	1.03	0.14
Cooling Tower - Building 27	CTB27C#	6,000	0.005	6,360	1.93	0.26	1.72	0.23	1.03	0.14
Cooling Tower - Building 28	CTB28C#	2,400	0.005	6,360	0.77	0.10	0.69	0.091	0.41	0.055
Cooling Tower - Building 29	CTB29C#	2,400	0.005	6,360	0.77	0.10	0.69	0.091	0.41	0.055
Cooling Tower - Building 30	CTB30C#	6,000	0.005	6,360	1.93	0.26	1.72	0.23	1.03	0.14
Cooling Tower - Building 31	CTB31C#	2,400	0.005	6,360	0.77	0.10	0.69	0.091	0.41	0.055
Cooling Tower - Building 32	CTB32C#	4,500	0.005	6,360	1.45	0.19	1.29	0.17	0.77	0.10
Cooling Tower - Building 33	CTB33C#	6,000	0.005	6,360	1.93	0.26	1.72	0.23	1.03	0.14
Cooling Tower - Building 34	CTB34C#	6,000	0.005	6,360	1.93	0.26	1.72	0.23	1.03	0.14
Cooling Tower - Building 35	CTB35C#	7,500	0.005	6,360	2.41	0.32	2.15	0.28	1.29	0.17
Cooling Tower - Building 36	CTB36C#	7,500	0.005	6,360	2.41	0.32	2.15	0.28	1.29	0.17
Cooling Tower - Building 37	CTB37C#	7,500	0.005	6,360	2.41	0.32	2.15	0.28	1.29	0.17
Cooling Tower - Building 38	CTB38C#	3,000	0.005	6,360	0.97	0.13	0.86	0.11	0.52	0.068
Cooling Tower - Buildings 6 and 7	CTB6_7C#	9000	0.005	6,360	2.90	0.38	2.58	0.34	1.55	0.21
Total					**57.7**	**7.65**	**51.4**	**6.81**	**30.8**	**4.09**

Notes:

(a) Maximum daily emissions estimate (lbs/day) = (Circulation water rate [gpm]) x (density of water [lbs/gal]) x (total dissolved solids concentration [ppmw]) x (10^{-6}) x (drift loss of circulating water [%] / 100) x (60 min/hr) x (daily hours of operation [hrs/day])

Total dissolved solids concentration (ppmw) = 536 (1)
Density of water (lbs/gal) = 8.34
Daily hours of operation (hrs/day) = 24 (1)

(b) Annual emissions estimate (tons/yr) = (Daily emissions [lbs/day]) / (daily hours of operation [hrs/day]) x (annual hours of operation [hrs/yr]) x (ton/2,000 lbs)

Daily hours of operation (hrs/day) = 24 (1)

(c) Maximum daily emissions estimate (lbs/day) = (PM emissions estimate [lbs/day]) x (percent of PM_{10} emissions [%] / 100)

Percent of PM_{10} emissions (%) = 89.0 (3)

(d) Maximum daily emissions estimate (lbs/day) = (PM_{10} emissions estimate [lbs/day]) x ($PM_{2.5}$ fraction of PM_{10})

$PM_{2.5}$ fraction of PM_{10} = 0.6 (4)

References:

(1) See Table F-1, LRDP Operations Input Assumptions for Emission Rate Calculations.
(2) Engineering judgment based on past work with industrial cooling towers.
(3) From the technical paper "Calculating Realistic PM10 Emissions from Cooling Towers", by Joel Reisman and Gordon Frisbie. The percent PM_{10} is based on total dissolved content.
(4) From Appendix A - Updated CEIDARS Table with PM2.5 Fractions to the CEQA handbook, supplemental information.

Table F-11
LRDP Operations Criteria Pollutant Emissions Summary - Annual Average Daily Emission Rates (1)

Source	Annual Operation (days/yr)	TAC		Criteria												Greenhouse Gases							
		DPM		PM_{10}		$PM_{2.5}$		NO_X		CO		SO_2		VOC		CO_2		CH_4		N_2O		CO_2e	
		(lbs/day)	(tons/yr)	(lbs/day)	(tons/yr)	(lbs/day)	(tons/yr)	(lbs/day)	(tons/yr)	(lbs/day)	(tons/yr)	(lbs/day)	(tons/yr)	(lbs/day)	(tons/yr)	(lbs/day)	(tons/yr)	(lbs/day)	(tons/yr)	(lbs/day)	(tons/yr)	(lbs/day)	(tons/yr)
Stationary Sources																							
Diesel generators	260	3.9E-02	5.1E-03	3.9E-02	5.1E-03	3.9E-02	5.1E-03	0.96	0.13	5.93	0.77	1.7E-02	2.3E-03	0.37	4.8E-02	1,841	239	3.3E-02	4.3E-03	0	0	1,841	239
Natural Gas Boilers	260	--	--	18.8	2.44	18.8	2.44	46.2	6.01	207	27.0	1.48	0.19	13.6	1.77	296,719	38,573	5.60	0.73	0.56	7.3E-02	297,010	38,611
Cooling Towers	260	--	--	52.4	6.81	31.4	4.09	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Lab Chemicals	260	--	--	--	--	--	--	--	--	--	--	--	--	76.1	9.89	--	--	--	--	--	--	--	--
Total Onsite Stationary Source Emissions	**--**	**3.9E-02**	**5.1E-03**	**71.2**	**9.26**	**50.2**	**6.53**	**47.2**	**6.13**	**213**	**27.7**	**1.50**	**0.19**	**90.1**	**11.7**	**298,559**	**38,813**	**5.63**	**0.73**	**0.56**	**7.3E-02**	**298,851**	**38,851**
Onsite On-Road Vehicle Emission Sources																							
Onsite On-Road Exhaust - Delivery Trucks	260	1.3E-02	1.7E-03	1.3E-02	1.7E-03	1.2E-02	1.6E-03	0.87	0.11	0.43	5.6E-02	0	0	0.23	3.0E-02	717	93.2	--	--	--	--	717	93.2
Onsite On-Road Exhaust - LBNL-RBC Shuttle	260	--	--	1.8E-04	2.3E-05	1.6E-04	2.1E-05	3.7E-03	4.8E-04	3.4E-02	4.4E-03	0	0	1.6E-03	2.0E-04	20.7	2.70	--	--	--	--	20.7	2.70
Onsite On-Road Exhaust - BART-RBC Shuttle	260	--	--	3.4E-04	4.4E-05	3.1E-04	4.1E-05	7.1E-03	9.2E-04	6.5E-02	8.4E-03	0	0	3.0E-03	3.9E-04	39.9	5.19	--	--	--	--	39.9	5.19
Onsite On-Road Exhaust - Employee Vehicles	260	--	--	0.65	8.4E-02	0.60	7.8E-02	6.44	0.84	65.9	8.57	0	0	2.78	0.36	35,750	4,647	--	--	--	--	35,750	4,647
Onsite On-Road Dust - Delivery Trucks	260	--	--	0.32	4.1E-02	7.8E-02	1.0E-02	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Onsite On-Road Dust - LBNL-RBC Shuttle	260	--	--	1.8E-02	2.3E-03	4.4E-03	5.7E-04	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Onsite On-Road Dust - BART-RBC Shuttle	260	--	--	3.4E-02	4.4E-03	8.4E-03	1.1E-03	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Onsite On-Road Dust - Employee Vehicles	260	--	--	25.7	3.34	6.30	0.82	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Onsite Idling Exhaust - Delivery Trucks	260	1.7E-03	2.2E-04	1.7E-03	2.2E-04	1.6E-03	2.0E-04	0.72	9.4E-02	0.47	6.2E-02	1.4E-03	1.8E-04	4.0E-02	5.2E-03	128	16.7	--	--	--	--	128	16.7
Onsite Idling Exhaust - LBNL-RBC Shuttle	260	--	--	1.6E-04	2.1E-05	1.5E-04	1.9E-05	2.4E-03	3.1E-04	2.1E-02	2.8E-03	0	0	1.4E-03	1.8E-04	16.1	2.09	--	--	--	--	16.1	2.09
Onsite Idling Exhaust - BART-RBC Shuttle	260	--	--	3.1E-04	4.0E-05	2.9E-04	3.7E-05	4.6E-03	6.0E-04	4.1E-02	5.3E-03	0	0	2.7E-03	3.5E-04	30.9	4.02	--	--	--	--	30.9	4.02
Total Onsite Vehicle Parking Lot Emissions	**260**	**--**	**--**	**0.23**	**3.0E-02**	**0.22**	**2.8E-02**	**2.49**	**0.32**	**43.6**	**5.67**	**3.4E-02**	**4.4E-03**	**6.32**	**0.82**	**3,287**	**427**	**--**	**--**	**--**	**--**	**3,287**	**427**
Total Onsite On-Road Vehicle Emissions	**--**	**1.5E-02**	**2.0E-03**	**27.0**	**3.50**	**7.23**	**0.94**	**10.5**	**1.37**	**111**	**14.4**	**3.5E-02**	**4.5E-03**	**9.38**	**1.22**	**39,989**	**5,199**	**--**	**--**	**--**	**--**	**39,989**	**5,199**
Offsite On-Road Emissions																							
Offsite On-Road Exhaust - Delivery Trucks	260	0.11	1.4E-02	0.52	6.8E-02	0.27	3.5E-02	2.94	0.38	1.16	0.15	3.2E-02	4.2E-03	0.33	4.3E-02	3,048	396	--	--	--	--	3,048	396
Offsite On-Road Exhaust - LBNL-RBC Shuttle	260	--	--	2.1E-02	2.7E-03	8.7E-03	1.1E-03	4.9E-02	6.3E-03	0.42	5.4E-02	2.6E-03	3.4E-04	4.8E-02	6.3E-03	185	24.1	--	--	--	--	185	24.1
Offsite On-Road Exhaust - BART-RBC Shuttle	260	--	--	2.1E-02	2.7E-03	8.6E-03	1.1E-03	4.8E-02	6.3E-03	0.41	5.4E-02	2.6E-03	3.4E-04	4.8E-02	6.2E-03	184	23.9	--	--	--	--	184	23.9
Offsite On-Road Exhaust - Employee Vehicles	260	--	--	42.7	5.55	17.9	2.33	49.9	6.48	482	62.6	3.10	0.40	35.7	4.64	185,182	24,074	--	--	--	--	185,182	24,074
Offsite On-Road Dust - Delivery Trucks	260	--	--	0.32	4.2E-02	7.9E-02	1.0E-02	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Offsite On-Road Dust - LBNL-RBC Shuttle	260	--	--	4.9E-02	6.4E-03	1.2E-02	1.6E-03	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Offsite On-Road Dust - BART-RBC Shuttle	260	--	--	4.9E-02	6.3E-03	1.2E-02	1.6E-03	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Offsite On-Road Dust - Employee Vehicles	260	--	--	101	13.1	24.7	3.21	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Total Offsite On-Road Vehicle Emissions	**--**	**0.11**	**1.4E-02**	**144**	**18.8**	**43.0**	**5.59**	**52.9**	**6.88**	**484**	**62.9**	**3.14**	**0.41**	**36.1**	**4.70**	**188,599**	**24,518**	**--**	**--**	**--**	**--**	**188,599**	**24,518**
Total Phase 1 Project Summary	**--**	**0.16**	**2.1E-02**	**242**	**31.5**	**100**	**13.1**	**111**	**14.4**	**808**	**105**	**4.67**	**0.61**	**136**	**17.6**	**527,147**	**68,529**	**5.63**	**0.73**	**0.56**	**7.3E-02**	**527,439**	**68,567**
Onsite Stationary Exhaust	**--**	**3.9E-02**	**5.1E-03**	**71.2**	**9.26**	**50.2**	**6.53**	**47.2**	**6.13**	**213**	**27.7**	**1.50**	**0.19**	**90.1**	**11.7**	**298,559**	**38,813**	**5.63**	**0.73**	**0.56**	**7.3E-02**	**298,851**	**38,851**
Onsite Mobile Exhaust	**--**	**1.5E-02**	**2.0E-03**	**0.90**	**0.12**	**0.83**	**0.11**	**10.5**	**1.37**	**111**	**14.4**	**3.5E-02**	**4.5E-03**	**9.38**	**1.22**	**39,989**	**5,199**	**0**	**0**	**0**	**0**	**39,989**	**5,199**
Onsite Fugitive Dust	**--**	**0**	**0**	**26.1**	**3.39**	**6.40**	**0.83**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**
Offsite Mobile Exhaust	**--**	**0.11**	**1.4E-02**	**43.2**	**5.62**	**18.2**	**2.37**	**52.9**	**6.88**	**484**	**62.9**	**3.14**	**0.41**	**36.1**	**4.70**	**188,599**	**24,518**	**0**	**0**	**0**	**0**	**188,599**	**24,518**
Offsite Fugitive Dust	**--**	**0**	**0**	**101**	**13.1**	**24.8**	**3.23**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**

References:

(1) Daily emission rates are annual average daily emission rates, which are calculated by dividing the annual emission rate by the annual days of operation, and converting form tons to pounds. Annual days of operation is set to 5 days per week, 52 weeks per year.

Table F-12
Onsite Employee Vehicle TAC Emission Estimates

Parameter		Parking Lot Emissions					Onroad Emissions
		Hot Soak / Running Evaporative	Resting Evaporative / Diurnal	Starting	Idling	Total	Running
Organic Speciation Profile	(1)	660	661	664	2105		2105
LDA TOG Emission Factor	(2)	4.85E-04 (lbs/vehicle)	6.63E-05 (lbs/vehicle)	1.41E-04 (lbs/vehicle)	1.21E-03 (lbs/hr)		1.01E-04 (lbs/VMT)
Maximum Daily Vehicle Trips (trips/day)	(3)	20,081	20,081	20,081	20,081		20,081
Annual Vehicle Trips (trips/yr)	(3)	5,221,060	5,221,060	5,221,060	5,221,060		5,221,060

TAC	CAS	TAC Emission Fraction of TOG (1)	Maximum Hourly Emissions Estimate (a) (lbs/hr)	Annual Average Emissions Estimate (b) (tons/yr)	TAC Emission Fraction of TOG (1)	Maximum Hourly Emissions Estimate (a) (lbs/hr)	Annual Average Emissions Estimate (b) (tons/yr)	TAC Emission Fraction of TOG (1)	Maximum Hourly Emissions Estimate (a) (lbs/hr)	Annual Average Emissions Estimate (b) (tons/yr)	TAC Emission Fraction of TOG (1)	Maximum Hourly Emissions Estimate (c) (lbs/hr)	Annual Average Emissions Estimate (d) (tons/yr)	Maximum Hourly Emissions Estimate (lbs/hr)	Annual Average Emissions Estimate (tons/yr)	TAC Emission Fraction of TOG (1)	Maximum Hourly Emissions Estimate (e) (lbs/hr)	Annual Average Emissions Estimate (f) (tons/yr)
1,3-Butadiene	106-99-0	No Data	--	--	No Data	--	--	7.0E-03	1.2E-03	2.6E-03	5.5E-03	0	0	1.2E-03	2.6E-03	5.5E-03	4.8E-04	9.9E-04
2-Butanone	78-93-3	No Data	--	--	No Data	--	--	6.0E-04	1.1E-04	2.2E-04	2.0E-04	0	0	1.1E-04	2.2E-04	2.0E-04	1.7E-05	3.6E-05
Acetaldehyde	75-07-0	No Data	--	--	No Data	--	--	5.2E-03	9.2E-04	1.9E-03	2.8E-03	0	0	9.2E-04	1.9E-03	2.8E-03	2.4E-04	5.0E-04
Acrolein	107-02-8	No Data	--	--	No Data	--	--	1.1E-03	1.9E-04	4.0E-04	1.3E-03	0	0	1.9E-04	4.0E-04	1.3E-03	1.1E-04	2.3E-04
Benzene	71-43-2	0.010	6.1E-03	0.013	3.6E-03	3.0E-04	6.2E-04	0.024	4.3E-03	8.9E-03	0.025	0	0	0.011	0.022	0.025	2.1E-03	4.4E-03
Ethylbenzene	100-41-4	0.016	1.0E-02	0.021	1.2E-03	1.0E-04	2.1E-04	0.016	2.8E-03	5.8E-03	0.011	0	0	0.013	0.027	0.011	9.1E-04	1.9E-03
Formaldehyde	50-00-0	No Data	--	--	No Data	--	--	0.013	2.2E-03	4.6E-03	0.016	0	0	2.2E-03	4.6E-03	0.016	1.4E-03	2.8E-03
Methanol	67-56-1	1.0E-04	6.1E-05	1.3E-04	No Data	--	--	2.9E-03	5.1E-04	1.1E-03	1.2E-03	0	0	5.7E-04	1.2E-03	1.2E-03	1.0E-04	2.2E-04
Naphthalene	91-20-3	1.4E-03	8.5E-04	1.8E-03	No Data	--	--	7.0E-04	1.2E-04	2.6E-04	5.0E-04	0	0	9.8E-04	2.0E-03	5.0E-04	4.3E-05	9.0E-05
n-Hexane	110-54-3	7.6E-03	4.6E-03	9.6E-03	0.015	1.3E-03	2.7E-03	0.018	3.2E-03	6.6E-03	0.016	0	0	9.1E-03	0.019	0.016	1.4E-03	2.9E-03
Propylene	115-07-1	No Data	--	--	No Data	--	--	0.033	5.9E-03	0.012	0.031	0	0	5.9E-03	0.012	0.031	2.6E-03	5.5E-03
Styrene	100-42-5	No Data	--	--	No Data	--	--	2.6E-03	4.6E-04	9.5E-04	1.2E-03	0	0	4.6E-04	9.5E-04	1.2E-03	1.0E-04	2.2E-04
Toluene	108-88-3	0.051	0.031	0.065	0.017	1.4E-03	2.9E-03	0.074	0.013	0.027	0.058	0	0	0.046	0.095	0.058	5.0E-03	0.010
m-Xylene	108-38-3	0.027	0.016	0.034	3.4E-03	2.8E-04	5.9E-04	0.053	9.4E-03	0.019	0.036	0	0	0.026	0.054	0.036	3.1E-03	6.4E-03
o-Xylene	95-47-6	0.016	9.7E-03	0.020	1.3E-03	1.1E-04	2.3E-04	0.018	3.2E-03	6.7E-03	0.012	0	0	0.013	0.027	0.012	1.1E-03	2.2E-03
p-Xylene	106-42-3	0.014	8.5E-03	0.018	1.1E-03	9.2E-05	1.9E-04	No Data	--	--	No Data	--	--	8.5E-03	0.018	No Data	--	--

Notes:

(a) Maximum hourly emissions estimate (lbs/hr) = (Emission factor [lbs/vehicle]) x (maximum daily vehicle trips [trips/day]) x (TAC emission fraction) / (daily hours of operation [hrs/day])
Daily hours of operation (hrs/day) = 16 (3)

(b) Annual emissions estimate (tons/yr) = (Emission factor [lbs/vehicle]) x (annual vehicle trips [trips/yr]) x (ton/2,000 lbs) x (TAC emission fraction)

(c) Maximum hourly emissions estimate (lbs/hr) = (Emission factor [lbs/hr]) x (maximum daily vehicle trips [trips/day]) x (idling time per trip [hrs/trip]) x (TAC emission fraction) / (daily hours of operation [hrs/day])
Idling time per trip (hrs/trip) = 0 (3)
Daily hours of operation (hrs/day) = 16 (3)

(d) Annual emissions estimate (tons/yr) = (Emission factor [lbs/hr]) x (annual vehicle trips [trips/yr]) x (idling time per trip [hrs/trip]) x (ton/2,000 lbs) x (TAC emission fraction)
Idling time per trip (hrs/trip) = 0 (3)

(e) Maximum hourly emissions estimate (lbs/hr) = (Emission factor [lbs/VMT]) x (maximum daily vehicle trips [trips/day]) x (onsite roundtrip distance [mi/trip]) x (TAC emission fraction) / (daily hours of operation [hrs/day])
Onsite roundtrip distance (mi/trip) = 0.68 (3)
Daily hours of operation (hrs/day) = 16 (3)

(f) Annual emissions estimate (tons/yr) = (Emission factor [lbs/VMT]) x (annual vehicle trips [trips/yr]) x (onsite roundtrip distance [mi/trip]) x (ton/2,000 lbs) x (TAC emission fraction)
Onsite roundtrip distance (mi/trip) = 0.68 (3)

References:

(1) California Air Resources Board Speciation Database. TAC emission fractions are derived from the individual speciation profiles listed. Profiles chosen to best represent the project vehicle fleet and existing gasoline formulation.
(2) Emission Factors source: EMFAC 2011 (Model Years to 2034). Onsite speed set to 15 mile per hour to conservatively estimate onsite emissions. No tire and brake wear emission factors are provided at 15 miles per hour.
(3) See Table F-1, LRDP Operations Input Assumptions for Emission Rate Calculations.

Table F-13
Offsite Employee Vehicle TAC Emission Estimates

Parameter		Onroad Emissions						Total
		Running		Tire Wear		Brake Wear		
Speciation Profile	(1)	2105	(organic)	472	(particulate)	473	(particulate)	
LDA Emission Factor (lbs/VMT)	(2)	3.61E-05	(TOG)	1.8E-05	(PM_{10})	8.1E-05	(PM_{10})	
Maximum Daily Vehicle Trips (trips/day)	(3)	20,081		20,081		20,081		
Annual Vehicle Trips (trips/yr)	(3)	5,221,060		5,221,060		5,221,060		

TAC	CAS	TAC Emission Fraction of TOG (1)	Maximum Hourly Emissions Estimate (a) (lbs/hr)	Annual Average Emissions Estimate (b) (tons/yr)	TAC Emission Fraction of PM_{10} (1)	Maximum Hourly Emissions Estimate (a) (lbs/hr)	Annual Average Emissions Estimate (b) (tons/yr)	TAC Emission Fraction of PM_{10} (1)	Maximum Hourly Emissions Estimate (a) (lbs/hr)	Annual Average Emissions Estimate (b) (tons/yr)	Maximum Hourly Emissions Estimate (lbs/hr)	Annual Average Emissions Estimate (tons/yr)
1,3-Butadiene	106-99-0	5.5E-03	5.1E-03	0.011	--	--	--	--	--	--	5.1E-03	0.011
2-Butanone	78-93-3	2.0E-04	1.9E-04	3.9E-04	--	--	--	--	--	--	1.9E-04	3.9E-04
Acetaldehyde	75-07-0	2.8E-03	2.6E-03	5.4E-03	--	--	--	--	--	--	2.6E-03	5.4E-03
Acrolein	107-02-8	1.3E-03	1.2E-03	2.5E-03	--	--	--	--	--	--	1.2E-03	2.5E-03
Benzene	71-43-2	0.025	0.023	0.048	--	--	--	--	--	--	0.023	0.048
Ethylbenzene	100-41-4	0.011	9.8E-03	0.020	--	--	--	--	--	--	9.8E-03	0.020
Formaldehyde	50-00-0	0.016	0.015	0.031	--	--	--	--	--	--	0.015	0.031
Methanol	67-56-1	1.2E-03	1.1E-03	2.3E-03	--	--	--	--	--	--	1.1E-03	2.3E-03
Naphthalene	91-20-3	5.0E-04	4.7E-04	9.7E-04	--	--	--	--	--	--	4.7E-04	9.7E-04
n-Hexane	110-54-3	0.016	0.015	0.031	--	--	--	--	--	--	0.015	0.031
Propylene	115-07-1	0.031	0.029	0.059	--	--	--	--	--	--	0.029	0.059
Styrene	100-42-5	1.2E-03	1.1E-03	2.3E-03	--	--	--	--	--	--	1.1E-03	2.3E-03
Toluene	108-88-3	0.058	0.054	0.11	--	--	--	--	--	--	0.054	0.11
m-Xylene	108-38-3	0.036	0.033	0.069	--	--	--	--	--	--	0.033	0.069
o-Xylene	95-47-6	0.012	0.012	0.024	--	--	--	--	--	--	0.012	0.024
Lead	7439-92-1	--	--	--	1.6E-04	7.3E-05	1.5E-04	5.0E-05	1.0E-04	2.2E-04	1.8E-04	3.7E-04
Manganese	7439-96-5	--	--	--	1.0E-04	4.6E-05	9.5E-05	1.7E-03	3.6E-03	7.4E-03	3.6E-03	7.5E-03
Nickel	7440-02-0	--	--	--	5.0E-05	2.3E-05	4.7E-05	6.6E-04	1.4E-03	2.9E-03	1.4E-03	2.9E-03
Arsenic	7440-38-2	--	--	--	No Data	--	--	1.0E-05	2.1E-05	4.4E-05	2.1E-05	4.4E-05
Copper	7440-50-8	--	--	--	4.9E-04	2.2E-04	4.6E-04	0.011	0.024	0.050	0.024	0.050
Vanadium	7440-62-2	--	--	--	No Data	--	--	6.6E-04	1.4E-03	2.9E-03	1.4E-03	2.9E-03
Bromine	7726-95-6	--	--	--	1.5E-05	6.8E-06	1.4E-05	4.0E-05	8.4E-05	1.7E-04	9.1E-05	1.9E-04
Selenium	7782-49-2	--	--	--	2.0E-05	9.1E-06	1.9E-05	2.0E-05	4.2E-05	8.7E-05	5.1E-05	1.1E-04
Chlorine	7782-50-5	--	--	--	7.8E-03	3.6E-03	7.4E-03	1.5E-03	3.1E-03	6.5E-03	6.7E-03	0.014

Notes:

(a) Maximum hourly emissions estimate (lbs/hr) = (Emission factor [lbs/VMT]) x (maximum daily vehicle trips [trips/day]) x (offsite roundtrip distance [mi/trip]) x (TAC emission fraction) / (daily hours of operation [hrs/day])

Offsite roundtrip distance (mi/trip) = 20.6 (3)

Daily hours of operation (hrs/day) = 16 (3)

(b) Annual emissions estimate (tons/yr) = (Emission factor [lbs/VMT]) x (annual vehicle trips [trips/yr]) x (offsite roundtrip distance [mi/trip]) x (ton/2,000 lbs) x (TAC emission fraction)

Offsite roundtrip distance (mi/trip) = 20.6 (3)

References:

(1) California Air Resources Board Speciation Database. TAC emission fractions are derived from the individual speciation profiles listed. Profiles chosen to best represent the project vehicle fleet and existing gasoline formulation.

(2) Emission Factors source: EMFAC 2011 (Model Years to 2034).

(3) See Table F-1, LRDP Operations Input Assumptions for Emission Rate Calculations.

Table F-14
Onsite Shuttle TAC Emission Estimates

Parameter		LBNL - RBC Shuttle		BART - RBC Shuttle		Total
		Idling	Running	Idling	Running	
Organic Speciation Profile	(1)	2105	2105	2105	2105	
MDV TOG Emission Factor	(2)	2.27E-03 (lbs/hr)	1.91E-04 (lbs/VMT)	2.27E-03 (lbs/hr)	1.91E-04 (lbs/VMT)	
Maximum Daily Vehicle Trips (trips/day)	(3)	13	13	25	25	
Annual Vehicle Trips (trips/yr)	(3)	3,380	3,380	6,500	6,500	
Idling Time per Trip (hrs/trip)	(3)	0.083	--	0.083	--	
Daily Hours of Operation (hrs/day)	(3)	13	13	13	13	
Onsite Roundtrip[Distance (mi/trip)	(3)	--	0.730	--	0.730	

TAC	CAS	TAC Emission Fraction of TOG (1)	Maximum Hourly Emissions Estimate (a) (lbs/hr)	Annual Average Emissions Estimate (b) (tons/yr)	TAC Emission Fraction of TOG (1)	Maximum Hourly Emissions Estimate (c) (lbs/hr)	Annual Average Emissions Estimate (d) (tons/yr)	TAC Emission Fraction of TOG (1)	Maximum Hourly Emissions Estimate (a) (lbs/hr)	Annual Average Emissions Estimate (b) (tons/yr)	TAC Emission Fraction of TOG (1)	Maximum Hourly Emissions Estimate (c) (lbs/hr)	Annual Average Emissions Estimate (d) (tons/yr)	Maximum Hourly Emissions Estimate (lbs/hr)	Annual Average Emissions Estimate (tons/yr)
1,3-Butadiene	106-99-0	5.5E-03	1.0E-06	1.8E-06	5.5E-03	7.7E-07	1.3E-06	5.5E-03	2.0E-06	3.4E-06	5.5E-03	1.5E-06	2.5E-06	5.3E-06	8.9E-06
2-Butanone	78-93-3	2.0E-04	3.8E-08	6.4E-08	2.0E-04	2.8E-08	4.7E-08	2.0E-04	7.3E-08	1.2E-07	2.0E-04	5.4E-08	9.1E-08	1.9E-07	3.2E-07
Acetaldehyde	75-07-0	2.8E-03	5.3E-07	9.0E-07	2.8E-03	3.9E-07	6.6E-07	2.8E-03	1.0E-06	1.7E-06	2.8E-03	7.5E-07	1.3E-06	2.7E-06	4.5E-06
Acrolein	107-02-8	1.3E-03	2.5E-07	4.2E-07	1.3E-03	1.8E-07	3.1E-07	1.3E-03	4.7E-07	8.0E-07	1.3E-03	3.5E-07	5.9E-07	1.2E-06	2.1E-06
Benzene	71-43-2	0.025	4.7E-06	7.9E-06	0.025	3.5E-06	5.8E-06	0.025	9.0E-06	1.5E-05	0.025	6.6E-06	1.1E-05	2.4E-05	4.0E-05
Ethylbenzene	100-41-4	0.011	2.0E-06	3.4E-06	0.011	1.5E-06	2.5E-06	0.011	3.8E-06	6.5E-06	0.011	2.8E-06	4.8E-06	1.0E-05	1.7E-05
Formaldehyde	50-00-0	0.016	3.0E-06	5.1E-06	0.016	2.2E-06	3.7E-06	0.016	5.7E-06	9.7E-06	0.016	4.2E-06	7.2E-06	1.5E-05	2.6E-05
Methanol	67-56-1	1.2E-03	2.3E-07	3.8E-07	1.2E-03	1.7E-07	2.8E-07	1.2E-03	4.4E-07	7.4E-07	1.2E-03	3.2E-07	5.4E-07	1.2E-06	1.9E-06
Naphthalene	91-20-3	5.0E-04	9.5E-08	1.6E-07	5.0E-04	7.0E-08	1.2E-07	5.0E-04	1.8E-07	3.1E-07	5.0E-04	1.3E-07	2.3E-07	4.8E-07	8.1E-07
n-Hexane	110-54-3	0.016	3.0E-06	5.1E-06	0.016	2.2E-06	3.8E-06	0.016	5.8E-06	9.8E-06	0.016	4.3E-06	7.3E-06	1.5E-05	2.6E-05
Propylene	115-07-1	0.031	5.8E-06	9.8E-06	0.031	4.3E-06	7.2E-06	0.031	1.1E-05	1.9E-05	0.031	8.2E-06	1.4E-05	2.9E-05	5.0E-05
Styrene	100-42-5	1.2E-03	2.3E-07	3.8E-07	1.2E-03	1.7E-07	2.8E-07	1.2E-03	4.4E-07	7.4E-07	1.2E-03	3.2E-07	5.4E-07	1.2E-06	1.9E-06
Toluene	108-88-3	0.058	1.1E-05	1.8E-05	0.058	8.0E-06	1.4E-05	0.058	2.1E-05	3.5E-05	0.058	1.5E-05	2.6E-05	5.5E-05	9.4E-05
m-Xylene	108-38-3	0.036	6.7E-06	1.1E-05	0.036	5.0E-06	8.4E-06	0.036	1.3E-05	2.2E-05	0.036	9.6E-06	1.6E-05	3.4E-05	5.8E-05
o-Xylene	95-47-6	0.012	2.3E-06	4.0E-06	0.012	1.7E-06	2.9E-06	0.012	4.5E-06	7.6E-06	0.012	3.3E-06	5.6E-06	1.2E-05	2.0E-05

Notes:

(a) Maximum hourly emissions estimate (lbs/hr) = (Emission factor [lbs/hr]) x (maximum daily vehicle trips [trips/day]) x (idling time per trip [hrs/trip]) x (TAC emission fraction) / (daily hours of operation [hrs/day])

(b) Annual emissions estimate (tons/yr) = (Emission factor [lbs/hr]) x (annual vehicle trips [trips/yr]) x (idling time per trip [hrs/trip]) x (ton/2,000 lbs) x (TAC emission fraction)

(c) Maximum hourly emissions estimate (lbs/hr) = (Emission factor [lbs/VMT]) x (maximum daily vehicle trips [trips/day]) x (onsite roundtrip distance [mi/trip]) x (TAC emission fraction) / (daily hours of operation [hrs/day])
Offsite roundtrip distance (mi/trip) = 0.68 (3)

(d) Annual emissions estimate (tons/yr) = (Emission factor [lbs/VMT]) x (annual vehicle trips [trips/yr]) x (onsite roundtrip distance [mi/trip]) x (ton/2,000 lbs) x (TAC emission fraction)
Offsite roundtrip distance (mi/trip) = 0.68 (3)

References:

(1) California Air Resources Board Speciation Database. TAC emission fractions are derived from the individual speciation profiles listed. Profiles chosen to best represent the project vehicle fleet and existing gasoline formulation.

(2) Emission Factors source: EMFAC 2011 (Model Years to 2034). Onsite speed set to 15 mile per hour to conservatively estimate onsite emissions. No tire and brake wear emission factors are provided at 15 miles per hour.

(3) See Table F-1, LRDP Operations Input Assumptions for Emission Rate Calculations.

Table F-15
Offsite Shuttle TAC Emission Estimates

Parameter		LBNL - RBC Shuttle									BART - RBC Shuttle									
		Running		Tire Wear		Brake Wear		Total	Running		Tire Wear		Brake Wear		Total
Speciation Profile	(1)	2105	(organic)	472	(particulate)	473	(particulate)		2105	(organic)	472	(particulate)	473	(particulate)	
MDV Emission Factor (lbs/VMT)	(2)	6.78E-05	(TOG)	1.8E-05	(PM_{10})	8.1E-05	(PM_{10})		6.78E-05	(TOG)	1.8E-05	(PM_{10})	8.1E-05	(PM_{10})	
Maximum Daily Vehicle Trips (trips/day)	(3)	13		13		13			25		25		25		
Annual Vehicle Trips (trips/yr)	(3)	3,380		3,380		3,380			6,500		6,500		6,500		
Daily Hours of Operation (hrs/day)	(3)	13		13		13			13		13		13		
Offsite Roundtrip[Distance (mi/trip)	(3)	15.5		15.5		15.5			8.0		8.0		8.0		

TAC	CAS	TAC Emission Fraction of TOG (1)	Maximum Hourly Emissions Estimate (a) (lbs/hr)	Annual Average Emissions Estimate (b) (tons/yr)	TAC Emission Fraction of PM_{10} (1)	Maximum Hourly Emissions Estimate (a) (lbs/hr)	Annual Average Emissions Estimate (b) (tons/yr)	TAC Emission Fraction of PM_{10} (1)	Maximum Hourly Emissions Estimate (a) (lbs/hr)	Annual Average Emissions Estimate (b) (tons/yr)	Maximum Hourly Emissions Estimate (lbs/hr)	Annual Average Emissions Estimate (tons/yr)	TAC Emission Fraction of TOG (1)	Maximum Hourly Emissions Estimate (a) (lbs/hr)	Annual Average Emissions Estimate (b) (tons/yr)	TAC Emission Fraction of PM_{10} (1)	Maximum Hourly Emissions Estimate (a) (lbs/hr)	Annual Average Emissions Estimate (b) (tons/yr)	TAC Emission Fraction of PM_{10} (1)	Maximum Hourly Emissions Estimate (a) (lbs/hr)	Annual Average Emissions Estimate (b) (tons/yr)	Maximum Hourly Emissions Estimate (lbs/hr)	Annual Average Emissions Estimate (tons/yr)
1,3-Butadiene	106-99-0	5.5E-03	5.8E-06	9.8E-06	--	--	--	--	--	--	5.8E-06	9.8E-06	5.5E-03	5.7E-06	9.7E-06	--	--	--	--	--	--	5.7E-06	9.7E-06
2-Butanone	78-93-3	2.0E-04	2.1E-07	3.6E-07	--	--	--	--	--	--	2.1E-07	3.6E-07	2.0E-04	2.1E-07	3.5E-07	--	--	--	--	--	--	2.1E-07	3.5E-07
Acetaldehyde	75-07-0	2.8E-03	2.9E-06	5.0E-06	--	--	--	--	--	--	2.9E-06	5.0E-06	2.8E-03	2.9E-06	4.9E-06	--	--	--	--	--	--	2.9E-06	4.9E-06
Acrolein	107-02-8	1.3E-03	1.4E-06	2.3E-06	--	--	--	--	--	--	1.4E-06	2.3E-06	1.3E-03	1.4E-06	2.3E-06	--	--	--	--	--	--	1.4E-06	2.3E-06
Benzene	71-43-2	0.025	2.6E-05	4.4E-05	--	--	--	--	--	--	2.6E-05	4.4E-05	0.025	2.6E-05	4.4E-05	--	--	--	--	--	--	2.6E-05	4.4E-05
Ethylbenzene	100-41-4	0.011	1.1E-05	1.9E-05	--	--	--	--	--	--	1.1E-05	1.9E-05	0.011	1.1E-05	1.9E-05	--	--	--	--	--	--	1.1E-05	1.9E-05
Formaldehyde	50-00-0	0.016	1.7E-05	2.8E-05	--	--	--	--	--	--	1.7E-05	2.8E-05	0.016	1.6E-05	2.8E-05	--	--	--	--	--	--	1.6E-05	2.8E-05
Methanol	67-56-1	1.2E-03	1.3E-06	2.1E-06	--	--	--	--	--	--	1.3E-06	2.1E-06	1.2E-03	1.3E-06	2.1E-06	--	--	--	--	--	--	1.3E-06	2.1E-06
Naphthalene	91-20-3	5.0E-04	5.3E-07	8.9E-07	--	--	--	--	--	--	5.3E-07	8.9E-07	5.0E-04	5.2E-07	8.8E-07	--	--	--	--	--	--	5.2E-07	8.8E-07
n-Hexane	110-54-3	0.016	1.7E-05	2.8E-05	--	--	--	--	--	--	1.7E-05	2.8E-05	0.016	1.7E-05	2.8E-05	--	--	--	--	--	--	1.7E-05	2.8E-05
Propylene	115-07-1	0.031	3.2E-05	5.4E-05	--	--	--	--	--	--	3.2E-05	5.4E-05	0.031	3.2E-05	5.4E-05	--	--	--	--	--	--	3.2E-05	5.4E-05
Styrene	100-42-5	1.2E-03	1.3E-06	2.1E-06	--	--	--	--	--	--	1.3E-06	2.1E-06	1.2E-03	1.3E-06	2.1E-06	--	--	--	--	--	--	1.3E-06	2.1E-06
Toluene	108-88-3	0.058	6.1E-05	1.0E-04	--	--	--	--	--	--	6.1E-05	1.0E-04	0.058	6.0E-05	1.0E-04	--	--	--	--	--	--	6.0E-05	1.0E-04
m-Xylene	108-38-3	0.036	3.7E-05	6.3E-05	--	--	--	--	--	--	3.7E-05	6.3E-05	0.036	3.7E-05	6.3E-05	--	--	--	--	--	--	3.7E-05	6.3E-05
o-Xylene	95-47-6	0.012	1.3E-05	2.2E-05	--	--	--	--	--	--	1.3E-05	2.2E-05	0.012	1.3E-05	2.2E-05	--	--	--	--	--	--	1.3E-05	2.2E-05
Lead	7439-92-1	--	--	--	1.6E-04	4.4E-08	7.4E-08	5.0E-05	6.3E-08	1.1E-07	1.1E-07	1.8E-07	--	--	--	1.6E-04	4.3E-08	7.3E-08	5.0E-05	6.2E-08	1.1E-07	1.1E-07	1.8E-07
Manganese	7439-96-5	--	--	--	1.0E-04	2.7E-08	4.6E-08	1.7E-03	2.1E-06	3.6E-06	2.2E-06	3.7E-06	--	--	--	1.0E-04	2.7E-08	4.6E-08	1.7E-03	2.1E-06	3.6E-06	2.1E-06	3.6E-06
Nickel	7440-02-0	--	--	--	5.0E-05	1.4E-08	2.3E-08	6.6E-04	8.3E-07	1.4E-06	8.4E-07	1.4E-06	--	--	--	5.0E-05	1.4E-08	2.3E-08	6.6E-04	8.2E-07	1.4E-06	8.4E-07	1.4E-06
Arsenic	7440-38-2	--	--	--	No Data	--	--	1.0E-05	1.3E-08	2.1E-08	1.3E-08	2.1E-08	--	--	--	No Data	--	--	1.0E-05	1.2E-08	2.1E-08	1.2E-08	2.1E-08
Copper	7440-50-8	--	--	--	4.9E-04	1.3E-07	2.3E-07	0.011	1.4E-05	2.4E-05	1.5E-05	2.5E-05	--	--	--	4.9E-04	1.3E-07	2.2E-07	0.011	1.4E-05	2.4E-05	1.4E-05	2.4E-05
Vanadium	7440-62-2	--	--	--	No Data	--	--	6.6E-04	8.3E-07	1.4E-06	8.3E-07	1.4E-06	--	--	--	No Data	--	--	6.6E-04	8.2E-07	1.4E-06	8.2E-07	1.4E-06
Bromine	7726-95-6	--	--	--	1.5E-05	4.1E-09	6.9E-09	4.0E-05	5.0E-08	8.5E-08	5.4E-08	9.2E-08	--	--	--	1.5E-05	4.1E-09	6.9E-09	4.0E-05	5.0E-08	8.4E-08	5.4E-08	9.1E-08
Selenium	7782-49-2	--	--	--	2.0E-05	5.5E-09	9.2E-09	2.0E-05	2.5E-08	4.2E-08	3.1E-08	5.2E-08	--	--	--	2.0E-05	5.4E-09	9.2E-09	2.0E-05	2.5E-08	4.2E-08	3.0E-08	5.1E-08
Chlorine	7782-50-5	--	--	--	7.8E-03	2.1E-06	3.6E-06	1.5E-03	1.9E-06	3.2E-06	4.0E-06	6.8E-06	--	--	--	7.8E-03	2.1E-06	3.6E-06	1.5E-03	1.9E-06	3.2E-06	4.0E-06	6.7E-06

Notes:

(a) Maximum hourly emissions estimate (lbs/hr) = (Emission factor [lbs/VMT]) x (maximum daily vehicle trips [trips/day]) x (offsite roundtrip distance [mi/trip]) x (TAC emission fraction) / (daily hours of operation [hrs/day])

(b) Annual emissions estimate (tons/yr) = (Emission factor [lbs/VMT]) x (annual vehicle trips [trips/yr]) x (offsite roundtrip distance [mi/trip]) x (ton/2,000 lbs) x (TAC emission fraction)

References:

(1) California Air Resources Board Speciation Database. TAC emission fractions are derived from the individual speciation profiles listed. Profiles chosen to best represent the project vehicle fleet and existing gasoline formulation.

(2) Emission Factors source: EMFAC 2011 (Model Years to 2034).

(3) See Table F-1, LRDP Operations Input Assumptions for Emission Rate Calculations.

Table F-16

Natural Gas Boiler TAC Emission Estimates

Source		Natural Gas Boiler - Buildings 6 and 7	Natural Gas Boiler - Building NRLF	Natural Gas Boiler - Building 8	Natural Gas Boiler - Building 9	Natural Gas Boiler - Building 10	Natural Gas Boiler - Building 11	Natural Gas Boiler - Building 12
Maximum Hourly Fuel Usage (MMBtu/hr)	(1)	24	23	12	12	11	6	11
Daily Hours of Operation (hrs/day)	(1)	24	24	24	24	24	24	24
Annual Fuel Usage (MMBtu/yr)	(1)	42,000	31,923	21,000	21,000	15,267	8,328	15,267
Modeling ID		NGB_B6_7	NGB_NRLF	NGB_B8	NGB_B9	NGB_B10	NGB_B11	NGB_B12

TAC	CAS	Emission Factor (lbs/MMscf)	Maximum Hourly [a] (lbs/hr)	Annual Average [b] (tons/yr)	Maximum Hourly [a] (lbs/hr)	Annual Average [b] (tons/yr)	Maximum Hourly [a] (lbs/hr)	Annual Average [b] (tons/yr)	Maximum Hourly [a] (lbs/hr)	Annual Average [b] (tons/yr)	Maximum Hourly [a] (lbs/hr)	Annual Average [b] (tons/yr)	Maximum Hourly [a] (lbs/hr)	Annual Average [b] (tons/yr)	Maximum Hourly [a] (lbs/hr)	Annual Average [b] (tons/yr)
7,12-Dimethylbenz(a)anthracene	57-97-6	1.6E-05 (2)	3.8E-07	3.3E-07	3.6E-07	2.5E-07	1.9E-07	1.6E-07	1.9E-07	1.6E-07	1.7E-07	1.2E-07	9.4E-08	6.5E-08	1.7E-07	1.2E-07
Acetaldehyde	75-07-0	8.9E-03 (3)	2.1E-04	1.8E-04	2.0E-04	1.4E-04	1.0E-04	9.1E-05	1.0E-04	9.1E-05	9.6E-05	6.6E-05	5.2E-05	3.6E-05	9.6E-05	6.6E-05
Benzene	71-43-2	4.3E-03 (3)	1.0E-04	8.9E-05	9.7E-05	6.7E-05	5.1E-05	4.4E-05	5.1E-05	4.4E-05	4.6E-05	3.2E-05	2.5E-05	1.8E-05	4.6E-05	3.2E-05
Dichlorobenzene	25321-22-6	1.2E-03 (4)	2.8E-05	2.5E-05	2.7E-05	1.9E-05	1.4E-05	1.2E-05	1.4E-05	1.2E-05	1.3E-05	9.0E-06	7.1E-06	4.9E-06	1.3E-05	9.0E-06
Ethylbenzene	100-41-4	6.9E-03 (5)	1.6E-04	1.4E-04	1.6E-04	1.1E-04	8.1E-05	7.1E-05	8.1E-05	7.1E-05	7.4E-05	5.2E-05	4.1E-05	2.8E-05	7.4E-05	5.2E-05
Fluoranthene	206-44-0	3.0E-06 (2)	7.1E-08	6.2E-08	6.8E-08	4.7E-08	3.5E-08	3.1E-08	3.5E-08	3.1E-08	3.2E-08	2.2E-08	1.8E-08	1.2E-08	3.2E-08	2.2E-08
Formaldehyde	50-00-0	2.2E-01 (3)	5.2E-03	4.6E-03	5.0E-03	3.5E-03	2.6E-03	2.3E-03	2.6E-03	2.3E-03	2.4E-03	1.7E-03	1.3E-03	9.0E-04	2.4E-03	1.7E-03
n-Hexane	110-54-3	4.6E-03 (5)	1.1E-04	9.5E-05	1.0E-04	7.2E-05	5.4E-05	4.7E-05	5.4E-05	4.7E-05	5.0E-05	3.4E-05	2.7E-05	1.9E-05	5.0E-05	3.4E-05
Naphthalene	91-20-3	3.0E-04 (5)	7.1E-06	6.2E-06	6.8E-06	4.7E-06	3.5E-06	3.1E-06	3.5E-06	3.1E-06	3.2E-06	2.2E-06	1.8E-06	1.2E-06	3.2E-06	2.2E-06
Propylene	115-07-1	5.3E-01 (5)	0.012	0.011	0.012	8.3E-03	6.2E-03	5.5E-03	6.2E-03	5.5E-03	5.7E-03	4.0E-03	3.1E-03	2.2E-03	5.7E-03	4.0E-03
Toluene	108-88-3	2.7E-02 (5)	6.2E-04	5.5E-04	6.0E-04	4.1E-04	3.1E-04	2.7E-04	3.1E-04	2.7E-04	2.9E-04	2.0E-04	1.6E-04	1.1E-04	2.9E-04	2.0E-04
Xylenes	1330-20-7	2.0E-02 (5)	4.6E-04	4.1E-04	4.4E-04	3.1E-04	2.3E-04	2.0E-04	2.3E-04	2.0E-04	2.1E-04	1.5E-04	1.2E-04	8.0E-05	2.1E-04	1.5E-04
Arsenic	7440-38-2	2.0E-04 (4)	4.7E-06	4.1E-06	4.5E-06	3.1E-06	2.4E-06	2.1E-06	2.4E-06	2.1E-06	2.2E-06	1.5E-06	1.2E-06	8.2E-07	2.2E-06	1.5E-06
Beryllium	7440-41-7	1.2E-05 (4)	2.8E-07	2.5E-07	2.7E-07	1.9E-07	1.4E-07	1.2E-07	1.4E-07	1.2E-07	1.3E-07	9.0E-08	7.1E-08	4.9E-08	1.3E-07	9.0E-08
Cadmium	7440-43-9	1.1E-03 (4)	2.6E-05	2.3E-05	2.5E-05	1.7E-05	1.3E-05	1.1E-05	1.3E-05	1.1E-05	1.2E-05	8.2E-06	6.5E-06	4.5E-06	1.2E-05	8.2E-06
Chromium VI	18540-29-9	2.4E-04 (6)	5.6E-06	4.9E-06	5.4E-06	3.7E-06	2.8E-06	2.5E-06	2.8E-06	2.5E-06	2.6E-06	1.8E-06	1.4E-06	9.7E-07	2.6E-06	1.8E-06
Cobalt	7440-48-4	8.4E-05 (4)	2.0E-06	1.7E-06	1.9E-06	1.3E-06	9.9E-07	8.6E-07	9.9E-07	8.6E-07	9.1E-07	6.3E-07	4.9E-07	3.4E-07	9.1E-07	6.3E-07
Copper	7440-50-8	8.5E-04 (4)	2.0E-05	1.8E-05	1.9E-05	1.3E-05	1.0E-05	8.8E-06	1.0E-05	8.8E-06	9.2E-06	6.4E-06	5.0E-06	3.5E-06	9.2E-06	6.4E-06
Lead	7439-92-1	5.0E-04 (4)	1.2E-05	1.0E-05	1.1E-05	7.8E-06	5.9E-06	5.1E-06	5.9E-06	5.1E-06	5.4E-06	3.7E-06	2.9E-06	2.0E-06	5.4E-06	3.7E-06
Manganese	7439-96-5	3.8E-04 (4)	8.9E-06	7.8E-06	8.6E-06	5.9E-06	4.5E-06	3.9E-06	4.5E-06	3.9E-06	4.1E-06	2.8E-06	2.2E-06	1.6E-06	4.1E-06	2.8E-06
Mercury	7439-97-6	2.6E-04 (4)	6.1E-06	5.4E-06	5.9E-06	4.1E-06	3.1E-06	2.7E-06	3.1E-06	2.7E-06	2.8E-06	1.9E-06	1.5E-06	1.1E-06	2.8E-06	1.9E-06
Nickel	7440-02-0	2.1E-03 (4)	4.9E-05	4.3E-05	4.7E-05	3.3E-05	2.5E-05	2.2E-05	2.5E-05	2.2E-05	2.3E-05	1.6E-05	1.2E-05	8.6E-06	2.3E-05	1.6E-05
Selenium	7782-49-2	2.4E-05 (4)	5.6E-07	4.9E-07	5.4E-07	3.8E-07	2.8E-07	2.5E-07	2.8E-07	2.5E-07	2.6E-07	1.8E-07	1.4E-07	9.8E-08	2.6E-07	1.8E-07

Notes:

(a) Maximum hourly emissions estimate (lbs/hr) = (Emission factor [lbs/MMscf]) x (maximum hourly heat input [MMBtu/hr])/ (natural gas heat content [Btu/scf])

Natural gas heat content (Btu/scf) = 1,020 (2)

(b) Annual emissions estimate (tons/yr) = (Emission factor [lbs/MMscf]) x (annual heat input [MMBtu/yr]) / (natural gas heat content [Btu/scf]) x (tons/2,000 lbs)

Natural gas heat content (Btu/scf) = 1,020 (2)

References:

(1) See Table F-1, LRDP Operations Input Assumptions for Emission Rate Calculations.
(2) AP-42 Chapter 1.4 (July 1998), Table 1.4-3 "Emission Factors For Speciated Organic Compounds from Natural Gas Combustion".
(3) California Air Toxics Emission Factor (CATEF) Database under Natural Gas Boilers.
(4) AP-42 Chapter 1.4 (July 1998), Table 1.4-4 "Emission Factors For Metals from Natural Gas Combustion".
(5) Ventura Air Quality Management District emission factor database.
(6) The AP-42 total chromium emission factor was multiplied by 17% to correct for emissions of hexavalent chromium per EPA assumptions when regulating combustion sources under 40 CFR Part 63 Subpart DDDD.

Table F-16

Natural Gas Boiler TAC Emission Estimates

Source		Natural Gas Boiler - Building 13	Natural Gas Boiler - Building 14	Natural Gas Boiler - Building 15	Natural Gas Boiler - Building 16	Natural Gas Boiler - Building 17	Natural Gas Boiler - Building 18	Natural Gas Boiler - Building 19
Maximum Hourly Fuel Usage (MMBtu/hr)	(1)	6	8	13	15	16	14	12
Daily Hours of Operation (hrs/day)	(1)	24	24	24	24	24	24	24
Annual Fuel Usage (MMBtu/yr)	(1)	8,328	11,104	18,043	20,819	22,207	19,431	16,655
Modeling ID		NGB_B13	NGB_B14	NGB_B15	NGB_B16	NGB_B17	NGB_B18	NGB_B19

TAC	CAS	Emission Factor (lbs/MMscf)	Maximum Hourly [a] (lbs/hr)	Annual Average [b] (tons/yr)	Maximum Hourly [a] (lbs/hr)	Annual Average [b] (tons/yr)	Maximum Hourly [a] (lbs/hr)	Annual Average [b] (tons/yr)	Maximum Hourly [a] (lbs/hr)	Annual Average [b] (tons/yr)	Maximum Hourly [a] (lbs/hr)	Annual Average [b] (tons/yr)	Maximum Hourly [a] (lbs/hr)	Annual Average [b] (tons/yr)	Maximum Hourly [a] (lbs/hr)	Annual Average [b] (tons/yr)
7,12-Dimethylbenz(a)anthracene	57-97-6	1.6E-05 (2)	9.4E-08	6.5E-08	1.3E-07	8.7E-08	2.0E-07	1.4E-07	2.4E-07	1.6E-07	2.5E-07	1.7E-07	2.2E-07	1.5E-07	1.9E-07	1.3E-07
Acetaldehyde	75-07-0	8.9E-03 (3)	5.2E-05	3.6E-05	7.0E-05	4.8E-05	1.1E-04	7.8E-05	1.3E-04	9.1E-05	1.4E-04	9.7E-05	1.2E-04	8.4E-05	1.0E-04	7.2E-05
Benzene	71-43-2	4.3E-03 (3)	2.5E-05	1.8E-05	3.4E-05	2.3E-05	5.5E-05	3.8E-05	6.3E-05	4.4E-05	6.8E-05	4.7E-05	5.9E-05	4.1E-05	5.1E-05	3.5E-05
Dichlorobenzene	25321-22-6	1.2E-03 (4)	7.1E-06	4.9E-06	9.4E-06	6.5E-06	1.5E-05	1.1E-05	1.8E-05	1.2E-05	1.9E-05	1.3E-05	1.6E-05	1.1E-05	1.4E-05	9.8E-06
Ethylbenzene	100-41-4	6.9E-03 (5)	4.1E-05	2.8E-05	5.4E-05	3.8E-05	8.8E-05	6.1E-05	1.0E-04	7.0E-05	1.1E-04	7.5E-05	9.5E-05	6.6E-05	8.1E-05	5.6E-05
Fluoranthene	206-44-0	3.0E-06 (2)	1.8E-08	1.2E-08	2.4E-08	1.6E-08	3.8E-08	2.7E-08	4.4E-08	3.1E-08	4.7E-08	3.3E-08	4.1E-08	2.9E-08	3.5E-08	2.4E-08
Formaldehyde	50-00-0	2.2E-01 (3)	1.3E-03	9.0E-04	1.7E-03	1.2E-03	2.8E-03	2.0E-03	3.3E-03	2.3E-03	3.5E-03	2.4E-03	3.0E-03	2.1E-03	2.6E-03	1.8E-03
n-Hexane	110-54-3	4.6E-03 (5)	2.7E-05	1.9E-05	3.6E-05	2.5E-05	5.9E-05	4.1E-05	6.8E-05	4.7E-05	7.2E-05	5.0E-05	6.3E-05	4.4E-05	5.4E-05	3.8E-05
Naphthalene	91-20-3	3.0E-04 (5)	1.8E-06	1.2E-06	2.4E-06	1.6E-06	3.8E-06	2.7E-06	4.4E-06	3.1E-06	4.7E-06	3.3E-06	4.1E-06	2.9E-06	3.5E-06	2.4E-06
Propylene	115-07-1	5.3E-01 (5)	3.1E-03	2.2E-03	4.2E-03	2.9E-03	6.8E-03	4.7E-03	7.8E-03	5.4E-03	8.3E-03	5.8E-03	7.3E-03	5.0E-03	6.2E-03	4.3E-03
Toluene	108-88-3	2.7E-02 (5)	1.6E-04	1.1E-04	2.1E-04	1.4E-04	3.4E-04	2.3E-04	3.9E-04	2.7E-04	4.2E-04	2.9E-04	3.6E-04	2.5E-04	3.1E-04	2.2E-04
Xylenes	1330-20-7	2.0E-02 (5)	1.2E-04	8.0E-05	1.5E-04	1.1E-04	2.5E-04	1.7E-04	2.9E-04	2.0E-04	3.1E-04	2.1E-04	2.7E-04	1.9E-04	2.3E-04	1.6E-04
Arsenic	7440-38-2	2.0E-04 (4)	1.2E-06	8.2E-07	1.6E-06	1.1E-06	2.5E-06	1.8E-06	2.9E-06	2.0E-06	3.1E-06	2.2E-06	2.7E-06	1.9E-06	2.4E-06	1.6E-06
Beryllium	7440-41-7	1.2E-05 (4)	7.1E-08	4.9E-08	9.4E-08	6.5E-08	1.5E-07	1.1E-07	1.8E-07	1.2E-07	1.9E-07	1.3E-07	1.6E-07	1.1E-07	1.4E-07	9.8E-08
Cadmium	7440-43-9	1.1E-03 (4)	6.5E-06	4.5E-06	8.6E-06	6.0E-06	1.4E-05	9.7E-06	1.6E-05	1.1E-05	1.7E-05	1.2E-05	1.5E-05	1.0E-05	1.3E-05	9.0E-06
Chromium VI	18540-29-9	2.4E-04 (6)	1.4E-06	9.7E-07	1.9E-06	1.3E-06	3.0E-06	2.1E-06	3.5E-06	2.4E-06	3.7E-06	2.6E-06	3.3E-06	2.3E-06	2.8E-06	1.9E-06
Cobalt	7440-48-4	8.4E-05 (4)	4.9E-07	3.4E-07	6.6E-07	4.6E-07	1.1E-06	7.4E-07	1.2E-06	8.6E-07	1.3E-06	9.1E-07	1.2E-06	8.0E-07	9.9E-07	6.9E-07
Copper	7440-50-8	8.5E-04 (4)	5.0E-06	3.5E-06	6.7E-06	4.6E-06	1.1E-05	7.5E-06	1.3E-05	8.7E-06	1.3E-05	9.3E-06	1.2E-05	8.1E-06	1.0E-05	6.9E-06
Lead	7439-92-1	5.0E-04 (4)	2.9E-06	2.0E-06	3.9E-06	2.7E-06	6.4E-06	4.4E-06	7.4E-06	5.1E-06	7.8E-06	5.4E-06	6.9E-06	4.8E-06	5.9E-06	4.1E-06
Manganese	7439-96-5	3.8E-04 (4)	2.2E-06	1.6E-06	3.0E-06	2.1E-06	4.8E-06	3.4E-06	5.6E-06	3.9E-06	6.0E-06	4.1E-06	5.2E-06	3.6E-06	4.5E-06	3.1E-06
Mercury	7439-97-6	2.6E-04 (4)	1.5E-06	1.1E-06	2.0E-06	1.4E-06	3.3E-06	2.3E-06	3.8E-06	2.7E-06	4.1E-06	2.8E-06	3.6E-06	2.5E-06	3.1E-06	2.1E-06
Nickel	7440-02-0	2.1E-03 (4)	1.2E-05	8.6E-06	1.6E-05	1.1E-05	2.7E-05	1.9E-05	3.1E-05	2.1E-05	3.3E-05	2.3E-05	2.9E-05	2.0E-05	2.5E-05	1.7E-05
Selenium	7782-49-2	2.4E-05 (4)	1.4E-07	9.8E-08	1.9E-07	1.3E-07	3.1E-07	2.1E-07	3.5E-07	2.4E-07	3.8E-07	2.6E-07	3.3E-07	2.3E-07	2.8E-07	2.0E-07

Notes:

(a) Maximum hourly emissions estimate (lbs/hr) = (Emission factor [lbs/MMscf]) x (maximum hourly heat input [MMBtu/hr])/ (natural gas heat content [Btu/scf])

Natural gas heat content (Btu/scf) = 1,020 (2)

(b) Annual emissions estimate (tons/yr) = (Emission factor [lbs/MMscf]) x (annual heat input [MMBtu/yr]) / (natural gas heat content [Btu/scf]) x (tons/2,000 lbs)

Natural gas heat content (Btu/scf) = 1,020 (2)

References:

(1) See Table F-1, LRDP Operations Input Assumptions for Emission Rate Calculations.
(2) AP-42 Chapter 1.4 (July 1998), Table 1.4-3 "Emission Factors For Speciated Organic Compounds from Natural Gas Combustion".
(3) California Air Toxics Emission Factor (CATEF) Database under Natural Gas Boilers.
(4) AP-42 Chapter 1.4 (July 1998), Table 1.4-4 "Emission Factors For Metals from Natural Gas Combustion".
(5) Ventura Air Quality Management District emission factor database.
(6) The AP-42 total chromium emission factor was multiplied by 17% to correct for emissions of hexavalent chromium per EPA assumptions when regulating combustion sources under 40 CFR Part 63 Subpart DDDD.

Table F-16

Natural Gas Boiler TAC Emission Estimates

Source		Natural Gas Boiler - Building 20	Natural Gas Boiler - Building 21	Natural Gas Boiler - Building 22	Natural Gas Boiler - Building 23	Natural Gas Boiler - Building 24	Natural Gas Boiler - Building 25	Natural Gas Boiler - Building 26
Maximum Hourly Fuel Usage (MMBtu/hr)	(1)	12	28	19	14	12	17	17
Daily Hours of Operation (hrs/day)	(1)	24	24	24	24	24	24	24
Annual Fuel Usage (MMBtu/yr)	(1)	16,655	38,863	26,371	19,431	16,655	23,595	23,595
Modeling ID		NGB_B20	NGB_B21	NGB_B22	NGB_B23	NGB_B24	NGB_B25	NGB_B26

TAC	CAS	Emission Factor (lbs/MMscf)	Maximum Hourly [a] (lbs/hr)	Annual Average [b] (tons/yr)	Maximum Hourly [a] (lbs/hr)	Annual Average [b] (tons/yr)	Maximum Hourly [a] (lbs/hr)	Annual Average [b] (tons/yr)	Maximum Hourly [a] (lbs/hr)	Annual Average [b] (tons/yr)	Maximum Hourly [a] (lbs/hr)	Annual Average [b] (tons/yr)	Maximum Hourly [a] (lbs/hr)	Annual Average [b] (tons/yr)	Maximum Hourly [a] (lbs/hr)	Annual Average [b] (tons/yr)
7,12-Dimethylbenz(a)anthracene	57-97-6	1.6E-05 (2)	1.9E-07	1.3E-07	4.4E-07	3.0E-07	3.0E-07	2.1E-07	2.2E-07	1.5E-07	1.9E-07	1.3E-07	2.7E-07	1.9E-07	2.7E-07	1.9E-07
Acetaldehyde	75-07-0	8.9E-03 (3)	1.0E-04	7.2E-05	2.4E-04	1.7E-04	1.7E-04	1.1E-04	1.2E-04	8.4E-05	1.0E-04	7.2E-05	1.5E-04	1.0E-04	1.5E-04	1.0E-04
Benzene	71-43-2	4.3E-03 (3)	5.1E-05	3.5E-05	1.2E-04	8.2E-05	8.0E-05	5.6E-05	5.9E-05	4.1E-05	5.1E-05	3.5E-05	7.2E-05	5.0E-05	7.2E-05	5.0E-05
Dichlorobenzene	25321-22-6	1.2E-03 (4)	1.4E-05	9.8E-06	3.3E-05	2.3E-05	2.2E-05	1.6E-05	1.6E-05	1.1E-05	1.4E-05	9.8E-06	2.0E-05	1.4E-05	2.0E-05	1.4E-05
Ethylbenzene	100-41-4	6.9E-03 (5)	8.1E-05	5.6E-05	1.9E-04	1.3E-04	1.3E-04	8.9E-05	9.5E-05	6.6E-05	8.1E-05	5.6E-05	1.2E-04	8.0E-05	1.2E-04	8.0E-05
Fluoranthene	206-44-0	3.0E-06 (2)	3.5E-08	2.4E-08	8.2E-08	5.7E-08	5.6E-08	3.9E-08	4.1E-08	2.9E-08	3.5E-08	2.4E-08	5.0E-08	3.5E-08	5.0E-08	3.5E-08
Formaldehyde	50-00-0	2.2E-01 (3)	2.6E-03	1.8E-03	6.1E-03	4.2E-03	4.1E-03	2.9E-03	3.0E-03	2.1E-03	2.6E-03	1.8E-03	3.7E-03	2.6E-03	3.7E-03	2.6E-03
n-Hexane	110-54-3	4.6E-03 (5)	5.4E-05	3.8E-05	1.3E-04	8.8E-05	8.6E-05	5.9E-05	6.3E-05	4.4E-05	5.4E-05	3.8E-05	7.7E-05	5.3E-05	7.7E-05	5.3E-05
Naphthalene	91-20-3	3.0E-04 (5)	3.5E-06	2.4E-06	8.2E-06	5.7E-06	5.6E-06	3.9E-06	4.1E-06	2.9E-06	3.5E-06	2.4E-06	5.0E-06	3.5E-06	5.0E-06	3.5E-06
Propylene	115-07-1	5.3E-01 (5)	6.2E-03	4.3E-03	0.015	0.010	9.9E-03	6.9E-03	7.3E-03	5.0E-03	6.2E-03	4.3E-03	8.8E-03	6.1E-03	8.8E-03	6.1E-03
Toluene	108-88-3	2.7E-02 (5)	3.1E-04	2.2E-04	7.3E-04	5.0E-04	4.9E-04	3.4E-04	3.6E-04	2.5E-04	3.1E-04	2.2E-04	4.4E-04	3.1E-04	4.4E-04	3.1E-04
Xylenes	1330-20-7	2.0E-02 (5)	2.3E-04	1.6E-04	5.4E-04	3.8E-04	3.7E-04	2.5E-04	2.7E-04	1.9E-04	2.3E-04	1.6E-04	3.3E-04	2.3E-04	3.3E-04	2.3E-04
Arsenic	7440-38-2	2.0E-04 (4)	2.4E-06	1.6E-06	5.5E-06	3.8E-06	3.7E-06	2.6E-06	2.7E-06	1.9E-06	2.4E-06	1.6E-06	3.3E-06	2.3E-06	3.3E-06	2.3E-06
Beryllium	7440-41-7	1.2E-05 (4)	1.4E-07	9.8E-08	3.3E-07	2.3E-07	2.2E-07	1.6E-07	1.6E-07	1.1E-07	1.4E-07	9.8E-08	2.0E-07	1.4E-07	2.0E-07	1.4E-07
Cadmium	7440-43-9	1.1E-03 (4)	1.3E-05	9.0E-06	3.0E-05	2.1E-05	2.0E-05	1.4E-05	1.5E-05	1.0E-05	1.3E-05	9.0E-06	1.8E-05	1.3E-05	1.8E-05	1.3E-05
Chromium VI	18540-29-9	2.4E-04 (6)	2.8E-06	1.9E-06	6.5E-06	4.5E-06	4.4E-06	3.1E-06	3.3E-06	2.3E-06	2.8E-06	1.9E-06	4.0E-06	2.8E-06	4.0E-06	2.8E-06
Cobalt	7440-48-4	8.4E-05 (4)	9.9E-07	6.9E-07	2.3E-06	1.6E-06	1.6E-06	1.1E-06	1.2E-06	8.0E-07	9.9E-07	6.9E-07	1.4E-06	9.7E-07	1.4E-06	9.7E-07
Copper	7440-50-8	8.5E-04 (4)	1.0E-05	6.9E-06	2.3E-05	1.6E-05	1.6E-05	1.1E-05	1.2E-05	8.1E-06	1.0E-05	6.9E-06	1.4E-05	9.8E-06	1.4E-05	9.8E-06
Lead	7439-92-1	5.0E-04 (4)	5.9E-06	4.1E-06	1.4E-05	9.5E-06	9.3E-06	6.5E-06	6.9E-06	4.8E-06	5.9E-06	4.1E-06	8.3E-06	5.8E-06	8.3E-06	5.8E-06
Manganese	7439-96-5	3.8E-04 (4)	4.5E-06	3.1E-06	1.0E-05	7.2E-06	7.1E-06	4.9E-06	5.2E-06	3.6E-06	4.5E-06	3.1E-06	6.3E-06	4.4E-06	6.3E-06	4.4E-06
Mercury	7439-97-6	2.6E-04 (4)	3.1E-06	2.1E-06	7.1E-06	5.0E-06	4.8E-06	3.4E-06	3.6E-06	2.5E-06	3.1E-06	2.1E-06	4.3E-06	3.0E-06	4.3E-06	3.0E-06
Nickel	7440-02-0	2.1E-03 (4)	2.5E-05	1.7E-05	5.8E-05	4.0E-05	3.9E-05	2.7E-05	2.9E-05	2.0E-05	2.5E-05	1.7E-05	3.5E-05	2.4E-05	3.5E-05	2.4E-05
Selenium	7782-49-2	2.4E-05 (4)	2.8E-07	2.0E-07	6.6E-07	4.6E-07	4.5E-07	3.1E-07	3.3E-07	2.3E-07	2.8E-07	2.0E-07	4.0E-07	2.8E-07	4.0E-07	2.8E-07

Notes:

(a) Maximum hourly emissions estimate (lbs/hr) = (Emission factor [lbs/MMscf]) x (maximum hourly heat input [MMBtu/hr])/ (natural gas heat content [Btu/scf])

Natural gas heat content (Btu/scf) = 1,020 (2)

(b) Annual emissions estimate (tons/yr) = (Emission factor [lbs/MMscf]) x (annual heat input [MMBtu/yr]) / (natural gas heat content [Btu/scf]) x (tons/2,000 lbs)

Natural gas heat content (Btu/scf) = 1,020 (2)

References:

(1) See Table F-1, LRDP Operations Input Assumptions for Emission Rate Calculations.
(2) AP-42 Chapter 1.4 (July 1998), Table 1.4-3 "Emission Factors For Speciated Organic Compounds from Natural Gas Combustion".
(3) California Air Toxics Emission Factor (CATEF) Database under Natural Gas Boilers.
(4) AP-42 Chapter 1.4 (July 1998), Table 1.4-4 "Emission Factors For Metals from Natural Gas Combustion".
(5) Ventura Air Quality Management District emission factor database.
(6) The AP-42 total chromium emission factor was multiplied by 17% to correct for emissions of hexavalent chromium per EPA assumptions when regulating combustion sources under 40 CFR Part 63 Subpart DDDD.

Table F-16

Natural Gas Boiler TAC Emission Estimates

Source		Natural Gas Boiler - Building 27	Natural Gas Boiler - Building 28	Natural Gas Boiler - Building 29	Natural Gas Boiler - Building 30	Natural Gas Boiler - Building 31	Natural Gas Boiler - Building 32	Natural Gas Boiler - Building 33
Maximum Hourly Fuel Usage (MMBtu/hr)	(1)	16	6	6	16	6	13	16
Daily Hours of Operation (hrs/day)	(1)	24	24	24	24	24	24	24
Annual Fuel Usage (MMBtu/yr)	(1)	22,207	8,328	8,328	22,207	8,328	18,043	22,207
Modeling ID		NGB_B27	NGB_B28	NGB_B29	NGB_B30	NGB_B31	NGB_B32	NGB_B33

TAC	CAS	Emission Factor (lbs/MMscf)	Maximum Hourly [a] (lbs/hr)	Annual Average [b] (tons/yr)	Maximum Hourly [a] (lbs/hr)	Annual Average [b] (tons/yr)	Maximum Hourly [a] (lbs/hr)	Annual Average [b] (tons/yr)	Maximum Hourly [a] (lbs/hr)	Annual Average [b] (tons/yr)	Maximum Hourly [a] (lbs/hr)	Annual Average [b] (tons/yr)	Maximum Hourly [a] (lbs/hr)	Annual Average [b] (tons/yr)	Maximum Hourly [a] (lbs/hr)	Annual Average [b] (tons/yr)	Maximum Hourly [a] (lbs/hr)	Annual Average [b] (tons/yr)
7,12-Dimethylbenz(a)anthracene	57-97-6	1.6E-05 (2)	2.5E-07	1.7E-07	9.4E-08	6.5E-08	9.4E-08	6.5E-08	2.5E-07	1.7E-07	9.4E-08	6.5E-08	2.0E-07	1.4E-07	2.5E-07	1.7E-07
Acetaldehyde	75-07-0	8.9E-03 (3)	1.4E-04	9.7E-05	5.2E-05	3.6E-05	5.2E-05	3.6E-05	1.4E-04	9.7E-05	5.2E-05	3.6E-05	1.1E-04	7.8E-05	1.4E-04	9.7E-05
Benzene	71-43-2	4.3E-03 (3)	6.8E-05	4.7E-05	2.5E-05	1.8E-05	2.5E-05	1.8E-05	6.8E-05	4.7E-05	2.5E-05	1.8E-05	5.5E-05	3.8E-05	6.8E-05	4.7E-05
Dichlorobenzene	25321-22-6	1.2E-03 (4)	1.9E-05	1.3E-05	7.1E-06	4.9E-06	7.1E-06	4.9E-06	1.9E-05	1.3E-05	7.1E-06	4.9E-06	1.5E-05	1.1E-05	1.9E-05	1.3E-05
Ethylbenzene	100-41-4	6.9E-03 (5)	1.1E-04	7.5E-05	4.1E-05	2.8E-05	4.1E-05	2.8E-05	1.1E-04	7.5E-05	4.1E-05	2.8E-05	8.8E-05	6.1E-05	1.1E-04	7.5E-05
Fluoranthene	206-44-0	3.0E-06 (2)	4.7E-08	3.3E-08	1.8E-08	1.2E-08	1.8E-08	1.2E-08	4.7E-08	3.3E-08	1.8E-08	1.2E-08	3.8E-08	2.7E-08	4.7E-08	3.3E-08
Formaldehyde	50-00-0	2.2E-01 (3)	3.5E-03	2.4E-03	1.3E-03	9.0E-04	1.3E-03	9.0E-04	3.5E-03	2.4E-03	1.3E-03	9.0E-04	2.8E-03	2.0E-03	3.5E-03	2.4E-03
n-Hexane	110-54-3	4.6E-03 (5)	7.2E-05	5.0E-05	2.7E-05	1.9E-05	2.7E-05	1.9E-05	7.2E-05	5.0E-05	2.7E-05	1.9E-05	5.9E-05	4.1E-05	7.2E-05	5.0E-05
Naphthalene	91-20-3	3.0E-04 (5)	4.7E-06	3.3E-06	1.8E-06	1.2E-06	1.8E-06	1.2E-06	4.7E-06	3.3E-06	1.8E-06	1.2E-06	3.8E-06	2.7E-06	4.7E-06	3.3E-06
Propylene	115-07-1	5.3E-01 (5)	8.3E-03	5.8E-03	3.1E-03	2.2E-03	3.1E-03	2.2E-03	8.3E-03	5.8E-03	3.1E-03	2.2E-03	6.8E-03	4.7E-03	8.3E-03	5.8E-03
Toluene	108-88-3	2.7E-02 (5)	4.2E-04	2.9E-04	1.6E-04	1.1E-04	1.6E-04	1.1E-04	4.2E-04	2.9E-04	1.6E-04	1.1E-04	3.4E-04	2.3E-04	4.2E-04	2.9E-04
Xylenes	1330-20-7	2.0E-02 (5)	3.1E-04	2.1E-04	1.2E-04	8.0E-05	1.2E-04	8.0E-05	3.1E-04	2.1E-04	1.2E-04	8.0E-05	2.5E-04	1.7E-04	3.1E-04	2.1E-04
Arsenic	7440-38-2	2.0E-04 (4)	3.1E-06	2.2E-06	1.2E-06	8.2E-07	1.2E-06	8.2E-07	3.1E-06	2.2E-06	1.2E-06	8.2E-07	2.5E-06	1.8E-06	3.1E-06	2.2E-06
Beryllium	7440-41-7	1.2E-05 (4)	1.9E-07	1.3E-07	7.1E-08	4.9E-08	7.1E-08	4.9E-08	1.9E-07	1.3E-07	7.1E-08	4.9E-08	1.5E-07	1.1E-07	1.9E-07	1.3E-07
Cadmium	7440-43-9	1.1E-03 (4)	1.7E-05	1.2E-05	6.5E-06	4.5E-06	6.5E-06	4.5E-06	1.7E-05	1.2E-05	6.5E-06	4.5E-06	1.4E-05	9.7E-06	1.7E-05	1.2E-05
Chromium VI	18540-29-9	2.4E-04 (6)	3.7E-06	2.6E-06	1.4E-06	9.7E-07	1.4E-06	9.7E-07	3.7E-06	2.6E-06	1.4E-06	9.7E-07	3.0E-06	2.1E-06	3.7E-06	2.6E-06
Cobalt	7440-48-4	8.4E-05 (4)	1.3E-06	9.1E-07	4.9E-07	3.4E-07	4.9E-07	3.4E-07	1.3E-06	9.1E-07	4.9E-07	3.4E-07	1.1E-06	7.4E-07	1.3E-06	9.1E-07
Copper	7440-50-8	8.5E-04 (4)	1.3E-05	9.3E-06	5.0E-06	3.5E-06	5.0E-06	3.5E-06	1.3E-05	9.3E-06	5.0E-06	3.5E-06	1.1E-05	7.5E-06	1.3E-05	9.3E-06
Lead	7439-92-1	5.0E-04 (4)	7.8E-06	5.4E-06	2.9E-06	2.0E-06	2.9E-06	2.0E-06	7.8E-06	5.4E-06	2.9E-06	2.0E-06	6.4E-06	4.4E-06	7.8E-06	5.4E-06
Manganese	7439-96-5	3.8E-04 (4)	6.0E-06	4.1E-06	2.2E-06	1.6E-06	2.2E-06	1.6E-06	6.0E-06	4.1E-06	2.2E-06	1.6E-06	4.8E-06	3.4E-06	6.0E-06	4.1E-06
Mercury	7439-97-6	2.6E-04 (4)	4.1E-06	2.8E-06	1.5E-06	1.1E-06	1.5E-06	1.1E-06	4.1E-06	2.8E-06	1.5E-06	1.1E-06	3.3E-06	2.3E-06	4.1E-06	2.8E-06
Nickel	7440-02-0	2.1E-03 (4)	3.3E-05	2.3E-05	1.2E-05	8.6E-06	1.2E-05	8.6E-06	3.3E-05	2.3E-05	1.2E-05	8.6E-06	2.7E-05	1.9E-05	3.3E-05	2.3E-05
Selenium	7782-49-2	2.4E-05 (4)	3.8E-07	2.6E-07	1.4E-07	9.8E-08	1.4E-07	9.8E-08	3.8E-07	2.6E-07	1.4E-07	9.8E-08	3.1E-07	2.1E-07	3.8E-07	2.6E-07

Notes:

(a) Maximum hourly emissions estimate (lbs/hr) = (Emission factor [lbs/MMscf]) x (maximum hourly heat input [MMBtu/hr])/ (natural gas heat content [Btu/scf])

Natural gas heat content (Btu/scf) = 1,020 (2)

(b) Annual emissions estimate (tons/yr) = (Emission factor [lbs/MMscf]) x (annual heat input [MMBtu/yr]) / (natural gas heat content [Btu/scf]) x (tons/2,000 lbs)

Natural gas heat content (Btu/scf) = 1,020 (2)

References:

(1) See Table F-1, LRDP Operations Input Assumptions for Emission Rate Calculations.
(2) AP-42 Chapter 1.4 (July 1998), Table 1.4-3 "Emission Factors For Speciated Organic Compounds from Natural Gas Combustion".
(3) California Air Toxics Emission Factor (CATEF) Database under Natural Gas Boilers.
(4) AP-42 Chapter 1.4 (July 1998), Table 1.4-4 "Emission Factors For Metals from Natural Gas Combustion".
(5) Ventura Air Quality Management District emission factor database.
(6) The AP-42 total chromium emission factor was multiplied by 17% to correct for emissions of hexavalent chromium per EPA assumptions when regulating combustion sources under 40 CFR Part 63 Subpart DDDD.

Table F-16
Natural Gas Boiler TAC Emission Estimates

Source		Natural Gas Boiler - Building 34	Natural Gas Boiler - Building 35	Natural Gas Boiler - Building 36	Natural Gas Boiler - Building 37	Natural Gas Boiler - Building 38	Total
Maximum Hourly Fuel Usage (MMBtu/hr)	(1)	17	19	18	20	8	
Daily Hours of Operation (hrs/day)	(1)	24	24	24	24	24	
Annual Fuel Usage (MMBtu/yr)	(1)	23,595	26,371	24,983	27,759	11,104	
Modeling ID		NGB_B34	NGB_B35	NGB_B36	NGB_B37	NGB_B38	

TAC	CAS	Emission Factor (lbs/MMscf)	Maximum Hourly [a] (lbs/hr)	Annual Average [b] (tons/yr)	Maximum Hourly [a] (lbs/hr)	Annual Average [b] (tons/yr)	Maximum Hourly [a] (lbs/hr)	Annual Average [b] (tons/yr)	Maximum Hourly [a] (lbs/hr)	Annual Average [b] (tons/yr)	Maximum Hourly [a] (lbs/hr)	Annual Average [b] (tons/yr)	Maximum Hourly Emissions Estimate (lbs/hr)	Annual Average Emissions Estimate (tons/yr)
7,12-Dimethylbenz(a)anthracene	57-97-6	1.6E-05 (2)	2.7E-07	1.9E-07	3.0E-07	2.1E-07	2.8E-07	2.0E-07	3.1E-07	2.2E-07	1.3E-07	8.7E-08	7.3E-06	5.2E-06
Acetaldehyde	75-07-0	8.9E-03 (3)	1.5E-04	1.0E-04	1.7E-04	1.1E-04	1.6E-04	1.1E-04	1.7E-04	1.2E-04	7.0E-05	4.8E-05	4.0E-03	2.9E-03
Benzene	71-43-2	4.3E-03 (3)	7.2E-05	5.0E-05	8.0E-05	5.6E-05	7.6E-05	5.3E-05	8.5E-05	5.9E-05	3.4E-05	2.3E-05	2.0E-03	1.4E-03
Dichlorobenzene	25321-22-6	1.2E-03 (4)	2.0E-05	1.4E-05	2.2E-05	1.6E-05	2.1E-05	1.5E-05	2.4E-05	1.6E-05	9.4E-06	6.5E-06	5.4E-04	3.9E-04
Ethylbenzene	100-41-4	6.9E-03 (5)	1.2E-04	8.0E-05	1.3E-04	8.9E-05	1.2E-04	8.5E-05	1.4E-04	9.4E-05	5.4E-05	3.8E-05	3.1E-03	2.2E-03
Fluoranthene	206-44-0	3.0E-06 (2)	5.0E-08	3.5E-08	5.6E-08	3.9E-08	5.3E-08	3.7E-08	5.9E-08	4.1E-08	2.4E-08	1.6E-08	1.4E-06	9.7E-07
Formaldehyde	50-00-0	2.2E-01 (3)	3.7E-03	2.6E-03	4.1E-03	2.9E-03	3.9E-03	2.7E-03	4.3E-03	3.0E-03	1.7E-03	1.2E-03	0.10	0.072
n-Hexane	110-54-3	4.6E-03 (5)	7.7E-05	5.3E-05	8.6E-05	5.9E-05	8.1E-05	5.6E-05	9.0E-05	6.3E-05	3.6E-05	2.5E-05	2.1E-03	1.5E-03
Naphthalene	91-20-3	3.0E-04 (5)	5.0E-06	3.5E-06	5.6E-06	3.9E-06	5.3E-06	3.7E-06	5.9E-06	4.1E-06	2.4E-06	1.6E-06	1.4E-04	9.7E-05
Propylene	115-07-1	5.3E-01 (5)	8.8E-03	6.1E-03	9.9E-03	6.9E-03	9.4E-03	6.5E-03	0.010	7.2E-03	4.2E-03	2.9E-03	0.24	0.17
Toluene	108-88-3	2.7E-02 (5)	4.4E-04	3.1E-04	4.9E-04	3.4E-04	4.7E-04	3.2E-04	5.2E-04	3.6E-04	2.1E-04	1.4E-04	0.012	8.6E-03
Xylenes	1330-20-7	2.0E-02 (5)	3.3E-04	2.3E-04	3.7E-04	2.5E-04	3.5E-04	2.4E-04	3.9E-04	2.7E-04	1.5E-04	1.1E-04	8.9E-03	6.4E-03
Arsenic	7440-38-2	2.0E-04 (4)	3.3E-06	2.3E-06	3.7E-06	2.6E-06	3.5E-06	2.4E-06	3.9E-06	2.7E-06	1.6E-06	1.1E-06	9.1E-05	6.5E-05
Beryllium	7440-41-7	1.2E-05 (4)	2.0E-07	1.4E-07	2.2E-07	1.6E-07	2.1E-07	1.5E-07	2.4E-07	1.6E-07	9.4E-08	6.5E-08	5.4E-06	3.9E-06
Cadmium	7440-43-9	1.1E-03 (4)	1.8E-05	1.3E-05	2.0E-05	1.4E-05	1.9E-05	1.3E-05	2.2E-05	1.5E-05	8.6E-06	6.0E-06	5.0E-04	3.6E-04
Chromium VI	18540-29-9	2.4E-04 (6)	4.0E-06	2.8E-06	4.4E-06	3.1E-06	4.2E-06	2.9E-06	4.7E-06	3.2E-06	1.9E-06	1.3E-06	1.1E-04	7.7E-05
Cobalt	7440-48-4	8.4E-05 (4)	1.4E-06	9.7E-07	1.6E-06	1.1E-06	1.5E-06	1.0E-06	1.6E-06	1.1E-06	6.6E-07	4.6E-07	3.8E-05	2.7E-05
Copper	7440-50-8	8.5E-04 (4)	1.4E-05	9.8E-06	1.6E-05	1.1E-05	1.5E-05	1.0E-05	1.7E-05	1.2E-05	6.7E-06	4.6E-06	3.9E-04	2.8E-04
Lead	7439-92-1	5.0E-04 (4)	8.3E-06	5.8E-06	9.3E-06	6.5E-06	8.8E-06	6.1E-06	9.8E-06	6.8E-06	3.9E-06	2.7E-06	2.3E-04	1.6E-04
Manganese	7439-96-5	3.8E-04 (4)	6.3E-06	4.4E-06	7.1E-06	4.9E-06	6.7E-06	4.7E-06	7.5E-06	5.2E-06	3.0E-06	2.1E-06	1.7E-04	1.2E-04
Mercury	7439-97-6	2.6E-04 (4)	4.3E-06	3.0E-06	4.8E-06	3.4E-06	4.6E-06	3.2E-06	5.1E-06	3.5E-06	2.0E-06	1.4E-06	1.2E-04	8.4E-05
Nickel	7440-02-0	2.1E-03 (4)	3.5E-05	2.4E-05	3.9E-05	2.7E-05	3.7E-05	2.6E-05	4.1E-05	2.9E-05	1.6E-05	1.1E-05	9.5E-04	6.8E-04
Selenium	7782-49-2	2.4E-05 (4)	4.0E-07	2.8E-07	4.5E-07	3.1E-07	4.2E-07	2.9E-07	4.7E-07	3.3E-07	1.9E-07	1.3E-07	1.1E-05	7.8E-06

Notes:

(a) Maximum hourly emissions estimate (lbs/hr) = (Emission factor [lbs/MMscf]) x (maximum hourly heat input [MMBtu/hr])/ (natural gas heat content [Btu/scf])

Natural gas heat content (Btu/scf) = 1,020 (2)

(b) Annual emissions estimate (tons/yr) = (Emission factor [lbs/MMscf]) x (annual heat input [MMBtu/yr]) / (natural gas heat content [Btu/scf]) x (tons/2,000 lbs)

Natural gas heat content (Btu/scf) = 1,020 (2)

References:

(1) See Table F-1, LRDP Operations Input Assumptions for Emission Rate Calculations.
(2) AP-42 Chapter 1.4 (July 1998), Table 1.4-3 "Emission Factors For Speciated Organic Compounds from Natural Gas Combustion".
(3) California Air Toxics Emission Factor (CATEF) Database under Natural Gas Boilers.
(4) AP-42 Chapter 1.4 (July 1998), Table 1.4-4 "Emission Factors For Metals from Natural Gas Combustion".
(5) Ventura Air Quality Management District emission factor database.
(6) The AP-42 total chromium emission factor was multiplied by 17% to correct for emissions of hexavalent chromium per EPA assumptions when regulating combustion sources under 40 CFR Part 63 Subpart DDDD.

Table F-17
Emergency Diesel Generator TAC Emission Estimates

Source		Diesel Generator - Building 6	Diesel Generator - Building 7	Diesel Generator - Building NRLF	Diesel Generator - Building 8	Diesel Generator - Building 9	Diesel Generator - Building 10	Diesel Generator - Building 11	Diesel Generator - Building 12	Diesel Generator - Building 13
BHP	(1)	440	440	700	440	440	410	240	420	170
Diesel Fuel Combustion (gal/hr)	(1)	22.3	22.3	35.5	22.3	22.3	20.8	12.2	21.3	8.6
Load Factor	(2)	0.74	0.74	0.74	0.74	0.74	0.74	0.74	0.74	0.74
Annual Operation (hrs/yr)	(1)	25.15	25.15	25.15	25.15	25.15	25.15	25.15	25.15	25.15
Modeling ID		DG_B6	DG_B7	DG_NRLF	DG_B8	DG_B9	DG_B10	DG_B11	DG_B12	DG_B13

TAC	CAS	Emission Factor ($lbs/10^3$ gal)	Maximum Hourly (lbs/hr)	Annual Average [a] (tons/yr)	Maximum Hourly (lbs/hr)	Annual Average [a] (tons/yr)	Maximum Hourly (lbs/hr)	Annual Average [a] (tons/yr)	Maximum Hourly (lbs/hr)	Annual Average [a] (tons/yr)	Maximum Hourly (lbs/hr)	Annual Average [a] (tons/yr)	Maximum Hourly (lbs/hr)	Annual Average [a] (tons/yr)	Maximum Hourly (lbs/hr)	Annual Average [a] (tons/yr)	Maximum Hourly (lbs/hr)	Annual Average [a] (tons/yr)	Maximum Hourly (lbs/hr)	Annual Average [a] (tons/yr)	Maximum Hourly (lbs/hr)	Annual Average [a] (tons/yr)
DPM	9901	-- [3]	0.011 [b]	1.4E-04	0.011 [b]	1.4E-04	0.017 [b]	2.2E-04	7.2E-03 [b]	9.0E-05	7.2E-03 [b]	9.0E-05	0.010 [b]	1.3E-04	5.9E-03 [b]	7.4E-05	0.010 [b]	1.3E-04	4.2E-03 [b]	5.2E-05
1,3-Butadiene	106-99-0	2.17E-01 [4]	3.6E-03 [c]	4.5E-05	3.6E-03 [c]	4.5E-05	5.7E-03 [c]	7.2E-05	3.6E-03 [c]	4.5E-05	3.6E-03 [c]	4.5E-05	3.3E-03 [c]	4.2E-05	2.0E-03 [c]	2.5E-05	3.4E-03 [c]	4.3E-05	1.4E-03 [c]	1.7E-05
Acetaldehyde	75-07-0	3.47E-03 [5]	5.7E-05 [c]	7.2E-07	5.7E-05 [c]	7.2E-07	9.1E-05 [c]	1.1E-06	5.7E-05 [c]	7.2E-07	5.7E-05 [c]	7.2E-07	5.3E-05 [c]	6.7E-07	3.1E-05 [c]	3.9E-07	5.5E-05 [c]	6.9E-07	2.2E-05 [c]	2.8E-07
Benzene	71-43-2	1.93E-01 [5]	3.2E-03 [c]	4.0E-05	3.2E-03 [c]	4.0E-05	5.1E-03 [c]	6.4E-05	3.2E-03 [c]	4.0E-05	3.2E-03 [c]	4.0E-05	3.0E-03 [c]	3.7E-05	1.7E-03 [c]	2.2E-05	3.0E-03 [c]	3.8E-05	1.2E-03 [c]	1.5E-05
Benzo(a)anthracene	56-55-3	-- [6]	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Benzo(b)fluoranthene	205-99-2	-- [6]	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Benzo(k)fluoranthene	207-08-9	-- [6]	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Chlorobenzene	108-90-7	2.00E-04 [4]	3.3E-06 [c]	4.2E-08	3.3E-06 [c]	4.2E-08	5.3E-06 [c]	6.6E-08	3.3E-06 [c]	4.2E-08	3.3E-06 [c]	4.2E-08	3.1E-06 [c]	3.9E-08	1.8E-06 [c]	2.3E-08	3.2E-06 [c]	4.0E-08	1.3E-06 [c]	1.6E-08
Chrysene	218-01-9	-- [6]	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Dibenz(a,h)anthracene	53-70-3	-- [6]	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Ethylbenzene	100-41-4	6.76E-03 [5]	1.1E-04 [c]	1.4E-06	1.1E-04 [c]	1.4E-06	1.8E-04 [c]	2.2E-06	1.1E-04 [c]	1.4E-06	1.1E-04 [c]	1.4E-06	1.0E-04 [c]	1.3E-06	6.1E-05 [c]	7.7E-07	1.1E-04 [c]	1.3E-06	4.3E-05 [c]	5.4E-07
Formaldehyde	50-00-0	5.06E-02 [5]	8.3E-04 [c]	1.0E-05	8.3E-04 [c]	1.0E-05	1.3E-03 [c]	1.7E-05	8.3E-04 [c]	1.0E-05	8.3E-04 [c]	1.0E-05	7.8E-04 [c]	9.8E-06	4.6E-04 [c]	5.7E-06	8.0E-04 [c]	1.0E-05	3.2E-04 [c]	4.1E-06
n-Hexane	110-54-3	1.39E-03 [5]	2.3E-05 [c]	2.9E-07	2.3E-05 [c]	2.9E-07	3.7E-05 [c]	4.6E-07	2.3E-05 [c]	2.9E-07	2.3E-05 [c]	2.9E-07	2.1E-05 [c]	2.7E-07	1.3E-05 [c]	1.6E-07	2.2E-05 [c]	2.8E-07	8.9E-06 [c]	1.1E-07
Hydrogen Chloride	7647-01-0	1.86E-01 [4]	3.1E-03 [c]	3.9E-05	3.1E-03 [c]	3.9E-05	4.9E-03 [c]	6.2E-05	3.1E-03 [c]	3.9E-05	3.1E-03 [c]	3.9E-05	2.9E-03 [c]	3.6E-05	1.7E-03 [c]	2.1E-05	2.9E-03 [c]	3.7E-05	1.2E-03 [c]	1.5E-05
Indeno(1,2,3-cd)pyrene	193-39-5	-- [6]	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Naphthalene	91-20-3	1.60E-02 [5]	2.6E-04 [c]	3.3E-06	2.6E-04 [c]	3.3E-06	4.2E-04 [c]	5.3E-06	2.6E-04 [c]	3.3E-06	2.6E-04 [c]	3.3E-06	2.5E-04 [c]	3.1E-06	1.4E-04 [c]	1.8E-06	2.5E-04 [c]	3.2E-06	1.0E-04 [c]	1.3E-06
Propylene	115-07-1	3.41E-01 [5]	5.6E-03 [c]	7.1E-05	5.6E-03 [c]	7.1E-05	9.0E-03 [c]	1.1E-04	5.6E-03 [c]	7.1E-05	5.6E-03 [c]	7.1E-05	5.2E-03 [c]	6.6E-05	3.1E-03 [c]	3.9E-05	5.4E-03 [c]	6.8E-05	2.2E-03 [c]	2.7E-05
Toluene	108-88-3	6.12E-02 [5]	1.0E-03 [c]	1.3E-05	1.0E-03 [c]	1.3E-05	1.6E-03 [c]	2.0E-05	1.0E-03 [c]	1.3E-05	1.0E-03 [c]	1.3E-05	9.4E-04 [c]	1.2E-05	5.5E-04 [c]	6.9E-06	9.6E-04 [c]	1.2E-05	3.9E-04 [c]	4.9E-06
Xylenes	1330-20-7	4.24E-02 [4]	7.0E-04 [c]	8.8E-06	7.0E-04 [c]	8.8E-06	1.1E-03 [c]	1.4E-05	7.0E-04 [c]	8.8E-06	7.0E-04 [c]	8.8E-06	6.5E-04 [c]	8.2E-06	3.8E-04 [c]	4.8E-06	6.7E-04 [c]	8.4E-06	2.7E-04 [c]	3.4E-06
Arsenic	7440-38-2	1.60E-03 [4]	2.6E-05 [c]	3.3E-07	2.6E-05 [c]	3.3E-07	4.2E-05 [c]	5.3E-07	2.6E-05 [c]	3.3E-07	2.6E-05 [c]	3.3E-07	2.5E-05 [c]	3.1E-07	1.4E-05 [c]	1.8E-07	2.5E-05 [c]	3.2E-07	1.0E-05 [c]	1.3E-07
Cadmium	7440-43-9	1.50E-03 [4]	2.5E-05 [c]	3.1E-07	2.5E-05 [c]	3.1E-07	3.9E-05 [c]	5.0E-07	2.5E-05 [c]	3.1E-07	2.5E-05 [c]	3.1E-07	2.3E-05 [c]	2.9E-07	1.4E-05 [c]	1.7E-07	2.4E-05 [c]	3.0E-07	9.6E-06 [c]	1.2E-07
Chromium VI	18540-29-9	1.00E-04 [7]	1.7E-06 [c]	2.1E-08	1.7E-06 [c]	2.1E-08	2.6E-06 [c]	3.3E-08	1.7E-06 [c]	2.1E-08	1.7E-06 [c]	2.1E-08	1.5E-06 [c]	1.9E-08	9.0E-07 [c]	1.1E-08	1.6E-06 [c]	2.0E-08	6.4E-07 [c]	8.0E-09
Copper	7440-50-8	4.10E-03 [4]	6.8E-05 [c]	8.5E-07	6.8E-05 [c]	8.5E-07	1.1E-04 [c]	1.4E-06	6.8E-05 [c]	8.5E-07	6.8E-05 [c]	8.5E-07	6.3E-05 [c]	7.9E-07	3.7E-05 [c]	4.6E-07	6.5E-05 [c]	8.1E-07	2.6E-05 [c]	3.3E-07
Lead	7439-92-1	8.30E-03 [4]	1.4E-04 [c]	1.7E-06	1.4E-04 [c]	1.7E-06	2.2E-04 [c]	2.7E-06	1.4E-04 [c]	1.7E-06	1.4E-04 [c]	1.7E-06	1.3E-04 [c]	1.6E-06	7.5E-05 [c]	9.4E-07	1.3E-04 [c]	1.6E-06	5.3E-05 [c]	6.7E-07
Manganese	7439-96-5	3.10E-03 [4]	5.1E-05 [c]	6.4E-07	5.1E-05 [c]	6.4E-07	8.1E-05 [c]	1.0E-06	5.1E-05 [c]	6.4E-07	5.1E-05 [c]	6.4E-07	4.8E-05 [c]	6.0E-07	2.8E-05 [c]	3.5E-07	4.9E-05 [c]	6.1E-07	2.0E-05 [c]	2.5E-07
Mercury	7439-97-6	2.00E-03 [4]	3.3E-05 [c]	4.2E-07	3.3E-05 [c]	4.2E-07	5.3E-05 [c]	6.6E-07	3.3E-05 [c]	4.2E-07	3.3E-05 [c]	4.2E-07	3.1E-05 [c]	3.9E-07	1.8E-05 [c]	2.3E-07	3.2E-05 [c]	4.0E-07	1.3E-05 [c]	1.6E-07
Nickel	7440-02-0	3.90E-03 [4]	6.4E-05 [c]	8.1E-07	6.4E-05 [c]	8.1E-07	1.0E-04 [c]	1.3E-06	6.4E-05 [c]	8.1E-07	6.4E-05 [c]	8.1E-07	6.0E-05 [c]	7.5E-07	3.5E-05 [c]	4.4E-07	6.1E-05 [c]	7.7E-07	2.5E-05 [c]	3.1E-07
Selenium	7782-49-2	2.20E-03 [4]	3.6E-05 [c]	4.6E-07	3.6E-05 [c]	4.6E-07	5.8E-05 [c]	7.3E-07	3.6E-05 [c]	4.6E-07	3.6E-05 [c]	4.6E-07	3.4E-05 [c]	4.3E-07	2.0E-05 [c]	2.5E-07	3.5E-05 [c]	4.4E-07	1.4E-05 [c]	1.8E-07

Modeling ID		DG_B6	DG_B7	DG_NRLF	DG_B8	DG_B9	DG_B10	DG_B11	DG_B12	DG_B13
Diesel Particulate Emission factor (g/hp-hr)	(6)	0.015	0.015	0.015	0.01	0.01	0.015	0.015	0.015	0.015

Notes:

(a) Annual average emission estimate (tons/yr) = (Maximum hourly emissions estimate [lbs/hr]) x (annual hours of operation [hrs/yr]) x (ton/2,000 lbs)

(b) Maximum hourly diesel particulate emissions estimate (lbs/hr) = (Emission factor [g/hp-hr]) x (engine horsepower [hp]) x (load factor) / (453.59 [g/lb])

(c) Maximum hourly emissions estimate (lbs/hr) = (Emission factor [$lbs/10^3$ gal]) x (load factor) x (fuel usage [gal/hr]) x (0.001 $gal/10^3$ gal)

References:

(1) See Table F-1, LRDP Operations Input Assumptions for Emission Rate Calculations.

(2) Default load factor for generators in URBEMIS emission model.

(3) See diesel particulate matter emission factors at the bottom of the table.

(4) Ventura County Air Pollution Control District AB 2588 Combustion Emission Factors Database, May 2001.

(5) California Toxic Emission Factor (CATEF) Database, except for Diesel PM. The emission factors for each TAC are averaged for diesel internal combustion engines operating at less than 13% oxygen in the exhaust. Per vendor information, the percent oxygen in the exhaust is less than 13% at loads greater than 50%. It is assumed that the generator would be run at 50% load or greater.

(6) Polycyclic Aromatic Hydrocarbons (PAHs) are assumed to be included in the particulate matter emission factor. PAHs that are not specifically listed in this table, but may be included in the particulate matter emission factor, include Acenaphthylene, Anthracene, Acenaphthene, Benzo(a)anthracene, Benzo(a)pyrene, Benzo(b)fluoranthene, Benzo(k)fluoranthene, Benzo(g,h,i)perylene, Chrysene, Dibenz(a,h)anthracene, Fluoranthene, Fluorene, Indeno(1,2,3-cd)pyrene, Phenanthrene, and Pyrene. For purposes of this inventory, it is assumed that all particulate is represented as Diesel Particulate Matter (DPM).

(7) The AP-42 total chromium emission factor was multiplied by 17% to correct for emissions of hexavalent chromium per EPA assumptions when regulating combustion sources under 40 CFR Part 63 Subpart DDDD.

Table F-17
Emergency Diesel Generator TAC Emission Estimates

Source		Diesel Generator - Building 14	Diesel Generator - Building 15	Diesel Generator - Building 16	Diesel Generator - Building 17	Diesel Generator - Building 18	Diesel Generator - Building 19	Diesel Generator - Building 20	Diesel Generator A - Building 21	Diesel Generator B - Building 21
BHP	(1)	290	480	560	600	510	460	450	510	510
Diesel Fuel Combustion (gal/hr)	(1)	14.7	24.3	28.4	30.4	25.9	23.3	22.8	25.9	25.9
Load Factor	(2)	0.74	0.74	0.74	0.74	0.74	0.74	0.74	0.74	0.74
Annual Operation (hrs/yr)	(1)	25.15	25.15	25.15	25.15	25.15	25.15	25.15	25.15	25.15
Modeling ID		DG_B14	DG_B15	DG_B16	DG_B17	DG_B18	DG_B19	DG_B20	DG_B21A	DG_B21B

TAC	CAS	Emission Factor ($lbs/10^3$ gal)	Maximum Hourly (lbs/hr)	Annual Average [a] (tons/yr)	Maximum Hourly (lbs/hr)	Annual Average [a] (tons/yr)	Maximum Hourly (lbs/hr)	Annual Average [a] (tons/yr)	Maximum Hourly (lbs/hr)	Annual Average [a] (tons/yr)	Maximum Hourly (lbs/hr)	Annual Average [a] (tons/yr)	Maximum Hourly (lbs/hr)	Annual Average [a] (tons/yr)	Maximum Hourly (lbs/hr)	Annual Average [a] (tons/yr)	Maximum Hourly (lbs/hr)	Annual Average [a] (tons/yr)	Maximum Hourly (lbs/hr)	Annual Average [a] (tons/yr)	Maximum Hourly (lbs/hr)	Annual Average [a] (tons/yr)
DPM	9901	-- [3]	7.1E-03 [b]	8.9E-05	0.012 [b]	1.5E-04	0.014 [b]	1.7E-04	0.015 [b]	1.8E-04	0.012 [b]	1.6E-04	0.011 [b]	1.4E-04	0.011 [b]	1.4E-04	0.012 [b]	1.6E-04	0.012 [b]	1.6E-04
1,3-Butadiene	106-99-0	2.17E-01 [4]	2.4E-03 [c]	3.0E-05	3.9E-03 [c]	4.9E-05	4.6E-03 [c]	5.7E-05	4.9E-03 [c]	6.2E-05	4.2E-03 [c]	5.2E-05	3.8E-03 [c]	4.7E-05	3.7E-03 [c]	4.6E-05	4.2E-03 [c]	5.2E-05	4.2E-03 [c]	5.2E-05
Acetaldehyde	75-07-0	3.47E-03 [5]	3.8E-05 [c]	4.7E-07	6.3E-05 [c]	7.9E-07	7.3E-05 [c]	9.2E-07	7.8E-05 [c]	9.8E-07	6.6E-05 [c]	8.4E-07	6.0E-05 [c]	7.5E-07	5.9E-05 [c]	7.4E-07	6.6E-05 [c]	8.4E-07	6.6E-05 [c]	8.4E-07
Benzene	71-43-2	1.93E-01 [5]	2.1E-03 [c]	2.6E-05	3.5E-03 [c]	4.4E-05	4.1E-03 [c]	5.1E-05	4.3E-03 [c]	5.5E-05	3.7E-03 [c]	4.6E-05	3.3E-03 [c]	4.2E-05	3.3E-03 [c]	4.1E-05	3.7E-03 [c]	4.6E-05	3.7E-03 [c]	4.6E-05
Benzo(a)anthracene	56-55-3	-- [6]	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Benzo(b)fluoranthene	205-99-2	-- [6]	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Benzo(k)fluoranthene	207-08-9	-- [6]	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Chlorobenzene	108-90-7	2.00E-04 [4]	2.2E-06 [c]	2.7E-08	3.6E-06 [c]	4.5E-08	4.2E-06 [c]	5.3E-08	4.5E-06 [c]	5.7E-08	3.8E-06 [c]	4.8E-08	3.5E-06 [c]	4.3E-08	3.4E-06 [c]	4.2E-08	3.8E-06 [c]	4.8E-08	3.8E-06 [c]	4.8E-08
Chrysene	218-01-9	-- [6]	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Dibenz(a,h)anthracene	53-70-3	-- [6]	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Ethylbenzene	100-41-4	6.76E-03 [5]	7.4E-05 [c]	9.3E-07	1.2E-04 [c]	1.5E-06	1.4E-04 [c]	1.8E-06	1.5E-04 [c]	1.9E-06	1.3E-04 [c]	1.6E-06	1.2E-04 [c]	1.5E-06	1.1E-04 [c]	1.4E-06	1.3E-04 [c]	1.6E-06	1.3E-04 [c]	1.6E-06
Formaldehyde	50-00-0	5.06E-02 [5]	5.5E-04 [c]	6.9E-06	9.1E-04 [c]	1.1E-05	1.1E-03 [c]	1.3E-05	1.1E-03 [c]	1.4E-05	9.7E-04 [c]	1.2E-05	8.7E-04 [c]	1.1E-05	8.5E-04 [c]	1.1E-05	9.7E-04 [c]	1.2E-05	9.7E-04 [c]	1.2E-05
n-Hexane	110-54-3	1.39E-03 [5]	1.5E-05 [c]	1.9E-07	2.5E-05 [c]	3.1E-07	2.9E-05 [c]	3.7E-07	3.1E-05 [c]	3.9E-07	2.7E-05 [c]	3.3E-07	2.4E-05 [c]	3.0E-07	2.3E-05 [c]	3.0E-07	2.7E-05 [c]	3.3E-07	2.7E-05 [c]	3.3E-07
Hydrogen Chloride	7647-01-0	1.86E-01 [4]	2.0E-03 [c]	2.6E-05	3.4E-03 [c]	4.2E-05	3.9E-03 [c]	4.9E-05	4.2E-03 [c]	5.3E-05	3.6E-03 [c]	4.5E-05	3.2E-03 [c]	4.0E-05	3.1E-03 [c]	4.0E-05	3.6E-03 [c]	4.5E-05	3.6E-03 [c]	4.5E-05
Indeno(1,2,3-cd)pyrene	193-39-5	-- [6]	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Naphthalene	91-20-3	1.60E-02 [5]	1.7E-04 [c]	2.2E-06	2.9E-04 [c]	3.6E-06	3.4E-04 [c]	4.2E-06	3.6E-04 [c]	4.5E-06	3.1E-04 [c]	3.8E-06	2.8E-04 [c]	3.5E-06	2.7E-04 [c]	3.4E-06	3.1E-04 [c]	3.8E-06	3.1E-04 [c]	3.8E-06
Propylene	115-07-1	3.41E-01 [5]	3.7E-03 [c]	4.7E-05	6.1E-03 [c]	7.7E-05	7.2E-03 [c]	9.0E-05	7.7E-03 [c]	9.7E-05	6.5E-03 [c]	8.2E-05	5.9E-03 [c]	7.4E-05	5.8E-03 [c]	7.2E-05	6.5E-03 [c]	8.2E-05	6.5E-03 [c]	8.2E-05
Toluene	108-88-3	6.12E-02 [5]	6.7E-04 [c]	8.4E-06	1.1E-03 [c]	1.4E-05	1.3E-03 [c]	1.6E-05	1.4E-03 [c]	1.7E-05	1.2E-03 [c]	1.5E-05	1.1E-03 [c]	1.3E-05	1.0E-03 [c]	1.3E-05	1.2E-03 [c]	1.5E-05	1.2E-03 [c]	1.5E-05
Xylenes	1330-20-7	4.24E-02 [4]	4.6E-04 [c]	5.8E-06	7.6E-04 [c]	9.6E-06	8.9E-04 [c]	1.1E-05	9.5E-04 [c]	1.2E-05	8.1E-04 [c]	1.0E-05	7.3E-04 [c]	9.2E-06	7.2E-04 [c]	9.0E-06	8.1E-04 [c]	1.0E-05	8.1E-04 [c]	1.0E-05
Arsenic	7440-38-2	1.60E-03 [4]	1.7E-05 [c]	2.2E-07	2.9E-05 [c]	3.6E-07	3.4E-05 [c]	4.2E-07	3.6E-05 [c]	4.5E-07	3.1E-05 [c]	3.9E-07	2.8E-05 [c]	3.5E-07	2.7E-05 [c]	3.4E-07	3.1E-05 [c]	3.9E-07	3.1E-05 [c]	3.9E-07
Cadmium	7440-43-9	1.50E-03 [4]	1.6E-05 [c]	2.1E-07	2.7E-05 [c]	3.4E-07	3.2E-05 [c]	4.0E-07	3.4E-05 [c]	4.2E-07	2.9E-05 [c]	3.6E-07	2.6E-05 [c]	3.3E-07	2.5E-05 [c]	3.2E-07	2.9E-05 [c]	3.6E-07	2.9E-05 [c]	3.6E-07
Chromium VI	18540-29-9	1.00E-04 [7]	1.1E-06 [c]	1.4E-08	1.8E-06 [c]	2.3E-08	2.1E-06 [c]	2.6E-08	2.3E-06 [c]	2.8E-08	1.9E-06 [c]	2.4E-08	1.7E-06 [c]	2.2E-08	1.7E-06 [c]	2.1E-08	1.9E-06 [c]	2.4E-08	1.9E-06 [c]	2.4E-08
Copper	7440-50-8	4.10E-03 [4]	4.5E-05 [c]	5.6E-07	7.4E-05 [c]	9.3E-07	8.6E-05 [c]	1.1E-06	9.2E-05 [c]	1.2E-06	7.8E-05 [c]	9.9E-07	7.1E-05 [c]	8.9E-07	6.9E-05 [c]	8.7E-07	7.8E-05 [c]	9.9E-07	7.8E-05 [c]	9.9E-07
Lead	7439-92-1	8.30E-03 [4]	9.0E-05 [c]	1.1E-06	1.5E-04 [c]	1.9E-06	1.7E-04 [c]	2.2E-06	1.9E-04 [c]	2.4E-06	1.6E-04 [c]	2.0E-06	1.4E-04 [c]	1.8E-06	1.4E-04 [c]	1.8E-06	1.6E-04 [c]	2.0E-06	1.6E-04 [c]	2.0E-06
Manganese	7439-96-5	3.10E-03 [4]	3.4E-05 [c]	4.2E-07	5.6E-05 [c]	7.0E-07	6.5E-05 [c]	8.2E-07	7.0E-05 [c]	8.8E-07	5.9E-05 [c]	7.5E-07	5.4E-05 [c]	6.7E-07	5.2E-05 [c]	6.6E-07	5.9E-05 [c]	7.5E-07	5.9E-05 [c]	7.5E-07
Mercury	7439-97-6	2.00E-03 [4]	2.2E-05 [c]	2.7E-07	3.6E-05 [c]	4.5E-07	4.2E-05 [c]	5.3E-07	4.5E-05 [c]	5.7E-07	3.8E-05 [c]	4.8E-07	3.5E-05 [c]	4.3E-07	3.4E-05 [c]	4.2E-07	3.8E-05 [c]	4.8E-07	3.8E-05 [c]	4.8E-07
Nickel	7440-02-0	3.90E-03 [4]	4.2E-05 [c]	5.3E-07	7.0E-05 [c]	8.8E-07	8.2E-05 [c]	1.0E-06	8.8E-05 [c]	1.1E-06	7.5E-05 [c]	9.4E-07	6.7E-05 [c]	8.5E-07	6.6E-05 [c]	8.3E-07	7.5E-05 [c]	9.4E-07	7.5E-05 [c]	9.4E-07
Selenium	7782-49-2	2.20E-03 [4]	2.4E-05 [c]	3.0E-07	4.0E-05 [c]	5.0E-07	4.6E-05 [c]	5.8E-07	5.0E-05 [c]	6.2E-07	4.2E-05 [c]	5.3E-07	3.8E-05 [c]	4.8E-07	3.7E-05 [c]	4.7E-07	4.2E-05 [c]	5.3E-07	4.2E-05 [c]	5.3E-07

Modeling ID		DG_B14	DG_B15	DG_B16	DG_B17	DG_B18	DG_B19	DG_B20	DG_B21A	DG_B21B
Diesel Particulate Emission factor (g/hp-hr)	(6)	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015

Notes:

(a) Annual average emission estimate (tons/yr) = (Maximum hourly emissions estimate [lbs/hr]) x (annual hours of operation [hrs/yr]) x (ton/2,000 lbs)
(b) Maximum hourly diesel particulate emissions estimate (lbs/hr) = (Emission factor [g/hp-hr]) x (engine horsepower [hp]) x (load factor) / (453.59 [g/lb])
(c) Maximum hourly emissions estimate (lbs/hr) = (Emission factor [lbs/103 gal]) x (load factor) x (fuel usage [gal/hr]) x (0.001 gal/103 gal)

References:

(1) See Table F-1, LRDP Operations Input Assumptions for Emission Rate Calculations.
(2) Default load factor for generators in URBEMIS emission model.
(3) See diesel particulate matter emission factors at the bottom of the table.
(4) Ventura County Air Pollution Control District AB 2588 Combustion Emission Factors Database, May 2001.
(5) California Toxic Emission Factor (CATEF) Database, except for Diesel PM. The emission factors for each TAC are averaged for diesel internal combustion engines operating at less than 13% oxygen in the exhaust. Per vendor information, the percent oxygen in the exhaust is less than 13% at loads greater than 50%. It is assumed that the generator would be run at 50% load or greater.
(6) Polycyclic Aromatic Hydrocarbons (PAHs) are assumed to be included in the particulate matter emission factor. PAHs that are not specifically listed in this table, but may be included in the particulate matter emission factor, include Acenaphthylene, Anthracene, Acenaphthene, Benzo(a)anthracene, Benzo(a)pyrene, Benzo(b)fluoranthene, Benzo(k)fluoranthene, Benzo(g,h,i)perylene, Chrysene, Dibenz(a,h)anthracene, Fluoranthene, Fluorene, Indeno(1,2,3-cd)pyrene, Phenanthrene, and Pyrene. For purposes of this inventory, it is assumed that all particulate is represented as Diesel Particulate Matter (DPM).
(7) The AP-42 total chromium emission factor was multiplied by 17% to correct for emissions of hexavalent chromium per EPA assumptions when regulating combustion sources under 40 CFR Part 63 Subpart DDDD.

Table F-17
Emergency Diesel Generator TAC Emission Estimates

Source		Diesel Generator - Building 22	Diesel Generator - Building 23	Diesel Generator - Building 24	Diesel Generator - Building 25	Diesel Generator - Building 26	Diesel Generator - Building 27	Diesel Generator - Building 28	Diesel Generator - Building 29	Diesel Generator - Building 30
BHP	(1)	700	530	460	630	610	590	230	180	600
Diesel Fuel Combustion (gal/hr)	(1)	35.5	26.9	23.3	32.0	30.9	29.9	11.7	9.1	30.4
Load Factor	(2)	0.74	0.74	0.74	0.74	0.74	0.74	0.74	0.74	0.74
Annual Operation (hrs/yr)	(1)	25.15	25.15	25.15	25.15	25.15	25.15	25.15	25.15	25.15
Modeling ID		DG_B22	DG_B23	DG_B24	DG_B25	DG_B26	DG_B27	DG_B28	DG_B29	DG_B30

TAC	CAS	Emission Factor ($lbs/10^3$ gal)	Maximum Hourly (lbs/hr)	Annual Average [a] (tons/yr)	Maximum Hourly (lbs/hr)	Annual Average [a] (tons/yr)	Maximum Hourly (lbs/hr)	Annual Average [a] (tons/yr)	Maximum Hourly (lbs/hr)	Annual Average [a] (tons/yr)	Maximum Hourly (lbs/hr)	Annual Average [a] (tons/yr)	Maximum Hourly (lbs/hr)	Annual Average [a] (tons/yr)	Maximum Hourly (lbs/hr)	Annual Average [a] (tons/yr)	Maximum Hourly (lbs/hr)	Annual Average [a] (tons/yr)	Maximum Hourly (lbs/hr)	Annual Average [a] (tons/yr)	Maximum Hourly (lbs/hr)	Annual Average [a] (tons/yr)
DPM	9901	-- [3]	0.017 [b]	2.2E-04	0.013 [b]	1.6E-04	0.011 [b]	1.4E-04	0.015 [b]	1.9E-04	0.015 [b]	1.9E-04	0.014 [b]	1.8E-04	5.6E-03 [b]	7.1E-05	4.4E-03 [b]	5.5E-05	0.015 [b]	1.8E-04
1,3-Butadiene	106-99-0	2.17E-01 [4]	5.7E-03 [c]	7.2E-05	4.3E-03 [c]	5.4E-05	3.8E-03 [c]	4.7E-05	5.1E-03 [c]	6.5E-05	5.0E-03 [c]	6.3E-05	4.8E-03 [c]	6.1E-05	1.9E-03 [c]	2.4E-05	1.5E-03 [c]	1.8E-05	4.9E-03 [c]	6.2E-05
Acetaldehyde	75-07-0	3.47E-03 [5]	9.1E-05 [c]	1.1E-06	6.9E-05 [c]	8.7E-07	6.0E-05 [c]	7.5E-07	8.2E-05 [c]	1.0E-06	7.9E-05 [c]	1.0E-06	7.7E-05 [c]	9.7E-07	3.0E-05 [c]	3.8E-07	2.3E-05 [c]	2.9E-07	7.8E-05 [c]	9.8E-07
Benzene	71-43-2	1.93E-01 [5]	5.1E-03 [c]	6.4E-05	3.8E-03 [c]	4.8E-05	3.3E-03 [c]	4.2E-05	4.6E-03 [c]	5.7E-05	4.4E-03 [c]	5.6E-05	4.3E-03 [c]	5.4E-05	1.7E-03 [c]	2.1E-05	1.3E-03 [c]	1.6E-05	4.3E-03 [c]	5.5E-05
Benzo(a)anthracene	56-55-3	-- [6]	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Benzo(b)fluoranthene	205-99-2	-- [6]	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Benzo(k)fluoranthene	207-08-9	-- [6]	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Chlorobenzene	108-90-7	2.00E-04 [4]	5.3E-06 [c]	6.6E-08	4.0E-06 [c]	5.0E-08	3.5E-06 [c]	4.3E-08	4.7E-06 [c]	5.9E-08	4.6E-06 [c]	5.8E-08	4.4E-06 [c]	5.6E-08	1.7E-06 [c]	2.2E-08	1.4E-06 [c]	1.7E-08	4.5E-06 [c]	5.7E-08
Chrysene	218-01-9	-- [6]	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Dibenz(a,h)anthracene	53-70-3	-- [6]	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Ethylbenzene	100-41-4	6.76E-03 [5]	1.8E-04 [c]	2.2E-06	1.3E-04 [c]	1.7E-06	1.2E-04 [c]	1.5E-06	1.6E-04 [c]	2.0E-06	1.5E-04 [c]	1.9E-06	1.5E-04 [c]	1.9E-06	5.8E-05 [c]	7.3E-07	4.6E-05 [c]	5.7E-07	1.5E-04 [c]	1.9E-06
Formaldehyde	50-00-0	5.06E-02 [5]	1.3E-03 [c]	1.7E-05	1.0E-03 [c]	1.3E-05	8.7E-04 [c]	1.1E-05	1.2E-03 [c]	1.5E-05	1.2E-03 [c]	1.5E-05	1.1E-03 [c]	1.4E-05	4.4E-04 [c]	5.5E-06	3.4E-04 [c]	4.3E-06	1.1E-03 [c]	1.4E-05
n-Hexane	110-54-3	1.39E-03 [5]	3.7E-05 [c]	4.6E-07	2.8E-05 [c]	3.5E-07	2.4E-05 [c]	3.0E-07	3.3E-05 [c]	4.1E-07	3.2E-05 [c]	4.0E-07	3.1E-05 [c]	3.9E-07	1.2E-05 [c]	1.5E-07	9.4E-06 [c]	1.2E-07	3.1E-05 [c]	3.9E-07
Hydrogen Chloride	7647-01-0	1.86E-01 [4]	4.9E-03 [c]	6.2E-05	3.7E-03 [c]	4.7E-05	3.2E-03 [c]	4.0E-05	4.4E-03 [c]	5.5E-05	4.3E-03 [c]	5.4E-05	4.1E-03 [c]	5.2E-05	1.6E-03 [c]	2.0E-05	1.3E-03 [c]	1.6E-05	4.2E-03 [c]	5.3E-05
Indeno(1,2,3-cd)pyrene	193-39-5	-- [6]	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Naphthalene	91-20-3	1.60E-02 [5]	4.2E-04 [c]	5.3E-06	3.2E-04 [c]	4.0E-06	2.8E-04 [c]	3.5E-06	3.8E-04 [c]	4.7E-06	3.7E-04 [c]	4.6E-06	3.5E-04 [c]	4.4E-06	1.4E-04 [c]	1.7E-06	1.1E-04 [c]	1.4E-06	3.6E-04 [c]	4.5E-06
Propylene	115-07-1	3.41E-01 [5]	9.0E-03 [c]	1.1E-04	6.8E-03 [c]	8.5E-05	5.9E-03 [c]	7.4E-05	8.1E-03 [c]	1.0E-04	7.8E-03 [c]	9.8E-05	7.6E-03 [c]	9.5E-05	2.9E-03 [c]	3.7E-05	2.3E-03 [c]	2.9E-05	7.7E-03 [c]	9.7E-05
Toluene	108-88-3	6.12E-02 [5]	1.6E-03 [c]	2.0E-05	1.2E-03 [c]	1.5E-05	1.1E-03 [c]	1.3E-05	1.4E-03 [c]	1.8E-05	1.4E-03 [c]	1.8E-05	1.4E-03 [c]	1.7E-05	5.3E-04 [c]	6.6E-06	4.1E-04 [c]	5.2E-06	1.4E-03 [c]	1.7E-05
Xylenes	1330-20-7	4.24E-02 [4]	1.1E-03 [c]	1.4E-05	8.4E-04 [c]	1.1E-05	7.3E-04 [c]	9.2E-06	1.0E-03 [c]	1.3E-05	9.7E-04 [c]	1.2E-05	9.4E-04 [c]	1.2E-05	3.7E-04 [c]	4.6E-06	2.9E-04 [c]	3.6E-06	9.5E-04 [c]	1.2E-05
Arsenic	7440-38-2	1.60E-03 [4]	4.2E-05 [c]	5.3E-07	3.2E-05 [c]	4.0E-07	2.8E-05 [c]	3.5E-07	3.8E-05 [c]	4.8E-07	3.7E-05 [c]	4.6E-07	3.5E-05 [c]	4.5E-07	1.4E-05 [c]	1.7E-07	1.1E-05 [c]	1.4E-07	3.6E-05 [c]	4.5E-07
Cadmium	7440-43-9	1.50E-03 [4]	3.9E-05 [c]	5.0E-07	3.0E-05 [c]	3.8E-07	2.6E-05 [c]	3.3E-07	3.5E-05 [c]	4.5E-07	3.4E-05 [c]	4.3E-07	3.3E-05 [c]	4.2E-07	1.3E-05 [c]	1.6E-07	1.0E-05 [c]	1.3E-07	3.4E-05 [c]	4.2E-07
Chromium VI	18540-29-9	1.00E-04 [7]	2.6E-06 [c]	3.3E-08	2.0E-06 [c]	2.5E-08	1.7E-06 [c]	2.2E-08	2.4E-06 [c]	3.0E-08	2.3E-06 [c]	2.9E-08	2.2E-06 [c]	2.8E-08	8.6E-07 [c]	1.1E-08	6.8E-07 [c]	8.5E-09	2.3E-06 [c]	2.8E-08
Copper	7440-50-8	4.10E-03 [4]	1.1E-04 [c]	1.4E-06	8.2E-05 [c]	1.0E-06	7.1E-05 [c]	8.9E-07	9.7E-05 [c]	1.2E-06	9.4E-05 [c]	1.2E-06	9.1E-05 [c]	1.1E-06	3.5E-05 [c]	4.5E-07	2.8E-05 [c]	3.5E-07	9.2E-05 [c]	1.2E-06
Lead	7439-92-1	8.30E-03 [4]	2.2E-04 [c]	2.7E-06	1.7E-04 [c]	2.1E-06	1.4E-04 [c]	1.8E-06	2.0E-04 [c]	2.5E-06	1.9E-04 [c]	2.4E-06	1.8E-04 [c]	2.3E-06	7.2E-05 [c]	9.0E-07	5.6E-05 [c]	7.1E-07	1.9E-04 [c]	2.4E-06
Manganese	7439-96-5	3.10E-03 [4]	8.1E-05 [c]	1.0E-06	6.2E-05 [c]	7.8E-07	5.4E-05 [c]	6.7E-07	7.3E-05 [c]	9.2E-07	7.1E-05 [c]	8.9E-07	6.9E-05 [c]	8.6E-07	2.7E-05 [c]	3.4E-07	2.1E-05 [c]	2.6E-07	7.0E-05 [c]	8.8E-07
Mercury	7439-97-6	2.00E-03 [4]	5.3E-05 [c]	6.6E-07	4.0E-05 [c]	5.0E-07	3.5E-05 [c]	4.3E-07	4.7E-05 [c]	5.9E-07	4.6E-05 [c]	5.8E-07	4.4E-05 [c]	5.6E-07	1.7E-05 [c]	2.2E-07	1.4E-05 [c]	1.7E-07	4.5E-05 [c]	5.7E-07
Nickel	7440-02-0	3.90E-03 [4]	1.0E-04 [c]	1.3E-06	7.8E-05 [c]	9.8E-07	6.7E-05 [c]	8.5E-07	9.2E-05 [c]	1.2E-06	8.9E-05 [c]	1.1E-06	8.6E-05 [c]	1.1E-06	3.4E-05 [c]	4.2E-07	2.6E-05 [c]	3.3E-07	8.8E-05 [c]	1.1E-06
Selenium	7782-49-2	2.20E-03 [4]	5.8E-05 [c]	7.3E-07	4.4E-05 [c]	5.5E-07	3.8E-05 [c]	4.8E-07	5.2E-05 [c]	6.5E-07	5.0E-05 [c]	6.3E-07	4.9E-05 [c]	6.1E-07	1.9E-05 [c]	2.4E-07	1.5E-05 [c]	1.9E-07	5.0E-05 [c]	6.2E-07

Modeling ID		DG_B22	DG_B23	DG_B24	DG_B25	DG_B26	DG_B27	DG_B28	DG_B29	DG_B30
Diesel Particulate Emission factor (g/hp-hr)	(6)	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015

Notes:

(a) Annual average emission estimate (tons/yr) = (Maximum hourly emissions estimate [lbs/hr]) x (annual hours of operation [hrs/yr]) x (ton/2,000 lbs)
(b) Maximum hourly diesel particulate emissions estimate (lbs/hr) = (Emission factor [g/hp-hr]) x (engine horsepower [hp]) x (load factor) / (453.59 [g/lb])
(c) Maximum hourly emissions estimate (lbs/hr) = (Emission factor [lbs/103 gal]) x (load factor) x (fuel usage [gal/hr]) x (0.001 gal/103 gal)

References:

(1) See Table F-1, LRDP Operations Input Assumptions for Emission Rate Calculations.
(2) Default load factor for generators in URBEMIS emission model.
(3) See diesel particulate matter emission factors at the bottom of the table.
(4) Ventura County Air Pollution Control District AB 2588 Combustion Emission Factors Database, May 2001.
(5) California Toxic Emission Factor (CATEF) Database, except for Diesel PM. The emission factors for each TAC are averaged for diesel internal combustion engines operating at less than 13% oxygen in the exhaust. Per vendor information, the percent oxygen in the exhaust is less than 13% at loads greater than 50%. It is assumed that the generator would be run at 50% load or greater.
(6) Polycyclic Aromatic Hydrocarbons (PAHs) are assumed to be included in the particulate matter emission factor. PAHs that are not specifically listed in this table, but may be included in the particulate matter emission factor, include Acenaphthylene, Anthracene, Acenaphthene, Benzo(a)anthracene, Benzo(a)pyrene, Benzo(b)fluoranthene, Benzo(k)fluoranthene, Benzo(g,h,i)perylene, Chrysene, Dibenz(a,h)anthracene, Fluoranthene, Fluorene, Indeno(1,2,3-cd)pyrene, Phenanthrene, and Pyrene. For purposes of this inventory, it is assumed that all particulate is represented as Diesel Particulate Matter (DPM).
(7) The AP-42 total chromium emission factor was multiplied by 17% to correct for emissions of hexavalent chromium per EPA assumptions when regulating combustion sources under 40 CFR Part 63 Subpart DDDD.

Table F-17
Emergency Diesel Generator TAC Emission Estimates

Source		Diesel Generator - Building 31	Diesel Generator - Building 32	Diesel Generator - Building 33	Diesel Generator - Building 34	Diesel Generator - Building 35	Diesel Generator - Building 36	Diesel Generator - Building 37	Diesel Generator - Building 38	Total
BHP	(1)	180	490	580	610	700	680	740	230	
Diesel Fuel Combustion (gal/hr)	(1)	9.1	24.9	29.4	30.9	35.5	34.5	37.5	11.7	
Load Factor	(2)	0.74	0.74	0.74	0.74	0.74	0.74	0.74	0.74	
Annual Operation (hrs/yr)	(1)	25.15	25.15	25.15	25.15	25.15	25.15	25.15	25.15	
Modeling ID		DG_B31	DG_B32	DG_B33	DG_B34	DG_B35	DG_B36	DG_B37	DG_B38	

TAC	CAS	Emission Factor (lbs/10^3 gal)	Maximum Hourly (lbs/hr)	Annual Average [a] (tons/yr)	Maximum Hourly (lbs/hr)	Annual Average [a] (tons/yr)	Maximum Hourly (lbs/hr)	Annual Average [a] (tons/yr)	Maximum Hourly (lbs/hr)	Annual Average [a] (tons/yr)	Maximum Hourly (lbs/hr)	Annual Average [a] (tons/yr)	Maximum Hourly (lbs/hr)	Annual Average [a] (tons/yr)	Maximum Hourly (lbs/hr)	Annual Average [a] (tons/yr)	Maximum Hourly (lbs/hr)	Annual Average [a] (tons/yr)	Maximum Hourly Emissions Estimate (lbs/hr)	Annual Average Emissions Estimate (tons/yr)
DPM	9901	-- [3]	4.4E-03 [b]	5.5E-05	0.012 [b]	1.5E-04	0.014 [b]	1.8E-04	0.015 [b]	1.9E-04	0.017 [b]	2.2E-04	0.017 [b]	2.1E-04	0.018 [b]	2.3E-04	5.6E-03 [b]	7.1E-05	0.40	5.1E-03
1,3-Butadiene	106-99-0	2.17E-01 [4]	1.5E-03 [c]	1.8E-05	4.0E-03 [c]	5.0E-05	4.7E-03 [c]	6.0E-05	5.0E-03 [c]	6.3E-05	5.7E-03 [c]	7.2E-05	5.5E-03 [c]	7.0E-05	6.0E-03 [c]	7.6E-05	1.9E-03 [c]	2.4E-05	0.14	1.7E-03
Acetaldehyde	75-07-0	3.47E-03 [5]	2.3E-05 [c]	2.9E-07	6.4E-05 [c]	8.0E-07	7.6E-05 [c]	9.5E-07	7.9E-05 [c]	1.0E-06	9.1E-05 [c]	1.1E-06	8.9E-05 [c]	1.1E-06	9.6E-05 [c]	1.2E-06	3.0E-05 [c]	3.8E-07	2.2E-03	2.8E-05
Benzene	71-43-2	1.93E-01 [5]	1.3E-03 [c]	1.6E-05	3.5E-03 [c]	4.5E-05	4.2E-03 [c]	5.3E-05	4.4E-03 [c]	5.6E-05	5.1E-03 [c]	6.4E-05	4.9E-03 [c]	6.2E-05	5.4E-03 [c]	6.7E-05	1.7E-03 [c]	2.1E-05	0.12	1.5E-03
Benzo(a)anthracene	56-55-3	-- [6]	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0	0
Benzo(b)fluoranthene	205-99-2	-- [6]	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0	0
Benzo(k)fluoranthene	207-08-9	-- [6]	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0	0
Chlorobenzene	108-90-7	2.00E-04 [4]	1.4E-06 [c]	1.7E-08	3.7E-06 [c]	4.6E-08	4.4E-06 [c]	5.5E-08	4.6E-06 [c]	5.8E-08	5.3E-06 [c]	6.6E-08	5.1E-06 [c]	6.4E-08	5.6E-06 [c]	7.0E-08	1.7E-06 [c]	2.2E-08	1.3E-04	1.6E-06
Chrysene	218-01-9	-- [6]	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0	0
Dibenz(a,h)anthracene	53-70-3	-- [6]	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0	0
Ethylbenzene	100-41-4	6.76E-03 [5]	4.6E-05 [c]	5.7E-07	1.2E-04 [c]	1.6E-06	1.5E-04 [c]	1.9E-06	1.5E-04 [c]	1.9E-06	1.8E-04 [c]	2.2E-06	1.7E-04 [c]	2.2E-06	1.9E-04 [c]	2.4E-06	5.8E-05 [c]	7.3E-07	4.3E-03	5.4E-05
Formaldehyde	50-00-0	5.06E-02 [5]	3.4E-04 [c]	4.3E-06	9.3E-04 [c]	1.2E-05	1.1E-03 [c]	1.4E-05	1.2E-03 [c]	1.5E-05	1.3E-03 [c]	1.7E-05	1.3E-03 [c]	1.6E-05	1.4E-03 [c]	1.8E-05	4.4E-04 [c]	5.5E-06	0.032	4.0E-04
n-Hexane	110-54-3	1.39E-03 [5]	9.4E-06 [c]	1.2E-07	2.6E-05 [c]	3.2E-07	3.0E-05 [c]	3.8E-07	3.2E-05 [c]	4.0E-07	3.7E-05 [c]	4.6E-07	3.5E-05 [c]	4.5E-07	3.9E-05 [c]	4.9E-07	1.2E-05 [c]	1.5E-07	8.8E-04	1.1E-05
Hydrogen Chloride	7647-01-0	1.86E-01 [4]	1.3E-03 [c]	1.6E-05	3.4E-03 [c]	4.3E-05	4.1E-03 [c]	5.1E-05	4.3E-03 [c]	5.4E-05	4.9E-03 [c]	6.2E-05	4.8E-03 [c]	6.0E-05	5.2E-03 [c]	6.5E-05	1.6E-03 [c]	2.0E-05	0.12	1.5E-03
Indeno(1,2,3-cd)pyrene	193-39-5	-- [6]	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0	0
Naphthalene	91-20-3	1.60E-02 [5]	1.1E-04 [c]	1.4E-06	2.9E-04 [c]	3.7E-06	3.5E-04 [c]	4.4E-06	3.7E-04 [c]	4.6E-06	4.2E-04 [c]	5.3E-06	4.1E-04 [c]	5.1E-06	4.4E-04 [c]	5.6E-06	1.4E-04 [c]	1.7E-06	0.010	1.3E-04
Propylene	115-07-1	3.41E-01 [5]	2.3E-03 [c]	2.9E-05	6.3E-03 [c]	7.9E-05	7.4E-03 [c]	9.3E-05	7.8E-03 [c]	9.8E-05	9.0E-03 [c]	1.1E-04	8.7E-03 [c]	1.1E-04	9.5E-03 [c]	1.2E-04	2.9E-03 [c]	3.7E-05	0.22	2.7E-03
Toluene	108-88-3	6.12E-02 [5]	4.1E-04 [c]	5.2E-06	1.1E-03 [c]	1.4E-05	1.3E-03 [c]	1.7E-05	1.4E-03 [c]	1.8E-05	1.6E-03 [c]	2.0E-05	1.6E-03 [c]	2.0E-05	1.7E-03 [c]	2.1E-05	5.3E-04 [c]	6.6E-06	0.039	4.9E-04
Xylenes	1330-20-7	4.24E-02 [4]	2.9E-04 [c]	3.6E-06	7.8E-04 [c]	9.8E-06	9.2E-04 [c]	1.2E-05	9.7E-04 [c]	1.2E-05	1.1E-03 [c]	1.4E-05	1.1E-03 [c]	1.4E-05	1.2E-03 [c]	1.5E-05	3.7E-04 [c]	4.6E-06	0.027	3.4E-04
Arsenic	7440-38-2	1.60E-03 [4]	1.1E-05 [c]	1.4E-07	2.9E-05 [c]	3.7E-07	3.5E-05 [c]	4.4E-07	3.7E-05 [c]	4.6E-07	4.2E-05 [c]	5.3E-07	4.1E-05 [c]	5.1E-07	4.4E-05 [c]	5.6E-07	1.4E-05 [c]	1.7E-07	1.0E-03	1.3E-05
Cadmium	7440-43-9	1.50E-03 [4]	1.0E-05 [c]	1.3E-07	2.8E-05 [c]	3.5E-07	3.3E-05 [c]	4.1E-07	3.4E-05 [c]	4.3E-07	3.9E-05 [c]	5.0E-07	3.8E-05 [c]	4.8E-07	4.2E-05 [c]	5.2E-07	1.3E-05 [c]	1.6E-07	9.5E-04	1.2E-05
Chromium VI	18540-29-9	1.00E-04 [7]	6.8E-07 [c]	8.5E-09	1.8E-06 [c]	2.3E-08	2.2E-06 [c]	2.7E-08	2.3E-06 [c]	2.9E-08	2.6E-06 [c]	3.3E-08	2.6E-06 [c]	3.2E-08	2.8E-06 [c]	3.5E-08	8.6E-07 [c]	1.1E-08	6.3E-05	7.9E-07
Copper	7440-50-8	4.10E-03 [4]	2.8E-05 [c]	3.5E-07	7.5E-05 [c]	9.5E-07	8.9E-05 [c]	1.1E-06	9.4E-05 [c]	1.2E-06	1.1E-04 [c]	1.4E-06	1.0E-04 [c]	1.3E-06	1.1E-04 [c]	1.4E-06	3.5E-05 [c]	4.5E-07	2.6E-03	3.3E-05
Lead	7439-92-1	8.30E-03 [4]	5.6E-05 [c]	7.1E-07	1.5E-04 [c]	1.9E-06	1.8E-04 [c]	2.3E-06	1.9E-04 [c]	2.4E-06	2.2E-04 [c]	2.7E-06	2.1E-04 [c]	2.7E-06	2.3E-04 [c]	2.9E-06	7.2E-05 [c]	9.0E-07	5.2E-03	6.6E-05
Manganese	7439-96-5	3.10E-03 [4]	2.1E-05 [c]	2.6E-07	5.7E-05 [c]	7.2E-07	6.7E-05 [c]	8.5E-07	7.1E-05 [c]	8.9E-07	8.1E-05 [c]	1.0E-06	7.9E-05 [c]	1.0E-06	8.6E-05 [c]	1.1E-06	2.7E-05 [c]	3.4E-07	2.0E-03	2.5E-05
Mercury	7439-97-6	2.00E-03 [4]	1.4E-05 [c]	1.7E-07	3.7E-05 [c]	4.6E-07	4.4E-05 [c]	5.5E-07	4.6E-05 [c]	5.8E-07	5.3E-05 [c]	6.6E-07	5.1E-05 [c]	6.4E-07	5.6E-05 [c]	7.0E-07	1.7E-05 [c]	2.2E-07	1.3E-03	1.6E-05
Nickel	7440-02-0	3.90E-03 [4]	2.6E-05 [c]	3.3E-07	7.2E-05 [c]	9.0E-07	8.5E-05 [c]	1.1E-06	8.9E-05 [c]	1.1E-06	1.0E-04 [c]	1.3E-06	1.0E-04 [c]	1.3E-06	1.1E-04 [c]	1.4E-06	3.4E-05 [c]	4.2E-07	2.5E-03	3.1E-05
Selenium	7782-49-2	2.20E-03 [4]	1.5E-05 [c]	1.9E-07	4.0E-05 [c]	5.1E-07	4.8E-05 [c]	6.0E-07	5.0E-05 [c]	6.3E-07	5.8E-05 [c]	7.3E-07	5.6E-05 [c]	7.1E-07	6.1E-05 [c]	7.7E-07	1.9E-05 [c]	2.4E-07	1.4E-03	1.7E-05

Modeling ID		DG_B31	DG_B32	DG_B33	DG_B34	DG_B35	DG_B36	DG_B37	DG_B38
Diesel Particulate Emission factor (g/hp-hr)	(6)	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015

Notes:

(a) Annual average emission estimate (tons/yr) = (Maximum hourly emissions estimate [lbs/hr]) x (annual hours of operation [hrs/yr]) x (ton/2,000 lbs)
(b) Maximum hourly diesel particulate emissions estimate (lbs/hr) = (Emission factor [g/hp-hr]) x (engine horsepower [hp]) x (load factor) / (453.59 [g/lb])
(c) Maximum hourly emissions estimate (lbs/hr) = (Emission factor [lbs/103 gal]) x (load factor) x (fuel usage [gal/hr]) x (0.001 gal/103 gal)

References:

(1) See Table F-1, LRDP Operations Input Assumptions for Emission Rate Calculations.
(2) Default load factor for generators in URBEMIS emission model.
(3) See diesel particulate matter emission factors at the bottom of the table.
(4) Ventura County Air Pollution Control District AB 2588 Combustion Emission Factors Database, May 2001.
(5) California Toxic Emission Factor (CATEF) Database, except for Diesel PM. The emission factors for each TAC are averaged for diesel internal combustion engines operating at less than 13% oxygen in the exhaust. Per vendor information, the percent oxygen in the exhaust is less than 13% at loads greater than 50%. It is assumed that the generator would be run at 50% load or greater.
(6) Polycyclic Aromatic Hydrocarbons (PAHs) are assumed to be included in the particulate matter emission factor. PAHs that are not specifically listed in this table, but may be included in the particulate matter emission factor, include Acenaphthylene, Anthracene, Acenaphthene, Benzo(a)anthracene, Benzo(a)pyrene, Benzo(b)fluoranthene, Benzo(k)fluoranthene, Benzo(g,h,i)perylene, Chrysene, Dibenz(a,h)anthracene, Fluoranthene, Fluorene, Indeno(1,2,3-cd)pyrene, Phenanthrene, and Pyrene. For purposes of this inventory, it is assumed that all particulate is represented as Diesel Particulate Matter (DPM).
(7) The AP-42 total chromium emission factor was multiplied by 17% to correct for emissions of hexavalent chromium per EPA assumptions when regulating combustion sources under 40 CFR Part 63 Subpart DDDD.

Table F-18
Cooling Tower Particulate Emission Estimates

Pollutant				Bromine	
				Emissions Estimates	
Source	Modeling ID	PM_{10} Emission Rate [1] (lbs/day)	Annual Operation [1] (hrs/yr)	Maximum Daily [a] (lbs/hr)	Annual Average [b] (tons/yr)
Cooling Tower - Building NRLF	CT_NRLF#	3.44	6,360	2.7E-04	8.5E-04
Cooling Tower - Building 8	CTB8C#	1.29	6,360	1.0E-04	3.2E-04
Cooling Tower - Building 9	CTB9C#	1.29	6,360	1.0E-04	3.2E-04
Cooling Tower - Building 10	CTB10C#	1.29	6,360	1.0E-04	3.2E-04
Cooling Tower - Building 11	CTB11C#	0.69	6,360	5.3E-05	1.7E-04
Cooling Tower - Building 12	CTB12C#	1.29	6,360	1.0E-04	3.2E-04
Cooling Tower - Building 13	CTB13C#	0.69	6,360	5.3E-05	1.7E-04
Cooling Tower - Building 14	CTB14C#	0.86	6,360	6.7E-05	2.1E-04
Cooling Tower - Building 15	CTB15C#	1.29	6,360	1.0E-04	3.2E-04
Cooling Tower - Building 16	CTB16C#	1.72	6,360	1.3E-04	4.3E-04
Cooling Tower - Building 17	CTB17C#	1.72	6,360	1.3E-04	4.3E-04
Cooling Tower - Building 18	CTB18C#	1.55	6,360	1.2E-04	3.8E-04
Cooling Tower - Building 19	CTB19C#	1.29	6,360	1.0E-04	3.2E-04
Cooling Tower - Building 20	CTB20C#	1.29	6,360	1.0E-04	3.2E-04
Cooling Tower - Building 21	CTB21C#	3.01	6,360	2.3E-04	7.4E-04
Cooling Tower - Building 22	CTB22C#	2.15	6,360	1.7E-04	5.3E-04
Cooling Tower - Building 23	CTB23C#	1.72	6,360	1.3E-04	4.3E-04
Cooling Tower - Building 24	CTB24C#	1.29	6,360	1.0E-04	3.2E-04
Cooling Tower - Building 25	CTB25C#	1.72	6,360	1.3E-04	4.3E-04
Cooling Tower - Building 26	CTB26C#	1.72	6,360	1.3E-04	4.3E-04
Cooling Tower - Building 27	CTB27C#	1.72	6,360	1.3E-04	4.3E-04
Cooling Tower - Building 28	CTB28C#	0.69	6,360	5.3E-05	1.7E-04
Cooling Tower - Building 29	CTB29C#	0.69	6,360	5.3E-05	1.7E-04
Cooling Tower - Building 30	CTB30C#	1.72	6,360	1.3E-04	4.3E-04
Cooling Tower - Building 31	CTB31C#	0.69	6,360	5.3E-05	1.7E-04
Cooling Tower - Building 32	CTB32C#	1.29	6,360	1.0E-04	3.2E-04
Cooling Tower - Building 33	CTB33C#	1.72	6,360	1.3E-04	4.3E-04
Cooling Tower - Building 34	CTB34C#	1.72	6,360	1.3E-04	4.3E-04
Cooling Tower - Building 35	CTB35C#	2.15	6,360	1.7E-04	5.3E-04
Cooling Tower - Building 36	CTB36C#	2.15	6,360	1.7E-04	5.3E-04
Cooling Tower - Building 37	CTB37C#	2.15	6,360	1.7E-04	5.3E-04
Cooling Tower - Building 38	CTB38C#	0.86	6,360	6.7E-05	2.1E-04
Cooling Tower - Buildings 6 and 7	CTB6_7C#	2.58	6,360	2.0E-04	6.4E-04
Total				**3.7E-03**	**0.012**

Notes:

(a) Maximum daily emissions estimate (lbs/day) = (PM_{10} emission rate [lbs/day]) x (ChemTreat CL-4910 bromine concentration [ppm]) / (total dissolved solids concentration [ppm]) / (daily hours of operation [hrs/day])

ChemTreat CL-4910 bromine concentration (ppm) =	1	(2)
Total dissolved solids concentration (ppmw) =	536	(3)
Daily hours of operation (hrs/day) =	24	(3)

(b) Annual emissions estimate (tons/yr) = (Hourly emissions [lbs/hr]) x (annual hours of operation [hrs/yr]) x (ton/2,000 lbs)

References:

(1) See Table F-10, Cooling Tower Particulate Emission Estimates.
(2) Provided by ChemTreat.
(3) See Table F-1, LRDP Operations Input Assumptions for Emission Rate Calculations.

Table F-19
Total Estimated Air Emissions of Laboratory Non-Radionuclide Liquid Chemicals

Source						Lab Hood Exhaust Stack - Buildings 6 and 7		Lab Hood Exhaust Stack - Building 8		Lab Hood Exhaust Stack - Building 9		Lab Hood Exhaust Stack - Building 10		Lab Hood Exhaust Stack - Building 11		Lab Hood Exhaust Stack - Building 12		Lab Hood Exhaust Stack - Building 14	
Building size (gsf)					[1]	253,954		110,510		137,451		117,700		67,280		119,504		81,472	
Modeling ID						LAB B6 7		LAB B8		LAB B9		LAB B10		LAB B11		LAB B12		LAB B14	
TAC	**CAS**	**Total Phase I Emissions [2] (tons/yr)**	**LBNL Chemical Emission Factor (tons/R&D gsf/yr)**	**UCB Chemical Emission Factor (tons/R&D gsf/yr)**	**Average Lab Chemical Emission Factor [a] (tons/R&D gsf/yr)**	**Maximum Hourly [b] (lbs/hr)**	**Annual Average [c] (tons/yr)**	**Maximum Hourly [b] (lbs/hr)**	**Annual Average [c] (tons/yr)**	**Maximum Hourly [b] (lbs/hr)**	**Annual Average [c] (tons/yr)**	**Maximum Hourly [b] (lbs/hr)**	**Annual Average [c] (tons/yr)**	**Maximum Hourly [b] (lbs/hr)**	**Annual Average [c] (tons/yr)**	**Maximum Hourly [b] (lbs/hr)**	**Annual Average [c] (tons/yr)**	**Maximum Hourly [b] (lbs/hr)**	**Annual Average [c] (tons/yr)**
1,3-Butadiene	106-99-0	3.2E-04	6.3E-10 [d]	--	2.3E-10	2.4E-04	5.9E-05	1.0E-04	2.6E-05	1.3E-04	3.2E-05	1.1E-04	2.7E-05	6.2E-05	1.6E-05	1.1E-04	2.8E-05	7.5E-05	1.9E-05
1,4-Dioxane	123-91-1	3.4E-03	6.8E-09 [d]	--	2.5E-09	2.5E-03	6.4E-04	1.1E-03	2.8E-04	1.4E-03	3.5E-04	1.2E-03	3.0E-04	6.7E-04	1.7E-04	1.2E-03	3.0E-04	8.2E-04	2.1E-04
Acetaldehyde	75-07-0	1.6E-04	3.2E-10 [d]	--	1.2E-10	1.2E-04	3.0E-05	5.2E-05	1.3E-05	6.4E-05	1.6E-05	5.5E-05	1.4E-05	3.1E-05	7.9E-06	5.6E-05	1.4E-05	3.8E-05	9.5E-06
Acrolein	107-02-8	7.7E-05	1.5E-10 [d]	--	5.7E-11	5.8E-05	1.4E-05	2.5E-05	6.3E-06	3.1E-05	7.8E-06	2.7E-05	6.7E-06	1.5E-05	3.8E-06	2.7E-05	6.8E-06	1.9E-05	4.6E-06
Acrylic acid	79-10-7	1.1E-05	2.2E-11 [d]	--	8.1E-12	8.2E-06	2.1E-06	3.6E-06	9.0E-07	4.5E-06	1.1E-06	3.8E-06	9.6E-07	2.2E-06	5.5E-07	3.9E-06	9.7E-07	2.6E-06	6.6E-07
Aniline	62-53-3	2.7E-06	5.4E-12 [d]	--	2.0E-12	2.0E-06	5.0E-07	8.7E-07	2.2E-07	1.1E-06	2.7E-07	9.3E-07	2.3E-07	5.3E-07	1.3E-07	9.4E-07	2.4E-07	6.4E-07	1.6E-07
Benzene	71-43-2	2.1E-03	4.3E-09 [d]	--	1.6E-09	1.6E-03	4.0E-04	6.9E-04	1.7E-04	8.6E-04	2.2E-04	7.4E-04	1.9E-04	4.2E-04	1.1E-04	7.5E-04	1.9E-04	5.1E-04	1.3E-04
Benzyl chloride	100-44-7	5.7E-06	1.1E-11 [d]	--	4.2E-12	4.2E-06	1.1E-06	1.8E-06	4.6E-07	2.3E-06	5.8E-07	2.0E-06	4.9E-07	1.1E-06	2.8E-07	2.0E-06	5.0E-07	1.4E-06	3.4E-07
Bromine	7726-95-6	1.2E-06	2.5E-12 [d]	1.8E-10 [e]	1.1E-10	1.1E-04	2.9E-05	5.0E-05	1.2E-05	6.2E-05	1.5E-05	5.3E-05	1.3E-05	3.0E-05	7.6E-06	5.4E-05	1.3E-05	3.7E-05	9.2E-06
Carbon tetrachloride	56-23-5	3.2E-04	6.5E-10 [d]	1.3E-08 [e]	8.4E-09	8.5E-03	2.1E-03	3.7E-03	9.2E-04	4.6E-03	1.1E-03	3.9E-03	9.8E-04	2.2E-03	5.6E-04	4.0E-03	1.0E-03	2.7E-03	6.8E-04
Chloroform	67-66-3	0.051	1.0E-07 [d]	1.7E-07 [e]	1.5E-07	0.15	0.037	0.065	0.016	0.080	0.020	0.069	0.017	0.039	9.9E-03	0.070	0.018	0.048	0.012
Diethanolamine	111-42-2	3.3E-09	6.6E-15 [d]	--	2.5E-15	2.5E-09	6.2E-10	1.1E-09	2.7E-10	1.3E-09	3.4E-10	1.2E-09	2.9E-10	6.6E-10	1.7E-10	1.2E-09	2.9E-10	8.0E-10	2.0E-10
Dimethyl formamide	68-12-2	5.7E-04	1.1E-09 [d]	6.5E-09 [e]	4.5E-09	4.6E-03	1.1E-03	2.0E-03	5.0E-04	2.5E-03	6.2E-04	2.1E-03	5.3E-04	1.2E-03	3.0E-04	2.1E-03	5.4E-04	1.5E-03	3.7E-04
Epichlorohydrin	106-89-8	1.6E-05	3.2E-11 [d]	--	1.2E-11	1.2E-05	3.1E-06	5.3E-06	1.3E-06	6.6E-06	1.7E-06	5.6E-06	1.4E-06	3.2E-06	8.1E-07	5.7E-06	1.4E-06	3.9E-06	9.8E-07
Ethylbenzene	100-41-4	1.0E-04	2.0E-10 [d]	--	7.4E-11	7.5E-05	1.9E-05	3.3E-05	8.2E-06	4.0E-05	1.0E-05	3.5E-05	8.7E-06	2.0E-05	5.0E-06	3.5E-05	8.8E-06	2.4E-05	6.0E-06
Ethylene dichloride [EDC]	107-06-2	2.3E-03	4.6E-09 [d]	--	1.7E-09	1.7E-03	4.3E-04	7.5E-04	1.9E-04	9.3E-04	2.3E-04	7.9E-04	2.0E-04	4.5E-04	1.1E-04	8.1E-04	2.0E-04	5.5E-04	1.4E-04
Ethylene glycol	107-21-1	6.0E-06	1.2E-11 [d]	--	4.4E-12	4.5E-06	1.1E-06	1.9E-06	4.9E-07	2.4E-06	6.1E-07	2.1E-06	5.2E-07	1.2E-06	3.0E-07	2.1E-06	5.3E-07	1.4E-06	3.6E-07
Ethylene glycol monomethyl ether	109-86-4	8.5E-05	1.7E-10 [d]	--	6.3E-11	6.3E-05	1.6E-05	2.8E-05	6.9E-06	3.4E-05	8.6E-06	2.9E-05	7.4E-06	1.7E-05	4.2E-06	3.0E-05	7.5E-06	2.0E-05	5.1E-06
Formaldehyde	50-00-0	0.014	2.7E-08 [d]	1.6E-07 [e]	1.1E-07	0.11	0.028	0.049	0.012	0.061	0.015	0.053	0.013	0.030	7.5E-03	0.053	0.013	0.036	9.1E-03
Glutaraldehyde	111-30-8	4.9E-05	9.8E-11 [d]	5.1E-09 [e]	3.2E-09	3.3E-03	8.2E-04	1.4E-03	3.6E-04	1.8E-03	4.5E-04	1.5E-03	3.8E-04	8.7E-04	2.2E-04	1.5E-03	3.9E-04	1.1E-03	2.6E-04
n-Hexane	110-54-3	0.044	8.8E-08 [d]	--	3.3E-08	0.033	8.3E-03	0.014	3.6E-03	0.018	4.5E-03	0.015	3.8E-03	8.7E-03	2.2E-03	0.015	3.9E-03	0.011	2.7E-03
Hydrogen Chloride	7647-01-0	0.042	8.3E-08 [d]	4.2E-07 [e]	2.9E-07	0.30	0.074	0.13	0.032	0.16	0.040	0.14	0.035	0.079	0.020	0.14	0.035	0.095	0.024
Hydrogen fluoride	7664-39-3	4.1E-05	8.2E-11 [d]	3.1E-09 [e]	2.0E-09	2.0E-03	5.1E-04	8.9E-04	2.2E-04	1.1E-03	2.8E-04	9.4E-04	2.4E-04	5.4E-04	1.4E-04	9.6E-04	2.4E-04	6.5E-04	1.6E-04
Isopropyl alcohol	67-63-0	0.039	7.8E-08 [d]	5.3E-07 [e]	3.6E-07	0.36	0.091	0.16	0.040	0.20	0.049	0.17	0.042	0.097	0.024	0.17	0.043	0.12	0.029
Lindane [gamma-Hexachlorocyclohexane]	58-89-9	1.3E-10	2.6E-16 [d]	--	9.7E-17	9.8E-11	2.5E-11	4.3E-11	1.1E-11	5.3E-11	1.3E-11	4.5E-11	1.1E-11	2.6E-11	6.5E-12	4.6E-11	1.2E-11	3.1E-11	7.9E-12
m-Cresol	108-39-4	1.3E-06	2.6E-12 [d]	--	9.6E-13	9.7E-07	2.4E-07	4.2E-07	1.1E-07	5.3E-07	1.3E-07	4.5E-07	1.1E-07	2.6E-07	6.5E-08	4.6E-07	1.2E-07	3.1E-07	7.8E-08
Methanol	67-56-1	0.050	1.0E-07 [d]	1.9E-06 [e]	1.2E-06	1.23	0.31	0.53	0.13	0.66	0.17	0.57	0.14	0.32	0.082	0.58	0.14	0.39	0.099
2-Butanone	78-93-3	1.1E-03	2.1E-09 [d]	--	7.9E-10	8.0E-04	2.0E-04	3.5E-04	8.8E-05	4.3E-04	1.1E-04	3.7E-04	9.3E-05	2.1E-04	5.3E-05	3.8E-04	9.5E-05	2.6E-04	6.5E-05
Methyl tert-butyl ether	1634-04-4	7.5E-04	1.5E-09 [d]	--	5.6E-10	5.6E-04	1.4E-04	2.4E-04	6.1E-05	3.0E-04	7.6E-05	2.6E-04	6.5E-05	1.5E-04	3.7E-05	2.6E-04	6.6E-05	1.8E-04	4.5E-05
Methylene chloride [Dichloromethane]	75-09-2	0.056	1.1E-07 [d]	--	4.1E-08	0.042	0.010	0.018	4.6E-03	0.023	5.7E-03	0.019	4.9E-03	0.011	2.8E-03	0.020	4.9E-03	0.013	3.4E-03
Nitric acid	7697-37-2	2.1E-03	4.1E-09 [d]	--	1.5E-09	1.5E-03	3.9E-04	6.7E-04	1.7E-04	8.3E-04	2.1E-04	7.1E-04	1.8E-04	4.1E-04	1.0E-04	7.2E-04	1.8E-04	4.9E-04	1.2E-04
Tetrachloroehtene	127-18-4	2.6E-04	5.2E-10 [d]	--	1.9E-10	1.9E-04	4.9E-05	8.4E-05	2.1E-05	1.1E-04	2.6E-05	9.0E-05	2.3E-05	5.1E-05	1.3E-05	9.1E-05	2.3E-05	6.2E-05	1.6E-05
Phosphoric acid	7664-38-2	5.9E-06	1.2E-11 [d]	--	4.4E-12	4.4E-06	1.1E-06	1.9E-06	4.8E-07	2.4E-06	6.0E-07	2.0E-06	5.1E-07	1.2E-06	2.9E-07	2.1E-06	5.2E-07	1.4E-06	3.6E-07
Propylene glycol monomethyl ether	107-98-2	1.1E-05	2.1E-11 [d]	--	7.9E-12	8.0E-06	2.0E-06	3.5E-06	8.7E-07	4.3E-06	1.1E-06	3.7E-06	9.3E-07	2.1E-06	5.3E-07	3.8E-06	9.4E-07	2.6E-06	6.4E-07
Propylene oxide	75-56-9	4.7E-07	9.3E-13 [d]	--	3.4E-13	3.5E-07	8.7E-08	1.5E-07	3.8E-08	1.9E-07	4.7E-08	1.6E-07	4.0E-08	9.2E-08	2.3E-08	1.6E-07	4.1E-08	1.1E-07	2.8E-08
Styrene	100-42-5	3.0E-05	6.0E-11 [d]	--	2.2E-11	2.2E-05	5.6E-06	9.8E-06	2.4E-06	1.2E-05	3.0E-06	1.0E-05	2.6E-06	5.9E-06	1.5E-06	1.1E-05	2.6E-06	7.2E-06	1.8E-06
Sulfuric acid	7664-93-9	2.1E-04	4.1E-10 [d]	--	1.5E-10	1.5E-04	3.9E-05	6.7E-05	1.7E-05	8.3E-05	2.1E-05	7.1E-05	1.8E-05	4.1E-05	1.0E-05	7.3E-05	1.8E-05	4.9E-05	1.2E-05
Toluene	108-88-3	5.1E-03	1.0E-08 [d]	1.6E-08 [e]	1.4E-08	0.014	3.5E-03	6.1E-03	1.5E-03	7.6E-03	1.9E-03	6.5E-03	1.6E-03	3.7E-03	9.4E-04	6.6E-03	1.7E-03	4.5E-03	1.1E-03
Trichloroethylene	79-01-6	1.2E-03	2.3E-09 [d]	--	8.6E-10	8.7E-04	2.2E-04	3.8E-04	9.5E-05	4.7E-04	1.2E-04	4.0E-04	1.0E-04	2.3E-04	5.8E-05	4.1E-04	1.0E-04	2.8E-04	7.0E-05
Triethylamine	121-44-8	1.4E-03	2.8E-09 [d]	--	1.0E-09	1.1E-03	2.6E-04	4.6E-04	1.1E-04	5.7E-04	1.4E-04	4.9E-04	1.2E-04	2.8E-04	7.0E-05	4.9E-04	1.2E-04	3.4E-04	8.5E-05
Xylenes	1330-20-7	9.6E-04	1.9E-09 [d]	3.2E-08 [e]	2.1E-08	0.021	5.3E-03	9.2E-03	2.3E-03	0.011	2.9E-03	9.8E-03	2.5E-03	5.6E-03	1.4E-03	1.0E-02	2.5E-03	6.8E-03	1.7E-03
Hydrazine	302-01-2	--	--	1.4E-10 [e]	8.9E-11	9.0E-05	2.3E-05	3.9E-05	9.8E-06	4.9E-05	1.2E-05	4.2E-05	1.0E-05	2.4E-05	6.0E-06	4.2E-05	1.1E-05	2.9E-05	7.2E-06
1,1,1-Trichloroethane	71-55-6	--	--	5.0E-10 [e]	3.1E-10	3.2E-04	7.9E-05	1.4E-04	3.4E-05	1.7E-04	4.3E-05	1.5E-04	3.7E-05	8.4E-05	2.1E-05	1.5E-04	3.7E-05	1.0E-04	2.5E-05
Total - All Chemicals Listed		**0.32**				**2.29**	**0.57**	**1.00**	**0.25**	**1.24**	**0.31**	**1.06**	**0.27**	**0.61**	**0.15**	**1.08**	**0.27**	**0.73**	**0.18**

Notes:

(a) Average lab chemical emission factor (tons/R&D gsf/yr) = (LBNL chemical emission factor [tons/R&D gsf/yr] x LBNL percentage of total lab space [%] / 100)
+ (UCB chemical emission factor [tons/R&D gsf/yr] x UCB percentage of total lab space [%] / 100)
LBNL percentage of total lab space (%) = 37 (2)
UCB percentage of total lab space (%) = 63 (2)

(b) Maximum hourly emissions estimate (lbs/hr) = (Annual average emissions [tons/year]) / (annual operation [days/year])
/ (daily operation [hrs/day]) x (2,000 lbs/ton) x (conversion factor)
Annual operation for all buildings (days/year) = 260 (1)
Daily operation for all buildings (hrs/day) = 10 (1)
Conversion factor = 5.18 (4)

(c) Annual average emissions estimate (tons/yr) = (Phase I emissions fraction [tons/gsf/yr]) x (building size [gsf])

(d) Lab chemical emission factor (tons/R&D gsf/yr) = (Phase I emissions [tons/yr]) / (total Phase I R&D building gsf)
Total Phase I building gsf = 501,915 (1)

(e) Lab chemical emission factor (tons/R&D gsf/yr) = (UCB emission factor [g/lab gsf/s]) x (lab fraction of R&D building gsf [lab gsf/R&D gsf]) x (lb/453.59 g) x (ton/2,000 lb) x (3,600 s/hr) x (8,760 hrs/yr)
Lab fraction of R&D building gsf (lab gsf/R&D gsf) = 0.60 (5)
UCB emission factor (g/lab gsf/s) = see (6)

References:

(1) See Table F-1, LRDP Operations Input Assumptions for Emission Rate Calculations.
(2) Provided by the University.
(3) Phase 1 Laboratory emissions calculated as part of the Phase 1 assessment. See Appendix G.
(4) Based in studies comparing maximum to average emission rates for laboratories. See text for further information.
(5) Based on average of existing and planned laboratory sizes.
(6) Emission factors provided by UC Berkeley.

Golder Associates

Table F-19
Total Estimated Air Emissions of Laboratory Non-Radionuclide Liquid Chemicals

Source						Lab Hood Exhaust Stack - Building 15		Lab Hood Exhaust Stack - Building 16		Lab Hood Exhaust Stack - Building 17		Lab Hood Exhaust Stack - Building 18		Lab Hood Exhaust Stack - Building 19		Lab Hood Exhaust Stack - Building 20		Lab Hood Exhaust Stack - Building 21	
Building size (gsf)					[1]	137,820		160,604		170,085		144,805		129,795		128,560		290,240	
Modeling ID						LAB_B15		LAB_B16		LAB_B17		LAB_B18		LAB_B19		LAB_B20		LAB_B21	
TAC	CAS	Total Phase I Emissions [2] (tons/yr)	LBNL Chemical Emission Factor (tons/R&D gsf/yr)	UCB Chemical Emission Factor (tons/R&D gsf/yr)	Average Lab Chemical Emission Factor [a] (tons/R&D gsf/yr)	Maximum Hourly [b] (lbs/hr)	Annual Average [c] (tons/yr)	Maximum Hourly [b] (lbs/hr)	Annual Average [c] (tons/yr)	Maximum Hourly [b] (lbs/hr)	Annual Average [c] (tons/yr)	Maximum Hourly [b] (lbs/hr)	Annual Average [c] (tons/yr)	Maximum Hourly [b] (lbs/hr)	Annual Average [c] (tons/yr)	Maximum Hourly [b] (lbs/hr)	Annual Average [c] (tons/yr)	Maximum Hourly [b] (lbs/hr)	Annual Average [c] (tons/yr)
1,3-Butadiene	106-99-0	3.2E-04	6.3E-10 [d]	--	2.3E-10	1.3E-04	3.2E-05	1.5E-04	3.7E-05	1.6E-04	4.0E-05	1.3E-04	3.4E-05	1.2E-04	3.0E-05	1.2E-04	3.0E-05	2.7E-04	6.7E-05
1,4-Dioxane	123-91-1	3.4E-03	6.8E-09 [d]	--	2.5E-09	1.4E-03	3.5E-04	1.6E-03	4.0E-04	1.7E-03	4.3E-04	1.5E-03	3.6E-04	1.3E-03	3.3E-04	1.3E-03	3.2E-04	2.9E-03	7.3E-04
Acetaldehyde	75-07-0	1.6E-04	3.2E-10 [d]	--	1.2E-10	6.4E-05	1.6E-05	7.5E-05	1.9E-05	7.9E-05	2.0E-05	6.8E-05	1.7E-05	6.1E-05	1.5E-05	6.0E-05	1.5E-05	1.4E-04	3.4E-05
Acrolein	107-02-8	7.7E-05	1.5E-10 [d]	--	5.7E-11	3.1E-05	7.9E-06	3.6E-05	9.2E-06	3.9E-05	9.7E-06	3.3E-05	8.3E-06	2.9E-05	7.4E-06	2.9E-05	7.3E-06	6.6E-05	1.7E-05
Acrylic acid	79-10-7	1.1E-05	2.2E-11 [d]	--	8.1E-12	4.5E-06	1.1E-06	5.2E-06	1.3E-06	5.5E-06	1.4E-06	4.7E-06	1.2E-06	4.2E-06	1.1E-06	4.2E-06	1.0E-06	9.4E-06	2.4E-06
Aniline	62-53-3	2.7E-06	5.4E-12 [d]	--	2.0E-12	1.1E-06	2.7E-07	1.3E-06	3.2E-07	1.3E-06	3.4E-07	1.1E-06	2.9E-07	1.0E-06	2.6E-07	1.0E-06	2.5E-07	2.3E-06	5.8E-07
Benzene	71-43-2	2.1E-03	4.3E-09 [d]	--	1.6E-09	8.7E-04	2.2E-04	1.0E-03	2.5E-04	1.1E-03	2.7E-04	9.1E-04	2.3E-04	8.2E-04	2.0E-04	8.1E-04	2.0E-04	1.8E-03	4.6E-04
Benzyl chloride	100-44-7	5.7E-06	1.1E-11 [d]	--	4.2E-12	2.3E-06	5.8E-07	2.7E-06	6.7E-07	2.8E-06	7.1E-07	2.4E-06	6.1E-07	2.2E-06	5.4E-07	2.1E-06	5.4E-07	4.9E-06	1.2E-06
Bromine	7726-95-6	1.2E-06	2.5E-12 [d]	1.8E-10 [e]	1.1E-10	6.2E-05	1.6E-05	7.2E-05	1.8E-05	7.6E-05	1.9E-05	6.5E-05	1.6E-05	5.8E-05	1.5E-05	5.8E-05	1.4E-05	1.3E-04	3.3E-05
Carbon tetrachloride	56-23-5	3.2E-04	6.5E-10 [d]	1.3E-08 [e]	8.4E-09	4.6E-03	1.2E-03	5.3E-03	1.3E-03	5.7E-03	1.4E-03	4.8E-03	1.2E-03	4.3E-03	1.1E-03	4.3E-03	1.1E-03	9.7E-03	2.4E-03
Chloroform	67-66-3	0.051	1.0E-07 [d]	1.7E-07 [e]	1.5E-07	0.080	0.020	0.094	0.024	0.099	0.025	0.085	0.021	0.076	0.019	0.075	0.019	0.17	0.043
Diethanolamine	111-42-2	3.3E-09	6.6E-15 [d]	--	2.5E-15	1.3E-09	3.4E-10	1.6E-09	3.9E-10	1.7E-09	4.2E-10	1.4E-09	3.6E-10	1.3E-09	3.2E-10	1.3E-09	3.2E-10	2.8E-09	7.1E-10
Dimethyl formamide	68-12-2	5.7E-04	1.1E-09 [d]	6.5E-09 [e]	4.5E-09	2.5E-03	6.2E-04	2.9E-03	7.2E-04	3.1E-03	7.7E-04	2.6E-03	6.5E-04	2.3E-03	5.8E-04	2.3E-03	5.8E-04	5.2E-03	1.3E-03
Epichlorohydrin	106-89-8	1.6E-05	3.2E-11 [d]	--	1.2E-11	6.6E-06	1.7E-06	7.7E-06	1.9E-06	8.2E-06	2.0E-06	6.9E-06	1.7E-06	6.2E-06	1.6E-06	6.2E-06	1.5E-06	1.4E-05	3.5E-06
Ethylbenzene	100-41-4	1.0E-04	2.0E-10 [d]	--	7.4E-11	4.1E-05	1.0E-05	4.7E-05	1.2E-05	5.0E-05	1.3E-05	4.3E-05	1.1E-05	3.8E-05	9.6E-06	3.8E-05	9.5E-06	8.5E-05	2.1E-05
Ethylene dichloride [EDC]	107-06-2	2.3E-03	4.6E-09 [d]	--	1.7E-09	9.3E-04	2.3E-04	1.1E-03	2.7E-04	1.1E-03	2.9E-04	9.8E-04	2.5E-04	8.8E-04	2.2E-04	8.7E-04	2.2E-04	2.0E-03	4.9E-04
Ethylene glycol	107-21-1	6.0E-06	1.2E-11 [d]	--	4.4E-12	2.4E-06	6.1E-07	2.8E-06	7.1E-07	3.0E-06	7.5E-07	2.5E-06	6.4E-07	2.3E-06	5.7E-07	2.3E-06	5.7E-07	5.1E-06	1.3E-06
Ethylene glycol monomethyl ether	109-86-4	8.5E-05	1.7E-10 [d]	--	6.3E-11	3.4E-05	8.6E-06	4.0E-05	1.0E-05	4.2E-05	1.1E-05	3.6E-05	9.1E-06	3.2E-05	8.1E-06	3.2E-05	8.0E-06	7.2E-05	1.8E-05
Formaldehyde	50-00-0	0.014	2.7E-08 [d]	1.6E-07 [e]	1.1E-07	0.062	0.015	0.072	0.018	0.076	0.019	0.065	0.016	0.058	0.015	0.057	0.014	0.13	0.033
Glutaraldehyde	111-30-8	4.9E-05	9.8E-11 [d]	5.1E-09 [e]	3.2E-09	1.8E-03	4.5E-04	2.1E-03	5.2E-04	2.2E-03	5.5E-04	1.9E-03	4.7E-04	1.7E-03	4.2E-04	1.7E-03	4.2E-04	3.7E-03	9.4E-04
n-Hexane	110-54-3	0.044	8.8E-08 [d]	--	3.3E-08	0.018	4.5E-03	0.021	5.2E-03	0.022	5.5E-03	0.019	4.7E-03	0.017	4.2E-03	0.017	4.2E-03	0.038	9.4E-03
Hydrogen Chloride	7647-01-0	0.042	8.3E-08 [d]	4.2E-07 [e]	2.9E-07	0.16	0.040	0.19	0.047	0.20	0.050	0.17	0.042	0.15	0.038	0.15	0.038	0.34	0.085
Hydrogen fluoride	7664-39-3	4.1E-05	8.2E-11 [d]	3.1E-09 [e]	2.0E-09	1.1E-03	2.8E-04	1.3E-03	3.2E-04	1.4E-03	3.4E-04	1.2E-03	2.9E-04	1.0E-03	2.6E-04	1.0E-03	2.6E-04	2.3E-03	5.8E-04
Isopropyl alcohol	67-63-0	0.039	7.8E-08 [d]	5.3E-07 [e]	3.6E-07	0.20	0.050	0.23	0.058	0.24	0.061	0.21	0.052	0.19	0.047	0.18	0.046	0.42	0.10
Lindane [gamma-Hexachlorocyclohexane]	58-89-9	1.3E-10	2.6E-16 [d]	--	9.7E-17	5.3E-11	1.3E-11	6.2E-11	1.6E-11	6.6E-11	1.6E-11	5.6E-11	1.4E-11	5.0E-11	1.3E-11	5.0E-11	1.2E-11	1.1E-10	2.8E-11
m-Cresol	108-39-4	1.3E-06	2.6E-12 [d]	--	9.6E-13	5.3E-07	1.3E-07	6.2E-07	1.5E-07	6.5E-07	1.6E-07	5.6E-07	1.4E-07	5.0E-07	1.2E-07	4.9E-07	1.2E-07	1.1E-06	2.8E-07
Methanol	67-56-1	0.050	1.0E-07 [d]	1.9E-06 [e]	1.2E-06	0.67	0.17	0.78	0.19	0.82	0.21	0.70	0.18	0.63	0.16	0.62	0.16	1.40	0.35
2-Butanone	78-93-3	1.1E-03	2.1E-09 [d]	--	7.9E-10	4.4E-04	1.1E-04	5.1E-04	1.3E-04	5.4E-04	1.3E-04	4.6E-04	1.1E-04	4.1E-04	1.0E-04	4.1E-04	1.0E-04	9.2E-04	2.3E-04
Methyl tert-butyl ether	1634-04-4	7.5E-04	1.5E-09 [d]	--	5.6E-10	3.0E-04	7.6E-05	3.6E-04	8.9E-05	3.8E-04	9.4E-05	3.2E-04	8.0E-05	2.9E-04	7.2E-05	2.8E-04	7.1E-05	6.4E-04	1.6E-04
Methylene chloride [Dichloromethane]	75-09-2	0.056	1.1E-07 [d]	--	4.1E-08	0.023	5.7E-03	0.026	6.6E-03	0.028	7.0E-03	0.024	6.0E-03	0.021	5.4E-03	0.021	5.3E-03	0.048	0.012
Nitric acid	7697-37-2	2.1E-03	4.1E-09 [d]	--	1.5E-09	8.3E-04	2.1E-04	9.7E-04	2.4E-04	1.0E-03	2.6E-04	8.8E-04	2.2E-04	7.8E-04	2.0E-04	7.8E-04	2.0E-04	1.8E-03	4.4E-04
Tetrachloroehtene	127-18-4	2.6E-04	5.2E-10 [d]	--	1.9E-10	1.1E-04	2.6E-05	1.2E-04	3.1E-05	1.3E-04	3.3E-05	1.1E-04	2.8E-05	9.9E-05	2.5E-05	9.8E-05	2.5E-05	2.2E-04	5.6E-05
Phosphoric acid	7664-38-2	5.9E-06	1.2E-11 [d]	--	4.4E-12	2.4E-06	6.0E-07	2.8E-06	7.0E-07	3.0E-06	7.4E-07	2.5E-06	6.3E-07	2.3E-06	5.7E-07	2.2E-06	5.6E-07	5.0E-06	1.3E-06
Propylene glycol monomethyl ether	107-98-2	1.1E-05	2.1E-11 [d]	--	7.9E-12	4.3E-06	1.1E-06	5.0E-06	1.3E-06	5.3E-06	1.3E-06	4.6E-06	1.1E-06	4.1E-06	1.0E-06	4.0E-06	1.0E-06	9.1E-06	2.3E-06
Propylene oxide	75-56-9	4.7E-07	9.3E-13 [d]	--	3.4E-13	1.9E-07	4.7E-08	2.2E-07	5.5E-08	2.3E-07	5.9E-08	2.0E-07	5.0E-08	1.8E-07	4.5E-08	1.8E-07	4.4E-08	4.0E-07	1.0E-07
Styrene	100-42-5	3.0E-05	6.0E-11 [d]	--	2.2E-11	1.2E-05	3.1E-06	1.4E-05	3.6E-06	1.5E-05	3.8E-06	1.3E-05	3.2E-06	1.1E-05	2.9E-06	1.1E-05	2.8E-06	2.6E-05	6.4E-06
Sulfuric acid	7664-93-9	2.1E-04	4.1E-10 [d]	--	1.5E-10	8.4E-05	2.1E-05	9.7E-05	2.4E-05	1.0E-04	2.6E-05	8.8E-05	2.2E-05	7.9E-05	2.0E-05	7.8E-05	2.0E-05	1.8E-04	4.4E-05
Toluene	108-88-3	5.1E-03	1.0E-08 [d]	1.6E-08 [e]	1.4E-08	7.7E-03	1.9E-03	8.9E-03	2.2E-03	9.4E-03	2.4E-03	8.0E-03	2.0E-03	7.2E-03	1.8E-03	7.1E-03	1.8E-03	0.016	4.0E-03
Trichloroethylene	79-01-6	1.2E-03	2.3E-09 [d]	--	8.6E-10	4.7E-04	1.2E-04	5.5E-04	1.4E-04	5.8E-04	1.5E-04	5.0E-04	1.2E-04	4.5E-04	1.1E-04	4.4E-04	1.1E-04	1.0E-03	2.5E-04
Triethylamine	121-44-8	1.4E-03	2.8E-09 [d]	--	1.0E-09	5.7E-04	1.4E-04	6.6E-04	1.7E-04	7.0E-04	1.8E-04	6.0E-04	1.5E-04	5.4E-04	1.3E-04	5.3E-04	1.3E-04	1.2E-03	3.0E-04
Xylenes	1330-20-7	9.6E-04	1.9E-09 [d]	3.2E-08 [e]	2.1E-08	0.012	2.9E-03	0.013	3.4E-03	0.014	3.6E-03	0.012	3.0E-03	0.011	2.7E-03	0.011	2.7E-03	0.024	6.1E-03
Hydrazine	302-01-2	--	--	1.4E-10 [e]	8.9E-11	4.9E-05	1.2E-05	5.7E-05	1.4E-05	6.0E-05	1.5E-05	5.1E-05	1.3E-05	4.6E-05	1.2E-05	4.6E-05	1.1E-05	1.0E-04	2.6E-05
1,1,1-Trichloroethane	71-55-6	--	--	5.0E-10 [e]	3.1E-10	1.7E-04	4.3E-05	2.0E-04	5.0E-05	2.1E-04	5.3E-05	1.8E-04	4.5E-05	1.6E-04	4.0E-05	1.6E-04	4.0E-05	3.6E-04	9.0E-05
Total - All Chemicals Listed		**0.32**				**1.24**	**0.31**	**1.45**	**0.36**	**1.53**	**0.38**	**1.31**	**0.33**	**1.17**	**0.29**	**1.16**	**0.29**	**2.62**	**0.66**

Notes:

(a) Average lab chemical emission factor (tons/R&D gsf/yr) = (LBNL chemical emission factor [tons/R&D gsf/yr] x LBNL percentage of total lab space [%] / 100)
+ (UCB chemical emission factor [tons/R&D gsf/yr] x UCB percentage of total lab space [%] / 100)

LBNL percentage of total lab space (%) =	37	(2)
UCB percentage of total lab space (%) =	63	(2)

(b) Maximum hourly emissions estimate (lbs/hr) = (Annual average emissions [tons/year]) / (annual operation [days/year])
/ (daily operation [hrs/day]) x (2,000 lbs/ton) x (conversion factor)

Annual operation for all buildings (days/year) =	260	(1)
Daily operation for all buildings (hrs/day) =	10	(1)
Conversion factor =	5.18	(4)

(c) Annual average emissions estimate (tons/yr) = (Phase I emissions fraction [tons/gsf/yr]) x (building size [gsf])

(d) Lab chemical emission factor (tons/R&D gsf/yr) = (Phase I emissions [tons/yr]) / (total Phase I R&D building gsf)

Total Phase I building gsf =	501,915	(1)

(e) Lab chemical emission factor (tons/R&D gsf/yr) = (UCB emission factor [g/lab gsf/s]) x (lab fraction of R&D building gsf [lab gsf/R&D gsf]) x (lb/453.59 g) x (ton/2,000 lb) x (3,600 s/hr) x (8,760 hrs/yr)

Lab fraction of R&D building gsf (lab gsf/R&D gsf) =	0.60	(5)
UCB emission factor (g/lab gsf/s) =	see	(6)

References:

(1) See Table F-1, LRDP Operations Input Assumptions for Emission Rate Calculations.
(2) Provided by the University.
(3) Phase 1 Laboratory emissions calculated as part of the Phase 1 assessment. See Appendix G.
(4) Based in studies comparing maximum to average emission rates for laboratories. See text for further information.
(5) Based on average of existing and planned laboratory sizes.
(6) Emission factors provided by UC Berkeley.

Table F-19
Total Estimated Air Emissions of Laboratory Non-Radionuclide Liquid Chemicals

Source						Lab Hood Exhaust Stack - Building 22		Lab Hood Exhaust Stack - Building 23		Lab Hood Exhaust Stack - Building 24		Lab Hood Exhaust Stack - Building 25		Lab Hood Exhaust Stack - Building 26		Lab Hood Exhaust Stack - Building 27		Lab Hood Exhaust Stack - Building 28	
Building size (gsf)					(1)	200,645		151,650		130,000		180,770		174,400		167,612		66,808	
Modeling ID						LAB B22		LAB B23		LAB B24		LAB B25		LAB B26		LAB B27		LAB B28	
TAC	**CAS**	**Total Phase I Emissions (2) (tons/yr)**	**LBNL Chemical Emission Factor (tons/R&D gsf/yr)**	**UCB Chemical Emission Factor (tons/R&D gsf/yr)**	**Average Lab Chemical Emission Factor (a) (tons/R&D gsf/yr)**	**Maximum Hourly (b) (lbs/hr)**	**Annual Average (c) (tons/yr)**	**Maximum Hourly (b) (lbs/hr)**	**Annual Average (c) (tons/yr)**	**Maximum Hourly (b) (lbs/hr)**	**Annual Average (c) (tons/yr)**	**Maximum Hourly (b) (lbs/hr)**	**Annual Average (c) (tons/yr)**	**Maximum Hourly (b) (lbs/hr)**	**Annual Average (c) (tons/yr)**	**Maximum Hourly (b) (lbs/hr)**	**Annual Average (c) (tons/yr)**	**Maximum Hourly (b) (lbs/hr)**	**Annual Average (c) (tons/yr)**
1,3-Butadiene	106-99-0	3.2E-04	6.3E-10 (d)	--	2.3E-10	1.9E-04	4.7E-05	1.4E-04	3.5E-05	1.2E-04	3.0E-05	1.7E-04	4.2E-05	1.6E-04	4.1E-05	1.6E-04	3.9E-05	6.2E-05	1.6E-05
1,4-Dioxane	123-91-1	3.4E-03	6.8E-09 (d)	--	2.5E-09	2.0E-03	5.1E-04	1.5E-03	3.8E-04	1.3E-03	3.3E-04	1.8E-03	4.6E-04	1.7E-03	4.4E-04	1.7E-03	4.2E-04	6.7E-04	1.7E-04
Acetaldehyde	75-07-0	1.6E-04	3.2E-10 (d)	--	1.2E-10	9.4E-05	2.4E-05	7.1E-05	1.8E-05	6.1E-05	1.5E-05	8.4E-05	2.1E-05	8.1E-05	2.0E-05	7.8E-05	2.0E-05	3.1E-05	7.8E-06
Acrolein	107-02-8	7.7E-05	1.5E-10 (d)	--	5.7E-11	4.6E-05	1.1E-05	3.4E-05	8.6E-06	3.0E-05	7.4E-06	4.1E-05	1.0E-05	4.0E-05	9.9E-06	3.8E-05	9.6E-06	1.5E-05	3.8E-06
Acrylic acid	79-10-7	1.1E-05	2.2E-11 (d)	--	8.1E-12	6.5E-06	1.6E-06	4.9E-06	1.2E-06	4.2E-06	1.1E-06	5.9E-06	1.5E-06	5.6E-06	1.4E-06	5.4E-06	1.4E-06	2.2E-06	5.4E-07
Aniline	62-53-3	2.7E-06	5.4E-12 (d)	--	2.0E-12	1.6E-06	4.0E-07	1.2E-06	3.0E-07	1.0E-06	2.6E-07	1.4E-06	3.6E-07	1.4E-06	3.5E-07	1.3E-06	3.3E-07	5.3E-07	1.3E-07
Benzene	71-43-2	2.1E-03	4.3E-09 (d)	--	1.6E-09	1.3E-03	3.2E-04	9.5E-04	2.4E-04	8.2E-04	2.1E-04	1.1E-03	2.9E-04	1.1E-03	2.8E-04	1.1E-03	2.6E-04	4.2E-04	1.1E-04
Benzyl chloride	100-44-7	5.7E-06	1.1E-11 (d)	--	4.2E-12	3.4E-06	8.4E-07	2.5E-06	6.4E-07	2.2E-06	5.5E-07	3.0E-06	7.6E-07	2.9E-06	7.3E-07	2.8E-06	7.0E-07	1.1E-06	2.8E-07
Bromine	7726-95-6	1.2E-06	2.5E-12 (d)	1.8E-10 (e)	1.1E-10	9.0E-05	2.3E-05	6.8E-05	1.7E-05	5.8E-05	1.5E-05	8.1E-05	2.0E-05	7.8E-05	2.0E-05	7.5E-05	1.9E-05	3.0E-05	7.5E-06
Carbon tetrachloride	56-23-5	3.2E-04	6.5E-10 (d)	1.3E-08 (e)	8.4E-09	6.7E-03	1.7E-03	5.0E-03	1.3E-03	4.3E-03	1.1E-03	6.0E-03	1.5E-03	5.8E-03	1.5E-03	5.6E-03	1.4E-03	2.2E-03	5.6E-04
Chloroform	67-66-3	0.051	1.0E-07 (d)	1.7E-07 (e)	1.5E-07	0.12	0.029	0.089	0.022	0.076	0.019	0.11	0.026	0.10	0.026	0.098	0.025	0.039	9.8E-03
Diethanolamine	111-42-2	3.3E-09	6.6E-15 (d)	--	2.5E-15	2.0E-09	4.9E-10	1.5E-09	3.7E-10	1.3E-09	3.2E-10	1.8E-09	4.4E-10	1.7E-09	4.3E-10	1.6E-09	4.1E-10	6.5E-10	1.6E-10
Dimethyl formamide	68-12-2	5.7E-04	1.1E-09 (d)	6.5E-09 (e)	4.5E-09	3.6E-03	9.0E-04	2.7E-03	6.8E-04	2.3E-03	5.9E-04	3.2E-03	8.1E-04	3.1E-03	7.9E-04	3.0E-03	7.5E-04	1.2E-03	3.0E-04
Epichlorohydrin	106-89-8	1.6E-05	3.2E-11 (d)	--	1.2E-11	9.6E-06	2.4E-06	7.3E-06	1.8E-06	6.2E-06	1.6E-06	8.7E-06	2.2E-06	8.4E-06	2.1E-06	8.0E-06	2.0E-06	3.2E-06	8.0E-07
Ethylbenzene	100-41-4	1.0E-04	2.0E-10 (d)	--	7.4E-11	5.9E-05	1.5E-05	4.5E-05	1.1E-05	3.8E-05	9.6E-06	5.3E-05	1.3E-05	5.1E-05	1.3E-05	4.9E-05	1.2E-05	2.0E-05	4.9E-06
Ethylene dichloride [EDC]	107-06-2	2.3E-03	4.6E-09 (d)	--	1.7E-09	1.4E-03	3.4E-04	1.0E-03	2.6E-04	8.8E-04	2.2E-04	1.2E-03	3.1E-04	1.2E-03	3.0E-04	1.1E-03	2.8E-04	4.5E-04	1.1E-04
Ethylene glycol	107-21-1	6.0E-06	1.2E-11 (d)	--	4.4E-12	3.5E-06	8.8E-07	2.7E-06	6.7E-07	2.3E-06	5.7E-07	3.2E-06	8.0E-07	3.1E-06	7.7E-07	2.9E-06	7.4E-07	1.2E-06	2.9E-07
Ethylene glycol monomethyl ether	109-86-4	8.5E-05	1.7E-10 (d)	--	6.3E-11	5.0E-05	1.3E-05	3.8E-05	9.5E-06	3.2E-05	8.1E-06	4.5E-05	1.1E-05	4.3E-05	1.1E-05	4.2E-05	1.0E-05	1.7E-05	4.2E-06
Formaldehyde	50-00-0	0.014	2.7E-08 (d)	1.6E-07 (e)	1.1E-07	0.090	0.022	0.068	0.017	0.058	0.015	0.081	0.020	0.078	0.020	0.075	0.019	0.030	7.5E-03
Glutaraldehyde	111-30-8	4.9E-05	9.8E-11 (d)	5.1E-09 (e)	3.2E-09	2.6E-03	6.5E-04	2.0E-03	4.9E-04	1.7E-03	4.2E-04	2.3E-03	5.9E-04	2.3E-03	5.7E-04	2.2E-03	5.4E-04	8.6E-04	2.2E-04
n-Hexane	110-54-3	0.044	8.8E-08 (d)	--	3.3E-08	0.026	6.5E-03	0.020	4.9E-03	0.017	4.2E-03	0.023	5.9E-03	0.023	5.7E-03	0.022	5.5E-03	8.7E-03	2.2E-03
Hydrogen Chloride	7647-01-0	0.042	8.3E-08 (d)	4.2E-07 (e)	2.9E-07	0.23	0.059	0.18	0.044	0.15	0.038	0.21	0.053	0.20	0.051	0.20	0.049	0.078	0.020
Hydrogen fluoride	7664-39-3	4.1E-05	8.2E-11 (d)	3.1E-09 (e)	2.0E-09	1.6E-03	4.0E-04	1.2E-03	3.0E-04	1.0E-03	2.6E-04	1.4E-03	3.6E-04	1.4E-03	3.5E-04	1.3E-03	3.4E-04	5.4E-04	1.3E-04
Isopropyl alcohol	67-63-0	0.039	7.8E-08 (d)	5.3E-07 (e)	3.6E-07	0.29	0.072	0.22	0.055	0.19	0.047	0.26	0.065	0.25	0.063	0.24	0.060	0.096	0.024
Lindane [gamma-Hexachlorocyclohexane]	58-89-9	1.3E-10	2.6E-16 (d)	--	9.7E-17	7.8E-11	1.9E-11	5.9E-11	1.5E-11	5.0E-11	1.3E-11	7.0E-11	1.8E-11	6.7E-11	1.7E-11	6.5E-11	1.6E-11	2.6E-11	6.5E-12
m-Cresol	108-39-4	1.3E-06	2.6E-12 (d)	--	9.6E-13	7.7E-07	1.9E-07	5.8E-07	1.5E-07	5.0E-07	1.3E-07	6.9E-07	1.7E-07	6.7E-07	1.7E-07	6.4E-07	1.6E-07	2.6E-07	6.4E-08
Methanol	67-56-1	0.050	1.0E-07 (d)	1.9E-06 (e)	1.2E-06	0.97	0.24	0.73	0.18	0.63	0.16	0.87	0.22	0.84	0.21	0.81	0.20	0.32	0.081
2-Butanone	78-93-3	1.1E-03	2.1E-09 (d)	--	7.9E-10	6.3E-04	1.6E-04	4.8E-04	1.2E-04	4.1E-04	1.0E-04	5.7E-04	1.4E-04	5.5E-04	1.4E-04	5.3E-04	1.3E-04	2.1E-04	5.3E-05
Methyl tert-butyl ether	1634-04-4	7.5E-04	1.5E-09 (d)	--	5.6E-10	4.4E-04	1.1E-04	3.4E-04	8.4E-05	2.9E-04	7.2E-05	4.0E-04	1.0E-04	3.9E-04	9.7E-05	3.7E-04	9.3E-05	1.5E-04	3.7E-05
Methylene chloride [Dichloromethane]	75-09-2	0.056	1.1E-07 (d)	--	4.1E-08	0.033	8.3E-03	0.025	6.3E-03	0.021	5.4E-03	0.030	7.5E-03	0.029	7.2E-03	0.028	6.9E-03	0.011	2.8E-03
Nitric acid	7697-37-2	2.1E-03	4.1E-09 (d)	--	1.5E-09	1.2E-03	3.0E-04	9.2E-04	2.3E-04	7.9E-04	2.0E-04	1.1E-03	2.7E-04	1.1E-03	2.6E-04	1.0E-03	2.5E-04	4.0E-04	1.0E-04
Tetrachloroehtene	127-18-4	2.6E-04	5.2E-10 (d)	--	1.9E-10	1.5E-04	3.8E-05	1.2E-04	2.9E-05	9.9E-05	2.5E-05	1.4E-04	3.5E-05	1.3E-04	3.3E-05	1.3E-04	3.2E-05	5.1E-05	1.3E-05
Phosphoric acid	7664-38-2	5.9E-06	1.2E-11 (d)	--	4.4E-12	3.5E-06	8.8E-07	2.6E-06	6.6E-07	2.3E-06	5.7E-07	3.1E-06	7.9E-07	3.0E-06	7.6E-07	2.9E-06	7.3E-07	1.2E-06	2.9E-07
Propylene glycol monomethyl ether	107-98-2	1.1E-05	2.1E-11 (d)	--	7.9E-12	6.3E-06	1.6E-06	4.8E-06	1.2E-06	4.1E-06	1.0E-06	5.7E-06	1.4E-06	5.5E-06	1.4E-06	5.3E-06	1.3E-06	2.1E-06	5.3E-07
Propylene oxide	75-56-9	4.7E-07	9.3E-13 (d)	--	3.4E-13	2.8E-07	6.9E-08	2.1E-07	5.2E-08	1.8E-07	4.5E-08	2.5E-07	6.2E-08	2.4E-07	6.0E-08	2.3E-07	5.8E-08	9.2E-08	2.3E-08
Styrene	100-42-5	3.0E-05	6.0E-11 (d)	--	2.2E-11	1.8E-05	4.4E-06	1.3E-05	3.4E-06	1.1E-05	2.9E-06	1.6E-05	4.0E-06	1.5E-05	3.9E-06	1.5E-05	3.7E-06	5.9E-06	1.5E-06
Sulfuric acid	7664-93-9	2.1E-04	4.1E-10 (d)	--	1.5E-10	1.2E-04	3.1E-05	9.2E-05	2.3E-05	7.9E-05	2.0E-05	1.1E-04	2.8E-05	1.1E-04	2.7E-05	1.0E-04	2.6E-05	4.1E-05	1.0E-05
Toluene	108-88-3	5.1E-03	1.0E-08 (d)	1.6E-08 (e)	1.4E-08	0.011	2.8E-03	8.4E-03	2.1E-03	7.2E-03	1.8E-03	0.010	2.5E-03	9.7E-03	2.4E-03	9.3E-03	2.3E-03	3.7E-03	9.3E-04
Trichloroethylene	79-01-6	1.2E-03	2.3E-09 (d)	--	8.6E-10	6.9E-04	1.7E-04	5.2E-04	1.3E-04	4.5E-04	1.1E-04	6.2E-04	1.6E-04	6.0E-04	1.5E-04	5.8E-04	1.4E-04	2.3E-04	5.8E-05
Triethylamine	121-44-8	1.4E-03	2.8E-09 (d)	--	1.0E-09	8.3E-04	2.1E-04	6.3E-04	1.6E-04	5.4E-04	1.3E-04	7.5E-04	1.9E-04	7.2E-04	1.8E-04	6.9E-04	1.7E-04	2.8E-04	6.9E-05
Xylenes	1330-20-7	9.6E-04	1.9E-09 (d)	3.2E-08 (e)	2.1E-08	0.017	4.2E-03	0.013	3.2E-03	0.011	2.7E-03	0.015	3.8E-03	0.015	3.7E-03	0.014	3.5E-03	5.6E-03	1.4E-03
Hydrazine	302-01-2	--	--	1.4E-10 (e)	8.9E-11	7.1E-05	1.8E-05	5.4E-05	1.3E-05	4.6E-05	1.2E-05	6.4E-05	1.6E-05	6.2E-05	1.6E-05	5.9E-05	1.5E-05	2.4E-05	5.9E-06
1,1,1-Trichloroethane	71-55-6	--	--	5.0E-10 (e)	3.1E-10	2.5E-04	6.3E-05	1.9E-04	4.7E-05	1.6E-04	4.1E-05	2.2E-04	5.6E-05	2.2E-04	5.4E-05	2.1E-04	5.2E-05	8.3E-05	2.1E-05
Total - All Chemicals Listed		**0.32**				**1.81**	**0.45**	**1.37**	**0.34**	**1.17**	**0.29**	**1.63**	**0.41**	**1.57**	**0.39**	**1.51**	**0.38**	**0.60**	**0.15**

Notes:

(a) Average lab chemical emission factor (tons/R&D gsf/yr) = (LBNL chemical emission factor [tons/R&D gsf/yr] x LBNL percentage of total lab space [%] / 100)
+ (UCB chemical emission factor [tons/R&D gsf/yr] x UCB percentage of total lab space [%] / 100)

LBNL percentage of total lab space (%) =	37	(2)
UCB percentage of total lab space (%) =	63	(2)

(b) Maximum hourly emissions estimate (lbs/hr) = (Annual average emissions [tons/year]) / (annual operation [days/year])
/ (daily operation [hrs/day]) x (2,000 lbs/ton) x (conversion factor)

Annual operation for all buildings (days/year) =	260	(1)
Daily operation for all buildings (hrs/day) =	10	(1)
Conversion factor =	5.18	(4)

(c) Annual average emissions estimate (tons/yr) = (Phase I emissions fraction [tons/gsf/yr]) x (building size [gsf])

(d) Lab chemical emission factor (tons/R&D gsf/yr) = (Phase I emissions [tons/yr]) / (total Phase I R&D building gsf)

Total Phase I building gsf =	501,915	(1)

(e) Lab chemical emission factor (tons/R&D gsf/yr) = (UCB emission factor [g/lab gsf/s]) x (lab fraction of R&D building gsf [lab gsf/R&D gsf]) x (lb/453.59 g) x (ton/2,000 lb) x (3,600 s/hr) x (8,760 hrs/yr)

Lab fraction of R&D building gsf (lab gsf/R&D gsf) =	0.60	(5)
UCB emission factor (g/lab gsf/s) =	see	(6)

References:

(1) See Table F-1, LRDP Operations Input Assumptions for Emission Rate Calculations.
(2) Provided by the University.
(3) Phase 1 Laboratory emissions calculated as part of the Phase 1 assessment. See Appendix G.
(4) Based in studies comparing maximum to average emission rates for laboratories. See text for further information.
(5) Based on average of existing and planned laboratory sizes.
(6) Emission factors provided by UC Berkeley.

Table F-19
Total Estimated Air Emissions of Laboratory Non-Radionuclide Liquid Chemicals

Source						Lab Hood Exhaust Stack - Building 30		Lab Hood Exhaust Stack - Building 32		Lab Hood Exhaust Stack - Building 33		Lab Hood Exhaust Stack - Building 34		Lab Hood Exhaust Stack - Building 35		Lab Hood Exhaust Stack - Building 36		Lab Hood Exhaust Stack - Building 37		Total	
Building size (gsf)					[1]	169,768		138,545		165,490		173,790		199,630		193,275		209,615			
Modeling ID						LAB B30		LAB B32		LAB B33		LAB B34		LAB B35		LAB B36		LAB B37			
TAC	CAS	Total Phase I Emissions [2] (tons/yr)	LBNL Chemical Emission Factor (tons/R&D gsf/yr)	UCB Chemical Emission Factor (tons/R&D gsf/yr)	Average Lab Chemical Emission Factor [a] (tons/R&D gsf/yr)	Maximum Hourly [b] (lbs/hr)	Annual Average [c] (tons/yr)	Maximum Hourly [b] (lbs/hr)	Annual Average [c] (tons/yr)	Maximum Hourly [b] (lbs/hr)	Annual Average [c] (tons/yr)	Maximum Hourly [b] (lbs/hr)	Annual Average [c] (tons/yr)	Maximum Hourly [b] (lbs/hr)	Annual Average [c] (tons/yr)	Maximum Hourly [b] (lbs/hr)	Annual Average [c] (tons/yr)	Maximum Hourly [b] (lbs/hr)	Annual Average [c] (tons/yr)	Maximum Hourly (lbs/hr)	Annual Average (tons/yr)
1,3-Butadiene	106-99-0	3.2E-04	6.3E-10 [d]	--	2.3E-10	1.6E-04	3.9E-05	1.3E-04	3.2E-05	1.5E-04	3.8E-05	1.6E-04	4.0E-05	1.8E-04	4.6E-05	1.8E-04	4.5E-05	1.9E-04	4.9E-05	4.0E-03	1.0E-03
1,4-Dioxane	123-91-1	3.4E-03	6.8E-09 [d]	--	2.5E-09	1.7E-03	4.3E-04	1.4E-03	3.5E-04	1.7E-03	4.2E-04	1.7E-03	4.4E-04	2.0E-03	5.0E-04	1.9E-03	4.9E-04	2.1E-03	5.3E-04	0.044	0.011
Acetaldehyde	75-07-0	1.6E-04	3.2E-10 [d]	--	1.2E-10	7.9E-05	2.0E-05	6.5E-05	1.6E-05	7.7E-05	1.9E-05	8.1E-05	2.0E-05	9.3E-05	2.3E-05	9.0E-05	2.3E-05	9.8E-05	2.5E-05	2.0E-03	5.1E-04
Acrolein	107-02-8	7.7E-05	1.5E-10 [d]	--	5.7E-11	3.9E-05	9.7E-06	3.1E-05	7.9E-06	3.8E-05	9.4E-06	3.9E-05	9.9E-06	4.5E-05	1.1E-05	4.4E-05	1.1E-05	4.8E-05	1.2E-05	9.9E-04	2.5E-04
Acrylic acid	79-10-7	1.1E-05	2.2E-11 [d]	--	8.1E-12	5.5E-06	1.4E-06	4.5E-06	1.1E-06	5.4E-06	1.3E-06	5.6E-06	1.4E-06	6.5E-06	1.6E-06	6.3E-06	1.6E-06	6.8E-06	1.7E-06	1.4E-04	3.6E-05
Aniline	62-53-3	2.7E-06	5.4E-12 [d]	--	2.0E-12	1.3E-06	3.4E-07	1.1E-06	2.7E-07	1.3E-06	3.3E-07	1.4E-06	3.4E-07	1.6E-06	4.0E-07	1.5E-06	3.8E-07	1.7E-06	4.2E-07	3.5E-05	8.7E-06
Benzene	71-43-2	2.1E-03	4.3E-09 [d]	--	1.6E-09	1.1E-03	2.7E-04	8.7E-04	2.2E-04	1.0E-03	2.6E-04	1.1E-03	2.7E-04	1.3E-03	3.1E-04	1.2E-03	3.0E-04	1.3E-03	3.3E-04	0.027	6.9E-03
Benzyl chloride	100-44-7	5.7E-06	1.1E-11 [d]	--	4.2E-12	2.8E-06	7.1E-07	2.3E-06	5.8E-07	2.8E-06	6.9E-07	2.9E-06	7.3E-07	3.3E-06	8.4E-07	3.2E-06	8.1E-07	3.5E-06	8.8E-07	7.3E-05	1.8E-05
Bromine	7726-95-6	1.2E-06	2.5E-12 [d]	1.8E-10 [e]	1.1E-10	7.6E-05	1.9E-05	6.2E-05	1.6E-05	7.4E-05	1.9E-05	7.8E-05	2.0E-05	9.0E-05	2.2E-05	8.7E-05	2.2E-05	9.4E-05	2.4E-05	2.0E-03	4.9E-04
Carbon tetrachloride	56-23-5	3.2E-04	6.5E-10 [d]	1.3E-08 [e]	8.4E-09	5.7E-03	1.4E-03	4.6E-03	1.2E-03	5.5E-03	1.4E-03	5.8E-03	1.5E-03	6.6E-03	1.7E-03	6.4E-03	1.6E-03	7.0E-03	1.8E-03	0.15	0.037
Chloroform	67-66-3	0.051	1.0E-07 [d]	1.7E-07 [e]	1.5E-07	0.099	0.025	0.081	0.020	0.097	0.024	0.10	0.025	0.12	0.029	0.11	0.028	0.12	0.031	2.55	0.64
Diethanolamine	111-42-2	3.3E-09	6.6E-15 [d]	--	2.5E-15	1.7E-09	4.2E-10	1.4E-09	3.4E-10	1.6E-09	4.1E-10	1.7E-09	4.3E-10	2.0E-09	4.9E-10	1.9E-09	4.7E-10	2.1E-09	5.1E-10	4.3E-08	1.1E-08
Dimethyl formamide	68-12-2	5.7E-04	1.1E-09 [d]	6.5E-09 [e]	4.5E-09	3.0E-03	7.6E-04	2.5E-03	6.2E-04	3.0E-03	7.5E-04	3.1E-03	7.8E-04	3.6E-03	9.0E-04	3.5E-03	8.7E-04	3.8E-03	9.4E-04	0.078	0.020
Epichlorohydrin	106-89-8	1.6E-05	3.2E-11 [d]	--	1.2E-11	8.1E-06	2.0E-06	6.6E-06	1.7E-06	7.9E-06	2.0E-06	8.3E-06	2.1E-06	9.6E-06	2.4E-06	9.3E-06	2.3E-06	1.0E-05	2.5E-06	2.1E-04	5.3E-05
Ethylbenzene	100-41-4	1.0E-04	2.0E-10 [d]	--	7.4E-11	5.0E-05	1.3E-05	4.1E-05	1.0E-05	4.9E-05	1.2E-05	5.1E-05	1.3E-05	5.9E-05	1.5E-05	5.7E-05	1.4E-05	6.2E-05	1.5E-05	1.3E-03	3.2E-04
Ethylene dichloride [EDC]	107-06-2	2.3E-03	4.6E-09 [d]	--	1.7E-09	1.1E-03	2.9E-04	9.4E-04	2.3E-04	1.1E-03	2.8E-04	1.2E-03	2.9E-04	1.3E-03	3.4E-04	1.3E-03	3.3E-04	1.4E-03	3.6E-04	0.030	7.4E-03
Ethylene glycol	107-21-1	6.0E-06	1.2E-11 [d]	--	4.4E-12	3.0E-06	7.5E-07	2.4E-06	6.1E-07	2.9E-06	7.3E-07	3.0E-06	7.7E-07	3.5E-06	8.8E-07	3.4E-06	8.5E-07	3.7E-06	9.2E-07	7.7E-05	1.9E-05
Ethylene glycol monomethyl ether	109-86-4	8.5E-05	1.7E-10 [d]	--	6.3E-11	4.2E-05	1.1E-05	3.5E-05	8.7E-06	4.1E-05	1.0E-05	4.3E-05	1.1E-05	5.0E-05	1.2E-05	4.8E-05	1.2E-05	5.2E-05	1.3E-05	1.1E-03	2.7E-04
Formaldehyde	50-00-0	0.014	2.7E-08 [d]	1.6E-07 [e]	1.1E-07	0.076	0.019	0.062	0.016	0.074	0.019	0.078	0.019	0.089	0.022	0.086	0.022	0.094	0.024	1.95	0.49
Glutaraldehyde	111-30-8	4.9E-05	9.8E-11 [d]	5.1E-09 [e]	3.2E-09	2.2E-03	5.5E-04	1.8E-03	4.5E-04	2.1E-03	5.4E-04	2.2E-03	5.6E-04	2.6E-03	6.5E-04	2.5E-03	6.3E-04	2.7E-03	6.8E-04	0.056	0.014
n-Hexane	110-54-3	0.044	8.8E-08 [d]	--	3.3E-08	0.022	5.5E-03	0.018	4.5E-03	0.021	5.4E-03	0.023	5.7E-03	0.026	6.5E-03	0.025	6.3E-03	0.027	6.8E-03	0.57	0.14
Hydrogen Chloride	7647-01-0	0.042	8.3E-08 [d]	4.2E-07 [e]	2.9E-07	0.20	0.050	0.16	0.041	0.19	0.049	0.20	0.051	0.23	0.059	0.23	0.057	0.24	0.061	5.11	1.28
Hydrogen fluoride	7664-39-3	4.1E-05	8.2E-11 [d]	3.1E-09 [e]	2.0E-09	1.4E-03	3.4E-04	1.1E-03	2.8E-04	1.3E-03	3.3E-04	1.4E-03	3.5E-04	1.6E-03	4.0E-04	1.5E-03	3.9E-04	1.7E-03	4.2E-04	0.035	8.8E-03
Isopropyl alcohol	67-63-0	0.039	7.8E-08 [d]	5.3E-07 [e]	3.6E-07	0.24	0.061	0.20	0.050	0.24	0.060	0.25	0.063	0.29	0.072	0.28	0.070	0.30	0.075	6.27	1.57
Lindane [gamma-Hexachlorocyclohexane]	58-89-9	1.3E-10	2.6E-16 [d]	--	9.7E-17	6.6E-11	1.6E-11	5.4E-11	1.3E-11	6.4E-11	1.6E-11	6.7E-11	1.7E-11	7.7E-11	1.9E-11	7.5E-11	1.9E-11	8.1E-11	2.0E-11	1.7E-09	4.2E-10
m-Cresol	108-39-4	1.3E-06	2.6E-12 [d]	--	9.6E-13	6.5E-07	1.6E-07	5.3E-07	1.3E-07	6.3E-07	1.6E-07	6.7E-07	1.7E-07	7.7E-07	1.9E-07	7.4E-07	1.9E-07	8.0E-07	2.0E-07	1.7E-05	4.2E-06
Methanol	67-56-1	0.050	1.0E-07 [d]	1.9E-06 [e]	1.2E-06	0.82	0.21	0.67	0.17	0.80	0.20	0.84	0.21	0.96	0.24	0.93	0.23	1.01	0.25	21.1	5.30
2-Butanone	78-93-3	1.1E-03	2.1E-09 [d]	--	7.9E-10	5.4E-04	1.3E-04	4.4E-04	1.1E-04	5.2E-04	1.3E-04	5.5E-04	1.4E-04	6.3E-04	1.6E-04	6.1E-04	1.5E-04	6.6E-04	1.7E-04	0.014	3.5E-03
Methyl tert-butyl ether	1634-04-4	7.5E-04	1.5E-09 [d]	--	5.6E-10	3.8E-04	9.4E-05	3.1E-04	7.7E-05	3.7E-04	9.2E-05	3.8E-04	9.6E-05	4.4E-04	1.1E-04	4.3E-04	1.1E-04	4.6E-04	1.2E-04	9.7E-03	2.4E-03
Methylene chloride [Dichloromethane]	75-09-2	0.056	1.1E-07 [d]	--	4.1E-08	0.028	7.0E-03	0.023	5.7E-03	0.027	6.8E-03	0.029	7.2E-03	0.033	8.2E-03	0.032	8.0E-03	0.034	8.6E-03	0.72	0.18
Nitric acid	7697-37-2	2.1E-03	4.1E-09 [d]	--	1.5E-09	1.0E-03	2.6E-04	8.4E-04	2.1E-04	1.0E-03	2.5E-04	1.1E-03	2.6E-04	1.2E-03	3.0E-04	1.2E-03	2.9E-04	1.3E-03	3.2E-04	0.026	6.6E-03
Tetrachloroehtene	127-18-4	2.6E-04	5.2E-10 [d]	--	1.9E-10	1.3E-04	3.3E-05	1.1E-04	2.7E-05	1.3E-04	3.2E-05	1.3E-04	3.3E-05	1.5E-04	3.8E-05	1.5E-04	3.7E-05	1.6E-04	4.0E-05	3.3E-03	8.4E-04
Phosphoric acid	7664-38-2	5.9E-06	1.2E-11 [d]	--	4.4E-12	3.0E-06	7.4E-07	2.4E-06	6.0E-07	2.9E-06	7.2E-07	3.0E-06	7.6E-07	3.5E-06	8.7E-07	3.4E-06	8.4E-07	3.6E-06	9.2E-07	7.6E-05	1.9E-05
Propylene glycol monomethyl ether	107-98-2	1.1E-05	2.1E-11 [d]	--	7.9E-12	5.3E-06	1.3E-06	4.4E-06	1.1E-06	5.2E-06	1.3E-06	5.5E-06	1.4E-06	6.3E-06	1.6E-06	6.1E-06	1.5E-06	6.6E-06	1.7E-06	1.4E-04	3.4E-05
Propylene oxide	75-56-9	4.7E-07	9.3E-13 [d]	--	3.4E-13	2.3E-07	5.8E-08	1.9E-07	4.8E-08	2.3E-07	5.7E-08	2.4E-07	6.0E-08	2.7E-07	6.9E-08	2.6E-07	6.6E-08	2.9E-07	7.2E-08	6.0E-06	1.5E-06
Styrene	100-42-5	3.0E-05	6.0E-11 [d]	--	2.2E-11	1.5E-05	3.8E-06	1.2E-05	3.1E-06	1.5E-05	3.7E-06	1.5E-05	3.9E-06	1.8E-05	4.4E-06	1.7E-05	4.3E-06	1.9E-05	4.6E-06	3.9E-04	9.7E-05
Sulfuric acid	7664-93-9	2.1E-04	4.1E-10 [d]	--	1.5E-10	1.0E-04	2.6E-05	8.4E-05	2.1E-05	1.0E-04	2.5E-05	1.1E-04	2.6E-05	1.2E-04	3.0E-05	1.2E-04	2.9E-05	1.3E-04	3.2E-05	2.7E-03	6.7E-04
Toluene	108-88-3	5.1E-03	1.0E-08 [d]	1.6E-08 [e]	1.4E-08	9.4E-03	2.4E-03	7.7E-03	1.9E-03	9.2E-03	2.3E-03	9.7E-03	2.4E-03	0.011	2.8E-03	0.011	2.7E-03	0.012	2.9E-03	0.24	0.061
Trichloroethylene	79-01-6	1.2E-03	2.3E-09 [d]	--	8.6E-10	5.8E-04	1.5E-04	4.8E-04	1.2E-04	5.7E-04	1.4E-04	6.0E-04	1.5E-04	6.9E-04	1.7E-04	6.6E-04	1.7E-04	7.2E-04	1.8E-04	0.015	3.8E-03
Triethylamine	121-44-8	1.4E-03	2.8E-09 [d]	--	1.0E-09	7.0E-04	1.8E-04	5.7E-04	1.4E-04	6.8E-04	1.7E-04	7.2E-04	1.8E-04	8.3E-04	2.1E-04	8.0E-04	2.0E-04	8.7E-04	2.2E-04	0.018	4.5E-03
Xylenes	1330-20-7	9.6E-04	1.9E-09 [d]	3.2E-08 [e]	2.1E-08	0.014	3.6E-03	0.012	2.9E-03	0.014	3.5E-03	0.015	3.6E-03	0.017	4.2E-03	0.016	4.1E-03	0.018	4.4E-03	0.37	0.092
Hydrazine	302-01-2	--	--	1.4E-10 [e]	8.9E-11	6.0E-05	1.5E-05	4.9E-05	1.2E-05	5.9E-05	1.5E-05	6.2E-05	1.5E-05	7.1E-05	1.8E-05	6.9E-05	1.7E-05	7.4E-05	1.9E-05	1.5E-03	3.9E-04
1,1,1-Trichloroethane	71-55-6	--	--	5.0E-10 [e]	3.1E-10	2.1E-04	5.3E-05	1.7E-04	4.3E-05	2.1E-04	5.2E-05	2.2E-04	5.4E-05	2.5E-04	6.2E-05	2.4E-04	6.0E-05	2.6E-04	6.5E-05	5.4E-03	1.4E-03
Total - All Chemicals Listed		**0.32**				**1.53**	**0.38**	**1.25**	**0.31**	**1.49**	**0.37**	**1.57**	**0.39**	**1.80**	**0.45**	**1.74**	**0.44**	**1.89**	**0.47**	**39.4**	**9.89**

Notes:

(a) Average lab chemical emission factor (tons/R&D gsf/yr) = (LBNL chemical emission factor [tons/R&D gsf/yr] x LBNL percentage of total lab space [%] / 100)
+ (UCB chemical emission factor [tons/R&D gsf/yr] x UCB percentage of total lab space [%] / 100)

LBNL percentage of total lab space (%) =	37	(2)
UCB percentage of total lab space (%) =	63	(2)

(b) Maximum hourly emissions estimate (lbs/hr) = (Annual average emissions [tons/year]) / (annual operation [days/year])
/ (daily operation [hrs/day]) x (2,000 lbs/ton) x (conversion factor)

Annual operation for all buildings (days/year) =	260	(1)
Daily operation for all buildings (hrs/day) =	10	(1)
Conversion factor =	5.18	(4)

(c) Annual average emissions estimate (tons/yr) = (Phase I emissions fraction [tons/gsf/yr]) x (building size [gsf])

(d) Lab chemical emission factor (tons/R&D gsf/yr) = (Phase I emissions [tons/yr]) / (total Phase I R&D building gsf)

Total Phase I building gsf =	501,915	(1)

(e) Lab chemical emission factor (tons/R&D gsf/yr) = (UCB emission factor [g/lab gsf/s]) x (lab fraction of R&D building gsf [lab gsf/R&D gsf]) x (lb/453.59 g) x (ton/2,000 lb) x (3,600 s/hr) x (8,760 hrs/yr)

Lab fraction of R&D building gsf (lab gsf/R&D gsf) =	0.60	(5)
UCB emission factor (g/lab gsf/s) =	see	(6)

References:

(1) See Table F-1, LRDP Operations Input Assumptions for Emission Rate Calculations.
(2) Provided by the University.
(3) Phase 1 Laboratory emissions calculated as part of the Phase 1 assessment. See Appendix G.
(4) Based in studies comparing maximum to average emission rates for laboratories. See text for further information.
(5) Based on average of existing and planned laboratory sizes.
(6) Emission factors provided by UC Berkeley.

Table F-20
LRDP Operations TAC Emissions Summary

TAC	CAS	Natural Gas Boilers		Diesel Generators		Cooling Towers		Laboratory Buildings		Onsite Onroad Exhaust		Offsite Onroad Exhaust		Total	
		(lbs/hr)	(tons/yr)	(lbs/hr)	(tons/yr)	(lbs/hr)	(tons/yr)	(lbs/hr)	(tons/yr)	(lbs/hr)	(tons/yr)	(lbs/hr)	(tons/yr)	(lbs/hr)	(tons/yr)
DPM (1)	9901	--	--	0.40	5.1E-03	--	--	--	--	9.4E-04	2.0E-03	6.8E-03	0.014	0.41	0.021
1,1,1-Trichloroethane	71-55-6	--	--	--	--	--	--	5.4E-03	1.4E-03	--	--	--	--	5.4E-03	1.4E-03
1,3-Butadiene	106-99-0	--	--	0.14	1.7E-03	--	--	4.0E-03	1.0E-03	1.7E-03	3.6E-03	5.1E-03	0.011	0.15	0.017
1,4-Dioxane	123-91-1	--	--	--	--	--	--	0.044	0.011	--	--	--	--	0.044	0.011
2-Butanone	78-93-3	--	--	--	--	--	--	0.014	3.5E-03	1.2E-04	2.6E-04	1.9E-04	3.9E-04	0.014	4.1E-03
7,12-Dimethylbenz(a)anthracene	57-97-6	7.3E-06	5.2E-06	--	--	--	--	--	--	--	--	--	--	7.3E-06	5.2E-06
Acetaldehyde	75-07-0	4.0E-03	2.9E-03	2.2E-03	2.8E-05	--	--	2.0E-03	5.1E-04	1.2E-03	2.4E-03	2.6E-03	5.4E-03	0.012	0.011
Acrolein	107-02-8	--	--	--	--	--	--	9.9E-04	2.5E-04	3.1E-04	6.4E-04	1.2E-03	2.5E-03	2.5E-03	3.4E-03
Acrylic acid	79-10-7	--	--	--	--	--	--	1.4E-04	3.6E-05	--	--	--	--	1.4E-04	3.6E-05
Aniline	62-53-3	--	--	--	--	--	--	3.5E-05	8.7E-06	--	--	--	--	3.5E-05	8.7E-06
Arsenic	7440-38-2	9.1E-05	6.5E-05	1.0E-03	1.3E-05	--	--	--	--	--	--	2.1E-05	4.4E-05	1.1E-03	1.2E-04
Benzene	71-43-2	2.0E-03	1.4E-03	0.12	1.5E-03	--	--	0.027	6.9E-03	0.013	0.027	0.023	0.048	0.19	0.084
Benzyl chloride	100-44-7	--	--	--	--	--	--	7.3E-05	1.8E-05	--	--	--	--	7.3E-05	1.8E-05
Beryllium	7440-41-7	5.4E-06	3.9E-06	--	--	--	--	--	--	--	--	--	--	5.4E-06	3.9E-06
Bromine	7726-95-6	--	--	--	--	3.7E-03	0.012	2.0E-03	4.9E-04	--	--	9.1E-05	1.9E-04	5.8E-03	0.013
Cadmium	7440-43-9	5.0E-04	3.6E-04	9.5E-04	1.2E-05	--	--	--	--	--	--	--	--	1.4E-03	3.7E-04
Carbon tetrachloride	56-23-5	--	--	--	--	--	--	0.15	0.037	--	--	--	--	0.15	0.037
Chlorine	7782-50-5	--	--	--	--	--	--	--	--	--	--	6.7E-03	0.014	6.7E-03	0.014
Chlorobenzene	108-90-7	--	--	1.3E-04	1.6E-06	--	--	--	--	--	--	--	--	1.3E-04	1.6E-06
Chloroform	67-66-3	--	--	--	--	--	--	2.55	0.64	--	--	--	--	2.55	0.64
Chromium VI	18540-29-9	1.1E-04	7.7E-05	6.3E-05	7.9E-07	--	--	--	--	--	--	--	--	1.7E-04	7.8E-05
Cobalt	7440-48-4	3.8E-05	2.7E-05	--	--	--	--	--	--	--	--	--	--	3.8E-05	2.7E-05
Copper	7440-50-8	3.9E-04	2.8E-04	2.6E-03	3.3E-05	--	--	--	--	--	--	0.024	0.050	0.027	0.051
Dichlorobenzene	25321-22-6	5.4E-04	3.9E-04	--	--	--	--	--	--	--	--	--	--	5.4E-04	3.9E-04
Diethanolamine	111-42-2	--	--	--	--	--	--	4.3E-08	1.1E-08	--	--	--	--	4.3E-08	1.1E-08
Dimethyl formamide	68-12-2	--	--	--	--	--	--	0.078	0.020	--	--	--	--	0.078	0.020
Epichlorohydrin	106-89-8	--	--	--	--	--	--	2.1E-04	5.3E-05	--	--	--	--	2.1E-04	5.3E-05
Ethylbenzene	100-41-4	3.1E-03	2.2E-03	4.3E-03	5.4E-05	--	--	1.3E-03	3.2E-04	0.014	0.029	9.8E-03	0.020	0.032	0.052
Ethylene dichloride [EDC]	107-06-2	--	--	--	--	--	--	0.030	7.4E-03	--	--	--	--	0.030	7.4E-03
Ethylene glycol	107-21-1	--	--	--	--	--	--	7.7E-05	1.9E-05	--	--	--	--	7.7E-05	1.9E-05
Ethylene glycol monomethyl ether	109-86-4	--	--	--	--	--	--	1.1E-03	2.7E-04	--	--	--	--	1.1E-03	2.7E-04
Fluoranthene	206-44-0	1.4E-06	9.7E-07	--	--	--	--	--	--	--	--	--	--	1.4E-06	9.7E-07
Formaldehyde	50-00-0	0.10	0.072	0.032	4.0E-04	--	--	1.95	0.49	3.6E-03	7.5E-03	0.015	0.031	2.10	0.60
Glutaraldehyde	111-30-8	--	--	--	--	--	--	0.056	0.014	--	--	--	--	0.056	0.014
Hydrazine	302-01-2	--	--	--	--	--	--	1.5E-03	3.9E-04	--	--	--	--	1.5E-03	3.9E-04
Hydrogen Chloride	7647-01-0	--	--	0.12	1.5E-03	--	--	5.11	1.28	--	--	--	--	5.23	1.28
Hydrogen fluoride	7664-39-3	--	--	--	--	--	--	0.035	8.8E-03	--	--	--	--	0.035	8.8E-03
Isopropyl alcohol	67-63-0	--	--	--	--	--	--	6.27	1.57	--	--	--	--	6.27	1.57
Lead	7439-92-1	2.3E-04	1.6E-04	5.2E-03	6.6E-05	--	--	--	--	--	--	1.8E-04	3.7E-04	5.6E-03	6.0E-04
Lindane [gamma-Hexachlorocyclohexane]	58-89-9	--	--	--	--	--	--	1.7E-09	4.2E-10	--	--	--	--	1.7E-09	4.2E-10
Manganese	7439-96-5	1.7E-04	1.2E-04	2.0E-03	2.5E-05	--	--	--	--	--	--	3.6E-03	7.5E-03	5.7E-03	7.6E-03
m-Cresol	108-39-4	--	--	--	--	--	--	1.7E-05	4.2E-06	--	--	--	--	1.7E-05	4.2E-06
Mercury	7439-97-6	1.2E-04	8.4E-05	1.3E-03	1.6E-05	--	--	--	--	--	--	--	--	1.4E-03	1.0E-04
Methanol	67-56-1	--	--	--	--	--	--	21.1	5.30	6.8E-04	1.4E-03	1.1E-03	2.3E-03	21.1	5.30
Methyl tert-butyl ether	1634-04-4	--	--	--	--	--	--	9.7E-03	2.4E-03	--	--	--	--	9.7E-03	2.4E-03
Methylene chloride [Dichloromethane]	75-09-2	--	--	--	--	--	--	0.72	0.18	--	--	--	--	0.72	0.18
Naphthalene	91-20-3	1.4E-04	9.7E-05	0.010	1.3E-04	--	--	--	--	1.0E-03	2.1E-03	4.7E-04	9.7E-04	0.012	3.3E-03
n-Hexane	110-54-3	2.1E-03	1.5E-03	8.8E-04	1.1E-05	--	--	0.57	0.14	0.010	0.022	0.015	0.031	0.60	0.20
Nickel	7440-02-0	9.5E-04	6.8E-04	2.5E-03	3.1E-05	--	--	--	--	--	--	1.4E-03	2.9E-03	4.8E-03	3.6E-03
Nitric acid	7697-37-2	--	--	--	--	--	--	0.026	6.6E-03	--	--	--	--	0.026	6.6E-03
Phosphoric acid	7664-38-2	--	--	--	--	--	--	7.6E-05	1.9E-05	--	--	--	--	7.6E-05	1.9E-05
Propylene	115-07-1	0.24	0.17	0.22	2.7E-03	--	--	--	--	8.6E-03	0.018	0.029	0.059	0.49	0.25
Propylene glycol monomethyl ether	107-98-2	--	--	--	--	--	--	1.4E-04	3.4E-05	--	--	--	--	1.4E-04	3.4E-05
Propylene oxide	75-56-9	--	--	--	--	--	--	6.0E-06	1.5E-06	--	--	--	--	6.0E-06	1.5E-06
Selenium	7782-49-2	1.1E-05	7.8E-06	1.4E-03	1.7E-05	--	--	--	--	--	--	5.1E-05	1.1E-04	1.5E-03	1.3E-04
Styrene	100-42-5	--	--	--	--	--	--	3.9E-04	9.7E-05	5.6E-04	1.2E-03	1.1E-03	2.3E-03	2.1E-03	3.6E-03
Sulfuric acid	7664-93-9	--	--	--	--	--	--	2.7E-03	6.7E-04	--	--	--	--	2.7E-03	6.7E-04
Tetrachloroehtene	127-18-4	--	--	--	--	--	--	3.3E-03	8.4E-04	--	--	--	--	3.3E-03	8.4E-04
Toluene	108-88-3	0.012	8.6E-03	0.039	4.9E-04	--	--	0.24	0.061	0.051	0.11	0.054	0.11	0.40	0.29
Trichloroethylene	79-01-6	--	--	--	--	--	--	0.015	3.8E-03	--	--	--	--	0.015	3.8E-03
Triethylamine	121-44-8	--	--	--	--	--	--	0.018	4.5E-03	--	--	--	--	0.018	4.5E-03
Vanadium	7440-62-2	--	--	--	--	--	--	--	--	--	--	1.4E-03	2.9E-03	1.4E-03	2.9E-03
m-Xylene	108-38-3	--	--	--	--	--	--	--	--	0.029	0.061	0.033	0.069	0.062	0.13
o-Xylene	95-47-6	--	--	--	--	--	--	--	--	0.014	0.029	0.012	0.024	0.026	0.054
p-Xylene	106-42-3	--	--	--	--	--	--	--	--	8.5E-03	0.018	--	--	8.5E-03	0.018
Xylenes	1330-20-7	8.9E-03	6.4E-03	0.027	3.4E-04	--	--	0.37	0.092	--	--	--	--	0.40	0.098
NO_2	10102-44-0	8.43	6.01	9.95	0.13	--	--	--	--	0.66	1.37	0.14	0.29	19.2	7.79
SO_2	7446-09-5	0.27	0.19	0.18	2.3E-03	--	--	--	--	2.2E-03	4.5E-03	6.9E-03	0.014	0.46	0.21
CO	630-08-0	37.8	27.0	61.3	0.77	--	--	--	--	6.91	14.4	1.02	2.13	107	44.2

References:

(1) On-site DPM emissions. Assumes all PM10 emissions from mobile source combustion equals diesel particulate matter (DPM). See Table F-11, Criteria Pollutant Emissions Summary, for DPM emissions from onsite onroad sources.

(2) NO_2 emissions are shown as NO_X emissions.

Appendix G

Laboratory Chemical Calculations

Table G-1
Total Estimated Air Emissions of Laboratory Non-Radionuclide Liquid Chemicals(1)
Proposed Richmond Bay Campus Long Range Development Plan, Richmond, California

CAS Number	Chemical Name	Estimated Emissions (grams/year)	Estimated Emissions (lbs/year)
106-99-0	1,3-Butadiene	285.77	0.63
123-91-1	1,4-Dioxane	3,095.08	6.82
75-07-0	Acetaldehyde	144.08	0.32
107-02-8	Acrolein	70.08	0.15
79-10-7	Acrylic acid	9.99	0.02
62-53-3	Aniline	2.44	0.01
71-43-2	Benzene	1,939.26	4.28
100-44-7	Benzyl chloride	5.16	0.01
7726-95-6	Bromine	1.13	0.00
56-23-5	Carbon tetrachloride	294.54	0.65
67-66-3	Chloroform	46,603.66	102.76
111-42-2	Diethanolamine	3.0E-03	6.7E-06
68-12-2	Dimethyl formamide	515.60	1.14
106-89-8	Epichlorohydrin	14.79	0.03
100-41-4	Ethyl benzene	90.75	0.20
107-06-2	Ethylene dichloride [EDC]	2,083.46	4.59
107-21-1	Ethylene glycol	5.41	0.01
109-86-4	Ethylene glycol monomethyl ether	76.91	0.17
50-00-0	Formaldehyde	12,391.31	27.32
111-30-8	Glutaraldehyde	44.5	0.10
110-54-3	Hexane	40,004.39	88.21
7647-01-0	Hydrochloric acid	37,991.59	83.77
7664-39-3	Hydrogen fluoride	37.50	0.08
67-63-0	Isopropyl alcohol	35,382.88	78.02
58-89-9	Lindane [gamma-Hexachlorocyclohexane]	1.2E-04	2.6E-07
108-39-4	m-Cresol	1.18	0.00
67-56-1	Methanol	45,342.02	99.98
78-93-3	Methyl ethyl ketone [2-Butanone]	974.22	2.15
1634-04-4	Methyl tert-butyl ether	682.39	1.50
75-09-2	Methylene chloride [Dichloromethane]	50,699.56	111.79
7697-37-2	Nitric acid	1,865.18	4.11
127-18-4	Perchloroethylene [Tetrachloroethene]	235.75	0.52
7664-38-2	Phosphoric acid	5.37	0.01
107-98-2	Propylene glycol monomethyl ether	9.70	0.02
75-56-9	Propylene oxide	0.42	0.00
100-42-5	Styrene	27.25	0.06
7664-93-9	Sulfuric acid	187.24	0.41
108-88-3	Toluene	4,636.09	10.22
79-01-6	Trichloroethylene	1,059.27	2.34
121-44-8	Triethylamine	1,276.26	2.81
1330-20-7	Xylenes (mixed isomers)	868.92	1.92
	Total - All Chemicals Listed	**288,961.03**	**637.16**

Notes:
(1) Estimation methods continued in Appendix G.

Calculation of Liquid Chemical Emissions
Phase 1 Laboratory Usage Scenario
Proposed Richmond Bay Campus Long Range Development Plan, Richmond, California
Emission Estimation Approach for Liquids

Step 1: Pour Liquid Into Receiving Container (i.e. Beaker)

Emissions based on quantity poured.

Loss (grams/liter) = 0.02887 * (S*VP*MW)/T From U.S. EPA AP-42 Section 5.2, converted from lbs/10^3 gal to gram/liter and VP in mmHg instead of psia.

where:
S = Saturation Factor (1.45 [unitless]) - From U.S. EPA AP-42 Table 5.2-1
VP = Vapor Pressure at room temperature (mmHg; assume 532 degrees Rankin)
MW = Molecular Weight (grams/mole)
T = Room Temperature (assume 532 degrees Rankin)

Assumptions: Liquid is poured when at room temperature.
Receiving vessel is an open beaker.

Step 2: Stir Liquid in Receiving Container (i.e. Beaker)

Emissions based on number of batches..

Loss (grams/30 min. batch) = $(0.002289*t*A*U^{0.78}*MW^{0.67}*VP)/(R*T)$ From: *Risk Management Program Guidance for Offsite Consequence Analysis*
United States Environmental Protection Agency
Emergency Response (Document 550-B-99-009)
April 1999

where:
t = Batch time in seconds (=1,800)
A = Surface Area (100 cm^2)
U = Surface Wind Speed (0.51 meters/second)
MW = Molecular Weight (grams/mole)
VP = Vapor Pressure at elevated temperature (mmHg)
R = Gas Constant (82.05 atm-cm^3/mole-deg K)
T = Temperature During Use (degrees Kelvin)

Assumptions: If VP(295 K) is > 100 mmHg, no heating is assumed.
*If VP(295 K) is < 100 mmHg, VP(as used) = 2 * VP(298 K), up to 100 mmHg maximum.*
Vessel used is an open beaker.
Diameter of beaker is such that A = 100 cm^2.
Assume that beaker contains pure chemical.
Assume that use occurs within a laboratory fume hood.
Assume fume hood face velocity of 100 ft/min (OSHA recommendation).
Assume batch (use) time of 30 minutes.
For calculation purposes, assume T = 295 deg K. Conservative because temperatures above room temperature would only decrease predicted emission rate.

Calculation of Liquid Chemical Emissions
Phase 1 Laboratory Usage Scenario
Proposed Richmond Bay Campus Long Range Development Plan, Richmond, California

Calculation Constants

Name	Value	Comment
TempAmbC	21.85	Assumed room temperature in degrees C
TempAmbK	295	Assumed room temperature in degrees K
TempAmbR	532	Assumed room temperature in degrees R
MaxPressBar	0.133	Maximum adjusted vapor pressure in Bars
MaxPressHg	100	Maximum adjusted vapor pressure in mmHg
SatFactor	1.45	Saturation factor for pouring emissions
SurfaceArea	100	Vessel surface area in cm^2
WindSpeed	0.51	Surface Wind Speed (meters/second)
GasConstant	82.05	Gas constant R (atm-cm^3/mole-deg K)

Calculation of Liquid Chemical Emissions
Phase 1 Laboratory Usage Scenario
Proposed Richmond Bay Campus Long Range Development Plan, Richmond, California
Chemical Inventory Data (Table G-2)

Conservatively assume specific gravity of 0.7 for laboratory liquids (0.649 liter/lb) when units are in pounds

Batch Assumptions:	*Annual Usage*	*Assumed Annual Batches*
	< 0.01 liter	*1*
	0.01-0.1 liter	*5*
	0.1-1.0 liter	*10*
	1.0-10 liter	*25*
	>10 liter	*100*

This list of chemicals comes from LBNL inventory data with solids & gases removed		*Entered Data*		*Calculated*	*Recalculated*	*Calculated*	*Entered Data*		*Calculated*
		Inventory Amount		**Inventory Amount**	**Inventory Amount**	**Annual Usage ***	**Building**	**Room**	**Estimated No. of Batches**
CAS No.	**Compound Name**	**Quantity**	**Units**	**(liters)**	**(liters)**	**(liters/yr)**			**(per year)**
50-00-0	NORTHERNMAX DENATURING GEL BUFFER	250	ML	0.25000	--	0.29341	9	0446	10
50-00-0	FORMALDEHYDE	500	ML	0.50000	--	0.58682	9	0412	10
50-00-0	FORMALDEHYDE	500	ML	0.50000	--	0.58682	9	0446	10
50-00-0	FORMALDEHYDE SOLUTION	500	ML	0.50000	--	0.58682	9	0446	10
50-00-0	FORMALDEHYDE	500	ML	0.50000	--	0.58682	9	0412	10
50-00-0	FORMALDEHYDE	500	ML	0.50000	--	0.58682	9	0412	10
50-00-0	FORMALDEHYDE SOLUTION	25	ML	0.02500	--	0.02934	9	0459	5
50-00-0	FORMALDEHYDE	25	ML	0.02500	--	0.02934	9	0446	5
50-00-0	FORMALDEHYDE	25	ML	0.02500	--	0.02934	9	0459	5
50-00-0	FORMALDEHYDE	25	ML	0.02500	--	0.02934	9	0459	5
50-00-0	FORMALDEHYDE	25	ML	0.02500	--	0.02934	9	0459	5
50-00-0	FORMALDEHYDE	25	ML	0.02500	--	0.02934	9	0459	5
50-00-0	FORMALDEHYDE	25	ML	0.02500	--	0.02934	9	0459	5
50-00-0	FORMALDEHYDE	25	ML	0.02500	--	0.02934	9	0459	5
50-00-0	FORMALDEHYDE	25	ML	0.02500	--	0.02934	9	0446	5
50-00-0	FORMALDEHYDE	25	ML	0.02500	--	0.02934	9	0446	5
50-00-0	FORMALDEHYDE	25	ML	0.02500	--	0.02934	9	0446	5
50-00-0	FORMALDEHYDE	25	ML	0.02500	--	0.02934	9	0446	5
50-00-0	FORMALDEHYDE	25	ML	0.02500	--	0.02934	9	0446	5
50-00-0	FORMALDEHYDE	500	ML	0.50000	--	0.58682	9	0412	10
50-00-0	FORMALDEHYDE	500	ML	0.50000	--	0.58682	9	0412	10
50-00-0	FORMALDEHYDE	500	ML	0.50000	--	0.58682	9	0412	10
50-00-0	FORMALDEHYDE	500	ML	0.50000	--	0.58682	9	0412	10
50-00-0	FORMALDEHYDE	500	ML	0.50000	--	0.58682	9	0412	10
50-00-0	FORMALDEHYDE	25	ML	0.02500	--	0.02934	9	0446	5
50-00-0	FORMALDEHYDE	25	ML	0.02500	--	0.02934	9	0446	5
50-00-0	FORMALDEHYDE	25	ML	0.02500	--	0.02934	9	0446	5
50-00-0	FORMALDEHYDE	25	ML	0.02500	--	0.02934	9	0446	5
50-00-0	FORMALDEHYDE	25	ML	0.02500	--	0.02934	9	0446	5
50-00-0	FORMALDEHYDE	25	ML	0.02500	--	0.02934	9	0446	5
50-00-0	FORMALDEHYDE	25	ML	0.02500	--	0.02934	9	0446	5
50-00-0	FORMALDEHYDE	25	ML	0.02500	--	0.02934	9	0459	5
50-00-0	FORMALDEHYDE	25	ML	0.02500	--	0.02934	9	0459	5
50-00-0	FORMALDEHYDE SOLUTION	500	ML	0.50000	--	0.58682	9	0412	10
50-00-0	FORMALDEHYDE	25	ML	0.02500	--	0.02934	9	0446	5
50-00-0	FORMALDEHYDE	25	ML	0.02500	--	0.02934	9	0446	5
50-00-0	FORMALDEHYDE	25	ML	0.02500	--	0.02934	9	0446	5
50-00-0	FORMALDEHYDE	25	ML	0.02500	--	0.02934	9	0446	5
50-00-0	FORMALDEHYDE	25	ML	0.02500	--	0.02934	9	0446	5
50-00-0	FORMALDEHYDE	25	ML	0.02500	--	0.02934	9	0446	5
50-00-0	FORMALDEHYDE SOLUTION	25	ML	0.02500	--	0.02934	9	0459	5
50-00-0	FORMALDEHYDE	450	ML	0.45000	--	0.52814	8	4550	10
50-00-0	FORMALDEHYDE	450	ML	0.45000	--	0.52814	8	4524	10
50-00-0	FORMALDEHYDE	450	ML	0.45000	--	0.52814	8	4440	10
50-00-0	FORMALDEHYDE	450	ML	0.45000	--	0.52814	8	4440	10
50-00-0	FORMALDEHYDE SOLUTION	500	ML	0.50000	--	0.58682	8	4310	10
50-00-0	FORMALDEHYDE SOLUTION	500	ML	0.50000	--	0.58682	8	4310	10
50-00-0	FORMALDEHYDE SOLUTION	500	G	**Units**	0.45872	0.53836	8	4310	10
50-00-0	FORMALDEHYDE SOLUTION	500	G	**Units**	0.45872	0.53836	8	4310	10
50-00-0	FORMALDEHYDE	100	ML	0.10000	--	0.11736	6/7	0166	10
50-00-0	NORTHERNMAX DENATURING GEL BUFFER	250	ML	0.25000	--	0.29341	6/7	0166	10

* Equals inventory x (365 days per yr/311 days)
[311 days = 95th percentile lowest turnover rate for historic use]

Golder Associates

Calculation of Liquid Chemical Emissions
Phase 1 Laboratory Usage Scenario
Proposed Richmond Bay Campus Long Range Development Plan, Richmond, California
Chemical Inventory Data (Table G-2)

Conservatively assume specific gravity of 0.7 for laboratory liquids (0.649 liter/lb) when units are in pounds

Batch Assumptions:	*Annual Usage*	*Assumed Annual Batches*
	< 0.01 liter	*1*
	0.01-0.1 liter	*5*
	0.1-1.0 liter	*10*
	1.0-10 liter	*25*
	>10 liter	*100*

This list of chemicals comes from LBNL inventory data with solids & gases removed		*Entered Data*		*Calculated*	*Recalculated*	*Calculated*	*Entered Data*		*Calculated*
		Inventory Amount		**Inventory Amount**	**Inventory Amount**	**Annual Usage ***	**Building**	**Room**	**Estimated No. of Batches (per year)**
CAS No.	**Compound Name**	**Quantity**	**Units**	**(liters)**	**(liters)**	**(liters/yr)**			
50-00-0	FORMALDEHYDE	100	ML	0.10000	--	0.11736	6/7	0293	10
50-00-0	FORMALDEHYDE	100	ML	0.10000	--	0.11736	6/7	0293	10
50-00-0	FORMALDEHYDE	100	ML	0.10000	--	0.11736	6/7	0293	10
50-00-0	FORMALDEHYDE	100	ML	0.10000	--	0.11736	6/7	0293	10
50-00-0	FORMALDEHYDE	500	ML	0.50000	--	0.58682	6/7	0293	10
50-00-0	FORMALIN SOLUTION 10%, NEUTRAL BUFFERED	1	GAL	3.78500	--	4.44220	6/7	0271	25
50-00-0	FORMALIN SOLUTION 10%, NEUTRAL BUFFERED	1	GAL	3.78500	--	4.44220	6/7	0271	25
50-00-0	FORMALIN SOLUTION 10%, NEUTRAL BUFFERED	1	GAL	3.78500	--	4.44220	6/7	0271	25
50-00-0	FORMALDEHYDE	500	ML	0.50000	--	0.58682	6/7	0244	10
50-00-0	FORMALDEHYDE	450	ML	0.45000	--	0.52814	6/7	0239	10
50-00-0	FORMALDEHYDE	500	ML	0.50000	--	0.58682	6/7	0239	10
50-00-0	FORMALDEHYDE	500	ML	0.50000	--	0.58682	6/7	0204	10
50-00-0	FORMALIN	120	ML	0.12000	--	0.14084	6/7	0128	10
50-00-0	FORMALDEHYDE	120	ML	0.12000	--	0.14084	6/7	0128	10
50-00-0	FORMALDEHYDE	120	ML	0.12000	--	0.14084	6/7	0128	10
50-00-0	FORMALDEHYDE	120	ML	0.12000	--	0.14084	6/7	0128	10
50-00-0	FORMALDEHYDE	120	ML	0.12000	--	0.14084	6/7	0128	10
50-00-0	FORMALDEHYDE	120	ML	0.12000	--	0.14084	6/7	0128	10
50-00-0	FORMALDEHYDE	120	ML	0.12000	--	0.14084	6/7	0128	10
50-00-0	FORMALDEHYDE	120	ML	0.12000	--	0.14084	6/7	0128	10
50-00-0	FORMALDEHYDE	120	ML	0.12000	--	0.14084	6/7	0128	10
50-00-0	FORMALDEHYDE	120	ML	0.12000	--	0.14084	6/7	0128	10
50-00-0	FORMALDEHYDE	120	ML	0.12000	--	0.14084	6/7	0128	10
50-00-0	FORMALDEHYDE	120	ML	0.12000	--	0.14084	6/7	0128	10
50-00-0	FORMALDEHYDE	120	ML	0.12000	--	0.14084	6/7	0128	10
50-00-0	FORMALDEHYDE	120	ML	0.12000	--	0.14084	6/7	0128	10
50-00-0	FORMALDEHYDE	120	ML	0.12000	--	0.14084	6/7	0128	10
50-00-0	FORMALDEHYDE	4	L	4.00000	--	4.69453	6/7	0128	25
50-00-0	FORMALDEHYDE	4	L	4.00000	--	4.69453	6/7	0128	25
50-00-0	FORMALIN SOLUTION 10%, NEUTRAL BUFFERED	15	ML	0.01500	--	0.01760	6/7	0128	5
50-00-0	FORMALIN SOLUTION 10%, NEUTRAL BUFFERED	15	ML	0.01500	--	0.01760	6/7	0128	5
50-00-0	FORMALIN SOLUTION 10%, NEUTRAL BUFFERED	15	ML	0.01500	--	0.01760	6/7	0128	5
50-00-0	FORMALIN SOLUTION 10%, NEUTRAL BUFFERED	15	ML	0.01500	--	0.01760	6/7	0128	5
50-00-0	FORMALIN SOLUTION 10%, NEUTRAL BUFFERED	15	ML	0.01500	--	0.01760	6/7	0128	5
50-00-0	FORMALIN SOLUTION 10%, NEUTRAL BUFFERED	15	ML	0.01500	--	0.01760	6/7	0128	5
50-00-0	FORMALINE SOLUTION ACCUSTAIN 10%	120	ML	0.12000	--	0.14084	6/7	0128	10
50-00-0	FORMALDEHYDE	500	ML	0.50000	--	0.58682	6/7	0128	10
50-00-0	FORMALDEHYDE	500	ML	0.50000	--	0.58682	6/7	0128	10
50-00-0	FORMALDEHYDE	500	ML	0.50000	--	0.58682	6/7	0128	10
50-00-0	FORMALDEHYDE	500	ML	0.50000	--	0.58682	6/7	0128	10
50-00-0	FORMALDEHYDE	25	ML	0.02500	--	0.02934	6/7	0128	5
50-00-0	FORMALINE SOLUTION ACCUSTAIN 10%	50	ML	0.05000	--	0.05868	6/7	0128	5
50-00-0	NORTHERNMAX DENATURING GEL BUFFER	250	ML	0.25000	--	0.29341	6/7	0196A	10
50-00-0	FORMALDEHYDE SOLUTION	500	ML	0.50000	--	0.58682	6/7	0196A	10
50-00-0	FORMALDEHYDE	500	ML	0.50000	--	0.58682	6/7	0116	10
50-00-0	FORMALDEHYDE SOLUTION	500	ML	0.50000	--	0.58682	6/7	0177	10
50-00-0	FORMALDEHYDE SOLUTION	500	ML	0.50000	--	0.58682	6/7	0177	10
50-00-0	FORMALDEHYDE	500	ML	0.50000	--	0.58682	6/7	0177	10
50-00-0	FORMALDEHYDE SOLUTION	500	ML	0.50000	--	0.58682	6/7	0177	10
50-00-0	FORMALDEHYDE	100	ML	0.10000	--	0.11736	6/7	0177	10
50-00-0	FORMALDEHYDE	100	ML	0.10000	--	0.11736	6/7	0177	10
50-00-0	FORMALDEHYDE	100	ML	0.10000	--	0.11736	6/7	0177	10

* Equals inventory x (365 days per yr/311 days)
[311 days = 95th percentile lowest turnover rate for historic use]

Golder Associates

Calculation of Liquid Chemical Emissions
Phase 1 Laboratory Usage Scenario
Proposed Richmond Bay Campus Long Range Development Plan, Richmond, California
Chemical Inventory Data (Table G-2)

Conservatively assume specific gravity of 0.7 for laboratory liquids (0.649 liter/lb) when units are in pounds

Batch Assumptions:	*Annual Usage*	*Assumed Annual Batches*
	< 0.01 liter	*1*
	0.01-0.1 liter	*5*
	0.1-1.0 liter	*10*
	1.0-10 liter	*25*
	>10 liter	*100*

This list of chemicals comes from LBNL inventory data with solids & gases removed		*Entered Data*		*Calculated*	*Recalculated*	*Calculated*	*Entered Data*		*Calculated*
		Inventory Amount		**Inventory Amount**	**Inventory Amount**	**Annual Usage ***	**Building**	**Room**	**Estimated No. of Batches (per year)**
CAS No.	**Compound Name**	**Quantity**	**Units**	**(liters)**	**(liters)**	**(liters/yr)**			
50-00-0	FORMALIN SOLUTION 10%, NEUTRAL BUFFERED	1	GAL	3.78500	--	4.44220	6/7	0109	25
50-00-0	FORMALDEHYDE	80	ML	0.08000	--	0.09389	6/7	0196	5
50-00-0	BUFFERED NEUTRAL FORMALIN	4	L	4.00000	--	4.69453	6/7	0239	25
50-00-0	FORMALDEHYDE	500	ML	0.50000	--	0.58682	6/7	0239	10
50-00-0	FORMALDEHYDE	500	ML	0.50000	--	0.58682	6/7	0239	10
50-00-0	FORMALDEHYDE	500	ML	0.50000	--	0.58682	6/7	0239	10
50-00-0	FORMALDEHYDE	500	ML	0.50000	--	0.58682	6/7	0239	10
50-00-0	FORMALDEHYDE	500	ML	0.50000	--	0.58682	6/7	0239	10
50-00-0	FORMALDEHYDE	500	ML	0.50000	--	0.58682	6/7	0239	10
50-00-0	FORMALDEHYDE	500	ML	0.50000	--	0.58682	6/7	0229	10
50-00-0	FORMALINE SOLUTION ACCUSTAIN 10%	4	L	4.00000	--	4.69453	6/7	0204	25
50-00-0	FORMALDEHYDE	500	ML	0.50000	--	0.58682	6/7	0204	10
50-00-0	FORMALIN SOLUTION 10%, NEUTRAL BUFFERED	1	GAL	3.78500	--	4.44220	6/7	0188C	25
50-00-0	FORMALIN SOLUTION 10%, NEUTRAL BUFFERED	1	GAL	3.78500	--	4.44220	6/7	0188C	25
50-00-0	FORMALIN SOLUTION 10%, NEUTRAL BUFFERED	1	GAL	3.78500	--	4.44220	6/7	0188C	25
50-00-0	FORMALIN SOLUTION 10%, NEUTRAL BUFFERED	1	GAL	3.78500	--	4.44220	6/7	0188C	25
50-00-0	FORMALDEHYDE SOLUTION	500	ML	0.50000	--	0.58682	6/7	0188C	10
50-00-0	FORMALDEHYDE	500	ML	0.50000	--	0.58682	6/7	0188C	10
50-00-0	FORMALDEHYDE	25	ML	0.02500	--	0.02934	6/7	0287	5
50-00-0	FORMALDEHYDE	10	ML	0.01000	--	0.01174	6/7	0287	5
50-00-0	FORMALDEHYDE	500	ML	0.50000	--	0.58682	6/7	0287	10
50-00-0	FORMALIN SOLUTION	15	ML	0.01500	--	0.01760	6/7	0241	5
50-00-0	FORMALDEHYDE SOLUTION	500	ML	0.50000	--	0.58682	6/7	0240	10
50-00-0	FORMALDEHYDE	500	ML	0.50000	--	0.58682	6/7	0239	10
50-00-0	FORMALDEHYDE	5	ML	0.00500	--	0.00587	6/7	0239	1
50-00-0	FORMALDEHYDE	150	ML	0.15000	--	0.17605	6/7	0295	10
50-00-0	FORMALDEHYDE	150	ML	0.15000	--	0.17605	6/7	0295	10
50-00-0	FORMALDEHYDE	500	ML	0.50000	--	0.58682	6/7	0295	10
50-00-0	FORMALIN SOLUTION 10%, NEUTRAL BUFFERED	35	ML	0.03500	--	0.04108	6/7	0128	5
50-00-0	FORMALDEHYDE	1	L	1.00000	--	1.17363	6/7	0185	25
50-00-0	FORMALDEHYDE, 37 WT IN H2O	500	ML	0.50000	--	0.58682	6/7	0216	10
50-00-0	FORMALDEHYDE	1000	ML	1.00000	--	1.17363	6/7	0209	25
50-00-0	FORMALDEHYDE, 37 WT	500	ML	0.50000	--	0.58682	6/7	0220	10
50-00-0	FORMALDEHYDE 37 % IN WATER	500	ML	0.50000	--	0.58682	6/7	0220	10
50-00-0	FORMALDEHYDE	100	ML	0.10000	--	0.11736	6/7	0220	10
50-00-0	FORMALDEHYDE	100	ML	0.10000	--	0.11736	6/7	0220	10
50-00-0	FORMALDEHYDE	500	ML	0.50000	--	0.58682	6/7	0220	10
50-00-0	FORMALDEHYDE	500	ML	0.50000	--	0.58682	6/7	0220	10
50-00-0	FORMALDEHYDE SOLUTION	500	ML	0.50000	--	0.58682	6/7	0220	10
50-00-0	FORMALIN	1	L	1.00000	--	1.17363	6/7	0255	25
56-23-5	CARBON TETRACHLORIDE	1	PT	0.47318	--	0.55534	6/7	0239	10
58-89-9	CYCLOHEXANE, 1,2,3,4,5,6-HEXACHLORO-, GAMMA-ISOMER	500	G	**Units**	0.31387	0.36837	6/7	0188C	10
58-89-9	CYCLOHEXANE, 1,2,3,4,5,6-HEXACHLORO-, GAMMA-ISOMER	500	G	**Units**	0.31387	0.36837	6/7	0188C	10
58-89-9	CYCLOHEXANE, 1,2,3,4,5,6-HEXACHLORO-, GAMMA-ISOMER	5	G	**Units**	0.00314	0.00368	6/7	0188C	1
58-89-9	CYCLOHEXANE, 1,2,3,4,5,6-HEXACHLORO-, GAMMA-ISOMER	5	G	**Units**	0.00314	0.00368	6/7	0188C	1
62-53-3	ANILINE OIL	500	G	**Units**	0.48924	0.57418	8	4310	10
62-53-3	BENZAMINE	5	G	**Units**	0.00489	0.00574	6/7	0230	1
67-56-1	METHANOL	1	GAL	3.78500	--	4.44220	9	0458	25
67-56-1	METHANOL	4	L	4.00000	--	4.69453	9	0459	25
67-56-1	METHANOL	2.5	L	2.50000	--	2.93408	9	0446	25
67-56-1	METHANOL	2.5	L	2.50000	--	2.93408	9	0446	25
67-56-1	METHANOL	1	ML	0.00100	--	0.00117	9	3219	1
67-56-1	METHANOL	4	L	4.00000	--	4.69453	9	3219	25

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Conservatively assume specific gravity of 0.7 for laboratory liquids (0.649 liter/lb) when units are in pounds

Batch Assumptions:	*Annual Usage*	*Assumed Annual Batches*
	< 0.01 liter	*1*
	0.01-0.1 liter	*5*
	0.1-1.0 liter	*10*
	1.0-10 liter	*25*
	>10 liter	*100*

This list of chemicals comes from LBNL inventory data with solids & gases removed		*Entered Data*		*Calculated*	*Recalculated*	*Calculated*	*Entered Data*		*Calculated*
		Inventory Amount		**Inventory Amount**	**Inventory Amount**	**Annual Usage ***	**Building**	**Room**	**Estimated No. of Batches**
CAS No.	**Compound Name**	**Quantity**	**Units**	**(liters)**	**(liters)**	**(liters/yr)**			**(per year)**
67-56-1	METHANOL	1	L	1.00000	--	1.17363	9	3219	25
67-56-1	COMBI METHANOL	1	L	1.00000	--	1.17363	9	3219	25
67-56-1	METHANOL	1	L	1.00000	--	1.17363	8		25
67-56-1	METHANOL	1	L	1.00000	--	1.17363	8	4550	25
67-56-1	METHANOL	4	L	4.00000	--	4.69453	8	4550	25
67-56-1	METHANOL	4	L	4.00000	--	4.69453	8	4550	25
67-56-1	METHANOL	1	L	1.00000	--	1.17363	8	4550	25
67-56-1	METHANOL	1	L	1.00000	--	1.17363	8	4550	25
67-56-1	METHANOL	2	L	2.00000	--	2.34727	8	4550	25
67-56-1	METHANOL	2	L	2.00000	--	2.34727	8	4550	25
67-56-1	METHANOL	2	L	2.00000	--	2.34727	8	4550	25
67-56-1	METHANOL	2	L	2.00000	--	2.34727	8	4550	25
67-56-1	METHANOL	4	L	4.00000	--	4.69453	8	4550	25
67-56-1	METHANOL	4	L	4.00000	--	4.69453	8	4550	25
67-56-1	METHANOL	4	L	4.00000	--	4.69453	8	4550	25
67-56-1	METHANOL	2	L	2.00000	--	2.34727	8	4550	25
67-56-1	METHANOL	4	L	4.00000	--	4.69453	8	4524	25
67-56-1	METHANOL	4	L	4.00000	--	4.69453	8	4524	25
67-56-1	METHANOL	1	L	1.00000	--	1.17363	8	4524	25
67-56-1	METHANOL	1	GAL	3.78500	--	4.44220	8	4524	25
67-56-1	METHANOL	100	ML	0.10000	--	0.11736	8	4510	10
67-56-1	METHANOL	4	L	4.00000	--	4.69453	8	4465R	25
67-56-1	METHANOL	4	L	4.00000	--	4.69453	8	4440	25
67-56-1	METHANOL	250	ML	0.25000	--	0.29341	8	4440	10
67-56-1	METHANOL	1	L	1.00000	--	1.17363	8	4440	25
67-56-1	METHANOL	1	GAL	3.78500	--	4.44220	8	4440	25
67-56-1	METHANOL	1	GAL	3.78500	--	4.44220	8	4440	25
67-56-1	METHANOL	4	L	4.00000	--	4.69453	8	4440	25
67-56-1	METHANOL	4	L	4.00000	--	4.69453	8	4440	25
67-56-1	METHANOL	4	L	4.00000	--	4.69453	8	4410	25
67-56-1	METHANOL	4	L	4.00000	--	4.69453	8	4410	25
67-56-1	METHANOL	4	L	4.00000	--	4.69453	8	4410	25
67-56-1	METHANOL	4	L	4.00000	--	4.69453	8	4410	25
67-56-1	METHANOL	4	L	4.00000	--	4.69453	8	4410	25
67-56-1	METHANOL	4	L	4.00000	--	4.69453	8	4410	25
67-56-1	METHANOL	1	GAL	3.78500	--	4.44220	8	4410	25
67-56-1	METHANOL	1	GAL	3.78500	--	4.44220	8	4410	25
67-56-1	METHANOL	1	GAL	3.78500	--	4.44220	8	4410	25
67-56-1	METHANOL	1	GAL	3.78500	--	4.44220	8	4410	25
67-56-1	METHANOL	1	L	1.00000	--	1.17363	8	4410	25
67-56-1	METHANOL	1	L	1.00000	--	1.17363	8	4410	25
67-56-1	METHANOL	1	L	1.00000	--	1.17363	8	4410	25
67-56-1	METHANOL	1	L	1.00000	--	1.17363	8	4410	25
67-56-1	METHANOL	19	L	19.00000	--	22.29904	8	4330M	100
67-56-1	METHANOL	19	L	19.00000	--	22.29904	8	4330M	100
67-56-1	METHANOL	1	L	1.00000	--	1.17363	8	4330M	25
67-56-1	METHANOL	1	L	1.00000	--	1.17363	8	4330M	25
67-56-1	METHANOL	1	L	1.00000	--	1.17363	8	4330M	25
67-56-1	METHANOL	1	L	1.00000	--	1.17363	8	4330M	25
67-56-1	METHANOL	4	L	4.00000	--	4.69453	8	4316	25
67-56-1	METHANOL	4	L	4.00000	--	4.69453	8	4316	25
67-56-1	METHANOL	4	L	4.00000	--	4.69453	8	4310	25
67-56-1	METHANOL	4	L	4.00000	--	4.69453	8	4310	25

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Batch Assumptions:	*Annual Usage*	*Assumed Annual Batches*
	< 0.01 liter	*1*
	0.01-0.1 liter	*5*
	0.1-1.0 liter	*10*
	1.0-10 liter	*25*
	>10 liter	*100*

This list of chemicals comes from LBNL inventory data with solids & gases removed		*Entered Data*		*Calculated*	*Recalculated*	*Calculated*	*Entered Data*		*Calculated*
		Inventory Amount		**Inventory Amount**	**Inventory Amount**	**Annual Usage ***	**Building**	**Room**	**Estimated No. of Batches**
CAS No.	**Compound Name**	**Quantity**	**Units**	**(liters)**	**(liters)**	**(liters/yr)**			**(per year)**
67-56-1	METHANOL	1	L	1.00000	--	1.17363	8	4310	25
67-56-1	METHANOL	4	L	4.00000	--	4.69453	8	4310	25
67-56-1	METHANOL	4	L	4.00000	--	4.69453	8	4310	25
67-56-1	METHANOL	1	L	1.00000	--	1.17363	8	4310	25
67-56-1	METHANOL	1	L	1.00000	--	1.17363	8	4310	25
67-56-1	METHANOL	1	L	1.00000	--	1.17363	8	4310	25
67-56-1	METHANOL	1	L	1.00000	--	1.17363	8	4310	25
67-56-1	METHANOL	1	L	1.00000	--	1.17363	8	4310	25
67-56-1	METHANOL	1	L	1.00000	--	1.17363	8	4310	25
67-56-1	METHANOL	4	L	4.00000	--	4.69453	8	4310	25
67-56-1	METHANOL	4	L	4.00000	--	4.69453	8	4310	25
67-56-1	METHANOL	4	L	4.00000	--	4.69453	8	4310	25
67-56-1	METHANOL	4	L	4.00000	--	4.69453	8	4310	25
67-56-1	METHANOL	100	ML	0.10000	--	0.11736	8	4310	10
67-56-1	METHANOL	1	L	1.00000	--	1.17363	8	4310	25
67-56-1	METHANOL	4	L	4.00000	--	4.69453	8	4310	25
67-56-1	METHANOL	4	L	4.00000	--	4.69453	8	4310	25
67-56-1	METHANOL	4	L	4.00000	--	4.69453	8	4310	25
67-56-1	METHANOL	4	L	4.00000	--	4.69453	8	4310	25
67-56-1	METHANOL	4	L	4.00000	--	4.69453	8	4310	25
67-56-1	METHANOL	4	L	4.00000	--	4.69453	8	4310	25
67-56-1	METHANOL	4	L	4.00000	--	4.69453	8	4310	25
67-56-1	METHANOL	500	ML	0.50000	--	0.58682	8	4310	10
67-56-1	METHANOL	100	ML	0.10000	--	0.11736	8	4310	10
67-56-1	METHANOL	1	L	1.00000	--	1.17363	8	4310	25
67-56-1	METHANOL	500	ML	0.50000	--	0.58682	8	4310	10
67-56-1	METHANOL	4	L	4.00000	--	4.69453	8	4310	25
67-56-1	METHANOL	4	L	4.00000	--	4.69453	8	4310	25
67-56-1	METHANOL	2.5	L	2.50000	--	2.93408	8	4310	25
67-56-1	METHANOL	2.5	L	2.50000	--	2.93408	8	4310	25
67-56-1	METHANOL	2.5	L	2.50000	--	2.93408	8	4310	25
67-56-1	METHANOL	2.5	L	2.50000	--	2.93408	8	4310	25
67-56-1	METHANOL	4	L	4.00000	--	4.69453	8	4310	25
67-56-1	METHANOL	4	L	4.00000	--	4.69453	8	4310	25
67-56-1	METHANOL	4	L	4.00000	--	4.69453	8	4310	25
67-56-1	METHANOL	4	L	4.00000	--	4.69453	8	4308	25
67-56-1	METHANOL	1	L	1.00000	--	1.17363	8	4308	25
67-56-1	METHANOL	1	L	1.00000	--	1.17363	8	4308	25
67-56-1	METHANOL	4	L	4.00000	--	4.69453	8	4308	25
67-56-1	METHANOL	4	L	4.00000	--	4.69453	8	4308	25
67-56-1	METHANOL	4	L	4.00000	--	4.69453	8	4308	25
67-56-1	METHANOL	4	L	4.00000	--	4.69453	8	4308	25
67-56-1	HYDRA-POINT METHANOL, DRY	1	L	1.00000	--	1.17363	8	4302	25
67-56-1	HYDRA-POINT METHANOL, DRY	1	L	1.00000	--	1.17363	8	4302	25
67-56-1	AMMONIA 7N SOLUTION IN METHANOL	100	ML	0.10000	--	0.11736	8	4302	10
67-56-1	METHANOL	1	L	1.00000	--	1.17363	8	4302	25
67-56-1	METHANOL	1	L	1.00000	--	1.17363	8	4302	25
67-56-1	METHANOL	1	L	1.00000	--	1.17363	8	4302	25
67-56-1	METHANOL	1	L	1.00000	--	1.17363	8	4302	25
67-56-1	METHANOL	1	L	1.00000	--	1.17363	8	4302	25
67-56-1	METHANOL	1	L	1.00000	--	1.17363	8	4302	25
67-56-1	METHANOL	1	L	1.00000	--	1.17363	8	4302	25

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	< 0.01 liter	*1*
	0.01-0.1 liter	*5*
	0.1-1.0 liter	*10*
	1.0-10 liter	*25*
	>10 liter	*100*

This list of chemicals comes from LBNL inventory data with solids & gases removed		*Entered Data*		*Calculated*	*Recalculated*	*Calculated*	*Entered Data*		*Calculated*
		Inventory Amount		**Inventory Amount**	**Inventory Amount**	**Annual Usage ***	**Building**	**Room**	**Estimated No. of Batches**
CAS No.	**Compound Name**	**Quantity**	**Units**	**(liters)**	**(liters)**	**(liters/yr)**			**(per year)**
67-56-1	METHANOL	100	ML	0.10000	--	0.11736	8	4240	10
67-56-1	METHANOL	1	ML	0.00100	--	0.00117	8	3219	1
67-56-1	METHANOL	4	L	4.00000	--	4.69453	8	3219	25
67-56-1	METHANOL	1	L	1.00000	--	1.17363	8	3219	25
67-56-1	COMBI METHANOL	1	L	1.00000	--	1.17363	8	3219	25
67-56-1	METHANOL	1	L	1.00000	--	1.17363	6/7	0293	25
67-56-1	METHANOL	4	L	4.00000	--	4.69453	6/7	0286	25
67-56-1	METHANOL	4	L	4.00000	--	4.69453	6/7	0286	25
67-56-1	METHANOL	4	L	4.00000	--	4.69453	6/7	0286	25
67-56-1	METHANOL	1	L	1.00000	--	1.17363	6/7	0244	25
67-56-1	METHANOL	1	L	1.00000	--	1.17363	6/7	0244	25
67-56-1	METHYL ALCOHOL	1	L	1.00000	--	1.17363	6/7	0244	25
67-56-1	METHANOL	4	L	4.00000	--	4.69453	6/7	0239	25
67-56-1	METHANOL	4	GAL	15.14000	--	17.76881	6/7	00196	100
67-56-1	METHANOL	1	L	1.00000	--	1.17363	6/7	0128	25
67-56-1	METHANOL	4	L	4.00000	--	4.69453	6/7	0128	25
67-56-1	METHANOL	4	L	4.00000	--	4.69453	6/7	0128	25
67-56-1	METHANOL	4	L	4.00000	--	4.69453	6/7	0128	25
67-56-1	METHANOL	4	L	4.00000	--	4.69453	6/7	0128	25
67-56-1	METHANOL	4	L	4.00000	--	4.69453	6/7	0128	25
67-56-1	METHANOL	4	L	4.00000	--	4.69453	6/7	0128	25
67-56-1	METHANOL	2	L	2.00000	--	2.34727	6/7	0116	25
67-56-1	METHANOL	4	L	4.00000	--	4.69453	6/7	0116	25
67-56-1	METHANOL	4	L	4.00000	--	4.69453	6/7	0116	25
67-56-1	METHANOL	4	L	4.00000	--	4.69453	6/7	0106	25
67-56-1	METHANOL	5	L	5.00000	--	5.86817	6/7	0177	25
67-56-1	METHANOL	100	ML	0.10000	--	0.11736	6/7	0177	10
67-56-1	METHANOL	1	L	1.00000	--	1.17363	6/7	0177	25
67-56-1	METHANOL	4	L	4.00000	--	4.69453	6/7	0196	25
67-56-1	METHANOL	1	L	1.00000	--	1.17363	6/7	0244	25
67-56-1	METHANOL	1	L	1.00000	--	1.17363	6/7	0239	25
67-56-1	METHANOL	4	L	4.00000	--	4.69453	6/7	0204	25
67-56-1	METHANOL	4	L	4.00000	--	4.69453	6/7	0204	25
67-56-1	METHANOL	4	L	4.00000	--	4.69453	6/7	0204	25
67-56-1	METHANOL	4	L	4.00000	--	4.69453	6/7	0204	25
67-56-1	METHANOL	500	ML	0.50000	--	0.58682	6/7	0188C	10
67-56-1	METHANOL	4	L	4.00000	--	4.69453	6/7	0188C	25
67-56-1	METHANOL	1	L	1.00000	--	1.17363	6/7	0188C	25
67-56-1	METHANOL	4	L	4.00000	--	4.69453	6/7	0293	25
67-56-1	METHANOL	4	L	4.00000	--	4.69453	6/7	0271	25
67-56-1	METHANOL	100	ML	0.10000	--	0.11736	6/7	0240	10
67-56-1	METHANOL	500	ML	0.50000	--	0.58682	6/7	0295	10
67-56-1	METHANOL	4	L	4.00000	--	4.69453	6/7	0295	25
67-56-1	METHANOL	4	L	4.00000	--	4.69453	6/7	0187	25
67-56-1	METHANOL	4	L	4.00000	--	4.69453	6/7	0187	25
67-56-1	METHANOL	1	GAL	3.78500	--	4.44220	6/7	0109	25
67-56-1	METHANOL	4	L	4.00000	--	4.69453	6/7	0216	25
67-56-1	METHANOL	4	L	4.00000	--	4.69453	6/7	0216	25
67-56-1	METHANOL	4	L	4.00000	--	4.69453	6/7	0216	25
67-56-1	METHANOL	4	L	4.00000	--	4.69453	6/7	0216	25
67-56-1	METHANOL	2	L	2.00000	--	2.34727	6/7	0209A	25
67-56-1	METHANOL	4	L	4.00000	--	4.69453	6/7	0209	25
67-56-1	METHANOL	1	GAL	3.78500	--	4.44220	6/7	0209	25

* Equals inventory x (365 days per yr/311 days)
[311 days = 95th percentile lowest turnover rate for historic use]

Calculation of Liquid Chemical Emissions
Phase 1 Laboratory Usage Scenario
Proposed Richmond Bay Campus Long Range Development Plan, Richmond, California
Chemical Inventory Data (Table G-2)

Conservatively assume specific gravity of 0.7 for laboratory liquids (0.649 liter/lb) when units are in pounds

Batch Assumptions:	*Annual Usage*	*Assumed Annual Batches*
	< 0.01 liter	*1*
	0.01-0.1 liter	*5*
	0.1-1.0 liter	*10*
	1.0-10 liter	*25*
	>10 liter	*100*

This list of chemicals comes from LBNL inventory data with solids & gases removed		*Entered Data*		*Calculated*	*Recalculated*	*Calculated*	*Entered Data*		*Calculated*
		Inventory Amount		**Inventory Amount**	**Inventory Amount**	**Annual Usage ***	**Building**	**Room**	**Estimated No. of Batches**
CAS No.	**Compound Name**	**Quantity**	**Units**	**(liters)**	**(liters)**	**(liters/yr)**			**(per year)**
67-56-1	METHANOL	1	L	1.00000	--	1.17363	6/7	0220	25
67-56-1	METHANOL	500	ML	0.50000	--	0.58682	6/7	0220	10
67-56-1	METHANOL	1	L	1.00000	--	1.17363	6/7	0220	25
67-63-0	ISOPROPYL ALCOHOL (2)	60	L	60.00000	--	70.41801	9	0120A	100
67-63-0	ISOPROPYL ALCOHOL	1	L	1.00000	--	1.17363	9	0139	25
67-63-0	ISOPROPANOL	4	L	4.00000	--	4.69453	9	0139	25
67-63-0	ISOPROPYL ALCOHOL	15	OZ	0.44360	--	0.52063	9	0355K	10
67-63-0	ISOPROPYL ALCOHOL	16	OZ	0.47318	--	0.55534	9	0355K	10
67-63-0	ISOPROPANOL	250	ML	0.25000	--	0.29341	9	0412	10
67-63-0	ISOPROPYL ALCOHOL	250	ML	0.25000	--	0.29341	9	0412	10
67-63-0	ISOPROPYL ALCOHOL	100	KG	**Units**	127.38854	149.50744	9	0458	100
67-63-0	ISOPROPANOL	15	L	15.00000	--	17.60450	9	0459	100
67-63-0	ISOPROPYL ALCOHOL	4	L	4.00000	--	4.69453	9	0458	25
67-63-0	2-PROPANOL	500	ML	0.50000	--	0.58682	9	0459	10
67-63-0	ISOPROPYL ALCOHOL	1	KG	**Units**	1.27389	1.49507	9	0459	25
67-63-0	ISOPROPANOL	500	ML	0.50000	--	0.58682	9	0412	10
67-63-0	2-PROPANOL	500	ML	0.50000	--	0.58682	9	0459	10
67-63-0	ISOPROPYL ALCOHOL	500	ML	0.50000	--	0.58682	9	0412	10
67-63-0	ISOPROPYL ALCOHOL	250	ML	0.25000	--	0.29341	9	0413	10
67-63-0	2-PROPANOL	500	ML	0.50000	--	0.58682	9	0412	10
67-63-0	ISOPROPANOL	1	L	1.00000	--	1.17363	9	0458	25
67-63-0	2-PROPANOL	500	ML	0.50000	--	0.58682	9	0413	10
67-63-0	ISOPROPYL ALCOHOL	1	L	1.00000	--	1.17363	9	0446	25
67-63-0	ISOPROPANOL	500	ML	0.50000	--	0.58682	9	0446	10
67-63-0	2-PROPANOL	500	ML	0.50000	--	0.58682	9	0446	10
67-63-0	ISOPROPYL ALCOHOL	500	ML	0.50000	--	0.58682	9	0413	10
67-63-0	ISOPROPYL ALCOHOL	1	L	1.00000	--	1.17363	9	0412	25
67-63-0	2-PROPANOL	25	ML	0.02500	--	0.02934	9	0412	5
67-63-0	2-PROPANOL	25	ML	0.02500	--	0.02934	9	0412	5
67-63-0	2-PROPANOL	500	ML	0.50000	--	0.58682	9	0412	10
67-63-0	2-PROPANOL	25	ML	0.02500	--	0.02934	9	0412	5
67-63-0	2-PROPANOL	25	ML	0.02500	--	0.02934	9	0412	5
67-63-0	2-PROPANOL	25	ML	0.02500	--	0.02934	9	0412	5
67-63-0	2-PROPANOL	25	ML	0.02500	--	0.02934	9	0412	5
67-63-0	2-PROPANOL	25	ML	0.02500	--	0.02934	9	0412	5
67-63-0	2-PROPANOL	25	ML	0.02500	--	0.02934	9	0412	5
67-63-0	2-PROPANOL	25	ML	0.02500	--	0.02934	9	0412	5
67-63-0	ISOPROPYL ALCOHOL	1	L	1.00000	--	1.17363	9	0415A	25
67-63-0	2-PROPANOL	500	ML	0.50000	--	0.58682	9	0412	10
67-63-0	2-PROPANOL	500	ML	0.50000	--	0.58682	9	0412	10
67-63-0	2-PROPANOL	500	ML	0.50000	--	0.58682	9	0412	10
67-63-0	ISOPROPYL ALCOHOL	1	L	1.00000	--	1.17363	9	3223	25
67-63-0	ISOPROPYL ALCOHOL	1	L	1.00000	--	1.17363	9	3223	25
67-63-0	ISOPROPYL ALCOHOL	1	L	1.00000	--	1.17363	9	3223	25
67-63-0	ISOPROPYL ALCOHOL	1	L	1.00000	--	1.17363	9	3223	25
67-63-0	ISOPROPYL ALCOHOL	1	L	1.00000	--	1.17363	9	3223	25
67-63-0	ISOPROPYL ALCOHOL	1	L	1.00000	--	1.17363	9	3223	25
67-63-0	ISOPROPYL ALCOHOL	1	L	1.00000	--	1.17363	9	3223	25
67-63-0	2-PROPANOL	1	L	1.00000	--	1.17363	9	3219	25
67-63-0	ISOPROPYL ALCOHOL	4	L	4.00000	--	4.69453	8	4550	25
67-63-0	ISOPROPYL ALCOHOL	25	ML	0.02500	--	0.02934	8	4550	5
67-63-0	ISOPROPYL	1	G	**Units**	1.27389	1.49507	8	4550	25
67-63-0	2-PROPANOL	500	ML	0.50000	--	0.58682	8	4550	10

* Equals inventory x (365 days per yr/311 days)
[311 days = 95th percentile lowest turnover rate for historic use]

Golder Associates

Calculation of Liquid Chemical Emissions
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Proposed Richmond Bay Campus Long Range Development Plan, Richmond, California
Chemical Inventory Data (Table G-2)

Conservatively assume specific gravity of 0.7 for laboratory liquids (0.649 liter/lb) when units are in pounds

Batch Assumptions:	*Annual Usage*	*Assumed Annual Batches*
	< 0.01 liter	*1*
	0.01-0.1 liter	*5*
	0.1-1.0 liter	*10*
	1.0-10 liter	*25*
	>10 liter	*100*

This list of chemicals comes from LBNL inventory data with solids & gases removed		*Entered Data*		*Calculated*	*Recalculated*	*Calculated*	*Entered Data*		*Calculated*
		Inventory Amount		**Inventory Amount**	**Inventory Amount**	**Annual Usage ***	**Building**	**Room**	**Estimated No. of Batches**
CAS No.	**Compound Name**	**Quantity**	**Units**	**(liters)**	**(liters)**	**(liters/yr)**			**(per year)**
67-63-0	ISOPROPYL ALCOHOL	1	L	1.00000	--	1.17363	8	4550	25
67-63-0	ISOPROPYL ALCOHOL	1	L	1.00000	--	1.17363	8	4550	25
67-63-0	ISOPROPYL ALCOHOL	1	L	1.00000	--	1.17363	8	4550	25
67-63-0	ISOPROPYL ALCOHOL	1	L	1.00000	--	1.17363	8	4550	25
67-63-0	ISOPROPYL ALCOHOL	1	L	1.00000	--	1.17363	8	4550	25
67-63-0	ISOPROPYL ALCOHOL	1	L	1.00000	--	1.17363	8	4550	25
67-63-0	2-PROPANOL	500	ML	0.50000	--	0.58682	8	4524	10
67-63-0	ISOPROPYL ALCOHOL	2	L	2.00000	--	2.34727	8	4524	25
67-63-0	ISOPROPYL ALCOHOL	4	L	4.00000	--	4.69453	8	4440	25
67-63-0	2-PROPANOL	500	ML	0.50000	--	0.58682	8	4440	10
67-63-0	2-PROPANOL	25	ML	0.02500	--	0.02934	8	4440	5
67-63-0	2-PROPANOL	1	GAL	3.78500	--	4.44220	8	4440	25
67-63-0	2-PROPANOL	1	GAL	3.78500	--	4.44220	8	4440	25
67-63-0	ISOPROPANOL	1	L	1.00000	--	1.17363	8	4440	25
67-63-0	ISOPROPANOL	1	L	1.00000	--	1.17363	8	4440	25
67-63-0	ISOPROPANOL	4	L	4.00000	--	4.69453	8	4410	25
67-63-0	ISOPROPYL ALCOHOL	4	L	4.00000	--	4.69453	8	4340	25
67-63-0	ISOPROPYL ALCOHOL	4	L	4.00000	--	4.69453	8	4340	25
67-63-0	ISOPROPYL ALCOHOL	4	L	4.00000	--	4.69453	8	4340	25
67-63-0	ISOPROPYL ALCOHOL	4	L	4.00000	--	4.69453	8	4340	25
67-63-0	ISOPROPYL ALCOHOL	5	L	5.00000	--	5.86817	8	4310	25
67-63-0	ISOPROPANOL	4	L	4.00000	--	4.69453	8	4308	25
67-63-0	ISOPROPANOL	4	L	4.00000	--	4.69453	8	4308	25
67-63-0	2-PROPANOL	5	L	5.00000	--	5.86817	8	4308	25
67-63-0	ISOPROPANOL	4	L	4.00000	--	4.69453	8	4302	25
67-63-0	ISOPROPANOL	4	L	4.00000	--	4.69453	8	4302	25
67-63-0	2-PROPANOL	4	L	4.00000	--	4.69453	8	4302	25
67-63-0	ISOPROPYL ALCOHOL	1	L	1.00000	--	1.17363	8	3202D	25
67-63-0	ISOPROPYL ALCOHOL	1	L	1.00000	--	1.17363	8	3223	25
67-63-0	ISOPROPYL ALCOHOL	1	L	1.00000	--	1.17363	8	3223	25
67-63-0	ISOPROPYL ALCOHOL	1	L	1.00000	--	1.17363	8	3223	25
67-63-0	ISOPROPYL ALCOHOL	1	L	1.00000	--	1.17363	8	3223	25
67-63-0	ISOPROPYL ALCOHOL	1	L	1.00000	--	1.17363	8	3223	25
67-63-0	ISOPROPYL ALCOHOL	1	L	1.00000	--	1.17363	8	3223	25
67-63-0	2-PROPANOL	1	L	1.00000	--	1.17363	8	3219	25
67-63-0	2-PROPANOL	1	L	1.00000	--	1.17363	6/7	0166	25
67-63-0	2-PROPANOL	500	ML	0.50000	--	0.58682	6/7	0166	10
67-63-0	ISOPROPYL ALCOHOL	500	ML	0.50000	--	0.58682	6/7	0166	10
67-63-0	2-PROPANOL	500	ML	0.50000	--	0.58682	6/7	0166	10
67-63-0	ISOPROPYL ALCOHOL	4	L	4.00000	--	4.69453	6/7	0293	25
67-63-0	ISOPROPYL ALCOHOL	4	L	4.00000	--	4.69453	6/7	0293	25
67-63-0	ISOPROPYL ALCOHOL	500	ML	0.50000	--	0.58682	6/7	0293	10
67-63-0	ISOPROPYL ALCOHOL	4	L	4.00000	--	4.69453	6/7	0271	25
67-63-0	ISOPROPYL ALCOHOL	4	L	4.00000	--	4.69453	6/7	0271	25
67-63-0	ISOPROPYL ALCOHOL	4	L	4.00000	--	4.69453	6/7	0271	25
67-63-0	ISOPROPYL ALCOHOL	500	ML	0.50000	--	0.58682	6/7	0244	10
67-63-0	2-PROPANOL	1	L	1.00000	--	1.17363	6/7	0244	25
67-63-0	2-PROPANOL	1	L	1.00000	--	1.17363	6/7	0196A	25
67-63-0	ISOPROPANOL	1	L	1.00000	--	1.17363	6/7	0196A	25
67-63-0	ISOPROPANOL	1	L	1.00000	--	1.17363	6/7	0196A	25
67-63-0	ISOPROPYL ALCOHOL	1	L	1.00000	--	1.17363	6/7	0196	25
67-63-0	ISOPROPYL ALCOHOL	25	ML	0.02500	--	0.02934	6/7	0128	5

* Equals inventory x (365 days per yr/311 days)
[311 days = 95th percentile lowest turnover rate for historic use]

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Conservatively assume specific gravity of 0.7 for laboratory liquids (0.649 liter/lb) when units are in pounds

Batch Assumptions:	*Annual Usage*	*Assumed Annual Batches*
	< 0.01 liter	*1*
	0.01-0.1 liter	*5*
	0.1-1.0 liter	*10*
	1.0-10 liter	*25*
	>10 liter	*100*

This list of chemicals comes from LBNL inventory data with solids & gases removed		*Entered Data*		*Calculated*	*Recalculated*	*Calculated*	*Entered Data*		*Calculated*
		Inventory Amount		**Inventory Amount**	**Inventory Amount**	**Annual Usage ***	**Building**	**Room**	**Estimated No. of Batches (per year)**
CAS No.	**Compound Name**	**Quantity**	**Units**	**(liters)**	**(liters)**	**(liters/yr)**			
67-63-0	ISOPROPYL ALCOHOL	25	ML	0.02500	--	0.02934	6/7	0128	5
67-63-0	ISOPROPYL ALCOHOL	25	ML	0.02500	--	0.02934	6/7	0128	5
67-63-0	ISOPROPYL ALCOHOL	25	ML	0.02500	--	0.02934	6/7	0128	5
67-63-0	ISOPROPYL ALCOHOL	25	ML	0.02500	--	0.02934	6/7	0128	5
67-63-0	ISOPROPYL ALCOHOL	25	ML	0.02500	--	0.02934	6/7	0128	5
67-63-0	ISOPROPYL ALCOHOL	25	ML	0.02500	--	0.02934	6/7	0128	5
67-63-0	ISOPROPANOL ALCOHOL	4	L	4.00000	--	4.69453	6/7	0128	25
67-63-0	ISOPROPANOL ALCOHOL	4	L	4.00000	--	4.69453	6/7	0128	25
67-63-0	2-PROPANOL	25	ML	0.02500	--	0.02934	6/7	0128	5
67-63-0	2-PROPANOL	25	ML	0.02500	--	0.02934	6/7	0128	5
67-63-0	2-PROPANOL	1	GAL	3.78500	--	4.44220	6/7	0128	25
67-63-0	2-PROPANOL	25	ML	0.02500	--	0.02934	6/7	0128	5
67-63-0	2-PROPANOL	1	GAL	3.78500	--	4.44220	6/7	0128	25
67-63-0	2-PROPANOL	4	L	4.00000	--	4.69453	6/7	0128	25
67-63-0	2-PROPANOL	25	ML	0.02500	--	0.02934	6/7	0128	5
67-63-0	2-PROPANOL	25	ML	0.02500	--	0.02934	6/7	0128	5
67-63-0	2-PROPANOL	25	ML	0.02500	--	0.02934	6/7	0128	5
67-63-0	2-PROPANOL	25	ML	0.02500	--	0.02934	6/7	0128	5
67-63-0	ISOPROPYL ALCOHOL	500	ML	0.50000	--	0.58682	6/7	0128	10
67-63-0	ISOPROPYL ALCOHOL	500	ML	0.50000	--	0.58682	6/7	0128	10
67-63-0	ISOPROPANOL	1	L	1.00000	--	1.17363	6/7	0196A	25
67-63-0	2-PROPANOL	500	ML	0.50000	--	0.58682	6/7	0116	10
67-63-0	2-PROPANOL	500	ML	0.50000	--	0.58682	6/7	0116	10
67-63-0	2-PROPANOL	500	ML	0.50000	--	0.58682	6/7	0116	10
67-63-0	2-PROPANOL	25	ML	0.02500	--	0.02934	6/7	0116	5
67-63-0	2-PROPANOL	2	L	2.00000	--	2.34727	6/7	0116	25
67-63-0	ISOPROPYL ALCOHOL	1	L	1.00000	--	1.17363	6/7	0177	25
67-63-0	ISOPROPANOL	250	ML	0.25000	--	0.29341	6/7	0177	10
67-63-0	ISOPROPYL ALCOHOL	1	L	1.00000	--	1.17363	6/7	0177	25
67-63-0	ISOPROPYL ALCOHOL	1	L	1.00000	--	1.17363	6/7	0177	25
67-63-0	2-PROPANOL	4	L	4.00000	--	4.69453	6/7	0196	25
67-63-0	ISOPROPYL ALCOHOL	500	ML	0.50000	--	0.58682	6/7	0239	10
67-63-0	MICROSHARP CLEANING FLUID	236	ML	0.23600	--	0.27698	6/7	0204	10
67-63-0	MICROSHARP CLEANING FLUID	236	ML	0.23600	--	0.27698	6/7	0204	10
67-63-0	MICROSHARP CLEANING FLUID	236	ML	0.23600	--	0.27698	6/7	0204	10
67-63-0	MICROSHARP CLEANING FLUID	236	ML	0.23600	--	0.27698	6/7	0204	10
67-63-0	MICROSHARP CLEANING FLUID	236	ML	0.23600	--	0.27698	6/7	0204	10
67-63-0	ISOPROPANOL	500	ML	0.50000	--	0.58682	6/7	0188C	10
67-63-0	2-PROPANOL	500	ML	0.50000	--	0.58682	6/7	0188C	10
67-63-0	ISOPROPANOL	25	ML	0.02500	--	0.02934	6/7	0188C	5
67-63-0	ISOPROPANOL	25	ML	0.02500	--	0.02934	6/7	0188C	5
67-63-0	2-PROPANOL	500	ML	0.50000	--	0.58682	6/7	0188C	10
67-63-0	2-PROPANOL	500	ML	0.50000	--	0.58682	6/7	0188C	10
67-63-0	2-PROPANOL	500	ML	0.50000	--	0.58682	6/7	0188C	10
67-63-0	2-PROPANOL	500	ML	0.50000	--	0.58682	6/7	0188C	10
67-63-0	ISOPROPANOL	500	ML	0.50000	--	0.58682	6/7	0293	10
67-63-0	N-HYDROXYSUCCINIMIDYL-ACTIVATED AGAROSE	5	ML	0.00500	--	0.00587	6/7	0287	1
67-63-0	2-PROPANOL	4	L	4.00000	--	4.69453	6/7	0287	25
67-63-0	ISOPROPYL ALCOHOL	4	L	4.00000	--	4.69453	6/7	0271	25
67-63-0	ISOPROPANOL	500	ML	0.50000	--	0.58682	6/7	0240	10
67-63-0	ISOPROPYL ALCOHOL	100	ML	0.10000	--	0.11736	6/7	0239	10
67-63-0	ISOPROPANOL	500	ML	0.50000	--	0.58682	6/7	0239	10
67-63-0	ISOPROPANOL	500	ML	0.50000	--	0.58682	6/7	0295	10

* Equals inventory x (365 days per yr/311 days)
[311 days = 95th percentile lowest turnover rate for historic use]

Golder Associates

Calculation of Liquid Chemical Emissions
Phase 1 Laboratory Usage Scenario
Proposed Richmond Bay Campus Long Range Development Plan, Richmond, California
Chemical Inventory Data (Table G-2)

Conservatively assume specific gravity of 0.7 for laboratory liquids (0.649 liter/lb) when units are in pounds

Batch Assumptions:	*Annual Usage*	*Assumed Annual Batches*
	< 0.01 liter	*1*
	0.01-0.1 liter	*5*
	0.1-1.0 liter	*10*
	1.0-10 liter	*25*
	>10 liter	*100*

This list of chemicals comes from LBNL inventory data with solids & gases removed		*Entered Data*		*Calculated*	*Recalculated*	*Calculated*	*Entered Data*		*Calculated*
		Inventory Amount		**Inventory Amount**	**Inventory Amount**	**Annual Usage ***	**Building**	**Room**	**Estimated No. of Batches**
CAS No.	**Compound Name**	**Quantity**	**Units**	**(liters)**	**(liters)**	**(liters/yr)**			**(per year)**
67-63-0	2-PROPANOL	1	L	1.00000	--	1.17363	6/7	0295	25
67-63-0	ISOPROPYL ALCOHOL	1	L	1.00000	--	1.17363	6/7	0240	25
67-63-0	2-PROPANOL	25	ML	0.02500	--	0.02934	6/7	0106	5
67-63-0	ISOPROPYL ALCOHOL	25	ML	0.02500	--	0.02934	6/7	0128	5
67-63-0	ISOPROPYL ALCOHOL	25	ML	0.02500	--	0.02934	6/7	0128	5
67-63-0	ISOPROPYL ALCOHOL	25	ML	0.02500	--	0.02934	6/7	0128	5
67-63-0	ISOPROPYL ALCOHOL	25	ML	0.02500	--	0.02934	6/7	0128	5
67-63-0	ISOPROPYL ALCOHOL	25	ML	0.02500	--	0.02934	6/7	0128	5
67-63-0	ISOPROPANOL	1	L	1.00000	--	1.17363	6/7	0187	25
67-63-0	ISOPROPYL ALCOHOL	1	L	1.00000	--	1.17363	6/7	0166	25
67-63-0	2-PROPANOL	25	ML	0.02500	--	0.02934	6/7	0109	5
67-63-0	ISOPROPYL ALCOHOL	2.5	L	2.50000	--	2.93408	6/7	0217	25
67-63-0	ISOPROPYL ALCOHOL	8	L	8.00000	--	9.38907	6/7	0216	25
67-63-0	2-PROPANOL	1	L	1.00000	--	1.17363	6/7	0209	25
67-63-0	ISOPROPYL ALCOHOL	500	ML	0.50000	--	0.58682	6/7	0208	10
67-63-0	ISOPROPYL ALCOHOL	500	ML	0.50000	--	0.58682	6/7	0220	10
67-63-0	ISOPROPYL ALCOHOL	500	ML	0.50000	--	0.58682	6/7	0220	10
67-63-0	ISOPROPYL ALCOHOL	4	L	4.00000	--	4.69453	6/7	0220	25
67-63-0	ISOPROPYL ALCOHOL	4	L	4.00000	--	4.69453	6/7	0220	25
67-63-0	ISOPROPYL ALCOHOL	500	ML	0.50000	--	0.58682	6/7	0220	10
67-63-0	ISOPROPANOL	25	ML	0.02500	--	0.02934	6/7	0220	5
67-63-0	ISOPROPYL ALCOHOL	1	L	1.00000	--	1.17363	6/7	0220	25
67-63-0	ISOPROPYL ALCOHOL	2	L	2.00000	--	2.34727	6/7	0220	25
67-66-3	CHLOROFORM	100	ML	0.10000	--	0.11736	9	0139	10
67-66-3	CHLOROFORM	500	ML	0.50000	--	0.58682	9	0139	10
67-66-3	CHLOROFORM:ISOAMYL ALCOHOL 24:1	500	ML	0.50000	--	0.58682	9	0412	10
67-66-3	CHLOROFORM ISOAMYL ALCOHOL	100	ML	0.10000	--	0.11736	9	0412	10
67-66-3	CHLOROFORM	500	ML	0.50000	--	0.58682	9	0459	10
67-66-3	CHLOROFORM ISOAMYL ALCOHOL	500	ML	0.50000	--	0.58682	9	0459	10
67-66-3	CHLOROFORM ISOAMYL ALCOHOL	500	ML	0.50000	--	0.58682	9	0459	10
67-66-3	CHLOROFORM	500	ML	0.50000	--	0.58682	9	0459	10
67-66-3	CHLOROFORM:ISOAMYL ALCOHOL 24:1	100	ML	0.10000	--	0.11736	9	0459	10
67-66-3	CHLOROFORM	1	L	1.00000	--	1.17363	9	0446	25
67-66-3	CHLOROFORM	1	L	1.00000	--	1.17363	9	0446	25
67-66-3	CHLOROFORM	500	ML	0.50000	--	0.58682	9	0413	10
67-66-3	CHLOROFORM	1	L	1.00000	--	1.17363	9	0412	25
67-66-3	CHLOROFORM	500	ML	0.50000	--	0.58682	9	0413	10
67-66-3	CHLOROFORM	500	ML	0.50000	--	0.58682	9	0459	10
67-66-3	CHLOROFORM	25	ML	0.02500	--	0.02934	9	0459	5
67-66-3	CHLOROFORM:ISOAMYL ALCOHOL 24:1	1	QT	0.94635	--	1.11067	9	0446	25
67-66-3	CHLOROFORM: ISOAMYL ALCOHOL MIXTURE	500	ML	0.50000	--	0.58682	9	0446	10
67-66-3	CHLOROFORM	25	ML	0.02500	--	0.02934	9	0412	5
67-66-3	CHLOROFORM	400	ML	0.40000	--	0.46945	9	0459	10
67-66-3	CHLOROFORM	400	ML	0.40000	--	0.46945	9	0459	10
67-66-3	CHLOROFORM	500	ML	0.50000	--	0.58682	9	0446	10
67-66-3	CHLOROFORM	500	ML	0.50000	--	0.58682	9	0446	10
67-66-3	CHLOROFORM	1	PT	0.47318	--	0.55534	9	0459	10
67-66-3	CHLOROFORM	1	PT	0.47318	--	0.55534	9	0459	10
67-66-3	CHLOROFORM	500	ML	0.50000	--	0.58682	9	0412	10
67-66-3	CHLOROFORM	500	ML	0.50000	--	0.58682	9	0412	10
67-66-3	CHLOROFORM	500	ML	0.50000	--	0.58682	9	0412	10
67-66-3	CHLOROFORM	4	L	4.00000	--	4.69453	9	3219	25
67-66-3	CHLOROFORM HPLC PURE	1	L	1.00000	--	1.17363	9	3219	25

* Equals inventory x (365 days per yr/311 days)
[311 days = 95th percentile lowest turnover rate for historic use]

Golder Associates

Calculation of Liquid Chemical Emissions
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Chemical Inventory Data (Table G-2)

Conservatively assume specific gravity of 0.7 for laboratory liquids (0.649 liter/lb) when units are in pounds

Batch Assumptions:	*Annual Usage*	*Assumed Annual Batches*
	< 0.01 liter	*1*
	0.01-0.1 liter	*5*
	0.1-1.0 liter	*10*
	1.0-10 liter	*25*
	>10 liter	*100*

This list of chemicals comes from LBNL inventory data with solids & gases removed		*Entered Data*		*Calculated*	*Recalculated*	*Calculated*	*Entered Data*		*Calculated*
		Inventory Amount		**Inventory Amount**	**Inventory Amount**	**Annual Usage ***	**Building**	**Room**	**Estimated No. of Batches (per year)**
CAS No.	**Compound Name**	**Quantity**	**Units**	**(liters)**	**(liters)**	**(liters/yr)**			
67-66-3	CHLOROFORM	4	L	4.00000	--	4.69453	8	4550	25
67-66-3	CHLOROFORM:ISOAMYL ALCOHOL MIXTURE	100	ML	0.10000	--	0.11736	8	4550	10
67-66-3	CHLOROFORM	25	ML	0.02500	--	0.02934	8	4550	5
67-66-3	CHLOROFORM	100	ML	0.10000	--	0.11736	8	4550	10
67-66-3	CHLOROFORM	1	L	1.00000	--	1.17363	8	4550	25
67-66-3	CHLOROFORM	500	ML	0.50000	--	0.58682	8	4550	10
67-66-3	CHLOROFORM	1	L	1.00000	--	1.17363	8	4550	25
67-66-3	CHLOROFORM	50	G	**Units**	0.03372	0.03957	8	4525	5
67-66-3	CHLOROFORM	25	ML	0.02500	--	0.02934	8	4524	5
67-66-3	CHLOROFORM	25	ML	0.02500	--	0.02934	8	4524	5
67-66-3	CHLOROFORM	25	ML	0.02500	--	0.02934	8	4524	5
67-66-3	CHLOROFORM	4	L	4.00000	--	4.69453	8	4440	25
67-66-3	CHLOROFORM	2	L	2.00000	--	2.34727	8	4440	25
67-66-3	CHLOROFORM	500	ML	0.50000	--	0.58682	8	4440	10
67-66-3	CHLOROFORM: ISOAMYL ALCOHOL	500	ML	0.50000	--	0.58682	8	4440	10
67-66-3	CHLOROFORM: ISOAMYL ALCOHOL	500	ML	0.50000	--	0.58682	8	4440	10
67-66-3	CHLOROFORM	4	L	4.00000	--	4.69453	8	4440	25
67-66-3	CHLOROFORM:ISOAMYL ALCOHOL	100	ML	0.10000	--	0.11736	8	4440	10
67-66-3	CHLOROFORM:ISOAMYL ALCOHOL 24:1	500	ML	0.50000	--	0.58682	8	4440	10
67-66-3	CHLOROFORM	1	L	1.00000	--	1.17363	8	4440	25
67-66-3	CHLOROFORM	500	ML	0.50000	--	0.58682	8	4330P	10
67-66-3	CHLOROFORM	1	L	1.00000	--	1.17363	8	4310	25
67-66-3	CHLOROFORM	2	L	2.00000	--	2.34727	8	4310	25
67-66-3	CHLOROFORM	2.5	L	2.50000	--	2.93408	8	4310	25
67-66-3	CHLOROFORM	2.5	L	2.50000	--	2.93408	8	4310	25
67-66-3	CHLOROFORM	2.5	L	2.50000	--	2.93408	8	4302	25
67-66-3	CHLOROFORM	500	ML	0.50000	--	0.58682	8	4230M	10
67-66-3	CHLOROFORM	500	ML	0.50000	--	0.58682	8	4230M	10
67-66-3	CHLOROFORM	500	ML	0.50000	--	0.58682	8	4230M	10
67-66-3	CHLOROFORM:ISOAMYL ALCOHOL	1	PT	0.47318	--	0.55534	8	3202D	10
67-66-3	CHLOROFORM	4	L	4.00000	--	4.69453	8	3219	25
67-66-3	CHLOROFORM HPLC PURE	1	L	1.00000	--	1.17363	8	3219	25
67-66-3	CHLOROFORM	100	ML	0.10000	--	0.11736	6/7	0166	10
67-66-3	TRICHLOROMETHANE	25	ML	0.02500	--	0.02934	6/7	0166	5
67-66-3	CHLOROFORM	25	ML	0.02500	--	0.02934	6/7	0166	5
67-66-3	CHLOROFORM	25	ML	0.02500	--	0.02934	6/7	0166	5
67-66-3	CHLOROFORM: ISOAMYL ALCOHOL MIXTURE	450	ML	0.45000	--	0.52814	6/7	0293	10
67-66-3	CHLOROFORM	500	ML	0.50000	--	0.58682	6/7	0293	10
67-66-3	CHLOROFORM	500	ML	0.50000	--	0.58682	6/7	0293	10
67-66-3	CHLOROFORM	500	ML	0.50000	--	0.58682	6/7	0244	10
67-66-3	CHLOROFORM	100	G	**Units**	0.06743	0.07914	6/7	0244	5
67-66-3	CHLOROFORM	1	QT	0.94635	--	1.11067	6/7	0128	25
67-66-3	CHLOROFORM	500	ML	0.50000	--	0.58682	6/7	0128	10
67-66-3	CHLOROFORM	500	ML	0.50000	--	0.58682	6/7	0128	10
67-66-3	CHLOROFORM	500	ML	0.50000	--	0.58682	6/7	0128	10
67-66-3	CHLOROFORM	4	L	4.00000	--	4.69453	6/7	0128	25
67-66-3	CHLOROFORM	4	L	4.00000	--	4.69453	6/7	0128	25
67-66-3	CHLOROFORM	4	L	4.00000	--	4.69453	6/7	0128	25
67-66-3	CHLOROFORM/ISOAMYL ALCOHOL	50	ML	0.05000	--	0.05868	6/7	0128	5
67-66-3	CHLOROFORM	1	L	1.00000	--	1.17363	6/7	0196A	25
67-66-3	CHLOROFORM	500	ML	0.50000	--	0.58682	6/7	0196A	10
67-66-3	CHLOROFORM	500	ML	0.50000	--	0.58682	6/7	0196A	10
67-66-3	CHLOROFORM	500	ML	0.50000	--	0.58682	6/7	0196A	10

* Equals inventory x (365 days per yr/311 days)
[311 days = 95th percentile lowest turnover rate for historic use]

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Chemical Inventory Data (Table G-2)

Conservatively assume specific gravity of 0.7 for laboratory liquids (0.649 liter/lb) when units are in pounds

Batch Assumptions:	*Annual Usage*	*Assumed Annual Batches*
	< 0.01 liter	*1*
	0.01-0.1 liter	*5*
	0.1-1.0 liter	*10*
	1.0-10 liter	*25*
	>10 liter	*100*

This list of chemicals comes from LBNL inventory data with solids & gases removed		*Entered Data*		*Calculated*	*Recalculated*	*Calculated*	*Entered Data*		*Calculated*
		Inventory Amount		**Inventory Amount**	**Inventory Amount**	**Annual Usage ***	**Building**	**Room**	**Estimated No. of Batches (per year)**
CAS No.	**Compound Name**	**Quantity**	**Units**	**(liters)**	**(liters)**	**(liters/yr)**			
67-66-3	CHLOROFORM	500	ML	0.50000	--	0.58682	6/7	0116	10
67-66-3	CHLOROFORM	500	ML	0.50000	--	0.58682	6/7	0116	10
67-66-3	CHLOROFORM	4	L	4.00000	--	4.69453	6/7	0177	25
67-66-3	CHLOROFORM	500	ML	0.50000	--	0.58682	6/7	0177	10
67-66-3	CHLOROFORM	25	ML	0.02500	--	0.02934	6/7	0177	5
67-66-3	CHLOROFORM	25	ML	0.02500	--	0.02934	6/7	0177	5
67-66-3	CHLOROFORM	25	ML	0.02500	--	0.02934	6/7	0177	5
67-66-3	CHLOROFORM	500	ML	0.50000	--	0.58682	6/7	0244	10
67-66-3	CHLOROFORM	4	L	4.00000	--	4.69453	6/7	0204	25
67-66-3	CHLOROFORM	500	ML	0.50000	--	0.58682	6/7	0204	10
67-66-3	CHLOROFORM	500	ML	0.50000	--	0.58682	6/7	0204	10
67-66-3	CHLOROFORM	500	ML	0.50000	--	0.58682	6/7	0204	10
67-66-3	CHLOROFORM	500	ML	0.50000	--	0.58682	6/7	0204	10
67-66-3	CHLOROFORM	25	ML	0.02500	--	0.02934	6/7	0188C	5
67-66-3	CHLOROFORM	1000	ML	1.00000	--	1.17363	6/7	0188C	25
67-66-3	CHLOROFORM	25	ML	0.02500	--	0.02934	6/7	0287	5
67-66-3	CHLOROFORM	100	ML	0.10000	--	0.11736	6/7	0287	10
67-66-3	CHLOROFORM	25	ML	0.02500	--	0.02934	6/7	0287	5
67-66-3	CHLOROFORM	500	ML	0.50000	--	0.58682	6/7	0239	10
67-66-3	CHLOROFORM	500	ML	0.50000	--	0.58682	6/7	0239	10
67-66-3	CHLOROFORM	950	ML	0.95000	--	1.11495	6/7	0295	25
67-66-3	CHLOROFORM	500	ML	0.50000	--	0.58682	6/7	0295	10
67-66-3	CHLOROFORM	25	ML	0.02500	--	0.02934	6/7	0295	5
67-66-3	CHLOROFORM	500	ML	0.50000	--	0.58682	6/7	0128	10
67-66-3	CHLOROFORM	25	ML	0.02500	--	0.02934	6/7	0109	5
67-66-3	CHLOROFORM	1	L	1.00000	--	1.17363	6/7	0217	25
67-66-3	CHLOROFORM	1	L	1.00000	--	1.17363	6/7	0216	25
67-66-3	CHLOROFORM	25	ML	0.02500	--	0.02934	6/7	0209	5
67-66-3	CHLOROFORM	500	ML	0.50000	--	0.58682	6/7	0209	10
67-66-3	CHLOROFORM	500	ML	0.50000	--	0.58682	6/7	0220	10
67-66-3	CHLOROFORM	500	ML	0.50000	--	0.58682	6/7	0220	10
68-12-2	N-N-DIMETHYLFOMAMIDE	100	ML	0.10000	--	0.11736	9	0446	10
68-12-2	N,N-DIMETHYLFORMAMIDE	500	ML	0.50000	--	0.58682	8	4550	10
68-12-2	N,N-DIMETHYLFORMAMIDE	1	L	1.00000	--	1.17363	8	4550	25
68-12-2	N,N-DIMETHYLFORMAMIDE	250	ML	0.25000	--	0.29341	8	4440	10
68-12-2	N,N-DIMETHYLFORMAMIDE	2	L	2.00000	--	2.34727	8	4440	25
68-12-2	N-N-DIMETHYL FORMAMIDE	4	L	4.00000	--	4.69453	8	4310	25
68-12-2	N,N-DIMETHYLFORMAMIDE	1	L	1.00000	--	1.17363	8	4310	25
68-12-2	N,N-DIMETHYLFORMAMIDE, ANHYDROUS	1	L	1.00000	--	1.17363	8	4310	25
68-12-2	DMF	500	ML	0.50000	--	0.58682	8	4208	10
68-12-2	DMF	500	ML	0.50000	--	0.58682	6/7	0166	10
68-12-2	DMF	1	L	1.00000	--	1.17363	6/7	0166	25
68-12-2	DMF	250	ML	0.25000	--	0.29341	6/7	0166	10
68-12-2	DIMETHYLFORMAMIDE	500	ML	0.50000	--	0.58682	6/7	0293	10
68-12-2	DMF	1	ML	0.00100	--	0.00117	6/7	0239	1
68-12-2	DMF	250	ML	0.25000	--	0.29341	6/7	0209	10
68-12-2	DMF	500	ML	0.50000	--	0.58682	6/7	0128	10
68-12-2	DIMETHYLFORMAMIDE	500	ML	0.50000	--	0.58682	6/7	0128	10
68-12-2	DIMETHYL-FORMAMIDE	250	ML	0.25000	--	0.29341	6/7	0196A	10
68-12-2	DIMETHYL-FORMAMIDE	250	ML	0.25000	--	0.29341	6/7	0116	10
68-12-2	DIMETHYLFORMAMIDE	250	ML	0.25000	--	0.29341	6/7	0116	10
68-12-2	DIMETHYLFORMAMIDE	1	L	1.00000	--	1.17363	6/7	0177	25
68-12-2	DMF	1	L	1.00000	--	1.17363	6/7	0177	25

* Equals inventory x (365 days per yr/311 days)
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Conservatively assume specific gravity of 0.7 for laboratory liquids (0.649 liter/lb) when units are in pounds

Batch Assumptions:	*Annual Usage*	*Assumed Annual Batches*
	< 0.01 liter	*1*
	0.01-0.1 liter	*5*
	0.1-1.0 liter	*10*
	1.0-10 liter	*25*
	>10 liter	*100*

This list of chemicals comes from LBNL inventory data with solids & gases removed		*Entered Data*		*Calculated*	*Recalculated*	*Calculated*	*Entered Data*		*Calculated*
		Inventory Amount		**Inventory Amount**	**Inventory Amount**	**Annual Usage ***	**Building**	**Room**	**Estimated No. of Batches**
CAS No.	**Compound Name**	**Quantity**	**Units**	**(liters)**	**(liters)**	**(liters/yr)**			**(per year)**
68-12-2	N, N-DIMETHYLFORMAMIDE, REAGENT GRADE	100	ML	0.10000	--	0.11736	6/7	0239	10
68-12-2	N,N-DIMETHYLFORMAMIDE	100	ML	0.10000	--	0.11736	6/7	0188F	10
68-12-2	DIMETHYLFORMAMIDE	100	ML	0.10000	--	0.11736	6/7	0188C	10
68-12-2	N,N-DIMETHYL FORMAMIDE	100	ML	0.10000	--	0.11736	6/7	0239	10
68-12-2	N,N'-DIMETHYL FORMAMIDE	1	L	1.00000	--	1.17363	6/7	0239	25
68-12-2	N,N-DIMETHYLFORMAMIDE	500	ML	0.50000	--	0.58682	6/7	0295	10
68-12-2	DMF	500	ML	0.50000	--	0.58682	6/7	0239	10
68-12-2	DMF	500	CC	**Units**	0.50000	0.58682	6/7	0220	10
68-12-2	DMF	500	ML	0.50000	--	0.58682	6/7	0220	10
68-12-2	N,N-DIMETHYLFORMAMIDE	250	ML	0.25000	--	0.29341	6/7	0220	10
71-43-2	BENZENE	1	L	1.00000	--	1.17363	9	0139	25
71-43-2	BENZENE(ANHYDROUS)	1	L	1.00000	--	1.17363	8	4310	25
71-43-2	BENZENE(ANHYDROUS)	2	L	2.00000	--	2.34727	8	4208	25
71-43-2	BENZENE	100	ML	0.10000	--	0.11736	8	4208	10
71-43-2	BENZENE	1	L	1.00000	--	1.17363	6/7	0244	25
75-07-0	ACETALDEHYDE	5	ML	0.00500	--	0.00587	8	4550	1
75-07-0	ACETALDEHYDE	100	ML	0.10000	--	0.11736	8	4550	10
75-07-0	ACETALDEHYDE	100	ML	0.10000	--	0.11736	8	4440	10
75-09-2	DICHLOROMETHANE	100	ML	0.10000	--	0.11736	9	0446	10
75-09-2	METHYLENE CHLORIDE	4	L	4.00000	--	4.69453	8	4550	25
75-09-2	DICHLOROMETHANE	19	L	19.00000	--	22.29904	8	4550	100
75-09-2	TO BE VALIDATED-DICHLOROME, ANHYDROUS	100	ML	0.10000	--	0.11736	8	4550	10
75-09-2	DICHLOROMETHANE	1	L	1.00000	--	1.17363	8	4524	25
75-09-2	METHYLENE CHLORIDE	19	L	19.00000	--	22.29904	8	4462	100
75-09-2	METHYLENE CHLORIDE	4	L	4.00000	--	4.69453	8	4450B	25
75-09-2	METHYLENE CHLORIDE	4	L	4.00000	--	4.69453	8	4450B	25
75-09-2	METHYLENE CHLORIDE	100	ML	0.10000	--	0.11736	8	4440	10
75-09-2	METHYLENE CHLORIDE	1	L	1.00000	--	1.17363	8	4440	25
75-09-2	METHYLENE CHLORIDE	100	ML	0.10000	--	0.11736	8	4410	10
75-09-2	DICHLOROMETHANE	4	L	4.00000	--	4.69453	8	4410	25
75-09-2	DICHLOROMETHANE	4	L	4.00000	--	4.69453	8	4410	25
75-09-2	DICHLOROMETHANE	1	L	1.00000	--	1.17363	8	4310	25
75-09-2	METHYLENE CHLORIDE	1	L	1.00000	--	1.17363	8	4310	25
75-09-2	METHYLENE CHLORIDE	1	L	1.00000	--	1.17363	8	4310	25
75-09-2	DICHLOROMETHANE	20	L	20.00000	--	23.47267	8	4310	100
75-09-2	METHYLENE CHLORIDE	1	L	1.00000	--	1.17363	8	4310	25
75-09-2	DICHLOROMETHANE	20	L	20.00000	--	23.47267	8	4310	100
75-09-2	METHYLENE CHLORIDE	4	L	4.00000	--	4.69453	8	4310	25
75-09-2	DICHLOROMETHANE	4	L	4.00000	--	4.69453	8	4310	25
75-09-2	DICHLOROMETHANE	4	L	4.00000	--	4.69453	8	4410	25
75-09-2	METHANE, DICHLORO-	500	ML	0.50000	--	0.58682	6/7	0204	10
75-09-2	METHYLENE CHLORIDE	1	L	1.00000	--	1.17363	6/7	0271	25
75-56-9	PROPYLENE OXIDE	250	MG	**Units**	0.00030	0.00035	6/7	0239	1
75-56-9	PROPYLENE OXIDE	250	MG	**Units**	0.00030	0.00035	6/7	0204	1
78-93-3	MEK	500	ML	0.50000	--	0.58682	8	4550	10
78-93-3	METHYL ETHYL KETONE	500	ML	0.50000	--	0.58682	8	4410	10
78-93-3	MEK	500	ML	0.50000	--	0.58682	8	4410	10
78-93-3	2-BUTANONE	1	L	1.00000	--	1.17363	8	4310	25
79-01-6	TRICHLOROETHYLENE	500	ML	0.50000	--	0.58682	8	4550	10
79-01-6	TRICHLOROETHYLENE	500	ML	0.50000	--	0.58682	8	4550	10
79-01-6	TRICHLOROETHYLENE	500	ML	0.50000	--	0.58682	8	4550	10
79-01-6	TRICHLOROETHYLENE	500	ML	0.50000	--	0.58682	6/7	0128	10
79-10-7	ACRYLIC ACID	5	G	**Units**	0.00476	0.00558	8	4550	1

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Chemical Inventory Data (Table G-2)

Conservatively assume specific gravity of 0.7 for laboratory liquids (0.649 liter/lb) when units are in pounds

Batch Assumptions:	*Annual Usage*	*Assumed Annual Batches*
	< 0.01 liter	*1*
	0.01-0.1 liter	*5*
	0.1-1.0 liter	*10*
	1.0-10 liter	*25*
	>10 liter	*100*

This list of chemicals comes from LBNL inventory data with solids & gases removed		*Entered Data*		*Calculated*	*Recalculated*	*Calculated*	*Entered Data*		*Calculated*
		Inventory Amount		**Inventory Amount**	**Inventory Amount**	**Annual Usage ***	**Building**	**Room**	**Estimated No. of Batches**
CAS No.	**Compound Name**	**Quantity**	**Units**	**(liters)**	**(liters)**	**(liters/yr)**			**(per year)**
79-10-7	ACRYLIC ACID	5	G	**Units**	0.00476	0.00558	8	4550	1
79-10-7	ACRYLIC ACID	5	G	**Units**	0.00476	0.00558	8	4450	1
100-41-4	ETHYL BENZENE	1	L	1.00000	--	1.17363	8	4310	25
100-42-5	STYRENE	100	ML	0.10000	--	0.11736	8	4550	10
100-42-5	STYRENE	5	ML	0.00500	--	0.00587	8	4550	1
100-44-7	BENZYL CHLORIDE	250	ML	0.25000	--	0.29341	8	4440	10
106-89-8	4-METHYLUMBELLIFERONE	25	G	**Units**	0.02113	0.02480	8	4440	5
106-99-0	1,3-BUTADIENE IN TOLUENE	250	G	**Units**	0.40323	0.47324	8	4550	10
107-02-8	ACROLEIN	100	ML	0.10000	--	0.11736	6/7	0128	10
107-06-2	1,2-DICHLOROETHANE	2.38	L	2.38000	--	2.79325	8	4550	25
107-06-2	1,2-DICHLOROETHANE	500	ML	0.50000	--	0.58682	8	4410	10
107-06-2	1,2-DICHLOROETHANE	1	L	1.00000	--	1.17363	8	4310	25
107-06-2	1,2-DICHLOROETHANE	4	L	4.00000	--	4.69453	8	4310	25
107-06-2	1,2-DICHLOROETHANE	500	ML	0.50000	--	0.58682	8	4310	10
107-21-1	ETHYLENE GLYCOL	1	L	1.00000	--	1.17363	9	0459	25
107-21-1	ETHYLENE GLYCOL	1	L	1.00000	--	1.17363	9	0459	25
107-21-1	ETHYLENE GLYCOL	1	L	1.00000	--	1.17363	9	0459	25
107-21-1	ETHYLENE GLYCOL	4	L	4.00000	--	4.69453	8	4524	25
107-21-1	ETHYLENE GLYCOL	4	KG	**Units**	3.27869	3.84798	8	4310	25
107-21-1	ETHYLENE GLYCOL	1	KG	**Units**	0.81967	0.96199	6/7	0239	10
107-21-1	ETHYLENE GLYCOL	1	L	1.00000	--	1.17363	6/7	0196A	25
107-21-1	ETHYLENE GLYCOL	500	ML	0.50000	--	0.58682	6/7	0244	10
107-21-1	ETHYLENE GLYCOL	250	ML	0.25000	--	0.29341	6/7	0239	10
107-21-1	ETHYLENE GLYCOL	250	ML	0.25000	--	0.29341	6/7	0239	10
107-21-1	ETHYLENE GLYCOL	2.5	L	2.50000	--	2.93408	6/7	0188C	25
107-21-1	ETHYLENE GLYCOL	1	L	1.00000	--	1.17363	6/7	0239	25
107-21-1	ETHYLENE GLYCOL	250	ML	0.25000	--	0.29341	6/7	0295	10
107-21-1	ETHYLENE GLYCOL	25	ML	0.02500	--	0.02934	6/7	0185	5
107-98-2	1-METHOXY-2-PROPANOL	8	ML	0.00800	--	0.00939	9	3219	1
107-98-2	1-METHOXY-2-PROPANOL	8	ML	0.00800	--	0.00939	8	3219	1
108-39-4	M-CRESOL	500	ML	0.50000	--	0.58682	8	4410	10
108-39-4	M-CRESOL	100	ML	0.10000	--	0.11736	6/7	0239	10
108-88-3	TOLUENE	100	ML	0.10000	--	0.11736	9	0413	10
108-88-3	TOLUENE	1	L	1.00000	--	1.17363	8	4550	25
108-88-3	TOLUENE	500	ML	0.50000	--	0.58682	8	4440	10
108-88-3	TOLUENE	1	L	1.00000	--	1.17363	8	4440	25
108-88-3	TOLUENE	1	L	1.00000	--	1.17363	8	4410	25
108-88-3	TOLUENE	2	L	2.00000	--	2.34727	8	4310	25
108-88-3	TOLUENE	1	L	1.00000	--	1.17363	8	4310	25
108-88-3	TOLUENE	1	L	1.00000	--	1.17363	8	4310	25
108-88-3	TOLUENE	1	L	1.00000	--	1.17363	8	4302	25
108-88-3	TOLUENE	1	L	1.00000	--	1.17363	8	4302	25
108-88-3	TOLUENE	1	L	1.00000	--	1.17363	8	4302	25
108-88-3	TOLUENE	1	L	1.00000	--	1.17363	8	4302	25
108-88-3	TOLUENE	100	ML	0.10000	--	0.11736	8	4208	10
108-88-3	TOLUENE	1	L	1.00000	--	1.17363	6/7	0293	25
108-88-3	TOLUENE	1	L	1.00000	--	1.17363	6/7	0128	25
108-88-3	TOLUENE	500	ML	0.50000	--	0.58682	6/7	0128	10
108-88-3	TOLUENE	1	L	1.00000	--	1.17363	6/7	0196A	25
108-88-3	TOLUENE	1	L	1.00000	--	1.17363	6/7	0239	25
108-88-3	TOLUENE	1	L	1.00000	--	1.17363	6/7	0204	25
108-88-3	TOLUENE	100	ML	0.10000	--	0.11736	6/7	0204	10
108-88-3	TOLUENE	500	ML	0.50000	--	0.58682	6/7	0239	10

* Equals inventory x (365 days per yr/311 days)
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Proposed Richmond Bay Campus Long Range Development Plan, Richmond, California
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Conservatively assume specific gravity of 0.7 for laboratory liquids (0.649 liter/lb) when units are in pounds

Batch Assumptions:	*Annual Usage*	*Assumed Annual Batches*
	< 0.01 liter	*1*
	0.01-0.1 liter	*5*
	0.1-1.0 liter	*10*
	1.0-10 liter	*25*
	>10 liter	*100*

This list of chemicals comes from LBNL inventory data with solids & gases removed		*Entered Data*		*Calculated*	*Recalculated*	*Calculated*	*Entered Data*		*Calculated*
		Inventory Amount		**Inventory Amount**	**Inventory Amount**	**Annual Usage ***	**Building**	**Room**	**Estimated No. of Batches (per year)**
CAS No.	**Compound Name**	**Quantity**	**Units**	**(liters)**	**(liters)**	**(liters/yr)**			
108-88-3	TOLUENE	2000	ML	2.00000	--	2.34727	6/7	0109	25
108-88-3	TOLUENE	500	ML	0.50000	--	0.58682	6/7	0209	10
109-86-4	2-METHOXYETHANOL	1	L	1.00000	--	1.17363	8	4310	25
110-54-3	HEXANE	1	L	1.00000	--	1.17363	9	0459	25
110-54-3	HEXANE, CHROMASOLV PLUS	1	L	1.00000	--	1.17363	9	0446	25
110-54-3	HEXANE	1	L	1.00000	--	1.17363	9	3219	25
110-54-3	HEXANE	4	L	4.00000	--	4.69453	8		25
110-54-3	HEXANE	4	L	4.00000	--	4.69453	8	4550	25
110-54-3	HEXANE	19	L	19.00000	--	22.29904	8	4550	100
110-54-3	HEXANE	1	L	1.00000	--	1.17363	8	4550	25
110-54-3	HEXANE	19	L	19.00000	--	22.29904	8	4524	100
110-54-3	HEXANE	1	L	1.00000	--	1.17363	8	4524	25
110-54-3	ALKANE STANDARD SOLUTION C8-C20	1	ML	0.00100	--	0.00117	8	4524	1
110-54-3	HEXANE	4	L	4.00000	--	4.69453	8	4440	25
110-54-3	HEXANE	4	L	4.00000	--	4.69453	8	4440	25
110-54-3	HEXANE	4	L	4.00000	--	4.69453	8	4440	25
110-54-3	HEXANE	4	L	4.00000	--	4.69453	8	4440	25
110-54-3	HEXANE	4	L	4.00000	--	4.69453	8	4440	25
110-54-3	HEXANE	4	L	4.00000	--	4.69453	8	4410	25
110-54-3	HEXANE	20	L	20.00000	--	23.47267	8	4310	100
110-54-3	HEXANE	24	L	24.00000	--	28.16720	8	4310	100
110-54-3	HEXANE	4	L	4.00000	--	4.69453	8	4310	25
110-54-3	HEXANE	19	L	19.00000	--	22.29904	8	4310	100
110-54-3	HEXANE	1	L	1.00000	--	1.17363	8	4310	25
110-54-3	HEXANE	4	L	4.00000	--	4.69453	8	4308	25
110-54-3	HEXANE	4	L	4.00000	--	4.69453	8	4302	25
110-54-3	HEXANE	4	L	4.00000	--	4.69453	8	4302	25
110-54-3	HEXANE	20	L	20.00000	--	23.47267	8	4240	100
110-54-3	HEXANE	20	L	20.00000	--	23.47267	8	4110	100
110-54-3	ALKANE STANDARD SOLUTION C8-C20	1	ML	0.00100	--	0.00117	8	4102	1
110-54-3	HEXANE	20	L	20.00000	--	23.47267	8	0102	100
110-54-3	HEXANE	1	L	1.00000	--	1.17363	8	3219	25
110-54-3	HEXANE	1	L	1.00000	--	1.17363	6/7	0239	25
110-54-3	N-HEXANE	1	L	1.00000	--	1.17363	6/7	0128	25
110-54-3	HEXANE	1	L	1.00000	--	1.17363	6/7	0128	25
110-54-3	HEXANE	1	L	1.00000	--	1.17363	6/7	0177	25
110-54-3	N-HEXANE	100	ML	0.10000	--	0.11736	6/7	0287	10
110-54-3	HEXANE	500	ML	0.50000	--	0.58682	6/7	0271	10
110-54-3	HEXANE	1	L	1.00000	--	1.17363	6/7	0216	25
110-54-3	HEXANE	1	L	1.00000	--	1.17363	6/7	0220	25
110-54-3	HEXANE	1	L	1.00000	--	1.17363	6/7	0220	25
110-54-3	HEXANE, CHROMASOLV PLUS	1	L	1.00000	--	1.17363	6/7	0220	25
110-54-3	HEXANE	1	L	1.00000	--	1.17363	6/7	0220	25
111-30-8	GLUTARALDEHYDE 25% AQUEOUS SOLUTION	1	L	1.00000	--	1.17363	9	0446	25
111-30-8	GLUTARALDEHYDE SOLUTION	25	G	**Units**	0.02352	0.02760	9	0446	5
111-30-8	GLUTARALDEHYDE	10	ML	0.01000	--	0.01174	9	0446	5
111-30-8	GLUTARALDEHYDE SOLUTION	100	ML	0.10000	--	0.11736	9	0459	10
111-30-8	GLUTARALDEHYDE	20	ML	0.02000	--	0.02347	8	4550	5
111-30-8	GLUTARALDEHYDE	100	ML	0.10000	--	0.11736	8	4440	10
111-30-8	GLUTARALDEHYDE SOLUTION	10	ML	0.01000	--	0.01174	6/7	0293	5
111-30-8	GLUTARALDEHYDE SOLUTION	10	ML	0.01000	--	0.01174	6/7	0293	5
111-30-8	GLUTARALDEHYDE	10	ML	0.01000	--	0.01174	6/7	0229	5
111-30-8	GLUTARALDEHYDE	10	ML	0.01000	--	0.01174	6/7	0128	5

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Batch Assumptions:	*Annual Usage*	*Assumed Annual Batches*
	< 0.01 liter	*1*
	0.01-0.1 liter	*5*
	0.1-1.0 liter	*10*
	1.0-10 liter	*25*
	>10 liter	*100*

This list of chemicals comes from LBNL inventory data with solids & gases removed		*Entered Data*		*Calculated*	*Recalculated*	*Calculated*	*Entered Data*		*Calculated*
		Inventory Amount		**Inventory Amount**	**Inventory Amount**	**Annual Usage ***	**Building**	**Room**	**Estimated No. of Batches**
CAS No.	**Compound Name**	**Quantity**	**Units**	**(liters)**	**(liters)**	**(liters/yr)**			**(per year)**
111-30-8	GLUTARALDEHYDE	10	ML	0.01000	--	0.01174	6/7	0196A	5
111-30-8	GLUTARALDEHYDE	90	ML	0.09000	--	0.10563	6/7	0196A	10
111-30-8	GLUTARALDEHYDE	90	ML	0.09000	--	0.10563	6/7	0196A	10
111-30-8	GLUTERALDEHYDE	2	ML	0.00200	--	0.00235	6/7	0196A	1
111-30-8	GLUTERALDEHYDE	10	ML	0.01000	--	0.01174	6/7	0196A	5
111-30-8	GLUTERALDEHYDE	10	ML	0.01000	--	0.01174	6/7	0106	5
111-30-8	GLUTARALDEHYDE	20	ML	0.02000	--	0.02347	6/7	0177	5
111-30-8	GLUTARALDEHYDE	2	ML	0.00200	--	0.00235	6/7	0177	1
111-30-8	GLUTARALDEHYDE	10	ML	0.01000	--	0.01174	6/7	0230	5
111-30-8	GLUTARALDEHYDE	100	ML	0.10000	--	0.11736	6/7	0204	10
111-30-8	GLUTARALDEHYDE	1	ML	0.00100	--	0.00117	6/7	0188C	1
111-30-8	GLUTARALDEHYDE 25% AQUEOUS SOLUTION	1	ML	0.00100	--	0.00117	6/7	0188C	1
111-30-8	GLUTARALDEHYDE 25% AQUEOUS SOLUTION	25	ML	0.02500	--	0.02934	6/7	0188C	5
111-30-8	GLUTARALDEHYDE 25% AQUEOUS SOLUTION	25	ML	0.02500	--	0.02934	6/7	0188C	5
111-30-8	GLUTARALDEHYDE	100	ML	0.10000	--	0.11736	6/7	0188C	10
111-30-8	GLUTARALDEHYDE	10	ML	0.01000	--	0.01174	6/7	0287	5
111-30-8	GLUTARIC DIALDEHYDE	1	L	1.00000	--	1.17363	6/7	0239	25
111-30-8	GLUTERALDEHYDE	100	ML	0.10000	--	0.11736	6/7	0294	10
111-30-8	GLUTARALDEHYDE	100	ML	0.10000	--	0.11736	6/7	0109	10
111-30-8	GLUTARALDEHYDE 25% AQUEOUS SOLUTION	100	ML	0.10000	--	0.11736	6/7	0209A	10
111-30-8	GLUTARALDEHYDE SOLUTION	25	ML	0.02500	--	0.02934	6/7	0220	5
111-42-2	DIETHANOLAMINE	500	G	**Units**	0.45579	0.53493	9	0446	10
111-42-2	DIETHANOLAMINE	30	ML	0.03000	--	0.03521	8	4302	5
111-42-2	DIETHANOLAMINE	100	G	**Units**	0.09116	0.10699	6/7	0288C	10
111-42-2	DIETHANOLAMINE	500	G	**Units**	0.45579	0.53493	6/7	0239	10
121-44-8	TRIETHYLAMINE	500	ML	0.50000	--	0.58682	8		10
121-44-8	TRIETHYLAMINE	100	ML	0.10000	--	0.11736	8	4550	10
121-44-8	TRIETHYLAMINE	10	ML	0.01000	--	0.01174	8	4450D	5
121-44-8	TRIETHYLAMINE	25	G	**Units**	0.03434	0.04030	8	4440	5
121-44-8	TRIETHYLAMINE	1	L	1.00000	--	1.17363	8	4310	25
121-44-8	TRIETHYLAMINE	100	ML	0.10000	--	0.11736	8	4310	10
121-44-8	TRIETHYLAMINE	100	ML	0.10000	--	0.11736	8	4121	10
121-44-8	TRIETHYLAMINE	100	ML	0.10000	--	0.11736	6/7	0271	10
121-44-8	TRIETHYLAMINE	500	ML	0.50000	--	0.58682	6/7	0295	10
123-91-1	1,4-DIOXANE	1	L	1.00000	--	1.17363	9	0446	25
123-91-1	DIOXANE	1	L	1.00000	--	1.17363	8	4550	25
123-91-1	1,4-DIOXANE	1	L	1.00000	--	1.17363	8	4450B	25
123-91-1	1,4 DIOXANE	2	L	2.00000	--	2.34727	8	4440	25
123-91-1	1,4 DIOXANE	2	L	2.00000	--	2.34727	8	4410	25
123-91-1	1,4-DIOXANE ANHYDROUS	500	G	**Units**	0.48370	0.56769	8	4410	10
123-91-1	DIOXANE	1	L	1.00000	--	1.17363	8	4310	25
123-91-1	DIOXANE	1	L	1.00000	--	1.17363	8	4310	25
123-91-1	DIOXANE	4	L	4.00000	--	4.69453	8	4310	25
123-91-1	DIOXANE	4	L	4.00000	--	4.69453	8	4310	25
123-91-1	1,4-DIOXANE ANHYDROUS	100	ML	0.10000	--	0.11736	8	4302	10
127-18-4	TETRACHLOROETHYLENE	1	L	1.00000	--	1.17363	8	4550	25
1330-20-7	XYLENE	1	L	1.00000	--	1.17363	6/7	0166	25
1330-20-7	XYLENE	500	ML	0.50000	--	0.58682	6/7	0166	10
1330-20-7	XYLENE	4	L	4.00000	--	4.69453	6/7	0286	25
1330-20-7	XYLENE	5	ML	0.00500	--	0.00587	6/7	0128	1
1330-20-7	XYLENE	500	ML	0.50000	--	0.58682	6/7	0177	10
1330-20-7	XYLENE	1	GAL	3.78500	--	4.44220	6/7	0204	25
1330-20-7	XYLENE	4	L	4.00000	--	4.69453	6/7	0204	25

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Conservatively assume specific gravity of 0.7 for laboratory liquids (0.649 liter/lb) when units are in pounds

Batch Assumptions:	*Annual Usage*	*Assumed Annual Batches*
	< 0.01 liter	*1*
	0.01-0.1 liter	*5*
	0.1-1.0 liter	*10*
	1.0-10 liter	*25*
	>10 liter	*100*

This list of chemicals comes from LBNL inventory data with solids & gases removed		*Entered Data*		*Calculated*	*Recalculated*	*Calculated*	*Entered Data*		*Calculated*
		Inventory Amount		**Inventory Amount**	**Inventory Amount**	**Annual Usage ***	**Building**	**Room**	**Estimated No. of Batches**
CAS No.	**Compound Name**	**Quantity**	**Units**	**(liters)**	**(liters)**	**(liters/yr)**			**(per year)**
1330-20-7	XYLENE	4	L	4.00000	--	4.69453	6/7	0204	25
1330-20-7	XYLENE	500	ML	0.50000	--	0.58682	6/7	0188C	10
1330-20-7	XYLENE	500	ML	0.50000	--	0.58682	6/7	0188C	10
1330-20-7	XYLENE	500	ML	0.50000	--	0.58682	6/7	0239	10
1330-20-7	XYLENE	1	GAL	3.78500	--	4.44220	6/7	0239	25
1330-20-7	XYLENE	4	L	4.00000	--	4.69453	6/7	0239	25
1330-20-7	XYLENES	500	ML	0.50000	--	0.58682	6/7	0239	10
1330-20-7	XYLENE	1	G	**Units**	0.00116	0.00136	6/7	0109	1
1330-20-7	XYLENE	500	ML	0.50000	--	0.58682	6/7	0209	10
1330-20-7	XYLENE	4	L	4.00000	--	4.69453	6/7	0204	25
1330-20-7	DEPEX MOUNTING MEDIA	100	ML	0.10000	--	0.11736	6/7	0220	10
1634-04-4	METHYL TERT-BUTYL ETHER	4	L	4.00000	--	4.69453	8	4310	25
1634-04-4	METHYL TERT-BUTYL ETHER	100	ML	0.10000	--	0.11736	6/7	0216	10
7647-01-0	HYDROCHLORIC ACID STANDARD SOLUTION	1	L	1.00000	--	1.17363	9	0139	25
7647-01-0	HCL	50	ML	0.05000	--	0.05868	9	0459	5
7647-01-0	HYDROCHLORIC ACID	1	L	1.00000	--	1.17363	9	0412	25
7647-01-0	HYDROCHLORIC ACID	1	L	1.00000	--	1.17363	9	0412	25
7647-01-0	HYDROCHLORIC ACID	1	L	1.00000	--	1.17363	9	0412	25
7647-01-0	HYDROCHLORIC ACID	1	L	1.00000	--	1.17363	9	0412	25
7647-01-0	HYDROCHLORIC ACID	1	L	1.00000	--	1.17363	9	0459	25
7647-01-0	HYDROCHLORIC ACID	500	ML	0.50000	--	0.58682	9	0446	10
7647-01-0	HYDROCHLORIC ACID	4	L	4.00000	--	4.69453	9	3219	25
7647-01-0	HYDROCHLORIC ACID	4	L	4.00000	--	4.69453	9	3219	25
7647-01-0	HYDROCHLORIC ACID	4	L	4.00000	--	4.69453	9	3219	25
7647-01-0	HYDROCHLORIC ACID	4	L	4.00000	--	4.69453	9	3219	25
7647-01-0	HYDROCHLORIC ACID	4	L	4.00000	--	4.69453	9	3219	25
7647-01-0	HYDROCHLORIC ACID	500	ML	0.50000	--	0.58682	9	3219	10
7647-01-0	HYDROCHLORIC ACID	2.5	L	2.50000	--	2.93408	8	4550	25
7647-01-0	HYDROCHLORIC ACID	1	L	1.00000	--	1.17363	8	4550	25
7647-01-0	HYDROCHLORIC ACID	500	ML	0.50000	--	0.58682	8	4550	10
7647-01-0	HYDROCHLORIC ACID	1	L	1.00000	--	1.17363	8	4550	25
7647-01-0	HYDROCHLORIC ACID	1	L	1.00000	--	1.17363	8	4550	25
7647-01-0	HYDROCHLORIC ACID	1	L	1.00000	--	1.17363	8	4550	25
7647-01-0	HYDROCHLORIC ACID	2.5	L	2.50000	--	2.93408	8	4550	25
7647-01-0	HYDROCHLORIC ACID	2.5	L	2.50000	--	2.93408	8	4524	25
7647-01-0	HYDROCHLORIC ACID	2.5	L	2.50000	--	2.93408	8	4524	25
7647-01-0	HYDROCHLORIC ACID	2.5	L	2.50000	--	2.93408	8	4524	25
7647-01-0	HYDROCHLORIC ACID	2.5	L	2.50000	--	2.93408	8	4524	25
7647-01-0	HYDROCHLORIC ACID	2.5	L	2.50000	--	2.93408	8	4524	25
7647-01-0	HYDROCHLORIC ACID	500	ML	0.50000	--	0.58682	8	4524	10
7647-01-0	HYDROCHLORIC ACID SOLUTION	100	ML	0.10000	--	0.11736	8	4440	10
7647-01-0	HYDROCHLORIC ACID	100	ML	0.10000	--	0.11736	8	4440	10
7647-01-0	HYDROCHLORIC ACID	500	ML	0.50000	--	0.58682	8	4410	10
7647-01-0	HYDROCHLORIC ACID	500	ML	0.50000	--	0.58682	8	4410	10
7647-01-0	HYDROCHLORIC ACID	100	ML	0.10000	--	0.11736	8	4310	10
7647-01-0	HYDROCHLORIC ACID	1	L	1.00000	--	1.17363	8	4310	25
7647-01-0	HYDROCHLORIC ACID	500	ML	0.50000	--	0.58682	8	4310	10
7647-01-0	HYDROCHLORIC ACID	1	L	1.00000	--	1.17363	8	4310	25
7647-01-0	HYDROCHLORIC ACID	4	L	4.00000	--	4.69453	8	3219	25
7647-01-0	HYDROCHLORIC ACID	4	L	4.00000	--	4.69453	8	3219	25
7647-01-0	HYDROCHLORIC ACID	4	L	4.00000	--	4.69453	8	3219	25
7647-01-0	HYDROCHLORIC ACID	4	L	4.00000	--	4.69453	8	3219	25
7647-01-0	HYDROCHLORIC ACID	4	L	4.00000	--	4.69453	8	3219	25

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Batch Assumptions:	*Annual Usage*	*Assumed Annual Batches*
	< 0.01 liter	*1*
	0.01-0.1 liter	*5*
	0.1-1.0 liter	*10*
	1.0-10 liter	*25*
	>10 liter	*100*

This list of chemicals comes from LBNL inventory data with solids & gases removed		*Entered Data*		*Calculated*	*Recalculated*	*Calculated*	*Entered Data*		*Calculated*
		Inventory Amount		**Inventory Amount**	**Inventory Amount**	**Annual Usage ***	**Building**	**Room**	**Estimated No. of Batches**
CAS No.	**Compound Name**	**Quantity**	**Units**	**(liters)**	**(liters)**	**(liters/yr)**			**(per year)**
7647-01-0	HYDROCHLORIC ACID	500	ML	0.50000	--	0.58682	8	3219	10
7647-01-0	HYDROCHLORIC ACID	500	ML	0.50000	--	0.58682	6/7	0166	10
7647-01-0	HYDROCHLORIC ACID SOLUTION	500	ML	0.50000	--	0.58682	6/7	0293	10
7647-01-0	HYDROCHLORIC ACID	500	ML	0.50000	--	0.58682	6/7	0286	10
7647-01-0	HYDROCHLORIC ACID	500	ML	0.50000	--	0.58682	6/7	0244	10
7647-01-0	HYDROCHLORIC ACID	1	L	1.00000	--	1.17363	6/7	0244	25
7647-01-0	HYDROCHLORIC ACID	1	ML	0.00100	--	0.00117	6/7	0239	1
7647-01-0	HYDROCHLORIC ACID	2.5	L	2.50000	--	2.93408	6/7	0128	25
7647-01-0	HYDROCHLORIC ACID	2.5	L	2.50000	--	2.93408	6/7	0128	25
7647-01-0	HYDROCHLORIC ACID	2.5	L	2.50000	--	2.93408	6/7	0128	25
7647-01-0	IMIDAZOLERIC ACID	25	G	**Units**	20.83333	24.45070	6/7	0196A	100
7647-01-0	HYDROCHLORIC ACID	2.5	L	2.50000	--	2.93408	6/7	0196A	25
7647-01-0	HYDROCHLORIC ACID	500	ML	0.50000	--	0.58682	6/7	0196A	10
7647-01-0	HYDROCHLORIC ACID	2.5	L	2.50000	--	2.93408	6/7	0177	25
7647-01-0	HYDROCHLORIC ACID	500	ML	0.50000	--	0.58682	6/7	0177	10
7647-01-0	HYDROCHLORIC ACID	2.5	L	2.50000	--	2.93408	6/7	0196	25
7647-01-0	HYDROCHLORIC ACID	2.5	L	2.50000	--	2.93408	6/7	0294	25
7647-01-0	HCL	500	ML	0.50000	--	0.58682	6/7	0239	10
7647-01-0	HYDROCHLORIC ACID	500	ML	0.50000	--	0.58682	6/7	0239	10
7647-01-0	HYDROCHLORIC ACID	500	ML	0.50000	--	0.58682	6/7	0239	10
7647-01-0	HYDROCHLORIC ACID	500	ML	0.50000	--	0.58682	6/7	0239	10
7647-01-0	HYDROCHLORIC ACID	500	ML	0.50000	--	0.58682	6/7	0239	10
7647-01-0	(TRIDECAFLUORO-1,1,2,2-TERAHYDROOCTYL)TRICHLOROSILANE	50	G	**Units**	41.66667	48.90139	6/7	0239	100
7647-01-0	HCL	500	ML	0.50000	--	0.58682	6/7	0239	10
7647-01-0	HCL	500	ML	0.50000	--	0.58682	6/7	0239	10
7647-01-0	HYDROCHLORIC ACID	500	ML	0.50000	--	0.58682	6/7	0188C	10
7647-01-0	HYDROCHLORIC ACID	500	ML	0.50000	--	0.58682	6/7	0188C	10
7647-01-0	HYDROCHLORIC ACID	500	ML	0.50000	--	0.58682	6/7	0293	10
7647-01-0	HYDROCHLORIC ACID	2.5	L	2.50000	--	2.93408	6/7	0287	25
7647-01-0	HYDROCHLORIC ACID	2.5	L	2.50000	--	2.93408	6/7	0271	25
7647-01-0	HYDROCHLORIC ACID	2.5	L	2.50000	--	2.93408	6/7	0239	25
7647-01-0	HYDROCHLORIC ACID	500	ML	0.50000	--	0.58682	6/7	0239	10
7647-01-0	HYDROCHLORIC ACID	6	GAL	22.71000	--	26.65322	6/7	0239	100
7647-01-0	HYDROCHLORIC ACID	500	ML	0.50000	--	0.58682	6/7	0239	10
7647-01-0	HYDROCHLORIC ACID	1	GAL	3.78500	--	4.44220	6/7	0239	25
7647-01-0	HYDROCHLORIC ACID	100	ML	0.10000	--	0.11736	6/7	0295	10
7647-01-0	HYDROCHLORIC ACID	500	ML	0.50000	--	0.58682	6/7	0295	10
7647-01-0	HYDROCHLORIC ACID	100	ML	0.10000	--	0.11736	6/7	0116	10
7647-01-0	HYDROCHLORIC ACID	500	ML	0.50000	--	0.58682	6/7	0187	10
7647-01-0	HYDROCHLORIC ACID	500	ML	0.50000	--	0.58682	6/7	0187	10
7647-01-0	HYDROCHLORIC ACID	500	ML	0.50000	--	0.58682	6/7	0187	10
7647-01-0	HYDROCHLORIC ACID	3	ML	0.00300	--	0.00352	6/7	0216	1
7647-01-0	HYDROCHLORIC ACID	2.5	L	2.50000	--	2.93408	6/7	0216	25
7647-01-0	HYDROCHLORIC ACID	500	ML	0.50000	--	0.58682	6/7	0208	10
7647-01-0	HYDROCHLORIC ACID	500	ML	0.50000	--	0.58682	6/7	0208	10
7647-01-0	HYDROCHLORIC ACID	2.5	L	2.50000	--	2.93408	6/7	0208	25
7647-01-0	HYDROCHLORIC ACID	500	ML	0.50000	--	0.58682	6/7	0208	10
7647-01-0	HYDROCHLORIC ACID	500	ML	0.50000	--	0.58682	6/7	0220	10
7647-01-0	HYDROCHLORIC ACID	500	CC	**Units**	0.50000	0.58682	6/7	0220	10
7647-01-0	HYDROCHLORIC ACID	500	ML	0.50000	--	0.58682	6/7	0220	10
7647-01-0	HYDROCHLORIC ACID	4	L	4.00000	--	4.69453	6/7	0255	25
7664-38-2	BIO-SAFE COOMASSIE	1	L	1.00000	--	1.17363	9	0451	25
7664-38-2	BIO-SAFE COOMASSIE	1	L	1.00000	--	1.17363	9	0459	25

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Batch Assumptions:	*Annual Usage*	*Assumed Annual Batches*
	< 0.01 liter	*1*
	0.01-0.1 liter	*5*
	0.1-1.0 liter	*10*
	1.0-10 liter	*25*
	>10 liter	*100*

This list of chemicals comes from LBNL inventory data with solids & gases removed		*Entered Data*		*Calculated*	*Recalculated*	*Calculated*	*Entered Data*		*Calculated*
		Inventory Amount		**Inventory Amount**	**Inventory Amount**	**Annual Usage ***	**Building**	**Room**	**Estimated No. of Batches (per year)**
CAS No.	**Compound Name**	**Quantity**	**Units**	**(liters)**	**(liters)**	**(liters/yr)**			
7664-38-2	BIO-SAFE COOMASSIE	1	L	1.00000	--	1.17363	9	0459	25
7664-38-2	BIO-SAFE COOMASSIE	1	L	1.00000	--	1.17363	9	0459	25
7664-38-2	PHOSPHORIC ACID	100	G	**Units**	0.05935	0.06965	9	3219	5
7664-38-2	PHOSPHORIC ACID	450	ML	0.45000	--	0.52814	8	4550	10
7664-38-2	PHOSPHORIC ACID	500	ML	0.50000	--	0.58682	8	4550	10
7664-38-2	LPH SE GERMICIDAL DETERGENT	1	GAL	3.78500	--	4.44220	8	4543	25
7664-38-2	PHOSPHORIC ACID	500	ML	0.50000	--	0.58682	8	4524	10
7664-38-2	PHOSPHORIC ACID	500	ML	0.50000	--	0.58682	8	4524	10
7664-38-2	PHOSPHORIC ACID	500	ML	0.50000	--	0.58682	8	4468	10
7664-38-2	PHOSPHORIC ACID	10	KG	**Units**	5.93472	6.96518	8	4450	25
7664-38-2	PHOSPHORIC ACID	500	ML	0.50000	--	0.58682	8	4440	10
7664-38-2	PHOSPHORIC ACID	2.5	L	2.50000	--	2.93408	8	4440	25
7664-38-2	PHOSPHORIC ACID	10	KG	**Units**	5.93472	6.96518	8	4310	25
7664-38-2	PHOSPHORIC ACID	500	ML	0.50000	--	0.58682	8	4310	10
7664-38-2	PHOSPHORIC ACID	100	G	**Units**	0.05935	0.06965	8	3219	5
7664-38-2	PHOSPHORIC ACID	500	ML	0.50000	--	0.58682	6/7	0166	10
7664-38-2	PHOSPHORIC ACID	500	ML	0.50000	--	0.58682	6/7	0239	10
7664-38-2	PHOSPHORIC ACID	450	ML	0.45000	--	0.52814	6/7	0128	10
7664-38-2	O-PHOSPHORIC ACID	1	L	1.00000	--	1.17363	6/7	0128	25
7664-38-2	PHOSPHORIC ACID	500	ML	0.50000	--	0.58682	6/7	0196A	10
7664-38-2	DYE REAGENT CONCENTRATE (PHOSPHAIC ACID/METHANOL)	450	ML	0.45000	--	0.52814	6/7	0177	10
7664-38-2	PHOSPHORIC ACID	500	ML	0.50000	--	0.58682	6/7	0287	10
7664-38-2	5'-MONOPHOSPHORIC ACID	500	MG	**Units**	0.00030	0.00035	6/7	0239	1
7664-38-2	PHOSPHORIC ACID	500	ML	0.50000	--	0.58682	6/7	0239	10
7664-38-2	PHOSPHORIC ACID	100	G	**Units**	0.05935	0.06965	6/7	0220	5
7664-38-2	PHOSPHORIC ACID	100	G	**Units**	0.05935	0.06965	6/7	0220	5
7664-38-2	PHOSPHORIC ACID	500	G	**Units**	0.29674	0.34826	6/7	0220	10
7664-38-2	PHOSPORIC ACID	50	ML	0.05000	--	0.05868	6/7	0220	5
7664-38-2	PHOSPHORIC ACID	500	ML	0.50000	--	0.58682	6/7	0255	10
7664-39-3	HYDROFLUORIC ACID	500	ML	0.50000	--	0.58682	6/7	0216	10
7664-93-9	SULFURIC ACID	100	ML	0.10000	--	0.11736	9	3219	10
7664-93-9	SULFURIC ACID	1	L	1.00000	--	1.17363	9	3219	25
7664-93-9	SULFURIC ACID	1	L	1.00000	--	1.17363	8		25
7664-93-9	SULFURIC ACID	1	L	1.00000	--	1.17363	8	4440	25
7664-93-9	SULFURIC ACID	500	ML	0.50000	--	0.58682	8	4410	10
7664-93-9	SULFURIC ACID	500	ML	0.50000	--	0.58682	8	4410	10
7664-93-9	SULFURIC ACID	500	ML	0.50000	--	0.58682	8	4410	10
7664-93-9	SULFURIC ACID	500	ML	0.50000	--	0.58682	8	4410	10
7664-93-9	SULFURIC ACID	500	ML	0.50000	--	0.58682	8	4410	10
7664-93-9	SULFURIC ACID	500	ML	0.50000	--	0.58682	8	4410	10
7664-93-9	SULFURIC ACID	500	ML	0.50000	--	0.58682	8	4310	10
7664-93-9	SULFURIC ACID	4	L	4.00000	--	4.69453	8	4310	25
7664-93-9	FISHER CLEANING SOLUTION	500	ML	0.50000	--	0.58682	8	4302	10
7664-93-9	SULFURIC ACID	1	L	1.00000	--	1.17363	8	4208	25
7664-93-9	SULFURIC ACID	100	ML	0.10000	--	0.11736	8	3219	10
7664-93-9	SULFURIC ACID	1	L	1.00000	--	1.17363	8	3219	25
7664-93-9	SULFURIC ACID	500	ML	0.50000	--	0.58682	6/7	0166	10
7664-93-9	SULFURIC ACID	50	ML	0.05000	--	0.05868	6/7	0128	5
7664-93-9	SULFURIC ACID	2.5	L	2.50000	--	2.93408	6/7	0177	25
7664-93-9	SULFURIC ACID	100	ML	0.10000	--	0.11736	6/7	0239	10
7664-93-9	SULFURIC ACID	100	ML	0.10000	--	0.11736	6/7	0188C	10
7664-93-9	SULFURIC ACID	2.5	L	2.50000	--	2.93408	6/7	0188C	25
7664-93-9	SULFURIC ACID	500	ML	0.50000	--	0.58682	6/7	0287	10

* Equals inventory x (365 days per yr/311 days)
[311 days = 95th percentile lowest turnover rate for historic use]

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Calculation of Liquid Chemical Emissions
Phase 1 Laboratory Usage Scenario
Proposed Richmond Bay Campus Long Range Development Plan, Richmond, California
Chemical Inventory Data (Table G-2)

Conservatively assume specific gravity of 0.7 for laboratory liquids (0.649 liter/lb) when units are in pounds

Batch Assumptions:	*Annual Usage*	*Assumed Annual Batches*
	< 0.01 liter	*1*
	0.01-0.1 liter	*5*
	0.1-1.0 liter	*10*
	1.0-10 liter	*25*
	>10 liter	*100*

This list of chemicals comes from LBNL inventory data with solids & gases removed		*Entered Data*		*Calculated*	*Recalculated*	*Calculated*	*Entered Data*		*Calculated*
		Inventory Amount		**Inventory Amount (liters)**	**Inventory Amount (liters)**	**Annual Usage * (liters/yr)**	**Building**	**Room**	**Estimated No. of Batches (per year)**
CAS No.	**Compound Name**	**Quantity**	**Units**						
7664-93-9	SULFURIC ACID	500	ML	0.50000	--	0.58682	6/7	0287	10
7664-93-9	SULFURIC ACID	5	L	5.00000	--	5.86817	6/7	0271	25
7664-93-9	SULFURIC ACID	5	LB	3.24500	--	3.80844	6/7	0239	25
7664-93-9	SULFURIC ACID	2.5	L	2.50000	--	2.93408	6/7	0295	25
7697-37-2	NITRIC ACID	2.5	L	2.50000	--	2.93408	9	3219	25
7697-37-2	NITRIC ACID	2.5	L	2.50000	--	2.93408	8	4550	25
7697-37-2	NITRIC ACID	2.5	L	2.50000	--	2.93408	8	4550	25
7697-37-2	NITRIC ACID	2.5	L	2.50000	--	2.93408	8	4550	25
7697-37-2	NITRIC ACID	500	ML	0.50000	--	0.58682	8	4550	10
7697-37-2	NITRIC ACID	500	ML	0.50000	--	0.58682	8	3219	10
7726-95-6	BROMINE	5	G	**Units**	0.00160	0.00188	8	4310	1

* Equals inventory x (365 days per yr/311 days)
[311 days = 95th percentile lowest turnover rate for historic use]

Golder Associates

Calculation of Liquid Chemical Emissions
Phase 1 Laboratory Usage Scenario
Proposed Richmond Bay Campus Long Range Development Plan, Richmond, California

Vapor Pressure Data (Table G-3)

Antoine Equation: $VP = 10^{[A - (B/(T+C))]}$

where: VP = Vapor Pressure (mmHg or bar, depending on source of A, B, C)
T = Temperature (K or C depending on source of A, B, C)
A, B, C = Antoine coefficients

(Reference Temperature should be near 295 deg K)

This list of chemicals comes from LBNL inventory data with solids & gases removed Must be identical to Chemical Inventory worksheet		*Must be entered manually* For Antoine Eq. @ 295 K				or	*Entered manually* Literature		*Entered manually*	*Calculated values*		*Calculated*
		Antoine Coefficients										
CAS No.	Compound Name	A	B	C	VP Units		VP @ Ref Temp (mmHg)	Ref Temp (K)	Vapor Pressure Reference	Vapor Pressure at Ref	Vapor Pressure at Ref (VP Units)	Adjusted Vapor Pressure [a] (mmHg)
50-00-0	NORTHERNMAX DENATURING GEL BUFFER						87.9	294	MSDS, 37% soln.	87.900	mmHg	100.00
50-00-0	FORMALDEHYDE						87.9	294	MSDS, 37% soln.	87.900	mmHg	100.00
50-00-0	FORMALDEHYDE						87.9	294	MSDS, 37% soln.	87.900	mmHg	100.00
50-00-0	FORMALDEHYDE SOLUTION						87.9	294	MSDS, 37% soln.	87.900	mmHg	100.00
50-00-0	FORMALDEHYDE						87.9	294	MSDS, 37% soln.	87.900	mmHg	100.00
50-00-0	FORMALDEHYDE						87.9	294	MSDS, 37% soln.	87.900	mmHg	100.00
50-00-0	FORMALDEHYDE SOLUTION						87.9	294	MSDS, 37% soln.	87.900	mmHg	100.00
50-00-0	FORMALDEHYDE						87.9	294	MSDS, 37% soln.	87.900	mmHg	100.00
50-00-0	FORMALDEHYDE						87.9	294	MSDS, 37% soln.	87.900	mmHg	100.00
50-00-0	FORMALDEHYDE						87.9	294	MSDS, 37% soln.	87.900	mmHg	100.00
50-00-0	FORMALDEHYDE						87.9	294	MSDS, 37% soln.	87.900	mmHg	100.00
50-00-0	FORMALDEHYDE						87.9	294	MSDS, 37% soln.	87.900	mmHg	100.00
50-00-0	FORMALDEHYDE						87.9	294	MSDS, 37% soln.	87.900	mmHg	100.00
50-00-0	FORMALDEHYDE						87.9	294	MSDS, 37% soln.	87.900	mmHg	100.00
50-00-0	FORMALDEHYDE						87.9	294	MSDS, 37% soln.	87.900	mmHg	100.00
50-00-0	FORMALDEHYDE						87.9	294	MSDS, 37% soln.	87.900	mmHg	100.00
50-00-0	FORMALDEHYDE						87.9	294	MSDS, 37% soln.	87.900	mmHg	100.00
50-00-0	FORMALDEHYDE						87.9	294	MSDS, 37% soln.	87.900	mmHg	100.00
50-00-0	FORMALDEHYDE						87.9	294	MSDS, 37% soln.	87.900	mmHg	100.00
50-00-0	FORMALDEHYDE						87.9	294	MSDS, 37% soln.	87.900	mmHg	100.00
50-00-0	FORMALDEHYDE						87.9	294	MSDS, 37% soln.	87.900	mmHg	100.00
50-00-0	FORMALDEHYDE						87.9	294	MSDS, 37% soln.	87.900	mmHg	100.00
50-00-0	FORMALDEHYDE						87.9	294	MSDS, 37% soln.	87.900	mmHg	100.00
50-00-0	FORMALDEHYDE						87.9	294	MSDS, 37% soln.	87.900	mmHg	100.00
50-00-0	FORMALDEHYDE						87.9	294	MSDS, 37% soln.	87.900	mmHg	100.00
50-00-0	FORMALDEHYDE						87.9	294	MSDS, 37% soln.	87.900	mmHg	100.00
50-00-0	FORMALDEHYDE						87.9	294	MSDS, 37% soln.	87.900	mmHg	100.00
50-00-0	FORMALDEHYDE						87.9	294	MSDS, 37% soln.	87.900	mmHg	100.00
50-00-0	FORMALDEHYDE						87.9	294	MSDS, 37% soln.	87.900	mmHg	100.00
50-00-0	FORMALDEHYDE						87.9	294	MSDS, 37% soln.	87.900	mmHg	100.00
50-00-0	FORMALDEHYDE						87.9	294	MSDS, 37% soln.	87.900	mmHg	100.00
50-00-0	FORMALDEHYDE						87.9	294	MSDS, 37% soln.	87.900	mmHg	100.00
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50-00-0	FORMALDEHYDE						87.9	294	MSDS, 37% soln.	87.900	mmHg	100.00
50-00-0	FORMALDEHYDE						87.9	294	MSDS, 37% soln.	87.900	mmHg	100.00
50-00-0	FORMALDEHYDE						87.9	294	MSDS, 37% soln.	87.900	mmHg	100.00
50-00-0	FORMALDEHYDE						87.9	294	MSDS, 37% soln.	87.900	mmHg	100.00
50-00-0	FORMALDEHYDE						87.9	294	MSDS, 37% soln.	87.900	mmHg	100.00
50-00-0	FORMALDEHYDE						87.9	294	MSDS, 37% soln.	87.900	mmHg	100.00
50-00-0	FORMALDEHYDE SOLUTION						87.9	294	MSDS, 37% soln.	87.900	mmHg	100.00
50-00-0	FORMALDEHYDE						87.9	294	MSDS, 37% soln.	87.900	mmHg	100.00
50-00-0	FORMALDEHYDE						87.9	294	MSDS, 37% soln.	87.900	mmHg	100.00
50-00-0	FORMALDEHYDE						87.9	294	MSDS, 37% soln.	87.900	mmHg	100.00
50-00-0	FORMALDEHYDE						87.9	294	MSDS, 37% soln.	87.900	mmHg	100.00
50-00-0	FORMALDEHYDE SOLUTION						87.9	294	MSDS, 37% soln.	87.900	mmHg	100.00

a. If VP (@ ref temp) < 100 mmHg, then VP = Lesser of twice the VP (@ ref temp) or 100 mmHg
If VP (@ ref temp) >= 100 mmHg, then not adjusted

Golder Associates

Calculation of Liquid Chemical Emissions
Phase 1 Laboratory Usage Scenario
Proposed Richmond Bay Campus Long Range Development Plan, Richmond, California

Vapor Pressure Data (Table G-3)

Antoine Equation: $VP = 10^{[A - (B/(T+C))]}$

where: VP = Vapor Pressure (mmHg or bar, depending on source of A, B, C)
T = Temperature (K or C depending on source of A, B, C)
A, B, C = Antoine coefficients

(Reference Temperature should be near 295 deg K)

This list of chemicals comes from LBNL inventory data with solids & gases removed Must be identical to Chemical Inventory worksheet		*Must be entered manually* For Antoine Eq. @ 295 K				or	*Entered manually* Literature		*Entered manually*	*Calculated values*		*Calculated*
		Antoine Coefficients										
CAS No.	Compound Name	A	B	C	VP Units		VP @ Ref Temp (mmHg)	Ref Temp (K)	Vapor Pressure Reference	Vapor Pressure at Ref	Vapor Pressure at Ref (VP Units)	Adjusted Vapor Pressure [a] (mmHg)
50-00-0	FORMALDEHYDE SOLUTION						87.9	294	MSDS, 37% soln.	87.900	mmHg	100.00
50-00-0	FORMALDEHYDE SOLUTION						87.9	294	MSDS, 37% soln.	87.900	mmHg	100.00
50-00-0	FORMALDEHYDE SOLUTION						87.9	294	MSDS, 37% soln.	87.900	mmHg	100.00
50-00-0	FORMALDEHYDE						87.9	294	MSDS, 37% soln.	87.900	mmHg	100.00
50-00-0	NORTHERNMAX DENATURING GEL BUFFER						87.9	294	MSDS, 37% soln.	87.900	mmHg	100.00
50-00-0	FORMALDEHYDE						87.9	294	MSDS, 37% soln.	87.900	mmHg	100.00
50-00-0	FORMALDEHYDE						87.9	294	MSDS, 37% soln.	87.900	mmHg	100.00
50-00-0	FORMALDEHYDE						87.9	294	MSDS, 37% soln.	87.900	mmHg	100.00
50-00-0	FORMALDEHYDE						87.9	294	MSDS, 37% soln.	87.900	mmHg	100.00
50-00-0	FORMALDEHYDE						87.9	294	MSDS, 37% soln.	87.900	mmHg	100.00
50-00-0	FORMALIN SOLUTION 10%, NEUTRAL BUFFERED						87.9	294	MSDS, 37% soln.	87.900	mmHg	100.00
50-00-0	FORMALIN SOLUTION 10%, NEUTRAL BUFFERED						87.9	294	MSDS, 37% soln.	87.900	mmHg	100.00
50-00-0	FORMALIN SOLUTION 10%, NEUTRAL BUFFERED						87.9	294	MSDS, 37% soln.	87.900	mmHg	100.00
50-00-0	FORMALDEHYDE						87.9	294	MSDS, 37% soln.	87.900	mmHg	100.00
50-00-0	FORMALDEHYDE						87.9	294	MSDS, 37% soln.	87.900	mmHg	100.00
50-00-0	FORMALDEHYDE						87.9	294	MSDS, 37% soln.	87.900	mmHg	100.00
50-00-0	FORMALDEHYDE						87.9	294	MSDS, 37% soln.	87.900	mmHg	100.00
50-00-0	FORMALIN						87.9	294	MSDS, 37% soln.	87.900	mmHg	100.00
50-00-0	FORMALDEHYDE						87.9	294	MSDS, 37% soln.	87.900	mmHg	100.00
50-00-0	FORMALDEHYDE						87.9	294	MSDS, 37% soln.	87.900	mmHg	100.00
50-00-0	FORMALDEHYDE						87.9	294	MSDS, 37% soln.	87.900	mmHg	100.00
50-00-0	FORMALDEHYDE						87.9	294	MSDS, 37% soln.	87.900	mmHg	100.00
50-00-0	FORMALDEHYDE						87.9	294	MSDS, 37% soln.	87.900	mmHg	100.00
50-00-0	FORMALDEHYDE						87.9	294	MSDS, 37% soln.	87.900	mmHg	100.00
50-00-0	FORMALDEHYDE						87.9	294	MSDS, 37% soln.	87.900	mmHg	100.00
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50-00-0	FORMALDEHYDE						87.9	294	MSDS, 37% soln.	87.900	mmHg	100.00
50-00-0	FORMALDEHYDE						87.9	294	MSDS, 37% soln.	87.900	mmHg	100.00
50-00-0	FORMALDEHYDE						87.9	294	MSDS, 37% soln.	87.900	mmHg	100.00
50-00-0	FORMALIN SOLUTION 10%, NEUTRAL BUFFERED						87.9	294	MSDS, 37% soln.	87.900	mmHg	100.00
50-00-0	FORMALIN SOLUTION 10%, NEUTRAL BUFFERED						87.9	294	MSDS, 37% soln.	87.900	mmHg	100.00
50-00-0	FORMALIN SOLUTION 10%, NEUTRAL BUFFERED						87.9	294	MSDS, 37% soln.	87.900	mmHg	100.00
50-00-0	FORMALIN SOLUTION 10%, NEUTRAL BUFFERED						87.9	294	MSDS, 37% soln.	87.900	mmHg	100.00
50-00-0	FORMALIN SOLUTION 10%, NEUTRAL BUFFERED						87.9	294	MSDS, 37% soln.	87.900	mmHg	100.00
50-00-0	FORMALIN SOLUTION 10%, NEUTRAL BUFFERED						87.9	294	MSDS, 37% soln.	87.900	mmHg	100.00
50-00-0	FORMALINE SOLUTION ACCUSTAIN 10%						87.9	294	MSDS, 37% soln.	87.900	mmHg	100.00
50-00-0	FORMALDEHYDE						87.9	294	MSDS, 37% soln.	87.900	mmHg	100.00
50-00-0	FORMALDEHYDE						87.9	294	MSDS, 37% soln.	87.900	mmHg	100.00
50-00-0	FORMALDEHYDE						87.9	294	MSDS, 37% soln.	87.900	mmHg	100.00
50-00-0	FORMALDEHYDE						87.9	294	MSDS, 37% soln.	87.900	mmHg	100.00
50-00-0	FORMALDEHYDE						87.9	294	MSDS, 37% soln.	87.900	mmHg	100.00

a. If VP (@ ref temp) < 100 mmHg, then VP = Lesser of twice the VP (@ ref temp) or 100 mmHg
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Golder Associates

Calculation of Liquid Chemical Emissions
Phase 1 Laboratory Usage Scenario
Proposed Richmond Bay Campus Long Range Development Plan, Richmond, California

Vapor Pressure Data (Table G-3)

Antoine Equation: $VP = 10^{[A - (B/(T+C))]}$

where: VP = Vapor Pressure (mmHg or bar, depending on source of A, B, C)
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A, B, C = Antoine coefficients

(Reference Temperature should be near 295 deg K)

This list of chemicals comes from LBNL inventory data with solids & gases removed Must be identical to Chemical Inventory worksheet		*Must be entered manually* For Antoine Eq. @ 295 K				or	*Entered manually* Literature		*Entered manually*	*Calculated values*		*Calculated*
		Antoine Coefficients										
CAS No.	Compound Name	A	B	C	VP Units		VP @ Ref Temp (mmHg)	Ref Temp (K)	Vapor Pressure Reference	Vapor Pressure at Ref	Vapor Pressure at Ref (VP Units)	Adjusted Vapor Pressure [a] (mmHg)
50-00-0	FORMALINE SOLUTION ACCUSTAIN 10%						87.9	294	MSDS, 37% soln.	87.900	mmHg	100.00
50-00-0	NORTHERNMAX DENATURING GEL BUFFER						87.9	294	MSDS, 37% soln.	87.900	mmHg	100.00
50-00-0	FORMALDEHYDE SOLUTION						87.9	294	MSDS, 37% soln.	87.900	mmHg	100.00
50-00-0	FORMALDEHYDE						87.9	294	MSDS, 37% soln.	87.900	mmHg	100.00
50-00-0	FORMALDEHYDE SOLUTION						87.9	294	MSDS, 37% soln.	87.900	mmHg	100.00
50-00-0	FORMALDEHYDE SOLUTION						87.9	294	MSDS, 37% soln.	87.900	mmHg	100.00
50-00-0	FORMALDEHYDE						87.9	294	MSDS, 37% soln.	87.900	mmHg	100.00
50-00-0	FORMALDEHYDE SOLUTION						87.9	294	MSDS, 37% soln.	87.900	mmHg	100.00
50-00-0	FORMALDEHYDE						87.9	294	MSDS, 37% soln.	87.900	mmHg	100.00
50-00-0	FORMALDEHYDE						87.9	294	MSDS, 37% soln.	87.900	mmHg	100.00
50-00-0	FORMALDEHYDE						87.9	294	MSDS, 37% soln.	87.900	mmHg	100.00
50-00-0	FORMALIN SOLUTION 10%, NEUTRAL BUFFERED						87.9	294	MSDS, 37% soln.	87.900	mmHg	100.00
50-00-0	FORMALDEHYDE						87.9	294	MSDS, 37% soln.	87.900	mmHg	100.00
50-00-0	BUFFERED NEUTRAL FORMALIN						87.9	294	MSDS, 37% soln.	87.900	mmHg	100.00
50-00-0	FORMALDEHYDE						87.9	294	MSDS, 37% soln.	87.900	mmHg	100.00
50-00-0	FORMALDEHYDE						87.9	294	MSDS, 37% soln.	87.900	mmHg	100.00
50-00-0	FORMALDEHYDE						87.9	294	MSDS, 37% soln.	87.900	mmHg	100.00
50-00-0	FORMALDEHYDE						87.9	294	MSDS, 37% soln.	87.900	mmHg	100.00
50-00-0	FORMALDEHYDE						87.9	294	MSDS, 37% soln.	87.900	mmHg	100.00
50-00-0	FORMALDEHYDE						87.9	294	MSDS, 37% soln.	87.900	mmHg	100.00
50-00-0	FORMALDEHYDE						87.9	294	MSDS, 37% soln.	87.900	mmHg	100.00
50-00-0	FORMALINE SOLUTION ACCUSTAIN 10%						87.9	294	MSDS, 37% soln.	87.900	mmHg	100.00
50-00-0	FORMALDEHYDE						87.9	294	MSDS, 37% soln.	87.900	mmHg	100.00
50-00-0	FORMALIN SOLUTION 10%, NEUTRAL BUFFERED						87.9	294	MSDS, 37% soln.	87.900	mmHg	100.00
50-00-0	FORMALIN SOLUTION 10%, NEUTRAL BUFFERED						87.9	294	MSDS, 37% soln.	87.900	mmHg	100.00
50-00-0	FORMALIN SOLUTION 10%, NEUTRAL BUFFERED						87.9	294	MSDS, 37% soln.	87.900	mmHg	100.00
50-00-0	FORMALIN SOLUTION 10%, NEUTRAL BUFFERED						87.9	294	MSDS, 37% soln.	87.900	mmHg	100.00
50-00-0	FORMALDEHYDE SOLUTION						87.9	294	MSDS, 37% soln.	87.900	mmHg	100.00
50-00-0	FORMALDEHYDE						87.9	294	MSDS, 37% soln.	87.900	mmHg	100.00
50-00-0	FORMALDEHYDE						87.9	294	MSDS, 37% soln.	87.900	mmHg	100.00
50-00-0	FORMALDEHYDE						87.9	294	MSDS, 37% soln.	87.900	mmHg	100.00
50-00-0	FORMALDEHYDE						87.9	294	MSDS, 37% soln.	87.900	mmHg	100.00
50-00-0	FORMALIN SOLUTION						87.9	294	MSDS, 37% soln.	87.900	mmHg	100.00
50-00-0	FORMALDEHYDE SOLUTION						87.9	294	MSDS, 37% soln.	87.900	mmHg	100.00
50-00-0	FORMALDEHYDE						87.9	294	MSDS, 37% soln.	87.900	mmHg	100.00
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50-00-0	FORMALDEHYDE						87.9	294	MSDS, 37% soln.	87.900	mmHg	100.00
50-00-0	FORMALDEHYDE						87.9	294	MSDS, 37% soln.	87.900	mmHg	100.00
50-00-0	FORMALIN SOLUTION 10%, NEUTRAL BUFFERED						87.9	294	MSDS, 37% soln.	87.900	mmHg	100.00
50-00-0	FORMALDEHYDE						87.9	294	MSDS, 37% soln.	87.900	mmHg	100.00
50-00-0	FORMALDEHYDE, 37 WT IN H2O						87.9	294	MSDS, 37% soln.	87.900	mmHg	100.00
50-00-0	FORMALDEHYDE						87.9	294	MSDS, 37% soln.	87.900	mmHg	100.00
50-00-0	FORMALDEHYDE, 37 WT						87.9	294	MSDS, 37% soln.	87.900	mmHg	100.00
50-00-0	FORMALDEHYDE 37 % IN WATER						87.9	294	MSDS, 37% soln.	87.900	mmHg	100.00
50-00-0	FORMALDEHYDE						87.9	294	MSDS, 37% soln.	87.900	mmHg	100.00
50-00-0	FORMALDEHYDE						87.9	294	MSDS, 37% soln.	87.900	mmHg	100.00

a. If VP (@ ref temp) < 100 mmHg, then VP = Lesser of twice the VP (@ ref temp) or 100 mmHg
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Vapor Pressure Data (Table G-3)

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where: VP = Vapor Pressure (mmHg or bar, depending on source of A, B, C)
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(Reference Temperature should be near 295 deg K)

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		Antoine Coefficients										
CAS No.	Compound Name	A	B	C	VP Units		VP @ Ref Temp (mmHg)	Ref Temp (K)	Vapor Pressure Reference	Vapor Pressure at Ref	Vapor Pressure at Ref (VP Units)	Adjusted Vapor Pressure [a] (mmHg)
50-00-0	FORMALDEHYDE						87.9	294	MSDS, 37% soln.	87.900	mmHg	100.00
50-00-0	FORMALDEHYDE						87.9	294	MSDS, 37% soln.	87.900	mmHg	100.00
50-00-0	FORMALDEHYDE SOLUTION						87.9	294	MSDS, 37% soln.	87.900	mmHg	100.00
50-00-0	FORMALIN						87.9	294	MSDS, 37% soln.	87.900	mmHg	100.00
56-23-5	CARBON TETRACHLORIDE	6.87926	1212.021	226.41	mmHg				LBNL Data File	99.357	mmHg	100.00
58-89-9	CYCLOHEXANE, 1,2,3,4,5,6-HEXACHLORO-, GAMMA-ISOMER						0.000006	293	MSDS	0.000	mmHg	0.00
58-89-9	CYCLOHEXANE, 1,2,3,4,5,6-HEXACHLORO-, GAMMA-ISOMER						0.000006	293	MSDS	0.000	mmHg	0.00
58-89-9	CYCLOHEXANE, 1,2,3,4,5,6-HEXACHLORO-, GAMMA-ISOMER						0.000006	293	MSDS	0.000	mmHg	0.00
58-89-9	CYCLOHEXANE, 1,2,3,4,5,6-HEXACHLORO-, GAMMA-ISOMER						0.000006	293	MSDS	0.000	mmHg	0.00
62-53-3	ANILINE OIL	7.3201	1731.515	206.049	mmHg				LBNL Data File	0.528	mmHg	1.06
62-53-3	BENZAMINE	7.3201	1731.515	206.049	mmHg				LBNL Data File	0.528	mmHg	1.06
67-56-1	METHANOL	7.8975	1474.08	229.13	mmHg				LBNL Data File	105.731	mmHg	105.73
67-56-1	METHANOL	7.8975	1474.08	229.13	mmHg				LBNL Data File	105.731	mmHg	105.73
67-56-1	METHANOL	7.8975	1474.08	229.13	mmHg				LBNL Data File	105.731	mmHg	105.73
67-56-1	METHANOL	7.8975	1474.08	229.13	mmHg				LBNL Data File	105.731	mmHg	105.73
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67-56-1	METHANOL	7.8975	1474.08	229.13	mmHg				LBNL Data File	105.731	mmHg	105.73
67-56-1	METHANOL	7.8975	1474.08	229.13	mmHg				LBNL Data File	105.731	mmHg	105.73
67-56-1	COMBI METHANOL	7.8975	1474.08	229.13	mmHg				LBNL Data File	105.731	mmHg	105.73
67-56-1	METHANOL	7.8975	1474.08	229.13	mmHg				LBNL Data File	105.731	mmHg	105.73
67-56-1	METHANOL	7.8975	1474.08	229.13	mmHg				LBNL Data File	105.731	mmHg	105.73
67-56-1	METHANOL	7.8975	1474.08	229.13	mmHg				LBNL Data File	105.731	mmHg	105.73
67-56-1	METHANOL	7.8975	1474.08	229.13	mmHg				LBNL Data File	105.731	mmHg	105.73
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67-56-1	METHANOL	7.8975	1474.08	229.13	mmHg				LBNL Data File	105.731	mmHg	105.73
67-56-1	METHANOL	7.8975	1474.08	229.13	mmHg				LBNL Data File	105.731	mmHg	105.73
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67-56-1	METHANOL	7.8975	1474.08	229.13	mmHg				LBNL Data File	105.731	mmHg	105.73
67-56-1	METHANOL	7.8975	1474.08	229.13	mmHg				LBNL Data File	105.731	mmHg	105.73
67-56-1	METHANOL	7.8975	1474.08	229.13	mmHg				LBNL Data File	105.731	mmHg	105.73
67-56-1	METHANOL	7.8975	1474.08	229.13	mmHg				LBNL Data File	105.731	mmHg	105.73
67-56-1	METHANOL	7.8975	1474.08	229.13	mmHg				LBNL Data File	105.731	mmHg	105.73
67-56-1	METHANOL	7.8975	1474.08	229.13	mmHg				LBNL Data File	105.731	mmHg	105.73

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Golder Associates

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Vapor Pressure Data (Table G-3)

Antoine Equation: $VP = 10^{[A - (B/(T+C))]}$

where: VP = Vapor Pressure (mmHg or bar, depending on source of A, B, C)
T = Temperature (K or C depending on source of A, B, C)
A, B, C = Antoine coefficients

(Reference Temperature should be near 295 deg K)

This list of chemicals comes from LBNL inventory data with solids & gases removed Must be identical to Chemical Inventory worksheet		*Must be entered manually* For Antoine Eq. @ 295 K				or	*Entered manually* Literature		*Entered manually*	*Calculated values*		*Calculated*
		Antoine Coefficients										
CAS No.	Compound Name	A	B	C	VP Units		VP @ Ref Temp (mmHg)	Ref Temp (K)	Vapor Pressure Reference	Vapor Pressure at Ref	Vapor Pressure at Ref (VP Units)	Adjusted Vapor Pressure [a] (mmHg)
67-56-1	METHANOL	7.8975	1474.08	229.13	mmHg				LBNL Data File	105.731	mmHg	105.73
67-56-1	METHANOL	7.8975	1474.08	229.13	mmHg				LBNL Data File	105.731	mmHg	105.73
67-56-1	METHANOL	7.8975	1474.08	229.13	mmHg				LBNL Data File	105.731	mmHg	105.73
67-56-1	METHANOL	7.8975	1474.08	229.13	mmHg				LBNL Data File	105.731	mmHg	105.73
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67-56-1	METHANOL	7.8975	1474.08	229.13	mmHg				LBNL Data File	105.731	mmHg	105.73
67-56-1	METHANOL	7.8975	1474.08	229.13	mmHg				LBNL Data File	105.731	mmHg	105.73
67-56-1	METHANOL	7.8975	1474.08	229.13	mmHg				LBNL Data File	105.731	mmHg	105.73
67-56-1	METHANOL	7.8975	1474.08	229.13	mmHg				LBNL Data File	105.731	mmHg	105.73
67-56-1	METHANOL	7.8975	1474.08	229.13	mmHg				LBNL Data File	105.731	mmHg	105.73
67-56-1	METHANOL	7.8975	1474.08	229.13	mmHg				LBNL Data File	105.731	mmHg	105.73
67-56-1	METHANOL	7.8975	1474.08	229.13	mmHg				LBNL Data File	105.731	mmHg	105.73
67-56-1	METHANOL	7.8975	1474.08	229.13	mmHg				LBNL Data File	105.731	mmHg	105.73
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67-56-1	METHANOL	7.8975	1474.08	229.13	mmHg				LBNL Data File	105.731	mmHg	105.73
67-56-1	METHANOL	7.8975	1474.08	229.13	mmHg				LBNL Data File	105.731	mmHg	105.73
67-56-1	METHANOL	7.8975	1474.08	229.13	mmHg				LBNL Data File	105.731	mmHg	105.73
67-56-1	METHANOL	7.8975	1474.08	229.13	mmHg				LBNL Data File	105.731	mmHg	105.73

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Antoine Equation: $VP = 10^{[A - (B/(T+C))]}$

where: VP = Vapor Pressure (mmHg or bar, depending on source of A, B, C)
T = Temperature (K or C depending on source of A, B, C)
A, B, C = Antoine coefficients

(Reference Temperature should be near 295 deg K)

This list of chemicals comes from LBNL inventory data with solids & gases removed Must be identical to Chemical Inventory worksheet		*Must be entered manually* For Antoine Eq. @ 295 K				or	*Entered manually* Literature		*Entered manually*	*Calculated values*		*Calculated*
		Antoine Coefficients										
CAS No.	Compound Name	A	B	C	VP Units		VP @ Ref Temp (mmHg)	Ref Temp (K)	Vapor Pressure Reference	Vapor Pressure at Ref	Vapor Pressure at Ref (VP Units)	Adjusted Vapor Pressure [a] (mmHg)
67-56-1	METHANOL	7.8975	1474.08	229.13	mmHg				LBNL Data File	105.731	mmHg	105.73
67-56-1	METHANOL	7.8975	1474.08	229.13	mmHg				LBNL Data File	105.731	mmHg	105.73
67-56-1	METHANOL	7.8975	1474.08	229.13	mmHg				LBNL Data File	105.731	mmHg	105.73
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67-56-1	METHANOL	7.8975	1474.08	229.13	mmHg				LBNL Data File	105.731	mmHg	105.73
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67-56-1	METHANOL	7.8975	1474.08	229.13	mmHg				LBNL Data File	105.731	mmHg	105.73
67-56-1	METHANOL	7.8975	1474.08	229.13	mmHg				LBNL Data File	105.731	mmHg	105.73
67-56-1	HYDRA-POINT METHANOL, DRY	7.8975	1474.08	229.13	mmHg				LBNL Data File	105.731	mmHg	105.73
67-56-1	HYDRA-POINT METHANOL, DRY	7.8975	1474.08	229.13	mmHg				LBNL Data File	105.731	mmHg	105.73
67-56-1	AMMONIA 7N SOLUTION IN METHANOL	7.8975	1474.08	229.13	mmHg				LBNL Data File	105.731	mmHg	105.73
67-56-1	METHANOL	7.8975	1474.08	229.13	mmHg				LBNL Data File	105.731	mmHg	105.73
67-56-1	METHANOL	7.8975	1474.08	229.13	mmHg				LBNL Data File	105.731	mmHg	105.73
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This list of chemicals comes from LBNL inventory data with solids & gases removed Must be identical to Chemical Inventory worksheet		*Must be entered manually* For Antoine Eq. @ 295 K				or	*Entered manually* Literature		*Entered manually*	*Calculated values*		*Calculated*
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CAS No.	Compound Name	A	B	C	VP Units		VP @ Ref Temp (mmHg)	Ref Temp (K)	Vapor Pressure Reference	Vapor Pressure at Ref	Vapor Pressure at Ref (VP Units)	Adjusted Vapor Pressure [a] (mmHg)
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67-56-1	METHANOL	7.8975	1474.08	229.13	mmHg				LBNL Data File	105.731	mmHg	105.73
67-56-1	METHANOL	7.8975	1474.08	229.13	mmHg				LBNL Data File	105.731	mmHg	105.73
67-56-1	METHANOL	7.8975	1474.08	229.13	mmHg				LBNL Data File	105.731	mmHg	105.73
67-56-1	METHANOL	7.8975	1474.08	229.13	mmHg				LBNL Data File	105.731	mmHg	105.73
67-56-1	METHANOL	7.8975	1474.08	229.13	mmHg				LBNL Data File	105.731	mmHg	105.73
67-56-1	METHANOL	7.8975	1474.08	229.13	mmHg				LBNL Data File	105.731	mmHg	105.73
67-56-1	METHANOL	7.8975	1474.08	229.13	mmHg				LBNL Data File	105.731	mmHg	105.73
67-56-1	METHANOL	7.8975	1474.08	229.13	mmHg				LBNL Data File	105.731	mmHg	105.73
67-56-1	METHANOL	7.8975	1474.08	229.13	mmHg				LBNL Data File	105.731	mmHg	105.73
67-56-1	METHANOL	7.8975	1474.08	229.13	mmHg				LBNL Data File	105.731	mmHg	105.73
67-63-0	ISOPROPYL ALCOHOL (2)	8.11778	1580.92	219.61	mmHg				LBNL Data File	37.191	mmHg	74.38
67-63-0	ISOPROPYL ALCOHOL	8.11778	1580.92	219.61	mmHg				LBNL Data File	37.191	mmHg	74.38
67-63-0	ISOPROPANOL	8.11778	1580.92	219.61	mmHg				LBNL Data File	37.191	mmHg	74.38
67-63-0	ISOPROPYL ALCOHOL	8.11778	1580.92	219.61	mmHg				LBNL Data File	37.191	mmHg	74.38
67-63-0	ISOPROPYL ALCOHOL	8.11778	1580.92	219.61	mmHg				LBNL Data File	37.191	mmHg	74.38
67-63-0	ISOPROPANOL	8.11778	1580.92	219.61	mmHg				LBNL Data File	37.191	mmHg	74.38
67-63-0	ISOPROPYL ALCOHOL	8.11778	1580.92	219.61	mmHg				LBNL Data File	37.191	mmHg	74.38
67-63-0	ISOPROPYL ALCOHOL	8.11778	1580.92	219.61	mmHg				LBNL Data File	37.191	mmHg	74.38

a. If VP (@ ref temp) < 100 mmHg, then VP = Lesser of twice the VP (@ ref temp) or 100 mmHg
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Golder Associates

Calculation of Liquid Chemical Emissions
Phase 1 Laboratory Usage Scenario
Proposed Richmond Bay Campus Long Range Development Plan, Richmond, California

Vapor Pressure Data (Table G-3)

Antoine Equation: $VP = 10^{[A - (B/(T+C))]}$

where: VP = Vapor Pressure (mmHg or bar, depending on source of A, B, C)
T = Temperature (K or C depending on source of A, B, C)
A, B, C = Antoine coefficients

(Reference Temperature should be near 295 deg K)

This list of chemicals comes from LBNL inventory data with solids & gases removed Must be identical to Chemical Inventory worksheet		*Must be entered manually* For Antoine Eq. @ 295 K				or	*Entered manually* Literature		*Entered manually*	*Calculated values*		*Calculated*
		Antoine Coefficients										
CAS No.	Compound Name	A	B	C	VP Units		VP @ Ref Temp (mmHg)	Ref Temp (K)	Vapor Pressure Reference	Vapor Pressure at Ref	Vapor Pressure at Ref (VP Units)	Adjusted Vapor Pressure [a] (mmHg)
67-63-0	ISOPROPANOL	8.11778	1580.92	219.61	mmHg				LBNL Data File	37.191	mmHg	74.38
67-63-0	ISOPROPYL ALCOHOL	8.11778	1580.92	219.61	mmHg				LBNL Data File	37.191	mmHg	74.38
67-63-0	2-PROPANOL	8.11778	1580.92	219.61	mmHg				LBNL Data File	37.191	mmHg	74.38
67-63-0	ISOPROPYL ALCOHOL	8.11778	1580.92	219.61	mmHg				LBNL Data File	37.191	mmHg	74.38
67-63-0	ISOPROPANOL	8.11778	1580.92	219.61	mmHg				LBNL Data File	37.191	mmHg	74.38
67-63-0	2-PROPANOL	8.11778	1580.92	219.61	mmHg				LBNL Data File	37.191	mmHg	74.38
67-63-0	ISOPROPYL ALCOHOL	8.11778	1580.92	219.61	mmHg				LBNL Data File	37.191	mmHg	74.38
67-63-0	ISOPROPYL ALCOHOL	8.11778	1580.92	219.61	mmHg				LBNL Data File	37.191	mmHg	74.38
67-63-0	2-PROPANOL	8.11778	1580.92	219.61	mmHg				LBNL Data File	37.191	mmHg	74.38
67-63-0	ISOPROPANOL	8.11778	1580.92	219.61	mmHg				LBNL Data File	37.191	mmHg	74.38
67-63-0	2-PROPANOL	8.11778	1580.92	219.61	mmHg				LBNL Data File	37.191	mmHg	74.38
67-63-0	ISOPROPYL ALCOHOL	8.11778	1580.92	219.61	mmHg				LBNL Data File	37.191	mmHg	74.38
67-63-0	ISOPROPANOL	8.11778	1580.92	219.61	mmHg				LBNL Data File	37.191	mmHg	74.38
67-63-0	2-PROPANOL	8.11778	1580.92	219.61	mmHg				LBNL Data File	37.191	mmHg	74.38
67-63-0	ISOPROPYL ALCOHOL	8.11778	1580.92	219.61	mmHg				LBNL Data File	37.191	mmHg	74.38
67-63-0	ISOPROPYL ALCOHOL	8.11778	1580.92	219.61	mmHg				LBNL Data File	37.191	mmHg	74.38
67-63-0	2-PROPANOL	8.11778	1580.92	219.61	mmHg				LBNL Data File	37.191	mmHg	74.38
67-63-0	2-PROPANOL	8.11778	1580.92	219.61	mmHg				LBNL Data File	37.191	mmHg	74.38
67-63-0	2-PROPANOL	8.11778	1580.92	219.61	mmHg				LBNL Data File	37.191	mmHg	74.38
67-63-0	2-PROPANOL	8.11778	1580.92	219.61	mmHg				LBNL Data File	37.191	mmHg	74.38
67-63-0	2-PROPANOL	8.11778	1580.92	219.61	mmHg				LBNL Data File	37.191	mmHg	74.38
67-63-0	2-PROPANOL	8.11778	1580.92	219.61	mmHg				LBNL Data File	37.191	mmHg	74.38
67-63-0	2-PROPANOL	8.11778	1580.92	219.61	mmHg				LBNL Data File	37.191	mmHg	74.38
67-63-0	2-PROPANOL	8.11778	1580.92	219.61	mmHg				LBNL Data File	37.191	mmHg	74.38
67-63-0	2-PROPANOL	8.11778	1580.92	219.61	mmHg				LBNL Data File	37.191	mmHg	74.38
67-63-0	ISOPROPYL ALCOHOL	8.11778	1580.92	219.61	mmHg				LBNL Data File	37.191	mmHg	74.38
67-63-0	2-PROPANOL	8.11778	1580.92	219.61	mmHg				LBNL Data File	37.191	mmHg	74.38
67-63-0	2-PROPANOL	8.11778	1580.92	219.61	mmHg				LBNL Data File	37.191	mmHg	74.38
67-63-0	2-PROPANOL	8.11778	1580.92	219.61	mmHg				LBNL Data File	37.191	mmHg	74.38
67-63-0	ISOPROPYL ALCOHOL	8.11778	1580.92	219.61	mmHg				LBNL Data File	37.191	mmHg	74.38
67-63-0	ISOPROPYL ALCOHOL	8.11778	1580.92	219.61	mmHg				LBNL Data File	37.191	mmHg	74.38
67-63-0	ISOPROPYL ALCOHOL	8.11778	1580.92	219.61	mmHg				LBNL Data File	37.191	mmHg	74.38
67-63-0	ISOPROPYL ALCOHOL	8.11778	1580.92	219.61	mmHg				LBNL Data File	37.191	mmHg	74.38
67-63-0	ISOPROPYL ALCOHOL	8.11778	1580.92	219.61	mmHg				LBNL Data File	37.191	mmHg	74.38
67-63-0	ISOPROPYL ALCOHOL	8.11778	1580.92	219.61	mmHg				LBNL Data File	37.191	mmHg	74.38
67-63-0	ISOPROPYL ALCOHOL	8.11778	1580.92	219.61	mmHg				LBNL Data File	37.191	mmHg	74.38
67-63-0	2-PROPANOL	8.11778	1580.92	219.61	mmHg				LBNL Data File	37.191	mmHg	74.38
67-63-0	ISOPROPYL ALCOHOL	8.11778	1580.92	219.61	mmHg				LBNL Data File	37.191	mmHg	74.38
67-63-0	ISOPROPYL ALCOHOL	8.11778	1580.92	219.61	mmHg				LBNL Data File	37.191	mmHg	74.38
67-63-0	ISOPROPYL	8.11778	1580.92	219.61	mmHg				LBNL Data File	37.191	mmHg	74.38
67-63-0	2-PROPANOL	8.11778	1580.92	219.61	mmHg				LBNL Data File	37.191	mmHg	74.38
67-63-0	ISOPROPYL ALCOHOL	8.11778	1580.92	219.61	mmHg				LBNL Data File	37.191	mmHg	74.38
67-63-0	ISOPROPYL ALCOHOL	8.11778	1580.92	219.61	mmHg				LBNL Data File	37.191	mmHg	74.38
67-63-0	ISOPROPYL ALCOHOL	8.11778	1580.92	219.61	mmHg				LBNL Data File	37.191	mmHg	74.38
67-63-0	ISOPROPYL ALCOHOL	8.11778	1580.92	219.61	mmHg				LBNL Data File	37.191	mmHg	74.38
67-63-0	ISOPROPYL ALCOHOL	8.11778	1580.92	219.61	mmHg				LBNL Data File	37.191	mmHg	74.38

a. If VP (@ ref temp) < 100 mmHg, then VP = Lesser of twice the VP (@ ref temp) or 100 mmHg
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Golder Associates

Calculation of Liquid Chemical Emissions
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Vapor Pressure Data (Table G-3)

Antoine Equation: $VP = 10^{[A - (B/(T+C))]}$

where: VP = Vapor Pressure (mmHg or bar, depending on source of A, B, C)
T = Temperature (K or C depending on source of A, B, C)
A, B, C = Antoine coefficients

(Reference Temperature should be near 295 deg K)

This list of chemicals comes from LBNL inventory data with solids & gases removed Must be identical to Chemical Inventory worksheet		*Must be entered manually* For Antoine Eq. @ 295 K				or	*Entered manually* Literature		*Entered manually*	*Calculated values*		*Calculated*
		Antoine Coefficients										
CAS No.	Compound Name	A	B	C	VP Units		VP @ Ref Temp (mmHg)	Ref Temp (K)	Vapor Pressure Reference	Vapor Pressure at Ref	Vapor Pressure at Ref (VP Units)	Adjusted Vapor Pressure [a] (mmHg)
67-63-0	ISOPROPYL ALCOHOL	8.11778	1580.92	219.61	mmHg				LBNL Data File	37.191	mmHg	74.38
67-63-0	2-PROPANOL	8.11778	1580.92	219.61	mmHg				LBNL Data File	37.191	mmHg	74.38
67-63-0	ISOPROPYL ALCOHOL	8.11778	1580.92	219.61	mmHg				LBNL Data File	37.191	mmHg	74.38
67-63-0	ISOPROPYL ALCOHOL	8.11778	1580.92	219.61	mmHg				LBNL Data File	37.191	mmHg	74.38
67-63-0	2-PROPANOL	8.11778	1580.92	219.61	mmHg				LBNL Data File	37.191	mmHg	74.38
67-63-0	2-PROPANOL	8.11778	1580.92	219.61	mmHg				LBNL Data File	37.191	mmHg	74.38
67-63-0	2-PROPANOL	8.11778	1580.92	219.61	mmHg				LBNL Data File	37.191	mmHg	74.38
67-63-0	2-PROPANOL	8.11778	1580.92	219.61	mmHg				LBNL Data File	37.191	mmHg	74.38
67-63-0	ISOPROPANOL	8.11778	1580.92	219.61	mmHg				LBNL Data File	37.191	mmHg	74.38
67-63-0	ISOPROPANOL	8.11778	1580.92	219.61	mmHg				LBNL Data File	37.191	mmHg	74.38
67-63-0	ISOPROPANOL	8.11778	1580.92	219.61	mmHg				LBNL Data File	37.191	mmHg	74.38
67-63-0	ISOPROPYL ALCOHOL	8.11778	1580.92	219.61	mmHg				LBNL Data File	37.191	mmHg	74.38
67-63-0	ISOPROPYL ALCOHOL	8.11778	1580.92	219.61	mmHg				LBNL Data File	37.191	mmHg	74.38
67-63-0	ISOPROPYL ALCOHOL	8.11778	1580.92	219.61	mmHg				LBNL Data File	37.191	mmHg	74.38
67-63-0	ISOPROPYL ALCOHOL	8.11778	1580.92	219.61	mmHg				LBNL Data File	37.191	mmHg	74.38
67-63-0	ISOPROPYL ALCOHOL	8.11778	1580.92	219.61	mmHg				LBNL Data File	37.191	mmHg	74.38
67-63-0	ISOPROPANOL	8.11778	1580.92	219.61	mmHg				LBNL Data File	37.191	mmHg	74.38
67-63-0	ISOPROPANOL	8.11778	1580.92	219.61	mmHg				LBNL Data File	37.191	mmHg	74.38
67-63-0	2-PROPANOL	8.11778	1580.92	219.61	mmHg				LBNL Data File	37.191	mmHg	74.38
67-63-0	ISOPROPANOL	8.11778	1580.92	219.61	mmHg				LBNL Data File	37.191	mmHg	74.38
67-63-0	ISOPROPANOL	8.11778	1580.92	219.61	mmHg				LBNL Data File	37.191	mmHg	74.38
67-63-0	2-PROPANOL	8.11778	1580.92	219.61	mmHg				LBNL Data File	37.191	mmHg	74.38
67-63-0	ISOPROPYL ALCOHOL	8.11778	1580.92	219.61	mmHg				LBNL Data File	37.191	mmHg	74.38
67-63-0	ISOPROPYL ALCOHOL	8.11778	1580.92	219.61	mmHg				LBNL Data File	37.191	mmHg	74.38
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67-63-0	ISOPROPYL ALCOHOL	8.11778	1580.92	219.61	mmHg				LBNL Data File	37.191	mmHg	74.38
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67-63-0	ISOPROPYL ALCOHOL	8.11778	1580.92	219.61	mmHg				LBNL Data File	37.191	mmHg	74.38
67-63-0	ISOPROPYL ALCOHOL	8.11778	1580.92	219.61	mmHg				LBNL Data File	37.191	mmHg	74.38
67-63-0	2-PROPANOL	8.11778	1580.92	219.61	mmHg				LBNL Data File	37.191	mmHg	74.38
67-63-0	2-PROPANOL	8.11778	1580.92	219.61	mmHg				LBNL Data File	37.191	mmHg	74.38
67-63-0	2-PROPANOL	8.11778	1580.92	219.61	mmHg				LBNL Data File	37.191	mmHg	74.38
67-63-0	ISOPROPYL ALCOHOL	8.11778	1580.92	219.61	mmHg				LBNL Data File	37.191	mmHg	74.38
67-63-0	2-PROPANOL	8.11778	1580.92	219.61	mmHg				LBNL Data File	37.191	mmHg	74.38
67-63-0	ISOPROPYL ALCOHOL	8.11778	1580.92	219.61	mmHg				LBNL Data File	37.191	mmHg	74.38
67-63-0	ISOPROPYL ALCOHOL	8.11778	1580.92	219.61	mmHg				LBNL Data File	37.191	mmHg	74.38
67-63-0	ISOPROPYL ALCOHOL	8.11778	1580.92	219.61	mmHg				LBNL Data File	37.191	mmHg	74.38
67-63-0	ISOPROPYL ALCOHOL	8.11778	1580.92	219.61	mmHg				LBNL Data File	37.191	mmHg	74.38
67-63-0	ISOPROPYL ALCOHOL	8.11778	1580.92	219.61	mmHg				LBNL Data File	37.191	mmHg	74.38
67-63-0	ISOPROPYL ALCOHOL	8.11778	1580.92	219.61	mmHg				LBNL Data File	37.191	mmHg	74.38
67-63-0	ISOPROPYL ALCOHOL	8.11778	1580.92	219.61	mmHg				LBNL Data File	37.191	mmHg	74.38
67-63-0	2-PROPANOL	8.11778	1580.92	219.61	mmHg				LBNL Data File	37.191	mmHg	74.38
67-63-0	2-PROPANOL	8.11778	1580.92	219.61	mmHg				LBNL Data File	37.191	mmHg	74.38
67-63-0	ISOPROPANOL	8.11778	1580.92	219.61	mmHg				LBNL Data File	37.191	mmHg	74.38
67-63-0	ISOPROPANOL	8.11778	1580.92	219.61	mmHg				LBNL Data File	37.191	mmHg	74.38
67-63-0	ISOPROPYL ALCOHOL	8.11778	1580.92	219.61	mmHg				LBNL Data File	37.191	mmHg	74.38

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Vapor Pressure Data (Table G-3)

Antoine Equation: $VP = 10^{[A - (B/(T+C))]}$

where: VP = Vapor Pressure (mmHg or bar, depending on source of A, B, C)
T = Temperature (K or C depending on source of A, B, C)
A, B, C = Antoine coefficients

(Reference Temperature should be near 295 deg K)

This list of chemicals comes from LBNL inventory data with solids & gases removed Must be identical to Chemical Inventory worksheet		*Must be entered manually* For Antoine Eq. @ 295 K				or	*Entered manually* Literature		*Entered manually*	*Calculated values*		*Calculated*
		Antoine Coefficients										
CAS No.	Compound Name	A	B	C	VP Units		VP @ Ref Temp (mmHg)	Ref Temp (K)	Vapor Pressure Reference	Vapor Pressure at Ref	Vapor Pressure at Ref (VP Units)	Adjusted Vapor Pressure [a] (mmHg)
67-63-0	ISOPROPYL ALCOHOL	8.11778	1580.92	219.61	mmHg				LBNL Data File	37.191	mmHg	74.38
67-63-0	ISOPROPYL ALCOHOL	8.11778	1580.92	219.61	mmHg				LBNL Data File	37.191	mmHg	74.38
67-63-0	ISOPROPYL ALCOHOL	8.11778	1580.92	219.61	mmHg				LBNL Data File	37.191	mmHg	74.38
67-63-0	ISOPROPYL ALCOHOL	8.11778	1580.92	219.61	mmHg				LBNL Data File	37.191	mmHg	74.38
67-63-0	ISOPROPYL ALCOHOL	8.11778	1580.92	219.61	mmHg				LBNL Data File	37.191	mmHg	74.38
67-63-0	ISOPROPYL ALCOHOL	8.11778	1580.92	219.61	mmHg				LBNL Data File	37.191	mmHg	74.38
67-63-0	ISOPROPYL ALCOHOL	8.11778	1580.92	219.61	mmHg				LBNL Data File	37.191	mmHg	74.38
67-63-0	ISOPROPANOL ALCOHOL	8.11778	1580.92	219.61	mmHg				LBNL Data File	37.191	mmHg	74.38
67-63-0	ISOPROPANOL ALCOHOL	8.11778	1580.92	219.61	mmHg				LBNL Data File	37.191	mmHg	74.38
67-63-0	2-PROPANOL	8.11778	1580.92	219.61	mmHg				LBNL Data File	37.191	mmHg	74.38
67-63-0	2-PROPANOL	8.11778	1580.92	219.61	mmHg				LBNL Data File	37.191	mmHg	74.38
67-63-0	2-PROPANOL	8.11778	1580.92	219.61	mmHg				LBNL Data File	37.191	mmHg	74.38
67-63-0	2-PROPANOL	8.11778	1580.92	219.61	mmHg				LBNL Data File	37.191	mmHg	74.38
67-63-0	2-PROPANOL	8.11778	1580.92	219.61	mmHg				LBNL Data File	37.191	mmHg	74.38
67-63-0	2-PROPANOL	8.11778	1580.92	219.61	mmHg				LBNL Data File	37.191	mmHg	74.38
67-63-0	2-PROPANOL	8.11778	1580.92	219.61	mmHg				LBNL Data File	37.191	mmHg	74.38
67-63-0	2-PROPANOL	8.11778	1580.92	219.61	mmHg				LBNL Data File	37.191	mmHg	74.38
67-63-0	2-PROPANOL	8.11778	1580.92	219.61	mmHg				LBNL Data File	37.191	mmHg	74.38
67-63-0	2-PROPANOL	8.11778	1580.92	219.61	mmHg				LBNL Data File	37.191	mmHg	74.38
67-63-0	ISOPROPYL ALCOHOL	8.11778	1580.92	219.61	mmHg				LBNL Data File	37.191	mmHg	74.38
67-63-0	ISOPROPYL ALCOHOL	8.11778	1580.92	219.61	mmHg				LBNL Data File	37.191	mmHg	74.38
67-63-0	ISOPROPANOL	8.11778	1580.92	219.61	mmHg				LBNL Data File	37.191	mmHg	74.38
67-63-0	2-PROPANOL	8.11778	1580.92	219.61	mmHg				LBNL Data File	37.191	mmHg	74.38
67-63-0	2-PROPANOL	8.11778	1580.92	219.61	mmHg				LBNL Data File	37.191	mmHg	74.38
67-63-0	2-PROPANOL	8.11778	1580.92	219.61	mmHg				LBNL Data File	37.191	mmHg	74.38
67-63-0	2-PROPANOL	8.11778	1580.92	219.61	mmHg				LBNL Data File	37.191	mmHg	74.38
67-63-0	2-PROPANOL	8.11778	1580.92	219.61	mmHg				LBNL Data File	37.191	mmHg	74.38
67-63-0	2-PROPANOL	8.11778	1580.92	219.61	mmHg				LBNL Data File	37.191	mmHg	74.38
67-63-0	ISOPROPYL ALCOHOL	8.11778	1580.92	219.61	mmHg				LBNL Data File	37.191	mmHg	74.38
67-63-0	ISOPROPANOL	8.11778	1580.92	219.61	mmHg				LBNL Data File	37.191	mmHg	74.38
67-63-0	ISOPROPYL ALCOHOL	8.11778	1580.92	219.61	mmHg				LBNL Data File	37.191	mmHg	74.38
67-63-0	ISOPROPYL ALCOHOL	8.11778	1580.92	219.61	mmHg				LBNL Data File	37.191	mmHg	74.38
67-63-0	2-PROPANOL	8.11778	1580.92	219.61	mmHg				LBNL Data File	37.191	mmHg	74.38
67-63-0	ISOPROPYL ALCOHOL	8.11778	1580.92	219.61	mmHg				LBNL Data File	37.191	mmHg	74.38
67-63-0	MICROSHARP CLEANING FLUID	8.11778	1580.92	219.61	mmHg				LBNL Data File	37.191	mmHg	74.38
67-63-0	MICROSHARP CLEANING FLUID	8.11778	1580.92	219.61	mmHg				LBNL Data File	37.191	mmHg	74.38
67-63-0	MICROSHARP CLEANING FLUID	8.11778	1580.92	219.61	mmHg				LBNL Data File	37.191	mmHg	74.38
67-63-0	MICROSHARP CLEANING FLUID	8.11778	1580.92	219.61	mmHg				LBNL Data File	37.191	mmHg	74.38
67-63-0	MICROSHARP CLEANING FLUID	8.11778	1580.92	219.61	mmHg				LBNL Data File	37.191	mmHg	74.38
67-63-0	ISOPROPANOL	8.11778	1580.92	219.61	mmHg				LBNL Data File	37.191	mmHg	74.38
67-63-0	2-PROPANOL	8.11778	1580.92	219.61	mmHg				LBNL Data File	37.191	mmHg	74.38
67-63-0	ISOPROPANOL	8.11778	1580.92	219.61	mmHg				LBNL Data File	37.191	mmHg	74.38
67-63-0	ISOPROPANOL	8.11778	1580.92	219.61	mmHg				LBNL Data File	37.191	mmHg	74.38
67-63-0	2-PROPANOL	8.11778	1580.92	219.61	mmHg				LBNL Data File	37.191	mmHg	74.38
67-63-0	2-PROPANOL	8.11778	1580.92	219.61	mmHg				LBNL Data File	37.191	mmHg	74.38
67-63-0	2-PROPANOL	8.11778	1580.92	219.61	mmHg				LBNL Data File	37.191	mmHg	74.38
67-63-0	2-PROPANOL	8.11778	1580.92	219.61	mmHg				LBNL Data File	37.191	mmHg	74.38
67-63-0	ISOPROPANOL	8.11778	1580.92	219.61	mmHg				LBNL Data File	37.191	mmHg	74.38

a. If VP (@ ref temp) < 100 mmHg, then VP = Lesser of twice the VP (@ ref temp) or 100 mmHg
If VP (@ ref temp) >= 100 mmHg, then not adjusted

Golder Associates

Calculation of Liquid Chemical Emissions
Phase 1 Laboratory Usage Scenario
Proposed Richmond Bay Campus Long Range Development Plan, Richmond, California

Vapor Pressure Data (Table G-3)

Antoine Equation: $VP = 10^{[A - (B/(T+C))]}$

where: VP = Vapor Pressure (mmHg or bar, depending on source of A, B, C)
T = Temperature (K or C depending on source of A, B, C)
A, B, C = Antoine coefficients

(Reference Temperature should be near 295 deg K)

This list of chemicals comes from LBNL inventory data with solids & gases removed Must be identical to Chemical Inventory worksheet		*Must be entered manually* For Antoine Eq. @ 295 K				or	*Entered manually* Literature		*Entered manually*	*Calculated values*		*Calculated*
		Antoine Coefficients										
CAS No.	Compound Name	A	B	C	VP Units		VP @ Ref Temp (mmHg)	Ref Temp (K)	Vapor Pressure Reference	Vapor Pressure at Ref	Vapor Pressure at Ref (VP Units)	Adjusted Vapor Pressure [a] (mmHg)
67-63-0	N-HYDROXYSUCCINIMIDYL-ACTIVATED AGAROSE	8.11778	1580.92	219.61	mmHg				LBNL Data File	37.191	mmHg	74.38
67-63-0	2-PROPANOL	8.11778	1580.92	219.61	mmHg				LBNL Data File	37.191	mmHg	74.38
67-63-0	ISOPROPYL ALCOHOL	8.11778	1580.92	219.61	mmHg				LBNL Data File	37.191	mmHg	74.38
67-63-0	ISOPROPANOL	8.11778	1580.92	219.61	mmHg				LBNL Data File	37.191	mmHg	74.38
67-63-0	ISOPROPYL ALCOHOL	8.11778	1580.92	219.61	mmHg				LBNL Data File	37.191	mmHg	74.38
67-63-0	ISOPROPANOL	8.11778	1580.92	219.61	mmHg				LBNL Data File	37.191	mmHg	74.38
67-63-0	ISOPROPANOL	8.11778	1580.92	219.61	mmHg				LBNL Data File	37.191	mmHg	74.38
67-63-0	2-PROPANOL	8.11778	1580.92	219.61	mmHg				LBNL Data File	37.191	mmHg	74.38
67-63-0	ISOPROPYL ALCOHOL	8.11778	1580.92	219.61	mmHg				LBNL Data File	37.191	mmHg	74.38
67-63-0	2-PROPANOL	8.11778	1580.92	219.61	mmHg				LBNL Data File	37.191	mmHg	74.38
67-63-0	ISOPROPYL ALCOHOL	8.11778	1580.92	219.61	mmHg				LBNL Data File	37.191	mmHg	74.38
67-63-0	ISOPROPYL ALCOHOL	8.11778	1580.92	219.61	mmHg				LBNL Data File	37.191	mmHg	74.38
67-63-0	ISOPROPYL ALCOHOL	8.11778	1580.92	219.61	mmHg				LBNL Data File	37.191	mmHg	74.38
67-63-0	ISOPROPYL ALCOHOL	8.11778	1580.92	219.61	mmHg				LBNL Data File	37.191	mmHg	74.38
67-63-0	ISOPROPYL ALCOHOL	8.11778	1580.92	219.61	mmHg				LBNL Data File	37.191	mmHg	74.38
67-63-0	ISOPROPANOL	8.11778	1580.92	219.61	mmHg				LBNL Data File	37.191	mmHg	74.38
67-63-0	ISOPROPYL ALCOHOL	8.11778	1580.92	219.61	mmHg				LBNL Data File	37.191	mmHg	74.38
67-63-0	2-PROPANOL	8.11778	1580.92	219.61	mmHg				LBNL Data File	37.191	mmHg	74.38
67-63-0	ISOPROPYL ALCOHOL	8.11778	1580.92	219.61	mmHg				LBNL Data File	37.191	mmHg	74.38
67-63-0	ISOPROPYL ALCOHOL	8.11778	1580.92	219.61	mmHg				LBNL Data File	37.191	mmHg	74.38
67-63-0	2-PROPANOL	8.11778	1580.92	219.61	mmHg				LBNL Data File	37.191	mmHg	74.38
67-63-0	ISOPROPYL ALCOHOL	8.11778	1580.92	219.61	mmHg				LBNL Data File	37.191	mmHg	74.38
67-63-0	ISOPROPYL ALCOHOL	8.11778	1580.92	219.61	mmHg				LBNL Data File	37.191	mmHg	74.38
67-63-0	ISOPROPYL ALCOHOL	8.11778	1580.92	219.61	mmHg				LBNL Data File	37.191	mmHg	74.38
67-63-0	ISOPROPYL ALCOHOL	8.11778	1580.92	219.61	mmHg				LBNL Data File	37.191	mmHg	74.38
67-63-0	ISOPROPYL ALCOHOL	8.11778	1580.92	219.61	mmHg				LBNL Data File	37.191	mmHg	74.38
67-63-0	ISOPROPANOL	8.11778	1580.92	219.61	mmHg				LBNL Data File	37.191	mmHg	74.38
67-63-0	ISOPROPYL ALCOHOL	8.11778	1580.92	219.61	mmHg				LBNL Data File	37.191	mmHg	74.38
67-63-0	ISOPROPYL ALCOHOL	8.11778	1580.92	219.61	mmHg				LBNL Data File	37.191	mmHg	74.38
67-66-3	CHLOROFORM	6.4934	929.44	196.03	mmHg				LBNL Data File	168.875	mmHg	168.88
67-66-3	CHLOROFORM	6.4934	929.44	196.03	mmHg				LBNL Data File	168.875	mmHg	168.88
67-66-3	CHLOROFORM:ISOAMYL ALCOHOL 24:1	6.4934	929.44	196.03	mmHg				LBNL Data File	168.875	mmHg	168.88
67-66-3	CHLOROFORM ISOAMYL ALCOHOL	6.4934	929.44	196.03	mmHg				LBNL Data File	168.875	mmHg	168.88
67-66-3	CHLOROFORM	6.4934	929.44	196.03	mmHg				LBNL Data File	168.875	mmHg	168.88
67-66-3	CHLOROFORM ISOAMYL ALCOHOL	6.4934	929.44	196.03	mmHg				LBNL Data File	168.875	mmHg	168.88
67-66-3	CHLOROFORM ISOAMYL ALCOHOL	6.4934	929.44	196.03	mmHg				LBNL Data File	168.875	mmHg	168.88
67-66-3	CHLOROFORM	6.4934	929.44	196.03	mmHg				LBNL Data File	168.875	mmHg	168.88
67-66-3	CHLOROFORM:ISOAMYL ALCOHOL 24:1	6.4934	929.44	196.03	mmHg				LBNL Data File	168.875	mmHg	168.88
67-66-3	CHLOROFORM	6.4934	929.44	196.03	mmHg				LBNL Data File	168.875	mmHg	168.88
67-66-3	CHLOROFORM	6.4934	929.44	196.03	mmHg				LBNL Data File	168.875	mmHg	168.88
67-66-3	CHLOROFORM	6.4934	929.44	196.03	mmHg				LBNL Data File	168.875	mmHg	168.88
67-66-3	CHLOROFORM	6.4934	929.44	196.03	mmHg				LBNL Data File	168.875	mmHg	168.88
67-66-3	CHLOROFORM	6.4934	929.44	196.03	mmHg				LBNL Data File	168.875	mmHg	168.88
67-66-3	CHLOROFORM	6.4934	929.44	196.03	mmHg				LBNL Data File	168.875	mmHg	168.88
67-66-3	CHLOROFORM	6.4934	929.44	196.03	mmHg				LBNL Data File	168.875	mmHg	168.88
67-66-3	CHLOROFORM:ISOAMYL ALCOHOL 24:1	6.4934	929.44	196.03	mmHg				LBNL Data File	168.875	mmHg	168.88

a. If VP (@ ref temp) < 100 mmHg, then VP = Lesser of twice the VP (@ ref temp) or 100 mmHg
If VP (@ ref temp) >= 100 mmHg, then not adjusted

Golder Associates

Calculation of Liquid Chemical Emissions
Phase 1 Laboratory Usage Scenario
Proposed Richmond Bay Campus Long Range Development Plan, Richmond, California

Vapor Pressure Data (Table G-3)

Antoine Equation: $VP = 10^{[A - (B/(T+C))]}$

where: VP = Vapor Pressure (mmHg or bar, depending on source of A, B, C)
T = Temperature (K or C depending on source of A, B, C)
A, B, C = Antoine coefficients

(Reference Temperature should be near 295 deg K)

This list of chemicals comes from LBNL inventory data with solids & gases removed Must be identical to Chemical Inventory worksheet		*Must be entered manually* For Antoine Eq. @ 295 K				or	*Entered manually* Literature		*Entered manually*	*Calculated values*		*Calculated*
		Antoine Coefficients										
CAS No.	Compound Name	A	B	C	VP Units		VP @ Ref Temp (mmHg)	Ref Temp (K)	Vapor Pressure Reference	Vapor Pressure at Ref	Vapor Pressure at Ref (VP Units)	Adjusted Vapor Pressure [a] (mmHg)
67-66-3	CHLOROFORM: ISOAMYL ALCOHOL MIXTURE	6.4934	929.44	196.03	mmHg				LBNL Data File	168.875	mmHg	168.88
67-66-3	CHLOROFORM	6.4934	929.44	196.03	mmHg				LBNL Data File	168.875	mmHg	168.88
67-66-3	CHLOROFORM	6.4934	929.44	196.03	mmHg				LBNL Data File	168.875	mmHg	168.88
67-66-3	CHLOROFORM	6.4934	929.44	196.03	mmHg				LBNL Data File	168.875	mmHg	168.88
67-66-3	CHLOROFORM	6.4934	929.44	196.03	mmHg				LBNL Data File	168.875	mmHg	168.88
67-66-3	CHLOROFORM	6.4934	929.44	196.03	mmHg				LBNL Data File	168.875	mmHg	168.88
67-66-3	CHLOROFORM	6.4934	929.44	196.03	mmHg				LBNL Data File	168.875	mmHg	168.88
67-66-3	CHLOROFORM	6.4934	929.44	196.03	mmHg				LBNL Data File	168.875	mmHg	168.88
67-66-3	CHLOROFORM	6.4934	929.44	196.03	mmHg				LBNL Data File	168.875	mmHg	168.88
67-66-3	CHLOROFORM	6.4934	929.44	196.03	mmHg				LBNL Data File	168.875	mmHg	168.88
67-66-3	CHLOROFORM	6.4934	929.44	196.03	mmHg				LBNL Data File	168.875	mmHg	168.88
67-66-3	CHLOROFORM	6.4934	929.44	196.03	mmHg				LBNL Data File	168.875	mmHg	168.88
67-66-3	CHLOROFORM HPLC PURE	6.4934	929.44	196.03	mmHg				LBNL Data File	168.875	mmHg	168.88
67-66-3	CHLOROFORM	6.4934	929.44	196.03	mmHg				LBNL Data File	168.875	mmHg	168.88
67-66-3	CHLOROFORM:ISOAMYL ALCOHOL MIXTURE	6.4934	929.44	196.03	mmHg				LBNL Data File	168.875	mmHg	168.88
67-66-3	CHLOROFORM	6.4934	929.44	196.03	mmHg				LBNL Data File	168.875	mmHg	168.88
67-66-3	CHLOROFORM	6.4934	929.44	196.03	mmHg				LBNL Data File	168.875	mmHg	168.88
67-66-3	CHLOROFORM	6.4934	929.44	196.03	mmHg				LBNL Data File	168.875	mmHg	168.88
67-66-3	CHLOROFORM	6.4934	929.44	196.03	mmHg				LBNL Data File	168.875	mmHg	168.88
67-66-3	CHLOROFORM	6.4934	929.44	196.03	mmHg				LBNL Data File	168.875	mmHg	168.88
67-66-3	CHLOROFORM	6.4934	929.44	196.03	mmHg				LBNL Data File	168.875	mmHg	168.88
67-66-3	CHLOROFORM	6.4934	929.44	196.03	mmHg				LBNL Data File	168.875	mmHg	168.88
67-66-3	CHLOROFORM	6.4934	929.44	196.03	mmHg				LBNL Data File	168.875	mmHg	168.88
67-66-3	CHLOROFORM	6.4934	929.44	196.03	mmHg				LBNL Data File	168.875	mmHg	168.88
67-66-3	CHLOROFORM	6.4934	929.44	196.03	mmHg				LBNL Data File	168.875	mmHg	168.88
67-66-3	CHLOROFORM	6.4934	929.44	196.03	mmHg				LBNL Data File	168.875	mmHg	168.88
67-66-3	CHLOROFORM: ISOAMYL ALCOHOL	6.4934	929.44	196.03	mmHg				LBNL Data File	168.875	mmHg	168.88
67-66-3	CHLOROFORM: ISOAMYL ALCOHOL	6.4934	929.44	196.03	mmHg				LBNL Data File	168.875	mmHg	168.88
67-66-3	CHLOROFORM	6.4934	929.44	196.03	mmHg				LBNL Data File	168.875	mmHg	168.88
67-66-3	CHLOROFORM:ISOAMYL ALCOHOL	6.4934	929.44	196.03	mmHg				LBNL Data File	168.875	mmHg	168.88
67-66-3	CHLOROFORM:ISOAMYL ALCOHOL 24:1	6.4934	929.44	196.03	mmHg				LBNL Data File	168.875	mmHg	168.88
67-66-3	CHLOROFORM	6.4934	929.44	196.03	mmHg				LBNL Data File	168.875	mmHg	168.88
67-66-3	CHLOROFORM	6.4934	929.44	196.03	mmHg				LBNL Data File	168.875	mmHg	168.88
67-66-3	CHLOROFORM	6.4934	929.44	196.03	mmHg				LBNL Data File	168.875	mmHg	168.88
67-66-3	CHLOROFORM	6.4934	929.44	196.03	mmHg				LBNL Data File	168.875	mmHg	168.88
67-66-3	CHLOROFORM	6.4934	929.44	196.03	mmHg				LBNL Data File	168.875	mmHg	168.88
67-66-3	CHLOROFORM	6.4934	929.44	196.03	mmHg				LBNL Data File	168.875	mmHg	168.88
67-66-3	CHLOROFORM	6.4934	929.44	196.03	mmHg				LBNL Data File	168.875	mmHg	168.88
67-66-3	CHLOROFORM	6.4934	929.44	196.03	mmHg				LBNL Data File	168.875	mmHg	168.88
67-66-3	CHLOROFORM	6.4934	929.44	196.03	mmHg				LBNL Data File	168.875	mmHg	168.88
67-66-3	CHLOROFORM	6.4934	929.44	196.03	mmHg				LBNL Data File	168.875	mmHg	168.88
67-66-3	CHLOROFORM	6.4934	929.44	196.03	mmHg				LBNL Data File	168.875	mmHg	168.88
67-66-3	CHLOROFORM:ISOAMYL ALCOHOL	6.4934	929.44	196.03	mmHg				LBNL Data File	168.875	mmHg	168.88
67-66-3	CHLOROFORM	6.4934	929.44	196.03	mmHg				LBNL Data File	168.875	mmHg	168.88
67-66-3	CHLOROFORM HPLC PURE	6.4934	929.44	196.03	mmHg				LBNL Data File	168.875	mmHg	168.88
67-66-3	CHLOROFORM	6.4934	929.44	196.03	mmHg				LBNL Data File	168.875	mmHg	168.88
67-66-3	TRICHLOROMETHANE	6.4934	929.44	196.03	mmHg				LBNL Data File	168.875	mmHg	168.88

a. If VP (@ ref temp) < 100 mmHg, then VP = Lesser of twice the VP (@ ref temp) or 100 mmHg
If VP (@ ref temp) >= 100 mmHg, then not adjusted

Golder Associates

Calculation of Liquid Chemical Emissions
Phase 1 Laboratory Usage Scenario
Proposed Richmond Bay Campus Long Range Development Plan, Richmond, California

Vapor Pressure Data (Table G-3)

Antoine Equation: $VP = 10^{[A - (B/(T+C))]}$

where: VP = Vapor Pressure (mmHg or bar, depending on source of A, B, C)
T = Temperature (K or C depending on source of A, B, C)
A, B, C = Antoine coefficients

(Reference Temperature should be near 295 deg K)

This list of chemicals comes from LBNL inventory data with solids & gases removed Must be identical to Chemical Inventory worksheet		*Must be entered manually* For Antoine Eq. @ 295 K				or	*Entered manually* Literature		*Entered manually*	*Calculated values*		*Calculated*
		Antoine Coefficients										
CAS No.	Compound Name	A	B	C	VP Units		VP @ Ref Temp (mmHg)	Ref Temp (K)	Vapor Pressure Reference	Vapor Pressure at Ref	Vapor Pressure at Ref (VP Units)	Adjusted Vapor Pressure [a] (mmHg)
67-66-3	CHLOROFORM	6.4934	929.44	196.03	mmHg				LBNL Data File	168.875	mmHg	168.88
67-66-3	CHLOROFORM	6.4934	929.44	196.03	mmHg				LBNL Data File	168.875	mmHg	168.88
67-66-3	CHLOROFORM: ISOAMYL ALCOHOL MIXTURE	6.4934	929.44	196.03	mmHg				LBNL Data File	168.875	mmHg	168.88
67-66-3	CHLOROFORM	6.4934	929.44	196.03	mmHg				LBNL Data File	168.875	mmHg	168.88
67-66-3	CHLOROFORM	6.4934	929.44	196.03	mmHg				LBNL Data File	168.875	mmHg	168.88
67-66-3	CHLOROFORM	6.4934	929.44	196.03	mmHg				LBNL Data File	168.875	mmHg	168.88
67-66-3	CHLOROFORM	6.4934	929.44	196.03	mmHg				LBNL Data File	168.875	mmHg	168.88
67-66-3	CHLOROFORM	6.4934	929.44	196.03	mmHg				LBNL Data File	168.875	mmHg	168.88
67-66-3	CHLOROFORM	6.4934	929.44	196.03	mmHg				LBNL Data File	168.875	mmHg	168.88
67-66-3	CHLOROFORM	6.4934	929.44	196.03	mmHg				LBNL Data File	168.875	mmHg	168.88
67-66-3	CHLOROFORM	6.4934	929.44	196.03	mmHg				LBNL Data File	168.875	mmHg	168.88
67-66-3	CHLOROFORM	6.4934	929.44	196.03	mmHg				LBNL Data File	168.875	mmHg	168.88
67-66-3	CHLOROFORM	6.4934	929.44	196.03	mmHg				LBNL Data File	168.875	mmHg	168.88
67-66-3	CHLOROFORM	6.4934	929.44	196.03	mmHg				LBNL Data File	168.875	mmHg	168.88
67-66-3	CHLOROFORM/ISOAMYL ALCOHOL	6.4934	929.44	196.03	mmHg				LBNL Data File	168.875	mmHg	168.88
67-66-3	CHLOROFORM	6.4934	929.44	196.03	mmHg				LBNL Data File	168.875	mmHg	168.88
67-66-3	CHLOROFORM	6.4934	929.44	196.03	mmHg				LBNL Data File	168.875	mmHg	168.88
67-66-3	CHLOROFORM	6.4934	929.44	196.03	mmHg				LBNL Data File	168.875	mmHg	168.88
67-66-3	CHLOROFORM	6.4934	929.44	196.03	mmHg				LBNL Data File	168.875	mmHg	168.88
67-66-3	CHLOROFORM	6.4934	929.44	196.03	mmHg				LBNL Data File	168.875	mmHg	168.88
67-66-3	CHLOROFORM	6.4934	929.44	196.03	mmHg				LBNL Data File	168.875	mmHg	168.88
67-66-3	CHLOROFORM	6.4934	929.44	196.03	mmHg				LBNL Data File	168.875	mmHg	168.88
67-66-3	CHLOROFORM	6.4934	929.44	196.03	mmHg				LBNL Data File	168.875	mmHg	168.88
67-66-3	CHLOROFORM	6.4934	929.44	196.03	mmHg				LBNL Data File	168.875	mmHg	168.88
67-66-3	CHLOROFORM	6.4934	929.44	196.03	mmHg				LBNL Data File	168.875	mmHg	168.88
67-66-3	CHLOROFORM	6.4934	929.44	196.03	mmHg				LBNL Data File	168.875	mmHg	168.88
67-66-3	CHLOROFORM	6.4934	929.44	196.03	mmHg				LBNL Data File	168.875	mmHg	168.88
67-66-3	CHLOROFORM	6.4934	929.44	196.03	mmHg				LBNL Data File	168.875	mmHg	168.88
67-66-3	CHLOROFORM	6.4934	929.44	196.03	mmHg				LBNL Data File	168.875	mmHg	168.88
67-66-3	CHLOROFORM	6.4934	929.44	196.03	mmHg				LBNL Data File	168.875	mmHg	168.88
67-66-3	CHLOROFORM	6.4934	929.44	196.03	mmHg				LBNL Data File	168.875	mmHg	168.88
67-66-3	CHLOROFORM	6.4934	929.44	196.03	mmHg				LBNL Data File	168.875	mmHg	168.88
67-66-3	CHLOROFORM	6.4934	929.44	196.03	mmHg				LBNL Data File	168.875	mmHg	168.88
67-66-3	CHLOROFORM	6.4934	929.44	196.03	mmHg				LBNL Data File	168.875	mmHg	168.88
67-66-3	CHLOROFORM	6.4934	929.44	196.03	mmHg				LBNL Data File	168.875	mmHg	168.88
67-66-3	CHLOROFORM	6.4934	929.44	196.03	mmHg				LBNL Data File	168.875	mmHg	168.88
67-66-3	CHLOROFORM	6.4934	929.44	196.03	mmHg				LBNL Data File	168.875	mmHg	168.88
67-66-3	CHLOROFORM	6.4934	929.44	196.03	mmHg				LBNL Data File	168.875	mmHg	168.88
67-66-3	CHLOROFORM	6.4934	929.44	196.03	mmHg				LBNL Data File	168.875	mmHg	168.88
67-66-3	CHLOROFORM	6.4934	929.44	196.03	mmHg				LBNL Data File	168.875	mmHg	168.88
67-66-3	CHLOROFORM	6.4934	929.44	196.03	mmHg				LBNL Data File	168.875	mmHg	168.88
67-66-3	CHLOROFORM	6.4934	929.44	196.03	mmHg				LBNL Data File	168.875	mmHg	168.88
67-66-3	CHLOROFORM	6.4934	929.44	196.03	mmHg				LBNL Data File	168.875	mmHg	168.88
67-66-3	CHLOROFORM	6.4934	929.44	196.03	mmHg				LBNL Data File	168.875	mmHg	168.88

a. If VP (@ ref temp) < 100 mmHg, then VP = Lesser of twice the VP (@ ref temp) or 100 mmHg
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Phase 1 Laboratory Usage Scenario
Proposed Richmond Bay Campus Long Range Development Plan, Richmond, California

Vapor Pressure Data (Table G-3)

Antoine Equation: $VP = 10^{[A - (B/(T+C))]}$

where: VP = Vapor Pressure (mmHg or bar, depending on source of A, B, C)
T = Temperature (K or C depending on source of A, B, C)
A, B, C = Antoine coefficients

(Reference Temperature should be near 295 deg K)

This list of chemicals comes from LBNL inventory data with solids & gases removed Must be identical to Chemical Inventory worksheet		*Must be entered manually* For Antoine Eq. @ 295 K				or	*Entered manually* Literature		*Entered manually*	*Calculated values*		*Calculated*
		Antoine Coefficients										
CAS No.	Compound Name	A	B	C	VP Units		VP @ Ref Temp (mmHg)	Ref Temp (K)	Vapor Pressure Reference	Vapor Pressure at Ref	Vapor Pressure at Ref (VP Units)	Adjusted Vapor Pressure [a] (mmHg)
67-66-3	CHLOROFORM	6.4934	929.44	196.03	mmHg				LBNL Data File	168.875	mmHg	168.88
67-66-3	CHLOROFORM	6.4934	929.44	196.03	mmHg				LBNL Data File	168.875	mmHg	168.88
67-66-3	CHLOROFORM	6.4934	929.44	196.03	mmHg				LBNL Data File	168.875	mmHg	168.88
68-12-2	N,N-DIMETHYLFORMAMIDE	6.928	1400.87	196.43	mmHg				LBNL Data File	3.238	mmHg	6.48
68-12-2	N-N-DIMETHYLFOMAMIDE	6.928	1400.87	196.43	mmHg				LBNL Data File	3.238	mmHg	6.48
68-12-2	N,N-DIMETHYLFORMAMIDE	6.928	1400.87	196.43	mmHg				LBNL Data File	3.238	mmHg	6.48
68-12-2	N,N-DIMETHYLFORMAMIDE	6.928	1400.87	196.43	mmHg				LBNL Data File	3.238	mmHg	6.48
68-12-2	N,N-DIMETHYLFORMAMIDE	6.928	1400.87	196.43	mmHg				LBNL Data File	3.238	mmHg	6.48
68-12-2	N,N-DIMETHYLFORMAMIDE	6.928	1400.87	196.43	mmHg				LBNL Data File	3.238	mmHg	6.48
68-12-2	N-N-DIMETHYL FORMAMIDE	6.928	1400.87	196.43	mmHg				LBNL Data File	3.238	mmHg	6.48
68-12-2	N,N-DIMETHYLFORMAMIDE	6.928	1400.87	196.43	mmHg				LBNL Data File	3.238	mmHg	6.48
68-12-2	N,N-DIMETHYLFORMAMIDE, ANHYDROUS	6.928	1400.87	196.43	mmHg				LBNL Data File	3.238	mmHg	6.48
68-12-2	DMF	6.928	1400.87	196.43	mmHg				LBNL Data File	3.238	mmHg	6.48
68-12-2	DMF	6.928	1400.87	196.43	mmHg				LBNL Data File	3.238	mmHg	6.48
68-12-2	DMF	6.928	1400.87	196.43	mmHg				LBNL Data File	3.238	mmHg	6.48
68-12-2	DMF	6.928	1400.87	196.43	mmHg				LBNL Data File	3.238	mmHg	6.48
68-12-2	DIMETHYLFORMAMIDE	6.928	1400.87	196.43	mmHg				LBNL Data File	3.238	mmHg	6.48
68-12-2	DMF	6.928	1400.87	196.43	mmHg				LBNL Data File	3.238	mmHg	6.48
68-12-2	DMF	6.928	1400.87	196.43	mmHg				LBNL Data File	3.238	mmHg	6.48
68-12-2	DMF	6.928	1400.87	196.43	mmHg				LBNL Data File	3.238	mmHg	6.48
68-12-2	DIMETHYLFORMAMIDE	6.928	1400.87	196.43	mmHg				LBNL Data File	3.238	mmHg	6.48
68-12-2	DIMETHYL-FORMAMIDE	6.928	1400.87	196.43	mmHg				LBNL Data File	3.238	mmHg	6.48
68-12-2	DIMETHYL-FORMAMIDE	6.928	1400.87	196.43	mmHg				LBNL Data File	3.238	mmHg	6.48
68-12-2	DIMETHYLFORMAMIDE	6.928	1400.87	196.43	mmHg				LBNL Data File	3.238	mmHg	6.48
68-12-2	DIMETHYLFORMAMIDE	6.928	1400.87	196.43	mmHg				LBNL Data File	3.238	mmHg	6.48
68-12-2	DMF	6.928	1400.87	196.43	mmHg				LBNL Data File	3.238	mmHg	6.48
68-12-2	N, N-DIMETHYLFORMAMIDE, REAGENT GRADE	6.928	1400.87	196.43	mmHg				LBNL Data File	3.238	mmHg	6.48
68-12-2	N,N-DIMETHYLFORMAMIDE	6.928	1400.87	196.43	mmHg				LBNL Data File	3.238	mmHg	6.48
68-12-2	DIMETHYLFORMAMIDE	6.928	1400.87	196.43	mmHg				LBNL Data File	3.238	mmHg	6.48
68-12-2	N,N-DIMETHYL FORMAMIDE	6.928	1400.87	196.43	mmHg				LBNL Data File	3.238	mmHg	6.48
68-12-2	N,N'-DIMETHYL FORMAMIDE	6.928	1400.87	196.43	mmHg				LBNL Data File	3.238	mmHg	6.48
68-12-2	N,N-DIMETHYLFORMAMIDE	6.928	1400.87	196.43	mmHg				LBNL Data File	3.238	mmHg	6.48
68-12-2	DMF	6.928	1400.87	196.43	mmHg				LBNL Data File	3.238	mmHg	6.48
68-12-2	DMF	6.928	1400.87	196.43	mmHg				LBNL Data File	3.238	mmHg	6.48
68-12-2	DMF	6.928	1400.87	196.43	mmHg				LBNL Data File	3.238	mmHg	6.48
71-43-2	BENZENE	6.90565	1211.033	220.79	mmHg				LBNL Data File	82.145	mmHg	100.00
71-43-2	BENZENE	6.90565	1211.033	220.79	mmHg				LBNL Data File	82.145	mmHg	100.00
71-43-2	BENZENE(ANHYDROUS)	6.90565	1211.033	220.79	mmHg				LBNL Data File	82.145	mmHg	100.00
71-43-2	BENZENE(ANHYDROUS)	6.90565	1211.033	220.79	mmHg				LBNL Data File	82.145	mmHg	100.00
71-43-2	BENZENE	6.90565	1211.033	220.79	mmHg				LBNL Data File	82.145	mmHg	100.00
75-07-0	ACETALDEHYDE	8.00552	1600.017	291.809	mmHg				LBNL Data File	802.388	mmHg	802.39
75-07-0	ACETALDEHYDE	8.00552	1600.017	291.809	mmHg				LBNL Data File	802.388	mmHg	802.39
75-07-0	ACETALDEHYDE	8.00552	1600.017	291.809	mmHg				LBNL Data File	802.388	mmHg	802.39
75-09-2	DICHLOROMETHANE	7.4092	1325.9	252.6	mmHg				LBNL Data File	378.515	mmHg	378.52
75-09-2	METHYLENE CHLORIDE	7.4092	1325.9	252.6	mmHg				LBNL Data File	378.515	mmHg	378.52
75-09-2	METHYLENE CHLORIDE	7.4092	1325.9	252.6	mmHg				LBNL Data File	378.515	mmHg	378.52
75-09-2	DICHLOROMETHANE	7.4092	1325.9	252.6	mmHg				LBNL Data File	378.515	mmHg	378.52

a. If VP (@ ref temp) < 100 mmHg, then VP = Lesser of twice the VP (@ ref temp) or 100 mmHg
If VP (@ ref temp) >= 100 mmHg, then not adjusted

Golder Associates

Calculation of Liquid Chemical Emissions
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This list of chemicals comes from LBNL inventory data with solids & gases removed Must be identical to Chemical Inventory worksheet		*Must be entered manually* For Antoine Eq. @ 295 K				or	*Entered manually* Literature		*Entered manually*	*Calculated values*		*Calculated*
		Antoine Coefficients										
CAS No.	Compound Name	A	B	C	VP Units		VP @ Ref Temp (mmHg)	Ref Temp (K)	Vapor Pressure Reference	Vapor Pressure at Ref	Vapor Pressure at Ref (VP Units)	Adjusted Vapor Pressure [a] (mmHg)
75-09-2	TO BE VALIDATED-DICHLOROME, ANHYDROUS	7.4092	1325.9	252.6	mmHg				LBNL Data File	378.515	mmHg	378.52
75-09-2	DICHLOROMETHANE	7.4092	1325.9	252.6	mmHg				LBNL Data File	378.515	mmHg	378.52
75-09-2	METHYLENE CHLORIDE	7.4092	1325.9	252.6	mmHg				LBNL Data File	378.515	mmHg	378.52
75-09-2	METHYLENE CHLORIDE	7.4092	1325.9	252.6	mmHg				LBNL Data File	378.515	mmHg	378.52
75-09-2	METHYLENE CHLORIDE	7.4092	1325.9	252.6	mmHg				LBNL Data File	378.515	mmHg	378.52
75-09-2	METHYLENE CHLORIDE	7.4092	1325.9	252.6	mmHg				LBNL Data File	378.515	mmHg	378.52
75-09-2	METHYLENE CHLORIDE	7.4092	1325.9	252.6	mmHg				LBNL Data File	378.515	mmHg	378.52
75-09-2	METHYLENE CHLORIDE	7.4092	1325.9	252.6	mmHg				LBNL Data File	378.515	mmHg	378.52
75-09-2	DICHLOROMETHANE	7.4092	1325.9	252.6	mmHg				LBNL Data File	378.515	mmHg	378.52
75-09-2	DICHLOROMETHANE	7.4092	1325.9	252.6	mmHg				LBNL Data File	378.515	mmHg	378.52
75-09-2	DICHLOROMETHANE	7.4092	1325.9	252.6	mmHg				LBNL Data File	378.515	mmHg	378.52
75-09-2	METHYLENE CHLORIDE	7.4092	1325.9	252.6	mmHg				LBNL Data File	378.515	mmHg	378.52
75-09-2	METHYLENE CHLORIDE	7.4092	1325.9	252.6	mmHg				LBNL Data File	378.515	mmHg	378.52
75-09-2	DICHLOROMETHANE	7.4092	1325.9	252.6	mmHg				LBNL Data File	378.515	mmHg	378.52
75-09-2	METHYLENE CHLORIDE	7.4092	1325.9	252.6	mmHg				LBNL Data File	378.515	mmHg	378.52
75-09-2	DICHLOROMETHANE	7.4092	1325.9	252.6	mmHg				LBNL Data File	378.515	mmHg	378.52
75-09-2	METHYLENE CHLORIDE	7.4092	1325.9	252.6	mmHg				LBNL Data File	378.515	mmHg	378.52
75-09-2	DICHLOROMETHANE	7.4092	1325.9	252.6	mmHg				LBNL Data File	378.515	mmHg	378.52
75-09-2	METHANE, DICHLORO-	7.4092	1325.9	252.6	mmHg				LBNL Data File	378.515	mmHg	378.52
75-09-2	METHYLENE CHLORIDE	7.4092	1325.9	252.6	mmHg				LBNL Data File	378.515	mmHg	378.52
75-56-9	PROPYLENE OXIDE	3.55046	802.487	-81.348	bar				NIST	0.623	bar	468.34
75-56-9	PROPYLENE OXIDE	3.55046	802.487	-81.348	bar				NIST	0.623	bar	468.34
78-93-3	MEK	7.06356	1261.34	221.97	mmHg				LBNL Data File	77.681	mmHg	100.00
78-93-3	METHYL ETHYL KETONE	7.06356	1261.34	221.97	mmHg				LBNL Data File	77.681	mmHg	100.00
78-93-3	MEK	7.06356	1261.34	221.97	mmHg				LBNL Data File	77.681	mmHg	100.00
78-93-3	2-BUTANONE	7.06356	1261.34	221.97	mmHg				LBNL Data File	77.681	mmHg	100.00
79-01-6	TRICHLOROETHYLENE	6.5183	1018.6	192.7	mmHg				LBNL Data File	58.978	mmHg	100.00
79-01-6	TRICHLOROETHYLENE	6.5183	1018.6	192.7	mmHg				LBNL Data File	58.978	mmHg	100.00
79-01-6	TRICHLOROETHYLENE	6.5183	1018.6	192.7	mmHg				LBNL Data File	58.978	mmHg	100.00
79-01-6	TRICHLOROETHYLENE	6.5183	1018.6	192.7	mmHg				LBNL Data File	58.978	mmHg	100.00
79-10-7	ACRYLIC ACID	5.65204	648.629	154.683	mmHg				LBNL Data File	95.011	mmHg	100.00
79-10-7	ACRYLIC ACID	5.65204	648.629	154.683	mmHg				LBNL Data File	95.011	mmHg	100.00
79-10-7	ACRYLIC ACID	5.65204	648.629	154.683	mmHg				LBNL Data File	95.011	mmHg	100.00
100-41-4	ETHYL BENZENE	6.95719	1424.255	213.21	mmHg				LBNL Data File	7.908	mmHg	15.82
100-42-5	STYRENE	7.14016	1574.51	224.09	mmHg				LBNL Data File	5.472	mmHg	10.94
100-42-5	STYRENE	7.14016	1574.51	224.09	mmHg				LBNL Data File	5.472	mmHg	10.94
100-44-7	BENZYL CHLORIDE	4.68263	1932.142	-39.396	bar				NIST	0.001	bar	2.00
106-89-8	4-METHYLUMBELLIFERONE						13	293	MSDS	13.000	mmHg	26.00
106-99-0	1,3-BUTADIENE IN TOLUENE						1838	293	NIST	1838.000	mmHg	1838.00
107-02-8	ACROLEIN	4.11586	1167.888	-41.56	bar				NIST	0.322	bar	242.03
107-06-2	1,2-DICHLOROETHANE	7.0253	1271.3	222.9	mmHg				LBNL Data File	67.767	mmHg	100.00
107-06-2	1,2-DICHLOROETHANE	7.0253	1271.3	222.9	mmHg				LBNL Data File	67.767	mmHg	100.00
107-06-2	1,2-DICHLOROETHANE	7.0253	1271.3	222.9	mmHg				LBNL Data File	67.767	mmHg	100.00
107-06-2	1,2-DICHLOROETHANE	7.0253	1271.3	222.9	mmHg				LBNL Data File	67.767	mmHg	100.00
107-06-2	1,2-DICHLOROETHANE	7.0253	1271.3	222.9	mmHg				LBNL Data File	67.767	mmHg	100.00

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		Antoine Coefficients										
CAS No.	Compound Name	A	B	C	VP Units		VP @ Ref Temp (mmHg)	Ref Temp (K)	Vapor Pressure Reference	Vapor Pressure at Ref	Vapor Pressure at Ref (VP Units)	Adjusted Vapor Pressure [a] (mmHg)
107-21-1	ETHYLENE GLYCOL	8.0908	2088.9	203.5	mmHg				LBNL Data File	0.066	mmHg	0.13
107-21-1	ETHYLENE GLYCOL	8.0908	2088.9	203.5	mmHg				LBNL Data File	0.066	mmHg	0.13
107-21-1	ETHYLENE GLYCOL	8.0908	2088.9	203.5	mmHg				LBNL Data File	0.066	mmHg	0.13
107-21-1	ETHYLENE GLYCOL	8.0908	2088.9	203.5	mmHg				LBNL Data File	0.066	mmHg	0.13
107-21-1	ETHYLENE GLYCOL	8.0908	2088.9	203.5	mmHg				LBNL Data File	0.066	mmHg	0.13
107-21-1	ETHYLENE GLYCOL	8.0908	2088.9	203.5	mmHg				LBNL Data File	0.066	mmHg	0.13
107-21-1	ETHYLENE GLYCOL	8.0908	2088.9	203.5	mmHg				LBNL Data File	0.066	mmHg	0.13
107-21-1	ETHYLENE GLYCOL	8.0908	2088.9	203.5	mmHg				LBNL Data File	0.066	mmHg	0.13
107-21-1	ETHYLENE GLYCOL	8.0908	2088.9	203.5	mmHg				LBNL Data File	0.066	mmHg	0.13
107-21-1	ETHYLENE GLYCOL	8.0908	2088.9	203.5	mmHg				LBNL Data File	0.066	mmHg	0.13
107-21-1	ETHYLENE GLYCOL	8.0908	2088.9	203.5	mmHg				LBNL Data File	0.066	mmHg	0.13
107-21-1	ETHYLENE GLYCOL	8.0908	2088.9	203.5	mmHg				LBNL Data File	0.066	mmHg	0.13
107-21-1	ETHYLENE GLYCOL	8.0908	2088.9	203.5	mmHg				LBNL Data File	0.066	mmHg	0.13
107-98-2	1-METHOXY-2-PROPANOL						11.8	298	MSDS	11.800	mmHg	23.60
107-98-2	1-METHOXY-2-PROPANOL						11.8	298	MSDS	11.800	mmHg	23.60
108-39-4	M-CRESOL	7.508	1856.36	199.07	mmHg				LBNL Data File	0.127	mmHg	0.25
108-39-4	M-CRESOL	7.508	1856.36	199.07	mmHg				LBNL Data File	0.127	mmHg	0.25
108-88-3	TOLUENE	6.95464	1344.8	219.48	mmHg				LBNL Data File	24.109	mmHg	48.22
108-88-3	TOLUENE	6.95464	1344.8	219.48	mmHg				LBNL Data File	24.109	mmHg	48.22
108-88-3	TOLUENE	6.95464	1344.8	219.48	mmHg				LBNL Data File	24.109	mmHg	48.22
108-88-3	TOLUENE	6.95464	1344.8	219.48	mmHg				LBNL Data File	24.109	mmHg	48.22
108-88-3	TOLUENE	6.95464	1344.8	219.48	mmHg				LBNL Data File	24.109	mmHg	48.22
108-88-3	TOLUENE	6.95464	1344.8	219.48	mmHg				LBNL Data File	24.109	mmHg	48.22
108-88-3	TOLUENE	6.95464	1344.8	219.48	mmHg				LBNL Data File	24.109	mmHg	48.22
108-88-3	TOLUENE	6.95464	1344.8	219.48	mmHg				LBNL Data File	24.109	mmHg	48.22
108-88-3	TOLUENE	6.95464	1344.8	219.48	mmHg				LBNL Data File	24.109	mmHg	48.22
108-88-3	TOLUENE	6.95464	1344.8	219.48	mmHg				LBNL Data File	24.109	mmHg	48.22
108-88-3	TOLUENE	6.95464	1344.8	219.48	mmHg				LBNL Data File	24.109	mmHg	48.22
108-88-3	TOLUENE	6.95464	1344.8	219.48	mmHg				LBNL Data File	24.109	mmHg	48.22
108-88-3	TOLUENE	6.95464	1344.8	219.48	mmHg				LBNL Data File	24.109	mmHg	48.22
108-88-3	TOLUENE	6.95464	1344.8	219.48	mmHg				LBNL Data File	24.109	mmHg	48.22
108-88-3	TOLUENE	6.95464	1344.8	219.48	mmHg				LBNL Data File	24.109	mmHg	48.22
108-88-3	TOLUENE	6.95464	1344.8	219.48	mmHg				LBNL Data File	24.109	mmHg	48.22
108-88-3	TOLUENE	6.95464	1344.8	219.48	mmHg				LBNL Data File	24.109	mmHg	48.22
108-88-3	TOLUENE	6.95464	1344.8	219.48	mmHg				LBNL Data File	24.109	mmHg	48.22
108-88-3	TOLUENE	6.95464	1344.8	219.48	mmHg				LBNL Data File	24.109	mmHg	48.22
108-88-3	TOLUENE	6.95464	1344.8	219.48	mmHg				LBNL Data File	24.109	mmHg	48.22
109-86-4	2-METHOXYETHANOL	5.06386	1853.556	-30.838	bar				NIST	0.011	bar	16.76
110-54-3	HEXANE	6.87601	1171.17	224.41	mmHg				LBNL Data File	131.881	mmHg	131.88
110-54-3	HEXANE, CHROMASOLV PLUS	6.87601	1171.17	224.41	mmHg				LBNL Data File	131.881	mmHg	131.88
110-54-3	HEXANE	6.87601	1171.17	224.41	mmHg				LBNL Data File	131.881	mmHg	131.88
110-54-3	HEXANE	6.87601	1171.17	224.41	mmHg				LBNL Data File	131.881	mmHg	131.88
110-54-3	HEXANE	6.87601	1171.17	224.41	mmHg				LBNL Data File	131.881	mmHg	131.88

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CAS No.	Compound Name	A	B	C	VP Units		VP @ Ref Temp (mmHg)	Ref Temp (K)	Vapor Pressure Reference	Vapor Pressure at Ref	Vapor Pressure at Ref (VP Units)	Adjusted Vapor Pressure [a] (mmHg)
110-54-3	HEXANE	6.87601	1171.17	224.41	mmHg				LBNL Data File	131.881	mmHg	131.88
110-54-3	HEXANE	6.87601	1171.17	224.41	mmHg				LBNL Data File	131.881	mmHg	131.88
110-54-3	HEXANE	6.87601	1171.17	224.41	mmHg				LBNL Data File	131.881	mmHg	131.88
110-54-3	HEXANE	6.87601	1171.17	224.41	mmHg				LBNL Data File	131.881	mmHg	131.88
110-54-3	HEXANE	6.87601	1171.17	224.41	mmHg				LBNL Data File	131.881	mmHg	131.88
110-54-3	HEXANE	6.87601	1171.17	224.41	mmHg				LBNL Data File	131.881	mmHg	131.88
110-54-3	ALKANE STANDARD SOLUTION C8-C20	6.87601	1171.17	224.41	mmHg				LBNL Data File	131.881	mmHg	131.88
110-54-3	HEXANE	6.87601	1171.17	224.41	mmHg				LBNL Data File	131.881	mmHg	131.88
110-54-3	HEXANE	6.87601	1171.17	224.41	mmHg				LBNL Data File	131.881	mmHg	131.88
110-54-3	HEXANE	6.87601	1171.17	224.41	mmHg				LBNL Data File	131.881	mmHg	131.88
110-54-3	HEXANE	6.87601	1171.17	224.41	mmHg				LBNL Data File	131.881	mmHg	131.88
110-54-3	HEXANE	6.87601	1171.17	224.41	mmHg				LBNL Data File	131.881	mmHg	131.88
110-54-3	HEXANE	6.87601	1171.17	224.41	mmHg				LBNL Data File	131.881	mmHg	131.88
110-54-3	HEXANE	6.87601	1171.17	224.41	mmHg				LBNL Data File	131.881	mmHg	131.88
110-54-3	HEXANE	6.87601	1171.17	224.41	mmHg				LBNL Data File	131.881	mmHg	131.88
110-54-3	HEXANE	6.87601	1171.17	224.41	mmHg				LBNL Data File	131.881	mmHg	131.88
110-54-3	HEXANE	6.87601	1171.17	224.41	mmHg				LBNL Data File	131.881	mmHg	131.88
110-54-3	HEXANE	6.87601	1171.17	224.41	mmHg				LBNL Data File	131.881	mmHg	131.88
110-54-3	HEXANE	6.87601	1171.17	224.41	mmHg				LBNL Data File	131.881	mmHg	131.88
110-54-3	HEXANE	6.87601	1171.17	224.41	mmHg				LBNL Data File	131.881	mmHg	131.88
110-54-3	HEXANE	6.87601	1171.17	224.41	mmHg				LBNL Data File	131.881	mmHg	131.88
110-54-3	HEXANE	6.87601	1171.17	224.41	mmHg				LBNL Data File	131.881	mmHg	131.88
110-54-3	ALKANE STANDARD SOLUTION C8-C20	6.87601	1171.17	224.41	mmHg				LBNL Data File	131.881	mmHg	131.88
110-54-3	HEXANE	6.87601	1171.17	224.41	mmHg				LBNL Data File	131.881	mmHg	131.88
110-54-3	HEXANE	6.87601	1171.17	224.41	mmHg				LBNL Data File	131.881	mmHg	131.88
110-54-3	HEXANE	6.87601	1171.17	224.41	mmHg				LBNL Data File	131.881	mmHg	131.88
110-54-3	HEXANE	6.87601	1171.17	224.41	mmHg				LBNL Data File	131.881	mmHg	131.88
110-54-3	N-HEXANE	6.87601	1171.17	224.41	mmHg				LBNL Data File	131.881	mmHg	131.88
110-54-3	HEXANE	6.87601	1171.17	224.41	mmHg				LBNL Data File	131.881	mmHg	131.88
110-54-3	HEXANE	6.87601	1171.17	224.41	mmHg				LBNL Data File	131.881	mmHg	131.88
110-54-3	N-HEXANE	6.87601	1171.17	224.41	mmHg				LBNL Data File	131.881	mmHg	131.88
110-54-3	HEXANE	6.87601	1171.17	224.41	mmHg				LBNL Data File	131.881	mmHg	131.88
110-54-3	HEXANE	6.87601	1171.17	224.41	mmHg				LBNL Data File	131.881	mmHg	131.88
110-54-3	HEXANE	6.87601	1171.17	224.41	mmHg				LBNL Data File	131.881	mmHg	131.88
110-54-3	HEXANE	6.87601	1171.17	224.41	mmHg				LBNL Data File	131.881	mmHg	131.88
110-54-3	HEXANE, CHROMASOLV PLUS	6.87601	1171.17	224.41	mmHg				LBNL Data File	131.881	mmHg	131.88
110-54-3	HEXANE	6.87601	1171.17	224.41	mmHg				LBNL Data File	131.881	mmHg	131.88
111-30-8	GLUTARALDEHYDE 25% AQUEOUS SOLUTION						0.45	293	MSDS	0.450	mmHg	0.90
111-30-8	GLUTARALDEHYDE SOLUTION						0.45	293	MSDS	0.450	mmHg	0.90
111-30-8	GLUTARALDEHYDE						0.45	293	MSDS	0.450	mmHg	0.90
111-30-8	GLUTARALDEHYDE SOLUTION						0.45	293	MSDS	0.450	mmHg	0.90
111-30-8	GLUTARALDEHYDE						0.45	293	MSDS	0.450	mmHg	0.90
111-30-8	GLUTARALDEHYDE						0.45	293	MSDS	0.450	mmHg	0.90
111-30-8	GLUTARALDEHYDE SOLUTION						0.45	293	MSDS	0.450	mmHg	0.90
111-30-8	GLUTARALDEHYDE SOLUTION						0.45	293	MSDS	0.450	mmHg	0.90

a. If VP (@ ref temp) < 100 mmHg, then VP = Lesser of twice the VP (@ ref temp) or 100 mmHg
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Calculation of Liquid Chemical Emissions
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Vapor Pressure Data (Table G-3)

Antoine Equation: $VP = 10^{[A - (B/(T+C))]}$

where: VP = Vapor Pressure (mmHg or bar, depending on source of A, B, C)
T = Temperature (K or C depending on source of A, B, C)
A, B, C = Antoine coefficients

(Reference Temperature should be near 295 deg K)

This list of chemicals comes from LBNL inventory data with solids & gases removed Must be identical to Chemical Inventory worksheet		*Must be entered manually* For Antoine Eq. @ 295 K				or	*Entered manually* Literature		*Entered manually*	*Calculated values*		*Calculated*
		Antoine Coefficients										
CAS No.	Compound Name	A	B	C	VP Units		VP @ Ref Temp (mmHg)	Ref Temp (K)	Vapor Pressure Reference	Vapor Pressure at Ref	Vapor Pressure at Ref (VP Units)	Adjusted Vapor Pressure [a] (mmHg)
111-30-8	GLUTARALDEHYDE						0.45	293	MSDS	0.450	mmHg	0.90
111-30-8	GLUTARALDEHYDE						0.45	293	MSDS	0.450	mmHg	0.90
111-30-8	GLUTARALDEHYDE						0.45	293	MSDS	0.450	mmHg	0.90
111-30-8	GLUTARALDEHYDE						0.45	293	MSDS	0.450	mmHg	0.90
111-30-8	GLUTARALDEHYDE						0.45	293	MSDS	0.450	mmHg	0.90
111-30-8	GLUTERALDEHYDE						0.45	293	MSDS	0.450	mmHg	0.90
111-30-8	GLUTERALDEHYDE						0.45	293	MSDS	0.450	mmHg	0.90
111-30-8	GLUTERALDEHYDE						0.45	293	MSDS	0.450	mmHg	0.90
111-30-8	GLUTARALDEHYDE						0.45	293	MSDS	0.450	mmHg	0.90
111-30-8	GLUTARALDEHYDE						0.45	293	MSDS	0.450	mmHg	0.90
111-30-8	GLUTARALDEHYDE						0.45	293	MSDS	0.450	mmHg	0.90
111-30-8	GLUTARALDEHYDE						0.45	293	MSDS	0.450	mmHg	0.90
111-30-8	GLUTARALDEHYDE						0.45	293	MSDS	0.450	mmHg	0.90
111-30-8	GLUTARALDEHYDE 25% AQUEOUS SOLUTION						0.45	293	MSDS	0.450	mmHg	0.90
111-30-8	GLUTARALDEHYDE 25% AQUEOUS SOLUTION						0.45	293	MSDS	0.450	mmHg	0.90
111-30-8	GLUTARALDEHYDE 25% AQUEOUS SOLUTION						0.45	293	MSDS	0.450	mmHg	0.90
111-30-8	GLUTARALDEHYDE						0.45	293	MSDS	0.450	mmHg	0.90
111-30-8	GLUTARALDEHYDE						0.45	293	MSDS	0.450	mmHg	0.90
111-30-8	GLUTARIC DIALDEHYDE						0.45	293	MSDS	0.450	mmHg	0.90
111-30-8	GLUTERALDEHYDE						0.45	293	MSDS	0.450	mmHg	0.90
111-30-8	GLUTARALDEHYDE						0.45	293	MSDS	0.450	mmHg	0.90
111-30-8	GLUTARALDEHYDE 25% AQUEOUS SOLUTION						0.45	293	MSDS	0.450	mmHg	0.90
111-30-8	GLUTARALDEHYDE SOLUTION						0.45	293	MSDS	0.450	mmHg	0.90
111-42-2	DIETHANOLAMINE	8.1388	2327.9	174.4	mmHg				LBNL Data File	0.000	mmHg	0.00
111-42-2	DIETHANOLAMINE	8.1388	2327.9	174.4	mmHg				LBNL Data File	0.000	mmHg	0.00
111-42-2	DIETHANOLAMINE	8.1388	2327.9	174.4	mmHg				LBNL Data File	0.000	mmHg	0.00
111-42-2	DIETHANOLAMINE	8.1388	2327.9	174.4	mmHg				LBNL Data File	0.000	mmHg	0.00
121-44-8	TRIETHYLAMINE	5.8588	695.7	144.8	mmHg				LBNL Data File	48.326	mmHg	96.65
121-44-8	TRIETHYLAMINE	5.8588	695.7	144.8	mmHg				LBNL Data File	48.326	mmHg	96.65
121-44-8	TRIETHYLAMINE	5.8588	695.7	144.8	mmHg				LBNL Data File	48.326	mmHg	96.65
121-44-8	TRIETHYLAMINE	5.8588	695.7	144.8	mmHg				LBNL Data File	48.326	mmHg	96.65
121-44-8	TRIETHYLAMINE	5.8588	695.7	144.8	mmHg				LBNL Data File	48.326	mmHg	96.65
121-44-8	TRIETHYLAMINE	5.8588	695.7	144.8	mmHg				LBNL Data File	48.326	mmHg	96.65
121-44-8	TRIETHYLAMINE	5.8588	695.7	144.8	mmHg				LBNL Data File	48.326	mmHg	96.65
121-44-8	TRIETHYLAMINE	5.8588	695.7	144.8	mmHg				LBNL Data File	48.326	mmHg	96.65
121-44-8	TRIETHYLAMINE	5.8588	695.7	144.8	mmHg				LBNL Data File	48.326	mmHg	96.65
123-91-1	1,4-DIOXANE ANHYDROUS	7.43155	1554.68	240.34	mmHg				LBNL Data File	31.766	mmHg	63.53
123-91-1	1,4-DIOXANE	7.43155	1554.68	240.34	mmHg				LBNL Data File	31.766	mmHg	63.53
123-91-1	DIOXANE	7.43155	1554.68	240.34	mmHg				LBNL Data File	31.766	mmHg	63.53
123-91-1	1,4-DIOXANE	7.43155	1554.68	240.34	mmHg				LBNL Data File	31.766	mmHg	63.53
123-91-1	1,4 DIOXANE	7.43155	1554.68	240.34	mmHg				LBNL Data File	31.766	mmHg	63.53
123-91-1	1,4 DIOXANE	7.43155	1554.68	240.34	mmHg				LBNL Data File	31.766	mmHg	63.53
123-91-1	1,4-DIOXANE ANHYDROUS	7.43155	1554.68	240.34	mmHg				LBNL Data File	31.766	mmHg	63.53
123-91-1	DIOXANE	7.43155	1554.68	240.34	mmHg				LBNL Data File	31.766	mmHg	63.53
123-91-1	DIOXANE	7.43155	1554.68	240.34	mmHg				LBNL Data File	31.766	mmHg	63.53
123-91-1	DIOXANE	7.43155	1554.68	240.34	mmHg				LBNL Data File	31.766	mmHg	63.53
123-91-1	DIOXANE	7.43155	1554.68	240.34	mmHg				LBNL Data File	31.766	mmHg	63.53

a. If VP (@ ref temp) < 100 mmHg, then VP = Lesser of twice the VP (@ ref temp) or 100 mmHg
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Golder Associates

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Vapor Pressure Data (Table G-3)

Antoine Equation: $VP = 10^{[A - (B/(T+C))]}$

where: VP = Vapor Pressure (mmHg or bar, depending on source of A, B, C)
T = Temperature (K or C depending on source of A, B, C)
A, B, C = Antoine coefficients

(Reference Temperature should be near 295 deg K)

This list of chemicals comes from LBNL inventory data with solids & gases removed Must be identical to Chemical Inventory worksheet		*Must be entered manually* For Antoine Eq. @ 295 K				or	*Entered manually* Literature		*Entered manually*	*Calculated values*		*Calculated*
		Antoine Coefficients										
CAS No.	Compound Name	A	B	C	VP Units		VP @ Ref Temp (mmHg)	Ref Temp (K)	Vapor Pressure Reference	Vapor Pressure at Ref	Vapor Pressure at Ref (VP Units)	Adjusted Vapor Pressure [a] (mmHg)
127-18-4	TETRACHLOROETHYLENE	6.97683	1386.92	217.53	mmHg				LBNL Data File	15.242	mmHg	30.48
1330-20-7	XYLENE						6.72	294	MSDS	6.720	mmHg	13.44
1330-20-7	XYLENE						6.72	294	MSDS	6.720	mmHg	13.44
1330-20-7	XYLENE						6.72	294	MSDS	6.720	mmHg	13.44
1330-20-7	XYLENE						6.72	294	MSDS	6.720	mmHg	13.44
1330-20-7	XYLENE						6.72	294	MSDS	6.720	mmHg	13.44
1330-20-7	XYLENE						6.72	294	MSDS	6.720	mmHg	13.44
1330-20-7	XYLENE						6.72	294	MSDS	6.720	mmHg	13.44
1330-20-7	XYLENE						6.72	294	MSDS	6.720	mmHg	13.44
1330-20-7	XYLENE						6.72	294	MSDS	6.720	mmHg	13.44
1330-20-7	XYLENE						6.72	294	MSDS	6.720	mmHg	13.44
1330-20-7	XYLENE						6.72	294	MSDS	6.720	mmHg	13.44
1330-20-7	XYLENE						6.72	294	MSDS	6.720	mmHg	13.44
1330-20-7	XYLENE						6.72	294	MSDS	6.720	mmHg	13.44
1330-20-7	XYLENES						6.72	294	MSDS	6.720	mmHg	13.44
1330-20-7	XYLENE						6.72	294	MSDS	6.720	mmHg	13.44
1330-20-7	XYLENE						6.72	294	MSDS	6.720	mmHg	13.44
1330-20-7	XYLENE						6.72	294	MSDS	6.720	mmHg	13.44
1330-20-7	DEPEX MOUNTING MEDIA						6.72	294	MSDS	6.720	mmHg	13.44
1634-04-4	METHYL TERT-BUTYL ETHER	6.8871	1162.1	219.9	mmHg				LBNL Data File	120.245	mmHg	120.25
1634-04-4	METHYL TERT-BUTYL ETHER	6.8871	1162.1	219.9	mmHg				LBNL Data File	120.245	mmHg	120.25
7647-01-0	HYDROCHLORIC ACID STANDARD SOLUTION						190	298	MSDS	190.000	mmHg	190.00
7647-01-0	HCL						190	298	MSDS	190.000	mmHg	190.00
7647-01-0	HYDROCHLORIC ACID						190	298	MSDS	190.000	mmHg	190.00
7647-01-0	HYDROCHLORIC ACID						190	298	MSDS	190.000	mmHg	190.00
7647-01-0	HYDROCHLORIC ACID						190	298	MSDS	190.000	mmHg	190.00
7647-01-0	HYDROCHLORIC ACID						190	298	MSDS	190.000	mmHg	190.00
7647-01-0	HYDROCHLORIC ACID						190	298	MSDS	190.000	mmHg	190.00
7647-01-0	HYDROCHLORIC ACID						190	298	MSDS	190.000	mmHg	190.00
7647-01-0	HYDROCHLORIC ACID						190	298	MSDS	190.000	mmHg	190.00
7647-01-0	HYDROCHLORIC ACID						190	298	MSDS	190.000	mmHg	190.00
7647-01-0	HYDROCHLORIC ACID						190	298	MSDS	190.000	mmHg	190.00
7647-01-0	HYDROCHLORIC ACID						190	298	MSDS	190.000	mmHg	190.00
7647-01-0	HYDROCHLORIC ACID						190	298	MSDS	190.000	mmHg	190.00
7647-01-0	HYDROCHLORIC ACID						190	298	MSDS	190.000	mmHg	190.00
7647-01-0	HYDROCHLORIC ACID						190	298	MSDS	190.000	mmHg	190.00
7647-01-0	HYDROCHLORIC ACID						190	298	MSDS	190.000	mmHg	190.00
7647-01-0	HYDROCHLORIC ACID						190	298	MSDS	190.000	mmHg	190.00
7647-01-0	HYDROCHLORIC ACID						190	298	MSDS	190.000	mmHg	190.00
7647-01-0	HYDROCHLORIC ACID						190	298	MSDS	190.000	mmHg	190.00
7647-01-0	HYDROCHLORIC ACID						190	298	MSDS	190.000	mmHg	190.00
7647-01-0	HYDROCHLORIC ACID						190	298	MSDS	190.000	mmHg	190.00
7647-01-0	HYDROCHLORIC ACID						190	298	MSDS	190.000	mmHg	190.00
7647-01-0	HYDROCHLORIC ACID						190	298	MSDS	190.000	mmHg	190.00
7647-01-0	HYDROCHLORIC ACID						190	298	MSDS	190.000	mmHg	190.00

a. If VP (@ ref temp) < 100 mmHg, then VP = Lesser of twice the VP (@ ref temp) or 100 mmHg
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where: VP = Vapor Pressure (mmHg or bar, depending on source of A, B, C)
T = Temperature (K or C depending on source of A, B, C)
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(Reference Temperature should be near 295 deg K)

This list of chemicals comes from LBNL inventory data with solids & gases removed Must be identical to Chemical Inventory worksheet		*Must be entered manually* For Antoine Eq. @ 295 K				or	*Entered manually* Literature		*Entered manually*	*Calculated values*		*Calculated*
		Antoine Coefficients										
CAS No.	Compound Name	A	B	C	VP Units		VP @ Ref Temp (mmHg)	Ref Temp (K)	Vapor Pressure Reference	Vapor Pressure at Ref	Vapor Pressure at Ref (VP Units)	Adjusted Vapor Pressure [a] (mmHg)
7647-01-0	HYDROCHLORIC ACID						190	298	MSDS	190.000	mmHg	190.00
7647-01-0	HYDROCHLORIC ACID SOLUTION						190	298	MSDS	190.000	mmHg	190.00
7647-01-0	HYDROCHLORIC ACID						190	298	MSDS	190.000	mmHg	190.00
7647-01-0	HYDROCHLORIC ACID						190	298	MSDS	190.000	mmHg	190.00
7647-01-0	HYDROCHLORIC ACID						190	298	MSDS	190.000	mmHg	190.00
7647-01-0	HYDROCHLORIC ACID						190	298	MSDS	190.000	mmHg	190.00
7647-01-0	HYDROCHLORIC ACID						190	298	MSDS	190.000	mmHg	190.00
7647-01-0	HYDROCHLORIC ACID						190	298	MSDS	190.000	mmHg	190.00
7647-01-0	HYDROCHLORIC ACID						190	298	MSDS	190.000	mmHg	190.00
7647-01-0	HYDROCHLORIC ACID						190	298	MSDS	190.000	mmHg	190.00
7647-01-0	HYDROCHLORIC ACID						190	298	MSDS	190.000	mmHg	190.00
7647-01-0	HYDROCHLORIC ACID						190	298	MSDS	190.000	mmHg	190.00
7647-01-0	HYDROCHLORIC ACID						190	298	MSDS	190.000	mmHg	190.00
7647-01-0	HYDROCHLORIC ACID						190	298	MSDS	190.000	mmHg	190.00
7647-01-0	HYDROCHLORIC ACID						190	298	MSDS	190.000	mmHg	190.00
7647-01-0	HYDROCHLORIC ACID						190	298	MSDS	190.000	mmHg	190.00
7647-01-0	HYDROCHLORIC ACID						190	298	MSDS	190.000	mmHg	190.00
7647-01-0	HYDROCHLORIC ACID SOLUTION						190	298	MSDS	190.000	mmHg	190.00
7647-01-0	HYDROCHLORIC ACID						190	298	MSDS	190.000	mmHg	190.00
7647-01-0	HYDROCHLORIC ACID						190	298	MSDS	190.000	mmHg	190.00
7647-01-0	HYDROCHLORIC ACID						190	298	MSDS	190.000	mmHg	190.00
7647-01-0	HYDROCHLORIC ACID						190	298	MSDS	190.000	mmHg	190.00
7647-01-0	HYDROCHLORIC ACID						190	298	MSDS	190.000	mmHg	190.00
7647-01-0	HYDROCHLORIC ACID						190	298	MSDS	190.000	mmHg	190.00
7647-01-0	HYDROCHLORIC ACID						190	298	MSDS	190.000	mmHg	190.00
7647-01-0	HYDROCHLORIC ACID						190	298	MSDS	190.000	mmHg	190.00
7647-01-0	IMIDAZOLERIC ACID						190	298	MSDS	190.000	mmHg	190.00
7647-01-0	HYDROCHLORIC ACID						190	298	MSDS	190.000	mmHg	190.00
7647-01-0	HYDROCHLORIC ACID						190	298	MSDS	190.000	mmHg	190.00
7647-01-0	HYDROCHLORIC ACID						190	298	MSDS	190.000	mmHg	190.00
7647-01-0	HYDROCHLORIC ACID						190	298	MSDS	190.000	mmHg	190.00
7647-01-0	HYDROCHLORIC ACID						190	298	MSDS	190.000	mmHg	190.00
7647-01-0	HYDROCHLORIC ACID						190	298	MSDS	190.000	mmHg	190.00
7647-01-0	HCL						190	298	MSDS	190.000	mmHg	190.00
7647-01-0	HYDROCHLORIC ACID						190	298	MSDS	190.000	mmHg	190.00
7647-01-0	HYDROCHLORIC ACID						190	298	MSDS	190.000	mmHg	190.00
7647-01-0	HYDROCHLORIC ACID						190	298	MSDS	190.000	mmHg	190.00
7647-01-0	HYDROCHLORIC ACID						190	298	MSDS	190.000	mmHg	190.00
7647-01-0	(TRIDECAFLUORO-1,1,2,2-TERAHYDROOCTYL)TRICHLOROSILANE						190	298	MSDS	190.000	mmHg	190.00
7647-01-0	HCL						190	298	MSDS	190.000	mmHg	190.00
7647-01-0	HCL						190	298	MSDS	190.000	mmHg	190.00
7647-01-0	HYDROCHLORIC ACID						190	298	MSDS	190.000	mmHg	190.00
7647-01-0	HYDROCHLORIC ACID						190	298	MSDS	190.000	mmHg	190.00
7647-01-0	HYDROCHLORIC ACID						190	298	MSDS	190.000	mmHg	190.00
7647-01-0	HYDROCHLORIC ACID						190	298	MSDS	190.000	mmHg	190.00
7647-01-0	HYDROCHLORIC ACID						190	298	MSDS	190.000	mmHg	190.00
7647-01-0	HYDROCHLORIC ACID						190	298	MSDS	190.000	mmHg	190.00
7647-01-0	HYDROCHLORIC ACID						190	298	MSDS	190.000	mmHg	190.00
7647-01-0	HYDROCHLORIC ACID						190	298	MSDS	190.000	mmHg	190.00

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This list of chemicals comes from LBNL inventory data with solids & gases removed Must be identical to Chemical Inventory worksheet		*Must be entered manually* For Antoine Eq. @ 295 K				or	*Entered manually* Literature		*Entered manually*	*Calculated values*		*Calculated*
		Antoine Coefficients										
CAS No.	Compound Name	A	B	C	VP Units		VP @ Ref Temp (mmHg)	Ref Temp (K)	Vapor Pressure Reference	Vapor Pressure at Ref	Vapor Pressure at Ref (VP Units)	Adjusted Vapor Pressure [a] (mmHg)
7647-01-0	HYDROCHLORIC ACID						190	298	MSDS	190.000	mmHg	190.00
7647-01-0	HYDROCHLORIC ACID						190	298	MSDS	190.000	mmHg	190.00
7647-01-0	HYDROCHLORIC ACID						190	298	MSDS	190.000	mmHg	190.00
7647-01-0	HYDROCHLORIC ACID						190	298	MSDS	190.000	mmHg	190.00
7647-01-0	HYDROCHLORIC ACID						190	298	MSDS	190.000	mmHg	190.00
7647-01-0	HYDROCHLORIC ACID						190	298	MSDS	190.000	mmHg	190.00
7647-01-0	HYDROCHLORIC ACID						190	298	MSDS	190.000	mmHg	190.00
7647-01-0	HYDROCHLORIC ACID						190	298	MSDS	190.000	mmHg	190.00
7647-01-0	HYDROCHLORIC ACID						190	298	MSDS	190.000	mmHg	190.00
7647-01-0	HYDROCHLORIC ACID						190	298	MSDS	190.000	mmHg	190.00
7647-01-0	HYDROCHLORIC ACID						190	298	MSDS	190.000	mmHg	190.00
7647-01-0	HYDROCHLORIC ACID						190	298	MSDS	190.000	mmHg	190.00
7647-01-0	HYDROCHLORIC ACID						190	298	MSDS	190.000	mmHg	190.00
7647-01-0	HYDROCHLORIC ACID						190	298	MSDS	190.000	mmHg	190.00
7647-01-0	HYDROCHLORIC ACID						190	298	MSDS	190.000	mmHg	190.00
7647-01-0	HYDROCHLORIC ACID						190	298	MSDS	190.000	mmHg	190.00
7664-38-2	BIO-SAFE COOMASSIE						0.03	293	MSDS	0.030	mmHg	0.06
7664-38-2	BIO-SAFE COOMASSIE						0.03	293	MSDS	0.030	mmHg	0.06
7664-38-2	BIO-SAFE COOMASSIE						0.03	293	MSDS	0.030	mmHg	0.06
7664-38-2	BIO-SAFE COOMASSIE						0.03	293	MSDS	0.030	mmHg	0.06
7664-38-2	PHOSPHORIC ACID						0.03	293	MSDS	0.030	mmHg	0.06
7664-38-2	PHOSPHORIC ACID						0.03	293	MSDS	0.030	mmHg	0.06
7664-38-2	PHOSPHORIC ACID						0.03	293	MSDS	0.030	mmHg	0.06
7664-38-2	LPH SE GERMICIDAL DETERGENT						0.03	293	MSDS	0.030	mmHg	0.06
7664-38-2	PHOSPHORIC ACID						0.03	293	MSDS	0.030	mmHg	0.06
7664-38-2	PHOSPHORIC ACID						0.03	293	MSDS	0.030	mmHg	0.06
7664-38-2	PHOSPHORIC ACID						0.03	293	MSDS	0.030	mmHg	0.06
7664-38-2	PHOSPHORIC ACID						0.03	293	MSDS	0.030	mmHg	0.06
7664-38-2	PHOSPHORIC ACID						0.03	293	MSDS	0.030	mmHg	0.06
7664-38-2	PHOSPHORIC ACID						0.03	293	MSDS	0.030	mmHg	0.06
7664-38-2	PHOSPHORIC ACID						0.03	293	MSDS	0.030	mmHg	0.06
7664-38-2	PHOSPHORIC ACID						0.03	293	MSDS	0.030	mmHg	0.06
7664-38-2	PHOSPHORIC ACID						0.03	293	MSDS	0.030	mmHg	0.06
7664-38-2	PHOSPHORIC ACID						0.03	293	MSDS	0.030	mmHg	0.06
7664-38-2	PHOSPHORIC ACID						0.03	293	MSDS	0.030	mmHg	0.06
7664-38-2	PHOSPHORIC ACID						0.03	293	MSDS	0.030	mmHg	0.06
7664-38-2	O-PHOSPHORIC ACID						0.03	293	MSDS	0.030	mmHg	0.06
7664-38-2	PHOSPHORIC ACID						0.03	293	MSDS	0.030	mmHg	0.06
7664-38-2	DYE REAGENT CONCENTRATE (PHOSPHAIC ACID/METHANOL)						0.03	293	MSDS	0.030	mmHg	0.06
7664-38-2	PHOSPHORIC ACID						0.03	293	MSDS	0.030	mmHg	0.06
7664-38-2	5'-MONOPHOSPHORIC ACID						0.03	293	MSDS	0.030	mmHg	0.06
7664-38-2	PHOSPHORIC ACID						0.03	293	MSDS	0.030	mmHg	0.06
7664-38-2	PHOSPHORIC ACID						0.03	293	MSDS	0.030	mmHg	0.06
7664-38-2	PHOSPHORIC ACID						0.03	293	MSDS	0.030	mmHg	0.06
7664-38-2	PHOSPHORIC ACID						0.03	293	MSDS	0.030	mmHg	0.06

a. If VP (@ ref temp) < 100 mmHg, then VP = Lesser of twice the VP (@ ref temp) or 100 mmHg
If VP (@ ref temp) >= 100 mmHg, then not adjusted

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Calculation of Liquid Chemical Emissions
Phase 1 Laboratory Usage Scenario
Proposed Richmond Bay Campus Long Range Development Plan, Richmond, California

Vapor Pressure Data (Table G-3)

Antoine Equation: $VP = 10^{[A - (B/(T+C))]}$

where: VP = Vapor Pressure (mmHg or bar, depending on source of A, B, C)
T = Temperature (K or C depending on source of A, B, C)
A, B, C = Antoine coefficients

(Reference Temperature should be near 295 deg K)

This list of chemicals comes from LBNL inventory data with solids & gases removed Must be identical to Chemical Inventory worksheet		*Must be entered manually* For Antoine Eq. @ 295 K				or	*Entered manually* Literature		*Entered manually*	*Calculated values*		*Calculated*
		Antoine Coefficients										
CAS No.	Compound Name	A	B	C	VP Units		VP @ Ref Temp (mmHg)	Ref Temp (K)	Vapor Pressure Reference	Vapor Pressure at Ref	Vapor Pressure at Ref (VP Units)	Adjusted Vapor Pressure [a] (mmHg)
7664-38-2	PHOSPORIC ACID						0.03	293	MSDS	0.030	mmHg	0.06
7664-38-2	PHOSPHORIC ACID						0.03	293	MSDS	0.030	mmHg	0.06
7664-39-3	HYDROFLUORIC ACID						25	293	MSDS	25.000	mmHg	50.00
7664-93-9	SULFURIC ACID						1	419	MSDS	1.000	mmHg	2.00
7664-93-9	SULFURIC ACID						1	419	MSDS	1.000	mmHg	2.00
7664-93-9	SULFURIC ACID						1	419	MSDS	1.000	mmHg	2.00
7664-93-9	SULFURIC ACID						1	419	MSDS	1.000	mmHg	2.00
7664-93-9	SULFURIC ACID						1	419	MSDS	1.000	mmHg	2.00
7664-93-9	SULFURIC ACID						1	419	MSDS	1.000	mmHg	2.00
7664-93-9	SULFURIC ACID						1	419	MSDS	1.000	mmHg	2.00
7664-93-9	SULFURIC ACID						1	419	MSDS	1.000	mmHg	2.00
7664-93-9	SULFURIC ACID						1	419	MSDS	1.000	mmHg	2.00
7664-93-9	SULFURIC ACID						1	419	MSDS	1.000	mmHg	2.00
7664-93-9	SULFURIC ACID						1	419	MSDS	1.000	mmHg	2.00
7664-93-9	SULFURIC ACID						1	419	MSDS	1.000	mmHg	2.00
7664-93-9	SULFURIC ACID						1	419	MSDS	1.000	mmHg	2.00
7664-93-9	FISHER CLEANING SOLUTION						1	419	MSDS	1.000	mmHg	2.00
7664-93-9	SULFURIC ACID						1	419	MSDS	1.000	mmHg	2.00
7664-93-9	SULFURIC ACID						1	419	MSDS	1.000	mmHg	2.00
7664-93-9	SULFURIC ACID						1	419	MSDS	1.000	mmHg	2.00
7664-93-9	SULFURIC ACID						1	419	MSDS	1.000	mmHg	2.00
7664-93-9	SULFURIC ACID						1	419	MSDS	1.000	mmHg	2.00
7664-93-9	SULFURIC ACID						1	419	MSDS	1.000	mmHg	2.00
7664-93-9	SULFURIC ACID						1	419	MSDS	1.000	mmHg	2.00
7664-93-9	SULFURIC ACID						1	419	MSDS	1.000	mmHg	2.00
7664-93-9	SULFURIC ACID						1	419	MSDS	1.000	mmHg	2.00
7664-93-9	SULFURIC ACID						1	419	MSDS	1.000	mmHg	2.00
7664-93-9	SULFURIC ACID						1	419	MSDS	1.000	mmHg	2.00
7664-93-9	SULFURIC ACID						1	419	MSDS	1.000	mmHg	2.00
7664-93-9	SULFURIC ACID						1	419	MSDS	1.000	mmHg	2.00
7697-37-2	NITRIC ACID						48	293	MSDS	48.000	mmHg	96.00
7697-37-2	NITRIC ACID						48	293	MSDS	48.000	mmHg	96.00
7697-37-2	NITRIC ACID						48	293	MSDS	48.000	mmHg	96.00
7697-37-2	NITRIC ACID						48	293	MSDS	48.000	mmHg	96.00
7697-37-2	NITRIC ACID						48	293	MSDS	48.000	mmHg	96.00
7697-37-2	NITRIC ACID						48	293	MSDS	48.000	mmHg	96.00
7726-95-6	BROMINE	6.8778	1119.68	221.38	mmHg				LBNL Data File	188.114	mmHg	188.11

a. If VP (@ ref temp) < 100 mmHg, then VP = Lesser of twice the VP (@ ref temp) or 100 mmHg
If VP (@ ref temp) >= 100 mmHg, then not adjusted

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Calculation of Liquid Chemical Emissions
Phase 1 Laboratory Usage Scenario
Proposed Richmond Bay Campus Long Range Development Plan, Richmond, California

Pouring Emissions Estimates (Table G-4)

S = Saturation Factor = 1.45
VP = Vapor Pressure = Chemical-specific
MW = Molecular Weight = Chemical-specific
T = Ambient Temperature (R) = 532

Loss (grams/liter) = 0.02887 * (S*VP*MW)/T
(limited to 700 g/liter)

This list of chemicals comes from LBNL inventory data with solids & gases removed Must be identical to Chemical Inventory worksheet		*MW entered manually*		*Calculated value from separate worksheet*	*Calculated* **Pouring Loss Emission Factor (grams/liter)**	*From separate worksheet* **Annual Usage (liters/yr)**	*Calculated* **Annual Emissions (grams/yr)**
CAS No.	**Compound Name**	**MW (g/mole)**	**MW Reference**	**VP (@ Ref Temp) (mmHg)**			
50-00-0	NORTHERNMAX DENATURING GEL BUFFER	30.03	LBNL Data File	87.9	0.20771	0.29341	0.06094
50-00-0	FORMALDEHYDE	30.03	LBNL Data File	87.9	0.20771	0.58682	0.12188
50-00-0	FORMALDEHYDE	30.03	LBNL Data File	87.9	0.20771	0.58682	0.12188
50-00-0	FORMALDEHYDE SOLUTION	30.03	LBNL Data File	87.9	0.20771	0.58682	0.12188
50-00-0	FORMALDEHYDE	30.03	LBNL Data File	87.9	0.20771	0.58682	0.12188
50-00-0	FORMALDEHYDE	30.03	LBNL Data File	87.9	0.20771	0.58682	0.12188
50-00-0	FORMALDEHYDE SOLUTION	30.03	LBNL Data File	87.9	0.20771	0.02934	0.00609
50-00-0	FORMALDEHYDE	30.03	LBNL Data File	87.9	0.20771	0.02934	0.00609
50-00-0	FORMALDEHYDE	30.03	LBNL Data File	87.9	0.20771	0.02934	0.00609
50-00-0	FORMALDEHYDE	30.03	LBNL Data File	87.9	0.20771	0.02934	0.00609
50-00-0	FORMALDEHYDE	30.03	LBNL Data File	87.9	0.20771	0.02934	0.00609
50-00-0	FORMALDEHYDE	30.03	LBNL Data File	87.9	0.20771	0.02934	0.00609
50-00-0	FORMALDEHYDE	30.03	LBNL Data File	87.9	0.20771	0.02934	0.00609
50-00-0	FORMALDEHYDE	30.03	LBNL Data File	87.9	0.20771	0.02934	0.00609
50-00-0	FORMALDEHYDE	30.03	LBNL Data File	87.9	0.20771	0.02934	0.00609
50-00-0	FORMALDEHYDE	30.03	LBNL Data File	87.9	0.20771	0.02934	0.00609
50-00-0	FORMALDEHYDE	30.03	LBNL Data File	87.9	0.20771	0.02934	0.00609
50-00-0	FORMALDEHYDE	30.03	LBNL Data File	87.9	0.20771	0.02934	0.00609
50-00-0	FORMALDEHYDE	30.03	LBNL Data File	87.9	0.20771	0.58682	0.12188
50-00-0	FORMALDEHYDE	30.03	LBNL Data File	87.9	0.20771	0.58682	0.12188
50-00-0	FORMALDEHYDE	30.03	LBNL Data File	87.9	0.20771	0.58682	0.12188
50-00-0	FORMALDEHYDE	30.03	LBNL Data File	87.9	0.20771	0.58682	0.12188
50-00-0	FORMALDEHYDE	30.03	LBNL Data File	87.9	0.20771	0.58682	0.12188
50-00-0	FORMALDEHYDE	30.03	LBNL Data File	87.9	0.20771	0.02934	0.00609
50-00-0	FORMALDEHYDE	30.03	LBNL Data File	87.9	0.20771	0.02934	0.00609
50-00-0	FORMALDEHYDE	30.03	LBNL Data File	87.9	0.20771	0.02934	0.00609
50-00-0	FORMALDEHYDE	30.03	LBNL Data File	87.9	0.20771	0.02934	0.00609
50-00-0	FORMALDEHYDE	30.03	LBNL Data File	87.9	0.20771	0.02934	0.00609
50-00-0	FORMALDEHYDE	30.03	LBNL Data File	87.9	0.20771	0.02934	0.00609
50-00-0	FORMALDEHYDE	30.03	LBNL Data File	87.9	0.20771	0.02934	0.00609
50-00-0	FORMALDEHYDE	30.03	LBNL Data File	87.9	0.20771	0.02934	0.00609
50-00-0	FORMALDEHYDE	30.03	LBNL Data File	87.9	0.20771	0.02934	0.00609

Calculation of Liquid Chemical Emissions
Phase 1 Laboratory Usage Scenario
Proposed Richmond Bay Campus Long Range Development Plan, Richmond, California

Pouring Emissions Estimates (Table G-4)

S = Saturation Factor = 1.45
VP = Vapor Pressure = Chemical-specific
MW = Molecular Weight = Chemical-specific
T = Ambient Temperature (R) = 532

Loss (grams/liter) = 0.02887 * (S*VP*MW)/T
(limited to 700 g/liter)

This list of chemicals comes from LBNL inventory data with solids & gases removed Must be identical to Chemical Inventory worksheet		*MW entered manually*		*Calculated value from separate worksheet*	*Calculated* **Pouring Loss Emission Factor**	*From separate worksheet* **Annual Usage**	*Calculated* **Annual Emissions**
CAS No.	**Compound Name**	**MW (g/mole)**	**MW Reference**	**VP (@ Ref Temp) (mmHg)**	**(grams/liter)**	**(liters/yr)**	**(grams/yr)**
50-00-0	FORMALDEHYDE SOLUTION	30.03	LBNL Data File	87.9	0.20771	0.58682	0.12188
50-00-0	FORMALDEHYDE	30.03	LBNL Data File	87.9	0.20771	0.02934	0.00609
50-00-0	FORMALDEHYDE	30.03	LBNL Data File	87.9	0.20771	0.02934	0.00609
50-00-0	FORMALDEHYDE	30.03	LBNL Data File	87.9	0.20771	0.02934	0.00609
50-00-0	FORMALDEHYDE	30.03	LBNL Data File	87.9	0.20771	0.02934	0.00609
50-00-0	FORMALDEHYDE	30.03	LBNL Data File	87.9	0.20771	0.02934	0.00609
50-00-0	FORMALDEHYDE	30.03	LBNL Data File	87.9	0.20771	0.02934	0.00609
50-00-0	FORMALDEHYDE SOLUTION	30.03	LBNL Data File	87.9	0.20771	0.02934	0.00609
50-00-0	FORMALDEHYDE	30.03	LBNL Data File	87.9	0.20771	0.52814	0.10970
50-00-0	FORMALDEHYDE	30.03	LBNL Data File	87.9	0.20771	0.52814	0.10970
50-00-0	FORMALDEHYDE	30.03	LBNL Data File	87.9	0.20771	0.52814	0.10970
50-00-0	FORMALDEHYDE	30.03	LBNL Data File	87.9	0.20771	0.52814	0.10970
50-00-0	FORMALDEHYDE SOLUTION	30.03	LBNL Data File	87.9	0.20771	0.58682	0.12188
50-00-0	FORMALDEHYDE SOLUTION	30.03	LBNL Data File	87.9	0.20771	0.58682	0.12188
50-00-0	FORMALDEHYDE SOLUTION	30.03	LBNL Data File	87.9	0.20771	0.53836	0.11182
50-00-0	FORMALDEHYDE SOLUTION	30.03	LBNL Data File	87.9	0.20771	0.53836	0.11182
50-00-0	FORMALDEHYDE	30.03	LBNL Data File	87.9	0.20771	0.11736	0.02438
50-00-0	NORTHERNMAX DENATURING GEL BUFFER	30.03	LBNL Data File	87.9	0.20771	0.29341	0.06094
50-00-0	FORMALDEHYDE	30.03	LBNL Data File	87.9	0.20771	0.11736	0.02438
50-00-0	FORMALDEHYDE	30.03	LBNL Data File	87.9	0.20771	0.11736	0.02438
50-00-0	FORMALDEHYDE	30.03	LBNL Data File	87.9	0.20771	0.11736	0.02438
50-00-0	FORMALDEHYDE	30.03	LBNL Data File	87.9	0.20771	0.11736	0.02438
50-00-0	FORMALDEHYDE	30.03	LBNL Data File	87.9	0.20771	0.58682	0.12188
50-00-0	FORMALIN SOLUTION 10%, NEUTRAL BUFFERED	30.03	LBNL Data File	87.9	0.20771	4.44220	0.92267
50-00-0	FORMALIN SOLUTION 10%, NEUTRAL BUFFERED	30.03	LBNL Data File	87.9	0.20771	4.44220	0.92267
50-00-0	FORMALIN SOLUTION 10%, NEUTRAL BUFFERED	30.03	LBNL Data File	87.9	0.20771	4.44220	0.92267
50-00-0	FORMALDEHYDE	30.03	LBNL Data File	87.9	0.20771	0.58682	0.12188
50-00-0	FORMALDEHYDE	30.03	LBNL Data File	87.9	0.20771	0.52814	0.10970
50-00-0	FORMALDEHYDE	30.03	LBNL Data File	87.9	0.20771	0.58682	0.12188
50-00-0	FORMALDEHYDE	30.03	LBNL Data File	87.9	0.20771	0.58682	0.12188
50-00-0	FORMALIN	30.03	LBNL Data File	87.9	0.20771	0.14084	0.02925
50-00-0	FORMALDEHYDE	30.03	LBNL Data File	87.9	0.20771	0.14084	0.02925
50-00-0	FORMALDEHYDE	30.03	LBNL Data File	87.9	0.20771	0.14084	0.02925
50-00-0	FORMALDEHYDE	30.03	LBNL Data File	87.9	0.20771	0.14084	0.02925

Calculation of Liquid Chemical Emissions
Phase 1 Laboratory Usage Scenario
Proposed Richmond Bay Campus Long Range Development Plan, Richmond, California

Pouring Emissions Estimates (Table G-4)

S = Saturation Factor = 1.45
VP = Vapor Pressure = Chemical-specific
MW = Molecular Weight = Chemical-specific
T = Ambient Temperature (R) = 532

Loss (grams/liter) = 0.02887 * (S*VP*MW)/T
(limited to 700 g/liter)

This list of chemicals comes from LBNL inventory data with solids & gases removed Must be identical to Chemical Inventory worksheet		*MW entered manually*		*Calculated value from separate worksheet*	*Calculated* **Pouring Loss Emission Factor**	*From separate worksheet* **Annual Usage**	*Calculated* **Annual Emissions**
CAS No.	**Compound Name**	**MW (g/mole)**	**MW Reference**	**VP (@ Ref Temp) (mmHg)**	**(grams/liter)**	**(liters/yr)**	**(grams/yr)**
50-00-0	FORMALDEHYDE	30.03	LBNL Data File	87.9	0.20771	0.14084	0.02925
50-00-0	FORMALDEHYDE	30.03	LBNL Data File	87.9	0.20771	0.14084	0.02925
50-00-0	FORMALDEHYDE	30.03	LBNL Data File	87.9	0.20771	0.14084	0.02925
50-00-0	FORMALDEHYDE	30.03	LBNL Data File	87.9	0.20771	0.14084	0.02925
50-00-0	FORMALDEHYDE	30.03	LBNL Data File	87.9	0.20771	0.14084	0.02925
50-00-0	FORMALDEHYDE	30.03	LBNL Data File	87.9	0.20771	0.14084	0.02925
50-00-0	FORMALDEHYDE	30.03	LBNL Data File	87.9	0.20771	0.14084	0.02925
50-00-0	FORMALDEHYDE	30.03	LBNL Data File	87.9	0.20771	0.14084	0.02925
50-00-0	FORMALDEHYDE	30.03	LBNL Data File	87.9	0.20771	0.14084	0.02925
50-00-0	FORMALDEHYDE	30.03	LBNL Data File	87.9	0.20771	0.14084	0.02925
50-00-0	FORMALDEHYDE	30.03	LBNL Data File	87.9	0.20771	0.14084	0.02925
50-00-0	FORMALDEHYDE	30.03	LBNL Data File	87.9	0.20771	0.14084	0.02925
50-00-0	FORMALDEHYDE	30.03	LBNL Data File	87.9	0.20771	4.69453	0.97508
50-00-0	FORMALDEHYDE	30.03	LBNL Data File	87.9	0.20771	4.69453	0.97508
50-00-0	FORMALIN SOLUTION 10%, NEUTRAL BUFFERED	30.03	LBNL Data File	87.9	0.20771	0.01760	0.00366
50-00-0	FORMALIN SOLUTION 10%, NEUTRAL BUFFERED	30.03	LBNL Data File	87.9	0.20771	0.01760	0.00366
50-00-0	FORMALIN SOLUTION 10%, NEUTRAL BUFFERED	30.03	LBNL Data File	87.9	0.20771	0.01760	0.00366
50-00-0	FORMALIN SOLUTION 10%, NEUTRAL BUFFERED	30.03	LBNL Data File	87.9	0.20771	0.01760	0.00366
50-00-0	FORMALIN SOLUTION 10%, NEUTRAL BUFFERED	30.03	LBNL Data File	87.9	0.20771	0.01760	0.00366
50-00-0	FORMALIN SOLUTION 10%, NEUTRAL BUFFERED	30.03	LBNL Data File	87.9	0.20771	0.01760	0.00366
50-00-0	FORMALINE SOLUTION ACCUSTAIN 10%	30.03	LBNL Data File	87.9	0.20771	0.14084	0.02925
50-00-0	FORMALDEHYDE	30.03	LBNL Data File	87.9	0.20771	0.58682	0.12188
50-00-0	FORMALDEHYDE	30.03	LBNL Data File	87.9	0.20771	0.58682	0.12188
50-00-0	FORMALDEHYDE	30.03	LBNL Data File	87.9	0.20771	0.58682	0.12188
50-00-0	FORMALDEHYDE	30.03	LBNL Data File	87.9	0.20771	0.58682	0.12188
50-00-0	FORMALDEHYDE	30.03	LBNL Data File	87.9	0.20771	0.02934	0.00609
50-00-0	FORMALINE SOLUTION ACCUSTAIN 10%	30.03	LBNL Data File	87.9	0.20771	0.05868	0.01219
50-00-0	NORTHERNMAX DENATURING GEL BUFFER	30.03	LBNL Data File	87.9	0.20771	0.29341	0.06094
50-00-0	FORMALDEHYDE SOLUTION	30.03	LBNL Data File	87.9	0.20771	0.58682	0.12188
50-00-0	FORMALDEHYDE	30.03	LBNL Data File	87.9	0.20771	0.58682	0.12188
50-00-0	FORMALDEHYDE SOLUTION	30.03	LBNL Data File	87.9	0.20771	0.58682	0.12188
50-00-0	FORMALDEHYDE SOLUTION	30.03	LBNL Data File	87.9	0.20771	0.58682	0.12188
50-00-0	FORMALDEHYDE	30.03	LBNL Data File	87.9	0.20771	0.58682	0.12188
50-00-0	FORMALDEHYDE SOLUTION	30.03	LBNL Data File	87.9	0.20771	0.58682	0.12188

Calculation of Liquid Chemical Emissions
Phase 1 Laboratory Usage Scenario
Proposed Richmond Bay Campus Long Range Development Plan, Richmond, California

Pouring Emissions Estimates (Table G-4)

S = Saturation Factor = 1.45
VP = Vapor Pressure = Chemical-specific
MW = Molecular Weight = Chemical-specific
T = Ambient Temperature (R) = 532

Loss (grams/liter) = 0.02887 * (S*VP*MW)/T
(limited to 700 g/liter)

This list of chemicals comes from LBNL inventory data with solids & gases removed Must be identical to Chemical Inventory worksheet		*MW entered manually*		*Calculated value from separate worksheet*	*Calculated* **Pouring Loss Emission Factor**	*From separate worksheet* **Annual Usage**	*Calculated* **Annual Emissions**
CAS No.	**Compound Name**	**MW (g/mole)**	**MW Reference**	**VP (@ Ref Temp) (mmHg)**	**(grams/liter)**	**(liters/yr)**	**(grams/yr)**
50-00-0	FORMALDEHYDE	30.03	LBNL Data File	87.9	0.20771	0.11736	0.02438
50-00-0	FORMALDEHYDE	30.03	LBNL Data File	87.9	0.20771	0.11736	0.02438
50-00-0	FORMALDEHYDE	30.03	LBNL Data File	87.9	0.20771	0.11736	0.02438
50-00-0	FORMALIN SOLUTION 10%, NEUTRAL BUFFERED	30.03	LBNL Data File	87.9	0.20771	4.44220	0.92267
50-00-0	FORMALDEHYDE	30.03	LBNL Data File	87.9	0.20771	0.09389	0.01950
50-00-0	BUFFERED NEUTRAL FORMALIN	30.03	LBNL Data File	87.9	0.20771	4.69453	0.97508
50-00-0	FORMALDEHYDE	30.03	LBNL Data File	87.9	0.20771	0.58682	0.12188
50-00-0	FORMALDEHYDE	30.03	LBNL Data File	87.9	0.20771	0.58682	0.12188
50-00-0	FORMALDEHYDE	30.03	LBNL Data File	87.9	0.20771	0.58682	0.12188
50-00-0	FORMALDEHYDE	30.03	LBNL Data File	87.9	0.20771	0.58682	0.12188
50-00-0	FORMALDEHYDE	30.03	LBNL Data File	87.9	0.20771	0.58682	0.12188
50-00-0	FORMALDEHYDE	30.03	LBNL Data File	87.9	0.20771	0.58682	0.12188
50-00-0	FORMALDEHYDE	30.03	LBNL Data File	87.9	0.20771	0.58682	0.12188
50-00-0	FORMALINE SOLUTION ACCUSTAIN 10%	30.03	LBNL Data File	87.9	0.20771	4.69453	0.97508
50-00-0	FORMALDEHYDE	30.03	LBNL Data File	87.9	0.20771	0.58682	0.12188
50-00-0	FORMALIN SOLUTION 10%, NEUTRAL BUFFERED	30.03	LBNL Data File	87.9	0.20771	4.44220	0.92267
50-00-0	FORMALIN SOLUTION 10%, NEUTRAL BUFFERED	30.03	LBNL Data File	87.9	0.20771	4.44220	0.92267
50-00-0	FORMALIN SOLUTION 10%, NEUTRAL BUFFERED	30.03	LBNL Data File	87.9	0.20771	4.44220	0.92267
50-00-0	FORMALIN SOLUTION 10%, NEUTRAL BUFFERED	30.03	LBNL Data File	87.9	0.20771	4.44220	0.92267
50-00-0	FORMALDEHYDE SOLUTION	30.03	LBNL Data File	87.9	0.20771	0.58682	0.12188
50-00-0	FORMALDEHYDE	30.03	LBNL Data File	87.9	0.20771	0.58682	0.12188
50-00-0	FORMALDEHYDE	30.03	LBNL Data File	87.9	0.20771	0.02934	0.00609
50-00-0	FORMALDEHYDE	30.03	LBNL Data File	87.9	0.20771	0.01174	0.00244
50-00-0	FORMALDEHYDE	30.03	LBNL Data File	87.9	0.20771	0.58682	0.12188
50-00-0	FORMALIN SOLUTION	30.03	LBNL Data File	87.9	0.20771	0.01760	0.00366
50-00-0	FORMALDEHYDE SOLUTION	30.03	LBNL Data File	87.9	0.20771	0.58682	0.12188
50-00-0	FORMALDEHYDE	30.03	LBNL Data File	87.9	0.20771	0.58682	0.12188
50-00-0	FORMALDEHYDE	30.03	LBNL Data File	87.9	0.20771	0.00587	0.00122
50-00-0	FORMALDEHYDE	30.03	LBNL Data File	87.9	0.20771	0.17605	0.03657
50-00-0	FORMALDEHYDE	30.03	LBNL Data File	87.9	0.20771	0.17605	0.03657
50-00-0	FORMALDEHYDE	30.03	LBNL Data File	87.9	0.20771	0.58682	0.12188
50-00-0	FORMALIN SOLUTION 10%, NEUTRAL BUFFERED	30.03	LBNL Data File	87.9	0.20771	0.04108	0.00853
50-00-0	FORMALDEHYDE	30.03	LBNL Data File	87.9	0.20771	1.17363	0.24377
50-00-0	FORMALDEHYDE, 37 WT IN H2O	30.03	LBNL Data File	87.9	0.20771	0.58682	0.12188

Calculation of Liquid Chemical Emissions
Phase 1 Laboratory Usage Scenario
Proposed Richmond Bay Campus Long Range Development Plan, Richmond, California

Pouring Emissions Estimates (Table G-4)

S = Saturation Factor = 1.45
VP = Vapor Pressure = Chemical-specific
MW = Molecular Weight = Chemical-specific
T = Ambient Temperature (R) = 532

Loss (grams/liter) = 0.02887 * (S*VP*MW)/T
(limited to 700 g/liter)

This list of chemicals comes from LBNL inventory data with solids & gases removed Must be identical to Chemical Inventory worksheet		*MW entered manually*		*Calculated value from separate worksheet*	*Calculated* **Pouring Loss Emission Factor**	*From separate worksheet* **Annual Usage**	*Calculated* **Annual Emissions**
CAS No.	**Compound Name**	**MW (g/mole)**	**MW Reference**	**VP (@ Ref Temp) (mmHg)**	**(grams/liter)**	**(liters/yr)**	**(grams/yr)**
50-00-0	FORMALDEHYDE	30.03	LBNL Data File	87.9	0.20771	1.17363	0.24377
50-00-0	FORMALDEHYDE, 37 WT	30.03	LBNL Data File	87.9	0.20771	0.58682	0.12188
50-00-0	FORMALDEHYDE 37 % IN WATER	30.03	LBNL Data File	87.9	0.20771	0.58682	0.12188
50-00-0	FORMALDEHYDE	30.03	LBNL Data File	87.9	0.20771	0.11736	0.02438
50-00-0	FORMALDEHYDE	30.03	LBNL Data File	87.9	0.20771	0.11736	0.02438
50-00-0	FORMALDEHYDE	30.03	LBNL Data File	87.9	0.20771	0.58682	0.12188
50-00-0	FORMALDEHYDE	30.03	LBNL Data File	87.9	0.20771	0.58682	0.12188
50-00-0	FORMALDEHYDE SOLUTION	30.03	LBNL Data File	87.9	0.20771	0.58682	0.12188
50-00-0	FORMALIN	30.03	LBNL Data File	87.9	0.20771	1.17363	0.24377
56-23-5	CARBON TETRACHLORIDE	153.8	LBNL Data File	99.4	1.20242	0.55534	0.66775
58-89-9	YCLOHEXANE, 1,2,3,4,5,6-HEXACHLORO-, GAMMA-ISOME	290.9	LBNL Data File	0.0	0.00000	0.36837	0.00000
58-89-9	YCLOHEXANE, 1,2,3,4,5,6-HEXACHLORO-, GAMMA-ISOME	291.9	LBNL Data File	0.0	0.00000	0.36837	0.00000
58-89-9	YCLOHEXANE, 1,2,3,4,5,6-HEXACHLORO-, GAMMA-ISOME	292.9	LBNL Data File	0.0	0.00000	0.00368	0.00000
58-89-9	YCLOHEXANE, 1,2,3,4,5,6-HEXACHLORO-, GAMMA-ISOME	293.9	LBNL Data File	0.0	0.00000	0.00368	0.00000
62-53-3	ANILINE OIL	93	LBNL Data File	0.5	0.00386	0.57418	0.00222
62-53-3	BENZAMINE	93	LBNL Data File	0.5	0.00386	0.00574	0.00002
67-56-1	METHANOL	32.1	LBNL Data File	105.7	0.26706	4.44220	1.18634
67-56-1	METHANOL	32.1	LBNL Data File	105.7	0.26706	4.69453	1.25373
67-56-1	METHANOL	32.1	LBNL Data File	105.7	0.26706	2.93408	0.78358
67-56-1	METHANOL	32.1	LBNL Data File	105.7	0.26706	2.93408	0.78358
67-56-1	METHANOL	32.1	LBNL Data File	105.7	0.26706	0.00117	0.00031
67-56-1	METHANOL	32.1	LBNL Data File	105.7	0.26706	4.69453	1.25373
67-56-1	METHANOL	32.1	LBNL Data File	105.7	0.26706	1.17363	0.31343
67-56-1	COMBI METHANOL	32.1	LBNL Data File	105.7	0.26706	1.17363	0.31343
67-56-1	METHANOL	32.1	LBNL Data File	105.7	0.26706	1.17363	0.31343
67-56-1	METHANOL	32.1	LBNL Data File	105.7	0.26706	1.17363	0.31343
67-56-1	METHANOL	32.1	LBNL Data File	105.7	0.26706	4.69453	1.25373
67-56-1	METHANOL	32.1	LBNL Data File	105.7	0.26706	4.69453	1.25373
67-56-1	METHANOL	32.1	LBNL Data File	105.7	0.26706	1.17363	0.31343
67-56-1	METHANOL	32.1	LBNL Data File	105.7	0.26706	1.17363	0.31343
67-56-1	METHANOL	32.1	LBNL Data File	105.7	0.26706	2.34727	0.62686
67-56-1	METHANOL	32.1	LBNL Data File	105.7	0.26706	2.34727	0.62686
67-56-1	METHANOL	32.1	LBNL Data File	105.7	0.26706	2.34727	0.62686
67-56-1	METHANOL	32.1	LBNL Data File	105.7	0.26706	2.34727	0.62686

Calculation of Liquid Chemical Emissions
Phase 1 Laboratory Usage Scenario
Proposed Richmond Bay Campus Long Range Development Plan, Richmond, California

Pouring Emissions Estimates (Table G-4)

S = Saturation Factor = 1.45
VP = Vapor Pressure = Chemical-specific
MW = Molecular Weight = Chemical-specific
T = Ambient Temperature (R) = 532

Loss (grams/liter) = 0.02887 * (S*VP*MW)/T
(limited to 700 g/liter)

This list of chemicals comes from LBNL inventory data with solids & gases removed Must be identical to Chemical Inventory worksheet		*MW entered manually*		*Calculated value from separate worksheet*	*Calculated* **Pouring Loss Emission Factor**	*From separate worksheet* **Annual Usage**	*Calculated* **Annual Emissions**
CAS No.	**Compound Name**	**MW (g/mole)**	**MW Reference**	**VP (@ Ref Temp) (mmHg)**	**(grams/liter)**	**(liters/yr)**	**(grams/yr)**
67-56-1	METHANOL	32.1	LBNL Data File	105.7	0.26706	4.69453	1.25373
67-56-1	METHANOL	32.1	LBNL Data File	105.7	0.26706	4.69453	1.25373
67-56-1	METHANOL	32.1	LBNL Data File	105.7	0.26706	4.69453	1.25373
67-56-1	METHANOL	32.1	LBNL Data File	105.7	0.26706	2.34727	0.62686
67-56-1	METHANOL	32.1	LBNL Data File	105.7	0.26706	4.69453	1.25373
67-56-1	METHANOL	32.1	LBNL Data File	105.7	0.26706	4.69453	1.25373
67-56-1	METHANOL	32.1	LBNL Data File	105.7	0.26706	1.17363	0.31343
67-56-1	METHANOL	32.1	LBNL Data File	105.7	0.26706	4.44220	1.18634
67-56-1	METHANOL	32.1	LBNL Data File	105.7	0.26706	0.11736	0.03134
67-56-1	METHANOL	32.1	LBNL Data File	105.7	0.26706	4.69453	1.25373
67-56-1	METHANOL	32.1	LBNL Data File	105.7	0.26706	4.69453	1.25373
67-56-1	METHANOL	32.1	LBNL Data File	105.7	0.26706	0.29341	0.07836
67-56-1	METHANOL	32.1	LBNL Data File	105.7	0.26706	1.17363	0.31343
67-56-1	METHANOL	32.1	LBNL Data File	105.7	0.26706	4.44220	1.18634
67-56-1	METHANOL	32.1	LBNL Data File	105.7	0.26706	4.44220	1.18634
67-56-1	METHANOL	32.1	LBNL Data File	105.7	0.26706	4.69453	1.25373
67-56-1	METHANOL	32.1	LBNL Data File	105.7	0.26706	4.69453	1.25373
67-56-1	METHANOL	32.1	LBNL Data File	105.7	0.26706	4.69453	1.25373
67-56-1	METHANOL	32.1	LBNL Data File	105.7	0.26706	4.69453	1.25373
67-56-1	METHANOL	32.1	LBNL Data File	105.7	0.26706	4.69453	1.25373
67-56-1	METHANOL	32.1	LBNL Data File	105.7	0.26706	4.69453	1.25373
67-56-1	METHANOL	32.1	LBNL Data File	105.7	0.26706	4.69453	1.25373
67-56-1	METHANOL	32.1	LBNL Data File	105.7	0.26706	4.69453	1.25373
67-56-1	METHANOL	32.1	LBNL Data File	105.7	0.26706	4.44220	1.18634
67-56-1	METHANOL	32.1	LBNL Data File	105.7	0.26706	4.44220	1.18634
67-56-1	METHANOL	32.1	LBNL Data File	105.7	0.26706	4.44220	1.18634
67-56-1	METHANOL	32.1	LBNL Data File	105.7	0.26706	4.44220	1.18634
67-56-1	METHANOL	32.1	LBNL Data File	105.7	0.26706	1.17363	0.31343
67-56-1	METHANOL	32.1	LBNL Data File	105.7	0.26706	1.17363	0.31343
67-56-1	METHANOL	32.1	LBNL Data File	105.7	0.26706	1.17363	0.31343
67-56-1	METHANOL	32.1	LBNL Data File	105.7	0.26706	1.17363	0.31343
67-56-1	METHANOL	32.1	LBNL Data File	105.7	0.26706	22.29904	5.95522
67-56-1	METHANOL	32.1	LBNL Data File	105.7	0.26706	22.29904	5.95522
67-56-1	METHANOL	32.1	LBNL Data File	105.7	0.26706	1.17363	0.31343

Calculation of Liquid Chemical Emissions
Phase 1 Laboratory Usage Scenario
Proposed Richmond Bay Campus Long Range Development Plan, Richmond, California

Pouring Emissions Estimates (Table G-4)

S = Saturation Factor = 1.45
VP = Vapor Pressure = Chemical-specific
MW = Molecular Weight = Chemical-specific
T = Ambient Temperature (R) = 532

Loss (grams/liter) = 0.02887 * (S*VP*MW)/T
(limited to 700 g/liter)

This list of chemicals comes from LBNL inventory data with solids & gases removed Must be identical to Chemical Inventory worksheet		*MW entered manually*		*Calculated value from separate worksheet*	*Calculated* **Pouring Loss Emission Factor (grams/liter)**	*From separate worksheet* **Annual Usage (liters/yr)**	*Calculated* **Annual Emissions (grams/yr)**
CAS No.	**Compound Name**	**MW (g/mole)**	**MW Reference**	**VP (@ Ref Temp) (mmHg)**			
67-56-1	METHANOL	32.1	LBNL Data File	105.7	0.26706	1.17363	0.31343
67-56-1	METHANOL	32.1	LBNL Data File	105.7	0.26706	1.17363	0.31343
67-56-1	METHANOL	32.1	LBNL Data File	105.7	0.26706	1.17363	0.31343
67-56-1	METHANOL	32.1	LBNL Data File	105.7	0.26706	0.00000	0.00000
67-56-1	METHANOL	32.1	LBNL Data File	105.7	0.26706	4.69453	1.25373
67-56-1	METHANOL	32.1	LBNL Data File	105.7	0.26706	4.69453	1.25373
67-56-1	METHANOL	32.1	LBNL Data File	105.7	0.26706	4.69453	1.25373
67-56-1	METHANOL	32.1	LBNL Data File	105.7	0.26706	4.69453	1.25373
67-56-1	METHANOL	32.1	LBNL Data File	105.7	0.26706	1.17363	0.31343
67-56-1	METHANOL	32.1	LBNL Data File	105.7	0.26706	4.69453	1.25373
67-56-1	METHANOL	32.1	LBNL Data File	105.7	0.26706	4.69453	1.25373
67-56-1	METHANOL	32.1	LBNL Data File	105.7	0.26706	1.17363	0.31343
67-56-1	METHANOL	32.1	LBNL Data File	105.7	0.26706	1.17363	0.31343
67-56-1	METHANOL	32.1	LBNL Data File	105.7	0.26706	1.17363	0.31343
67-56-1	METHANOL	32.1	LBNL Data File	105.7	0.26706	1.17363	0.31343
67-56-1	METHANOL	32.1	LBNL Data File	105.7	0.26706	1.17363	0.31343
67-56-1	METHANOL	32.1	LBNL Data File	105.7	0.26706	4.69453	1.25373
67-56-1	METHANOL	32.1	LBNL Data File	105.7	0.26706	4.69453	1.25373
67-56-1	METHANOL	32.1	LBNL Data File	105.7	0.26706	4.69453	1.25373
67-56-1	METHANOL	32.1	LBNL Data File	105.7	0.26706	4.69453	1.25373
67-56-1	METHANOL	32.1	LBNL Data File	105.7	0.26706	0.11736	0.03134
67-56-1	METHANOL	32.1	LBNL Data File	105.7	0.26706	1.17363	0.31343
67-56-1	METHANOL	32.1	LBNL Data File	105.7	0.26706	4.69453	1.25373
67-56-1	METHANOL	32.1	LBNL Data File	105.7	0.26706	4.69453	1.25373
67-56-1	METHANOL	32.1	LBNL Data File	105.7	0.26706	4.69453	1.25373
67-56-1	METHANOL	32.1	LBNL Data File	105.7	0.26706	4.69453	1.25373
67-56-1	METHANOL	32.1	LBNL Data File	105.7	0.26706	4.69453	1.25373
67-56-1	METHANOL	32.1	LBNL Data File	105.7	0.26706	4.69453	1.25373
67-56-1	METHANOL	32.1	LBNL Data File	105.7	0.26706	4.69453	1.25373
67-56-1	METHANOL	32.1	LBNL Data File	105.7	0.26706	0.58682	0.15672
67-56-1	METHANOL	32.1	LBNL Data File	105.7	0.26706	0.11736	0.03134
67-56-1	METHANOL	32.1	LBNL Data File	105.7	0.26706	1.17363	0.31343
67-56-1	METHANOL	32.1	LBNL Data File	105.7	0.26706	0.58682	0.15672

Calculation of Liquid Chemical Emissions
Phase 1 Laboratory Usage Scenario
Proposed Richmond Bay Campus Long Range Development Plan, Richmond, California

Pouring Emissions Estimates (Table G-4)

S = Saturation Factor = 1.45
VP = Vapor Pressure = Chemical-specific
MW = Molecular Weight = Chemical-specific
T = Ambient Temperature (R) = 532

Loss (grams/liter) = 0.02887 * (S*VP*MW)/T
(limited to 700 g/liter)

This list of chemicals comes from LBNL inventory data with solids & gases removed Must be identical to Chemical Inventory worksheet		*MW entered manually*		*Calculated value from separate worksheet*	*Calculated* **Pouring Loss Emission Factor**	*From separate worksheet* **Annual Usage**	*Calculated* **Annual Emissions**
CAS No.	**Compound Name**	**MW (g/mole)**	**MW Reference**	**VP (@ Ref Temp) (mmHg)**	**(grams/liter)**	**(liters/yr)**	**(grams/yr)**
67-56-1	METHANOL	32.1	LBNL Data File	105.7	0.26706	4.69453	1.25373
67-56-1	METHANOL	32.1	LBNL Data File	105.7	0.26706	4.69453	1.25373
67-56-1	METHANOL	32.1	LBNL Data File	105.7	0.26706	2.93408	0.78358
67-56-1	METHANOL	32.1	LBNL Data File	105.7	0.26706	2.93408	0.78358
67-56-1	METHANOL	32.1	LBNL Data File	105.7	0.26706	2.93408	0.78358
67-56-1	METHANOL	32.1	LBNL Data File	105.7	0.26706	2.93408	0.78358
67-56-1	METHANOL	32.1	LBNL Data File	105.7	0.26706	4.69453	1.25373
67-56-1	METHANOL	32.1	LBNL Data File	105.7	0.26706	4.69453	1.25373
67-56-1	METHANOL	32.1	LBNL Data File	105.7	0.26706	4.69453	1.25373
67-56-1	METHANOL	32.1	LBNL Data File	105.7	0.26706	4.69453	1.25373
67-56-1	METHANOL	32.1	LBNL Data File	105.7	0.26706	1.17363	0.31343
67-56-1	METHANOL	32.1	LBNL Data File	105.7	0.26706	1.17363	0.31343
67-56-1	METHANOL	32.1	LBNL Data File	105.7	0.26706	4.69453	1.25373
67-56-1	METHANOL	32.1	LBNL Data File	105.7	0.26706	4.69453	1.25373
67-56-1	METHANOL	32.1	LBNL Data File	105.7	0.26706	4.69453	1.25373
67-56-1	METHANOL	32.1	LBNL Data File	105.7	0.26706	4.69453	1.25373
67-56-1	HYDRA-POINT METHANOL, DRY	32.1	LBNL Data File	105.7	0.26706	1.17363	0.31343
67-56-1	HYDRA-POINT METHANOL, DRY	32.1	LBNL Data File	105.7	0.26706	1.17363	0.31343
67-56-1	AMMONIA 7N SOLUTION IN METHANOL	32.1	LBNL Data File	105.7	0.26706	0.11736	0.03134
67-56-1	METHANOL	32.1	LBNL Data File	105.7	0.26706	1.17363	0.31343
67-56-1	METHANOL	32.1	LBNL Data File	105.7	0.26706	1.17363	0.31343
67-56-1	METHANOL	32.1	LBNL Data File	105.7	0.26706	1.17363	0.31343
67-56-1	METHANOL	32.1	LBNL Data File	105.7	0.26706	1.17363	0.31343
67-56-1	METHANOL	32.1	LBNL Data File	105.7	0.26706	1.17363	0.31343
67-56-1	METHANOL	32.1	LBNL Data File	105.7	0.26706	1.17363	0.31343
67-56-1	METHANOL	32.1	LBNL Data File	105.7	0.26706	1.17363	0.31343
67-56-1	METHANOL	32.1	LBNL Data File	105.7	0.26706	1.17363	0.31343
67-56-1	METHANOL	32.1	LBNL Data File	105.7	0.26706	0.11736	0.03134
67-56-1	METHANOL	32.1	LBNL Data File	105.7	0.26706	0.00117	0.00031
67-56-1	METHANOL	32.1	LBNL Data File	105.7	0.26706	4.69453	1.25373
67-56-1	METHANOL	32.1	LBNL Data File	105.7	0.26706	1.17363	0.31343
67-56-1	COMBI METHANOL	32.1	LBNL Data File	105.7	0.26706	1.17363	0.31343
67-56-1	METHANOL	32.1	LBNL Data File	105.7	0.26706	1.17363	0.31343
67-56-1	METHANOL	32.1	LBNL Data File	105.7	0.26706	4.69453	1.25373

Calculation of Liquid Chemical Emissions
Phase 1 Laboratory Usage Scenario
Proposed Richmond Bay Campus Long Range Development Plan, Richmond, California

Pouring Emissions Estimates (Table G-4)

S = Saturation Factor = 1.45
VP = Vapor Pressure = Chemical-specific
MW = Molecular Weight = Chemical-specific
T = Ambient Temperature (R) = 532

Loss (grams/liter) = 0.02887 * (S*VP*MW)/T
(limited to 700 g/liter)

This list of chemicals comes from LBNL inventory data with solids & gases removed Must be identical to Chemical Inventory worksheet		*MW entered manually*		*Calculated value from separate worksheet*	*Calculated* **Pouring Loss Emission Factor**	*From separate worksheet* **Annual Usage**	*Calculated* **Annual Emissions**
CAS No.	**Compound Name**	**MW (g/mole)**	**MW Reference**	**VP (@ Ref Temp) (mmHg)**	**(grams/liter)**	**(liters/yr)**	**(grams/yr)**
67-56-1	METHANOL	32.1	LBNL Data File	105.7	0.26706	4.69453	1.25373
67-56-1	METHANOL	32.1	LBNL Data File	105.7	0.26706	4.69453	1.25373
67-56-1	METHANOL	32.1	LBNL Data File	105.7	0.26706	1.17363	0.31343
67-56-1	METHANOL	32.1	LBNL Data File	105.7	0.26706	1.17363	0.31343
67-56-1	METHYL ALCOHOL	32.1	LBNL Data File	105.7	0.26706	1.17363	0.31343
67-56-1	METHANOL	32.1	LBNL Data File	105.7	0.26706	4.69453	1.25373
67-56-1	METHANOL	32.1	LBNL Data File	105.7	0.26706	17.76881	4.74537
67-56-1	METHANOL	32.1	LBNL Data File	105.7	0.26706	1.17363	0.31343
67-56-1	METHANOL	32.1	LBNL Data File	105.7	0.26706	4.69453	1.25373
67-56-1	METHANOL	32.1	LBNL Data File	105.7	0.26706	4.69453	1.25373
67-56-1	METHANOL	32.1	LBNL Data File	105.7	0.26706	4.69453	1.25373
67-56-1	METHANOL	32.1	LBNL Data File	105.7	0.26706	4.69453	1.25373
67-56-1	METHANOL	32.1	LBNL Data File	105.7	0.26706	4.69453	1.25373
67-56-1	METHANOL	32.1	LBNL Data File	105.7	0.26706	4.69453	1.25373
67-56-1	METHANOL	32.1	LBNL Data File	105.7	0.26706	2.34727	0.62686
67-56-1	METHANOL	32.1	LBNL Data File	105.7	0.26706	4.69453	1.25373
67-56-1	METHANOL	32.1	LBNL Data File	105.7	0.26706	4.69453	1.25373
67-56-1	METHANOL	32.1	LBNL Data File	105.7	0.26706	4.69453	1.25373
67-56-1	METHANOL	32.1	LBNL Data File	105.7	0.26706	5.86817	1.56716
67-56-1	METHANOL	32.1	LBNL Data File	105.7	0.26706	0.11736	0.03134
67-56-1	METHANOL	32.1	LBNL Data File	105.7	0.26706	1.17363	0.31343
67-56-1	METHANOL	32.1	LBNL Data File	105.7	0.26706	4.69453	1.25373
67-56-1	METHANOL	32.1	LBNL Data File	105.7	0.26706	1.17363	0.31343
67-56-1	METHANOL	32.1	LBNL Data File	105.7	0.26706	1.17363	0.31343
67-56-1	METHANOL	32.1	LBNL Data File	105.7	0.26706	4.69453	1.25373
67-56-1	METHANOL	32.1	LBNL Data File	105.7	0.26706	4.69453	1.25373
67-56-1	METHANOL	32.1	LBNL Data File	105.7	0.26706	4.69453	1.25373
67-56-1	METHANOL	32.1	LBNL Data File	105.7	0.26706	4.69453	1.25373
67-56-1	METHANOL	32.1	LBNL Data File	105.7	0.26706	0.58682	0.15672
67-56-1	METHANOL	32.1	LBNL Data File	105.7	0.26706	4.69453	1.25373
67-56-1	METHANOL	32.1	LBNL Data File	105.7	0.26706	1.17363	0.31343
67-56-1	METHANOL	32.1	LBNL Data File	105.7	0.26706	4.69453	1.25373
67-56-1	METHANOL	32.1	LBNL Data File	105.7	0.26706	4.69453	1.25373
67-56-1	METHANOL	32.1	LBNL Data File	105.7	0.26706	0.11736	0.03134

Calculation of Liquid Chemical Emissions
Phase 1 Laboratory Usage Scenario
Proposed Richmond Bay Campus Long Range Development Plan, Richmond, California

Pouring Emissions Estimates (Table G-4)

S = Saturation Factor = 1.45
VP = Vapor Pressure = Chemical-specific
MW = Molecular Weight = Chemical-specific
T = Ambient Temperature (R) = 532

Loss (grams/liter) = 0.02887 * (S*VP*MW)/T
(limited to 700 g/liter)

This list of chemicals comes from LBNL inventory data with solids & gases removed Must be identical to Chemical Inventory worksheet		*MW entered manually*		*Calculated value from separate worksheet*	*Calculated* **Pouring Loss Emission Factor (grams/liter)**	*From separate worksheet* **Annual Usage (liters/yr)**	*Calculated* **Annual Emissions (grams/yr)**
CAS No.	**Compound Name**	**MW (g/mole)**	**MW Reference**	**VP (@ Ref Temp) (mmHg)**			
67-56-1	METHANOL	32.1	LBNL Data File	105.7	0.26706	0.58682	0.15672
67-56-1	METHANOL	32.1	LBNL Data File	105.7	0.26706	4.69453	1.25373
67-56-1	METHANOL	32.1	LBNL Data File	105.7	0.26706	4.69453	1.25373
67-56-1	METHANOL	32.1	LBNL Data File	105.7	0.26706	4.69453	1.25373
67-56-1	METHANOL	32.1	LBNL Data File	105.7	0.26706	4.44220	1.18634
67-56-1	METHANOL	32.1	LBNL Data File	105.7	0.26706	4.69453	1.25373
67-56-1	METHANOL	32.1	LBNL Data File	105.7	0.26706	4.69453	1.25373
67-56-1	METHANOL	32.1	LBNL Data File	105.7	0.26706	4.69453	1.25373
67-56-1	METHANOL	32.1	LBNL Data File	105.7	0.26706	4.69453	1.25373
67-56-1	METHANOL	32.1	LBNL Data File	105.7	0.26706	2.34727	0.62686
67-56-1	METHANOL	32.1	LBNL Data File	105.7	0.26706	4.69453	1.25373
67-56-1	METHANOL	32.1	LBNL Data File	105.7	0.26706	4.44220	1.18634
67-56-1	METHANOL	32.1	LBNL Data File	105.7	0.26706	1.17363	0.31343
67-56-1	METHANOL	32.1	LBNL Data File	105.7	0.26706	0.58682	0.15672
67-56-1	METHANOL	32.1	LBNL Data File	105.7	0.26706	1.17363	0.31343
67-63-0	ISOPROPYL ALCOHOL (2)	60.1	LBNL Data File	37.2	0.17588	70.41801	12.38524
67-63-0	ISOPROPYL ALCOHOL	60.1	LBNL Data File	37.2	0.17588	1.17363	0.20642
67-63-0	ISOPROPANOL	60.1	LBNL Data File	37.2	0.17588	4.69453	0.82568
67-63-0	ISOPROPYL ALCOHOL	60.1	LBNL Data File	37.2	0.17588	0.52063	0.09157
67-63-0	ISOPROPYL ALCOHOL	60.1	LBNL Data File	37.2	0.17588	0.55534	0.09767
67-63-0	ISOPROPANOL	60.1	LBNL Data File	37.2	0.17588	0.29341	0.05161
67-63-0	ISOPROPYL ALCOHOL	60.1	LBNL Data File	37.2	0.17588	0.29341	0.05161
67-63-0	ISOPROPYL ALCOHOL	60.1	LBNL Data File	37.2	0.17588	149.50744	26.29562
67-63-0	ISOPROPANOL	60.1	LBNL Data File	37.2	0.17588	17.60450	3.09631
67-63-0	ISOPROPYL ALCOHOL	60.1	LBNL Data File	37.2	0.17588	4.69453	0.82568
67-63-0	2-PROPANOL	60.1	LBNL Data File	37.2	0.17588	0.58682	0.10321
67-63-0	ISOPROPYL ALCOHOL	60.1	LBNL Data File	37.2	0.17588	1.49507	0.26296
67-63-0	ISOPROPANOL	60.1	LBNL Data File	37.2	0.17588	0.58682	0.10321
67-63-0	2-PROPANOL	60.1	LBNL Data File	37.2	0.17588	0.58682	0.10321
67-63-0	ISOPROPYL ALCOHOL	60.1	LBNL Data File	37.2	0.17588	0.58682	0.10321
67-63-0	ISOPROPYL ALCOHOL	60.1	LBNL Data File	37.2	0.17588	0.29341	0.05161
67-63-0	2-PROPANOL	60.1	LBNL Data File	37.2	0.17588	0.58682	0.10321
67-63-0	ISOPROPANOL	60.1	LBNL Data File	37.2	0.17588	1.17363	0.20642
67-63-0	2-PROPANOL	60.1	LBNL Data File	37.2	0.17588	0.58682	0.10321

Calculation of Liquid Chemical Emissions
Phase 1 Laboratory Usage Scenario
Proposed Richmond Bay Campus Long Range Development Plan, Richmond, California

Pouring Emissions Estimates (Table G-4)

S = Saturation Factor = 1.45
VP = Vapor Pressure = Chemical-specific
MW = Molecular Weight = Chemical-specific
T = Ambient Temperature (R) = 532

Loss (grams/liter) = 0.02887 * (S*VP*MW)/T
(limited to 700 g/liter)

This list of chemicals comes from LBNL inventory data with solids & gases removed Must be identical to Chemical Inventory worksheet		*MW entered manually*		*Calculated value from separate worksheet*	*Calculated* **Pouring Loss Emission Factor**	*From separate worksheet* **Annual Usage**	*Calculated* **Annual Emissions**
CAS No.	**Compound Name**	**MW (g/mole)**	**MW Reference**	**VP (@ Ref Temp) (mmHg)**	**(grams/liter)**	**(liters/yr)**	**(grams/yr)**
67-63-0	ISOPROPYL ALCOHOL	60.1	LBNL Data File	37.2	0.17588	1.17363	0.20642
67-63-0	ISOPROPANOL	60.1	LBNL Data File	37.2	0.17588	0.58682	0.10321
67-63-0	2-PROPANOL	60.1	LBNL Data File	37.2	0.17588	0.58682	0.10321
67-63-0	ISOPROPYL ALCOHOL	60.1	LBNL Data File	37.2	0.17588	0.58682	0.10321
67-63-0	ISOPROPYL ALCOHOL	60.1	LBNL Data File	37.2	0.17588	1.17363	0.20642
67-63-0	2-PROPANOL	60.1	LBNL Data File	37.2	0.17588	0.02934	0.00516
67-63-0	2-PROPANOL	60.1	LBNL Data File	37.2	0.17588	0.02934	0.00516
67-63-0	2-PROPANOL	60.1	LBNL Data File	37.2	0.17588	0.58682	0.10321
67-63-0	2-PROPANOL	60.1	LBNL Data File	37.2	0.17588	0.02934	0.00516
67-63-0	2-PROPANOL	60.1	LBNL Data File	37.2	0.17588	0.02934	0.00516
67-63-0	2-PROPANOL	60.1	LBNL Data File	37.2	0.17588	0.02934	0.00516
67-63-0	2-PROPANOL	60.1	LBNL Data File	37.2	0.17588	0.02934	0.00516
67-63-0	2-PROPANOL	60.1	LBNL Data File	37.2	0.17588	0.02934	0.00516
67-63-0	2-PROPANOL	60.1	LBNL Data File	37.2	0.17588	0.02934	0.00516
67-63-0	ISOPROPYL ALCOHOL	60.1	LBNL Data File	37.2	0.17588	1.17363	0.20642
67-63-0	2-PROPANOL	60.1	LBNL Data File	37.2	0.17588	0.58682	0.10321
67-63-0	2-PROPANOL	60.1	LBNL Data File	37.2	0.17588	0.58682	0.10321
67-63-0	2-PROPANOL	60.1	LBNL Data File	37.2	0.17588	0.58682	0.10321
67-63-0	ISOPROPYL ALCOHOL	60.1	LBNL Data File	37.2	0.17588	1.17363	0.20642
67-63-0	ISOPROPYL ALCOHOL	60.1	LBNL Data File	37.2	0.17588	1.17363	0.20642
67-63-0	ISOPROPYL ALCOHOL	60.1	LBNL Data File	37.2	0.17588	1.17363	0.20642
67-63-0	ISOPROPYL ALCOHOL	60.1	LBNL Data File	37.2	0.17588	1.17363	0.20642
67-63-0	ISOPROPYL ALCOHOL	60.1	LBNL Data File	37.2	0.17588	1.17363	0.20642
67-63-0	ISOPROPYL ALCOHOL	60.1	LBNL Data File	37.2	0.17588	1.17363	0.20642
67-63-0	ISOPROPYL ALCOHOL	60.1	LBNL Data File	37.2	0.17588	1.17363	0.20642
67-63-0	2-PROPANOL	60.1	LBNL Data File	37.2	0.17588	1.17363	0.20642
67-63-0	ISOPROPYL ALCOHOL	60.1	LBNL Data File	37.2	0.17588	4.69453	0.82568
67-63-0	ISOPROPYL ALCOHOL	60.1	LBNL Data File	37.2	0.17588	0.02934	0.00516
67-63-0	ISOPROPYL	60.1	LBNL Data File	37.2	0.17588	1.49507	0.26296
67-63-0	2-PROPANOL	60.1	LBNL Data File	37.2	0.17588	0.58682	0.10321
67-63-0	ISOPROPYL ALCOHOL	60.1	LBNL Data File	37.2	0.17588	1.17363	0.20642
67-63-0	ISOPROPYL ALCOHOL	60.1	LBNL Data File	37.2	0.17588	1.17363	0.20642
67-63-0	ISOPROPYL ALCOHOL	60.1	LBNL Data File	37.2	0.17588	1.17363	0.20642

Calculation of Liquid Chemical Emissions
Phase 1 Laboratory Usage Scenario
Proposed Richmond Bay Campus Long Range Development Plan, Richmond, California

Pouring Emissions Estimates (Table G-4)

S = Saturation Factor = 1.45
VP = Vapor Pressure = Chemical-specific
MW = Molecular Weight = Chemical-specific
T = Ambient Temperature (R) = 532

Loss (grams/liter) = 0.02887 * (S*VP*MW)/T
(limited to 700 g/liter)

This list of chemicals comes from LBNL inventory data with solids & gases removed Must be identical to Chemical Inventory worksheet		*MW entered manually*		*Calculated value from separate worksheet*	*Calculated* **Pouring Loss Emission Factor**	*From separate worksheet* **Annual Usage**	*Calculated* **Annual Emissions**
CAS No.	**Compound Name**	**MW (g/mole)**	**MW Reference**	**VP (@ Ref Temp) (mmHg)**	**(grams/liter)**	**(liters/yr)**	**(grams/yr)**
67-63-0	ISOPROPYL ALCOHOL	60.1	LBNL Data File	37.2	0.17588	1.17363	0.20642
67-63-0	ISOPROPYL ALCOHOL	60.1	LBNL Data File	37.2	0.17588	1.17363	0.20642
67-63-0	ISOPROPYL ALCOHOL	60.1	LBNL Data File	37.2	0.17588	1.17363	0.20642
67-63-0	2-PROPANOL	60.1	LBNL Data File	37.2	0.17588	0.58682	0.10321
67-63-0	ISOPROPYL ALCOHOL	60.1	LBNL Data File	37.2	0.17588	2.34727	0.41284
67-63-0	ISOPROPYL ALCOHOL	60.1	LBNL Data File	37.2	0.17588	4.69453	0.82568
67-63-0	2-PROPANOL	60.1	LBNL Data File	37.2	0.17588	0.58682	0.10321
67-63-0	2-PROPANOL	60.1	LBNL Data File	37.2	0.17588	0.02934	0.00516
67-63-0	2-PROPANOL	60.1	LBNL Data File	37.2	0.17588	4.44220	0.78130
67-63-0	2-PROPANOL	60.1	LBNL Data File	37.2	0.17588	4.44220	0.78130
67-63-0	ISOPROPANOL	60.1	LBNL Data File	37.2	0.17588	1.17363	0.20642
67-63-0	ISOPROPANOL	60.1	LBNL Data File	37.2	0.17588	1.17363	0.20642
67-63-0	ISOPROPANOL	60.1	LBNL Data File	37.2	0.17588	4.69453	0.82568
67-63-0	ISOPROPYL ALCOHOL	60.1	LBNL Data File	37.2	0.17588	4.69453	0.82568
67-63-0	ISOPROPYL ALCOHOL	60.1	LBNL Data File	37.2	0.17588	4.69453	0.82568
67-63-0	ISOPROPYL ALCOHOL	60.1	LBNL Data File	37.2	0.17588	4.69453	0.82568
67-63-0	ISOPROPYL ALCOHOL	60.1	LBNL Data File	37.2	0.17588	4.69453	0.82568
67-63-0	ISOPROPYL ALCOHOL	60.1	LBNL Data File	37.2	0.17588	5.86817	1.03210
67-63-0	ISOPROPANOL	60.1	LBNL Data File	37.2	0.17588	4.69453	0.82568
67-63-0	ISOPROPANOL	60.1	LBNL Data File	37.2	0.17588	4.69453	0.82568
67-63-0	2-PROPANOL	60.1	LBNL Data File	37.2	0.17588	5.86817	1.03210
67-63-0	ISOPROPANOL	60.1	LBNL Data File	37.2	0.17588	4.69453	0.82568
67-63-0	ISOPROPANOL	60.1	LBNL Data File	37.2	0.17588	4.69453	0.82568
67-63-0	2-PROPANOL	60.1	LBNL Data File	37.2	0.17588	4.69453	0.82568
67-63-0	ISOPROPYL ALCOHOL	60.1	LBNL Data File	37.2	0.17588	1.17363	0.20642
67-63-0	ISOPROPYL ALCOHOL	60.1	LBNL Data File	37.2	0.17588	1.17363	0.20642
67-63-0	ISOPROPYL ALCOHOL	60.1	LBNL Data File	37.2	0.17588	1.17363	0.20642
67-63-0	ISOPROPYL ALCOHOL	60.1	LBNL Data File	37.2	0.17588	1.17363	0.20642
67-63-0	ISOPROPYL ALCOHOL	60.1	LBNL Data File	37.2	0.17588	1.17363	0.20642
67-63-0	ISOPROPYL ALCOHOL	60.1	LBNL Data File	37.2	0.17588	1.17363	0.20642
67-63-0	ISOPROPYL ALCOHOL	60.1	LBNL Data File	37.2	0.17588	1.17363	0.20642
67-63-0	ISOPROPYL ALCOHOL	60.1	LBNL Data File	37.2	0.17588	1.17363	0.20642
67-63-0	2-PROPANOL	60.1	LBNL Data File	37.2	0.17588	1.17363	0.20642
67-63-0	2-PROPANOL	60.1	LBNL Data File	37.2	0.17588	1.17363	0.20642

Calculation of Liquid Chemical Emissions
Phase 1 Laboratory Usage Scenario
Proposed Richmond Bay Campus Long Range Development Plan, Richmond, California

Pouring Emissions Estimates (Table G-4)

S = Saturation Factor = 1.45
VP = Vapor Pressure = Chemical-specific
MW = Molecular Weight = Chemical-specific
T = Ambient Temperature (R) = 532

Loss (grams/liter) = 0.02887 * (S*VP*MW)/T
(limited to 700 g/liter)

This list of chemicals comes from LBNL inventory data with solids & gases removed Must be identical to Chemical Inventory worksheet		*MW entered manually*		*Calculated value from separate worksheet*	*Calculated* **Pouring Loss Emission Factor**	*From separate worksheet* **Annual Usage**	*Calculated* **Annual Emissions**
CAS No.	**Compound Name**	**MW (g/mole)**	**MW Reference**	**VP (@ Ref Temp) (mmHg)**	**(grams/liter)**	**(liters/yr)**	**(grams/yr)**
67-63-0	2-PROPANOL	60.1	LBNL Data File	37.2	0.17588	0.58682	0.10321
67-63-0	ISOPROPYL ALCOHOL	60.1	LBNL Data File	37.2	0.17588	0.58682	0.10321
67-63-0	2-PROPANOL	60.1	LBNL Data File	37.2	0.17588	0.58682	0.10321
67-63-0	ISOPROPYL ALCOHOL	60.1	LBNL Data File	37.2	0.17588	4.69453	0.82568
67-63-0	ISOPROPYL ALCOHOL	60.1	LBNL Data File	37.2	0.17588	4.69453	0.82568
67-63-0	ISOPROPYL ALCOHOL	60.1	LBNL Data File	37.2	0.17588	0.58682	0.10321
67-63-0	ISOPROPYL ALCOHOL	60.1	LBNL Data File	37.2	0.17588	4.69453	0.82568
67-63-0	ISOPROPYL ALCOHOL	60.1	LBNL Data File	37.2	0.17588	4.69453	0.82568
67-63-0	ISOPROPYL ALCOHOL	60.1	LBNL Data File	37.2	0.17588	4.69453	0.82568
67-63-0	ISOPROPYL ALCOHOL	60.1	LBNL Data File	37.2	0.17588	0.58682	0.10321
67-63-0	2-PROPANOL	60.1	LBNL Data File	37.2	0.17588	1.17363	0.20642
67-63-0	2-PROPANOL	60.1	LBNL Data File	37.2	0.17588	1.17363	0.20642
67-63-0	ISOPROPANOL	60.1	LBNL Data File	37.2	0.17588	1.17363	0.20642
67-63-0	ISOPROPANOL	60.1	LBNL Data File	37.2	0.17588	1.17363	0.20642
67-63-0	ISOPROPYL ALCOHOL	60.1	LBNL Data File	37.2	0.17588	1.17363	0.20642
67-63-0	ISOPROPYL ALCOHOL	60.1	LBNL Data File	37.2	0.17588	0.02934	0.00516
67-63-0	ISOPROPYL ALCOHOL	60.1	LBNL Data File	37.2	0.17588	0.02934	0.00516
67-63-0	ISOPROPYL ALCOHOL	60.1	LBNL Data File	37.2	0.17588	0.02934	0.00516
67-63-0	ISOPROPYL ALCOHOL	60.1	LBNL Data File	37.2	0.17588	0.02934	0.00516
67-63-0	ISOPROPYL ALCOHOL	60.1	LBNL Data File	37.2	0.17588	0.02934	0.00516
67-63-0	ISOPROPYL ALCOHOL	60.1	LBNL Data File	37.2	0.17588	0.02934	0.00516
67-63-0	ISOPROPYL ALCOHOL	60.1	LBNL Data File	37.2	0.17588	0.02934	0.00516
67-63-0	ISOPROPANOL ALCOHOL	60.1	LBNL Data File	37.2	0.17588	4.69453	0.82568
67-63-0	ISOPROPANOL ALCOHOL	60.1	LBNL Data File	37.2	0.17588	4.69453	0.82568
67-63-0	2-PROPANOL	60.1	LBNL Data File	37.2	0.17588	0.02934	0.00516
67-63-0	2-PROPANOL	60.1	LBNL Data File	37.2	0.17588	0.02934	0.00516
67-63-0	2-PROPANOL	60.1	LBNL Data File	37.2	0.17588	4.44220	0.78130
67-63-0	2-PROPANOL	60.1	LBNL Data File	37.2	0.17588	0.02934	0.00516
67-63-0	2-PROPANOL	60.1	LBNL Data File	37.2	0.17588	4.44220	0.78130
67-63-0	2-PROPANOL	60.1	LBNL Data File	37.2	0.17588	4.69453	0.82568
67-63-0	2-PROPANOL	60.1	LBNL Data File	37.2	0.17588	0.02934	0.00516
67-63-0	2-PROPANOL	60.1	LBNL Data File	37.2	0.17588	0.02934	0.00516
67-63-0	2-PROPANOL	60.1	LBNL Data File	37.2	0.17588	0.02934	0.00516
67-63-0	2-PROPANOL	60.1	LBNL Data File	37.2	0.17588	0.02934	0.00516

Calculation of Liquid Chemical Emissions
Phase 1 Laboratory Usage Scenario
Proposed Richmond Bay Campus Long Range Development Plan, Richmond, California

Pouring Emissions Estimates (Table G-4)

S = Saturation Factor = 1.45
VP = Vapor Pressure = Chemical-specific
MW = Molecular Weight = Chemical-specific
T = Ambient Temperature (R) = 532

Loss (grams/liter) = 0.02887 * (S*VP*MW)/T
(limited to 700 g/liter)

This list of chemicals comes from LBNL inventory data with solids & gases removed Must be identical to Chemical Inventory worksheet		*MW entered manually*		*Calculated value from separate worksheet*	*Calculated* **Pouring Loss Emission Factor**	*From separate worksheet* **Annual Usage**	*Calculated* **Annual Emissions**
CAS No.	**Compound Name**	**MW (g/mole)**	**MW Reference**	**VP (@ Ref Temp) (mmHg)**	**(grams/liter)**	**(liters/yr)**	**(grams/yr)**
67-63-0	ISOPROPYL ALCOHOL	60.1	LBNL Data File	37.2	0.17588	0.58682	0.10321
67-63-0	ISOPROPYL ALCOHOL	60.1	LBNL Data File	37.2	0.17588	0.58682	0.10321
67-63-0	ISOPROPANOL	60.1	LBNL Data File	37.2	0.17588	1.17363	0.20642
67-63-0	2-PROPANOL	60.1	LBNL Data File	37.2	0.17588	0.58682	0.10321
67-63-0	2-PROPANOL	60.1	LBNL Data File	37.2	0.17588	0.58682	0.10321
67-63-0	2-PROPANOL	60.1	LBNL Data File	37.2	0.17588	0.58682	0.10321
67-63-0	2-PROPANOL	60.1	LBNL Data File	37.2	0.17588	0.02934	0.00516
67-63-0	2-PROPANOL	60.1	LBNL Data File	37.2	0.17588	2.34727	0.41284
67-63-0	ISOPROPYL ALCOHOL	60.1	LBNL Data File	37.2	0.17588	1.17363	0.20642
67-63-0	ISOPROPANOL	60.1	LBNL Data File	37.2	0.17588	0.29341	0.05161
67-63-0	ISOPROPYL ALCOHOL	60.1	LBNL Data File	37.2	0.17588	1.17363	0.20642
67-63-0	ISOPROPYL ALCOHOL	60.1	LBNL Data File	37.2	0.17588	1.17363	0.20642
67-63-0	2-PROPANOL	60.1	LBNL Data File	37.2	0.17588	4.69453	0.82568
67-63-0	ISOPROPYL ALCOHOL	60.1	LBNL Data File	37.2	0.17588	0.58682	0.10321
67-63-0	MICROSHARP CLEANING FLUID	60.1	LBNL Data File	37.2	0.17588	0.27698	0.04872
67-63-0	MICROSHARP CLEANING FLUID	60.1	LBNL Data File	37.2	0.17588	0.27698	0.04872
67-63-0	MICROSHARP CLEANING FLUID	60.1	LBNL Data File	37.2	0.17588	0.27698	0.04872
67-63-0	MICROSHARP CLEANING FLUID	60.1	LBNL Data File	37.2	0.17588	0.27698	0.04872
67-63-0	MICROSHARP CLEANING FLUID	60.1	LBNL Data File	37.2	0.17588	0.27698	0.04872
67-63-0	ISOPROPANOL	60.1	LBNL Data File	37.2	0.17588	0.58682	0.10321
67-63-0	2-PROPANOL	60.1	LBNL Data File	37.2	0.17588	0.58682	0.10321
67-63-0	ISOPROPANOL	60.1	LBNL Data File	37.2	0.17588	0.02934	0.00516
67-63-0	ISOPROPANOL	60.1	LBNL Data File	37.2	0.17588	0.02934	0.00516
67-63-0	2-PROPANOL	60.1	LBNL Data File	37.2	0.17588	0.58682	0.10321
67-63-0	2-PROPANOL	60.1	LBNL Data File	37.2	0.17588	0.58682	0.10321
67-63-0	2-PROPANOL	60.1	LBNL Data File	37.2	0.17588	0.58682	0.10321
67-63-0	2-PROPANOL	60.1	LBNL Data File	37.2	0.17588	0.58682	0.10321
67-63-0	ISOPROPANOL	60.1	LBNL Data File	37.2	0.17588	0.58682	0.10321
67-63-0	N-HYDROXYSUCCINIMIDYL-ACTIVATED AGAROSE	60.1	LBNL Data File	37.2	0.17588	0.00587	0.00103
67-63-0	2-PROPANOL	60.1	LBNL Data File	37.2	0.17588	4.69453	0.82568
67-63-0	ISOPROPYL ALCOHOL	60.1	LBNL Data File	37.2	0.17588	4.69453	0.82568
67-63-0	ISOPROPANOL	60.1	LBNL Data File	37.2	0.17588	0.58682	0.10321
67-63-0	ISOPROPYL ALCOHOL	60.1	LBNL Data File	37.2	0.17588	0.11736	0.02064
67-63-0	ISOPROPANOL	60.1	LBNL Data File	37.2	0.17588	0.58682	0.10321

Calculation of Liquid Chemical Emissions
Phase 1 Laboratory Usage Scenario
Proposed Richmond Bay Campus Long Range Development Plan, Richmond, California

Pouring Emissions Estimates (Table G-4)

S = Saturation Factor = 1.45
VP = Vapor Pressure = Chemical-specific
MW = Molecular Weight = Chemical-specific
T = Ambient Temperature (R) = 532

Loss (grams/liter) = 0.02887 * (S*VP*MW)/T
(limited to 700 g/liter)

This list of chemicals comes from LBNL inventory data with solids & gases removed Must be identical to Chemical Inventory worksheet		*MW entered manually*		*Calculated value from separate worksheet*	*Calculated* **Pouring Loss Emission Factor**	*From separate worksheet* **Annual Usage**	*Calculated* **Annual Emissions**
CAS No.	**Compound Name**	**MW (g/mole)**	**MW Reference**	**VP (@ Ref Temp) (mmHg)**	**(grams/liter)**	**(liters/yr)**	**(grams/yr)**
67-63-0	ISOPROPANOL	60.1	LBNL Data File	37.2	0.17588	0.58682	0.10321
67-63-0	2-PROPANOL	60.1	LBNL Data File	37.2	0.17588	1.17363	0.20642
67-63-0	ISOPROPYL ALCOHOL	60.1	LBNL Data File	37.2	0.17588	1.17363	0.20642
67-63-0	2-PROPANOL	60.1	LBNL Data File	37.2	0.17588	0.02934	0.00516
67-63-0	ISOPROPYL ALCOHOL	60.1	LBNL Data File	37.2	0.17588	0.02934	0.00516
67-63-0	ISOPROPYL ALCOHOL	60.1	LBNL Data File	37.2	0.17588	0.02934	0.00516
67-63-0	ISOPROPYL ALCOHOL	60.1	LBNL Data File	37.2	0.17588	0.02934	0.00516
67-63-0	ISOPROPYL ALCOHOL	60.1	LBNL Data File	37.2	0.17588	0.02934	0.00516
67-63-0	ISOPROPYL ALCOHOL	60.1	LBNL Data File	37.2	0.17588	0.02934	0.00516
67-63-0	ISOPROPANOL	60.1	LBNL Data File	37.2	0.17588	1.17363	0.20642
67-63-0	ISOPROPYL ALCOHOL	60.1	LBNL Data File	37.2	0.17588	1.17363	0.20642
67-63-0	2-PROPANOL	60.1	LBNL Data File	37.2	0.17588	0.02934	0.00516
67-63-0	ISOPROPYL ALCOHOL	60.1	LBNL Data File	37.2	0.17588	2.93408	0.51605
67-63-0	ISOPROPYL ALCOHOL	60.1	LBNL Data File	37.2	0.17588	9.38907	1.65136
67-63-0	2-PROPANOL	60.1	LBNL Data File	37.2	0.17588	1.17363	0.20642
67-63-0	ISOPROPYL ALCOHOL	60.1	LBNL Data File	37.2	0.17588	0.58682	0.10321
67-63-0	ISOPROPYL ALCOHOL	60.1	LBNL Data File	37.2	0.17588	0.58682	0.10321
67-63-0	ISOPROPYL ALCOHOL	60.1	LBNL Data File	37.2	0.17588	0.58682	0.10321
67-63-0	ISOPROPYL ALCOHOL	60.1	LBNL Data File	37.2	0.17588	4.69453	0.82568
67-63-0	ISOPROPYL ALCOHOL	60.1	LBNL Data File	37.2	0.17588	4.69453	0.82568
67-63-0	ISOPROPYL ALCOHOL	60.1	LBNL Data File	37.2	0.17588	0.58682	0.10321
67-63-0	ISOPROPANOL	60.1	LBNL Data File	37.2	0.17588	0.02934	0.00516
67-63-0	ISOPROPYL ALCOHOL	60.1	LBNL Data File	37.2	0.17588	1.17363	0.20642
67-63-0	ISOPROPYL ALCOHOL	60.1	LBNL Data File	37.2	0.17588	2.34727	0.41284
67-66-3	CHLOROFORM	119.4	LBNL Data File	168.9	1.58662	0.11736	0.18621
67-66-3	CHLOROFORM	119.4	LBNL Data File	168.9	1.58662	0.58682	0.93106
67-66-3	CHLOROFORM:ISOAMYL ALCOHOL 24:1	119.4	LBNL Data File	168.9	1.58662	0.58682	0.93106
67-66-3	CHLOROFORM ISOAMYL ALCOHOL	119.4	LBNL Data File	168.9	1.58662	0.11736	0.18621
67-66-3	CHLOROFORM	119.4	LBNL Data File	168.9	1.58662	0.58682	0.93106
67-66-3	CHLOROFORM ISOAMYL ALCOHOL	119.4	LBNL Data File	168.9	1.58662	0.58682	0.93106
67-66-3	CHLOROFORM ISOAMYL ALCOHOL	119.4	LBNL Data File	168.9	1.58662	0.58682	0.93106
67-66-3	CHLOROFORM	119.4	LBNL Data File	168.9	1.58662	0.58682	0.93106
67-66-3	CHLOROFORM:ISOAMYL ALCOHOL 24:1	119.4	LBNL Data File	168.9	1.58662	0.11736	0.18621
67-66-3	CHLOROFORM	119.4	LBNL Data File	168.9	1.58662	1.17363	1.86211

Calculation of Liquid Chemical Emissions
Phase 1 Laboratory Usage Scenario
Proposed Richmond Bay Campus Long Range Development Plan, Richmond, California

Pouring Emissions Estimates (Table G-4)

S = Saturation Factor = 1.45
VP = Vapor Pressure = Chemical-specific
MW = Molecular Weight = Chemical-specific
T = Ambient Temperature (R) = 532

Loss (grams/liter) = 0.02887 * (S*VP*MW)/T
(limited to 700 g/liter)

This list of chemicals comes from LBNL inventory data with solids & gases removed Must be identical to Chemical Inventory worksheet		*MW entered manually*		*Calculated value from separate worksheet*	*Calculated* **Pouring Loss Emission Factor (grams/liter)**	*From separate worksheet* **Annual Usage (liters/yr)**	*Calculated* **Annual Emissions (grams/yr)**
CAS No.	**Compound Name**	**MW (g/mole)**	**MW Reference**	**VP (@ Ref Temp) (mmHg)**			
67-66-3	CHLOROFORM	119.4	LBNL Data File	168.9	1.58662	1.17363	1.86211
67-66-3	CHLOROFORM	119.4	LBNL Data File	168.9	1.58662	0.58682	0.93106
67-66-3	CHLOROFORM	119.4	LBNL Data File	168.9	1.58662	1.17363	1.86211
67-66-3	CHLOROFORM	119.4	LBNL Data File	168.9	1.58662	0.58682	0.93106
67-66-3	CHLOROFORM	119.4	LBNL Data File	168.9	1.58662	0.58682	0.93106
67-66-3	CHLOROFORM	119.4	LBNL Data File	168.9	1.58662	0.02934	0.04655
67-66-3	CHLOROFORM:ISOAMYL ALCOHOL 24:1	119.4	LBNL Data File	168.9	1.58662	1.11067	1.76221
67-66-3	CHLOROFORM: ISOAMYL ALCOHOL MIXTURE	119.4	LBNL Data File	168.9	1.58662	0.58682	0.93106
67-66-3	CHLOROFORM	119.4	LBNL Data File	168.9	1.58662	0.02934	0.04655
67-66-3	CHLOROFORM	119.4	LBNL Data File	168.9	1.58662	0.46945	0.74484
67-66-3	CHLOROFORM	119.4	LBNL Data File	168.9	1.58662	0.46945	0.74484
67-66-3	CHLOROFORM	119.4	LBNL Data File	168.9	1.58662	0.58682	0.93106
67-66-3	CHLOROFORM	119.4	LBNL Data File	168.9	1.58662	0.58682	0.93106
67-66-3	CHLOROFORM	119.4	LBNL Data File	168.9	1.58662	0.55534	0.88111
67-66-3	CHLOROFORM	119.4	LBNL Data File	168.9	1.58662	0.55534	0.88111
67-66-3	CHLOROFORM	119.4	LBNL Data File	168.9	1.58662	0.58682	0.93106
67-66-3	CHLOROFORM	119.4	LBNL Data File	168.9	1.58662	0.58682	0.93106
67-66-3	CHLOROFORM	119.4	LBNL Data File	168.9	1.58662	0.58682	0.93106
67-66-3	CHLOROFORM	119.4	LBNL Data File	168.9	1.58662	4.69453	7.44844
67-66-3	CHLOROFORM HPLC PURE	119.4	LBNL Data File	168.9	1.58662	1.17363	1.86211
67-66-3	CHLOROFORM	119.4	LBNL Data File	168.9	1.58662	4.69453	7.44844
67-66-3	CHLOROFORM:ISOAMYL ALCOHOL MIXTURE	119.4	LBNL Data File	168.9	1.58662	0.11736	0.18621
67-66-3	CHLOROFORM	119.4	LBNL Data File	168.9	1.58662	0.02934	0.04655
67-66-3	CHLOROFORM	119.4	LBNL Data File	168.9	1.58662	0.11736	0.18621
67-66-3	CHLOROFORM	119.4	LBNL Data File	168.9	1.58662	1.17363	1.86211
67-66-3	CHLOROFORM	119.4	LBNL Data File	168.9	1.58662	0.58682	0.93106
67-66-3	CHLOROFORM	119.4	LBNL Data File	168.9	1.58662	1.17363	1.86211
67-66-3	CHLOROFORM	119.4	LBNL Data File	168.9	1.58662	0.03957	0.06278
67-66-3	CHLOROFORM	119.4	LBNL Data File	168.9	1.58662	0.02934	0.04655
67-66-3	CHLOROFORM	119.4	LBNL Data File	168.9	1.58662	0.02934	0.04655
67-66-3	CHLOROFORM	119.4	LBNL Data File	168.9	1.58662	0.02934	0.04655
67-66-3	CHLOROFORM	119.4	LBNL Data File	168.9	1.58662	4.69453	7.44844
67-66-3	CHLOROFORM	119.4	LBNL Data File	168.9	1.58662	2.34727	3.72422
67-66-3	CHLOROFORM	119.4	LBNL Data File	168.9	1.58662	0.58682	0.93106

Calculation of Liquid Chemical Emissions
Phase 1 Laboratory Usage Scenario
Proposed Richmond Bay Campus Long Range Development Plan, Richmond, California

Pouring Emissions Estimates (Table G-4)

S = Saturation Factor = 1.45
VP = Vapor Pressure = Chemical-specific
MW = Molecular Weight = Chemical-specific
T = Ambient Temperature (R) = 532

Loss (grams/liter) = 0.02887 * (S*VP*MW)/T
(limited to 700 g/liter)

This list of chemicals comes from LBNL inventory data with solids & gases removed Must be identical to Chemical Inventory worksheet		*MW entered manually*		*Calculated value from separate worksheet*	*Calculated* **Pouring Loss Emission Factor (grams/liter)**	*From separate worksheet* **Annual Usage (liters/yr)**	*Calculated* **Annual Emissions (grams/yr)**
CAS No.	**Compound Name**	**MW (g/mole)**	**MW Reference**	**VP (@ Ref Temp) (mmHg)**			
67-66-3	CHLOROFORM: ISOAMYL ALCOHOL	119.4	LBNL Data File	168.9	1.58662	0.58682	0.93106
67-66-3	CHLOROFORM: ISOAMYL ALCOHOL	119.4	LBNL Data File	168.9	1.58662	0.58682	0.93106
67-66-3	CHLOROFORM	119.4	LBNL Data File	168.9	1.58662	4.69453	7.44844
67-66-3	CHLOROFORM:ISOAMYL ALCOHOL	119.4	LBNL Data File	168.9	1.58662	0.11736	0.18621
67-66-3	CHLOROFORM:ISOAMYL ALCOHOL 24:1	119.4	LBNL Data File	168.9	1.58662	0.58682	0.93106
67-66-3	CHLOROFORM	119.4	LBNL Data File	168.9	1.58662	1.17363	1.86211
67-66-3	CHLOROFORM	119.4	LBNL Data File	168.9	1.58662	0.58682	0.93106
67-66-3	CHLOROFORM	119.4	LBNL Data File	168.9	1.58662	1.17363	1.86211
67-66-3	CHLOROFORM	119.4	LBNL Data File	168.9	1.58662	2.34727	3.72422
67-66-3	CHLOROFORM	119.4	LBNL Data File	168.9	1.58662	2.93408	4.65528
67-66-3	CHLOROFORM	119.4	LBNL Data File	168.9	1.58662	2.93408	4.65528
67-66-3	CHLOROFORM	119.4	LBNL Data File	168.9	1.58662	2.93408	4.65528
67-66-3	CHLOROFORM	119.4	LBNL Data File	168.9	1.58662	0.58682	0.93106
67-66-3	CHLOROFORM	119.4	LBNL Data File	168.9	1.58662	0.58682	0.93106
67-66-3	CHLOROFORM	119.4	LBNL Data File	168.9	1.58662	0.58682	0.93106
67-66-3	CHLOROFORM:ISOAMYL ALCOHOL	119.4	LBNL Data File	168.9	1.58662	0.55534	0.88111
67-66-3	CHLOROFORM	119.4	LBNL Data File	168.9	1.58662	4.69453	7.44844
67-66-3	CHLOROFORM HPLC PURE	119.4	LBNL Data File	168.9	1.58662	1.17363	1.86211
67-66-3	CHLOROFORM	119.4	LBNL Data File	168.9	1.58662	0.11736	0.18621
67-66-3	TRICHLOROMETHANE	119.4	LBNL Data File	168.9	1.58662	0.02934	0.04655
67-66-3	CHLOROFORM	119.4	LBNL Data File	168.9	1.58662	0.02934	0.04655
67-66-3	CHLOROFORM	119.4	LBNL Data File	168.9	1.58662	0.02934	0.04655
67-66-3	CHLOROFORM: ISOAMYL ALCOHOL MIXTURE	119.4	LBNL Data File	168.9	1.58662	0.52814	0.83795
67-66-3	CHLOROFORM	119.4	LBNL Data File	168.9	1.58662	0.58682	0.93106
67-66-3	CHLOROFORM	119.4	LBNL Data File	168.9	1.58662	0.58682	0.93106
67-66-3	CHLOROFORM	119.4	LBNL Data File	168.9	1.58662	0.58682	0.93106
67-66-3	CHLOROFORM	119.4	LBNL Data File	168.9	1.58662	0.07914	0.12556
67-66-3	CHLOROFORM	119.4	LBNL Data File	168.9	1.58662	1.11067	1.76221
67-66-3	CHLOROFORM	119.4	LBNL Data File	168.9	1.58662	0.58682	0.93106
67-66-3	CHLOROFORM	119.4	LBNL Data File	168.9	1.58662	0.58682	0.93106
67-66-3	CHLOROFORM	119.4	LBNL Data File	168.9	1.58662	0.58682	0.93106
67-66-3	CHLOROFORM	119.4	LBNL Data File	168.9	1.58662	4.69453	7.44844
67-66-3	CHLOROFORM	119.4	LBNL Data File	168.9	1.58662	4.69453	7.44844
67-66-3	CHLOROFORM	119.4	LBNL Data File	168.9	1.58662	4.69453	7.44844

Calculation of Liquid Chemical Emissions
Phase 1 Laboratory Usage Scenario
Proposed Richmond Bay Campus Long Range Development Plan, Richmond, California

Pouring Emissions Estimates (Table G-4)

S = Saturation Factor = 1.45
VP = Vapor Pressure = Chemical-specific
MW = Molecular Weight = Chemical-specific
T = Ambient Temperature (R) = 532

Loss (grams/liter) = 0.02887 * (S*VP*MW)/T
(limited to 700 g/liter)

This list of chemicals comes from LBNL inventory data with solids & gases removed Must be identical to Chemical Inventory worksheet		*MW entered manually*		*Calculated value from separate worksheet*	*Calculated* **Pouring Loss Emission Factor (grams/liter)**	*From separate worksheet* **Annual Usage (liters/yr)**	*Calculated* **Annual Emissions (grams/yr)**
CAS No.	**Compound Name**	**MW (g/mole)**	**MW Reference**	**VP (@ Ref Temp) (mmHg)**			
67-66-3	CHLOROFORM/ISOAMYL ALCOHOL	119.4	LBNL Data File	168.9	1.58662	0.05868	0.09311
67-66-3	CHLOROFORM	119.4	LBNL Data File	168.9	1.58662	1.17363	1.86211
67-66-3	CHLOROFORM	119.4	LBNL Data File	168.9	1.58662	0.58682	0.93106
67-66-3	CHLOROFORM	119.4	LBNL Data File	168.9	1.58662	0.58682	0.93106
67-66-3	CHLOROFORM	119.4	LBNL Data File	168.9	1.58662	0.58682	0.93106
67-66-3	CHLOROFORM	119.4	LBNL Data File	168.9	1.58662	0.58682	0.93106
67-66-3	CHLOROFORM	119.4	LBNL Data File	168.9	1.58662	0.58682	0.93106
67-66-3	CHLOROFORM	119.4	LBNL Data File	168.9	1.58662	4.69453	7.44844
67-66-3	CHLOROFORM	119.4	LBNL Data File	168.9	1.58662	0.58682	0.93106
67-66-3	CHLOROFORM	119.4	LBNL Data File	168.9	1.58662	0.02934	0.04655
67-66-3	CHLOROFORM	119.4	LBNL Data File	168.9	1.58662	0.02934	0.04655
67-66-3	CHLOROFORM	119.4	LBNL Data File	168.9	1.58662	0.02934	0.04655
67-66-3	CHLOROFORM	119.4	LBNL Data File	168.9	1.58662	0.58682	0.93106
67-66-3	CHLOROFORM	119.4	LBNL Data File	168.9	1.58662	4.69453	7.44844
67-66-3	CHLOROFORM	119.4	LBNL Data File	168.9	1.58662	0.58682	0.93106
67-66-3	CHLOROFORM	119.4	LBNL Data File	168.9	1.58662	0.58682	0.93106
67-66-3	CHLOROFORM	119.4	LBNL Data File	168.9	1.58662	0.58682	0.93106
67-66-3	CHLOROFORM	119.4	LBNL Data File	168.9	1.58662	0.58682	0.93106
67-66-3	CHLOROFORM	119.4	LBNL Data File	168.9	1.58662	0.02934	0.04655
67-66-3	CHLOROFORM	119.4	LBNL Data File	168.9	1.58662	1.17363	1.86211
67-66-3	CHLOROFORM	119.4	LBNL Data File	168.9	1.58662	0.02934	0.04655
67-66-3	CHLOROFORM	119.4	LBNL Data File	168.9	1.58662	0.11736	0.18621
67-66-3	CHLOROFORM	119.4	LBNL Data File	168.9	1.58662	0.02934	0.04655
67-66-3	CHLOROFORM	119.4	LBNL Data File	168.9	1.58662	0.58682	0.93106
67-66-3	CHLOROFORM	119.4	LBNL Data File	168.9	1.58662	0.58682	0.93106
67-66-3	CHLOROFORM	119.4	LBNL Data File	168.9	1.58662	1.11495	1.76901
67-66-3	CHLOROFORM	119.4	LBNL Data File	168.9	1.58662	0.58682	0.93106
67-66-3	CHLOROFORM	119.4	LBNL Data File	168.9	1.58662	0.02934	0.04655
67-66-3	CHLOROFORM	119.4	LBNL Data File	168.9	1.58662	0.58682	0.93106
67-66-3	CHLOROFORM	119.4	LBNL Data File	168.9	1.58662	0.02934	0.04655
67-66-3	CHLOROFORM	119.4	LBNL Data File	168.9	1.58662	1.17363	1.86211
67-66-3	CHLOROFORM	119.4	LBNL Data File	168.9	1.58662	1.17363	1.86211
67-66-3	CHLOROFORM	119.4	LBNL Data File	168.9	1.58662	0.02934	0.04655
67-66-3	CHLOROFORM	119.4	LBNL Data File	168.9	1.58662	0.58682	0.93106

Calculation of Liquid Chemical Emissions
Phase 1 Laboratory Usage Scenario
Proposed Richmond Bay Campus Long Range Development Plan, Richmond, California

Pouring Emissions Estimates (Table G-4)

S = Saturation Factor = 1.45
VP = Vapor Pressure = Chemical-specific
MW = Molecular Weight = Chemical-specific
T = Ambient Temperature (R) = 532

Loss (grams/liter) = 0.02887 * (S*VP*MW)/T
(limited to 700 g/liter)

This list of chemicals comes from LBNL inventory data with solids & gases removed Must be identical to Chemical Inventory worksheet		*MW entered manually*		*Calculated value from separate worksheet*	*Calculated* **Pouring Loss Emission Factor**	*From separate worksheet* **Annual Usage**	*Calculated* **Annual Emissions**
CAS No.	**Compound Name**	**MW (g/mole)**	**MW Reference**	**VP (@ Ref Temp) (mmHg)**	**(grams/liter)**	**(liters/yr)**	**(grams/yr)**
67-66-3	CHLOROFORM	119.4	LBNL Data File	168.9	1.58662	0.58682	0.93106
67-66-3	CHLOROFORM	119.4	LBNL Data File	168.9	1.58662	0.58682	0.93106
68-12-2	N,N-DIMETHYLFORMAMIDE	73.1	LBNL Data File	3.2	0.01862	0.11736	0.00219
68-12-2	N-N-DIMETHYLFOMAMIDE	73.1	LBNL Data File	3.2	0.01862	0.58682	0.01093
68-12-2	N,N-DIMETHYLFORMAMIDE	73.1	LBNL Data File	3.2	0.01862	1.17363	0.02186
68-12-2	N,N-DIMETHYLFORMAMIDE	73.1	LBNL Data File	3.2	0.01862	0.29341	0.00546
68-12-2	N,N-DIMETHYLFORMAMIDE	73.1	LBNL Data File	3.2	0.01862	2.34727	0.04371
68-12-2	N,N-DIMETHYLFORMAMIDE	73.1	LBNL Data File	3.2	0.01862	4.69453	0.08743
68-12-2	N-N-DIMETHYL FORMAMIDE	73.1	LBNL Data File	3.2	0.01862	1.17363	0.02186
68-12-2	N,N-DIMETHYLFORMAMIDE	73.1	LBNL Data File	3.2	0.01862	1.17363	0.02186
68-12-2	N,N-DIMETHYLFORMAMIDE, ANHYDROUS	73.1	LBNL Data File	3.2	0.01862	0.58682	0.01093
68-12-2	DMF	73.1	LBNL Data File	3.2	0.01862	0.58682	0.01093
68-12-2	DMF	73.1	LBNL Data File	3.2	0.01862	1.17363	0.02186
68-12-2	DMF	73.1	LBNL Data File	3.2	0.01862	0.29341	0.00546
68-12-2	DMF	73.1	LBNL Data File	3.2	0.01862	0.58682	0.01093
68-12-2	DIMETHYLFORMAMIDE	73.1	LBNL Data File	3.2	0.01862	0.00117	0.00002
68-12-2	DMF	73.1	LBNL Data File	3.2	0.01862	0.29341	0.00546
68-12-2	DMF	73.1	LBNL Data File	3.2	0.01862	0.58682	0.01093
68-12-2	DMF	73.1	LBNL Data File	3.2	0.01862	0.58682	0.01093
68-12-2	DIMETHYLFORMAMIDE	73.1	LBNL Data File	3.2	0.01862	0.29341	0.00546
68-12-2	DIMETHYL-FORMAMIDE	73.1	LBNL Data File	3.2	0.01862	0.29341	0.00546
68-12-2	DIMETHYL-FORMAMIDE	73.1	LBNL Data File	3.2	0.01862	0.29341	0.00546
68-12-2	DIMETHYLFORMAMIDE	73.1	LBNL Data File	3.2	0.01862	1.17363	0.02186
68-12-2	DIMETHYLFORMAMIDE	73.1	LBNL Data File	3.2	0.01862	1.17363	0.02186
68-12-2	DMF	73.1	LBNL Data File	3.2	0.01862	0.11736	0.00219
68-12-2	N, N-DIMETHYLFORMAMIDE, REAGENT GRADE	73.1	LBNL Data File	3.2	0.01862	0.11736	0.00219
68-12-2	N,N-DIMETHYLFORMAMIDE	73.1	LBNL Data File	3.2	0.01862	0.11736	0.00219
68-12-2	DIMETHYLFORMAMIDE	73.1	LBNL Data File	3.2	0.01862	0.11736	0.00219
68-12-2	N,N-DIMETHYL FORMAMIDE	73.1	LBNL Data File	3.2	0.01862	1.17363	0.02186
68-12-2	N,N'-DIMETHYL FORMAMIDE	73.1	LBNL Data File	3.2	0.01862	0.58682	0.01093
68-12-2	N,N-DIMETHYLFORMAMIDE	73.1	LBNL Data File	3.2	0.01862	0.58682	0.01093
68-12-2	DMF	73.1	LBNL Data File	3.2	0.01862	0.58682	0.01093
68-12-2	DMF	73.1	LBNL Data File	3.2	0.01862	0.58682	0.01093
68-12-2	DMF	73.1	LBNL Data File	3.2	0.01862	0.29341	0.00546

Calculation of Liquid Chemical Emissions
Phase 1 Laboratory Usage Scenario
Proposed Richmond Bay Campus Long Range Development Plan, Richmond, California

Pouring Emissions Estimates (Table G-4)

S = Saturation Factor = 1.45
VP = Vapor Pressure = Chemical-specific
MW = Molecular Weight = Chemical-specific
T = Ambient Temperature (R) = 532

Loss (grams/liter) = 0.02887 * (S*VP*MW)/T
(limited to 700 g/liter)

This list of chemicals comes from LBNL inventory data with solids & gases removed Must be identical to Chemical Inventory worksheet		*MW entered manually*		*Calculated value from separate worksheet*	*Calculated* **Pouring Loss Emission Factor (grams/liter)**	*From separate worksheet* **Annual Usage (liters/yr)**	*Calculated* **Annual Emissions (grams/yr)**
CAS No.	**Compound Name**	**MW (g/mole)**	**MW Reference**	**VP (@ Ref Temp) (mmHg)**			
71-43-2	BENZENE	78.1	LBNL Data File	82.1	0.50482	1.17363	0.59247
71-43-2	BENZENE	78.1	LBNL Data File	82.1	0.50482	1.17363	0.59247
71-43-2	BENZENE(ANHYDROUS)	78.1	LBNL Data File	82.1	0.50482	2.34727	1.18494
71-43-2	BENZENE(ANHYDROUS)	78.1	LBNL Data File	82.1	0.50482	0.11736	0.05925
71-43-2	BENZENE	78.1	LBNL Data File	82.1	0.50482	1.17363	0.59247
75-07-0	ACETALDEHYDE	44.1	LBNL Data File	802.4	2.78437	0.00587	0.01634
75-07-0	ACETALDEHYDE	44.1	LBNL Data File	802.4	2.78437	0.11736	0.32678
75-07-0	ACETALDEHYDE	44.1	LBNL Data File	802.4	2.78437	0.11736	0.32678
75-09-2	DICHLOROMETHANE	84.9	LBNL Data File	378.5	2.52868	0.11736	0.29677
75-09-2	METHYLENE CHLORIDE	84.9	LBNL Data File	378.5	2.52868	0.00000	0.00000
75-09-2	METHYLENE CHLORIDE	84.9	LBNL Data File	378.5	2.52868	4.69453	11.87098
75-09-2	DICHLOROMETHANE	84.9	LBNL Data File	378.5	2.52868	22.29904	56.38715
75-09-2	TO BE VALIDATED-DICHLOROME, ANHYDROUS	84.9	LBNL Data File	378.5	2.52868	0.11736	0.29677
75-09-2	DICHLOROMETHANE	84.9	LBNL Data File	378.5	2.52868	1.17363	2.96774
75-09-2	METHYLENE CHLORIDE	84.9	LBNL Data File	378.5	2.52868	22.29904	56.38715
75-09-2	METHYLENE CHLORIDE	84.9	LBNL Data File	378.5	2.52868	4.69453	11.87098
75-09-2	METHYLENE CHLORIDE	84.9	LBNL Data File	378.5	2.52868	4.69453	11.87098
75-09-2	METHYLENE CHLORIDE	84.9	LBNL Data File	378.5	2.52868	0.11736	0.29677
75-09-2	METHYLENE CHLORIDE	84.9	LBNL Data File	378.5	2.52868	1.17363	2.96774
75-09-2	METHYLENE CHLORIDE	84.9	LBNL Data File	378.5	2.52868	0.11736	0.29677
75-09-2	DICHLOROMETHANE	84.9	LBNL Data File	378.5	2.52868	4.69453	11.87098
75-09-2	DICHLOROMETHANE	84.9	LBNL Data File	378.5	2.52868	4.69453	11.87098
75-09-2	DICHLOROMETHANE	84.9	LBNL Data File	378.5	2.52868	1.17363	2.96774
75-09-2	METHYLENE CHLORIDE	84.9	LBNL Data File	378.5	2.52868	1.17363	2.96774
75-09-2	METHYLENE CHLORIDE	84.9	LBNL Data File	378.5	2.52868	1.17363	2.96774
75-09-2	DICHLOROMETHANE	84.9	LBNL Data File	378.5	2.52868	23.47267	59.35489
75-09-2	METHYLENE CHLORIDE	84.9	LBNL Data File	378.5	2.52868	1.17363	2.96774
75-09-2	DICHLOROMETHANE	84.9	LBNL Data File	378.5	2.52868	23.47267	59.35489
75-09-2	METHYLENE CHLORIDE	84.9	LBNL Data File	378.5	2.52868	4.69453	11.87098
75-09-2	DICHLOROMETHANE	84.9	LBNL Data File	378.5	2.52868	4.69453	11.87098
75-09-2	METHYLENE CHLORIDE	84.9	LBNL Data File	378.5	2.52868	0.00000	0.00000
75-09-2	DICHLOROMETHANE	84.9	LBNL Data File	378.5	2.52868	4.69453	11.87098
75-09-2	METHANE, DICHLORO-	84.9	LBNL Data File	378.5	2.52868	0.58682	1.48387
75-09-2	METHYLENE CHLORIDE	84.9	LBNL Data File	378.5	2.52868	1.17363	2.96774

Calculation of Liquid Chemical Emissions
Phase 1 Laboratory Usage Scenario
Proposed Richmond Bay Campus Long Range Development Plan, Richmond, California

Pouring Emissions Estimates (Table G-4)

S = Saturation Factor = 1.45
VP = Vapor Pressure = Chemical-specific
MW = Molecular Weight = Chemical-specific
T = Ambient Temperature (R) = 532

Loss (grams/liter) = 0.02887 * (S*VP*MW)/T
(limited to 700 g/liter)

This list of chemicals comes from LBNL inventory data with solids & gases removed Must be identical to Chemical Inventory worksheet		*MW entered manually*		*Calculated value from separate worksheet*	*Calculated* **Pouring Loss Emission Factor (grams/liter)**	*From separate worksheet* **Annual Usage (liters/yr)**	*Calculated* **Annual Emissions (grams/yr)**
CAS No.	**Compound Name**	**MW (g/mole)**	**MW Reference**	**VP (@ Ref Temp) (mmHg)**			
75-56-9	PROPYLENE OXIDE	58.08	LBNL Data File	468.3	2.14038	0.00035	0.00076
75-56-9	PROPYLENE OXIDE	58.08	LBNL Data File	468.3	2.14038	0.00035	0.00076
78-93-3	MEK	72.1	LBNL Data File	77.7	0.44071	0.58682	0.25862
78-93-3	METHYL ETHYL KETONE	72.1	LBNL Data File	77.7	0.44071	0.58682	0.25862
78-93-3	MEK	72.1	LBNL Data File	77.7	0.44071	0.58682	0.25862
78-93-3	2-BUTANONE	72.1	LBNL Data File	77.7	0.44071	1.17363	0.51724
79-01-6	TRICHLOROETHYLENE	131.4	LBNL Data File	59.0	0.60980	0.58682	0.35784
79-01-6	TRICHLOROETHYLENE	131.4	LBNL Data File	59.0	0.60980	0.58682	0.35784
79-01-6	TRICHLOROETHYLENE	131.4	LBNL Data File	59.0	0.60980	0.58682	0.35784
79-01-6	TRICHLOROETHYLENE	131.4	LBNL Data File	59.0	0.60980	0.58682	0.35784
79-10-7	ACRYLIC ACID	72.06	LBNL Data File	95.0	0.53873	0.00558	0.00301
79-10-7	ACRYLIC ACID	72.06	LBNL Data File	95.0	0.53873	0.00558	0.00301
79-10-7	ACRYLIC ACID	72.06	LBNL Data File	95.0	0.53873	0.00558	0.00301
100-41-4	ETHYL BENZENE	106.2	LBNL Data File	7.9	0.06609	1.17363	0.07756
100-42-5	STYRENE	104.14	LBNL Data File	5.5	0.04484	0.11736	0.00526
100-42-5	STYRENE	104.14	LBNL Data File	5.5	0.04484	0.00587	0.00026
100-44-7	BENZYL CHLORIDE	126.58	LBNL Data File	1.0	0.00995	0.29341	0.00292
106-89-8	4-METHYLUMBELLIFERONE	92.5	LBNL Data File	13.0	0.09462	0.02480	0.00235
106-99-0	1,3-BUTADIENE IN TOLUENE	54.1	LBNL Data File	1838.0	7.82431	0.47324	3.70277
107-02-8	ACROLEIN	56.1	LBNL Data File	242.0	1.06839	0.11736	0.12539
107-06-2	1,2-DICHLOROETHANE	99	LBNL Data File	67.8	0.52791	2.79325	1.47458
107-06-2	1,2-DICHLOROETHANE	99	LBNL Data File	67.8	0.52791	0.58682	0.30979
107-06-2	1,2-DICHLOROETHANE	99	LBNL Data File	67.8	0.52791	1.17363	0.61957
107-06-2	1,2-DICHLOROETHANE	99	LBNL Data File	67.8	0.52791	4.69453	2.47828
107-06-2	1,2-DICHLOROETHANE	99	LBNL Data File	67.8	0.52791	0.58682	0.30979
107-21-1	ETHYLENE GLYCOL	62.07	LBNL Data File	0.1	0.00032	1.17363	0.00038
107-21-1	ETHYLENE GLYCOL	62.07	LBNL Data File	0.1	0.00032	1.17363	0.00038
107-21-1	ETHYLENE GLYCOL	62.07	LBNL Data File	0.1	0.00032	1.17363	0.00038
107-21-1	ETHYLENE GLYCOL	62.07	LBNL Data File	0.1	0.00032	4.69453	0.00152
107-21-1	ETHYLENE GLYCOL	62.07	LBNL Data File	0.1	0.00032	3.84798	0.00125
107-21-1	ETHYLENE GLYCOL	62.07	LBNL Data File	0.1	0.00032	0.96199	0.00031
107-21-1	ETHYLENE GLYCOL	62.07	LBNL Data File	0.1	0.00032	1.17363	0.00038
107-21-1	ETHYLENE GLYCOL	62.07	LBNL Data File	0.1	0.00032	0.58682	0.00019
107-21-1	ETHYLENE GLYCOL	62.07	LBNL Data File	0.1	0.00032	0.29341	0.00009

Calculation of Liquid Chemical Emissions
Phase 1 Laboratory Usage Scenario
Proposed Richmond Bay Campus Long Range Development Plan, Richmond, California

Pouring Emissions Estimates (Table G-4)

S = Saturation Factor = 1.45
VP = Vapor Pressure = Chemical-specific
MW = Molecular Weight = Chemical-specific
T = Ambient Temperature (R) = 532

Loss (grams/liter) = 0.02887 * (S*VP*MW)/T
(limited to 700 g/liter)

This list of chemicals comes from LBNL inventory data with solids & gases removed Must be identical to Chemical Inventory worksheet		*MW entered manually*		*Calculated value from separate worksheet*	*Calculated* **Pouring Loss Emission Factor (grams/liter)**	*From separate worksheet* **Annual Usage (liters/yr)**	*Calculated* **Annual Emissions (grams/yr)**
CAS No.	**Compound Name**	**MW (g/mole)**	**MW Reference**	**VP (@ Ref Temp) (mmHg)**			
107-21-1	ETHYLENE GLYCOL	62.07	LBNL Data File	0.1	0.00032	0.29341	0.00009
107-21-1	ETHYLENE GLYCOL	62.07	LBNL Data File	0.1	0.00032	2.93408	0.00095
107-21-1	ETHYLENE GLYCOL	62.07	LBNL Data File	0.1	0.00032	1.17363	0.00038
107-21-1	ETHYLENE GLYCOL	62.07	LBNL Data File	0.1	0.00032	0.29341	0.00009
107-21-1	ETHYLENE GLYCOL	62.07	LBNL Data File	0.1	0.00032	0.02934	0.00001
107-98-2	1-METHOXY-2-PROPANOL	90.12	NIST	11.8	0.08368	0.00939	0.00079
107-98-2	1-METHOXY-2-PROPANOL	90.12	NIST	11.8	0.08368	0.00939	0.00079
108-39-4	M-CRESOL	108.1	LBNL Data File	0.1	0.00108	0.58682	0.00064
108-39-4	M-CRESOL	108.1	LBNL Data File	0.1	0.00108	0.11736	0.00013
108-88-3	TOLUENE	92.1	LBNL Data File	24.1	0.17472	0.11736	0.02051
108-88-3	TOLUENE	92.1	LBNL Data File	24.1	0.17472	1.17363	0.20506
108-88-3	TOLUENE	92.1	LBNL Data File	24.1	0.17472	0.58682	0.10253
108-88-3	TOLUENE	92.1	LBNL Data File	24.1	0.17472	1.17363	0.20506
108-88-3	TOLUENE	92.1	LBNL Data File	24.1	0.17472	1.17363	0.20506
108-88-3	TOLUENE	92.1	LBNL Data File	24.1	0.17472	2.34727	0.41012
108-88-3	TOLUENE	92.1	LBNL Data File	24.1	0.17472	1.17363	0.20506
108-88-3	TOLUENE	92.1	LBNL Data File	24.1	0.17472	1.17363	0.20506
108-88-3	TOLUENE	92.1	LBNL Data File	24.1	0.17472	1.17363	0.20506
108-88-3	TOLUENE	92.1	LBNL Data File	24.1	0.17472	1.17363	0.20506
108-88-3	TOLUENE	92.1	LBNL Data File	24.1	0.17472	1.17363	0.20506
108-88-3	TOLUENE	92.1	LBNL Data File	24.1	0.17472	1.17363	0.20506
108-88-3	TOLUENE	92.1	LBNL Data File	24.1	0.17472	0.11736	0.02051
108-88-3	TOLUENE	92.1	LBNL Data File	24.1	0.17472	1.17363	0.20506
108-88-3	TOLUENE	92.1	LBNL Data File	24.1	0.17472	1.17363	0.20506
108-88-3	TOLUENE	92.1	LBNL Data File	24.1	0.17472	0.58682	0.10253
108-88-3	TOLUENE	92.1	LBNL Data File	24.1	0.17472	1.17363	0.20506
108-88-3	TOLUENE	92.1	LBNL Data File	24.1	0.17472	1.17363	0.20506
108-88-3	TOLUENE	92.1	LBNL Data File	24.1	0.17472	1.17363	0.20506
108-88-3	TOLUENE	92.1	LBNL Data File	24.1	0.17472	0.11736	0.02051
108-88-3	TOLUENE	92.1	LBNL Data File	24.1	0.17472	0.58682	0.10253
108-88-3	TOLUENE	92.1	LBNL Data File	24.1	0.17472	2.34727	0.41012
108-88-3	TOLUENE	92.1	LBNL Data File	24.1	0.17472	0.58682	0.10253
109-86-4	2-METHOXYETHANOL	76.09	NIST	8.4	0.05018	1.17363	0.05889
110-54-3	HEXANE	86.17	LBNL Data File	131.9	0.89422	1.17363	1.04948

Calculation of Liquid Chemical Emissions
Phase 1 Laboratory Usage Scenario
Proposed Richmond Bay Campus Long Range Development Plan, Richmond, California

Pouring Emissions Estimates (Table G-4)

S = Saturation Factor = 1.45
VP = Vapor Pressure = Chemical-specific
MW = Molecular Weight = Chemical-specific
T = Ambient Temperature (R) = 532

Loss (grams/liter) = 0.02887 * (S*VP*MW)/T
(limited to 700 g/liter)

This list of chemicals comes from LBNL inventory data with solids & gases removed Must be identical to Chemical Inventory worksheet		*MW entered manually*		*Calculated value from separate worksheet*	*Calculated* **Pouring Loss Emission Factor**	*From separate worksheet* **Annual Usage**	*Calculated* **Annual Emissions**
CAS No.	**Compound Name**	**MW (g/mole)**	**MW Reference**	**VP (@ Ref Temp) (mmHg)**	**(grams/liter)**	**(liters/yr)**	**(grams/yr)**
110-54-3	HEXANE, CHROMASOLV PLUS	86.17	LBNL Data File	131.9	0.89422	1.17363	1.04948
110-54-3	HEXANE	86.17	LBNL Data File	131.9	0.89422	1.17363	1.04948
110-54-3	HEXANE	86.17	LBNL Data File	131.9	0.89422	0.00000	0.00000
110-54-3	HEXANE	86.17	LBNL Data File	131.9	0.89422	4.69453	4.19792
110-54-3	HEXANE	86.17	LBNL Data File	131.9	0.89422	4.69453	4.19792
110-54-3	HEXANE	86.17	LBNL Data File	131.9	0.89422	22.29904	19.94014
110-54-3	HEXANE	86.17	LBNL Data File	131.9	0.89422	1.17363	1.04948
110-54-3	HEXANE	86.17	LBNL Data File	131.9	0.89422	0.00000	0.00000
110-54-3	HEXANE	86.17	LBNL Data File	131.9	0.89422	22.29904	19.94014
110-54-3	HEXANE	86.17	LBNL Data File	131.9	0.89422	1.17363	1.04948
110-54-3	ALKANE STANDARD SOLUTION C8-C20	86.17	LBNL Data File	131.9	0.89422	0.00117	0.00105
110-54-3	HEXANE	86.17	LBNL Data File	131.9	0.89422	0.00000	0.00000
110-54-3	HEXANE	86.17	LBNL Data File	131.9	0.89422	4.69453	4.19792
110-54-3	HEXANE	86.17	LBNL Data File	131.9	0.89422	4.69453	4.19792
110-54-3	HEXANE	86.17	LBNL Data File	131.9	0.89422	4.69453	4.19792
110-54-3	HEXANE	86.17	LBNL Data File	131.9	0.89422	4.69453	4.19792
110-54-3	HEXANE	86.17	LBNL Data File	131.9	0.89422	4.69453	4.19792
110-54-3	HEXANE	86.17	LBNL Data File	131.9	0.89422	4.69453	4.19792
110-54-3	HEXANE	86.17	LBNL Data File	131.9	0.89422	23.47267	20.98962
110-54-3	HEXANE	86.17	LBNL Data File	131.9	0.89422	28.16720	25.18754
110-54-3	HEXANE	86.17	LBNL Data File	131.9	0.89422	4.69453	4.19792
110-54-3	HEXANE	86.17	LBNL Data File	131.9	0.89422	22.29904	19.94014
110-54-3	HEXANE	86.17	LBNL Data File	131.9	0.89422	1.17363	1.04948
110-54-3	HEXANE	86.17	LBNL Data File	131.9	0.89422	4.69453	4.19792
110-54-3	HEXANE	86.17	LBNL Data File	131.9	0.89422	4.69453	4.19792
110-54-3	HEXANE	86.17	LBNL Data File	131.9	0.89422	4.69453	4.19792
110-54-3	HEXANE	86.17	LBNL Data File	131.9	0.89422	23.47267	20.98962
110-54-3	HEXANE	86.17	LBNL Data File	131.9	0.89422	23.47267	20.98962
110-54-3	ALKANE STANDARD SOLUTION C8-C20	86.17	LBNL Data File	131.9	0.89422	0.00117	0.00105
110-54-3	HEXANE	86.17	LBNL Data File	131.9	0.89422	23.47267	20.98962
110-54-3	HEXANE	86.17	LBNL Data File	131.9	0.89422	1.17363	1.04948
110-54-3	HEXANE	86.17	LBNL Data File	131.9	0.89422	0.00000	0.00000
110-54-3	HEXANE	86.17	LBNL Data File	131.9	0.89422	1.17363	1.04948
110-54-3	N-HEXANE	86.17	LBNL Data File	131.9	0.89422	1.17363	1.04948

Calculation of Liquid Chemical Emissions
Phase 1 Laboratory Usage Scenario
Proposed Richmond Bay Campus Long Range Development Plan, Richmond, California

Pouring Emissions Estimates (Table G-4)

S = Saturation Factor = 1.45
VP = Vapor Pressure = Chemical-specific
MW = Molecular Weight = Chemical-specific
T = Ambient Temperature (R) = 532

Loss (grams/liter) = 0.02887 * (S*VP*MW)/T
(limited to 700 g/liter)

This list of chemicals comes from LBNL inventory data with solids & gases removed Must be identical to Chemical Inventory worksheet		*MW entered manually*		*Calculated value from separate worksheet*	*Calculated* **Pouring Loss Emission Factor (grams/liter)**	*From separate worksheet* **Annual Usage (liters/yr)**	*Calculated* **Annual Emissions (grams/yr)**
CAS No.	**Compound Name**	**MW (g/mole)**	**MW Reference**	**VP (@ Ref Temp) (mmHg)**			
110-54-3	HEXANE	86.17	LBNL Data File	131.9	0.89422	1.17363	1.04948
110-54-3	HEXANE	86.17	LBNL Data File	131.9	0.89422	1.17363	1.04948
110-54-3	N-HEXANE	86.17	LBNL Data File	131.9	0.89422	0.11736	0.10495
110-54-3	HEXANE	86.17	LBNL Data File	131.9	0.89422	0.58682	0.52474
110-54-3	HEXANE	86.17	LBNL Data File	131.9	0.89422	1.17363	1.04948
110-54-3	HEXANE	86.17	LBNL Data File	131.9	0.89422	1.17363	1.04948
110-54-3	HEXANE	86.17	LBNL Data File	131.9	0.89422	1.17363	1.04948
110-54-3	HEXANE, CHROMASOLV PLUS	86.17	LBNL Data File	131.9	0.89422	1.17363	1.04948
110-54-3	HEXANE	86.17	LBNL Data File	131.9	0.89422	1.17363	1.04948
111-30-8	GLUTARALDEHYDE 25% AQUEOUS SOLUTION	100.12	NIST	0.5	0.00355	1.17363	0.00416
111-30-8	GLUTARALDEHYDE SOLUTION	100.12	NIST	0.5	0.00355	0.02760	0.00010
111-30-8	GLUTARALDEHYDE	100.12	NIST	0.5	0.00355	0.01174	0.00004
111-30-8	GLUTARALDEHYDE SOLUTION	100.12	NIST	0.5	0.00355	0.11736	0.00042
111-30-8	GLUTARALDEHYDE	100.12	NIST	0.5	0.00355	0.02347	0.00008
111-30-8	GLUTARALDEHYDE	100.12	NIST	0.5	0.00355	0.11736	0.00042
111-30-8	GLUTARALDEHYDE SOLUTION	100.12	NIST	0.5	0.00355	0.01174	0.00004
111-30-8	GLUTARALDEHYDE SOLUTION	100.12	NIST	0.5	0.00355	0.01174	0.00004
111-30-8	GLUTARALDEHYDE	100.12	NIST	0.5	0.00355	0.01174	0.00004
111-30-8	GLUTARALDEHYDE	100.12	NIST	0.5	0.00355	0.01174	0.00004
111-30-8	GLUTARALDEHYDE	100.12	NIST	0.5	0.00355	0.01174	0.00004
111-30-8	GLUTARALDEHYDE	100.12	NIST	0.5	0.00355	0.10563	0.00037
111-30-8	GLUTARALDEHYDE	100.12	NIST	0.5	0.00355	0.10563	0.00037
111-30-8	GLUTERALDEHYDE	100.12	NIST	0.5	0.00355	0.00235	0.00001
111-30-8	GLUTERALDEHYDE	100.12	NIST	0.5	0.00355	0.01174	0.00004
111-30-8	GLUTERALDEHYDE	100.12	NIST	0.5	0.00355	0.01174	0.00004
111-30-8	GLUTARALDEHYDE	100.12	NIST	0.5	0.00355	0.02347	0.00008
111-30-8	GLUTARALDEHYDE	100.12	NIST	0.5	0.00355	0.00235	0.00001
111-30-8	GLUTARALDEHYDE	100.12	NIST	0.5	0.00355	0.01174	0.00004
111-30-8	GLUTARALDEHYDE	100.12	NIST	0.5	0.00355	0.11736	0.00042
111-30-8	GLUTARALDEHYDE	100.12	NIST	0.5	0.00355	0.00117	0.00000
111-30-8	GLUTARALDEHYDE 25% AQUEOUS SOLUTION	100.12	NIST	0.5	0.00355	0.00117	0.00000
111-30-8	GLUTARALDEHYDE 25% AQUEOUS SOLUTION	100.12	NIST	0.5	0.00355	0.02934	0.00010
111-30-8	GLUTARALDEHYDE 25% AQUEOUS SOLUTION	100.12	NIST	0.5	0.00355	0.02934	0.00010
111-30-8	GLUTARALDEHYDE	100.12	NIST	0.5	0.00355	0.11736	0.00042

Calculation of Liquid Chemical Emissions
Phase 1 Laboratory Usage Scenario
Proposed Richmond Bay Campus Long Range Development Plan, Richmond, California

Pouring Emissions Estimates (Table G-4)

S = Saturation Factor = 1.45
VP = Vapor Pressure = Chemical-specific
MW = Molecular Weight = Chemical-specific
T = Ambient Temperature (R) = 532

Loss (grams/liter) = 0.02887 * (S*VP*MW)/T
(limited to 700 g/liter)

This list of chemicals comes from LBNL inventory data with solids & gases removed Must be identical to Chemical Inventory worksheet		*MW entered manually*		*Calculated value from separate worksheet*	*Calculated* **Pouring Loss Emission Factor (grams/liter)**	*From separate worksheet* **Annual Usage (liters/yr)**	*Calculated* **Annual Emissions (grams/yr)**
CAS No.	**Compound Name**	**MW (g/mole)**	**MW Reference**	**VP (@ Ref Temp) (mmHg)**			
111-30-8	GLUTARALDEHYDE	100.12	NIST	0.5	0.00355	0.01174	0.00004
111-30-8	GLUTARIC DIALDEHYDE	100.12	NIST	0.5	0.00355	1.17363	0.00416
111-30-8	GLUTERALDEHYDE	100.12	NIST	0.5	0.00355	0.11736	0.00042
111-30-8	GLUTARALDEHYDE	100.12	NIST	0.5	0.00355	0.11736	0.00042
111-30-8	GLUTARALDEHYDE 25% AQUEOUS SOLUTION	100.12	NIST	0.5	0.00355	0.11736	0.00042
111-30-8	GLUTARALDEHYDE SOLUTION	100.12	NIST	0.5	0.00355	0.02934	0.00010
111-42-2	DIETHANOLAMINE	105.1	LBNL Data File	0.0	0.00000	0.53493	0.00000
111-42-2	DIETHANOLAMINE	105.1	LBNL Data File	0.0	0.00000	0.03521	0.00000
111-42-2	DIETHANOLAMINE	105.1	LBNL Data File	0.0	0.00000	0.10699	0.00000
111-42-2	DIETHANOLAMINE	105.1	LBNL Data File	0.0	0.00000	0.53493	0.00000
121-44-8	TRIETHYLAMINE	101	LBNL Data File	48.3	0.38407	0.58682	0.22538
121-44-8	TRIETHYLAMINE	101	LBNL Data File	48.3	0.38407	0.11736	0.04508
121-44-8	TRIETHYLAMINE	101	LBNL Data File	48.3	0.38407	0.01174	0.00451
121-44-8	TRIETHYLAMINE	101	LBNL Data File	48.3	0.38407	0.04030	0.01548
121-44-8	TRIETHYLAMINE	101	LBNL Data File	48.3	0.38407	1.17363	0.45075
121-44-8	TRIETHYLAMINE	101	LBNL Data File	48.3	0.38407	0.11736	0.04508
121-44-8	TRIETHYLAMINE	101	LBNL Data File	48.3	0.38407	0.11736	0.04508
121-44-8	TRIETHYLAMINE	101	LBNL Data File	48.3	0.38407	0.11736	0.04508
121-44-8	TRIETHYLAMINE	101	LBNL Data File	48.3	0.38407	0.58682	0.22538
123-91-1	1,4-DIOXANE ANHYDROUS	88.1	LBNL Data File	31.8	0.22021	1.17363	0.25845
123-91-1	1,4-DIOXANE	88.1	LBNL Data File	31.8	0.22021	1.17363	0.25845
123-91-1	DIOXANE	88.1	LBNL Data File	31.8	0.22021	1.17363	0.25845
123-91-1	1,4-DIOXANE	88.1	LBNL Data File	31.8	0.22021	2.34727	0.51689
123-91-1	1,4 DIOXANE	88.1	LBNL Data File	31.8	0.22021	2.34727	0.51689
123-91-1	1,4 DIOXANE	88.1	LBNL Data File	31.8	0.22021	0.56769	0.12501
123-91-1	1,4-DIOXANE ANHYDROUS	88.1	LBNL Data File	31.8	0.22021	1.17363	0.25845
123-91-1	DIOXANE	88.1	LBNL Data File	31.8	0.22021	1.17363	0.25845
123-91-1	DIOXANE	88.1	LBNL Data File	31.8	0.22021	4.69453	1.03378
123-91-1	DIOXANE	88.1	LBNL Data File	31.8	0.22021	4.69453	1.03378
123-91-1	DIOXANE	88.1	LBNL Data File	31.8	0.22021	0.11736	0.02584
127-18-4	TETRACHLOROETHYLENE	165.8	LBNL Data File	15.2	0.19885	1.17363	0.23337
1330-20-7	XYLENE	106.2	LBNL Data File	6.7	0.05616	1.17363	0.06591
1330-20-7	XYLENE	106.2	LBNL Data File	6.7	0.05616	0.58682	0.03295
1330-20-7	XYLENE	106.2	LBNL Data File	6.7	0.05616	4.69453	0.26363

Calculation of Liquid Chemical Emissions
Phase 1 Laboratory Usage Scenario
Proposed Richmond Bay Campus Long Range Development Plan, Richmond, California

Pouring Emissions Estimates (Table G-4)

S = Saturation Factor = 1.45
VP = Vapor Pressure = Chemical-specific
MW = Molecular Weight = Chemical-specific
T = Ambient Temperature (R) = 532

Loss (grams/liter) = 0.02887 * (S*VP*MW)/T
(limited to 700 g/liter)

This list of chemicals comes from LBNL inventory data with solids & gases removed Must be identical to Chemical Inventory worksheet		*MW entered manually*		*Calculated value from separate worksheet*	*Calculated* **Pouring Loss Emission Factor**	*From separate worksheet* **Annual Usage**	*Calculated* **Annual Emissions**
CAS No.	**Compound Name**	**MW (g/mole)**	**MW Reference**	**VP (@ Ref Temp) (mmHg)**	**(grams/liter)**	**(liters/yr)**	**(grams/yr)**
1330-20-7	XYLENE	106.2	LBNL Data File	6.7	0.05616	0.00587	0.00033
1330-20-7	XYLENE	106.2	LBNL Data File	6.7	0.05616	0.58682	0.03295
1330-20-7	XYLENE	106.2	LBNL Data File	6.7	0.05616	4.44220	0.24946
1330-20-7	XYLENE	106.2	LBNL Data File	6.7	0.05616	4.69453	0.26363
1330-20-7	XYLENE	106.2	LBNL Data File	6.7	0.05616	4.69453	0.26363
1330-20-7	XYLENE	106.2	LBNL Data File	6.7	0.05616	0.58682	0.03295
1330-20-7	XYLENE	106.2	LBNL Data File	6.7	0.05616	0.58682	0.03295
1330-20-7	XYLENE	106.2	LBNL Data File	6.7	0.05616	0.58682	0.03295
1330-20-7	XYLENE	106.2	LBNL Data File	6.7	0.05616	4.44220	0.24946
1330-20-7	XYLENE	106.2	LBNL Data File	6.7	0.05616	4.69453	0.26363
1330-20-7	XYLENES	106.2	LBNL Data File	6.7	0.05616	0.58682	0.03295
1330-20-7	XYLENE	106.2	LBNL Data File	6.7	0.05616	0.00136	0.00008
1330-20-7	XYLENE	106.2	LBNL Data File	6.7	0.05616	0.58682	0.03295
1330-20-7	XYLENE	106.2	LBNL Data File	6.7	0.05616	4.69453	0.26363
1330-20-7	DEPEX MOUNTING MEDIA	106.2	LBNL Data File	6.7	0.05616	0.11736	0.00659
1634-04-4	METHYL TERT-BUTYL ETHER	88.15	LBNL Data File	120.2	0.83405	4.69453	3.91549
1634-04-4	METHYL TERT-BUTYL ETHER	88.15	LBNL Data File	120.2	0.83405	0.11736	0.09789
7647-01-0	HYDROCHLORIC ACID STANDARD SOLUTION	36.47	LBNL Data File	190.0	0.54525	1.17363	0.63992
7647-01-0	HCL	36.47	LBNL Data File	190.0	0.54525	0.05868	0.03200
7647-01-0	HYDROCHLORIC ACID	36.47	LBNL Data File	190.0	0.54525	1.17363	0.63992
7647-01-0	HYDROCHLORIC ACID	36.47	LBNL Data File	190.0	0.54525	1.17363	0.63992
7647-01-0	HYDROCHLORIC ACID	36.47	LBNL Data File	190.0	0.54525	1.17363	0.63992
7647-01-0	HYDROCHLORIC ACID	36.47	LBNL Data File	190.0	0.54525	1.17363	0.63992
7647-01-0	HYDROCHLORIC ACID	36.47	LBNL Data File	190.0	0.54525	1.17363	0.63992
7647-01-0	HYDROCHLORIC ACID	36.47	LBNL Data File	190.0	0.54525	0.58682	0.31996
7647-01-0	HYDROCHLORIC ACID	36.47	LBNL Data File	190.0	0.54525	4.69453	2.55968
7647-01-0	HYDROCHLORIC ACID	36.47	LBNL Data File	190.0	0.54525	4.69453	2.55968
7647-01-0	HYDROCHLORIC ACID	36.47	LBNL Data File	190.0	0.54525	4.69453	2.55968
7647-01-0	HYDROCHLORIC ACID	36.47	LBNL Data File	190.0	0.54525	4.69453	2.55968
7647-01-0	HYDROCHLORIC ACID	36.47	LBNL Data File	190.0	0.54525	4.69453	2.55968
7647-01-0	HYDROCHLORIC ACID	36.47	LBNL Data File	190.0	0.54525	0.58682	0.31996
7647-01-0	HYDROCHLORIC ACID	36.47	LBNL Data File	190.0	0.54525	2.93408	1.59980
7647-01-0	HYDROCHLORIC ACID	36.47	LBNL Data File	190.0	0.54525	1.17363	0.63992
7647-01-0	HYDROCHLORIC ACID	36.47	LBNL Data File	190.0	0.54525	0.58682	0.31996

Calculation of Liquid Chemical Emissions
Phase 1 Laboratory Usage Scenario
Proposed Richmond Bay Campus Long Range Development Plan, Richmond, California

Pouring Emissions Estimates (Table G-4)

S = Saturation Factor = 1.45
VP = Vapor Pressure = Chemical-specific
MW = Molecular Weight = Chemical-specific
T = Ambient Temperature (R) = 532

Loss (grams/liter) = 0.02887 * (S*VP*MW)/T
(limited to 700 g/liter)

This list of chemicals comes from LBNL inventory data with solids & gases removed Must be identical to Chemical Inventory worksheet		*MW entered manually*		*Calculated value from separate worksheet*	*Calculated* **Pouring Loss Emission Factor (grams/liter)**	*From separate worksheet* **Annual Usage (liters/yr)**	*Calculated* **Annual Emissions (grams/yr)**
CAS No.	**Compound Name**	**MW (g/mole)**	**MW Reference**	**VP (@ Ref Temp) (mmHg)**			
7647-01-0	HYDROCHLORIC ACID	36.47	LBNL Data File	190.0	0.54525	1.17363	0.63992
7647-01-0	HYDROCHLORIC ACID	36.47	LBNL Data File	190.0	0.54525	1.17363	0.63992
7647-01-0	HYDROCHLORIC ACID	36.47	LBNL Data File	190.0	0.54525	1.17363	0.63992
7647-01-0	HYDROCHLORIC ACID	36.47	LBNL Data File	190.0	0.54525	2.93408	1.59980
7647-01-0	HYDROCHLORIC ACID	36.47	LBNL Data File	190.0	0.54525	2.93408	1.59980
7647-01-0	HYDROCHLORIC ACID	36.47	LBNL Data File	190.0	0.54525	2.93408	1.59980
7647-01-0	HYDROCHLORIC ACID	36.47	LBNL Data File	190.0	0.54525	2.93408	1.59980
7647-01-0	HYDROCHLORIC ACID	36.47	LBNL Data File	190.0	0.54525	2.93408	1.59980
7647-01-0	HYDROCHLORIC ACID	36.47	LBNL Data File	190.0	0.54525	2.93408	1.59980
7647-01-0	HYDROCHLORIC ACID	36.47	LBNL Data File	190.0	0.54525	0.58682	0.31996
7647-01-0	HYDROCHLORIC ACID SOLUTION	36.47	LBNL Data File	190.0	0.54525	0.11736	0.06399
7647-01-0	HYDROCHLORIC ACID	36.47	LBNL Data File	190.0	0.54525	0.11736	0.06399
7647-01-0	HYDROCHLORIC ACID	36.47	LBNL Data File	190.0	0.54525	0.58682	0.31996
7647-01-0	HYDROCHLORIC ACID	36.47	LBNL Data File	190.0	0.54525	0.58682	0.31996
7647-01-0	HYDROCHLORIC ACID	36.47	LBNL Data File	190.0	0.54525	0.11736	0.06399
7647-01-0	HYDROCHLORIC ACID	36.47	LBNL Data File	190.0	0.54525	1.17363	0.63992
7647-01-0	HYDROCHLORIC ACID	36.47	LBNL Data File	190.0	0.54525	0.58682	0.31996
7647-01-0	HYDROCHLORIC ACID	36.47	LBNL Data File	190.0	0.54525	1.17363	0.63992
7647-01-0	HYDROCHLORIC ACID	36.47	LBNL Data File	190.0	0.54525	4.69453	2.55968
7647-01-0	HYDROCHLORIC ACID	36.47	LBNL Data File	190.0	0.54525	4.69453	2.55968
7647-01-0	HYDROCHLORIC ACID	36.47	LBNL Data File	190.0	0.54525	4.69453	2.55968
7647-01-0	HYDROCHLORIC ACID	36.47	LBNL Data File	190.0	0.54525	4.69453	2.55968
7647-01-0	HYDROCHLORIC ACID	36.47	LBNL Data File	190.0	0.54525	4.69453	2.55968
7647-01-0	HYDROCHLORIC ACID	36.47	LBNL Data File	190.0	0.54525	0.58682	0.31996
7647-01-0	HYDROCHLORIC ACID	36.47	LBNL Data File	190.0	0.54525	0.58682	0.31996
7647-01-0	HYDROCHLORIC ACID SOLUTION	36.47	LBNL Data File	190.0	0.54525	0.58682	0.31996
7647-01-0	HYDROCHLORIC ACID	36.47	LBNL Data File	190.0	0.54525	0.58682	0.31996
7647-01-0	HYDROCHLORIC ACID	36.47	LBNL Data File	190.0	0.54525	0.58682	0.31996
7647-01-0	HYDROCHLORIC ACID	36.47	LBNL Data File	190.0	0.54525	1.17363	0.63992
7647-01-0	HYDROCHLORIC ACID	36.47	LBNL Data File	190.0	0.54525	0.00117	0.00064
7647-01-0	HYDROCHLORIC ACID	36.47	LBNL Data File	190.0	0.54525	2.93408	1.59980
7647-01-0	HYDROCHLORIC ACID	36.47	LBNL Data File	190.0	0.54525	2.93408	1.59980
7647-01-0	HYDROCHLORIC ACID	36.47	LBNL Data File	190.0	0.54525	2.93408	1.59980
7647-01-0	IMIDAZOLERIC ACID	36.47	LBNL Data File	190.0	0.54525	24.45070	13.33165

Calculation of Liquid Chemical Emissions
Phase 1 Laboratory Usage Scenario
Proposed Richmond Bay Campus Long Range Development Plan, Richmond, California

Pouring Emissions Estimates (Table G-4)

S = Saturation Factor = 1.45
VP = Vapor Pressure = Chemical-specific
MW = Molecular Weight = Chemical-specific
T = Ambient Temperature (R) = 532

Loss (grams/liter) = 0.02887 * (S*VP*MW)/T
(limited to 700 g/liter)

This list of chemicals comes from LBNL inventory data with solids & gases removed Must be identical to Chemical Inventory worksheet		*MW entered manually*		*Calculated value from separate worksheet*	*Calculated* **Pouring Loss Emission Factor**	*From separate worksheet* **Annual Usage**	*Calculated* **Annual Emissions**
CAS No.	**Compound Name**	**MW (g/mole)**	**MW Reference**	**VP (@ Ref Temp) (mmHg)**	**(grams/liter)**	**(liters/yr)**	**(grams/yr)**
7647-01-0	HYDROCHLORIC ACID	36.47	LBNL Data File	190.0	0.54525	2.93408	1.59980
7647-01-0	HYDROCHLORIC ACID	36.47	LBNL Data File	190.0	0.54525	0.58682	0.31996
7647-01-0	HYDROCHLORIC ACID	36.47	LBNL Data File	190.0	0.54525	2.93408	1.59980
7647-01-0	HYDROCHLORIC ACID	36.47	LBNL Data File	190.0	0.54525	0.58682	0.31996
7647-01-0	HYDROCHLORIC ACID	36.47	LBNL Data File	190.0	0.54525	2.93408	1.59980
7647-01-0	HYDROCHLORIC ACID	36.47	LBNL Data File	190.0	0.54525	2.93408	1.59980
7647-01-0	HCL	36.47	LBNL Data File	190.0	0.54525	0.58682	0.31996
7647-01-0	HYDROCHLORIC ACID	36.47	LBNL Data File	190.0	0.54525	0.58682	0.31996
7647-01-0	HYDROCHLORIC ACID	36.47	LBNL Data File	190.0	0.54525	0.58682	0.31996
7647-01-0	HYDROCHLORIC ACID	36.47	LBNL Data File	190.0	0.54525	0.58682	0.31996
7647-01-0	HYDROCHLORIC ACID	36.47	LBNL Data File	190.0	0.54525	0.58682	0.31996
7647-01-0	DECAFLUORO-1,1,2,2-TERAHYDROOCTYL)TRICHLOROSI	36.47	LBNL Data File	190.0	0.54525	48.90139	26.66329
7647-01-0	HCL	36.47	LBNL Data File	190.0	0.54525	0.58682	0.31996
7647-01-0	HCL	36.47	LBNL Data File	190.0	0.54525	0.58682	0.31996
7647-01-0	HYDROCHLORIC ACID	36.47	LBNL Data File	190.0	0.54525	0.58682	0.31996
7647-01-0	HYDROCHLORIC ACID	36.47	LBNL Data File	190.0	0.54525	0.58682	0.31996
7647-01-0	HYDROCHLORIC ACID	36.47	LBNL Data File	190.0	0.54525	0.58682	0.31996
7647-01-0	HYDROCHLORIC ACID	36.47	LBNL Data File	190.0	0.54525	2.93408	1.59980
7647-01-0	HYDROCHLORIC ACID	36.47	LBNL Data File	190.0	0.54525	2.93408	1.59980
7647-01-0	HYDROCHLORIC ACID	36.47	LBNL Data File	190.0	0.54525	2.93408	1.59980
7647-01-0	HYDROCHLORIC ACID	36.47	LBNL Data File	190.0	0.54525	0.58682	0.31996
7647-01-0	HYDROCHLORIC ACID	36.47	LBNL Data File	190.0	0.54525	26.65322	14.53256
7647-01-0	HYDROCHLORIC ACID	36.47	LBNL Data File	190.0	0.54525	0.58682	0.31996
7647-01-0	HYDROCHLORIC ACID	36.47	LBNL Data File	190.0	0.54525	4.44220	2.42209
7647-01-0	HYDROCHLORIC ACID	36.47	LBNL Data File	190.0	0.54525	0.11736	0.06399
7647-01-0	HYDROCHLORIC ACID	36.47	LBNL Data File	190.0	0.54525	0.58682	0.31996
7647-01-0	HYDROCHLORIC ACID	36.47	LBNL Data File	190.0	0.54525	0.11736	0.06399
7647-01-0	HYDROCHLORIC ACID	36.47	LBNL Data File	190.0	0.54525	0.58682	0.31996
7647-01-0	HYDROCHLORIC ACID	36.47	LBNL Data File	190.0	0.54525	0.58682	0.31996
7647-01-0	HYDROCHLORIC ACID	36.47	LBNL Data File	190.0	0.54525	0.58682	0.31996
7647-01-0	HYDROCHLORIC ACID	36.47	LBNL Data File	190.0	0.54525	0.00352	0.00192
7647-01-0	HYDROCHLORIC ACID	36.47	LBNL Data File	190.0	0.54525	2.93408	1.59980
7647-01-0	HYDROCHLORIC ACID	36.47	LBNL Data File	190.0	0.54525	0.58682	0.31996
7647-01-0	HYDROCHLORIC ACID	36.47	LBNL Data File	190.0	0.54525	0.58682	0.31996

Calculation of Liquid Chemical Emissions
Phase 1 Laboratory Usage Scenario
Proposed Richmond Bay Campus Long Range Development Plan, Richmond, California

Pouring Emissions Estimates (Table G-4)

S = Saturation Factor = 1.45
VP = Vapor Pressure = Chemical-specific
MW = Molecular Weight = Chemical-specific
T = Ambient Temperature (R) = 532

Loss (grams/liter) = 0.02887 * (S*VP*MW)/T
(limited to 700 g/liter)

This list of chemicals comes from LBNL inventory data with solids & gases removed Must be identical to Chemical Inventory worksheet		*MW entered manually*		*Calculated value from separate worksheet*	*Calculated* **Pouring Loss Emission Factor**	*From separate worksheet* **Annual Usage**	*Calculated* **Annual Emissions**
CAS No.	**Compound Name**	**MW (g/mole)**	**MW Reference**	**VP (@ Ref Temp) (mmHg)**	**(grams/liter)**	**(liters/yr)**	**(grams/yr)**
7647-01-0	HYDROCHLORIC ACID	36.47	LBNL Data File	190.0	0.54525	2.93408	1.59980
7647-01-0	HYDROCHLORIC ACID	36.47	LBNL Data File	190.0	0.54525	0.58682	0.31996
7647-01-0	HYDROCHLORIC ACID	36.47	LBNL Data File	190.0	0.54525	0.58682	0.31996
7647-01-0	HYDROCHLORIC ACID	36.47	LBNL Data File	190.0	0.54525	0.58682	0.31996
7647-01-0	HYDROCHLORIC ACID	36.47	LBNL Data File	190.0	0.54525	0.58682	0.31996
7647-01-0	HYDROCHLORIC ACID	36.47	LBNL Data File	190.0	0.54525	4.69453	2.55968
7664-38-2	BIO-SAFE COOMASSIE	98.04	LBNL Data File	0.0	0.00023	1.17363	0.00027
7664-38-2	BIO-SAFE COOMASSIE	98.04	LBNL Data File	0.0	0.00023	1.17363	0.00027
7664-38-2	BIO-SAFE COOMASSIE	98.04	LBNL Data File	0.0	0.00023	1.17363	0.00027
7664-38-2	BIO-SAFE COOMASSIE	98.04	LBNL Data File	0.0	0.00023	1.17363	0.00027
7664-38-2	PHOSPHORIC ACID	98.04	LBNL Data File	0.0	0.00023	0.06965	0.00002
7664-38-2	PHOSPHORIC ACID	98.04	LBNL Data File	0.0	0.00023	0.52814	0.00012
7664-38-2	PHOSPHORIC ACID	98.04	LBNL Data File	0.0	0.00023	0.58682	0.00014
7664-38-2	LPH SE GERMICIDAL DETERGENT	98.04	LBNL Data File	0.0	0.00023	4.44220	0.00103
7664-38-2	PHOSPHORIC ACID	98.04	LBNL Data File	0.0	0.00023	0.58682	0.00014
7664-38-2	PHOSPHORIC ACID	98.04	LBNL Data File	0.0	0.00023	0.58682	0.00014
7664-38-2	PHOSPHORIC ACID	98.04	LBNL Data File	0.0	0.00023	0.58682	0.00014
7664-38-2	PHOSPHORIC ACID	98.04	LBNL Data File	0.0	0.00023	6.96518	0.00161
7664-38-2	PHOSPHORIC ACID	98.04	LBNL Data File	0.0	0.00023	0.58682	0.00014
7664-38-2	PHOSPHORIC ACID	98.04	LBNL Data File	0.0	0.00023	2.93408	0.00068
7664-38-2	PHOSPHORIC ACID	98.04	LBNL Data File	0.0	0.00023	6.96518	0.00161
7664-38-2	PHOSPHORIC ACID	98.04	LBNL Data File	0.0	0.00023	0.58682	0.00014
7664-38-2	PHOSPHORIC ACID	98.04	LBNL Data File	0.0	0.00023	0.06965	0.00002
7664-38-2	PHOSPHORIC ACID	98.04	LBNL Data File	0.0	0.00023	0.58682	0.00014
7664-38-2	PHOSPHORIC ACID	98.04	LBNL Data File	0.0	0.00023	0.58682	0.00014
7664-38-2	PHOSPHORIC ACID	98.04	LBNL Data File	0.0	0.00023	0.52814	0.00012
7664-38-2	O-PHOSPHORIC ACID	98.04	LBNL Data File	0.0	0.00023	1.17363	0.00027
7664-38-2	PHOSPHORIC ACID	98.04	LBNL Data File	0.0	0.00023	0.58682	0.00014
7664-38-2	E REAGENT CONCENTRATE (PHOSPHAIC ACID/METHAN	98.04	LBNL Data File	0.0	0.00023	0.52814	0.00012
7664-38-2	PHOSPHORIC ACID	98.04	LBNL Data File	0.0	0.00023	0.58682	0.00014
7664-38-2	5'-MONOPHOSPHORIC ACID	98.04	LBNL Data File	0.0	0.00023	0.00035	0.00000
7664-38-2	PHOSPHORIC ACID	98.04	LBNL Data File	0.0	0.00023	0.58682	0.00014
7664-38-2	PHOSPHORIC ACID	98.04	LBNL Data File	0.0	0.00023	0.06965	0.00002
7664-38-2	PHOSPHORIC ACID	98.04	LBNL Data File	0.0	0.00023	0.06965	0.00002

Calculation of Liquid Chemical Emissions
Phase 1 Laboratory Usage Scenario
Proposed Richmond Bay Campus Long Range Development Plan, Richmond, California

Pouring Emissions Estimates (Table G-4)

S = Saturation Factor = 1.45
VP = Vapor Pressure = Chemical-specific
MW = Molecular Weight = Chemical-specific
T = Ambient Temperature (R) = 532

Loss (grams/liter) = 0.02887 * (S*VP*MW)/T
(limited to 700 g/liter)

This list of chemicals comes from LBNL inventory data with solids & gases removed Must be identical to Chemical Inventory worksheet		*MW entered manually*		*Calculated value from separate worksheet*	*Calculated* **Pouring Loss Emission Factor (grams/liter)**	*From separate worksheet* **Annual Usage (liters/yr)**	*Calculated* **Annual Emissions (grams/yr)**
CAS No.	**Compound Name**	**MW (g/mole)**	**MW Reference**	**VP (@ Ref Temp) (mmHg)**			
7664-38-2	PHOSPHORIC ACID	98.04	LBNL Data File	0.0	0.00023	0.34826	0.00008
7664-38-2	PHOSPORIC ACID	98.04	LBNL Data File	0.0	0.00023	0.05868	0.00001
7664-38-2	PHOSPHORIC ACID	98.04	LBNL Data File	0.0	0.00023	0.58682	0.00014
7664-39-3	HYDROFLUORIC ACID	20.01	LBNL Data File	25.0	0.03936	0.58682	0.02310
7664-93-9	SULFURIC ACID	98.08	NIST	1.0	0.00772	0.11736	0.00091
7664-93-9	SULFURIC ACID	98.08	NIST	1.0	0.00772	1.17363	0.00906
7664-93-9	SULFURIC ACID	98.08	NIST	1.0	0.00772	1.17363	0.00906
7664-93-9	SULFURIC ACID	98.08	NIST	1.0	0.00772	1.17363	0.00906
7664-93-9	SULFURIC ACID	98.08	NIST	1.0	0.00772	0.58682	0.00453
7664-93-9	SULFURIC ACID	98.08	NIST	1.0	0.00772	0.58682	0.00453
7664-93-9	SULFURIC ACID	98.08	NIST	1.0	0.00772	0.58682	0.00453
7664-93-9	SULFURIC ACID	98.08	NIST	1.0	0.00772	0.58682	0.00453
7664-93-9	SULFURIC ACID	98.08	NIST	1.0	0.00772	0.58682	0.00453
7664-93-9	SULFURIC ACID	98.08	NIST	1.0	0.00772	0.58682	0.00453
7664-93-9	SULFURIC ACID	98.08	NIST	1.0	0.00772	0.58682	0.00453
7664-93-9	SULFURIC ACID	98.08	NIST	1.0	0.00772	4.69453	0.03623
7664-93-9	FISHER CLEANING SOLUTION	98.08	NIST	1.0	0.00772	0.58682	0.00453
7664-93-9	SULFURIC ACID	98.08	NIST	1.0	0.00772	1.17363	0.00906
7664-93-9	SULFURIC ACID	98.08	NIST	1.0	0.00772	0.11736	0.00091
7664-93-9	SULFURIC ACID	98.08	NIST	1.0	0.00772	1.17363	0.00906
7664-93-9	SULFURIC ACID	98.08	NIST	1.0	0.00772	0.58682	0.00453
7664-93-9	SULFURIC ACID	98.08	NIST	1.0	0.00772	0.05868	0.00045
7664-93-9	SULFURIC ACID	98.08	NIST	1.0	0.00772	2.93408	0.02264
7664-93-9	SULFURIC ACID	98.08	NIST	1.0	0.00772	0.11736	0.00091
7664-93-9	SULFURIC ACID	98.08	NIST	1.0	0.00772	0.11736	0.00091
7664-93-9	SULFURIC ACID	98.08	NIST	1.0	0.00772	2.93408	0.02264
7664-93-9	SULFURIC ACID	98.08	NIST	1.0	0.00772	0.58682	0.00453
7664-93-9	SULFURIC ACID	98.08	NIST	1.0	0.00772	0.58682	0.00453
7664-93-9	SULFURIC ACID	98.08	NIST	1.0	0.00772	5.86817	0.04529
7664-93-9	SULFURIC ACID	98.08	NIST	1.0	0.00772	3.80844	0.02939
7664-93-9	SULFURIC ACID	98.08	NIST	1.0	0.00772	2.93408	0.02264
7697-37-2	NITRIC ACID	63.02	LBNL Data File	48.0	0.23803	2.93408	0.69839
7697-37-2	NITRIC ACID	63.02	LBNL Data File	48.0	0.23803	2.93408	0.69839
7697-37-2	NITRIC ACID	63.02	LBNL Data File	48.0	0.23803	2.93408	0.69839

Calculation of Liquid Chemical Emissions
Phase 1 Laboratory Usage Scenario
Proposed Richmond Bay Campus Long Range Development Plan, Richmond, California

Pouring Emissions Estimates (Table G-4)

S = Saturation Factor = 1.45
VP = Vapor Pressure = Chemical-specific
MW = Molecular Weight = Chemical-specific
T = Ambient Temperature (R) = 532

Loss (grams/liter) = 0.02887 * (S*VP*MW)/T
(limited to 700 g/liter)

This list of chemicals comes from LBNL inventory data with solids & gases removed Must be identical to Chemical Inventory worksheet		*MW entered manually*		*Calculated value from separate worksheet*	*Calculated*	*From separate worksheet*	*Calculated*
CAS No.	**Compound Name**	**MW (g/mole)**	**MW Reference**	**VP (@ Ref Temp) (mmHg)**	**Pouring Loss Emission Factor (grams/liter)**	**Annual Usage (liters/yr)**	**Annual Emissions (grams/yr)**
7697-37-2	NITRIC ACID	63.02	LBNL Data File	48.0	0.23803	2.93408	0.69839
7697-37-2	NITRIC ACID	63.02	LBNL Data File	48.0	0.23803	0.58682	0.13968
7697-37-2	NITRIC ACID	63.02	LBNL Data File	48.0	0.23803	0.58682	0.13968
7726-95-6	BROMINE	159.8	LBNL Data File	188.1	2.36538	0.00188	0.00445

Calculation of Liquid Chemical Emissions
Phase 1 Laboratory Usage Scenario
Proposed Richmond Bay Campus Long Range Development Plan, Richmond, California
Emissions from Evaporation During Use (Table G-5)

A = Surface Area (cm^2) = 100
U = Wind Speed (m/s) = 0.51
MW = Molecular Weight (g/mole) = Chemical-specific
VP = Vapor Pressure (mmHg) = Chemical-specific
R = Gas Constant (atm-cm^3/mole-deg K) = 82.05
T = Ambient Temperature (K) = 295

Loss (grams/batch) = $(4.120*A*U^{0.78}*MW^{0.67}*VP)/(R*T)$

This list of chemicals comes from merging the purchase and inventory lists Must be identical to Total Usage worksheet		*MW entered manually*		*From previous worksheet*	*From previous worksheet*	*Calculated*	*Calculated*
CAS No.	**Compound Name**	**MW (g/mole)**	**MW Reference**	**Adjusted Vapor Pressure (mmHg)**	**Assumed No. of Batches (per yr)**	**Estimated Loss Emission Factor (grams/batch)**	**Estimated Emissions (grams/yr)**
50-00-0	NORTHERNMAX DENATURING GEL BUFFER	30.03	LBNL Data File	100	10	9.837	98.37
50-00-0	FORMALDEHYDE	30.03	LBNL Data File	100	10	9.837	98.37
50-00-0	FORMALDEHYDE	30.03	LBNL Data File	100	10	9.837	98.37
50-00-0	FORMALDEHYDE SOLUTION	30.03	LBNL Data File	100	10	9.837	98.37
50-00-0	FORMALDEHYDE	30.03	LBNL Data File	100	10	9.837	98.37
50-00-0	FORMALDEHYDE	30.03	LBNL Data File	100	10	9.837	98.37
50-00-0	FORMALDEHYDE SOLUTION	30.03	LBNL Data File	100	5	9.837	17.49
50-00-0	FORMALDEHYDE	30.03	LBNL Data File	100	5	9.837	17.49
50-00-0	FORMALDEHYDE	30.03	LBNL Data File	100	5	9.837	17.49
50-00-0	FORMALDEHYDE	30.03	LBNL Data File	100	5	9.837	17.49
50-00-0	FORMALDEHYDE	30.03	LBNL Data File	100	5	9.837	17.49
50-00-0	FORMALDEHYDE	30.03	LBNL Data File	100	5	9.837	17.49
50-00-0	FORMALDEHYDE	30.03	LBNL Data File	100	5	9.837	17.49
50-00-0	FORMALDEHYDE	30.03	LBNL Data File	100	5	9.837	17.49
50-00-0	FORMALDEHYDE	30.03	LBNL Data File	100	5	9.837	17.49
50-00-0	FORMALDEHYDE	30.03	LBNL Data File	100	5	9.837	17.49
50-00-0	FORMALDEHYDE	30.03	LBNL Data File	100	5	9.837	17.49
50-00-0	FORMALDEHYDE	30.03	LBNL Data File	100	5	9.837	17.49
50-00-0	FORMALDEHYDE	30.03	LBNL Data File	100	5	9.837	17.49
50-00-0	FORMALDEHYDE	30.03	LBNL Data File	100	10	9.837	98.37
50-00-0	FORMALDEHYDE	30.03	LBNL Data File	100	10	9.837	98.37
50-00-0	FORMALDEHYDE	30.03	LBNL Data File	100	10	9.837	98.37
50-00-0	FORMALDEHYDE	30.03	LBNL Data File	100	10	9.837	98.37
50-00-0	FORMALDEHYDE	30.03	LBNL Data File	100	10	9.837	98.37
50-00-0	FORMALDEHYDE	30.03	LBNL Data File	100	5	9.837	17.49
50-00-0	FORMALDEHYDE	30.03	LBNL Data File	100	5	9.837	17.49
50-00-0	FORMALDEHYDE	30.03	LBNL Data File	100	5	9.837	17.49
50-00-0	FORMALDEHYDE	30.03	LBNL Data File	100	5	9.837	17.49
50-00-0	FORMALDEHYDE	30.03	LBNL Data File	100	5	9.837	17.49
50-00-0	FORMALDEHYDE	30.03	LBNL Data File	100	5	9.837	17.49
50-00-0	FORMALDEHYDE	30.03	LBNL Data File	100	5	9.837	17.49
50-00-0	FORMALDEHYDE	30.03	LBNL Data File	100	5	9.837	17.49
50-00-0	FORMALDEHYDE	30.03	LBNL Data File	100	5	9.837	17.49
50-00-0	FORMALDEHYDE	30.03	LBNL Data File	100	5	9.837	17.49
50-00-0	FORMALDEHYDE SOLUTION	30.03	LBNL Data File	100	10	9.837	98.37
50-00-0	FORMALDEHYDE	30.03	LBNL Data File	100	5	9.837	17.49
50-00-0	FORMALDEHYDE	30.03	LBNL Data File	100	5	9.837	17.49
50-00-0	FORMALDEHYDE	30.03	LBNL Data File	100	5	9.837	17.49
50-00-0	FORMALDEHYDE	30.03	LBNL Data File	100	5	9.837	17.49
50-00-0	FORMALDEHYDE	30.03	LBNL Data File	100	5	9.837	17.49
50-00-0	FORMALDEHYDE	30.03	LBNL Data File	100	5	9.837	17.49
50-00-0	FORMALDEHYDE SOLUTION	30.03	LBNL Data File	100	5	9.837	17.49
50-00-0	FORMALDEHYDE	30.03	LBNL Data File	100	10	9.837	98.37
50-00-0	FORMALDEHYDE	30.03	LBNL Data File	100	10	9.837	98.37
50-00-0	FORMALDEHYDE	30.03	LBNL Data File	100	10	9.837	98.37
50-00-0	FORMALDEHYDE	30.03	LBNL Data File	100	10	9.837	98.37
50-00-0	FORMALDEHYDE SOLUTION	30.03	LBNL Data File	100	10	9.837	98.37
50-00-0	FORMALDEHYDE SOLUTION	30.03	LBNL Data File	100	10	9.837	98.37
50-00-0	FORMALDEHYDE SOLUTION	30.03	LBNL Data File	100	10	9.837	98.37
50-00-0	FORMALDEHYDE SOLUTION	30.03	LBNL Data File	100	10	9.837	98.37
50-00-0	FORMALDEHYDE	30.03	LBNL Data File	100	10	9.837	69.95
50-00-0	NORTHERNMAX DENATURING GEL BUFFER	30.03	LBNL Data File	100	10	9.837	98.37
50-00-0	FORMALDEHYDE	30.03	LBNL Data File	100	10	9.837	69.95
50-00-0	FORMALDEHYDE	30.03	LBNL Data File	100	10	9.837	69.95
50-00-0	FORMALDEHYDE	30.03	LBNL Data File	100	10	9.837	69.95
50-00-0	FORMALDEHYDE	30.03	LBNL Data File	100	10	9.837	69.95
50-00-0	FORMALDEHYDE	30.03	LBNL Data File	100	10	9.837	98.37
50-00-0	FORMALIN SOLUTION 10%, NEUTRAL BUFFERED	30.03	LBNL Data File	100	25	9.837	245.93
50-00-0	FORMALIN SOLUTION 10%, NEUTRAL BUFFERED	30.03	LBNL Data File	100	25	9.837	245.93
50-00-0	FORMALIN SOLUTION 10%, NEUTRAL BUFFERED	30.03	LBNL Data File	100	25	9.837	245.93
50-00-0	FORMALDEHYDE	30.03	LBNL Data File	100	10	9.837	98.37
50-00-0	FORMALDEHYDE	30.03	LBNL Data File	100	10	9.837	98.37
50-00-0	FORMALDEHYDE	30.03	LBNL Data File	100	10	9.837	98.37
50-00-0	FORMALDEHYDE	30.03	LBNL Data File	100	10	9.837	98.37
50-00-0	FORMALIN	30.03	LBNL Data File	100	10	9.837	83.94
50-00-0	FORMALDEHYDE	30.03	LBNL Data File	100	10	9.837	83.94
50-00-0	FORMALDEHYDE	30.03	LBNL Data File	100	10	9.837	83.94
50-00-0	FORMALDEHYDE	30.03	LBNL Data File	100	10	9.837	83.94
50-00-0	FORMALDEHYDE	30.03	LBNL Data File	100	10	9.837	83.94
50-00-0	FORMALDEHYDE	30.03	LBNL Data File	100	10	9.837	83.94
50-00-0	FORMALDEHYDE	30.03	LBNL Data File	100	10	9.837	83.94
50-00-0	FORMALDEHYDE	30.03	LBNL Data File	100	10	9.837	83.94
50-00-0	FORMALDEHYDE	30.03	LBNL Data File	100	10	9.837	83.94
50-00-0	FORMALDEHYDE	30.03	LBNL Data File	100	10	9.837	83.94

Calculation of Liquid Chemical Emissions
Phase 1 Laboratory Usage Scenario
Proposed Richmond Bay Campus Long Range Development Plan, Richmond, California
Emissions from Evaporation During Use (Table G-5)

A = Surface Area (cm^2) = 100
U = Wind Speed (m/s) = 0.51
MW = Molecular Weight (g/mole) = Chemical-specific
VP = Vapor Pressure (mmHg) = Chemical-specific
R = Gas Constant (atm-cm^3/mole-deg K) = 82.05
T = Ambient Temperature (K) = 295

Loss (grams/batch) = $(4.120*A*U^{0.78}*MW^{0.67}*VP)/(R*T)$

This list of chemicals comes from merging the purchase and inventory lists Must be identical to Total Usage worksheet		*MW entered manually*		*From previous worksheet*	*From previous worksheet*	*Calculated*	*Calculated*
CAS No.	**Compound Name**	**MW (g/mole)**	**MW Reference**	**Adjusted Vapor Pressure (mmHg)**	**Assumed No. of Batches (per yr)**	**Estimated Loss Emission Factor (grams/batch)**	**Estimated Emissions (grams/yr)**
50-00-0	FORMALDEHYDE	30.03	LBNL Data File	100	10	9.837	83.94
50-00-0	FORMALDEHYDE	30.03	LBNL Data File	100	10	9.837	83.94
50-00-0	FORMALDEHYDE	30.03	LBNL Data File	100	10	9.837	83.94
50-00-0	FORMALDEHYDE	30.03	LBNL Data File	100	10	9.837	83.94
50-00-0	FORMALDEHYDE	30.03	LBNL Data File	100	10	9.837	83.94
50-00-0	FORMALDEHYDE	30.03	LBNL Data File	100	25	9.837	245.93
50-00-0	FORMALDEHYDE	30.03	LBNL Data File	100	25	9.837	245.93
50-00-0	FORMALIN SOLUTION 10%, NEUTRAL BUFFERED	30.03	LBNL Data File	100	5	9.837	10.49
50-00-0	FORMALIN SOLUTION 10%, NEUTRAL BUFFERED	30.03	LBNL Data File	100	5	9.837	10.49
50-00-0	FORMALIN SOLUTION 10%, NEUTRAL BUFFERED	30.03	LBNL Data File	100	5	9.837	10.49
50-00-0	FORMALIN SOLUTION 10%, NEUTRAL BUFFERED	30.03	LBNL Data File	100	5	9.837	10.49
50-00-0	FORMALIN SOLUTION 10%, NEUTRAL BUFFERED	30.03	LBNL Data File	100	5	9.837	10.49
50-00-0	FORMALIN SOLUTION 10%, NEUTRAL BUFFERED	30.03	LBNL Data File	100	5	9.837	10.49
50-00-0	FORMALINE SOLUTION ACCUSTAIN 10%	30.03	LBNL Data File	100	10	9.837	83.94
50-00-0	FORMALDEHYDE	30.03	LBNL Data File	100	10	9.837	98.37
50-00-0	FORMALDEHYDE	30.03	LBNL Data File	100	10	9.837	98.37
50-00-0	FORMALDEHYDE	30.03	LBNL Data File	100	10	9.837	98.37
50-00-0	FORMALDEHYDE	30.03	LBNL Data File	100	10	9.837	98.37
50-00-0	FORMALDEHYDE	30.03	LBNL Data File	100	5	9.837	17.49
50-00-0	FORMALINE SOLUTION ACCUSTAIN 10%	30.03	LBNL Data File	100	5	9.837	34.98
50-00-0	NORTHERNMAX DENATURING GEL BUFFER	30.03	LBNL Data File	100	10	9.837	98.37
50-00-0	FORMALDEHYDE SOLUTION	30.03	LBNL Data File	100	10	9.837	98.37
50-00-0	FORMALDEHYDE	30.03	LBNL Data File	100	10	9.837	98.37
50-00-0	FORMALDEHYDE SOLUTION	30.03	LBNL Data File	100	10	9.837	98.37
50-00-0	FORMALDEHYDE SOLUTION	30.03	LBNL Data File	100	10	9.837	98.37
50-00-0	FORMALDEHYDE	30.03	LBNL Data File	100	10	9.837	98.37
50-00-0	FORMALDEHYDE SOLUTION	30.03	LBNL Data File	100	10	9.837	98.37
50-00-0	FORMALDEHYDE	30.03	LBNL Data File	100	10	9.837	69.95
50-00-0	FORMALDEHYDE	30.03	LBNL Data File	100	10	9.837	69.95
50-00-0	FORMALDEHYDE	30.03	LBNL Data File	100	10	9.837	69.95
50-00-0	FORMALIN SOLUTION 10%, NEUTRAL BUFFERED	30.03	LBNL Data File	100	25	9.837	245.93
50-00-0	FORMALDEHYDE	30.03	LBNL Data File	100	5	9.837	49.19
50-00-0	BUFFERED NEUTRAL FORMALIN	30.03	LBNL Data File	100	25	9.837	245.93
50-00-0	FORMALDEHYDE	30.03	LBNL Data File	100	10	9.837	98.37
50-00-0	FORMALDEHYDE	30.03	LBNL Data File	100	10	9.837	98.37
50-00-0	FORMALDEHYDE	30.03	LBNL Data File	100	10	9.837	98.37
50-00-0	FORMALDEHYDE	30.03	LBNL Data File	100	10	9.837	98.37
50-00-0	FORMALDEHYDE	30.03	LBNL Data File	100	10	9.837	98.37
50-00-0	FORMALDEHYDE	30.03	LBNL Data File	100	10	9.837	98.37
50-00-0	FORMALDEHYDE	30.03	LBNL Data File	100	10	9.837	98.37
50-00-0	FORMALINE SOLUTION ACCUSTAIN 10%	30.03	LBNL Data File	100	25	9.837	245.93
50-00-0	FORMALDEHYDE	30.03	LBNL Data File	100	10	9.837	98.37
50-00-0	FORMALIN SOLUTION 10%, NEUTRAL BUFFERED	30.03	LBNL Data File	100	25	9.837	245.93
50-00-0	FORMALIN SOLUTION 10%, NEUTRAL BUFFERED	30.03	LBNL Data File	100	25	9.837	245.93
50-00-0	FORMALIN SOLUTION 10%, NEUTRAL BUFFERED	30.03	LBNL Data File	100	25	9.837	245.93
50-00-0	FORMALIN SOLUTION 10%, NEUTRAL BUFFERED	30.03	LBNL Data File	100	25	9.837	245.93
50-00-0	FORMALDEHYDE SOLUTION	30.03	LBNL Data File	100	10	9.837	98.37
50-00-0	FORMALDEHYDE	30.03	LBNL Data File	100	10	9.837	98.37
50-00-0	FORMALDEHYDE	30.03	LBNL Data File	100	5	9.837	17.49
50-00-0	FORMALDEHYDE	30.03	LBNL Data File	100	5	9.837	7.00
50-00-0	FORMALDEHYDE	30.03	LBNL Data File	100	10	9.837	98.37
50-00-0	FORMALIN SOLUTION	30.03	LBNL Data File	100	5	9.837	10.49
50-00-0	FORMALDEHYDE SOLUTION	30.03	LBNL Data File	100	10	9.837	98.37
50-00-0	FORMALDEHYDE	30.03	LBNL Data File	100	10	9.837	98.37
50-00-0	FORMALDEHYDE	30.03	LBNL Data File	100	1	9.837	3.50
50-00-0	FORMALDEHYDE	30.03	LBNL Data File	100	10	9.837	98.37
50-00-0	FORMALDEHYDE	30.03	LBNL Data File	100	10	9.837	98.37
50-00-0	FORMALDEHYDE	30.03	LBNL Data File	100	10	9.837	98.37
50-00-0	FORMALIN SOLUTION 10%, NEUTRAL BUFFERED	30.03	LBNL Data File	100	5	9.837	24.48
50-00-0	FORMALDEHYDE	30.03	LBNL Data File	100	25	9.837	245.93
50-00-0	FORMALDEHYDE, 37 WT IN H2O	30.03	LBNL Data File	100	10	9.837	98.37
50-00-0	FORMALDEHYDE	30.03	LBNL Data File	100	25	9.837	245.93
50-00-0	FORMALDEHYDE, 37 WT	30.03	LBNL Data File	100	10	9.837	98.37
50-00-0	FORMALDEHYDE 37 % IN WATER	30.03	LBNL Data File	100	10	9.837	98.37
50-00-0	FORMALDEHYDE	30.03	LBNL Data File	100	10	9.837	69.95
50-00-0	FORMALDEHYDE	30.03	LBNL Data File	100	10	9.837	69.95
50-00-0	FORMALDEHYDE	30.03	LBNL Data File	100	10	9.837	98.37
50-00-0	FORMALDEHYDE	30.03	LBNL Data File	100	10	9.837	98.37
50-00-0	FORMALDEHYDE SOLUTION	30.03	LBNL Data File	100	10	9.837	98.37
50-00-0	FORMALIN	30.03	LBNL Data File	100	25	9.837	245.93
56-23-5	CARBON TETRACHLORIDE	153.8	LBNL Data File	100	10	29.387	293.87
58-89-9	YCLOHEXANE, 1,2,3,4,5,6-HEXACHLORO-, GAMMA-ISOME	290.9	LBNL Data File	0	10	0.000	0.00
58-89-9	YCLOHEXANE, 1,2,3,4,5,6-HEXACHLORO-, GAMMA-ISOME	291.9	LBNL Data File	0	10	0.000	0.00
58-89-9	YCLOHEXANE, 1,2,3,4,5,6-HEXACHLORO-, GAMMA-ISOME	292.9	LBNL Data File	0	1	0.000	0.00
58-89-9	YCLOHEXANE, 1,2,3,4,5,6-HEXACHLORO-, GAMMA-ISOME	293.9	LBNL Data File	0	1	0.000	0.00

Calculation of Liquid Chemical Emissions
Phase 1 Laboratory Usage Scenario
Proposed Richmond Bay Campus Long Range Development Plan, Richmond, California
Emissions from Evaporation During Use (Table G-5)

A = Surface Area (cm^2) = 100
U = Wind Speed (m/s) = 0.51
MW = Molecular Weight (g/mole) = Chemical-specific
VP = Vapor Pressure (mmHg) = Chemical-specific
R = Gas Constant (atm-cm^3/mole-deg K) = 82.05
T = Ambient Temperature (K) = 295

Loss (grams/batch) = $(4.120*A*U^{0.78}*MW^{0.67}*VP)/(R*T)$

This list of chemicals comes from merging the purchase and inventory lists Must be identical to Total Usage worksheet		*MW entered manually*		*From previous worksheet*	*From previous worksheet*	*Calculated*	*Calculated*
CAS No.	**Compound Name**	**MW (g/mole)**	**MW Reference**	**Adjusted Vapor Pressure (mmHg)**	**Assumed No. of Batches (per yr)**	**Estimated Loss Emission Factor (grams/batch)**	**Estimated Emissions (grams/yr)**
62-53-3	ANILINE OIL	93	LBNL Data File	1	10	0.221	2.21
62-53-3	BENZAMINE	93	LBNL Data File	1	1	0.221	0.22
67-56-1	METHANOL	32.1	LBNL Data File	106	25	10.876	271.90
67-56-1	METHANOL	32.1	LBNL Data File	106	25	10.876	271.90
67-56-1	METHANOL	32.1	LBNL Data File	106	25	10.876	271.90
67-56-1	METHANOL	32.1	LBNL Data File	106	25	10.876	271.90
67-56-1	METHANOL	32.1	LBNL Data File	106	1	10.876	0.70
67-56-1	METHANOL	32.1	LBNL Data File	106	25	10.876	271.90
67-56-1	METHANOL	32.1	LBNL Data File	106	25	10.876	271.90
67-56-1	COMBI METHANOL	32.1	LBNL Data File	106	25	10.876	271.90
67-56-1	METHANOL	32.1	LBNL Data File	106	25	10.876	271.90
67-56-1	METHANOL	32.1	LBNL Data File	106	25	10.876	271.90
67-56-1	METHANOL	32.1	LBNL Data File	106	25	10.876	271.90
67-56-1	METHANOL	32.1	LBNL Data File	106	25	10.876	271.90
67-56-1	METHANOL	32.1	LBNL Data File	106	25	10.876	271.90
67-56-1	METHANOL	32.1	LBNL Data File	106	25	10.876	271.90
67-56-1	METHANOL	32.1	LBNL Data File	106	25	10.876	271.90
67-56-1	METHANOL	32.1	LBNL Data File	106	25	10.876	271.90
67-56-1	METHANOL	32.1	LBNL Data File	106	25	10.876	271.90
67-56-1	METHANOL	32.1	LBNL Data File	106	25	10.876	271.90
67-56-1	METHANOL	32.1	LBNL Data File	106	25	10.876	271.90
67-56-1	METHANOL	32.1	LBNL Data File	106	25	10.876	271.90
67-56-1	METHANOL	32.1	LBNL Data File	106	25	10.876	271.90
67-56-1	METHANOL	32.1	LBNL Data File	106	25	10.876	271.90
67-56-1	METHANOL	32.1	LBNL Data File	106	25	10.876	271.90
67-56-1	METHANOL	32.1	LBNL Data File	106	10	10.876	69.95
67-56-1	METHANOL	32.1	LBNL Data File	106	25	10.876	271.90
67-56-1	METHANOL	32.1	LBNL Data File	106	25	10.876	271.90
67-56-1	METHANOL	32.1	LBNL Data File	106	10	10.876	108.76
67-56-1	METHANOL	32.1	LBNL Data File	106	25	10.876	271.90
67-56-1	METHANOL	32.1	LBNL Data File	106	25	10.876	271.90
67-56-1	METHANOL	32.1	LBNL Data File	106	25	10.876	271.90
67-56-1	METHANOL	32.1	LBNL Data File	106	25	10.876	271.90
67-56-1	METHANOL	32.1	LBNL Data File	106	25	10.876	271.90
67-56-1	METHANOL	32.1	LBNL Data File	106	25	10.876	271.90
67-56-1	METHANOL	32.1	LBNL Data File	106	25	10.876	271.90
67-56-1	METHANOL	32.1	LBNL Data File	106	25	10.876	271.90
67-56-1	METHANOL	32.1	LBNL Data File	106	25	10.876	271.90
67-56-1	METHANOL	32.1	LBNL Data File	106	25	10.876	271.90
67-56-1	METHANOL	32.1	LBNL Data File	106	25	10.876	271.90
67-56-1	METHANOL	32.1	LBNL Data File	106	25	10.876	271.90
67-56-1	METHANOL	32.1	LBNL Data File	106	25	10.876	271.90
67-56-1	METHANOL	32.1	LBNL Data File	106	25	10.876	271.90
67-56-1	METHANOL	32.1	LBNL Data File	106	25	10.876	271.90
67-56-1	METHANOL	32.1	LBNL Data File	106	25	10.876	271.90
67-56-1	METHANOL	32.1	LBNL Data File	106	25	10.876	271.90
67-56-1	METHANOL	32.1	LBNL Data File	106	25	10.876	271.90
67-56-1	METHANOL	32.1	LBNL Data File	106	100	10.876	1087.58
67-56-1	METHANOL	32.1	LBNL Data File	106	100	10.876	1087.58
67-56-1	METHANOL	32.1	LBNL Data File	106	25	10.876	271.90
67-56-1	METHANOL	32.1	LBNL Data File	106	25	10.876	271.90
67-56-1	METHANOL	32.1	LBNL Data File	106	25	10.876	271.90
67-56-1	METHANOL	32.1	LBNL Data File	106	25	10.876	271.90
67-56-1	METHANOL	32.1	LBNL Data File	106	0	10.876	0.00
67-56-1	METHANOL	32.1	LBNL Data File	106	25	10.876	271.90
67-56-1	METHANOL	32.1	LBNL Data File	106	25	10.876	271.90
67-56-1	METHANOL	32.1	LBNL Data File	106	25	10.876	271.90
67-56-1	METHANOL	32.1	LBNL Data File	106	25	10.876	271.90
67-56-1	METHANOL	32.1	LBNL Data File	106	25	10.876	271.90
67-56-1	METHANOL	32.1	LBNL Data File	106	25	10.876	271.90
67-56-1	METHANOL	32.1	LBNL Data File	106	25	10.876	271.90
67-56-1	METHANOL	32.1	LBNL Data File	106	25	10.876	271.90
67-56-1	METHANOL	32.1	LBNL Data File	106	25	10.876	271.90
67-56-1	METHANOL	32.1	LBNL Data File	106	25	10.876	271.90
67-56-1	METHANOL	32.1	LBNL Data File	106	25	10.876	271.90
67-56-1	METHANOL	32.1	LBNL Data File	106	25	10.876	271.90
67-56-1	METHANOL	32.1	LBNL Data File	106	25	10.876	271.90
67-56-1	METHANOL	32.1	LBNL Data File	106	25	10.876	271.90
67-56-1	METHANOL	32.1	LBNL Data File	106	25	10.876	271.90
67-56-1	METHANOL	32.1	LBNL Data File	106	25	10.876	271.90
67-56-1	METHANOL	32.1	LBNL Data File	106	25	10.876	271.90
67-56-1	METHANOL	32.1	LBNL Data File	106	25	10.876	271.90

Calculation of Liquid Chemical Emissions
Phase 1 Laboratory Usage Scenario
Proposed Richmond Bay Campus Long Range Development Plan, Richmond, California
Emissions from Evaporation During Use (Table G-5)

A = Surface Area (cm^2) = 100
U = Wind Speed (m/s) = 0.51
MW = Molecular Weight (g/mole) = Chemical-specific
VP = Vapor Pressure (mmHg) = Chemical-specific
R = Gas Constant (atm-cm^3/mole-deg K) = 82.05
T = Ambient Temperature (K) = 295

Loss (grams/batch) = $(4.120*A*U^{0.78}*MW^{0.67}*VP)/(R*T)$

This list of chemicals comes from merging the purchase and inventory lists Must be identical to Total Usage worksheet		*MW entered manually*		*From previous worksheet*	*From previous worksheet*	*Calculated*	*Calculated*
CAS No.	**Compound Name**	**MW (g/mole)**	**MW Reference**	**Adjusted Vapor Pressure (mmHg)**	**Assumed No. of Batches (per yr)**	**Estimated Loss Emission Factor (grams/batch)**	**Estimated Emissions (grams/yr)**
67-56-1	METHANOL	32.1	LBNL Data File	106	10	10.876	69.95
67-56-1	METHANOL	32.1	LBNL Data File	106	25	10.876	271.90
67-56-1	METHANOL	32.1	LBNL Data File	106	25	10.876	271.90
67-56-1	METHANOL	32.1	LBNL Data File	106	25	10.876	271.90
67-56-1	METHANOL	32.1	LBNL Data File	106	25	10.876	271.90
67-56-1	METHANOL	32.1	LBNL Data File	106	25	10.876	271.90
67-56-1	METHANOL	32.1	LBNL Data File	106	25	10.876	271.90
67-56-1	METHANOL	32.1	LBNL Data File	106	25	10.876	271.90
67-56-1	METHANOL	32.1	LBNL Data File	106	25	10.876	271.90
67-56-1	METHANOL	32.1	LBNL Data File	106	10	10.876	108.76
67-56-1	METHANOL	32.1	LBNL Data File	106	10	10.876	69.95
67-56-1	METHANOL	32.1	LBNL Data File	106	25	10.876	271.90
67-56-1	METHANOL	32.1	LBNL Data File	106	10	10.876	108.76
67-56-1	METHANOL	32.1	LBNL Data File	106	25	10.876	271.90
67-56-1	METHANOL	32.1	LBNL Data File	106	25	10.876	271.90
67-56-1	METHANOL	32.1	LBNL Data File	106	25	10.876	271.90
67-56-1	METHANOL	32.1	LBNL Data File	106	25	10.876	271.90
67-56-1	METHANOL	32.1	LBNL Data File	106	25	10.876	271.90
67-56-1	METHANOL	32.1	LBNL Data File	106	25	10.876	271.90
67-56-1	METHANOL	32.1	LBNL Data File	106	25	10.876	271.90
67-56-1	METHANOL	32.1	LBNL Data File	106	25	10.876	271.90
67-56-1	METHANOL	32.1	LBNL Data File	106	25	10.876	271.90
67-56-1	METHANOL	32.1	LBNL Data File	106	25	10.876	271.90
67-56-1	METHANOL	32.1	LBNL Data File	106	25	10.876	271.90
67-56-1	METHANOL	32.1	LBNL Data File	106	25	10.876	271.90
67-56-1	METHANOL	32.1	LBNL Data File	106	25	10.876	271.90
67-56-1	HYDRA-POINT METHANOL, DRY	32.1	LBNL Data File	106	25	10.876	271.90
67-56-1	HYDRA-POINT METHANOL, DRY	32.1	LBNL Data File	106	25	10.876	271.90
67-56-1	AMMONIA 7N SOLUTION IN METHANOL	32.1	LBNL Data File	106	10	10.876	69.95
67-56-1	METHANOL	32.1	LBNL Data File	106	25	10.876	271.90
67-56-1	METHANOL	32.1	LBNL Data File	106	25	10.876	271.90
67-56-1	METHANOL	32.1	LBNL Data File	106	25	10.876	271.90
67-56-1	METHANOL	32.1	LBNL Data File	106	25	10.876	271.90
67-56-1	METHANOL	32.1	LBNL Data File	106	25	10.876	271.90
67-56-1	METHANOL	32.1	LBNL Data File	106	25	10.876	271.90
67-56-1	METHANOL	32.1	LBNL Data File	106	25	10.876	271.90
67-56-1	METHANOL	32.1	LBNL Data File	106	25	10.876	271.90
67-56-1	METHANOL	32.1	LBNL Data File	106	10	10.876	69.95
67-56-1	METHANOL	32.1	LBNL Data File	106	1	10.876	0.70
67-56-1	METHANOL	32.1	LBNL Data File	106	25	10.876	271.90
67-56-1	METHANOL	32.1	LBNL Data File	106	25	10.876	271.90
67-56-1	COMBI METHANOL	32.1	LBNL Data File	106	25	10.876	271.90
67-56-1	METHANOL	32.1	LBNL Data File	106	25	10.876	271.90
67-56-1	METHANOL	32.1	LBNL Data File	106	25	10.876	271.90
67-56-1	METHANOL	32.1	LBNL Data File	106	25	10.876	271.90
67-56-1	METHANOL	32.1	LBNL Data File	106	25	10.876	271.90
67-56-1	METHANOL	32.1	LBNL Data File	106	25	10.876	271.90
67-56-1	METHANOL	32.1	LBNL Data File	106	25	10.876	271.90
67-56-1	METHYL ALCOHOL	32.1	LBNL Data File	106	25	10.876	271.90
67-56-1	METHANOL	32.1	LBNL Data File	106	25	10.876	271.90
67-56-1	METHANOL	32.1	LBNL Data File	106	100	10.876	1087.58
67-56-1	METHANOL	32.1	LBNL Data File	106	25	10.876	271.90
67-56-1	METHANOL	32.1	LBNL Data File	106	25	10.876	271.90
67-56-1	METHANOL	32.1	LBNL Data File	106	25	10.876	271.90
67-56-1	METHANOL	32.1	LBNL Data File	106	25	10.876	271.90
67-56-1	METHANOL	32.1	LBNL Data File	106	25	10.876	271.90
67-56-1	METHANOL	32.1	LBNL Data File	106	25	10.876	271.90
67-56-1	METHANOL	32.1	LBNL Data File	106	25	10.876	271.90
67-56-1	METHANOL	32.1	LBNL Data File	106	25	10.876	271.90
67-56-1	METHANOL	32.1	LBNL Data File	106	25	10.876	271.90
67-56-1	METHANOL	32.1	LBNL Data File	106	25	10.876	271.90
67-56-1	METHANOL	32.1	LBNL Data File	106	25	10.876	271.90
67-56-1	METHANOL	32.1	LBNL Data File	106	25	10.876	271.90
67-56-1	METHANOL	32.1	LBNL Data File	106	10	10.876	69.95
67-56-1	METHANOL	32.1	LBNL Data File	106	25	10.876	271.90
67-56-1	METHANOL	32.1	LBNL Data File	106	25	10.876	271.90
67-56-1	METHANOL	32.1	LBNL Data File	106	25	10.876	271.90
67-56-1	METHANOL	32.1	LBNL Data File	106	25	10.876	271.90
67-56-1	METHANOL	32.1	LBNL Data File	106	25	10.876	271.90
67-56-1	METHANOL	32.1	LBNL Data File	106	25	10.876	271.90
67-56-1	METHANOL	32.1	LBNL Data File	106	25	10.876	271.90

Calculation of Liquid Chemical Emissions
Phase 1 Laboratory Usage Scenario
Proposed Richmond Bay Campus Long Range Development Plan, Richmond, California
Emissions from Evaporation During Use (Table G-5)

A = Surface Area (cm^2) = 100
U = Wind Speed (m/s) = 0.51
MW = Molecular Weight (g/mole) = Chemical-specific
VP = Vapor Pressure (mmHg) = Chemical-specific
R = Gas Constant (atm-cm^3/mole-deg K) = 82.05
T = Ambient Temperature (K) = 295

Loss (grams/batch) = $(4.120*A*U^{0.78}*MW^{0.67}*VP)/(R*T)$

This list of chemicals comes from merging the purchase and inventory lists Must be identical to Total Usage worksheet		*MW entered manually*		*From previous worksheet*	*From previous worksheet*	*Calculated*	*Calculated*
CAS No.	**Compound Name**	**MW (g/mole)**	**MW Reference**	**Adjusted Vapor Pressure (mmHg)**	**Assumed No. of Batches (per yr)**	**Estimated Loss Emission Factor (grams/batch)**	**Estimated Emissions (grams/yr)**
67-56-1	METHANOL	32.1	LBNL Data File	106	10	10.876	108.76
67-56-1	METHANOL	32.1	LBNL Data File	106	25	10.876	271.90
67-56-1	METHANOL	32.1	LBNL Data File	106	25	10.876	271.90
67-56-1	METHANOL	32.1	LBNL Data File	106	25	10.876	271.90
67-56-1	METHANOL	32.1	LBNL Data File	106	25	10.876	271.90
67-56-1	METHANOL	32.1	LBNL Data File	106	10	10.876	69.95
67-56-1	METHANOL	32.1	LBNL Data File	106	10	10.876	108.76
67-56-1	METHANOL	32.1	LBNL Data File	106	25	10.876	271.90
67-56-1	METHANOL	32.1	LBNL Data File	106	25	10.876	271.90
67-56-1	METHANOL	32.1	LBNL Data File	106	25	10.876	271.90
67-56-1	METHANOL	32.1	LBNL Data File	106	25	10.876	271.90
67-56-1	METHANOL	32.1	LBNL Data File	106	25	10.876	271.90
67-56-1	METHANOL	32.1	LBNL Data File	106	25	10.876	271.90
67-56-1	METHANOL	32.1	LBNL Data File	106	25	10.876	271.90
67-56-1	METHANOL	32.1	LBNL Data File	106	25	10.876	271.90
67-56-1	METHANOL	32.1	LBNL Data File	106	25	10.876	271.90
67-56-1	METHANOL	32.1	LBNL Data File	106	25	10.876	271.90
67-56-1	METHANOL	32.1	LBNL Data File	106	25	10.876	271.90
67-56-1	METHANOL	32.1	LBNL Data File	106	10	10.876	108.76
67-56-1	METHANOL	32.1	LBNL Data File	106	25	10.876	271.90
67-63-0	ISOPROPYL ALCOHOL (2)	60.1	LBNL Data File	74	100	11.647	1164.72
67-63-0	ISOPROPYL ALCOHOL	60.1	LBNL Data File	74	25	11.647	291.18
67-63-0	ISOPROPANOL	60.1	LBNL Data File	74	25	11.647	291.18
67-63-0	ISOPROPYL ALCOHOL	60.1	LBNL Data File	74	10	11.647	116.47
67-63-0	ISOPROPYL ALCOHOL	60.1	LBNL Data File	74	10	11.647	116.47
67-63-0	ISOPROPANOL	60.1	LBNL Data File	74	10	11.647	116.47
67-63-0	ISOPROPYL ALCOHOL	60.1	LBNL Data File	74	10	11.647	116.47
67-63-0	ISOPROPYL ALCOHOL	60.1	LBNL Data File	74	100	11.647	1164.72
67-63-0	ISOPROPANOL	60.1	LBNL Data File	74	100	11.647	1164.72
67-63-0	ISOPROPYL ALCOHOL	60.1	LBNL Data File	74	25	11.647	291.18
67-63-0	2-PROPANOL	60.1	LBNL Data File	74	10	11.647	116.47
67-63-0	ISOPROPYL ALCOHOL	60.1	LBNL Data File	74	25	11.647	291.18
67-63-0	ISOPROPANOL	60.1	LBNL Data File	74	10	11.647	116.47
67-63-0	2-PROPANOL	60.1	LBNL Data File	74	10	11.647	116.47
67-63-0	ISOPROPYL ALCOHOL	60.1	LBNL Data File	74	10	11.647	116.47
67-63-0	ISOPROPYL ALCOHOL	60.1	LBNL Data File	74	10	11.647	116.47
67-63-0	2-PROPANOL	60.1	LBNL Data File	74	10	11.647	116.47
67-63-0	ISOPROPANOL	60.1	LBNL Data File	74	25	11.647	291.18
67-63-0	2-PROPANOL	60.1	LBNL Data File	74	10	11.647	116.47
67-63-0	ISOPROPYL ALCOHOL	60.1	LBNL Data File	74	25	11.647	291.18
67-63-0	ISOPROPANOL	60.1	LBNL Data File	74	10	11.647	116.47
67-63-0	2-PROPANOL	60.1	LBNL Data File	74	10	11.647	116.47
67-63-0	ISOPROPYL ALCOHOL	60.1	LBNL Data File	74	10	11.647	116.47
67-63-0	ISOPROPYL ALCOHOL	60.1	LBNL Data File	74	25	11.647	291.18
67-63-0	2-PROPANOL	60.1	LBNL Data File	74	5	11.647	17.49
67-63-0	2-PROPANOL	60.1	LBNL Data File	74	5	11.647	17.49
67-63-0	2-PROPANOL	60.1	LBNL Data File	74	10	11.647	116.47
67-63-0	2-PROPANOL	60.1	LBNL Data File	74	5	11.647	17.49
67-63-0	2-PROPANOL	60.1	LBNL Data File	74	5	11.647	17.49
67-63-0	2-PROPANOL	60.1	LBNL Data File	74	5	11.647	17.49
67-63-0	2-PROPANOL	60.1	LBNL Data File	74	5	11.647	17.49
67-63-0	2-PROPANOL	60.1	LBNL Data File	74	5	11.647	17.49
67-63-0	2-PROPANOL	60.1	LBNL Data File	74	5	11.647	17.49
67-63-0	ISOPROPYL ALCOHOL	60.1	LBNL Data File	74	25	11.647	291.18
67-63-0	2-PROPANOL	60.1	LBNL Data File	74	10	11.647	116.47
67-63-0	2-PROPANOL	60.1	LBNL Data File	74	10	11.647	116.47
67-63-0	2-PROPANOL	60.1	LBNL Data File	74	10	11.647	116.47
67-63-0	ISOPROPYL ALCOHOL	60.1	LBNL Data File	74	25	11.647	291.18
67-63-0	ISOPROPYL ALCOHOL	60.1	LBNL Data File	74	25	11.647	291.18
67-63-0	ISOPROPYL ALCOHOL	60.1	LBNL Data File	74	25	11.647	291.18
67-63-0	ISOPROPYL ALCOHOL	60.1	LBNL Data File	74	25	11.647	291.18
67-63-0	ISOPROPYL ALCOHOL	60.1	LBNL Data File	74	25	11.647	291.18
67-63-0	ISOPROPYL ALCOHOL	60.1	LBNL Data File	74	25	11.647	291.18
67-63-0	ISOPROPYL ALCOHOL	60.1	LBNL Data File	74	25	11.647	291.18
67-63-0	2-PROPANOL	60.1	LBNL Data File	74	25	11.647	291.18
67-63-0	ISOPROPYL ALCOHOL	60.1	LBNL Data File	74	25	11.647	291.18
67-63-0	ISOPROPYL ALCOHOL	60.1	LBNL Data File	74	5	11.647	17.49
67-63-0	ISOPROPYL	60.1	LBNL Data File	74	25	11.647	291.18
67-63-0	2-PROPANOL	60.1	LBNL Data File	74	10	11.647	116.47
67-63-0	ISOPROPYL ALCOHOL	60.1	LBNL Data File	74	25	11.647	291.18
67-63-0	ISOPROPYL ALCOHOL	60.1	LBNL Data File	74	25	11.647	291.18
67-63-0	ISOPROPYL ALCOHOL	60.1	LBNL Data File	74	25	11.647	291.18
67-63-0	ISOPROPYL ALCOHOL	60.1	LBNL Data File	74	25	11.647	291.18

Calculation of Liquid Chemical Emissions
Phase 1 Laboratory Usage Scenario
Proposed Richmond Bay Campus Long Range Development Plan, Richmond, California
Emissions from Evaporation During Use (Table G-5)

A = Surface Area (cm^2) = 100
U = Wind Speed (m/s) = 0.51
MW = Molecular Weight (g/mole) = Chemical-specific
VP = Vapor Pressure (mmHg) = Chemical-specific
R = Gas Constant (atm-cm^3/mole-deg K) = 82.05
T = Ambient Temperature (K) = 295

Loss (grams/batch) = $(4.120*A*U^{0.78}*MW^{0.67}*VP)/(R*T)$

This list of chemicals comes from merging the purchase and inventory lists Must be identical to Total Usage worksheet		*MW entered manually*		*From previous worksheet*	*From previous worksheet*	*Calculated*	*Calculated*
CAS No.	**Compound Name**	**MW (g/mole)**	**MW Reference**	**Adjusted Vapor Pressure (mmHg)**	**Assumed No. of Batches (per yr)**	**Estimated Loss Emission Factor (grams/batch)**	**Estimated Emissions (grams/yr)**
67-63-0	ISOPROPYL ALCOHOL	60.1	LBNL Data File	74	25	11.647	291.18
67-63-0	ISOPROPYL ALCOHOL	60.1	LBNL Data File	74	25	11.647	291.18
67-63-0	2-PROPANOL	60.1	LBNL Data File	74	10	11.647	116.47
67-63-0	ISOPROPYL ALCOHOL	60.1	LBNL Data File	74	25	11.647	291.18
67-63-0	ISOPROPYL ALCOHOL	60.1	LBNL Data File	74	25	11.647	291.18
67-63-0	2-PROPANOL	60.1	LBNL Data File	74	10	11.647	116.47
67-63-0	2-PROPANOL	60.1	LBNL Data File	74	5	11.647	17.49
67-63-0	2-PROPANOL	60.1	LBNL Data File	74	25	11.647	291.18
67-63-0	2-PROPANOL	60.1	LBNL Data File	74	25	11.647	291.18
67-63-0	ISOPROPANOL	60.1	LBNL Data File	74	25	11.647	291.18
67-63-0	ISOPROPANOL	60.1	LBNL Data File	74	25	11.647	291.18
67-63-0	ISOPROPANOL	60.1	LBNL Data File	74	25	11.647	291.18
67-63-0	ISOPROPYL ALCOHOL	60.1	LBNL Data File	74	25	11.647	291.18
67-63-0	ISOPROPYL ALCOHOL	60.1	LBNL Data File	74	25	11.647	291.18
67-63-0	ISOPROPYL ALCOHOL	60.1	LBNL Data File	74	25	11.647	291.18
67-63-0	ISOPROPYL ALCOHOL	60.1	LBNL Data File	74	25	11.647	291.18
67-63-0	ISOPROPYL ALCOHOL	60.1	LBNL Data File	74	25	11.647	291.18
67-63-0	ISOPROPANOL	60.1	LBNL Data File	74	25	11.647	291.18
67-63-0	ISOPROPANOL	60.1	LBNL Data File	74	25	11.647	291.18
67-63-0	2-PROPANOL	60.1	LBNL Data File	74	25	11.647	291.18
67-63-0	ISOPROPANOL	60.1	LBNL Data File	74	25	11.647	291.18
67-63-0	ISOPROPANOL	60.1	LBNL Data File	74	25	11.647	291.18
67-63-0	2-PROPANOL	60.1	LBNL Data File	74	25	11.647	291.18
67-63-0	ISOPROPYL ALCOHOL	60.1	LBNL Data File	74	25	11.647	291.18
67-63-0	ISOPROPYL ALCOHOL	60.1	LBNL Data File	74	25	11.647	291.18
67-63-0	ISOPROPYL ALCOHOL	60.1	LBNL Data File	74	25	11.647	291.18
67-63-0	ISOPROPYL ALCOHOL	60.1	LBNL Data File	74	25	11.647	291.18
67-63-0	ISOPROPYL ALCOHOL	60.1	LBNL Data File	74	25	11.647	291.18
67-63-0	ISOPROPYL ALCOHOL	60.1	LBNL Data File	74	25	11.647	291.18
67-63-0	ISOPROPYL ALCOHOL	60.1	LBNL Data File	74	25	11.647	291.18
67-63-0	2-PROPANOL	60.1	LBNL Data File	74	25	11.647	291.18
67-63-0	2-PROPANOL	60.1	LBNL Data File	74	25	11.647	291.18
67-63-0	2-PROPANOL	60.1	LBNL Data File	74	10	11.647	116.47
67-63-0	ISOPROPYL ALCOHOL	60.1	LBNL Data File	74	10	11.647	116.47
67-63-0	2-PROPANOL	60.1	LBNL Data File	74	10	11.647	116.47
67-63-0	ISOPROPYL ALCOHOL	60.1	LBNL Data File	74	25	11.647	291.18
67-63-0	ISOPROPYL ALCOHOL	60.1	LBNL Data File	74	25	11.647	291.18
67-63-0	ISOPROPYL ALCOHOL	60.1	LBNL Data File	74	10	11.647	116.47
67-63-0	ISOPROPYL ALCOHOL	60.1	LBNL Data File	74	25	11.647	291.18
67-63-0	ISOPROPYL ALCOHOL	60.1	LBNL Data File	74	25	11.647	291.18
67-63-0	ISOPROPYL ALCOHOL	60.1	LBNL Data File	74	25	11.647	291.18
67-63-0	ISOPROPYL ALCOHOL	60.1	LBNL Data File	74	10	11.647	116.47
67-63-0	2-PROPANOL	60.1	LBNL Data File	74	25	11.647	291.18
67-63-0	2-PROPANOL	60.1	LBNL Data File	74	25	11.647	291.18
67-63-0	ISOPROPANOL	60.1	LBNL Data File	74	25	11.647	291.18
67-63-0	ISOPROPANOL	60.1	LBNL Data File	74	25	11.647	291.18
67-63-0	ISOPROPYL ALCOHOL	60.1	LBNL Data File	74	25	11.647	291.18
67-63-0	ISOPROPYL ALCOHOL	60.1	LBNL Data File	74	5	11.647	17.49
67-63-0	ISOPROPYL ALCOHOL	60.1	LBNL Data File	74	5	11.647	17.49
67-63-0	ISOPROPYL ALCOHOL	60.1	LBNL Data File	74	5	11.647	17.49
67-63-0	ISOPROPYL ALCOHOL	60.1	LBNL Data File	74	5	11.647	17.49
67-63-0	ISOPROPYL ALCOHOL	60.1	LBNL Data File	74	5	11.647	17.49
67-63-0	ISOPROPYL ALCOHOL	60.1	LBNL Data File	74	5	11.647	17.49
67-63-0	ISOPROPYL ALCOHOL	60.1	LBNL Data File	74	5	11.647	17.49
67-63-0	ISOPROPANOL ALCOHOL	60.1	LBNL Data File	74	25	11.647	291.18
67-63-0	ISOPROPANOL ALCOHOL	60.1	LBNL Data File	74	25	11.647	291.18
67-63-0	2-PROPANOL	60.1	LBNL Data File	74	5	11.647	17.49
67-63-0	2-PROPANOL	60.1	LBNL Data File	74	5	11.647	17.49
67-63-0	2-PROPANOL	60.1	LBNL Data File	74	25	11.647	291.18
67-63-0	2-PROPANOL	60.1	LBNL Data File	74	5	11.647	17.49
67-63-0	2-PROPANOL	60.1	LBNL Data File	74	25	11.647	291.18
67-63-0	2-PROPANOL	60.1	LBNL Data File	74	25	11.647	291.18
67-63-0	2-PROPANOL	60.1	LBNL Data File	74	5	11.647	17.49
67-63-0	2-PROPANOL	60.1	LBNL Data File	74	5	11.647	17.49
67-63-0	2-PROPANOL	60.1	LBNL Data File	74	5	11.647	17.49
67-63-0	2-PROPANOL	60.1	LBNL Data File	74	5	11.647	17.49
67-63-0	ISOPROPYL ALCOHOL	60.1	LBNL Data File	74	10	11.647	116.47
67-63-0	ISOPROPYL ALCOHOL	60.1	LBNL Data File	74	10	11.647	116.47
67-63-0	ISOPROPANOL	60.1	LBNL Data File	74	25	11.647	291.18
67-63-0	2-PROPANOL	60.1	LBNL Data File	74	10	11.647	116.47
67-63-0	2-PROPANOL	60.1	LBNL Data File	74	10	11.647	116.47
67-63-0	2-PROPANOL	60.1	LBNL Data File	74	10	11.647	116.47
67-63-0	2-PROPANOL	60.1	LBNL Data File	74	5	11.647	17.49
67-63-0	2-PROPANOL	60.1	LBNL Data File	74	25	11.647	291.18

Calculation of Liquid Chemical Emissions
Phase 1 Laboratory Usage Scenario
Proposed Richmond Bay Campus Long Range Development Plan, Richmond, California
Emissions from Evaporation During Use (Table G-5)

A = Surface Area (cm^2) = 100
U = Wind Speed (m/s) = 0.51
MW = Molecular Weight (g/mole) = Chemical-specific
VP = Vapor Pressure (mmHg) = Chemical-specific
R = Gas Constant (atm-cm^3/mole-deg K) = 82.05
T = Ambient Temperature (K) = 295

Loss (grams/batch) = $(4.120*A*U^{0.78}*MW^{0.67}*VP)/(R*T)$

This list of chemicals comes from merging the purchase and inventory lists Must be identical to Total Usage worksheet		*MW entered manually*		*From previous worksheet*	*From previous worksheet*	*Calculated*	*Calculated*
CAS No.	**Compound Name**	**MW (g/mole)**	**MW Reference**	**Adjusted Vapor Pressure (mmHg)**	**Assumed No. of Batches (per yr)**	**Estimated Loss Emission Factor (grams/batch)**	**Estimated Emissions (grams/yr)**
67-63-0	ISOPROPYL ALCOHOL	60.1	LBNL Data File	74	25	11.647	291.18
67-63-0	ISOPROPANOL	60.1	LBNL Data File	74	10	11.647	116.47
67-63-0	ISOPROPYL ALCOHOL	60.1	LBNL Data File	74	25	11.647	291.18
67-63-0	ISOPROPYL ALCOHOL	60.1	LBNL Data File	74	25	11.647	291.18
67-63-0	2-PROPANOL	60.1	LBNL Data File	74	25	11.647	291.18
67-63-0	ISOPROPYL ALCOHOL	60.1	LBNL Data File	74	10	11.647	116.47
67-63-0	MICROSHARP CLEANING FLUID	60.1	LBNL Data File	74	10	11.647	116.47
67-63-0	MICROSHARP CLEANING FLUID	60.1	LBNL Data File	74	10	11.647	116.47
67-63-0	MICROSHARP CLEANING FLUID	60.1	LBNL Data File	74	10	11.647	116.47
67-63-0	MICROSHARP CLEANING FLUID	60.1	LBNL Data File	74	10	11.647	116.47
67-63-0	MICROSHARP CLEANING FLUID	60.1	LBNL Data File	74	10	11.647	116.47
67-63-0	ISOPROPANOL	60.1	LBNL Data File	74	10	11.647	116.47
67-63-0	2-PROPANOL	60.1	LBNL Data File	74	10	11.647	116.47
67-63-0	ISOPROPANOL	60.1	LBNL Data File	74	5	11.647	17.49
67-63-0	ISOPROPANOL	60.1	LBNL Data File	74	5	11.647	17.49
67-63-0	2-PROPANOL	60.1	LBNL Data File	74	10	11.647	116.47
67-63-0	2-PROPANOL	60.1	LBNL Data File	74	10	11.647	116.47
67-63-0	2-PROPANOL	60.1	LBNL Data File	74	10	11.647	116.47
67-63-0	2-PROPANOL	60.1	LBNL Data File	74	10	11.647	116.47
67-63-0	ISOPROPANOL	60.1	LBNL Data File	74	10	11.647	116.47
67-63-0	N-HYDROXYSUCCINIMIDYL-ACTIVATED AGAROSE	60.1	LBNL Data File	74	1	11.647	3.50
67-63-0	2-PROPANOL	60.1	LBNL Data File	74	25	11.647	291.18
67-63-0	ISOPROPYL ALCOHOL	60.1	LBNL Data File	74	25	11.647	291.18
67-63-0	ISOPROPANOL	60.1	LBNL Data File	74	10	11.647	116.47
67-63-0	ISOPROPYL ALCOHOL	60.1	LBNL Data File	74	10	11.647	69.95
67-63-0	ISOPROPANOL	60.1	LBNL Data File	74	10	11.647	116.47
67-63-0	ISOPROPANOL	60.1	LBNL Data File	74	10	11.647	116.47
67-63-0	2-PROPANOL	60.1	LBNL Data File	74	25	11.647	291.18
67-63-0	ISOPROPYL ALCOHOL	60.1	LBNL Data File	74	25	11.647	291.18
67-63-0	2-PROPANOL	60.1	LBNL Data File	74	5	11.647	17.49
67-63-0	ISOPROPYL ALCOHOL	60.1	LBNL Data File	74	5	11.647	17.49
67-63-0	ISOPROPYL ALCOHOL	60.1	LBNL Data File	74	5	11.647	17.49
67-63-0	ISOPROPYL ALCOHOL	60.1	LBNL Data File	74	5	11.647	17.49
67-63-0	ISOPROPYL ALCOHOL	60.1	LBNL Data File	74	5	11.647	17.49
67-63-0	ISOPROPYL ALCOHOL	60.1	LBNL Data File	74	5	11.647	17.49
67-63-0	ISOPROPANOL	60.1	LBNL Data File	74	25	11.647	291.18
67-63-0	ISOPROPYL ALCOHOL	60.1	LBNL Data File	74	25	11.647	291.18
67-63-0	2-PROPANOL	60.1	LBNL Data File	74	5	11.647	17.49
67-63-0	ISOPROPYL ALCOHOL	60.1	LBNL Data File	74	25	11.647	291.18
67-63-0	ISOPROPYL ALCOHOL	60.1	LBNL Data File	74	25	11.647	291.18
67-63-0	2-PROPANOL	60.1	LBNL Data File	74	25	11.647	291.18
67-63-0	ISOPROPYL ALCOHOL	60.1	LBNL Data File	74	10	11.647	116.47
67-63-0	ISOPROPYL ALCOHOL	60.1	LBNL Data File	74	10	11.647	116.47
67-63-0	ISOPROPYL ALCOHOL	60.1	LBNL Data File	74	10	11.647	116.47
67-63-0	ISOPROPYL ALCOHOL	60.1	LBNL Data File	74	25	11.647	291.18
67-63-0	ISOPROPYL ALCOHOL	60.1	LBNL Data File	74	25	11.647	291.18
67-63-0	ISOPROPYL ALCOHOL	60.1	LBNL Data File	74	10	11.647	116.47
67-63-0	ISOPROPANOL	60.1	LBNL Data File	74	5	11.647	17.49
67-63-0	ISOPROPYL ALCOHOL	60.1	LBNL Data File	74	25	11.647	291.18
67-63-0	ISOPROPYL ALCOHOL	60.1	LBNL Data File	74	25	11.647	291.18
67-66-3	CHLOROFORM	119.4	LBNL Data File	169	10	41.885	69.95
67-66-3	CHLOROFORM	119.4	LBNL Data File	169	10	41.885	349.77
67-66-3	CHLOROFORM:ISOAMYL ALCOHOL 24:1	119.4	LBNL Data File	169	10	41.885	349.77
67-66-3	CHLOROFORM ISOAMYL ALCOHOL	119.4	LBNL Data File	169	10	41.885	69.95
67-66-3	CHLOROFORM	119.4	LBNL Data File	169	10	41.885	349.77
67-66-3	CHLOROFORM ISOAMYL ALCOHOL	119.4	LBNL Data File	169	10	41.885	349.77
67-66-3	CHLOROFORM ISOAMYL ALCOHOL	119.4	LBNL Data File	169	10	41.885	349.77
67-66-3	CHLOROFORM	119.4	LBNL Data File	169	10	41.885	349.77
67-66-3	CHLOROFORM:ISOAMYL ALCOHOL 24:1	119.4	LBNL Data File	169	10	41.885	69.95
67-66-3	CHLOROFORM	119.4	LBNL Data File	169	25	41.885	699.54
67-66-3	CHLOROFORM	119.4	LBNL Data File	169	25	41.885	699.54
67-66-3	CHLOROFORM	119.4	LBNL Data File	169	10	41.885	349.77
67-66-3	CHLOROFORM	119.4	LBNL Data File	169	25	41.885	699.54
67-66-3	CHLOROFORM	119.4	LBNL Data File	169	10	41.885	349.77
67-66-3	CHLOROFORM	119.4	LBNL Data File	169	10	41.885	349.77
67-66-3	CHLOROFORM	119.4	LBNL Data File	169	5	41.885	17.49
67-66-3	CHLOROFORM:ISOAMYL ALCOHOL 24:1	119.4	LBNL Data File	169	25	41.885	662.01
67-66-3	CHLOROFORM: ISOAMYL ALCOHOL MIXTURE	119.4	LBNL Data File	169	10	41.885	349.77
67-66-3	CHLOROFORM	119.4	LBNL Data File	169	5	41.885	17.49
67-66-3	CHLOROFORM	119.4	LBNL Data File	169	10	41.885	279.82
67-66-3	CHLOROFORM	119.4	LBNL Data File	169	10	41.885	279.82
67-66-3	CHLOROFORM	119.4	LBNL Data File	169	10	41.885	349.77
67-66-3	CHLOROFORM	119.4	LBNL Data File	169	10	41.885	349.77
67-66-3	CHLOROFORM	119.4	LBNL Data File	169	10	41.885	331.00
67-66-3	CHLOROFORM	119.4	LBNL Data File	169	10	41.885	331.00

Calculation of Liquid Chemical Emissions
Phase 1 Laboratory Usage Scenario
Proposed Richmond Bay Campus Long Range Development Plan, Richmond, California
Emissions from Evaporation During Use (Table G-5)

A = Surface Area (cm^2) = 100
U = Wind Speed (m/s) = 0.51
MW = Molecular Weight (g/mole) = Chemical-specific
VP = Vapor Pressure (mmHg) = Chemical-specific
R = Gas Constant (atm-cm^3/mole-deg K) = 82.05
T = Ambient Temperature (K) = 295

Loss (grams/batch) = $(4.120*A*U^{0.78}*MW^{0.67}*VP)/(R*T)$

This list of chemicals comes from merging the purchase and inventory lists Must be identical to Total Usage worksheet		*MW entered manually*		*From previous worksheet*	*From previous worksheet*	*Calculated*	*Calculated*
CAS No.	**Compound Name**	**MW (g/mole)**	**MW Reference**	**Adjusted Vapor Pressure (mmHg)**	**Assumed No. of Batches (per yr)**	**Estimated Loss Emission Factor (grams/batch)**	**Estimated Emissions (grams/yr)**
67-66-3	CHLOROFORM	119.4	LBNL Data File	169	10	41.885	349.77
67-66-3	CHLOROFORM	119.4	LBNL Data File	169	10	41.885	349.77
67-66-3	CHLOROFORM	119.4	LBNL Data File	169	10	41.885	349.77
67-66-3	CHLOROFORM	119.4	LBNL Data File	169	25	41.885	1047.13
67-66-3	CHLOROFORM HPLC PURE	119.4	LBNL Data File	169	25	41.885	699.54
67-66-3	CHLOROFORM	119.4	LBNL Data File	169	25	41.885	1047.13
67-66-3	CHLOROFORM:ISOAMYL ALCOHOL MIXTURE	119.4	LBNL Data File	169	10	41.885	69.95
67-66-3	CHLOROFORM	119.4	LBNL Data File	169	5	41.885	17.49
67-66-3	CHLOROFORM	119.4	LBNL Data File	169	10	41.885	69.95
67-66-3	CHLOROFORM	119.4	LBNL Data File	169	25	41.885	699.54
67-66-3	CHLOROFORM	119.4	LBNL Data File	169	10	41.885	349.77
67-66-3	CHLOROFORM	119.4	LBNL Data File	169	25	41.885	699.54
67-66-3	CHLOROFORM	119.4	LBNL Data File	169	5	41.885	23.59
67-66-3	CHLOROFORM	119.4	LBNL Data File	169	5	41.885	17.49
67-66-3	CHLOROFORM	119.4	LBNL Data File	169	5	41.885	17.49
67-66-3	CHLOROFORM	119.4	LBNL Data File	169	5	41.885	17.49
67-66-3	CHLOROFORM	119.4	LBNL Data File	169	25	41.885	1047.13
67-66-3	CHLOROFORM	119.4	LBNL Data File	169	25	41.885	1047.13
67-66-3	CHLOROFORM	119.4	LBNL Data File	169	10	41.885	349.77
67-66-3	CHLOROFORM: ISOAMYL ALCOHOL	119.4	LBNL Data File	169	10	41.885	349.77
67-66-3	CHLOROFORM: ISOAMYL ALCOHOL	119.4	LBNL Data File	169	10	41.885	349.77
67-66-3	CHLOROFORM	119.4	LBNL Data File	169	25	41.885	1047.13
67-66-3	CHLOROFORM:ISOAMYL ALCOHOL	119.4	LBNL Data File	169	10	41.885	69.95
67-66-3	CHLOROFORM:ISOAMYL ALCOHOL 24:1	119.4	LBNL Data File	169	10	41.885	349.77
67-66-3	CHLOROFORM	119.4	LBNL Data File	169	25	41.885	699.54
67-66-3	CHLOROFORM	119.4	LBNL Data File	169	10	41.885	349.77
67-66-3	CHLOROFORM	119.4	LBNL Data File	169	25	41.885	699.54
67-66-3	CHLOROFORM	119.4	LBNL Data File	169	25	41.885	1047.13
67-66-3	CHLOROFORM	119.4	LBNL Data File	169	25	41.885	1047.13
67-66-3	CHLOROFORM	119.4	LBNL Data File	169	25	41.885	1047.13
67-66-3	CHLOROFORM	119.4	LBNL Data File	169	25	41.885	1047.13
67-66-3	CHLOROFORM	119.4	LBNL Data File	169	10	41.885	349.77
67-66-3	CHLOROFORM	119.4	LBNL Data File	169	10	41.885	349.77
67-66-3	CHLOROFORM	119.4	LBNL Data File	169	10	41.885	349.77
67-66-3	CHLOROFORM:ISOAMYL ALCOHOL	119.4	LBNL Data File	169	10	41.885	331.00
67-66-3	CHLOROFORM	119.4	LBNL Data File	169	25	41.885	1047.13
67-66-3	CHLOROFORM HPLC PURE	119.4	LBNL Data File	169	25	41.885	699.54
67-66-3	CHLOROFORM	119.4	LBNL Data File	169	10	41.885	69.95
67-66-3	TRICHLOROMETHANE	119.4	LBNL Data File	169	5	41.885	17.49
67-66-3	CHLOROFORM	119.4	LBNL Data File	169	5	41.885	17.49
67-66-3	CHLOROFORM	119.4	LBNL Data File	169	5	41.885	17.49
67-66-3	CHLOROFORM: ISOAMYL ALCOHOL MIXTURE	119.4	LBNL Data File	169	10	41.885	314.79
67-66-3	CHLOROFORM	119.4	LBNL Data File	169	10	41.885	349.77
67-66-3	CHLOROFORM	119.4	LBNL Data File	169	10	41.885	349.77
67-66-3	CHLOROFORM	119.4	LBNL Data File	169	10	41.885	349.77
67-66-3	CHLOROFORM	119.4	LBNL Data File	169	5	41.885	47.17
67-66-3	CHLOROFORM	119.4	LBNL Data File	169	25	41.885	662.01
67-66-3	CHLOROFORM	119.4	LBNL Data File	169	10	41.885	349.77
67-66-3	CHLOROFORM	119.4	LBNL Data File	169	10	41.885	349.77
67-66-3	CHLOROFORM	119.4	LBNL Data File	169	10	41.885	349.77
67-66-3	CHLOROFORM	119.4	LBNL Data File	169	25	41.885	1047.13
67-66-3	CHLOROFORM	119.4	LBNL Data File	169	25	41.885	1047.13
67-66-3	CHLOROFORM	119.4	LBNL Data File	169	25	41.885	1047.13
67-66-3	CHLOROFORM/ISOAMYL ALCOHOL	119.4	LBNL Data File	169	5	41.885	34.98
67-66-3	CHLOROFORM	119.4	LBNL Data File	169	25	41.885	699.54
67-66-3	CHLOROFORM	119.4	LBNL Data File	169	10	41.885	349.77
67-66-3	CHLOROFORM	119.4	LBNL Data File	169	10	41.885	349.77
67-66-3	CHLOROFORM	119.4	LBNL Data File	169	10	41.885	349.77
67-66-3	CHLOROFORM	119.4	LBNL Data File	169	10	41.885	349.77
67-66-3	CHLOROFORM	119.4	LBNL Data File	169	10	41.885	349.77
67-66-3	CHLOROFORM	119.4	LBNL Data File	169	25	41.885	1047.13
67-66-3	CHLOROFORM	119.4	LBNL Data File	169	10	41.885	349.77
67-66-3	CHLOROFORM	119.4	LBNL Data File	169	5	41.885	17.49
67-66-3	CHLOROFORM	119.4	LBNL Data File	169	5	41.885	17.49
67-66-3	CHLOROFORM	119.4	LBNL Data File	169	5	41.885	17.49
67-66-3	CHLOROFORM	119.4	LBNL Data File	169	10	41.885	349.77
67-66-3	CHLOROFORM	119.4	LBNL Data File	169	25	41.885	1047.13
67-66-3	CHLOROFORM	119.4	LBNL Data File	169	10	41.885	349.77
67-66-3	CHLOROFORM	119.4	LBNL Data File	169	10	41.885	349.77
67-66-3	CHLOROFORM	119.4	LBNL Data File	169	10	41.885	349.77
67-66-3	CHLOROFORM	119.4	LBNL Data File	169	5	41.885	17.49
67-66-3	CHLOROFORM	119.4	LBNL Data File	169	25	41.885	699.54
67-66-3	CHLOROFORM	119.4	LBNL Data File	169	5	41.885	17.49
67-66-3	CHLOROFORM	119.4	LBNL Data File	169	10	41.885	69.95

Calculation of Liquid Chemical Emissions
Phase 1 Laboratory Usage Scenario
Proposed Richmond Bay Campus Long Range Development Plan, Richmond, California
Emissions from Evaporation During Use (Table G-5)

A = Surface Area (cm^2) = 100
U = Wind Speed (m/s) = 0.51
MW = Molecular Weight (g/mole) = Chemical-specific
VP = Vapor Pressure (mmHg) = Chemical-specific
R = Gas Constant (atm-cm^3/mole-deg K) = 82.05
T = Ambient Temperature (K) = 295

Loss (grams/batch) = $(4.120*A*U^{0.78}*MW^{0.67}*VP)/(R*T)$

This list of chemicals comes from merging the purchase and inventory lists Must be identical to Total Usage worksheet		*MW entered manually*		*From previous worksheet*	*From previous worksheet*	*Calculated*	*Calculated*
CAS No.	**Compound Name**	**MW (g/mole)**	**MW Reference**	**Adjusted Vapor Pressure (mmHg)**	**Assumed No. of Batches (per yr)**	**Estimated Loss Emission Factor (grams/batch)**	**Estimated Emissions (grams/yr)**
67-66-3	CHLOROFORM	119.4	LBNL Data File	169	5	41.885	17.49
67-66-3	CHLOROFORM	119.4	LBNL Data File	169	10	41.885	349.77
67-66-3	CHLOROFORM	119.4	LBNL Data File	169	10	41.885	349.77
67-66-3	CHLOROFORM	119.4	LBNL Data File	169	25	41.885	664.56
67-66-3	CHLOROFORM	119.4	LBNL Data File	169	10	41.885	349.77
67-66-3	CHLOROFORM	119.4	LBNL Data File	169	5	41.885	17.49
67-66-3	CHLOROFORM	119.4	LBNL Data File	169	10	41.885	349.77
67-66-3	CHLOROFORM	119.4	LBNL Data File	169	5	41.885	17.49
67-66-3	CHLOROFORM	119.4	LBNL Data File	169	25	41.885	699.54
67-66-3	CHLOROFORM	119.4	LBNL Data File	169	25	41.885	699.54
67-66-3	CHLOROFORM	119.4	LBNL Data File	169	5	41.885	17.49
67-66-3	CHLOROFORM	119.4	LBNL Data File	169	10	41.885	349.77
67-66-3	CHLOROFORM	119.4	LBNL Data File	169	10	41.885	349.77
67-66-3	CHLOROFORM	119.4	LBNL Data File	169	10	41.885	349.77
68-12-2	N,N-DIMETHYLFORMAMIDE	73.1	LBNL Data File	6	10	1.156	11.56
68-12-2	N-N-DIMETHYLFOMAMIDE	73.1	LBNL Data File	6	10	1.156	11.56
68-12-2	N,N-DIMETHYLFORMAMIDE	73.1	LBNL Data File	6	25	1.156	28.90
68-12-2	N,N-DIMETHYLFORMAMIDE	73.1	LBNL Data File	6	10	1.156	11.56
68-12-2	N,N-DIMETHYLFORMAMIDE	73.1	LBNL Data File	6	25	1.156	28.90
68-12-2	N,N-DIMETHYLFORMAMIDE	73.1	LBNL Data File	6	25	1.156	28.90
68-12-2	N-N-DIMETHYL FORMAMIDE	73.1	LBNL Data File	6	25	1.156	28.90
68-12-2	N,N-DIMETHYLFORMAMIDE	73.1	LBNL Data File	6	25	1.156	28.90
68-12-2	N,N-DIMETHYLFORMAMIDE, ANHYDROUS	73.1	LBNL Data File	6	10	1.156	11.56
68-12-2	DMF	73.1	LBNL Data File	6	10	1.156	11.56
68-12-2	DMF	73.1	LBNL Data File	6	25	1.156	28.90
68-12-2	DMF	73.1	LBNL Data File	6	10	1.156	11.56
68-12-2	DMF	73.1	LBNL Data File	6	10	1.156	11.56
68-12-2	DIMETHYLFORMAMIDE	73.1	LBNL Data File	6	1	1.156	0.70
68-12-2	DMF	73.1	LBNL Data File	6	10	1.156	11.56
68-12-2	DMF	73.1	LBNL Data File	6	10	1.156	11.56
68-12-2	DMF	73.1	LBNL Data File	6	10	1.156	11.56
68-12-2	DIMETHYLFORMAMIDE	73.1	LBNL Data File	6	10	1.156	11.56
68-12-2	DIMETHYL-FORMAMIDE	73.1	LBNL Data File	6	10	1.156	11.56
68-12-2	DIMETHYL-FORMAMIDE	73.1	LBNL Data File	6	10	1.156	11.56
68-12-2	DIMETHYLFORMAMIDE	73.1	LBNL Data File	6	25	1.156	28.90
68-12-2	DIMETHYLFORMAMIDE	73.1	LBNL Data File	6	25	1.156	28.90
68-12-2	DMF	73.1	LBNL Data File	6	10	1.156	11.56
68-12-2	N, N-DIMETHYLFORMAMIDE, REAGENT GRADE	73.1	LBNL Data File	6	10	1.156	11.56
68-12-2	N,N-DIMETHYLFORMAMIDE	73.1	LBNL Data File	6	10	1.156	11.56
68-12-2	DIMETHYLFORMAMIDE	73.1	LBNL Data File	6	10	1.156	11.56
68-12-2	N,N-DIMETHYL FORMAMIDE	73.1	LBNL Data File	6	25	1.156	28.90
68-12-2	N,N'-DIMETHYL FORMAMIDE	73.1	LBNL Data File	6	10	1.156	11.56
68-12-2	N,N-DIMETHYLFORMAMIDE	73.1	LBNL Data File	6	10	1.156	11.56
68-12-2	DMF	73.1	LBNL Data File	6	10	1.156	11.56
68-12-2	DMF	73.1	LBNL Data File	6	10	1.156	11.56
68-12-2	DMF	73.1	LBNL Data File	6	10	1.156	11.56
71-43-2	BENZENE	78.1	LBNL Data File	100	25	18.663	466.57
71-43-2	BENZENE	78.1	LBNL Data File	100	25	18.663	466.57
71-43-2	BENZENE(ANHYDROUS)	78.1	LBNL Data File	100	25	18.663	466.57
71-43-2	BENZENE(ANHYDROUS)	78.1	LBNL Data File	100	10	18.663	69.95
71-43-2	BENZENE	78.1	LBNL Data File	100	25	18.663	466.57
75-07-0	ACETALDEHYDE	44.1	LBNL Data File	802	1	102.108	3.50
75-07-0	ACETALDEHYDE	44.1	LBNL Data File	802	10	102.108	69.95
75-07-0	ACETALDEHYDE	44.1	LBNL Data File	802	10	102.108	69.95
75-09-2	DICHLOROMETHANE	84.9	LBNL Data File	379	10	74.706	69.95
75-09-2	METHYLENE CHLORIDE	84.9	LBNL Data File	379	0	74.706	0.00
75-09-2	METHYLENE CHLORIDE	84.9	LBNL Data File	379	25	74.706	1867.64
75-09-2	DICHLOROMETHANE	84.9	LBNL Data File	379	100	74.706	7470.55
75-09-2	TO BE VALIDATED-DICHLOROME, ANHYDROUS	84.9	LBNL Data File	379	10	74.706	69.95
75-09-2	DICHLOROMETHANE	84.9	LBNL Data File	379	25	74.706	699.54
75-09-2	METHYLENE CHLORIDE	84.9	LBNL Data File	379	100	74.706	7470.55
75-09-2	METHYLENE CHLORIDE	84.9	LBNL Data File	379	25	74.706	1867.64
75-09-2	METHYLENE CHLORIDE	84.9	LBNL Data File	379	25	74.706	1867.64
75-09-2	METHYLENE CHLORIDE	84.9	LBNL Data File	379	10	74.706	69.95
75-09-2	METHYLENE CHLORIDE	84.9	LBNL Data File	379	25	74.706	699.54
75-09-2	METHYLENE CHLORIDE	84.9	LBNL Data File	379	10	74.706	69.95
75-09-2	DICHLOROMETHANE	84.9	LBNL Data File	379	25	74.706	1867.64
75-09-2	DICHLOROMETHANE	84.9	LBNL Data File	379	25	74.706	1867.64
75-09-2	DICHLOROMETHANE	84.9	LBNL Data File	379	25	74.706	699.54
75-09-2	METHYLENE CHLORIDE	84.9	LBNL Data File	379	25	74.706	699.54
75-09-2	METHYLENE CHLORIDE	84.9	LBNL Data File	379	25	74.706	699.54
75-09-2	DICHLOROMETHANE	84.9	LBNL Data File	379	100	74.706	7470.55
75-09-2	METHYLENE CHLORIDE	84.9	LBNL Data File	379	25	74.706	699.54
75-09-2	DICHLOROMETHANE	84.9	LBNL Data File	379	100	74.706	7470.55
75-09-2	METHYLENE CHLORIDE	84.9	LBNL Data File	379	25	74.706	1867.64

Calculation of Liquid Chemical Emissions
Phase 1 Laboratory Usage Scenario
Proposed Richmond Bay Campus Long Range Development Plan, Richmond, California
Emissions from Evaporation During Use (Table G-5)

A = Surface Area (cm^2) = 100
U = Wind Speed (m/s) = 0.51
MW = Molecular Weight (g/mole) = Chemical-specific
VP = Vapor Pressure (mmHg) = Chemical-specific
R = Gas Constant (atm-cm^3/mole-deg K) = 82.05
T = Ambient Temperature (K) = 295

Loss (grams/batch) = $(4.120*A*U^{0.78}*MW^{0.67}*VP)/(R*T)$

This list of chemicals comes from merging the purchase and inventory lists Must be identical to Total Usage worksheet		*MW entered manually*		*From previous worksheet*	*From previous worksheet*	*Calculated*	*Calculated*
CAS No.	**Compound Name**	**MW (g/mole)**	**MW Reference**	**Adjusted Vapor Pressure (mmHg)**	**Assumed No. of Batches (per yr)**	**Estimated Loss Emission Factor (grams/batch)**	**Estimated Emissions (grams/yr)**
75-09-2	DICHLOROMETHANE	84.9	LBNL Data File	379	25	74.706	1867.64
75-09-2	METHYLENE CHLORIDE	84.9	LBNL Data File	379	0	74.706	0.00
75-09-2	DICHLOROMETHANE	84.9	LBNL Data File	379	25	74.706	1867.64
75-09-2	METHANE, DICHLORO-	84.9	LBNL Data File	379	10	74.706	349.77
75-09-2	METHYLENE CHLORIDE	84.9	LBNL Data File	379	25	74.706	699.54
75-56-9	PROPYLENE OXIDE	58.08	LBNL Data File	468	1	71.674	0.21
75-56-9	PROPYLENE OXIDE	58.08	LBNL Data File	468	1	71.674	0.21
78-93-3	MEK	72.1	LBNL Data File	100	10	17.690	176.90
78-93-3	METHYL ETHYL KETONE	72.1	LBNL Data File	100	10	17.690	176.90
78-93-3	MEK	72.1	LBNL Data File	100	10	17.690	176.90
78-93-3	2-BUTANONE	72.1	LBNL Data File	100	25	17.690	442.24
79-01-6	TRICHLOROETHYLENE	131.4	LBNL Data File	100	10	26.446	264.46
79-01-6	TRICHLOROETHYLENE	131.4	LBNL Data File	100	10	26.446	264.46
79-01-6	TRICHLOROETHYLENE	131.4	LBNL Data File	100	10	26.446	264.46
79-01-6	TRICHLOROETHYLENE	131.4	LBNL Data File	100	10	26.446	264.46
79-10-7	ACRYLIC ACID	72.06	LBNL Data File	100	1	17.683	3.33
79-10-7	ACRYLIC ACID	72.06	LBNL Data File	100	1	17.683	3.33
79-10-7	ACRYLIC ACID	72.06	LBNL Data File	100	1	17.683	3.33
100-41-4	ETHYL BENZENE	106.2	LBNL Data File	16	25	3.627	90.67
100-42-5	STYRENE	104.14	LBNL Data File	11	10	2.477	24.77
100-42-5	STYRENE	104.14	LBNL Data File	11	1	2.477	2.48
100-44-7	BENZYL CHLORIDE	126.58	LBNL Data File	2	10	0.515	5.15
106-89-8	4-METHYLUMBELLIFERONE	92.5	LBNL Data File	26	5	5.435	14.78
106-99-0	1,3-BUTADIENE IN TOLUENE	54.1	LBNL Data File	1838	10	268.219	282.07
107-02-8	ACROLEIN	56.1	LBNL Data File	242	10	36.189	69.95
107-06-2	1,2-DICHLOROETHANE	99	LBNL Data File	100	25	21.876	546.91
107-06-2	1,2-DICHLOROETHANE	99	LBNL Data File	100	10	21.876	218.76
107-06-2	1,2-DICHLOROETHANE	99	LBNL Data File	100	25	21.876	546.91
107-06-2	1,2-DICHLOROETHANE	99	LBNL Data File	100	25	21.876	546.91
107-06-2	1,2-DICHLOROETHANE	99	LBNL Data File	100	10	21.876	218.76
107-21-1	ETHYLENE GLYCOL	62.07	LBNL Data File	0	25	0.021	0.53
107-21-1	ETHYLENE GLYCOL	62.07	LBNL Data File	0	25	0.021	0.53
107-21-1	ETHYLENE GLYCOL	62.07	LBNL Data File	0	25	0.021	0.53
107-21-1	ETHYLENE GLYCOL	62.07	LBNL Data File	0	25	0.021	0.53
107-21-1	ETHYLENE GLYCOL	62.07	LBNL Data File	0	10	0.021	0.21
107-21-1	ETHYLENE GLYCOL	62.07	LBNL Data File	0	25	0.021	0.53
107-21-1	ETHYLENE GLYCOL	62.07	LBNL Data File	0	10	0.021	0.21
107-21-1	ETHYLENE GLYCOL	62.07	LBNL Data File	0	10	0.021	0.21
107-21-1	ETHYLENE GLYCOL	62.07	LBNL Data File	0	10	0.021	0.21
107-21-1	ETHYLENE GLYCOL	62.07	LBNL Data File	0	25	0.021	0.53
107-21-1	ETHYLENE GLYCOL	62.07	LBNL Data File	0	25	0.021	0.53
107-21-1	ETHYLENE GLYCOL	62.07	LBNL Data File	0	10	0.021	0.21
107-21-1	ETHYLENE GLYCOL	62.07	LBNL Data File	0	5	0.021	0.11
107-98-2	1-METHOXY-2-PROPANOL	90.12	NIST	24	1	4.848	4.85
107-98-2	1-METHOXY-2-PROPANOL	90.12	NIST	24	1	4.848	4.85
108-39-4	M-CRESOL	108.1	LBNL Data File	0	10	0.059	0.59
108-39-4	M-CRESOL	108.1	LBNL Data File	0	10	0.059	0.59
108-88-3	TOLUENE	92.1	LBNL Data File	48	10	10.050	69.95
108-88-3	TOLUENE	92.1	LBNL Data File	48	25	10.050	251.25
108-88-3	TOLUENE	92.1	LBNL Data File	48	10	10.050	100.50
108-88-3	TOLUENE	92.1	LBNL Data File	48	25	10.050	251.25
108-88-3	TOLUENE	92.1	LBNL Data File	48	25	10.050	251.25
108-88-3	TOLUENE	92.1	LBNL Data File	48	25	10.050	251.25
108-88-3	TOLUENE	92.1	LBNL Data File	48	25	10.050	251.25
108-88-3	TOLUENE	92.1	LBNL Data File	48	25	10.050	251.25
108-88-3	TOLUENE	92.1	LBNL Data File	48	25	10.050	251.25
108-88-3	TOLUENE	92.1	LBNL Data File	48	25	10.050	251.25
108-88-3	TOLUENE	92.1	LBNL Data File	48	25	10.050	251.25
108-88-3	TOLUENE	92.1	LBNL Data File	48	25	10.050	251.25
108-88-3	TOLUENE	92.1	LBNL Data File	48	10	10.050	69.95
108-88-3	TOLUENE	92.1	LBNL Data File	48	25	10.050	251.25
108-88-3	TOLUENE	92.1	LBNL Data File	48	25	10.050	251.25
108-88-3	TOLUENE	92.1	LBNL Data File	48	10	10.050	100.50
108-88-3	TOLUENE	92.1	LBNL Data File	48	25	10.050	251.25
108-88-3	TOLUENE	92.1	LBNL Data File	48	25	10.050	251.25
108-88-3	TOLUENE	92.1	LBNL Data File	48	25	10.050	251.25
108-88-3	TOLUENE	92.1	LBNL Data File	48	10	10.050	69.95
108-88-3	TOLUENE	92.1	LBNL Data File	48	10	10.050	100.50
108-88-3	TOLUENE	92.1	LBNL Data File	48	25	10.050	251.25
108-88-3	TOLUENE	92.1	LBNL Data File	48	10	10.050	100.50
109-86-4	2-METHOXYETHANOL	76.09	NIST	17	25	3.074	76.85
110-54-3	HEXANE	86.17	LBNL Data File	132	25	26.289	657.22
110-54-3	HEXANE, CHROMASOLV PLUS	86.17	LBNL Data File	132	25	26.289	657.22
110-54-3	HEXANE	86.17	LBNL Data File	132	25	26.289	657.22

Calculation of Liquid Chemical Emissions
Phase 1 Laboratory Usage Scenario
Proposed Richmond Bay Campus Long Range Development Plan, Richmond, California
Emissions from Evaporation During Use (Table G-5)

A = Surface Area (cm^2) = 100
U = Wind Speed (m/s) = 0.51
MW = Molecular Weight (g/mole) = Chemical-specific
VP = Vapor Pressure (mmHg) = Chemical-specific
R = Gas Constant (atm-cm^3/mole-deg K) = 82.05
T = Ambient Temperature (K) = 295

Loss (grams/batch) = $(4.120*A*U^{0.78}*MW^{0.67}*VP)/(R*T)$

This list of chemicals comes from merging the purchase and inventory lists Must be identical to Total Usage worksheet		*MW entered manually*		*From previous worksheet*	*From previous worksheet*	*Calculated*	*Calculated*
CAS No.	**Compound Name**	**MW (g/mole)**	**MW Reference**	**Adjusted Vapor Pressure (mmHg)**	**Assumed No. of Batches (per yr)**	**Estimated Loss Emission Factor (grams/batch)**	**Estimated Emissions (grams/yr)**
110-54-3	HEXANE	86.17	LBNL Data File	132	0	26.289	0.00
110-54-3	HEXANE	86.17	LBNL Data File	132	25	26.289	657.22
110-54-3	HEXANE	86.17	LBNL Data File	132	25	26.289	657.22
110-54-3	HEXANE	86.17	LBNL Data File	132	100	26.289	2628.89
110-54-3	HEXANE	86.17	LBNL Data File	132	25	26.289	657.22
110-54-3	HEXANE	86.17	LBNL Data File	132	0	26.289	0.00
110-54-3	HEXANE	86.17	LBNL Data File	132	100	26.289	2628.89
110-54-3	HEXANE	86.17	LBNL Data File	132	25	26.289	657.22
110-54-3	ALKANE STANDARD SOLUTION C8-C20	86.17	LBNL Data File	132	1	26.289	0.70
110-54-3	HEXANE	86.17	LBNL Data File	132	0	26.289	0.00
110-54-3	HEXANE	86.17	LBNL Data File	132	25	26.289	657.22
110-54-3	HEXANE	86.17	LBNL Data File	132	25	26.289	657.22
110-54-3	HEXANE	86.17	LBNL Data File	132	25	26.289	657.22
110-54-3	HEXANE	86.17	LBNL Data File	132	25	26.289	657.22
110-54-3	HEXANE	86.17	LBNL Data File	132	25	26.289	657.22
110-54-3	HEXANE	86.17	LBNL Data File	132	25	26.289	657.22
110-54-3	HEXANE	86.17	LBNL Data File	132	100	26.289	2628.89
110-54-3	HEXANE	86.17	LBNL Data File	132	100	26.289	2628.89
110-54-3	HEXANE	86.17	LBNL Data File	132	25	26.289	657.22
110-54-3	HEXANE	86.17	LBNL Data File	132	100	26.289	2628.89
110-54-3	HEXANE	86.17	LBNL Data File	132	25	26.289	657.22
110-54-3	HEXANE	86.17	LBNL Data File	132	25	26.289	657.22
110-54-3	HEXANE	86.17	LBNL Data File	132	25	26.289	657.22
110-54-3	HEXANE	86.17	LBNL Data File	132	25	26.289	657.22
110-54-3	HEXANE	86.17	LBNL Data File	132	100	26.289	2628.89
110-54-3	HEXANE	86.17	LBNL Data File	132	100	26.289	2628.89
110-54-3	ALKANE STANDARD SOLUTION C8-C20	86.17	LBNL Data File	132	1	26.289	0.70
110-54-3	HEXANE	86.17	LBNL Data File	132	100	26.289	2628.89
110-54-3	HEXANE	86.17	LBNL Data File	132	25	26.289	657.22
110-54-3	HEXANE	86.17	LBNL Data File	132	0	26.289	0.00
110-54-3	HEXANE	86.17	LBNL Data File	132	25	26.289	657.22
110-54-3	N-HEXANE	86.17	LBNL Data File	132	25	26.289	657.22
110-54-3	HEXANE	86.17	LBNL Data File	132	25	26.289	657.22
110-54-3	HEXANE	86.17	LBNL Data File	132	25	26.289	657.22
110-54-3	N-HEXANE	86.17	LBNL Data File	132	10	26.289	69.95
110-54-3	HEXANE	86.17	LBNL Data File	132	10	26.289	262.89
110-54-3	HEXANE	86.17	LBNL Data File	132	25	26.289	657.22
110-54-3	HEXANE	86.17	LBNL Data File	132	25	26.289	657.22
110-54-3	HEXANE	86.17	LBNL Data File	132	25	26.289	657.22
110-54-3	HEXANE, CHROMASOLV PLUS	86.17	LBNL Data File	132	25	26.289	657.22
110-54-3	HEXANE	86.17	LBNL Data File	132	25	26.289	657.22
111-30-8	GLUTARALDEHYDE 25% AQUEOUS SOLUTION	100.12	NIST	1	25	0.198	4.96
111-30-8	GLUTARALDEHYDE SOLUTION	100.12	NIST	1	5	0.198	0.99
111-30-8	GLUTARALDEHYDE	100.12	NIST	1	5	0.198	0.99
111-30-8	GLUTARALDEHYDE SOLUTION	100.12	NIST	1	10	0.198	1.98
111-30-8	GLUTARALDEHYDE	100.12	NIST	1	5	0.198	0.99
111-30-8	GLUTARALDEHYDE	100.12	NIST	1	10	0.198	1.98
111-30-8	GLUTARALDEHYDE SOLUTION	100.12	NIST	1	5	0.198	0.99
111-30-8	GLUTARALDEHYDE SOLUTION	100.12	NIST	1	5	0.198	0.99
111-30-8	GLUTARALDEHYDE	100.12	NIST	1	5	0.198	0.99
111-30-8	GLUTARALDEHYDE	100.12	NIST	1	5	0.198	0.99
111-30-8	GLUTARALDEHYDE	100.12	NIST	1	5	0.198	0.99
111-30-8	GLUTARALDEHYDE	100.12	NIST	1	10	0.198	1.98
111-30-8	GLUTARALDEHYDE	100.12	NIST	1	10	0.198	1.98
111-30-8	GLUTERALDEHYDE	100.12	NIST	1	1	0.198	0.20
111-30-8	GLUTERALDEHYDE	100.12	NIST	1	5	0.198	0.99
111-30-8	GLUTERALDEHYDE	100.12	NIST	1	5	0.198	0.99
111-30-8	GLUTARALDEHYDE	100.12	NIST	1	5	0.198	0.99
111-30-8	GLUTARALDEHYDE	100.12	NIST	1	1	0.198	0.20
111-30-8	GLUTARALDEHYDE	100.12	NIST	1	5	0.198	0.99
111-30-8	GLUTARALDEHYDE	100.12	NIST	1	10	0.198	1.98
111-30-8	GLUTARALDEHYDE	100.12	NIST	1	1	0.198	0.20
111-30-8	GLUTARALDEHYDE 25% AQUEOUS SOLUTION	100.12	NIST	1	1	0.198	0.20
111-30-8	GLUTARALDEHYDE 25% AQUEOUS SOLUTION	100.12	NIST	1	5	0.198	0.99
111-30-8	GLUTARALDEHYDE 25% AQUEOUS SOLUTION	100.12	NIST	1	5	0.198	0.99
111-30-8	GLUTARALDEHYDE	100.12	NIST	1	10	0.198	1.98
111-30-8	GLUTARALDEHYDE	100.12	NIST	1	5	0.198	0.99
111-30-8	GLUTARIC DIALDEHYDE	100.12	NIST	1	25	0.198	4.96
111-30-8	GLUTERALDEHYDE	100.12	NIST	1	10	0.198	1.98
111-30-8	GLUTARALDEHYDE	100.12	NIST	1	10	0.198	1.98
111-30-8	GLUTARALDEHYDE 25% AQUEOUS SOLUTION	100.12	NIST	1	10	0.198	1.98
111-30-8	GLUTARALDEHYDE SOLUTION	100.12	NIST	1	5	0.198	0.99
111-42-2	DIETHANOLAMINE	105.1	LBNL Data File	0	10	0.000	0.00
111-42-2	DIETHANOLAMINE	105.1	LBNL Data File	0	5	0.000	0.00
111-42-2	DIETHANOLAMINE	105.1	LBNL Data File	0	10	0.000	0.00

Calculation of Liquid Chemical Emissions
Phase 1 Laboratory Usage Scenario
Proposed Richmond Bay Campus Long Range Development Plan, Richmond, California
Emissions from Evaporation During Use (Table G-5)

A = Surface Area (cm^2) = 100
U = Wind Speed (m/s) = 0.51
MW = Molecular Weight (g/mole) = Chemical-specific
VP = Vapor Pressure (mmHg) = Chemical-specific
R = Gas Constant (atm-cm^3/mole-deg K) = 82.05
T = Ambient Temperature (K) = 295

Loss (grams/batch) = $(4.120*A*U^{0.78}*MW^{0.67}*VP)/(R*T)$

This list of chemicals comes from merging the purchase and inventory lists Must be identical to Total Usage worksheet		*MW entered manually*		*From previous worksheet*	*From previous worksheet*	*Calculated*	*Calculated*
CAS No.	**Compound Name**	**MW (g/mole)**	**MW Reference**	**Adjusted Vapor Pressure (mmHg)**	**Assumed No. of Batches (per yr)**	**Estimated Loss Emission Factor (grams/batch)**	**Estimated Emissions (grams/yr)**
111-42-2	DIETHANOLAMINE	105.1	LBNL Data File	0	10	0.000	0.00
121-44-8	TRIETHYLAMINE	101	LBNL Data File	97	10	21.429	214.29
121-44-8	TRIETHYLAMINE	101	LBNL Data File	97	10	21.429	69.95
121-44-8	TRIETHYLAMINE	101	LBNL Data File	97	5	21.429	7.00
121-44-8	TRIETHYLAMINE	101	LBNL Data File	97	5	21.429	24.02
121-44-8	TRIETHYLAMINE	101	LBNL Data File	97	25	21.429	535.73
121-44-8	TRIETHYLAMINE	101	LBNL Data File	97	10	21.429	69.95
121-44-8	TRIETHYLAMINE	101	LBNL Data File	97	10	21.429	69.95
121-44-8	TRIETHYLAMINE	101	LBNL Data File	97	10	21.429	69.95
121-44-8	TRIETHYLAMINE	101	LBNL Data File	97	10	21.429	214.29
123-91-1	1,4-DIOXANE ANHYDROUS	88.1	LBNL Data File	64	25	12.854	321.34
123-91-1	1,4-DIOXANE	88.1	LBNL Data File	64	25	12.854	321.34
123-91-1	DIOXANE	88.1	LBNL Data File	64	25	12.854	321.34
123-91-1	1,4-DIOXANE	88.1	LBNL Data File	64	25	12.854	321.34
123-91-1	1,4 DIOXANE	88.1	LBNL Data File	64	25	12.854	321.34
123-91-1	1,4 DIOXANE	88.1	LBNL Data File	64	10	12.854	128.54
123-91-1	1,4-DIOXANE ANHYDROUS	88.1	LBNL Data File	64	25	12.854	321.34
123-91-1	DIOXANE	88.1	LBNL Data File	64	25	12.854	321.34
123-91-1	DIOXANE	88.1	LBNL Data File	64	25	12.854	321.34
123-91-1	DIOXANE	88.1	LBNL Data File	64	25	12.854	321.34
123-91-1	DIOXANE	88.1	LBNL Data File	64	10	12.854	69.95
127-18-4	TETRACHLOROETHYLENE	165.8	LBNL Data File	30	25	9.421	235.52
1330-20-7	XYLENE	106.2	LBNL Data File	13	25	3.082	77.04
1330-20-7	XYLENE	106.2	LBNL Data File	13	10	3.082	30.82
1330-20-7	XYLENE	106.2	LBNL Data File	13	25	3.082	77.04
1330-20-7	XYLENE	106.2	LBNL Data File	13	1	3.082	3.08
1330-20-7	XYLENE	106.2	LBNL Data File	13	10	3.082	30.82
1330-20-7	XYLENE	106.2	LBNL Data File	13	25	3.082	77.04
1330-20-7	XYLENE	106.2	LBNL Data File	13	25	3.082	77.04
1330-20-7	XYLENE	106.2	LBNL Data File	13	25	3.082	77.04
1330-20-7	XYLENE	106.2	LBNL Data File	13	10	3.082	30.82
1330-20-7	XYLENE	106.2	LBNL Data File	13	10	3.082	30.82
1330-20-7	XYLENE	106.2	LBNL Data File	13	10	3.082	30.82
1330-20-7	XYLENE	106.2	LBNL Data File	13	25	3.082	77.04
1330-20-7	XYLENE	106.2	LBNL Data File	13	25	3.082	77.04
1330-20-7	XYLENES	106.2	LBNL Data File	13	10	3.082	30.82
1330-20-7	XYLENE	106.2	LBNL Data File	13	1	3.082	0.81
1330-20-7	XYLENE	106.2	LBNL Data File	13	10	3.082	30.82
1330-20-7	XYLENE	106.2	LBNL Data File	13	25	3.082	77.04
1330-20-7	DEPEX MOUNTING MEDIA	106.2	LBNL Data File	13	10	3.082	30.82
1634-04-4	METHYL TERT-BUTYL ETHER	88.15	LBNL Data File	120	25	24.337	608.43
1634-04-4	METHYL TERT-BUTYL ETHER	88.15	LBNL Data File	120	10	24.337	69.95
7647-01-0	HYDROCHLORIC ACID STANDARD SOLUTION	36.47	LBNL Data File	190	25	21.289	532.22
7647-01-0	HCL	36.47	LBNL Data File	190	5	21.289	34.98
7647-01-0	HYDROCHLORIC ACID	36.47	LBNL Data File	190	25	21.289	532.22
7647-01-0	HYDROCHLORIC ACID	36.47	LBNL Data File	190	25	21.289	532.22
7647-01-0	HYDROCHLORIC ACID	36.47	LBNL Data File	190	25	21.289	532.22
7647-01-0	HYDROCHLORIC ACID	36.47	LBNL Data File	190	25	21.289	532.22
7647-01-0	HYDROCHLORIC ACID	36.47	LBNL Data File	190	25	21.289	532.22
7647-01-0	HYDROCHLORIC ACID	36.47	LBNL Data File	190	10	21.289	212.89
7647-01-0	HYDROCHLORIC ACID	36.47	LBNL Data File	190	25	21.289	532.22
7647-01-0	HYDROCHLORIC ACID	36.47	LBNL Data File	190	25	21.289	532.22
7647-01-0	HYDROCHLORIC ACID	36.47	LBNL Data File	190	25	21.289	532.22
7647-01-0	HYDROCHLORIC ACID	36.47	LBNL Data File	190	25	21.289	532.22
7647-01-0	HYDROCHLORIC ACID	36.47	LBNL Data File	190	25	21.289	532.22
7647-01-0	HYDROCHLORIC ACID	36.47	LBNL Data File	190	10	21.289	212.89
7647-01-0	HYDROCHLORIC ACID	36.47	LBNL Data File	190	25	21.289	532.22
7647-01-0	HYDROCHLORIC ACID	36.47	LBNL Data File	190	25	21.289	532.22
7647-01-0	HYDROCHLORIC ACID	36.47	LBNL Data File	190	10	21.289	212.89
7647-01-0	HYDROCHLORIC ACID	36.47	LBNL Data File	190	25	21.289	532.22
7647-01-0	HYDROCHLORIC ACID	36.47	LBNL Data File	190	25	21.289	532.22
7647-01-0	HYDROCHLORIC ACID	36.47	LBNL Data File	190	25	21.289	532.22
7647-01-0	HYDROCHLORIC ACID	36.47	LBNL Data File	190	25	21.289	532.22
7647-01-0	HYDROCHLORIC ACID	36.47	LBNL Data File	190	25	21.289	532.22
7647-01-0	HYDROCHLORIC ACID	36.47	LBNL Data File	190	25	21.289	532.22
7647-01-0	HYDROCHLORIC ACID	36.47	LBNL Data File	190	25	21.289	532.22
7647-01-0	HYDROCHLORIC ACID	36.47	LBNL Data File	190	10	21.289	212.89
7647-01-0	HYDROCHLORIC ACID SOLUTION	36.47	LBNL Data File	190	10	21.289	69.95
7647-01-0	HYDROCHLORIC ACID	36.47	LBNL Data File	190	10	21.289	69.95
7647-01-0	HYDROCHLORIC ACID	36.47	LBNL Data File	190	10	21.289	212.89
7647-01-0	HYDROCHLORIC ACID	36.47	LBNL Data File	190	10	21.289	212.89
7647-01-0	HYDROCHLORIC ACID	36.47	LBNL Data File	190	10	21.289	69.95
7647-01-0	HYDROCHLORIC ACID	36.47	LBNL Data File	190	25	21.289	532.22

Calculation of Liquid Chemical Emissions
Phase 1 Laboratory Usage Scenario
Proposed Richmond Bay Campus Long Range Development Plan, Richmond, California
Emissions from Evaporation During Use (Table G-5)

A = Surface Area (cm^2) = 100
U = Wind Speed (m/s) = 0.51
MW = Molecular Weight (g/mole) = Chemical-specific
VP = Vapor Pressure (mmHg) = Chemical-specific
R = Gas Constant (atm-cm^3/mole-deg K) = 82.05
T = Ambient Temperature (K) = 295

Loss (grams/batch) = $(4.120*A*U^{0.78}*MW^{0.67}*VP)/(R*T)$

This list of chemicals comes from merging the purchase and inventory lists Must be identical to Total Usage worksheet		*MW entered manually*		*From previous worksheet*	*From previous worksheet*	*Calculated*	*Calculated*
CAS No.	**Compound Name**	**MW (g/mole)**	**MW Reference**	**Adjusted Vapor Pressure (mmHg)**	**Assumed No. of Batches (per yr)**	**Estimated Loss Emission Factor (grams/batch)**	**Estimated Emissions (grams/yr)**
7647-01-0	HYDROCHLORIC ACID	36.47	LBNL Data File	190	10	21.289	212.89
7647-01-0	HYDROCHLORIC ACID	36.47	LBNL Data File	190	25	21.289	532.22
7647-01-0	HYDROCHLORIC ACID	36.47	LBNL Data File	190	25	21.289	532.22
7647-01-0	HYDROCHLORIC ACID	36.47	LBNL Data File	190	25	21.289	532.22
7647-01-0	HYDROCHLORIC ACID	36.47	LBNL Data File	190	25	21.289	532.22
7647-01-0	HYDROCHLORIC ACID	36.47	LBNL Data File	190	25	21.289	532.22
7647-01-0	HYDROCHLORIC ACID	36.47	LBNL Data File	190	25	21.289	532.22
7647-01-0	HYDROCHLORIC ACID	36.47	LBNL Data File	190	10	21.289	212.89
7647-01-0	HYDROCHLORIC ACID	36.47	LBNL Data File	190	10	21.289	212.89
7647-01-0	HYDROCHLORIC ACID SOLUTION	36.47	LBNL Data File	190	10	21.289	212.89
7647-01-0	HYDROCHLORIC ACID	36.47	LBNL Data File	190	10	21.289	212.89
7647-01-0	HYDROCHLORIC ACID	36.47	LBNL Data File	190	10	21.289	212.89
7647-01-0	HYDROCHLORIC ACID	36.47	LBNL Data File	190	25	21.289	532.22
7647-01-0	HYDROCHLORIC ACID	36.47	LBNL Data File	190	1	21.289	0.70
7647-01-0	HYDROCHLORIC ACID	36.47	LBNL Data File	190	25	21.289	532.22
7647-01-0	HYDROCHLORIC ACID	36.47	LBNL Data File	190	25	21.289	532.22
7647-01-0	HYDROCHLORIC ACID	36.47	LBNL Data File	190	25	21.289	532.22
7647-01-0	IMIDAZOLERIC ACID	36.47	LBNL Data File	190	100	21.289	2128.88
7647-01-0	HYDROCHLORIC ACID	36.47	LBNL Data File	190	25	21.289	532.22
7647-01-0	HYDROCHLORIC ACID	36.47	LBNL Data File	190	10	21.289	212.89
7647-01-0	HYDROCHLORIC ACID	36.47	LBNL Data File	190	25	21.289	532.22
7647-01-0	HYDROCHLORIC ACID	36.47	LBNL Data File	190	10	21.289	212.89
7647-01-0	HYDROCHLORIC ACID	36.47	LBNL Data File	190	25	21.289	532.22
7647-01-0	HYDROCHLORIC ACID	36.47	LBNL Data File	190	25	21.289	532.22
7647-01-0	HCL	36.47	LBNL Data File	190	10	21.289	212.89
7647-01-0	HYDROCHLORIC ACID	36.47	LBNL Data File	190	10	21.289	212.89
7647-01-0	HYDROCHLORIC ACID	36.47	LBNL Data File	190	10	21.289	212.89
7647-01-0	HYDROCHLORIC ACID	36.47	LBNL Data File	190	10	21.289	212.89
7647-01-0	HYDROCHLORIC ACID	36.47	LBNL Data File	190	10	21.289	212.89
7647-01-0	DECAFLUORO-1,1,2,2-TERAHYDROOCTYL)TRICHLOROSIL	36.47	LBNL Data File	190	100	21.289	2128.88
7647-01-0	HCL	36.47	LBNL Data File	190	10	21.289	212.89
7647-01-0	HCL	36.47	LBNL Data File	190	10	21.289	212.89
7647-01-0	HYDROCHLORIC ACID	36.47	LBNL Data File	190	10	21.289	212.89
7647-01-0	HYDROCHLORIC ACID	36.47	LBNL Data File	190	10	21.289	212.89
7647-01-0	HYDROCHLORIC ACID	36.47	LBNL Data File	190	10	21.289	212.89
7647-01-0	HYDROCHLORIC ACID	36.47	LBNL Data File	190	25	21.289	532.22
7647-01-0	HYDROCHLORIC ACID	36.47	LBNL Data File	190	25	21.289	532.22
7647-01-0	HYDROCHLORIC ACID	36.47	LBNL Data File	190	25	21.289	532.22
7647-01-0	HYDROCHLORIC ACID	36.47	LBNL Data File	190	10	21.289	212.89
7647-01-0	HYDROCHLORIC ACID	36.47	LBNL Data File	190	100	21.289	2128.88
7647-01-0	HYDROCHLORIC ACID	36.47	LBNL Data File	190	10	21.289	212.89
7647-01-0	HYDROCHLORIC ACID	36.47	LBNL Data File	190	25	21.289	532.22
7647-01-0	HYDROCHLORIC ACID	36.47	LBNL Data File	190	10	21.289	69.95
7647-01-0	HYDROCHLORIC ACID	36.47	LBNL Data File	190	10	21.289	212.89
7647-01-0	HYDROCHLORIC ACID	36.47	LBNL Data File	190	10	21.289	69.95
7647-01-0	HYDROCHLORIC ACID	36.47	LBNL Data File	190	10	21.289	212.89
7647-01-0	HYDROCHLORIC ACID	36.47	LBNL Data File	190	10	21.289	212.89
7647-01-0	HYDROCHLORIC ACID	36.47	LBNL Data File	190	10	21.289	212.89
7647-01-0	HYDROCHLORIC ACID	36.47	LBNL Data File	190	1	21.289	2.10

Calculation of Liquid Chemical Emissions
Phase 1 Laboratory Usage Scenario
Proposed Richmond Bay Campus Long Range Development Plan, Richmond, California
Emissions from Evaporation During Use (Table G-5)

A = Surface Area (cm^2) = 100
U = Wind Speed (m/s) = 0.51
MW = Molecular Weight (g/mole) = Chemical-specific
VP = Vapor Pressure (mmHg) = Chemical-specific
R = Gas Constant (atm-cm^3/mole-deg K) = 82.05
T = Ambient Temperature (K) = 295

Loss (grams/batch) = $(4.120*A*U^{0.78}*MW^{0.67}*VP)/(R*T)$

This list of chemicals comes from merging the purchase and inventory lists Must be identical to Total Usage worksheet		*MW entered manually*		*From previous worksheet*	*From previous worksheet*	*Calculated*	*Calculated*
CAS No.	**Compound Name**	**MW (g/mole)**	**MW Reference**	**Adjusted Vapor Pressure (mmHg)**	**Assumed No. of Batches (per yr)**	**Estimated Loss Emission Factor (grams/batch)**	**Estimated Emissions (grams/yr)**
7647-01-0	HYDROCHLORIC ACID	36.47	LBNL Data File	190	25	21.289	532.22
7647-01-0	HYDROCHLORIC ACID	36.47	LBNL Data File	190	10	21.289	212.89
7647-01-0	HYDROCHLORIC ACID	36.47	LBNL Data File	190	10	21.289	212.89
7647-01-0	HYDROCHLORIC ACID	36.47	LBNL Data File	190	25	21.289	532.22
7647-01-0	HYDROCHLORIC ACID	36.47	LBNL Data File	190	10	21.289	212.89
7647-01-0	HYDROCHLORIC ACID	36.47	LBNL Data File	190	10	21.289	212.89
7647-01-0	HYDROCHLORIC ACID	36.47	LBNL Data File	190	10	21.289	212.89
7647-01-0	HYDROCHLORIC ACID	36.47	LBNL Data File	190	10	21.289	212.89
7647-01-0	HYDROCHLORIC ACID	36.47	LBNL Data File	190	25	21.289	532.22
7664-38-2	BIO-SAFE COOMASSIE	98.04	LBNL Data File	0	25	0.013	0.33
7664-38-2	BIO-SAFE COOMASSIE	98.04	LBNL Data File	0	25	0.013	0.33
7664-38-2	BIO-SAFE COOMASSIE	98.04	LBNL Data File	0	25	0.013	0.33
7664-38-2	BIO-SAFE COOMASSIE	98.04	LBNL Data File	0	25	0.013	0.33
7664-38-2	PHOSPHORIC ACID	98.04	LBNL Data File	0	5	0.013	0.07
7664-38-2	PHOSPHORIC ACID	98.04	LBNL Data File	0	10	0.013	0.13
7664-38-2	PHOSPHORIC ACID	98.04	LBNL Data File	0	10	0.013	0.13
7664-38-2	LPH SE GERMICIDAL DETERGENT	98.04	LBNL Data File	0	25	0.013	0.33
7664-38-2	PHOSPHORIC ACID	98.04	LBNL Data File	0	10	0.013	0.13
7664-38-2	PHOSPHORIC ACID	98.04	LBNL Data File	0	10	0.013	0.13
7664-38-2	PHOSPHORIC ACID	98.04	LBNL Data File	0	10	0.013	0.13
7664-38-2	PHOSPHORIC ACID	98.04	LBNL Data File	0	25	0.013	0.33
7664-38-2	PHOSPHORIC ACID	98.04	LBNL Data File	0	10	0.013	0.13
7664-38-2	PHOSPHORIC ACID	98.04	LBNL Data File	0	25	0.013	0.33
7664-38-2	PHOSPHORIC ACID	98.04	LBNL Data File	0	25	0.013	0.33
7664-38-2	PHOSPHORIC ACID	98.04	LBNL Data File	0	10	0.013	0.13
7664-38-2	PHOSPHORIC ACID	98.04	LBNL Data File	0	5	0.013	0.07
7664-38-2	PHOSPHORIC ACID	98.04	LBNL Data File	0	10	0.013	0.13
7664-38-2	PHOSPHORIC ACID	98.04	LBNL Data File	0	10	0.013	0.13
7664-38-2	PHOSPHORIC ACID	98.04	LBNL Data File	0	10	0.013	0.13
7664-38-2	O-PHOSPHORIC ACID	98.04	LBNL Data File	0	25	0.013	0.33
7664-38-2	PHOSPHORIC ACID	98.04	LBNL Data File	0	10	0.013	0.13
7664-38-2	E REAGENT CONCENTRATE (PHOSPHAIC ACID/METHAN	98.04	LBNL Data File	0	10	0.013	0.13
7664-38-2	PHOSPHORIC ACID	98.04	LBNL Data File	0	10	0.013	0.13
7664-38-2	5'-MONOPHOSPHORIC ACID	98.04	LBNL Data File	0	1	0.013	0.01
7664-38-2	PHOSPHORIC ACID	98.04	LBNL Data File	0	10	0.013	0.13
7664-38-2	PHOSPHORIC ACID	98.04	LBNL Data File	0	5	0.013	0.07
7664-38-2	PHOSPHORIC ACID	98.04	LBNL Data File	0	5	0.013	0.07
7664-38-2	PHOSPHORIC ACID	98.04	LBNL Data File	0	10	0.013	0.13
7664-38-2	PHOSPORIC ACID	98.04	LBNL Data File	0	5	0.013	0.07
7664-38-2	PHOSPHORIC ACID	98.04	LBNL Data File	0	10	0.013	0.13
7664-39-3	HYDROFLUORIC ACID	20.01	LBNL Data File	50	10	3.747	37.47
7664-93-9	SULFURIC ACID	98.08	NIST	2	10	0.435	4.35
7664-93-9	SULFURIC ACID	98.08	NIST	2	25	0.435	10.87
7664-93-9	SULFURIC ACID	98.08	NIST	2	25	0.435	10.87
7664-93-9	SULFURIC ACID	98.08	NIST	2	25	0.435	10.87
7664-93-9	SULFURIC ACID	98.08	NIST	2	10	0.435	4.35
7664-93-9	SULFURIC ACID	98.08	NIST	2	10	0.435	4.35
7664-93-9	SULFURIC ACID	98.08	NIST	2	10	0.435	4.35
7664-93-9	SULFURIC ACID	98.08	NIST	2	10	0.435	4.35
7664-93-9	SULFURIC ACID	98.08	NIST	2	10	0.435	4.35
7664-93-9	SULFURIC ACID	98.08	NIST	2	10	0.435	4.35
7664-93-9	SULFURIC ACID	98.08	NIST	2	10	0.435	4.35
7664-93-9	SULFURIC ACID	98.08	NIST	2	25	0.435	10.87
7664-93-9	FISHER CLEANING SOLUTION	98.08	NIST	2	10	0.435	4.35
7664-93-9	SULFURIC ACID	98.08	NIST	2	25	0.435	10.87
7664-93-9	SULFURIC ACID	98.08	NIST	2	10	0.435	4.35
7664-93-9	SULFURIC ACID	98.08	NIST	2	25	0.435	10.87
7664-93-9	SULFURIC ACID	98.08	NIST	2	10	0.435	4.35
7664-93-9	SULFURIC ACID	98.08	NIST	2	5	0.435	2.17
7664-93-9	SULFURIC ACID	98.08	NIST	2	25	0.435	10.87
7664-93-9	SULFURIC ACID	98.08	NIST	2	10	0.435	4.35
7664-93-9	SULFURIC ACID	98.08	NIST	2	10	0.435	4.35
7664-93-9	SULFURIC ACID	98.08	NIST	2	25	0.435	10.87
7664-93-9	SULFURIC ACID	98.08	NIST	2	10	0.435	4.35
7664-93-9	SULFURIC ACID	98.08	NIST	2	10	0.435	4.35
7664-93-9	SULFURIC ACID	98.08	NIST	2	25	0.435	10.87
7664-93-9	SULFURIC ACID	98.08	NIST	2	25	0.435	10.87
7664-93-9	SULFURIC ACID	98.08	NIST	2	25	0.435	10.87
7697-37-2	NITRIC ACID	63.02	LBNL Data File	96	25	15.518	387.94
7697-37-2	NITRIC ACID	63.02	LBNL Data File	96	25	15.518	387.94
7697-37-2	NITRIC ACID	63.02	LBNL Data File	96	25	15.518	387.94
7697-37-2	NITRIC ACID	63.02	LBNL Data File	96	25	15.518	387.94
7697-37-2	NITRIC ACID	63.02	LBNL Data File	96	10	15.518	155.18
7697-37-2	NITRIC ACID	63.02	LBNL Data File	96	10	15.518	155.18
7726-95-6	BROMINE	159.8	LBNL Data File	188	1	56.718	1.12

Calculation of Liquid Chemical Emissions
Phase 1 Laboratory Usage Scenario
Proposed Richmond Bay Campus Long Range Development Plan, Richmond, California
Total Estimated Emissions (Table G-6)

Limit total annual emissions to inventory usage quantity. Assume 1,000 grams/liter when converting liters used to grams.

This list of chemicals comes from merging the purchase and inventory lists Must be identical to Total Usage worksheet			*From previous worksheet (A3)*	*From previous worksheet (A4)*	*Chemical Often Used For Cleaning or Drying?*	*Calculated - Sum of Pouring & Stirring Emissions*
CAS No.		**Compound Name**	**Pouring Annual Emissions (grams/yr)**	**Stirring Annual Emissions (grams/yr)**	**(Yes/No) ***	**Total Annual Emissions * (grams/yr)**
50-00-0	50000	Formaldehyde	0.061	98.37	No	98.43
50-00-0	50000	Formaldehyde	0.122	98.37	No	98.49
50-00-0	50000	Formaldehyde	0.122	98.37	No	98.49
50-00-0	50000	Formaldehyde	0.122	98.37	No	98.49
50-00-0	50000	Formaldehyde	0.122	98.37	No	98.49
50-00-0	50000	Formaldehyde	0.122	98.37	No	98.49
50-00-0	50000	Formaldehyde	0.006	17.49	No	17.49
50-00-0	50000	Formaldehyde	0.006	17.49	No	17.49
50-00-0	50000	Formaldehyde	0.006	17.49	No	17.49
50-00-0	50000	Formaldehyde	0.006	17.49	No	17.49
50-00-0	50000	Formaldehyde	0.006	17.49	No	17.49
50-00-0	50000	Formaldehyde	0.006	17.49	No	17.49
50-00-0	50000	Formaldehyde	0.006	17.49	No	17.49
50-00-0	50000	Formaldehyde	0.006	17.49	No	17.49
50-00-0	50000	Formaldehyde	0.006	17.49	No	17.49
50-00-0	50000	Formaldehyde	0.006	17.49	No	17.49
50-00-0	50000	Formaldehyde	0.006	17.49	No	17.49
50-00-0	50000	Formaldehyde	0.006	17.49	No	17.49
50-00-0	50000	Formaldehyde	0.006	17.49	No	17.49
50-00-0	50000	Formaldehyde	0.006	17.49	No	17.49
50-00-0	50000	Formaldehyde	0.122	98.37	No	98.49
50-00-0	50000	Formaldehyde	0.122	98.37	No	98.49
50-00-0	50000	Formaldehyde	0.122	98.37	No	98.49
50-00-0	50000	Formaldehyde	0.122	98.37	No	98.49
50-00-0	50000	Formaldehyde	0.122	98.37	No	98.49
50-00-0	50000	Formaldehyde	0.006	17.49	No	17.49
50-00-0	50000	Formaldehyde	0.006	17.49	No	17.49
50-00-0	50000	Formaldehyde	0.006	17.49	No	17.49
50-00-0	50000	Formaldehyde	0.006	17.49	No	17.49
50-00-0	50000	Formaldehyde	0.006	17.49	No	17.49
50-00-0	50000	Formaldehyde	0.006	17.49	No	17.49
50-00-0	50000	Formaldehyde	0.006	17.49	No	17.49
50-00-0	50000	Formaldehyde	0.006	17.49	No	17.49
50-00-0	50000	Formaldehyde	0.006	17.49	No	17.49
50-00-0	50000	Formaldehyde	0.006	17.49	No	17.49
50-00-0	50000	Formaldehyde	0.006	17.49	No	17.49
50-00-0	50000	Formaldehyde	0.122	98.37	No	98.49
50-00-0	50000	Formaldehyde	0.006	17.49	No	17.49
50-00-0	50000	Formaldehyde	0.006	17.49	No	17.49
50-00-0	50000	Formaldehyde	0.006	17.49	No	17.49
50-00-0	50000	Formaldehyde	0.006	17.49	No	17.49
50-00-0	50000	Formaldehyde	0.006	17.49	No	17.49
50-00-0	50000	Formaldehyde	0.006	17.49	No	17.49
50-00-0	50000	Formaldehyde	0.006	17.49	No	17.49
50-00-0	50000	Formaldehyde	0.110	98.37	No	98.48
50-00-0	50000	Formaldehyde	0.110	98.37	No	98.48
50-00-0	50000	Formaldehyde	0.110	98.37	No	98.48
50-00-0	50000	Formaldehyde	0.110	98.37	No	98.48
50-00-0	50000	Formaldehyde	0.122	98.37	No	98.49
50-00-0	50000	Formaldehyde	0.122	98.37	No	98.49
50-00-0	50000	Formaldehyde	0.112	98.37	No	98.48
50-00-0	50000	Formaldehyde	0.112	98.37	No	98.48
50-00-0	50000	Formaldehyde	0.024	69.95	No	69.98
50-00-0	50000	Formaldehyde	0.061	98.37	No	98.43
50-00-0	50000	Formaldehyde	0.024	69.95	No	69.98
50-00-0	50000	Formaldehyde	0.024	69.95	No	69.98
50-00-0	50000	Formaldehyde	0.024	69.95	No	69.98
50-00-0	50000	Formaldehyde	0.024	69.95	No	69.98
50-00-0	50000	Formaldehyde	0.122	98.37	No	98.49
50-00-0	50000	Formaldehyde	0.923	245.93	No	246.85
50-00-0	50000	Formaldehyde	0.923	245.93	No	246.85
50-00-0	50000	Formaldehyde	0.923	245.93	No	246.85
50-00-0	50000	Formaldehyde	0.122	98.37	No	98.49
50-00-0	50000	Formaldehyde	0.110	98.37	No	98.48
50-00-0	50000	Formaldehyde	0.122	98.37	No	98.49
50-00-0	50000	Formaldehyde	0.122	98.37	No	98.49
50-00-0	50000	Formaldehyde	0.029	83.94	No	83.97
50-00-0	50000	Formaldehyde	0.029	83.94	No	83.97
50-00-0	50000	Formaldehyde	0.029	83.94	No	83.97
50-00-0	50000	Formaldehyde	0.029	83.94	No	83.97

* Chemicals identified as being frequently used to clean, dry, or sterilize glassware and surfaces assigned emissions of at least 50% of usage.

Calculation of Liquid Chemical Emissions
Phase 1 Laboratory Usage Scenario
Proposed Richmond Bay Campus Long Range Development Plan, Richmond, California
Total Estimated Emissions (Table G-6)

Limit total annual emissions to inventory usage quantity. Assume 1,000 grams/liter when converting liters used to grams.

This list of chemicals comes from merging the purchase and inventory lists Must be identical to Total Usage worksheet			*From previous worksheet (A3)*	*From previous worksheet (A4)*	*Chemical Often Used For Cleaning or Drying?*	*Calculated - Sum of Pouring & Stirring Emissions*
CAS No.		**Compound Name**	**Pouring Annual Emissions (grams/yr)**	**Stirring Annual Emissions (grams/yr)**	**(Yes/No) ***	**Total Annual Emissions * (grams/yr)**
50-00-0	50000	Formaldehyde	0.029	83.94	No	83.97
50-00-0	50000	Formaldehyde	0.029	83.94	No	83.97
50-00-0	50000	Formaldehyde	0.029	83.94	No	83.97
50-00-0	50000	Formaldehyde	0.029	83.94	No	83.97
50-00-0	50000	Formaldehyde	0.029	83.94	No	83.97
50-00-0	50000	Formaldehyde	0.029	83.94	No	83.97
50-00-0	50000	Formaldehyde	0.029	83.94	No	83.97
50-00-0	50000	Formaldehyde	0.029	83.94	No	83.97
50-00-0	50000	Formaldehyde	0.029	83.94	No	83.97
50-00-0	50000	Formaldehyde	0.029	83.94	No	83.97
50-00-0	50000	Formaldehyde	0.029	83.94	No	83.97
50-00-0	50000	Formaldehyde	0.029	83.94	No	83.97
50-00-0	50000	Formaldehyde	0.975	245.93	No	246.90
50-00-0	50000	Formaldehyde	0.975	245.93	No	246.90
50-00-0	50000	Formaldehyde	0.004	10.49	No	10.50
50-00-0	50000	Formaldehyde	0.004	10.49	No	10.50
50-00-0	50000	Formaldehyde	0.004	10.49	No	10.50
50-00-0	50000	Formaldehyde	0.004	10.49	No	10.50
50-00-0	50000	Formaldehyde	0.004	10.49	No	10.50
50-00-0	50000	Formaldehyde	0.004	10.49	No	10.50
50-00-0	50000	Formaldehyde	0.029	83.94	No	83.97
50-00-0	50000	Formaldehyde	0.122	98.37	No	98.49
50-00-0	50000	Formaldehyde	0.122	98.37	No	98.49
50-00-0	50000	Formaldehyde	0.122	98.37	No	98.49
50-00-0	50000	Formaldehyde	0.122	98.37	No	98.49
50-00-0	50000	Formaldehyde	0.006	17.49	No	17.49
50-00-0	50000	Formaldehyde	0.012	34.98	No	34.99
50-00-0	50000	Formaldehyde	0.061	98.37	No	98.43
50-00-0	50000	Formaldehyde	0.122	98.37	No	98.49
50-00-0	50000	Formaldehyde	0.122	98.37	No	98.49
50-00-0	50000	Formaldehyde	0.122	98.37	No	98.49
50-00-0	50000	Formaldehyde	0.122	98.37	No	98.49
50-00-0	50000	Formaldehyde	0.122	98.37	No	98.49
50-00-0	50000	Formaldehyde	0.122	98.37	No	98.49
50-00-0	50000	Formaldehyde	0.024	69.95	No	69.98
50-00-0	50000	Formaldehyde	0.024	69.95	No	69.98
50-00-0	50000	Formaldehyde	0.024	69.95	No	69.98
50-00-0	50000	Formaldehyde	0.923	245.93	No	246.85
50-00-0	50000	Formaldehyde	0.020	49.19	No	49.20
50-00-0	50000	Formaldehyde	0.975	245.93	No	246.90
50-00-0	50000	Formaldehyde	0.122	98.37	No	98.49
50-00-0	50000	Formaldehyde	0.122	98.37	No	98.49
50-00-0	50000	Formaldehyde	0.122	98.37	No	98.49
50-00-0	50000	Formaldehyde	0.122	98.37	No	98.49
50-00-0	50000	Formaldehyde	0.122	98.37	No	98.49
50-00-0	50000	Formaldehyde	0.122	98.37	No	98.49
50-00-0	50000	Formaldehyde	0.122	98.37	No	98.49
50-00-0	50000	Formaldehyde	0.975	245.93	No	246.90
50-00-0	50000	Formaldehyde	0.122	98.37	No	98.49
50-00-0	50000	Formaldehyde	0.923	245.93	No	246.85
50-00-0	50000	Formaldehyde	0.923	245.93	No	246.85
50-00-0	50000	Formaldehyde	0.923	245.93	No	246.85
50-00-0	50000	Formaldehyde	0.923	245.93	No	246.85
50-00-0	50000	Formaldehyde	0.122	98.37	No	98.49
50-00-0	50000	Formaldehyde	0.122	98.37	No	98.49
50-00-0	50000	Formaldehyde	0.006	17.49	No	17.49
50-00-0	50000	Formaldehyde	0.002	7.00	No	7.00
50-00-0	50000	Formaldehyde	0.122	98.37	No	98.49
50-00-0	50000	Formaldehyde	0.004	10.49	No	10.50
50-00-0	50000	Formaldehyde	0.122	98.37	No	98.49
50-00-0	50000	Formaldehyde	0.122	98.37	No	98.49
50-00-0	50000	Formaldehyde	0.001	3.50	No	3.50
50-00-0	50000	Formaldehyde	0.037	98.37	No	98.41
50-00-0	50000	Formaldehyde	0.037	98.37	No	98.41
50-00-0	50000	Formaldehyde	0.122	98.37	No	98.49
50-00-0	50000	Formaldehyde	0.009	24.48	No	24.49
50-00-0	50000	Formaldehyde	0.244	245.93	No	246.17
50-00-0	50000	Formaldehyde	0.122	98.37	No	98.49

* Chemicals identified as being frequently used to clean, dry, or sterilize glassware and surfaces assigned emissions of at least 50% of usage.

Calculation of Liquid Chemical Emissions
Phase 1 Laboratory Usage Scenario
Proposed Richmond Bay Campus Long Range Development Plan, Richmond, California
Total Estimated Emissions (Table G-6)

Limit total annual emissions to inventory usage quantity. Assume 1,000 grams/liter when converting liters used to grams.

This list of chemicals comes from merging the purchase and inventory lists Must be identical to Total Usage worksheet			*From previous worksheet (A3)*	*From previous worksheet (A4)*	*Chemical Often Used For Cleaning or Drying?*	*Calculated - Sum of Pouring & Stirring Emissions*
CAS No.		**Compound Name**	**Pouring Annual Emissions (grams/yr)**	**Stirring Annual Emissions (grams/yr)**	**(Yes/No) ***	**Total Annual Emissions * (grams/yr)**
50-00-0	50000	Formaldehyde	0.244	245.93	No	246.17
50-00-0	50000	Formaldehyde	0.122	98.37	No	98.49
50-00-0	50000	Formaldehyde	0.122	98.37	No	98.49
50-00-0	50000	Formaldehyde	0.024	69.95	No	69.98
50-00-0	50000	Formaldehyde	0.024	69.95	No	69.98
50-00-0	50000	Formaldehyde	0.122	98.37	No	98.49
50-00-0	50000	Formaldehyde	0.122	98.37	No	98.49
50-00-0	50000	Formaldehyde	0.122	98.37	No	98.49
50-00-0	50000	Formaldehyde	0.244	245.93	No	246.17
56-23-5	56236	Carbon tetrachloride	0.668	293.87	No	294.54
58-89-9	58899	Lindane [gamma-Hexachlorocyclohexane]	0.000	0.00	No	5.41E-05
58-89-9	58899	Lindane [gamma-Hexachlorocyclohexane]	0.000	0.00	No	5.42E-05
58-89-9	58899	Lindane [gamma-Hexachlorocyclohexane]	0.000	0.00	No	5.43E-06
58-89-9	58899	Lindane [gamma-Hexachlorocyclohexane]	0.000	0.00	No	5.44E-06
62-53-3	62534	Aniline	0.002	2.21	No	2.22
62-53-3	62534	Aniline	0.000	0.22	No	0.22
67-56-1	67561	Benzamine	1.186	271.90	No	273.08
67-56-1	67561	Methanol	1.254	271.90	No	273.15
67-56-1	67561	Methanol	0.784	271.90	No	272.68
67-56-1	67561	Methanol	0.784	271.90	No	272.68
67-56-1	67561	Methanol	0.000	0.70	No	0.70
67-56-1	67561	Methanol	1.254	271.90	No	273.15
67-56-1	67561	Methanol	0.313	271.90	No	272.21
67-56-1	67561	Methanol	0.313	271.90	No	272.21
67-56-1	67561	Methanol	0.313	271.90	No	272.21
67-56-1	67561	Methanol	0.313	271.90	No	272.21
67-56-1	67561	Methanol	1.254	271.90	No	273.15
67-56-1	67561	Methanol	1.254	271.90	No	273.15
67-56-1	67561	Methanol	0.313	271.90	No	272.21
67-56-1	67561	Methanol	0.313	271.90	No	272.21
67-56-1	67561	Methanol	0.627	271.90	No	272.52
67-56-1	67561	Methanol	0.627	271.90	No	272.52
67-56-1	67561	Methanol	0.627	271.90	No	272.52
67-56-1	67561	Methanol	0.627	271.90	No	272.52
67-56-1	67561	Methanol	1.254	271.90	No	273.15
67-56-1	67561	Methanol	1.254	271.90	No	273.15
67-56-1	67561	Methanol	1.254	271.90	No	273.15
67-56-1	67561	Methanol	0.627	271.90	No	272.52
67-56-1	67561	Methanol	1.254	271.90	No	273.15
67-56-1	67561	Methanol	1.254	271.90	No	273.15
67-56-1	67561	Methanol	0.313	271.90	No	272.21
67-56-1	67561	Methanol	1.186	271.90	No	273.08
67-56-1	67561	Methanol	0.031	69.95	No	69.99
67-56-1	67561	Methanol	1.254	271.90	No	273.15
67-56-1	67561	Methanol	1.254	271.90	No	273.15
67-56-1	67561	Methanol	0.078	108.76	No	108.84
67-56-1	67561	Methanol	0.313	271.90	No	272.21
67-56-1	67561	Methanol	1.186	271.90	No	273.08
67-56-1	67561	Methanol	1.186	271.90	No	273.08
67-56-1	67561	Methanol	1.254	271.90	No	273.15
67-56-1	67561	Methanol	1.254	271.90	No	273.15
67-56-1	67561	Methanol	1.254	271.90	No	273.15
67-56-1	67561	Methanol	1.254	271.90	No	273.15
67-56-1	67561	Methanol	1.254	271.90	No	273.15
67-56-1	67561	Methanol	1.254	271.90	No	273.15
67-56-1	67561	Methanol	1.254	271.90	No	273.15
67-56-1	67561	Methanol	1.254	271.90	No	273.15
67-56-1	67561	Methanol	1.186	271.90	No	273.08
67-56-1	67561	Methanol	1.186	271.90	No	273.08
67-56-1	67561	Methanol	1.186	271.90	No	273.08
67-56-1	67561	Methanol	1.186	271.90	No	273.08
67-56-1	67561	Methanol	0.313	271.90	No	272.21
67-56-1	67561	Methanol	0.313	271.90	No	272.21
67-56-1	67561	Methanol	0.313	271.90	No	272.21
67-56-1	67561	Methanol	0.313	271.90	No	272.21
67-56-1	67561	Methanol	5.955	1087.58	No	1093.54
67-56-1	67561	Methanol	5.955	1087.58	No	1093.54
67-56-1	67561	Methanol	0.313	271.90	No	272.21

* Chemicals identified as being frequently used to clean, dry, or sterilize glassware and surfaces assigned emissions of at least 50% of usage.

Calculation of Liquid Chemical Emissions
Phase 1 Laboratory Usage Scenario
Proposed Richmond Bay Campus Long Range Development Plan, Richmond, California
Total Estimated Emissions (Table G-6)

Limit total annual emissions to inventory usage quantity. Assume 1,000 grams/liter when converting liters used to grams.

This list of chemicals comes from merging the purchase and inventory lists Must be identical to Total Usage worksheet			*From previous worksheet (A3)*	*From previous worksheet (A4)*	*Chemical Often Used For Cleaning or Drying?*	*Calculated - Sum of Pouring & Stirring Emissions*
CAS No.		**Compound Name**	**Pouring Annual Emissions (grams/yr)**	**Stirring Annual Emissions (grams/yr)**	**(Yes/No) ***	**Total Annual Emissions * (grams/yr)**
67-56-1	67561	Methanol	0.313	271.90	No	272.21
67-56-1	67561	Methanol	0.313	271.90	No	272.21
67-56-1	67561	Methanol	0.313	271.90	No	272.21
67-56-1	67561	Methanol	1.254	271.90	No	273.15
67-56-1	67561	Methanol	1.254	271.90	No	273.15
67-56-1	67561	Methanol	1.254	271.90	No	273.15
67-56-1	67561	Methanol	1.254	271.90	No	273.15
67-56-1	67561	Methanol	0.313	271.90	No	272.21
67-56-1	67561	Methanol	1.254	271.90	No	273.15
67-56-1	67561	Methanol	1.254	271.90	No	273.15
67-56-1	67561	Methanol	0.313	271.90	No	272.21
67-56-1	67561	Methanol	0.313	271.90	No	272.21
67-56-1	67561	Methanol	0.313	271.90	No	272.21
67-56-1	67561	Methanol	0.313	271.90	No	272.21
67-56-1	67561	Methanol	0.313	271.90	No	272.21
67-56-1	67561	Methanol	0.313	271.90	No	272.21
67-56-1	67561	Methanol	1.254	271.90	No	273.15
67-56-1	67561	Methanol	1.254	271.90	No	273.15
67-56-1	67561	Methanol	1.254	271.90	No	273.15
67-56-1	67561	Methanol	1.254	271.90	No	273.15
67-56-1	67561	Methanol	0.031	69.95	No	69.99
67-56-1	67561	Methanol	0.313	271.90	No	272.21
67-56-1	67561	Methanol	1.254	271.90	No	273.15
67-56-1	67561	Methanol	1.254	271.90	No	273.15
67-56-1	67561	Methanol	1.254	271.90	No	273.15
67-56-1	67561	Methanol	1.254	271.90	No	273.15
67-56-1	67561	Methanol	1.254	271.90	No	273.15
67-56-1	67561	Methanol	1.254	271.90	No	273.15
67-56-1	67561	Methanol	1.254	271.90	No	273.15
67-56-1	67561	Methanol	0.157	108.76	No	108.92
67-56-1	67561	Methanol	0.031	69.95	No	69.99
67-56-1	67561	Methanol	0.313	271.90	No	272.21
67-56-1	67561	Methanol	0.157	108.76	No	108.92
67-56-1	67561	Methanol	1.254	271.90	No	273.15
67-56-1	67561	Methanol	1.254	271.90	No	273.15
67-56-1	67561	Methanol	0.784	271.90	No	272.68
67-56-1	67561	Methanol	0.784	271.90	No	272.68
67-56-1	67561	Methanol	0.784	271.90	No	272.68
67-56-1	67561	Methanol	0.784	271.90	No	272.68
67-56-1	67561	Methanol	1.254	271.90	No	273.15
67-56-1	67561	Methanol	1.254	271.90	No	273.15
67-56-1	67561	Methanol	1.254	271.90	No	273.15
67-56-1	67561	Methanol	1.254	271.90	No	273.15
67-56-1	67561	Methanol	0.313	271.90	No	272.21
67-56-1	67561	Methanol	0.313	271.90	No	272.21
67-56-1	67561	Methanol	1.254	271.90	No	273.15
67-56-1	67561	Methanol	1.254	271.90	No	273.15
67-56-1	67561	Methanol	1.254	271.90	No	273.15
67-56-1	67561	Methanol	1.254	271.90	No	273.15
67-56-1	67561	Methanol	0.313	271.90	No	272.21
67-56-1	67561	Methanol	0.313	271.90	No	272.21
67-56-1	67561	Methanol	0.031	69.95	No	69.99
67-56-1	67561	Methanol	0.313	271.90	No	272.21
67-56-1	67561	Methanol	0.313	271.90	No	272.21
67-56-1	67561	Methanol	0.313	271.90	No	272.21
67-56-1	67561	Methanol	0.313	271.90	No	272.21
67-56-1	67561	Methanol	0.313	271.90	No	272.21
67-56-1	67561	Methanol	0.313	271.90	No	272.21
67-56-1	67561	Methanol	0.313	271.90	No	272.21
67-56-1	67561	Methanol	0.313	271.90	No	272.21
67-56-1	67561	Methanol	0.031	69.95	No	69.99
67-56-1	67561	Methanol	0.000	0.70	No	0.70
67-56-1	67561	Methanol	1.254	271.90	No	273.15
67-56-1	67561	Methanol	0.313	271.90	No	272.21
67-56-1	67561	Methanol	0.313	271.90	No	272.21
67-56-1	67561	Methanol	0.313	271.90	No	272.21
67-56-1	67561	Methanol	1.254	271.90	No	273.15
67-56-1	67561	Methanol	1.254	271.90	No	273.15

* Chemicals identified as being frequently used to clean, dry, or sterilize glassware and surfaces assigned emissions of at least 50% of usage.

Calculation of Liquid Chemical Emissions
Phase 1 Laboratory Usage Scenario
Proposed Richmond Bay Campus Long Range Development Plan, Richmond, California
Total Estimated Emissions (Table G-6)

Limit total annual emissions to inventory usage quantity. Assume 1,000 grams/liter when converting liters used to grams.

This list of chemicals comes from merging the purchase and inventory lists Must be identical to Total Usage worksheet			*From previous worksheet (A3)*	*From previous worksheet (A4)*	*Chemical Often Used For Cleaning or Drying?*	*Calculated - Sum of Pouring & Stirring Emissions*
CAS No.		**Compound Name**	**Pouring Annual Emissions (grams/yr)**	**Stirring Annual Emissions (grams/yr)**	**(Yes/No) ***	**Total Annual Emissions * (grams/yr)**
67-56-1	67561	Methanol	1.254	271.90	No	273.15
67-56-1	67561	Methanol	0.313	271.90	No	272.21
67-56-1	67561	Methanol	0.313	271.90	No	272.21
67-56-1	67561	Methanol	0.313	271.90	No	272.21
67-56-1	67561	Methanol	1.254	271.90	No	273.15
67-56-1	67561	Methanol	4.745	1087.58	No	1092.33
67-56-1	67561	Methanol	0.313	271.90	No	272.21
67-56-1	67561	Methanol	1.254	271.90	No	273.15
67-56-1	67561	Methanol	1.254	271.90	No	273.15
67-56-1	67561	Methanol	1.254	271.90	No	273.15
67-56-1	67561	Methanol	1.254	271.90	No	273.15
67-56-1	67561	Methanol	1.254	271.90	No	273.15
67-56-1	67561	Methanol	1.254	271.90	No	273.15
67-56-1	67561	Methanol	0.627	271.90	No	272.52
67-56-1	67561	Methanol	1.254	271.90	No	273.15
67-56-1	67561	Methanol	1.254	271.90	No	273.15
67-56-1	67561	Methanol	1.254	271.90	No	273.15
67-56-1	67561	Methanol	1.567	271.90	No	273.46
67-56-1	67561	Methanol	0.031	69.95	No	69.99
67-56-1	67561	Methanol	0.313	271.90	No	272.21
67-56-1	67561	Methanol	1.254	271.90	No	273.15
67-56-1	67561	Methanol	0.313	271.90	No	272.21
67-56-1	67561	Methanol	0.313	271.90	No	272.21
67-56-1	67561	Methanol	1.254	271.90	No	273.15
67-56-1	67561	Methanol	1.254	271.90	No	273.15
67-56-1	67561	Methanol	1.254	271.90	No	273.15
67-56-1	67561	Methanol	1.254	271.90	No	273.15
67-56-1	67561	Methanol	0.157	108.76	No	108.92
67-56-1	67561	Methanol	1.254	271.90	No	273.15
67-56-1	67561	Methanol	0.313	271.90	No	272.21
67-56-1	67561	Methanol	1.254	271.90	No	273.15
67-56-1	67561	Methanol	1.254	271.90	No	273.15
67-56-1	67561	Methanol	0.031	69.95	No	69.99
67-56-1	67561	Methanol	0.157	108.76	No	108.92
67-56-1	67561	Methanol	1.254	271.90	No	273.15
67-56-1	67561	Methanol	1.254	271.90	No	273.15
67-56-1	67561	Methanol	1.254	271.90	No	273.15
67-56-1	67561	Methanol	1.186	271.90	No	273.08
67-56-1	67561	Methanol	1.254	271.90	No	273.15
67-56-1	67561	Methanol	1.254	271.90	No	273.15
67-56-1	67561	Methanol	1.254	271.90	No	273.15
67-56-1	67561	Methanol	1.254	271.90	No	273.15
67-56-1	67561	Methanol	0.627	271.90	No	272.52
67-56-1	67561	Methanol	1.254	271.90	No	273.15
67-56-1	67561	Methanol	1.186	271.90	No	273.08
67-56-1	67561	Methanol	0.313	271.90	No	272.21
67-56-1	67561	Methanol	0.157	108.76	No	108.92
67-56-1	67561	Methanol	0.313	271.90	No	272.21
67-63-0	67630	Isopropyl alcohol	12.385	1164.72	No	1177.10
67-63-0	67630	Isopropyl alcohol	0.206	291.18	No	291.39
67-63-0	67630	Isopropyl alcohol	0.826	291.18	No	292.00
67-63-0	67630	Isopropyl alcohol	0.092	116.47	No	116.56
67-63-0	67630	Isopropyl alcohol	0.098	116.47	No	116.57
67-63-0	67630	Isopropyl alcohol	0.052	116.47	No	116.52
67-63-0	67630	Isopropyl alcohol	0.052	116.47	No	116.52
67-63-0	67630	Isopropyl alcohol	26.296	1164.72	No	1191.01
67-63-0	67630	Isopropyl alcohol	3.096	1164.72	No	1167.81
67-63-0	67630	Isopropyl alcohol	0.826	291.18	No	292.00
67-63-0	67630	Isopropyl alcohol	0.103	116.47	No	116.57
67-63-0	67630	Isopropyl alcohol	0.263	291.18	No	291.44
67-63-0	67630	Isopropyl alcohol	0.103	116.47	No	116.57
67-63-0	67630	Isopropyl alcohol	0.103	116.47	No	116.57
67-63-0	67630	Isopropyl alcohol	0.103	116.47	No	116.57
67-63-0	67630	Isopropyl alcohol	0.052	116.47	No	116.52
67-63-0	67630	Isopropyl alcohol	0.103	116.47	No	116.57
67-63-0	67630	Isopropyl alcohol	0.206	291.18	No	291.39
67-63-0	67630	Isopropyl alcohol	0.103	116.47	No	116.57
67-63-0	67630	Isopropyl alcohol	0.206	291.18	No	291.39

* Chemicals identified as being frequently used to clean, dry, or sterilize glassware and surfaces assigned emissions of at least 50% of usage.

Calculation of Liquid Chemical Emissions
Phase 1 Laboratory Usage Scenario
Proposed Richmond Bay Campus Long Range Development Plan, Richmond, California
Total Estimated Emissions (Table G-6)

Limit total annual emissions to inventory usage quantity. Assume 1,000 grams/liter when converting liters used to grams.

This list of chemicals comes from merging the purchase and inventory lists Must be identical to Total Usage worksheet			*From previous worksheet (A3)*	*From previous worksheet (A4)*	*Chemical Often Used For Cleaning or Drying?*	*Calculated - Sum of Pouring & Stirring Emissions*
CAS No.		**Compound Name**	**Pouring Annual Emissions (grams/yr)**	**Stirring Annual Emissions (grams/yr)**	**(Yes/No) ***	**Total Annual Emissions * (grams/yr)**
67-63-0	67630	Isopropyl alcohol	0.103	116.47	No	116.57
67-63-0	67630	Isopropyl alcohol	0.103	116.47	No	116.57
67-63-0	67630	Isopropyl alcohol	0.103	116.47	No	116.57
67-63-0	67630	Isopropyl alcohol	0.206	291.18	No	291.39
67-63-0	67630	Isopropyl alcohol	0.005	17.49	No	17.49
67-63-0	67630	Isopropyl alcohol	0.005	17.49	No	17.49
67-63-0	67630	Isopropyl alcohol	0.103	116.47	No	116.57
67-63-0	67630	Isopropyl alcohol	0.005	17.49	No	17.49
67-63-0	67630	Isopropyl alcohol	0.005	17.49	No	17.49
67-63-0	67630	Isopropyl alcohol	0.005	17.49	No	17.49
67-63-0	67630	Isopropyl alcohol	0.005	17.49	No	17.49
67-63-0	67630	Isopropyl alcohol	0.005	17.49	No	17.49
67-63-0	67630	Isopropyl alcohol	0.005	17.49	No	17.49
67-63-0	67630	Isopropyl alcohol	0.005	17.49	No	17.49
67-63-0	67630	Isopropyl alcohol	0.206	291.18	No	291.39
67-63-0	67630	Isopropyl alcohol	0.103	116.47	No	116.57
67-63-0	67630	Isopropyl alcohol	0.103	116.47	No	116.57
67-63-0	67630	Isopropyl alcohol	0.103	116.47	No	116.57
67-63-0	67630	Isopropyl alcohol	0.206	291.18	No	291.39
67-63-0	67630	Isopropyl alcohol	0.206	291.18	No	291.39
67-63-0	67630	Isopropyl alcohol	0.206	291.18	No	291.39
67-63-0	67630	Isopropyl alcohol	0.206	291.18	No	291.39
67-63-0	67630	Isopropyl alcohol	0.206	291.18	No	291.39
67-63-0	67630	Isopropyl alcohol	0.206	291.18	No	291.39
67-63-0	67630	Isopropyl alcohol	0.206	291.18	No	291.39
67-63-0	67630	Isopropyl alcohol	0.206	291.18	No	291.39
67-63-0	67630	Isopropyl alcohol	0.826	291.18	No	292.00
67-63-0	67630	Isopropyl alcohol	0.005	17.49	No	17.49
67-63-0	67630	Isopropyl alcohol	0.263	291.18	No	291.44
67-63-0	67630	Isopropyl alcohol	0.103	116.47	No	116.57
67-63-0	67630	Isopropyl alcohol	0.206	291.18	No	291.39
67-63-0	67630	Isopropyl alcohol	0.206	291.18	No	291.39
67-63-0	67630	Isopropyl alcohol	0.206	291.18	No	291.39
67-63-0	67630	Isopropyl alcohol	0.206	291.18	No	291.39
67-63-0	67630	Isopropyl alcohol	0.206	291.18	No	291.39
67-63-0	67630	Isopropyl alcohol	0.206	291.18	No	291.39
67-63-0	67630	Isopropyl alcohol	0.206	291.18	No	291.39
67-63-0	67630	Isopropyl alcohol	0.103	116.47	No	116.57
67-63-0	67630	Isopropyl alcohol	0.413	291.18	No	291.59
67-63-0	67630	Isopropyl alcohol	0.826	291.18	No	292.00
67-63-0	67630	Isopropyl alcohol	0.103	116.47	No	116.57
67-63-0	67630	Isopropyl alcohol	0.005	17.49	No	17.49
67-63-0	67630	Isopropyl alcohol	0.781	291.18	No	291.96
67-63-0	67630	Isopropyl alcohol	0.781	291.18	No	291.96
67-63-0	67630	Isopropyl alcohol	0.206	291.18	No	291.39
67-63-0	67630	Isopropyl alcohol	0.206	291.18	No	291.39
67-63-0	67630	Isopropyl alcohol	0.826	291.18	No	292.00
67-63-0	67630	Isopropyl alcohol	0.826	291.18	No	292.00
67-63-0	67630	Isopropyl alcohol	0.826	291.18	No	292.00
67-63-0	67630	Isopropyl alcohol	0.826	291.18	No	292.00
67-63-0	67630	Isopropyl alcohol	0.826	291.18	No	292.00
67-63-0	67630	Isopropyl alcohol	1.032	291.18	No	292.21
67-63-0	67630	Isopropyl alcohol	0.826	291.18	No	292.00
67-63-0	67630	Isopropyl alcohol	0.826	291.18	No	292.00
67-63-0	67630	Isopropyl alcohol	1.032	291.18	No	292.21
67-63-0	67630	Isopropyl alcohol	0.826	291.18	No	292.00
67-63-0	67630	Isopropyl alcohol	0.826	291.18	No	292.00
67-63-0	67630	Isopropyl alcohol	0.826	291.18	No	292.00
67-63-0	67630	Isopropyl alcohol	0.206	291.18	No	291.39
67-63-0	67630	Isopropyl alcohol	0.206	291.18	No	291.39
67-63-0	67630	Isopropyl alcohol	0.206	291.18	No	291.39
67-63-0	67630	Isopropyl alcohol	0.206	291.18	No	291.39
67-63-0	67630	Isopropyl alcohol	0.206	291.18	No	291.39
67-63-0	67630	Isopropyl alcohol	0.206	291.18	No	291.39
67-63-0	67630	Isopropyl alcohol	0.206	291.18	No	291.39
67-63-0	67630	Isopropyl alcohol	0.206	291.18	No	291.39
67-63-0	67630	Isopropyl alcohol	0.206	291.18	No	291.39
67-63-0	67630	Isopropyl alcohol	0.103	116.47	No	116.57

* Chemicals identified as being frequently used to clean, dry, or sterilize glassware and surfaces assigned emissions of at least 50% of usage.

Calculation of Liquid Chemical Emissions
Phase 1 Laboratory Usage Scenario
Proposed Richmond Bay Campus Long Range Development Plan, Richmond, California
Total Estimated Emissions (Table G-6)

Limit total annual emissions to inventory usage quantity. Assume 1,000 grams/liter when converting liters used to grams.

This list of chemicals comes from merging the purchase and inventory lists Must be identical to Total Usage worksheet			*From previous worksheet (A3)*	*From previous worksheet (A4)*	*Chemical Often Used For Cleaning or Drying?*	*Calculated - Sum of Pouring & Stirring Emissions*
CAS No.		**Compound Name**	**Pouring Annual Emissions (grams/yr)**	**Stirring Annual Emissions (grams/yr)**	**(Yes/No) ***	**Total Annual Emissions * (grams/yr)**
67-63-0	67630	Isopropyl alcohol	0.103	116.47	No	116.57
67-63-0	67630	Isopropyl alcohol	0.103	116.47	No	116.57
67-63-0	67630	Isopropyl alcohol	0.826	291.18	No	292.00
67-63-0	67630	Isopropyl alcohol	0.826	291.18	No	292.00
67-63-0	67630	Isopropyl alcohol	0.103	116.47	No	116.57
67-63-0	67630	Isopropyl alcohol	0.826	291.18	No	292.00
67-63-0	67630	Isopropyl alcohol	0.826	291.18	No	292.00
67-63-0	67630	Isopropyl alcohol	0.826	291.18	No	292.00
67-63-0	67630	Isopropyl alcohol	0.103	116.47	No	116.57
67-63-0	67630	Isopropyl alcohol	0.206	291.18	No	291.39
67-63-0	67630	Isopropyl alcohol	0.206	291.18	No	291.39
67-63-0	67630	Isopropyl alcohol	0.206	291.18	No	291.39
67-63-0	67630	Isopropyl alcohol	0.206	291.18	No	291.39
67-63-0	67630	Isopropyl alcohol	0.206	291.18	No	291.39
67-63-0	67630	Isopropyl alcohol	0.005	17.49	No	17.49
67-63-0	67630	Isopropyl alcohol	0.005	17.49	No	17.49
67-63-0	67630	Isopropyl alcohol	0.005	17.49	No	17.49
67-63-0	67630	Isopropyl alcohol	0.005	17.49	No	17.49
67-63-0	67630	Isopropyl alcohol	0.005	17.49	No	17.49
67-63-0	67630	Isopropyl alcohol	0.005	17.49	No	17.49
67-63-0	67630	Isopropyl alcohol	0.005	17.49	No	17.49
67-63-0	67630	Isopropyl alcohol	0.826	291.18	No	292.00
67-63-0	67630	Isopropyl alcohol	0.826	291.18	No	292.00
67-63-0	67630	Isopropyl alcohol	0.005	17.49	No	17.49
67-63-0	67630	Isopropyl alcohol	0.005	17.49	No	17.49
67-63-0	67630	Isopropyl alcohol	0.781	291.18	No	291.96
67-63-0	67630	Isopropyl alcohol	0.005	17.49	No	17.49
67-63-0	67630	Isopropyl alcohol	0.781	291.18	No	291.96
67-63-0	67630	Isopropyl alcohol	0.826	291.18	No	292.00
67-63-0	67630	Isopropyl alcohol	0.005	17.49	No	17.49
67-63-0	67630	Isopropyl alcohol	0.005	17.49	No	17.49
67-63-0	67630	Isopropyl alcohol	0.005	17.49	No	17.49
67-63-0	67630	Isopropyl alcohol	0.005	17.49	No	17.49
67-63-0	67630	Isopropyl alcohol	0.103	116.47	No	116.57
67-63-0	67630	Isopropyl alcohol	0.103	116.47	No	116.57
67-63-0	67630	Isopropyl alcohol	0.206	291.18	No	291.39
67-63-0	67630	Isopropyl alcohol	0.103	116.47	No	116.57
67-63-0	67630	Isopropyl alcohol	0.103	116.47	No	116.57
67-63-0	67630	Isopropyl alcohol	0.103	116.47	No	116.57
67-63-0	67630	Isopropyl alcohol	0.005	17.49	No	17.49
67-63-0	67630	Isopropyl alcohol	0.413	291.18	No	291.59
67-63-0	67630	Isopropyl alcohol	0.206	291.18	No	291.39
67-63-0	67630	Isopropyl alcohol	0.052	116.47	No	116.52
67-63-0	67630	Isopropyl alcohol	0.206	291.18	No	291.39
67-63-0	67630	Isopropyl alcohol	0.206	291.18	No	291.39
67-63-0	67630	Isopropyl alcohol	0.826	291.18	No	292.00
67-63-0	67630	Isopropyl alcohol	0.103	116.47	No	116.57
67-63-0	67630	Isopropyl alcohol	0.049	116.47	No	116.52
67-63-0	67630	Isopropyl alcohol	0.049	116.47	No	116.52
67-63-0	67630	Isopropyl alcohol	0.049	116.47	No	116.52
67-63-0	67630	Isopropyl alcohol	0.049	116.47	No	116.52
67-63-0	67630	Isopropyl alcohol	0.049	116.47	No	116.52
67-63-0	67630	Isopropyl alcohol	0.103	116.47	No	116.57
67-63-0	67630	Isopropyl alcohol	0.103	116.47	No	116.57
67-63-0	67630	Isopropyl alcohol	0.005	17.49	No	17.49
67-63-0	67630	Isopropyl alcohol	0.005	17.49	No	17.49
67-63-0	67630	Isopropyl alcohol	0.103	116.47	No	116.57
67-63-0	67630	Isopropyl alcohol	0.103	116.47	No	116.57
67-63-0	67630	Isopropyl alcohol	0.103	116.47	No	116.57
67-63-0	67630	Isopropyl alcohol	0.103	116.47	No	116.57
67-63-0	67630	Isopropyl alcohol	0.103	116.47	No	116.57
67-63-0	67630	Isopropyl alcohol	0.001	3.50	No	3.50
67-63-0	67630	Isopropyl alcohol	0.826	291.18	No	292.00
67-63-0	67630	Isopropyl alcohol	0.826	291.18	No	292.00
67-63-0	67630	Isopropyl alcohol	0.103	116.47	No	116.57
67-63-0	67630	Isopropyl alcohol	0.021	69.95	No	69.97
67-63-0	67630	Isopropyl alcohol	0.103	116.47	No	116.57
67-63-0	67630	Isopropyl alcohol	0.103	116.47	No	116.57

* Chemicals identified as being frequently used to clean, dry, or sterilize glassware and surfaces assigned emissions of at least 50% of usage.

Calculation of Liquid Chemical Emissions
Phase 1 Laboratory Usage Scenario
Proposed Richmond Bay Campus Long Range Development Plan, Richmond, California
Total Estimated Emissions (Table G-6)

Limit total annual emissions to inventory usage quantity. Assume 1,000 grams/liter when converting liters used to grams.

This list of chemicals comes from merging the purchase and inventory lists Must be identical to Total Usage worksheet			*From previous worksheet (A3)*	*From previous worksheet (A4)*	*Chemical Often Used For Cleaning or Drying?*	*Calculated - Sum of Pouring & Stirring Emissions*
CAS No.		**Compound Name**	**Pouring Annual Emissions (grams/yr)**	**Stirring Annual Emissions (grams/yr)**	**(Yes/No) ***	**Total Annual Emissions * (grams/yr)**
67-63-0	67630	Isopropyl alcohol	0.206	291.18	No	291.39
67-63-0	67630	Isopropyl alcohol	0.206	291.18	No	291.39
67-63-0	67630	Isopropyl alcohol	0.005	17.49	No	17.49
67-63-0	67630	Isopropyl alcohol	0.005	17.49	No	17.49
67-63-0	67630	Isopropyl alcohol	0.005	17.49	No	17.49
67-63-0	67630	Isopropyl alcohol	0.005	17.49	No	17.49
67-63-0	67630	Isopropyl alcohol	0.005	17.49	No	17.49
67-63-0	67630	Isopropyl alcohol	0.005	17.49	No	17.49
67-63-0	67630	Isopropyl alcohol	0.206	291.18	No	291.39
67-63-0	67630	Isopropyl alcohol	0.206	291.18	No	291.39
67-63-0	67630	Isopropyl alcohol	0.005	17.49	No	17.49
67-63-0	67630	Isopropyl alcohol	0.516	291.18	No	291.70
67-63-0	67630	Isopropyl alcohol	1.651	291.18	No	292.83
67-63-0	67630	Isopropyl alcohol	0.206	291.18	No	291.39
67-63-0	67630	Isopropyl alcohol	0.103	116.47	No	116.57
67-63-0	67630	Isopropyl alcohol	0.103	116.47	No	116.57
67-63-0	67630	Isopropyl alcohol	0.103	116.47	No	116.57
67-63-0	67630	Isopropyl alcohol	0.826	291.18	No	292.00
67-63-0	67630	Isopropyl alcohol	0.826	291.18	No	292.00
67-63-0	67630	Isopropyl alcohol	0.103	116.47	No	116.57
67-63-0	67630	Isopropyl alcohol	0.005	17.49	No	17.49
67-63-0	67630	Isopropyl alcohol	0.206	291.18	No	291.39
67-63-0	67630	Isopropyl alcohol	0.413	291.18	No	291.59
67-66-3	67663	Chloroform	0.186	69.95	No	70.14
67-66-3	67663	Chloroform	0.931	349.77	No	350.70
67-66-3	67663	Chloroform	0.931	349.77	No	350.70
67-66-3	67663	Chloroform	0.186	69.95	No	70.14
67-66-3	67663	Chloroform	0.931	349.77	No	350.70
67-66-3	67663	Chloroform	0.931	349.77	No	350.70
67-66-3	67663	Chloroform	0.931	349.77	No	350.70
67-66-3	67663	Chloroform	0.931	349.77	No	350.70
67-66-3	67663	Chloroform	0.186	69.95	No	70.14
67-66-3	67663	Chloroform	1.862	699.54	No	701.40
67-66-3	67663	Chloroform	1.862	699.54	No	701.40
67-66-3	67663	Chloroform	0.931	349.77	No	350.70
67-66-3	67663	Chloroform	1.862	699.54	No	701.40
67-66-3	67663	Chloroform	0.931	349.77	No	350.70
67-66-3	67663	Chloroform	0.931	349.77	No	350.70
67-66-3	67663	Chloroform	0.047	17.49	No	17.53
67-66-3	67663	Chloroform	1.762	662.01	No	663.77
67-66-3	67663	Chloroform	0.931	349.77	No	350.70
67-66-3	67663	Chloroform	0.047	17.49	No	17.53
67-66-3	67663	Chloroform	0.745	279.82	No	280.56
67-66-3	67663	Chloroform	0.745	279.82	No	280.56
67-66-3	67663	Chloroform	0.931	349.77	No	350.70
67-66-3	67663	Chloroform	0.931	349.77	No	350.70
67-66-3	67663	Chloroform	0.881	331.00	No	331.89
67-66-3	67663	Chloroform	0.881	331.00	No	331.89
67-66-3	67663	Chloroform	0.931	349.77	No	350.70
67-66-3	67663	Chloroform	0.931	349.77	No	350.70
67-66-3	67663	Chloroform	0.931	349.77	No	350.70
67-66-3	67663	Chloroform	7.448	1047.13	No	1054.58
67-66-3	67663	Chloroform	1.862	699.54	No	701.40
67-66-3	67663	Chloroform	7.448	1047.13	No	1054.58
67-66-3	67663	Chloroform	0.186	69.95	No	70.14
67-66-3	67663	Chloroform	0.047	17.49	No	17.53
67-66-3	67663	Chloroform	0.186	69.95	No	70.14
67-66-3	67663	Chloroform	1.862	699.54	No	701.40
67-66-3	67663	Chloroform	0.931	349.77	No	350.70
67-66-3	67663	Chloroform	1.862	699.54	No	701.40
67-66-3	67663	Chloroform	0.063	23.59	No	23.65
67-66-3	67663	Chloroform	0.047	17.49	No	17.53
67-66-3	67663	Chloroform	0.047	17.49	No	17.53
67-66-3	67663	Chloroform	0.047	17.49	No	17.53
67-66-3	67663	Chloroform	7.448	1047.13	No	1054.58
67-66-3	67663	Chloroform	3.724	1047.13	No	1050.85
67-66-3	67663	Chloroform	0.931	349.77	No	350.70
67-66-3	67663	Chloroform	0.931	349.77	No	350.70

* Chemicals identified as being frequently used to clean, dry, or sterilize glassware and surfaces assigned emissions of at least 50% of usage.

Calculation of Liquid Chemical Emissions
Phase 1 Laboratory Usage Scenario
Proposed Richmond Bay Campus Long Range Development Plan, Richmond, California
Total Estimated Emissions (Table G-6)

Limit total annual emissions to inventory usage quantity. Assume 1,000 grams/liter when converting liters used to grams.

This list of chemicals comes from merging the purchase and inventory lists Must be identical to Total Usage worksheet			*From previous worksheet (A3)*	*From previous worksheet (A4)*	*Chemical Often Used For Cleaning or Drying?*	*Calculated - Sum of Pouring & Stirring Emissions*
CAS No.		**Compound Name**	**Pouring Annual Emissions (grams/yr)**	**Stirring Annual Emissions (grams/yr)**	**(Yes/No) ***	**Total Annual Emissions * (grams/yr)**
67-66-3	67663	Chloroform	0.931	349.77	No	350.70
67-66-3	67663	Chloroform	7.448	1047.13	No	1054.58
67-66-3	67663	Chloroform	0.186	69.95	No	70.14
67-66-3	67663	Chloroform	0.931	349.77	No	350.70
67-66-3	67663	Chloroform	1.862	699.54	No	701.40
67-66-3	67663	Chloroform	0.931	349.77	No	350.70
67-66-3	67663	Chloroform	1.862	699.54	No	701.40
67-66-3	67663	Chloroform	3.724	1047.13	No	1050.85
67-66-3	67663	Chloroform	4.655	1047.13	No	1051.78
67-66-3	67663	Chloroform	4.655	1047.13	No	1051.78
67-66-3	67663	Chloroform	4.655	1047.13	No	1051.78
67-66-3	67663	Chloroform	0.931	349.77	No	350.70
67-66-3	67663	Chloroform	0.931	349.77	No	350.70
67-66-3	67663	Chloroform	0.931	349.77	No	350.70
67-66-3	67663	Chloroform	0.881	331.00	No	331.89
67-66-3	67663	Chloroform	7.448	1047.13	No	1054.58
67-66-3	67663	Chloroform	1.862	699.54	No	701.40
67-66-3	67663	Chloroform	0.186	69.95	No	70.14
67-66-3	67663	Chloroform	0.047	17.49	No	17.53
67-66-3	67663	Chloroform	0.047	17.49	No	17.53
67-66-3	67663	Chloroform	0.047	17.49	No	17.53
67-66-3	67663	Chloroform	0.838	314.79	No	315.63
67-66-3	67663	Chloroform	0.931	349.77	No	350.70
67-66-3	67663	Chloroform	0.931	349.77	No	350.70
67-66-3	67663	Chloroform	0.931	349.77	No	350.70
67-66-3	67663	Chloroform	0.126	47.17	No	47.30
67-66-3	67663	Chloroform	1.762	662.01	No	663.77
67-66-3	67663	Chloroform	0.931	349.77	No	350.70
67-66-3	67663	Chloroform	0.931	349.77	No	350.70
67-66-3	67663	Chloroform	0.931	349.77	No	350.70
67-66-3	67663	Chloroform	7.448	1047.13	No	1054.58
67-66-3	67663	Chloroform	7.448	1047.13	No	1054.58
67-66-3	67663	Chloroform	7.448	1047.13	No	1054.58
67-66-3	67663	Chloroform	0.093	34.98	No	35.07
67-66-3	67663	Chloroform	1.862	699.54	No	701.40
67-66-3	67663	Chloroform	0.931	349.77	No	350.70
67-66-3	67663	Chloroform	0.931	349.77	No	350.70
67-66-3	67663	Chloroform	0.931	349.77	No	350.70
67-66-3	67663	Chloroform	0.931	349.77	No	350.70
67-66-3	67663	Chloroform	0.931	349.77	No	350.70
67-66-3	67663	Chloroform	7.448	1047.13	No	1054.58
67-66-3	67663	Chloroform	0.931	349.77	No	350.70
67-66-3	67663	Chloroform	0.047	17.49	No	17.53
67-66-3	67663	Chloroform	0.047	17.49	No	17.53
67-66-3	67663	Chloroform	0.047	17.49	No	17.53
67-66-3	67663	Chloroform	0.931	349.77	No	350.70
67-66-3	67663	Chloroform	7.448	1047.13	No	1054.58
67-66-3	67663	Chloroform	0.931	349.77	No	350.70
67-66-3	67663	Chloroform	0.931	349.77	No	350.70
67-66-3	67663	Chloroform	0.931	349.77	No	350.70
67-66-3	67663	Chloroform	0.931	349.77	No	350.70
67-66-3	67663	Chloroform	0.047	17.49	No	17.53
67-66-3	67663	Chloroform	1.862	699.54	No	701.40
67-66-3	67663	Chloroform	0.047	17.49	No	17.53
67-66-3	67663	Chloroform	0.186	69.95	No	70.14
67-66-3	67663	Chloroform	0.047	17.49	No	17.53
67-66-3	67663	Chloroform	0.931	349.77	No	350.70
67-66-3	67663	Chloroform	0.931	349.77	No	350.70
67-66-3	67663	Chloroform	1.769	664.56	No	666.33
67-66-3	67663	Chloroform	0.931	349.77	No	350.70
67-66-3	67663	Chloroform	0.047	17.49	No	17.53
67-66-3	67663	Chloroform	0.931	349.77	No	350.70
67-66-3	67663	Chloroform	0.047	17.49	No	17.53
67-66-3	67663	Chloroform	1.862	699.54	No	701.40
67-66-3	67663	Chloroform	1.862	699.54	No	701.40
67-66-3	67663	Chloroform	0.047	17.49	No	17.53
67-66-3	67663	Chloroform	0.931	349.77	No	350.70
67-66-3	67663	Chloroform	0.931	349.77	No	350.70

* Chemicals identified as being frequently used to clean, dry, or sterilize glassware and surfaces assigned emissions of at least 50% of usage.

Calculation of Liquid Chemical Emissions
Phase 1 Laboratory Usage Scenario
Proposed Richmond Bay Campus Long Range Development Plan, Richmond, California
Total Estimated Emissions (Table G-6)

Limit total annual emissions to inventory usage quantity. Assume 1,000 grams/liter when converting liters used to grams.

This list of chemicals comes from merging the purchase and inventory lists Must be identical to Total Usage worksheet			*From previous worksheet (A3)*	*From previous worksheet (A4)*	*Chemical Often Used For Cleaning or Drying?*	*Calculated - Sum of Pouring & Stirring Emissions*
CAS No.		**Compound Name**	**Pouring Annual Emissions (grams/yr)**	**Stirring Annual Emissions (grams/yr)**	**(Yes/No) ***	**Total Annual Emissions * (grams/yr)**
67-66-3	67663	Chloroform	0.931	349.77	No	350.70
68-12-2	68122	Dimethyl formamide	0.002	11.56	No	11.56
68-12-2	68122	Dimethyl formamide	0.011	11.56	No	11.57
68-12-2	68122	Dimethyl formamide	0.022	28.90	No	28.92
68-12-2	68122	Dimethyl formamide	0.005	11.56	No	11.57
68-12-2	68122	Dimethyl formamide	0.044	28.90	No	28.95
68-12-2	68122	Dimethyl formamide	0.087	28.90	No	28.99
68-12-2	68122	Dimethyl formamide	0.022	28.90	No	28.92
68-12-2	68122	Dimethyl formamide	0.022	28.90	No	28.92
68-12-2	68122	Dimethyl formamide	0.011	11.56	No	11.57
68-12-2	68122	Dimethyl formamide	0.011	11.56	No	11.57
68-12-2	68122	Dimethyl formamide	0.022	28.90	No	28.92
68-12-2	68122	Dimethyl formamide	0.005	11.56	No	11.57
68-12-2	68122	Dimethyl formamide	0.011	11.56	No	11.57
68-12-2	68122	Dimethyl formamide	0.000	0.70	No	0.70
68-12-2	68122	Dimethyl formamide	0.005	11.56	No	11.57
68-12-2	68122	Dimethyl formamide	0.011	11.56	No	11.57
68-12-2	68122	Dimethyl formamide	0.011	11.56	No	11.57
68-12-2	68122	Dimethyl formamide	0.005	11.56	No	11.57
68-12-2	68122	Dimethyl formamide	0.005	11.56	No	11.57
68-12-2	68122	Dimethyl formamide	0.005	11.56	No	11.57
68-12-2	68122	Dimethyl formamide	0.022	28.90	No	28.92
68-12-2	68122	Dimethyl formamide	0.022	28.90	No	28.92
68-12-2	68122	Dimethyl formamide	0.002	11.56	No	11.56
68-12-2	68122	Dimethyl formamide	0.002	11.56	No	11.56
68-12-2	68122	Dimethyl formamide	0.002	11.56	No	11.56
68-12-2	68122	Dimethyl formamide	0.002	11.56	No	11.56
68-12-2	68122	Dimethyl formamide	0.022	28.90	No	28.92
68-12-2	68122	Dimethyl formamide	0.011	11.56	No	11.57
68-12-2	68122	Dimethyl formamide	0.011	11.56	No	11.57
68-12-2	68122	Dimethyl formamide	0.011	11.56	No	11.57
68-12-2	68122	Dimethyl formamide	0.011	11.56	No	11.57
68-12-2	68123	Dimethyl formamide	0.005	11.56	No	11.57
71-43-2	71432	Benzene	0.592	466.57	No	467.16
71-43-2	71432	Benzene	0.592	466.57	No	467.16
71-43-2	71432	Benzene	1.185	466.57	No	467.76
71-43-2	71433	Benzene	0.059	69.95	No	70.01
71-43-2	71433	Benzene	0.592	466.57	No	467.16
75-07-0	75070	Acetaldhyde	0.016	3.50	No	3.51
75-07-0	75070	Acetaldhyde	0.327	69.95	No	70.28
75-07-0	75070	Acetaldhyde	0.327	69.95	No	70.28
75-09-2	75092	Methylene chloride [Dichloromethane]	0.297	69.95	No	70.25
75-09-2	75092	Methylene chloride [Dichloromethane]	11.871	1867.64	No	1879.51
75-09-2	75092	Methylene chloride [Dichloromethane]	56.387	7470.55	No	7526.94
75-09-2	75092	Methylene chloride [Dichloromethane]	0.297	69.95	No	70.25
75-09-2	75092	Methylene chloride [Dichloromethane]	2.968	699.54	No	702.51
75-09-2	75092	Methylene chloride [Dichloromethane]	56.387	7470.55	No	7526.94
75-09-2	75092	Methylene chloride [Dichloromethane]	11.871	1867.64	No	1879.51
75-09-2	75092	Methylene chloride [Dichloromethane]	11.871	1867.64	No	1879.51
75-09-2	75092	Methylene chloride [Dichloromethane]	0.297	69.95	No	70.25
75-09-2	75092	Methylene chloride [Dichloromethane]	2.968	699.54	No	702.51
75-09-2	75092	Methylene chloride [Dichloromethane]	0.297	69.95	No	70.25
75-09-2	75092	Methylene chloride [Dichloromethane]	11.871	1867.64	No	1879.51
75-09-2	75092	Methylene chloride [Dichloromethane]	11.871	1867.64	No	1879.51
75-09-2	75092	Methylene chloride [Dichloromethane]	2.968	699.54	No	702.51
75-09-2	75092	Methylene chloride [Dichloromethane]	2.968	699.54	No	702.51
75-09-2	75092	Methylene chloride [Dichloromethane]	2.968	699.54	No	702.51
75-09-2	75092	Methylene chloride [Dichloromethane]	59.355	7470.55	No	7529.91
75-09-2	75092	Methylene chloride [Dichloromethane]	2.968	699.54	No	702.51
75-09-2	75092	Methylene chloride [Dichloromethane]	59.355	7470.55	No	7529.91
75-09-2	75092	Methylene chloride [Dichloromethane]	11.871	1867.64	No	1879.51
75-09-2	75092	Methylene chloride [Dichloromethane]	11.871	1867.64	No	1879.51
75-09-2	75092	Methylene chloride [Dichloromethane]	11.871	1867.64	No	1879.51
75-09-2	75092	Methylene chloride [Dichloromethane]	1.484	349.77	No	351.25
75-09-2	75092	Methylene chloride [Dichloromethane]	2.968	699.54	No	702.51
75-56-9	75569	Propylene oxide	0.001	0.21	No	0.21
75-56-9	75569	Propylene oxide	0.001	0.21	No	0.21
78-93-3	78933	Methyl ethyl ketone [2-Butanone]	0.259	176.90	No	177.15

* Chemicals identified as being frequently used to clean, dry, or sterilize glassware and surfaces assigned emissions of at least 50% of usage.

Calculation of Liquid Chemical Emissions
Phase 1 Laboratory Usage Scenario
Proposed Richmond Bay Campus Long Range Development Plan, Richmond, California
Total Estimated Emissions (Table G-6)

Limit total annual emissions to inventory usage quantity. Assume 1,000 grams/liter when converting liters used to grams.

This list of chemicals comes from merging the purchase and inventory lists Must be identical to Total Usage worksheet			*From previous worksheet (A3)*	*From previous worksheet (A4)*	*Chemical Often Used For Cleaning or Drying?*	*Calculated - Sum of Pouring & Stirring Emissions*
CAS No.		**Compound Name**	**Pouring Annual Emissions (grams/yr)**	**Stirring Annual Emissions (grams/yr)**	**(Yes/No) ***	**Total Annual Emissions * (grams/yr)**
78-93-3	78933	Methyl ethyl ketone [2-Butanone]	0.259	176.90	No	177.15
78-93-3	78933	Methyl ethyl ketone [2-Butanone]	0.259	176.90	No	177.15
78-93-3	78933	Methyl ethyl ketone [2-Butanone]	0.517	442.24	No	442.76
79-01-6	79016	Trichloroethylene	0.358	264.46	No	264.82
79-01-6	79016	Trichloroethylene	0.358	264.46	No	264.82
79-01-6	79016	Trichloroethylene	0.358	264.46	No	264.82
79-01-6	79017	Trichloroethylene	0.358	264.46	No	264.82
79-10-7	79107	Acrylic Acid	0.003	3.33	No	3.33
79-10-7	79107	Acrylic Acid	0.003	3.33	No	3.33
79-10-7	79107	Acrylic Acid	0.003	3.33	No	3.33
100-41-4	100415	Ethyl benzene	0.078	90.67	No	90.75
100-42-5	100425	Styrene	0.005	24.77	No	24.77
100-42-5	100425	Styrene	0.000	2.48	No	2.48
100-44-7	100448	Benzyl chloride	0.003	5.15	No	5.16
106-89-8	106899	Epichlorohydrin	0.002	14.78	No	14.79
106-99-0	106991	1,3-Butadiene	3.703	282.07	No	285.77
107-02-8	107029	Acrolein	0.125	69.95	No	70.08
107-06-2	107062	Ethylene dichloride [EDC]	1.475	546.91	No	548.39
107-06-2	107062	Ethylene dichloride [EDC]	0.310	218.76	No	219.07
107-06-2	107062	Ethylene dichloride [EDC]	0.620	546.91	No	547.53
107-06-2	107062	Ethylene dichloride [EDC]	2.478	546.91	No	549.39
107-06-2	107062	Ethylene dichloride [EDC]	0.310	218.76	No	219.07
107-21-1	107211	Ethylene glycol	0.000	0.53	No	0.53
107-21-1	107211	Ethylene glycol	0.000	0.53	No	0.53
107-21-1	107211	Ethylene glycol	0.000	0.53	No	0.53
107-21-1	107211	Ethylene glycol	0.002	0.53	No	0.53
107-21-1	107211	Ethylene glycol	0.001	0.53	No	0.53
107-21-1	107211	Ethylene glycol	0.000	0.21	No	0.21
107-21-1	107211	Ethylene glycol	0.000	0.53	No	0.53
107-21-1	107211	Ethylene glycol	0.000	0.21	No	0.21
107-21-1	107211	Ethylene glycol	0.000	0.21	No	0.21
107-21-1	107211	Ethylene glycol	0.000	0.21	No	0.21
107-21-1	107211	Ethylene glycol	0.001	0.53	No	0.53
107-21-1	107211	Ethylene glycol	0.000	0.53	No	0.53
107-21-1	107211	Ethylene glycol	0.000	0.21	No	0.21
107-21-1	107211	Ethylene glycol	0.000	0.11	No	0.11
107-98-2	107983	Propylene glycol monomethyl ether	0.001	4.85	No	4.85
107-98-2	107983	Propylene glycol monomethyl ether	0.001	4.85	No	4.85
108-39-4	108395	m-Cresol	0.001	0.59	No	0.59
108-39-4	108395	m-Cresol	0.000	0.59	No	0.59
108-88-3	108883	Toluene	0.021	69.95	No	69.97
108-88-3	108883	Toluene	0.205	251.25	No	251.46
108-88-3	108883	Toluene	0.103	100.50	No	100.60
108-88-3	108883	Toluene	0.205	251.25	No	251.46
108-88-3	108883	Toluene	0.205	251.25	No	251.46
108-88-3	108883	Toluene	0.410	251.25	No	251.66
108-88-3	108883	Toluene	0.205	251.25	No	251.46
108-88-3	108883	Toluene	0.205	251.25	No	251.46
108-88-3	108883	Toluene	0.205	251.25	No	251.46
108-88-3	108883	Toluene	0.205	251.25	No	251.46
108-88-3	108883	Toluene	0.205	251.25	No	251.46
108-88-3	108883	Toluene	0.205	251.25	No	251.46
108-88-3	108883	Toluene	0.021	69.95	No	69.97
108-88-3	108883	Toluene	0.205	251.25	No	251.46
108-88-3	108883	Toluene	0.205	251.25	No	251.46
108-88-3	108883	Toluene	0.103	100.50	No	100.60
108-88-3	108883	Toluene	0.205	251.25	No	251.46
108-88-3	108883	Toluene	0.205	251.25	No	251.46
108-88-3	108883	Toluene	0.205	251.25	No	251.46
108-88-3	108883	Toluene	0.021	69.95	No	69.97
108-88-3	108883	Toluene	0.103	100.50	No	100.60
108-88-3	108883	Toluene	0.410	251.25	No	251.66
108-88-3	108884	Toluene	0.103	100.50	No	100.60
109-86-4	109865	Ethylene glycol monomethyl ether	0.059	76.85	No	76.91
110-54-3	110543	Hexane	1.049	657.22	No	658.27
110-54-3	110543	Hexane	1.049	657.22	No	658.27
110-54-3	110543	Hexane	1.049	657.22	No	658.27
110-54-3	110543	Hexane	4.198	657.22	No	661.42

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Calculation of Liquid Chemical Emissions
Phase 1 Laboratory Usage Scenario
Proposed Richmond Bay Campus Long Range Development Plan, Richmond, California
Total Estimated Emissions (Table G-6)

Limit total annual emissions to inventory usage quantity. Assume 1,000 grams/liter when converting liters used to grams.

This list of chemicals comes from merging the purchase and inventory lists Must be identical to Total Usage worksheet			*From previous worksheet (A3)*	*From previous worksheet (A4)*	*Chemical Often Used For Cleaning or Drying?*	*Calculated - Sum of Pouring & Stirring Emissions*
CAS No.		**Compound Name**	**Pouring Annual Emissions (grams/yr)**	**Stirring Annual Emissions (grams/yr)**	**(Yes/No) ***	**Total Annual Emissions * (grams/yr)**
110-54-3	110543	Hexane	4.198	657.22	No	661.42
110-54-3	110543	Hexane	19.940	2628.89	No	2648.83
110-54-3	110543	Hexane	1.049	657.22	No	658.27
110-54-3	110543	Hexane	19.940	2628.89	No	2648.83
110-54-3	110543	Hexane	1.049	657.22	No	658.27
110-54-3	110543	Hexane	0.001	0.70	No	0.70
110-54-3	110543	Hexane	4.198	657.22	No	661.42
110-54-3	110543	Hexane	4.198	657.22	No	661.42
110-54-3	110543	Hexane	4.198	657.22	No	661.42
110-54-3	110543	Hexane	4.198	657.22	No	661.42
110-54-3	110543	Hexane	4.198	657.22	No	661.42
110-54-3	110543	Hexane	4.198	657.22	No	661.42
110-54-3	110543	Hexane	20.990	2628.89	No	2649.88
110-54-3	110543	Hexane	25.188	2628.89	No	2654.08
110-54-3	110543	Hexane	4.198	657.22	No	661.42
110-54-3	110543	Hexane	19.940	2628.89	No	2648.83
110-54-3	110543	Hexane	1.049	657.22	No	658.27
110-54-3	110543	Hexane	4.198	657.22	No	661.42
110-54-3	110543	Hexane	4.198	657.22	No	661.42
110-54-3	110543	Hexane	4.198	657.22	No	661.42
110-54-3	110543	Hexane	20.990	2628.89	No	2649.88
110-54-3	110543	Hexane	20.990	2628.89	No	2649.88
110-54-3	110543	Hexane	0.001	0.70	No	0.70
110-54-3	110543	Hexane	20.990	2628.89	No	2649.88
110-54-3	110543	Hexane	1.049	657.22	No	658.27
110-54-3	110543	Hexane	1.049	657.22	No	658.27
110-54-3	110543	Hexane	1.049	657.22	No	658.27
110-54-3	110543	Hexane	1.049	657.22	No	658.27
110-54-3	110543	Hexane	1.049	657.22	No	658.27
110-54-3	110543	Hexane	0.105	69.95	No	70.06
110-54-3	110543	Hexane	0.525	262.89	No	263.41
110-54-3	110543	Hexane	1.049	657.22	No	658.27
110-54-3	110543	Hexane	1.049	657.22	No	658.27
110-54-3	110543	Hexane	1.049	657.22	No	658.27
110-54-3	110543	Hexane	1.049	657.22	No	658.27
110-54-3	110543	Hexane	1.049	657.22	No	658.27
111-30-8	111308	Glutaraldehyde	0.004	4.96	No	4.96
111-30-8	111308	Glutaraldehyde	0.0001	0.99	No	0.99
111-30-8	111308	Glutaraldehyde	0.000	0.99	No	0.99
111-30-8	111308	Glutaraldehyde	0.000	1.98	No	1.98
111-30-8	111308	Glutaraldehyde	0.000	0.99	No	0.99
111-30-8	111308	Glutaraldehyde	0.000	1.98	No	1.98
111-30-8	111308	Glutaraldehyde	0.000	0.99	No	0.99
111-30-8	111308	Glutaraldehyde	0.000	0.99	No	0.99
111-30-8	111308	Glutaraldehyde	0.000	0.99	No	0.99
111-30-8	111308	Glutaraldehyde	0.000	0.99	No	0.99
111-30-8	111308	Glutaraldehyde	0.000	0.99	No	0.99
111-30-8	111308	Glutaraldehyde	0.000	1.98	No	1.98
111-30-8	111308	Glutaraldehyde	0.000	1.98	No	1.98
111-30-8	111308	Glutaraldehyde	0.000	0.20	No	0.20
111-30-8	111308	Glutaraldehyde	0.000	0.99	No	0.99
111-30-8	111308	Glutaraldehyde	0.000	0.99	No	0.99
111-30-8	111308	Glutaraldehyde	0.000	0.99	No	0.99
111-30-8	111308	Glutaraldehyde	0.000	0.20	No	0.20
111-30-8	111308	Glutaraldehyde	0.000	0.99	No	0.99
111-30-8	111308	Glutaraldehyde	0.000	1.98	No	1.98
111-30-8	111308	Glutaraldehyde	0.000	0.20	No	0.20
111-30-8	111308	Glutaraldehyde	0.000	0.20	No	0.20
111-30-8	111308	Glutaraldehyde	0.000	0.99	No	0.99
111-30-8	111308	Glutaraldehyde	0.000	0.99	No	0.99
111-30-8	111308	Glutaraldehyde	0.000	1.98	No	1.98
111-30-8	111308	Glutaraldehyde	0.000	0.99	No	0.99
111-30-8	111308	Glutaraldehyde	0.004	4.96	No	4.96
111-30-8	111308	Glutaraldehyde	0.000	1.98	No	1.98
111-30-8	111308	Glutaraldehyde	0.000	1.98	No	1.98
111-30-8	111308	Glutaraldehyde	0.000	1.98	No	1.98
111-30-8	111308	Glutaraldehyde	0.000	0.99	No	0.99
111-42-2	111422	Diethanolamine	0.000	0.00	No	0.00

* Chemicals identified as being frequently used to clean, dry, or sterilize glassware and surfaces assigned emissions of at least 50% of usage.

Calculation of Liquid Chemical Emissions
Phase 1 Laboratory Usage Scenario
Proposed Richmond Bay Campus Long Range Development Plan, Richmond, California
Total Estimated Emissions (Table G-6)

Limit total annual emissions to inventory usage quantity. Assume 1,000 grams/liter when converting liters used to grams.

This list of chemicals comes from merging the purchase and inventory lists Must be identical to Total Usage worksheet			*From previous worksheet (A3)*	*From previous worksheet (A4)*	*Chemical Often Used For Cleaning or Drying?*	*Calculated - Sum of Pouring & Stirring Emissions*
CAS No.		**Compound Name**	**Pouring Annual Emissions (grams/yr)**	**Stirring Annual Emissions (grams/yr)**	**(Yes/No) ***	**Total Annual Emissions * (grams/yr)**
111-42-2	111422	Diethanolamine	0.000	0.00	No	0.00
111-42-2	111423	Diethanolamine	0.000	0.00	No	0.00
111-42-2	111423	Diethanolamine	0.000	0.00	No	0.00
121-44-8	121448	Triethylamine	0.225	214.29	No	214.52
121-44-8	121448	Triethylamine	0.045	69.95	No	70.00
121-44-8	121448	Triethylamine	0.005	7.00	No	7.00
121-44-8	121448	Triethylamine	0.015	24.02	No	24.04
121-44-8	121448	Triethylamine	0.451	535.73	No	536.18
121-44-8	121448	Triethylamine	0.045	69.95	No	70.00
121-44-8	121448	Triethylamine	0.045	69.95	No	70.00
121-44-8	121448	Triethylamine	0.045	69.95	No	70.00
121-44-8	121448	Triethylamine	0.225	214.29	No	214.52
123-91-1	123911	1,4-Dioxane	0.258	321.34	No	321.60
123-91-1	123911	1,4-Dioxane	0.258	321.34	No	321.60
123-91-1	123911	1,4-Dioxane	0.258	321.34	No	321.60
123-91-1	123911	1,4-Dioxane	0.517	321.34	No	321.85
123-91-1	123911	1,4-Dioxane	0.517	321.34	No	321.85
123-91-1	123911	1,4-Dioxane	0.125	128.54	No	128.66
123-91-1	123911	1,4-Dioxane	0.258	321.34	No	321.60
123-91-1	123911	1,4-Dioxane	0.258	321.34	No	321.60
123-91-1	123911	1,4-Dioxane	1.034	321.34	No	322.37
123-91-1	123911	1,4-Dioxane	1.034	321.34	No	322.37
123-91-1	123912	1,4-Dioxane	0.026	69.95	No	69.98
127-18-4	127185	Perchloroethylene [Tetrachloroethene]	0.233	235.52	No	235.75
1330-20-7	1330207	Xylenes (mixed isomers)	0.066	77.04	No	77.11
1330-20-7	1330207	Xylenes (mixed isomers)	0.033	30.82	No	30.85
1330-20-7	1330207	Xylenes (mixed isomers)	0.264	77.04	No	77.31
1330-20-7	1330207	Xylenes (mixed isomers)	0.000	3.08	No	3.08
1330-20-7	1330207	Xylenes (mixed isomers)	0.033	30.82	No	30.85
1330-20-7	1330207	Xylenes (mixed isomers)	0.249	77.04	No	77.29
1330-20-7	1330207	Xylenes (mixed isomers)	0.264	77.04	No	77.31
1330-20-7	1330207	Xylenes (mixed isomers)	0.264	77.04	No	77.31
1330-20-7	1330207	Xylenes (mixed isomers)	0.033	30.82	No	30.85
1330-20-7	1330207	Xylenes (mixed isomers)	0.033	30.82	No	30.85
1330-20-7	1330207	Xylenes (mixed isomers)	0.033	30.82	No	30.85
1330-20-7	1330207	Xylenes (mixed isomers)	0.249	77.04	No	77.29
1330-20-7	1330207	Xylenes (mixed isomers)	0.264	77.04	No	77.31
1330-20-7	1330207	Xylenes (mixed isomers)	0.033	30.82	No	30.85
1330-20-7	1330207	Xylenes (mixed isomers)	0.000	0.81	No	0.81
1330-20-7	1330207	Xylenes (mixed isomers)	0.033	30.82	No	30.85
1330-20-7	1330207	Xylenes (mixed isomers)	0.264	77.04	No	77.31
1330-20-7	1330207	Xylenes (mixed isomers)	0.007	30.82	No	30.82
1634-04-4	1634045	Methyl tert-butyl ether	3.915	608.43	No	612.34
1634-04-4	1634045	Methyl tert-butyl ether	0.098	69.95	No	70.05
7647-01-0	7647010	Hydrochloric acid	0.640	532.22	No	532.86
7647-01-0	7647010	Hydrochloric acid	0.032	34.98	No	35.01
7647-01-0	7647010	Hydrochloric acid	0.640	532.22	No	532.86
7647-01-0	7647010	Hydrochloric acid	0.640	532.22	No	532.86
7647-01-0	7647010	Hydrochloric acid	0.640	532.22	No	532.86
7647-01-0	7647010	Hydrochloric acid	0.640	532.22	No	532.86
7647-01-0	7647010	Hydrochloric acid	0.640	532.22	No	532.86
7647-01-0	7647010	Hydrochloric acid	0.320	212.89	No	213.21
7647-01-0	7647010	Hydrochloric acid	2.560	532.22	No	534.78
7647-01-0	7647010	Hydrochloric acid	2.560	532.22	No	534.78
7647-01-0	7647010	Hydrochloric acid	2.560	532.22	No	534.78
7647-01-0	7647010	Hydrochloric acid	2.560	532.22	No	534.78
7647-01-0	7647010	Hydrochloric acid	2.560	532.22	No	534.78
7647-01-0	7647010	Hydrochloric acid	0.320	212.89	No	213.21
7647-01-0	7647010	Hydrochloric acid	1.600	532.22	No	533.82
7647-01-0	7647010	Hydrochloric acid	0.640	532.22	No	532.86
7647-01-0	7647010	Hydrochloric acid	0.320	212.89	No	213.21
7647-01-0	7647010	Hydrochloric acid	0.640	532.22	No	532.86
7647-01-0	7647010	Hydrochloric acid	0.640	532.22	No	532.86
7647-01-0	7647010	Hydrochloric acid	0.640	532.22	No	532.86
7647-01-0	7647010	Hydrochloric acid	1.600	532.22	No	533.82
7647-01-0	7647010	Hydrochloric acid	1.600	532.22	No	533.82
7647-01-0	7647010	Hydrochloric acid	1.600	532.22	No	533.82
7647-01-0	7647010	Hydrochloric acid	1.600	532.22	No	533.82

* Chemicals identified as being frequently used to clean, dry, or sterilize glassware and surfaces assigned emissions of at least 50% of usage.

Calculation of Liquid Chemical Emissions
Phase 1 Laboratory Usage Scenario
Proposed Richmond Bay Campus Long Range Development Plan, Richmond, California
Total Estimated Emissions (Table G-6)

Limit total annual emissions to inventory usage quantity. Assume 1,000 grams/liter when converting liters used to grams.

This list of chemicals comes from merging the purchase and inventory lists Must be identical to Total Usage worksheet			*From previous worksheet (A3)*	*From previous worksheet (A4)*	*Chemical Often Used For Cleaning or Drying?*	*Calculated - Sum of Pouring & Stirring Emissions*
CAS No.		**Compound Name**	**Pouring Annual Emissions (grams/yr)**	**Stirring Annual Emissions (grams/yr)**	**(Yes/No) ***	**Total Annual Emissions * (grams/yr)**
7647-01-0	7647010	Hydrochloric acid	1.600	532.22	No	533.82
7647-01-0	7647010	Hydrochloric acid	1.600	532.22	No	533.82
7647-01-0	7647010	Hydrochloric acid	0.320	212.89	No	213.21
7647-01-0	7647010	Hydrochloric acid	0.064	69.95	No	70.02
7647-01-0	7647010	Hydrochloric acid	0.064	69.95	No	70.02
7647-01-0	7647010	Hydrochloric acid	0.320	212.89	No	213.21
7647-01-0	7647010	Hydrochloric acid	0.320	212.89	No	213.21
7647-01-0	7647010	Hydrochloric acid	0.064	69.95	No	70.02
7647-01-0	7647010	Hydrochloric acid	0.640	532.22	No	532.86
7647-01-0	7647010	Hydrochloric acid	0.320	212.89	No	213.21
7647-01-0	7647010	Hydrochloric acid	0.640	532.22	No	532.86
7647-01-0	7647010	Hydrochloric acid	2.560	532.22	No	534.78
7647-01-0	7647010	Hydrochloric acid	2.560	532.22	No	534.78
7647-01-0	7647010	Hydrochloric acid	2.560	532.22	No	534.78
7647-01-0	7647010	Hydrochloric acid	2.560	532.22	No	534.78
7647-01-0	7647010	Hydrochloric acid	2.560	532.22	No	534.78
7647-01-0	7647010	Hydrochloric acid	0.320	212.89	No	213.21
7647-01-0	7647010	Hydrochloric acid	0.320	212.89	No	213.21
7647-01-0	7647010	Hydrochloric acid	0.320	212.89	No	213.21
7647-01-0	7647010	Hydrochloric acid	0.320	212.89	No	213.21
7647-01-0	7647010	Hydrochloric acid	0.320	212.89	No	213.21
7647-01-0	7647010	Hydrochloric acid	0.640	532.22	No	532.86
7647-01-0	7647010	Hydrochloric acid	0.001	0.70	No	0.70
7647-01-0	7647010	Hydrochloric acid	1.600	532.22	No	533.82
7647-01-0	7647010	Hydrochloric acid	1.600	532.22	No	533.82
7647-01-0	7647010	Hydrochloric acid	1.600	532.22	No	533.82
7647-01-0	7647010	Hydrochloric acid	13.332	2128.88	No	2142.22
7647-01-0	7647010	Hydrochloric acid	1.600	532.22	No	533.82
7647-01-0	7647010	Hydrochloric acid	0.320	212.89	No	213.21
7647-01-0	7647010	Hydrochloric acid	1.600	532.22	No	533.82
7647-01-0	7647010	Hydrochloric acid	0.320	212.89	No	213.21
7647-01-0	7647010	Hydrochloric acid	1.600	532.22	No	533.82
7647-01-0	7647010	Hydrochloric acid	1.600	532.22	No	533.82
7647-01-0	7647010	Hydrochloric acid	0.320	212.89	No	213.21
7647-01-0	7647010	Hydrochloric acid	0.320	212.89	No	213.21
7647-01-0	7647010	Hydrochloric acid	0.320	212.89	No	213.21
7647-01-0	7647010	Hydrochloric acid	0.320	212.89	No	213.21
7647-01-0	7647010	Hydrochloric acid	0.320	212.89	No	213.21
7647-01-0	7647010	Hydrochloric acid	26.663	2128.88	No	2155.55
7647-01-0	7647010	Hydrochloric acid	0.320	212.89	No	213.21
7647-01-0	7647010	Hydrochloric acid	0.320	212.89	No	213.21
7647-01-0	7647010	Hydrochloric acid	0.320	212.89	No	213.21
7647-01-0	7647010	Hydrochloric acid	0.320	212.89	No	213.21
7647-01-0	7647010	Hydrochloric acid	0.320	212.89	No	213.21
7647-01-0	7647010	Hydrochloric acid	1.600	532.22	No	533.82
7647-01-0	7647010	Hydrochloric acid	1.600	532.22	No	533.82
7647-01-0	7647010	Hydrochloric acid	1.600	532.22	No	533.82
7647-01-0	7647010	Hydrochloric acid	0.320	212.89	No	213.21
7647-01-0	7647010	Hydrochloric acid	14.533	2128.88	No	2143.42
7647-01-0	7647010	Hydrochloric acid	0.320	212.89	No	213.21
7647-01-0	7647010	Hydrochloric acid	2.422	532.22	No	534.64
7647-01-0	7647010	Hydrochloric acid	0.064	69.95	No	70.02
7647-01-0	7647010	Hydrochloric acid	0.320	212.89	No	213.21
7647-01-0	7647010	Hydrochloric acid	0.064	69.95	No	70.02
7647-01-0	7647010	Hydrochloric acid	0.320	212.89	No	213.21
7647-01-0	7647010	Hydrochloric acid	0.320	212.89	No	213.21
7647-01-0	7647010	Hydrochloric acid	0.320	212.89	No	213.21
7647-01-0	7647010	Hydrochloric acid	0.002	2.10	No	2.10
7647-01-0	7647010	Hydrochloric acid	1.600	532.22	No	533.82
7647-01-0	7647010	Hydrochloric acid	0.320	212.89	No	213.21
7647-01-0	7647010	Hydrochloric acid	0.320	212.89	No	213.21
7647-01-0	7647010	Hydrochloric acid	1.600	532.22	No	533.82
7647-01-0	7647010	Hydrochloric acid	0.320	212.89	No	213.21
7647-01-0	7647010	Hydrochloric acid	0.320	212.89	No	213.21
7647-01-0	7647010	Hydrochloric acid	0.320	212.89	No	213.21
7647-01-0	7647010	Hydrochloric acid	0.320	212.89	No	213.21
7647-01-0	7647010	Hydrochloric acid	2.560	532.22	No	534.78
7664-38-2	7664382	Phosphoric acid	0.000	0.33	No	0.33

* Chemicals identified as being frequently used to clean, dry, or sterilize glassware and surfaces assigned emissions of at least 50% of usage.

Calculation of Liquid Chemical Emissions
Phase 1 Laboratory Usage Scenario
Proposed Richmond Bay Campus Long Range Development Plan, Richmond, California
Total Estimated Emissions (Table G-6)

Limit total annual emissions to inventory usage quantity. Assume 1,000 grams/liter when converting liters used to grams.

This list of chemicals comes from merging the purchase and inventory lists Must be identical to Total Usage worksheet			*From previous worksheet (A3)*	*From previous worksheet (A4)*	*Chemical Often Used For Cleaning or Drying?*	*Calculated - Sum of Pouring & Stirring Emissions*
CAS No.		**Compound Name**	**Pouring Annual Emissions (grams/yr)**	**Stirring Annual Emissions (grams/yr)**	**(Yes/No) ***	**Total Annual Emissions * (grams/yr)**
7664-38-2	7664382	Phosphoric acid	0.000	0.33	No	0.33
7664-38-2	7664382	Phosphoric acid	0.000	0.33	No	0.33
7664-38-2	7664382	Phosphoric acid	0.000	0.33	No	0.33
7664-38-2	7664382	Phosphoric acid	0.000	0.07	No	0.07
7664-38-2	7664382	Phosphoric acid	0.000	0.13	No	0.13
7664-38-2	7664382	Phosphoric acid	0.000	0.13	No	0.13
7664-38-2	7664382	Phosphoric acid	0.001	0.33	No	0.33
7664-38-2	7664382	Phosphoric acid	0.000	0.13	No	0.13
7664-38-2	7664382	Phosphoric acid	0.000	0.13	No	0.13
7664-38-2	7664382	Phosphoric acid	0.000	0.13	No	0.13
7664-38-2	7664382	Phosphoric acid	0.002	0.33	No	0.33
7664-38-2	7664382	Phosphoric acid	0.000	0.13	No	0.13
7664-38-2	7664382	Phosphoric acid	0.001	0.33	No	0.33
7664-38-2	7664382	Phosphoric acid	0.002	0.33	No	0.33
7664-38-2	7664382	Phosphoric acid	0.000	0.13	No	0.13
7664-38-2	7664382	Phosphoric acid	0.000	0.07	No	0.07
7664-38-2	7664382	Phosphoric acid	0.000	0.13	No	0.13
7664-38-2	7664382	Phosphoric acid	0.000	0.13	No	0.13
7664-38-2	7664382	Phosphoric acid	0.000	0.13	No	0.13
7664-38-2	7664382	Phosphoric acid	0.000	0.33	No	0.33
7664-38-2	7664382	Phosphoric acid	0.000	0.13	No	0.13
7664-38-2	7664382	Phosphoric acid	0.000	0.13	No	0.13
7664-38-2	7664382	Phosphoric acid	0.000	0.13	No	0.13
7664-38-2	7664382	Phosphoric acid	0.000	0.01	No	0.01
7664-38-2	7664382	Phosphoric acid	0.000	0.13	No	0.13
7664-38-2	7664382	Phosphoric acid	0.000	0.07	No	0.07
7664-38-2	7664382	Phosphoric acid	0.000	0.07	No	0.07
7664-38-2	7664382	Phosphoric acid	0.000	0.13	No	0.13
7664-38-2	7664382	Phosphoric acid	0.000	0.07	No	0.07
7664-38-2	7664382	Phosphoric acid	0.000	0.13	No	0.13
7664-39-3	7664394	Hydrogen fluoride	0.023	37.47	No	37.50
7664-93-9	7664939	Sulfuric acid	0.001	4.35	No	4.35
7664-93-9	7664939	Sulfuric acid	0.009	10.87	No	10.88
7664-93-9	7664939	Sulfuric acid	0.009	10.87	No	10.88
7664-93-9	7664939	Sulfuric acid	0.009	10.87	No	10.88
7664-93-9	7664939	Sulfuric acid	0.005	4.35	No	4.35
7664-93-9	7664939	Sulfuric acid	0.005	4.35	No	4.35
7664-93-9	7664939	Sulfuric acid	0.005	4.35	No	4.35
7664-93-9	7664939	Sulfuric acid	0.005	4.35	No	4.35
7664-93-9	7664939	Sulfuric acid	0.005	4.35	No	4.35
7664-93-9	7664939	Sulfuric acid	0.005	4.35	No	4.35
7664-93-9	7664939	Sulfuric acid	0.005	4.35	No	4.35
7664-93-9	7664939	Sulfuric acid	0.036	10.87	No	10.91
7664-93-9	7664939	Sulfuric acid	0.005	4.35	No	4.35
7664-93-9	7664939	Sulfuric acid	0.009	10.87	No	10.88
7664-93-9	7664939	Sulfuric acid	0.001	4.35	No	4.35
7664-93-9	7664939	Sulfuric acid	0.009	10.87	No	10.88
7664-93-9	7664939	Sulfuric acid	0.005	4.35	No	4.35
7664-93-9	7664939	Sulfuric acid	0.000	2.17	No	2.17
7664-93-9	7664939	Sulfuric acid	0.023	10.87	No	10.89
7664-93-9	7664939	Sulfuric acid	0.001	4.35	No	4.35
7664-93-9	7664939	Sulfuric acid	0.001	4.35	No	4.35
7664-93-9	7664939	Sulfuric acid	0.023	10.87	No	10.89
7664-93-9	7664939	Sulfuric acid	0.005	4.35	No	4.35
7664-93-9	7664939	Sulfuric acid	0.005	4.35	No	4.35
7664-93-9	7664939	Sulfuric acid	0.045	10.87	No	10.92
7664-93-9	7664939	Sulfuric acid	0.029	10.87	No	10.90
7664-93-9	7664939	Sulfuric acid	0.023	10.87	No	10.89
7697-37-2	7697372	Nitric acid	0.698	387.94	No	388.64
7697-37-2	7697372	Nitric acid	0.698	387.94	No	388.64
7697-37-2	7697372	Nitric acid	0.698	387.94	No	388.64
7697-37-2	7697372	Nitric acid	0.698	387.94	No	388.64
7697-37-2	7697372	Nitric acid	0.140	155.18	No	155.32
7697-37-2	7697373	Nitric acid	0.140	155.18	No	155.32
7726-95-6	7726957	Bromine	0.004	1.12	No	1.13

* Chemicals identified as being frequently used to clean, dry, or sterilize glassware and surfaces assigned emissions of at least 50% of usage.

Appendix H

Phase 1 Operations Indirect Greenhouse Gas Summary and CalEEMod Output

Table H-1
CalEEMod Indirect Greenhouse Gas Emissions Summary - Phase 1

Operation	Indirect Greenhouse Gas Emissions [(a)] (tons/yr)			
	Total CO_2	CH_4	N_2O	CO_2e
Electricity	2,595	0.23	0.23	2,671
Water	34.2	1.28	3.3E-02	71.9
Solid Waste	10.2	0.61	0	22.9
Total Indirect Emissions	**2,639**	**2.12**	**0.26**	**2,765**

Notes:

(a) Pollutant (tons/yr) = (CalEEMod GHG emission [MT/yr]) x (conversion factor [short ton/metric ton])

Conversion factor [short ton/metric ton] = 1.10231 (1)

References:

(1) CalEEMod greenhouse gas emission results are provided in metric tons/yr.

Phase 1 Development - GHG - 03/29/2012
Bay Area AQMD Air District, Annual

1.0 Project Characteristics

1.1 Land Usage

Land Uses	Size	Metric
Research & Development	600	1000sqft
Parking Lot	600	Space

1.2 Other Project Characteristics

				Utility Company	Pacific Gas & Electric Company
Urbanization	Urban	**Wind Speed (m/s)**			
Climate Zone	5		2.2		
		Precipitation Freq (Days)			
			64		

1.3 User Entered Comments

Project Characteristics - LBNL estimates for indirect GHG emissions
Land Use - For GHG emissions, the full Phase 1 construction gsf is used (600,000). Updated: 3/22/13
Construction Phase -
Off-road Equipment - Pumps = 307 hp. Updated: 3/22/13
Off-road Equipment -
Trips and VMT -
Demolition -
Grading - Blank - Updated: 3/29/13
Energy Use - LBNL provided: (15,820 MWhr/yr) / (600,000 gsf) x (1,000 kWhr/1 MWhr) / (3 columns) = 8.79 kWhr/size/yr - Updated: 3/29/13
Water And Wastewater - 38,000,000 gallons/yr - LBNL provided estimate - 3/29/13
Construction Off-road Equipment Mitigation -

2.0 Emissions Summary

2.2 Overall Operational

Unmitigated Operational

	ROG	NOx	CO	SO2	Fugitive	Exhaust	PM10 Total	Fugitive	Exhaust	PM2.5	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	tons/yr										MT/yr					
Area	4.25	0.00	0.00	0.00		0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Energy	0.08	0.76	0.63	0.00		0.00	0.06		0.00	0.06	0.00	3,176.20	3,176.20	0.22	0.22	3,250.09
Mobile	2.68	5.05	23.51	0.05	4.49	0.22	4.71	0.08	0.21	0.29	0.00	3,878.34	3,878.34	0.17	0.00	3,881.89
Waste						0.00	0.00		0.00	0.00	9.26	0.00	9.26	0.55	0.00	20.74
Water						0.00	0.00		0.00	0.00	0.00	31.02	31.02	1.16	0.03	65.19
Total	**7.01**	**5.81**	**24.14**	**0.05**	**4.49**	**0.22**	**4.77**	**0.08**	**0.21**	**0.35**	**9.26**	**7,085.56**	**7,094.82**	**2.10**	**0.25**	**7,217.91**

Mitigated Operational

	ROG	NOx	CO	SO2	Fugitive	Exhaust	PM10 Total	Fugitive	Exhaust	PM2.5	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	tons/yr										MT/yr					
Area	4.25	0.00	0.00	0.00		0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Energy	0.08	0.76	0.63	0.00		0.00	0.06		0.00	0.06	0.00	3,176.20	3,176.20	0.22	0.22	3,250.09
Mobile	2.68	5.05	23.51	0.05	4.49	0.22	4.71	0.08	0.21	0.29	0.00	3,878.34	3,878.34	0.17	0.00	3,881.89
Waste						0.00	0.00		0.00	0.00	9.26	0.00	9.26	0.55	0.00	20.74
Water						0.00	0.00		0.00	0.00	0.00	31.02	31.02	1.16	0.03	65.19
Total	**7.01**	**5.81**	**24.14**	**0.05**	**4.49**	**0.22**	**4.77**	**0.08**	**0.21**	**0.35**	**9.26**	**7,085.56**	**7,094.82**	**2.10**	**0.25**	**7,217.91**

3.0 Construction Detail

3.1 Mitigation Measures Construction

4.0 Mobile Detail

4.1 Mitigation Measures Mobile

	ROG	NOx	CO	SO2	Fugitive	Exhaust	PM10 Total	Fugitive	Exhaust	PM2.5	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	tons/yr										MT/yr					
Mitigated	2.68	5.05	23.51	0.05	4.49	0.22	4.71	0.08	0.21	0.29	0.00	3,878.34	3,878.34	0.17	0.00	3,881.89
Unmitigated	2.68	5.05	23.51	0.05	4.49	0.22	4.71	0.08	0.21	0.29	0.00	3,878.34	3,878.34	0.17	0.00	3,881.89
Total	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**

4.2 Trip Summary Information

	Average Daily Trip Rate			Unmitigated	Mitigated
Land Use	Weekday	Saturday	Sunday	Annual VMT	Annual VMT
Parking Lot	0.00	0.00	0.00		
Research & Development	4,866.00	1,140.00	666.00	9,357,612	9,357,612
Total	4,866.00	1,140.00	666.00	9,357,612	9,357,612

4.3 Trip Type Information

	Miles			Trip %		
Land Use	H-W or C-W	H-S or C-C	H-O or C-NW	H-W or C-W	H-S or C-C	H-O or C-NW
Parking Lot	9.50	7.30	7.30	0.00	0.00	0.00
Research & Development	9.50	7.30	7.30	33.00	48.00	19.00

5.0 Energy Detail

5.1 Mitigation Measures Energy

	ROG	NOx	CO	SO2	Fugitive	Exhaust	PM10 Total	Fugitive	Exhaust	PM2.5	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	tons/yr										MT/yr					
Electricity Mitigated						0.00	0.00		0.00	0.00	0.00	2,353.97	2,353.97	0.21	0.21	2,422.86
Electricity						0.00	0.00		0.00	0.00	0.00	2,353.97	2,353.97	0.21	0.21	2,422.86
NaturalGas	0.08	0.76	0.63	0.00		0.00	0.06		0.00	0.06	0.00	822.23	822.23	0.02	0.02	827.23
NaturalGas	0.08	0.76	0.63	0.00		0.00	0.06		0.00	0.06	0.00	822.23	822.23	0.02	0.02	827.23
Total	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**

5.2 Energy by Land Use - NaturalGas

Unmitigated

	NaturalGas Use	ROG	NOx	CO	SO2	Fugitive	Exhaust	PM10 Total	Fugitive	Exhaust	PM2.5	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Land Use	kBTU	tons/yr										MT/yr					
Parking Lot	0	0.00	0.00	0.00	0.00		0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Research &	1.5408e+007	0.08	0.76	0.63	0.00		0.00	0.06		0.00	0.06	0.00	822.23	822.23	0.02	0.02	827.23
Total		**0.08**	**0.76**	**0.63**	**0.00**		**0.00**	**0.06**		**0.00**	**0.06**	**0.00**	**822.23**	**822.23**	**0.02**	**0.02**	**827.23**

Mitigated

	NaturalGas Use	ROG	NOx	CO	SO2	Fugitive	Exhaust	PM10 Total	Fugitive	Exhaust	PM2.5	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Land Use	kBTU	tons/yr										MT/yr					
Parking Lot	0	0.00	0.00	0.00	0.00		0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Research &	1.5408e+007	0.08	0.76	0.63	0.00		0.00	0.06		0.00	0.06	0.00	822.23	822.23	0.02	0.02	827.23
Total		**0.08**	**0.76**	**0.63**	**0.00**		**0.00**	**0.06**		**0.00**	**0.06**	**0.00**	**822.23**	**822.23**	**0.02**	**0.02**	**827.23**

5.3 Energy by Land Use - Electricity

Unmitigated

	Electricity Use	ROG	NOx	CO	SO2	Total CO2	CH4	N2O	CO2e
Land Use	kWh	tons/yr				MT/yr			
Parking Lot	0					0.00	0.00	0.00	0.00
Research &	1.5822e+007					2,353.97	0.21	0.21	2,422.86
Total						**2,353.97**	**0.21**	**0.21**	**2,422.86**

Mitigated

	Electricity Use	ROG	NOx	CO	SO2	Total CO2	CH4	N2O	CO2e
Land Use	kWh	tons/yr				MT/yr			
Parking Lot	0					0.00	0.00	0.00	0.00
Research &	1.5822e+007					2,353.97	0.21	0.21	2,422.86
Total						**2,353.97**	**0.21**	**0.21**	**2,422.86**

6.0 Area Detail

6.1 Mitigation Measures Area

	ROG	NOx	CO	SO2	Fugitive	Exhaust	PM10 Total	Fugitive	Exhaust	PM2.5	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	tons/yr										MT/yr					
Mitigated	4.25	0.00	0.00	0.00		0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Unmitigated	4.25	0.00	0.00	0.00		0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**

6.2 Area by SubCategory

Unmitigated

	ROG	NOx	CO	SO2	Fugitive	Exhaust	PM10 Total	Fugitive	Exhaust	PM2.5	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
SubCategory	tons/yr										MT/yr					
Architectural	0.97					0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Consumer Products	3.28					0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Landscaping	0.00	0.00	0.00	0.00		0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	**4.25**	**0.00**	**0.00**	**0.00**		**0.00**	**0.00**		**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**

Mitigated

	ROG	NOx	CO	SO2	Fugitive	Exhaust	PM10 Total	Fugitive	Exhaust	PM2.5	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
SubCategory	tons/yr										MT/yr					
Architectural	0.97					0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Consumer Products	3.28					0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Landscaping	0.00	0.00	0.00	0.00		0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	**4.25**	**0.00**	**0.00**	**0.00**		**0.00**	**0.00**		**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**

7.0 Water Detail

7.1 Mitigation Measures Water

	ROG	NOx	CO	SO2	Total CO2	CH4	N2O	CO2e
Category	tons/yr				MT/yr			
Mitigated					31.02	1.16	0.03	65.19
Unmitigated					31.02	1.16	0.03	65.19
Total	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**

7.2 Water by Land Use

Unmitigated

	Indoor/Outdoor	ROG	NOx	CO	SO2	Total CO2	CH4	N2O	CO2e
Land Use	Mgal	tons/yr				MT/yr			
Parking Lot	0 / 0					0.00	0.00	0.00	0.00
Research &	38 / 0					31.02	1.16	0.03	65.19
Total						**31.02**	**1.16**	**0.03**	**65.19**

Mitigated

	Indoor/Outdoor	ROG	NOx	CO	SO2	Total CO2	CH4	N2O	CO2e
Land Use	Mgal	tons/yr				MT/yr			
Parking Lot	0 / 0					0.00	0.00	0.00	0.00
Research &	38 / 0					31.02	1.16	0.03	65.19
Total						**31.02**	**1.16**	**0.03**	**65.19**

8.0 Waste Detail

8.1 Mitigation Measures Waste

Category/Year

	ROG	NOx	CO	SO2	Total CO2	CH4	N2O	CO2e
	tons/yr				MT/yr			
Mitigated					9.26	0.55	0.00	20.74
Unmitigated					9.26	0.55	0.00	20.74
Total	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**

8.2 Waste by Land Use

Unmitigated

	Waste Disposed	ROG	NOx	CO	SO2	Total CO2	CH4	N2O	CO2e
Land Use	tons	tons/yr				MT/yr			
Parking Lot	0					0.00	0.00	0.00	0.00
Research &	45.6					9.26	0.55	0.00	20.74
Total						**9.26**	**0.55**	**0.00**	**20.74**

Mitigated

	Waste Disposed	ROG	NOx	CO	SO2	Total CO2	CH4	N2O	CO2e
Land Use	tons	tons/yr				MT/yr			
Parking Lot	0					0.00	0.00	0.00	0.00
Research &	45.6					9.26	0.55	0.00	20.74
Total						**9.26**	**0.55**	**0.00**	**20.74**

Appendix I

Full LRDP Operations Indirect Greenhouse Gas Summary and CalEEMod Output

Table I-1
Indirect Electricity Usage Greenhouse Gas Emissions Summary - Full LRDP

Greenhouse Gas	Emission Factor			Indirect Electricity Usage Greenhouse Gas Emissions (tons/yr)	
CO_2	0.149	(tonnes/MWhr)	(1)	23,339	(a)
CH_4	0.029	(lbs/MWhr)	(3)	2.06	(b)
N_2O	0.011	(lbs/MWhr)	(3)	0.78	(b)
CO_2e	--			23,626	(c)

Notes:

(a) Indirect electricity CO_2 emissions (tons/yr) = (Electricity usage [MW-hr/yr]) x (GHG intensity factor [tonnes CO_2/MW-hr]) x (projected electricity demand [MWhr/yr]) x (1.1 ton/tonne)

Projected electricity demand (MWhr/yr) = 142,400 (2)

(b) Indirect electricity greenhouse gas emissions (lbs/yr) = (Emission factor [lbs/MWhr]) x (projected electricity demand [MWhr/yr]) x (ton/2,000 lbs) x (global warming potential)

Projected electricity demand (MWhr/yr) = 142,400 (2)

(c) CO_2e emissions (tons/yr) = (CO_2 emissions [tons/yr]) + (CH_4 emissions [tons/yr] x CH_4 global warming potential) + (N_2O emissions [tons/yr] x N_2O global warming potential)

CH_4 global warming potential = 21 (4)

N_2O global warming potential = 310 (4)

References:

(1) PG&E GHG emission factor for 2018, from CPUC GHG Calculator.

(2) Projected electricity demand provided by LBNL.

(3) CalEEMod Appendix D, Table 1.2, "Electrical Utility Emission Factors of Greenhouse Gases".

(4) 40 CFR Part 98 Subpart A, Table A-1, Global Warming Potentials.

Table I-2
CalEEMod Indirect Greenhouse Gas Emissions Summary - Full LRDP

Operation	Indirect Greenhouse Gas Emissions (tons/yr)			
	Total CO_2 [(a)]	CH_4 [(a)]	N_2O [(a)]	CO_2e
Electricity	--	--	--	23,626 [(2)]
Water	594	11.5	0.30	926 [(a)]
Solid Waste	86.7	5.13	0	194 [(a)]
Total Indirect Emissions	**681**	**16.6**	**0.30**	**24,746**

Notes:

(a) Pollutant (tons/yr) = (CalEEMod GHG emission [MT/yr]) x (conversion factor [short ton/metric ton])

Conversion factor [short ton/metric ton] = 1.10231 (1)

References:

(1) CalEEMod greenhouse gas emission results are provided in metric tons/yr.

(2) See Table I-1, Indirect Electricity Usage Greenhouse Gas Emissions Summary - Full LRDP.

CalEEMod Version: CalEEMod.2011.1.1 Date: 3/26/2013

LRDP - GHG - 03/26/2013

Bay Area AQMD Air District, Annual

1.0 Project Characteristics

1.1 Land Usage

Land Uses	Size	Metric
Research & Development	5100	1000sqft
Parking Structure	1900	1000sqft

1.2 Other Project Characteristics

Urbanization	Urban	**Wind Speed (m/s)**		**Utility Company**	Pacific Gas & Electric Company
Climate Zone	5		2.2		
		Precipitation Freq (Days)			
			64		

1.3 User Entered Comments

Project Characteristics -

Land Use - Average construction of 5,100,000 gsf for R&D and 1,900,000 gsf for Parking structure with a 10,000 campus population. Updated: 3/26/2013

Construction Phase - One year full run (1/1/2018 - 12/31/2018). Updated: 3/26/2013

Trips and VMT - Blanked -Updated: 3/26/13

Demolition - Blanked - Updated: 3/26/2013

Grading - Blanked - Updated: 3/26/13

Energy Use - Blanked - Updated: 3/26/13

Construction Off-road Equipment Mitigation - Watering 2 times per day at 55%. -Updated: 3/26/13

Water And Wastewater - 340,000,000 gallons/year potable water - project description, table 3 - Updated: 3/26/13

Off-road Equipment -

Off-road Equipment -

2.0 Emissions Summary

2.1 Overall Construction

Unmitigated Construction

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Year	tons/yr										MT/yr					
2018	67.84				0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	**67.84**				**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**

Mitigated Construction

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Year	tons/yr										MT/yr					
2018	67.84				0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	**67.84**				**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**

2.2 Overall Operational

Unmitigated Operational

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	tons/yr										MT/yr					
Area	29.67	0.00	0.00	0.00		0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Energy	0.71	6.42	5.39	0.04		0.00	0.49		0.00	0.49	0.00	19,258.72	19,258.72	0.69	0.34	19,378.15
Mobile	22.80	42.88	199.84	0.41	38.16	1.90	40.06	0.67	1.76	2.43	0.00	32,965.89	32,965.89	1.44	0.00	32,996.09
Waste						0.00	0.00		0.00	0.00	78.67	0.00	78.67	4.65	0.00	176.31
Water						0.00	0.00		0.00	0.00	0.00	539.01	539.01	10.40	0.27	840.10
Total	**53.18**	**49.30**	**205.23**	**0.45**	**38.16**	**1.90**	**40.55**	**0.67**	**1.76**	**2.92**	**78.67**	**52,763.62**	**52,842.29**	**17.18**	**0.61**	**53,390.65**

Mitigated Operational

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	tons/yr										MT/yr					
Area	29.67	0.00	0.00	0.00		0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Energy	0.71	6.42	5.39	0.04		0.00	0.49		0.00	0.49	0.00	19,258.72	19,258.72	0.69	0.34	19,378.15
Mobile	22.80	42.88	199.84	0.41	38.16	1.90	40.06	0.67	1.76	2.43	0.00	32,965.89	32,965.89	1.44	0.00	32,996.09
Waste						0.00	0.00		0.00	0.00	78.67	0.00	78.67	4.65	0.00	176.31
Water						0.00	0.00		0.00	0.00	0.00	539.01	539.01	10.40	0.27	840.10
Total	**53.18**	**49.30**	**205.23**	**0.45**	**38.16**	**1.90**	**40.55**	**0.67**	**1.76**	**2.92**	**78.67**	**52,763.62**	**52,842.29**	**17.18**	**0.61**	**53,390.65**

3.0 Construction Detail

3.1 Mitigation Measures Construction

Water Exposed Area

Mitigated Construction Off-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	tons/yr										MT/yr					
Hauling					0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Vendor					0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Worker					0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total					**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**

3.2 Demolition - 2018

Unmitigated Construction On-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	tons/yr										MT/yr					
Fugitive Dust					0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total					**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**

Mitigated Construction On-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	tons/yr										MT/yr					
Fugitive Dust					0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total					**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**

3.6 Paving - 2018

Unmitigated Construction On-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	tons/yr										MT/yr					
Paving	0.00					0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	**0.00**					**0.00**	**0.00**		**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**

Mitigated Construction On-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	tons/yr										MT/yr					
Paving	0.00					0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	**0.00**					**0.00**	**0.00**		**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**

3.7 Architectural Coating - 2018

Unmitigated Construction On-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	tons/yr										MT/yr					
Archit. Coating	67.84					0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	**67.84**					**0.00**	**0.00**		**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**

Mitigated Construction On-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	tons/yr										MT/yr					
Archit. Coating	67.84					0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	**67.84**					**0.00**	**0.00**		**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**

4.0 Mobile Detail

4.1 Mitigation Measures Mobile

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	tons/yr										MT/yr					
Mitigated	22.80	42.88	199.84	0.41	38.16	1.90	40.06	0.67	1.76	2.43	0.00	32,965.89	32,965.89	1.44	0.00	32,996.09
Unmitigated	22.80	42.88	199.84	0.41	38.16	1.90	40.06	0.67	1.76	2.43	0.00	32,965.89	32,965.89	1.44	0.00	32,996.09
Total	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**

4.2 Trip Summary Information

	Average Daily Trip Rate			Unmitigated	Mitigated
Land Use	Weekday	Saturday	Sunday	Annual VMT	Annual VMT
Parking Structure	0.00	0.00	0.00		
Research & Development	41,361.00	9,690.00	5661.00	79,539,699	79,539,699
Total	41,361.00	9,690.00	5,661.00	79,539,699	79,539,699

4.3 Trip Type Information

	Miles			Trip %		
Land Use	H-W or C-W	H-S or C-C	H-O or C-NW	H-W or C-W	H-S or C-C	H-O or C-NW
Parking Structure	9.50	7.30	7.30	0.00	0.00	0.00
Research & Development	9.50	7.30	7.30	33.00	48.00	19.00

5.0 Energy Detail

5.1 Mitigation Measures Energy

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	tons/yr										MT/yr					
Electricity Mitigated						0.00	0.00		0.00	0.00	0.00	12,269.77	12,269.77	0.55	0.21	12,346.66
Electricity Unmitigated						0.00	0.00		0.00	0.00	0.00	12,269.77	12,269.77	0.55	0.21	12,346.66
NaturalGas Mitigated	0.71	6.42	5.39	0.04		0.00	0.49		0.00	0.49	0.00	6,988.95	6,988.95	0.13	0.13	7,031.48
NaturalGas Unmitigated	0.71	6.42	5.39	0.04		0.00	0.49		0.00	0.49	0.00	6,988.95	6,988.95	0.13	0.13	7,031.48
Total	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**

5.2 Energy by Land Use - NaturalGas

Unmitigated

	NaturalGas Use	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Land Use	kBTU	tons/yr										MT/yr					
Parking Structure	0	0.00	0.00	0.00	0.00		0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Research & Development	1.30968e+008	0.71	6.42	5.39	0.04		0.00	0.49		0.00	0.49	0.00	6,988.95	6,988.95	0.13	0.13	7,031.48
Total		**0.71**	**6.42**	**5.39**	**0.04**		**0.00**	**0.49**		**0.00**	**0.49**	**0.00**	**6,988.95**	**6,988.95**	**0.13**	**0.13**	**7,031.48**

Mitigated

	NaturalGas Use	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Land Use	kBTU	tons/yr										MT/yr					
Parking Structure	0	0.00	0.00	0.00	0.00		0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Research & Development	1.30968e+008	0.71	6.42	5.39	0.04		0.00	0.49		0.00	0.49	0.00	6,988.95	6,988.95	0.13	0.13	7,031.48
Total		**0.71**	**6.42**	**5.39**	**0.04**		**0.00**	**0.49**		**0.00**	**0.49**	**0.00**	**6,988.95**	**6,988.95**	**0.13**	**0.13**	**7,031.48**

5.3 Energy by Land Use - Electricity

Unmitigated

	Electricity Use	ROG	NOx	CO	SO2	Total CO2	CH4	N2O	CO2e
Land Use	kWh	tons/yr				MT/yr			
Parking Structure	0					0.00	0.00	0.00	0.00
Research & Development	4.2177e+007					12,269.77	0.55	0.21	12,346.66
Total						**12,269.77**	**0.55**	**0.21**	**12,346.66**

Mitigated

	Electricity Use	ROG	NOx	CO	SO2	Total CO2	CH4	N2O	CO2e
Land Use	kWh	tons/yr				MT/yr			
Parking Structure	0					0.00	0.00	0.00	0.00
Research & Development	4.2177e+007					12,269.77	0.55	0.21	12,346.66
Total						**12,269.77**	**0.55**	**0.21**	**12,346.66**

6.0 Area Detail

6.1 Mitigation Measures Area

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	tons/yr										MT/yr					
Mitigated	29.67	0.00	0.00	0.00		0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Unmitigated	29.67	0.00	0.00	0.00		0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**

6.2 Area by SubCategory

Unmitigated

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
SubCategory	tons/yr										MT/yr					
Architectural Coating	6.78					0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Consumer Products	22.89					0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Landscaping	0.00	0.00	0.00	0.00		0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	**29.67**	**0.00**	**0.00**	**0.00**		**0.00**	**0.00**		**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**

Mitigated

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
SubCategory	tons/yr										MT/yr					
Architectural Coating	6.78					0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Consumer Products	22.89					0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Landscaping	0.00	0.00	0.00	0.00		0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	**29.67**	**0.00**	**0.00**	**0.00**		**0.00**	**0.00**		**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**

7.0 Water Detail

7.1 Mitigation Measures Water

	ROG	NOx	CO	SO2	Total CO2	CH4	N2O	CO2e
Category	tons/yr				MT/yr			
Mitigated					539.01	10.40	0.27	840.10
Unmitigated					539.01	10.40	0.27	840.10
Total	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**

7.2 Water by Land Use

Unmitigated

	Indoor/Outdoor Use	ROG	NOx	CO	SO2	Total CO2	CH4	N2O	CO2e
Land Use	Mgal	tons/yr				MT/yr			
Parking Structure	0 / 0					0.00	0.00	0.00	0.00
Research & Development	340 / 0					539.01	10.40	0.27	840.10
Total						**539.01**	**10.40**	**0.27**	**840.10**

Mitigated

	Indoor/Outdoor Use	ROG	NOx	CO	SO2	Total CO2	CH4	N2O	CO2e
Land Use	Mgal	tons/yr				MT/yr			
Parking Structure	0 / 0					0.00	0.00	0.00	0.00
Research & Development	340 / 0					539.01	10.40	0.27	840.10
Total						**539.01**	**10.40**	**0.27**	**840.10**

8.0 Waste Detail

8.1 Mitigation Measures Waste

Category/Year

	ROG	NOx	CO	SO2	Total CO2	CH4	N2O	CO2e
	tons/yr				MT/yr			
Mitigated					78.67	4.65	0.00	176.31
Unmitigated					78.67	4.65	0.00	176.31
Total	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**

8.2 Waste by Land Use

Unmitigated

	Waste Disposed	ROG	NOx	CO	SO2	Total CO2	CH4	N2O	CO2e
Land Use	tons	tons/yr				MT/yr			
Parking Structure	0					0.00	0.00	0.00	0.00
Research & Development	387.56					78.67	4.65	0.00	176.31
Total						**78.67**	**4.65**	**0.00**	**176.31**

Mitigated

	Waste Disposed	ROG	NOx	CO	SO2	Total CO2	CH4	N2O	CO2e
Land Use	tons	tons/yr				MT/yr			
Parking Structure	0					0.00	0.00	0.00	0.00
Research & Development	387.56					78.67	4.65	0.00	176.31
Total						**78.67**	**4.65**	**0.00**	**176.31**

Appendix J

Operations Greenhouse Gas Offsets

Table J-1

Phase 1 Greenhouse Gas Emissions Offsets

Parameter [1]		Phase 1 Total		Existing Offsite Employee "Offset" [2]		Net Increase [a]
Number of Vehicle Trips	(trips/day)	2,031	(3)	1,334		697
Employee Vehicle GHG Emissions	(tons/yr)	3,352	(4)	2,202	(b)	1,150
Delivery Vehicle GHG Emissions	(tons/yr)	49.5	(4)	0		49.5
Shuttle GHG Emissions	(tons/yr)	73.4	(4)	0		73.4
Total Vehicle GHG Emissions	(tons/yr)	3,475		2,202		1,273
Electricity Usage	(MW-hr/yr)	15,820	(5)	13,892	(6)	1,928
Electricity Indirect GHG Emissions	(tons/yr)	2,593	(c)	2,277	(c)	316
Natural Gas Usage	(therms/yr)	840,000	(3)	626,123	(6)	213,877
Natural Gas GHG Emissions	(tons/yr)	4,953	(4)	3,692	(d)	1,261

Notes:

(a) Net increase = (Phase 1 total) - (existing offsite employee "offset")

(b) Existing offsite employee "offset" vehicle GHG emissions (tons/yr) = (Phase 1 total employee vehicle GHG emissions [tons/yr]) x ("offset" employee vehicle trips [trips/day]) / (phase 1 total employee vehicle trips [trips/day])

(c) Electricity indirect GHG emissions (tons/yr) = (Electricity usage [MW-hr/yr]) x (GHG intensity factor [tonnes CO2/MW-hr]) x (1.1 ton/tonne)

GHG intensity factor (tonnes CO2/MW-hr) = 0.149 (7)

(d) Existing offsite employee "offset" natural gas GHG emissions (tons/yr) = (Phase 1 total employee natural gas GHG emissions [tons/yr]) x ("offset" employee natural gas usage [therms/yr]) / (phase 1 total employee natural gas usage [therms/yr])

References:

(1) Indirect GHG emissions from water usage and water treatment are not included in this analysis because the offset usages are higher than the Phase 1 Total usages.

(2) Based on information provided by LBNL, approximately two-thirds of the employees (667) currently working at the Hill Campus will transfer to RBC. The Hill Campus will not be re-occupied once the employees transfer to RBC. Thus, emissions associated with the transfers act as an emissions "offset". Traffic estimates result in approximately 2 trips per employee per day (1,000 employees, 2,031 total trips), so 1,334 trips are "offset".

(3) See Table E-1, Phase 1 Operations Input Assumptions for Emission Rate Calculations.

(4) See Table E-11, Phase 1 Operations Criteria Pollutant Emissions Summary.

(5) Provided by LBNL.

(6) Utility usage attributable to the transfer employees at the Hill Campus.

(7) PG&E GHG emission factor for 2018, from CPUC GHG Calculator.

Table J-2

LRDP Greenhouse Gas Emissions Offsets

Parameter [1]		LRDP Total		Existing Offsite Employee "Offset" [2]		Net Increase [a]
Number of Vehicle Trips	(trips/day)	20,081	(3)	1,334	(2)	18,747
Employee Vehicle GHG Emissions	(tons/yr)	29,148	(4)	1,936	(b)	27,212
Delivery Vehicle GHG Emissions	(tons/yr)	506	(4)	0		506
Shuttle GHG Emissions	(tons/yr)	61.9	(4)	0		61.9
Total Vehicle GHG Emissions	(tons/yr)	29,716		1,936		27,780
Electricity Usage	(MW-hr/yr)	142,400	(5)	13,892	(6)	128,508
Electricity Indirect GHG Emissions	(tons/yr)	23,339	(c)	2,277	(c)	21,063
Natural Gas Usage	(therms/yr)	6,600,000	(3)	626,123	(6)	5,973,877
Natural Gas GHG Emissions	(tons/yr)	38,611	(4)	3,663	(d)	34,948

Notes:

(a) Net increase = (LRDP total) - (existing offsite employee "offset")

(b) Existing offsite employee "offset" vehicle GHG emissions (tons/yr) = (Phase 1 total employee vehicle GHG emissions [tons/yr]) x ("offset" employee vehicle trips [trips/day]) / (phase 1 total employee vehicle trips [trips/day])

(c) Electricity indirect GHG emissions (tons/yr) = (Electricity usage [MW-hr/yr]) x (GHG intensity factor [tonnes CO2/MW-hr]) x (1.1 ton/tonne)

GHG intensity factor (tonnes CO2/MW-hr) = 0.149 (7)

(d) Existing offsite employee "offset" natural gas GHG emissions (tons/yr) = (Phase 1 total employee natural gas GHG emissions [tons/yr]) x ("offset" employee natural gas usage [therms/yr]) / (phase 1 total employee natural gas usage [therms/yr])

References:

(1) Indirect GHG emissions from water usage and water treatment are not included in this analysis because the offset usages are higher than the Phase 1 Phase 1 Total usages.

(2) Based on information provided by LBNL, approximately two-thirds of the employees (667) currently working at the Hill Campus will transfer to RBC. The Hill Campus will not be re-occupied once the employees transfer to RBC. Thus, emissions associated with the transfers act as an emissions "offset". Traffic estimates result in approximately 2 trips per employee per day (1,000 employees, 2,031 total trips), so 1,334 trips are "offset".

(3) See Table F-1, LRDP Operations Input Assumptions for Emission Rate Calculations.

(4) See Table F-11, LRDP Operations Criteria Pollutant Emissions Summary - Annual Average Daily Emission Rates.

(5) Provided by LBNL.

(6) Utility usage attributable to the transfer employees at the Hill Campus.

(7) PG&E GHG emission factor for 2018, from CPUC GHG Calculator.

Appendix K

Emissions Estimates – Existing Richmond Field Station Sources – Phase 1

Table K-1
Existing Richmond Field Station Phase 1 Source Operation Input Assumptions for Emission Rate Calculations

Source		*Diesel Emergency Engines*		*Natural Gas Boilers*		
		Engine Size [1] (BHP)	Fuel Usage (gal/hr)	Maximum Heat Input [1] (MMBtu/hr)	Daily Operation (hrs/day)	Annual Fuel Usage [2] (MMBtu/yr)
Building 112 [3]		87.5	4.4 [a]	1.75	24	875
Building 194 [3]		87.5	4.4 [a]	--	--	--
Building 275		--	--	0.3	24	150
Building 400a	(PH1 - BR1)	--	--	1.35	24	675
Building 400b	(PH2 - BR17)	--	--	1.46	24	730
Building 400c	(PH2 - BR18)	--	--	1.46	24	730
Building 400d	(PH2 - B/3-3)	--	--	1.5	24	750
Building 451		--	--	0.65	24	325
Building 452		--	--	0.399	24	199
Building 454		--	--	0.45	24	225
Building 472		--	--	0.375	24	187
Building 477		--	--	0.6	24	300
Building 478a	(122 - BR1)	--	--	0.502	24	251
Building 478b	(122 - BR2)	--	--	0.502	24	251
Building 478c	(122A - LCE13)	--	--	1.966	24	983
Building 480		--	--	0.45	24	225
Building 484		--	--	1.008	24	504
Building 400	(emergency engine)	87.5	4.4 [a]	--	--	--
Building 400f	(fire pump engine)	87.5	4.4 [a]	--	--	--
Total		350	17.8	14.722	--	7,360 [1]

Facility Data			
Source	Source Parameter	Short Term Input (units)	Annual Input (units)
	Facility Operation (Laboratory)	10 (hrs/day) [5]	260 (days/yr) [6]
	Emergency Engine Usage	2 (hrs/day) [7]	25.15 (hrs/yr) [7]
	Gasoline Tank Throughput	0.011 (Mgal/day)	4 (Mgal/yr)
	Diesel Tank Throughput	0.003 (Mgal/day)	1.2 (Mgal/yr)
	Offroad Vehicle Usage	10 (hrs/day)	200 (hrs/yr)

Notes:

(a) Engine fuel consumption (gal/hr) = (Engine size [hp]) x (average brake-specific fuel consumption [Btu/hp-hr]) / (liquid fuel higher heating value [Btu/gal])

Average brake-specific fuel consumption (Btu/hp-hr) = 7,000 (1)

Liquid fuel higher heating value (Btu/gal) = 138,000 (4)

References:

(1) Provided by the University.
(2) Total annual RFS natural gas usage apportioned to individual buildings based on the maximum hourly heat input.
(3) Buildings only included to properly apportion annual natural gas usage to individual buildings. Buildings assumed to be removed during Phase 1.
(4) ULSD higher heating value.
(5) Conservatively assumes laboratory work and offroad equipment usage is conducted over 10 hours per day.
(6) Assumes employee-based operations will generally be active 5 days per week, 52 weeks per year.
(7) Hourly value conservatively assumes a maximum of 2 hours per day of operation for maintenance and testing. Annual value is based on the average historical emergency engine usage from the LBNL LRDP.

Table K-2
Summary of Existing Onsite Off-Road Exhaust Criteria Pollutant Emission Estimates

Pollutant	Vehicle Type	Quantity	Horsepower [1]	Load Factor [2]	Daily hours of operation [3]	Annual hours of operation [3]	Emission Factor [4] (g/hp-hr)	Maximum Daily Emissions Estimate [a] (lbs/day)	Annual Average Emissions Estimate [b] (tons/yr)
ROG	Aerial Lifts	1.0	48	0.31	10	200	1.5	0.50	5.0E-03
	Tractors/Loaders/Backhoes	2.0	39	0.37	10	200	1.5	0.94	9.4E-03
	Sweepers/Scrubbers	1.0	37	0.46	10	200	1.6	0.61	6.1E-03
	Lawnmowers	3.0	28	1.0	10	200	8.4	15	0.15
	Total ROG Emissions							**17**	**0.17**
NO_X	Aerial Lifts	1.0	48	0.31	10	200	5.1	1.7	1.7E-02
	Tractors/Loaders/Backhoes	2.0	39	0.37	10	200	5.2	3.3	3.3E-02
	Sweepers/Scrubbers	1.0	37	0.46	10	200	5.3	2.0	2.0E-02
	Lawnmowers	3.0	28	1.0	10	200	5.7	10	0.10
	Total NO_X Emissions							**17**	**0.17**
CO	Aerial Lifts	1.0	48	0.31	10	200	4.9	1.6	1.6E-02
	Tractors/Loaders/Backhoes	2.0	39	0.37	10	200	5.8	3.7	3.7E-02
	Sweepers/Scrubbers	1.0	37	0.46	10	200	5.9	2.2	2.2E-02
	Lawnmowers	3.0	28	1.0	10	200	545	992	9.9
	Total CO Emissions							**1,000**	**10.0**
SO_2	Aerial Lifts	1.0	48	0.31	10	200	7.0E-03	2.3E-03	2.3E-05
	Tractors/Loaders/Backhoes	2.0	39	0.37	10	200	7.0E-03	4.5E-03	4.5E-05
	Sweepers/Scrubbers	1.0	37	0.46	10	200	7.0E-03	2.6E-03	2.6E-05
	Lawnmowers	3.0	28	1.0	10	200	2.1E-02	3.8E-02	3.8E-04
	Total SO_2 Emissions							**4.8E-02**	**4.8E-04**
PM_{10}	Aerial Lifts	1.0	48	0.31	10	200	0.40	0.13	1.3E-03
	Tractors/Loaders/Backhoes	2.0	39	0.37	10	200	0.40	0.25	2.5E-03
	Sweepers/Scrubbers	1.0	37	0.46	10	200	0.43	0.16	1.6E-03
	Lawnmowers	3.0	28	1.0	10	200	0.37	0.67	6.7E-03
	Total PM_{10} Emissions							**1.2**	**1.2E-02**
$PM_{2.5}$	Aerial Lifts	1.0	48	0.31	10	200	0.40	0.13	1.3E-03
	Tractors/Loaders/Backhoes	2.0	39	0.37	10	200	0.40	0.25	2.5E-03
	Sweepers/Scrubbers	1.0	37	0.46	10	200	0.43	0.16	1.6E-03
	Lawnmowers	3.0	28	1.0	10	200	0.37	0.67	6.7E-03
	Total $PM_{2.5}$ Emissions							**1.2**	**1.2E-02**
CO_2	Aerial Lifts	1.0	48	0.31	10	200	568	186	1.9
	Tractors/Loaders/Backhoes	2.0	39	0.37	10	200	568	362	3.6
	Sweepers/Scrubbers	1.0	37	0.46	10	200	568	213	2.1
	Lawnmowers	3.0	28	1.0	10	200	859	1,562	16
	Total CO_2 Emissions							**2,323**	**23**
CH_4	Aerial Lifts	1.0	48	0.31	10	200	0.14	4.5E-02	4.5E-04
	Tractors/Loaders/Backhoes	2.0	39	0.37	10	200	0.13	8.5E-02	8.5E-04
	Sweepers/Scrubbers	1.0	37	0.46	10	200	0.15	5.4E-02	5.4E-04
	Lawnmowers	3.0	28	1.0	10	200	0.47	0.85	8.5E-03
	Total CH_4 Emissions							**1.0**	**1.0E-02**

Notes:
(a) Maximum daily emissions estimate (lbs/day) = (Equipment horsepower [hp]) x (load factor) x (daily hours of operation [hrs/day]) x (emission factor [g/hp-hr]) x (lb/453.59 g)
(b) Annual average emissions estimate (tons/yr) = (Equipment horsepower [hp]) x (load factor) x (annual hours of operation [hrs/yr]) x (emission factor [g/hp-hr]) x (lb/453.59 g) x (ton/2,000 lbs)

References:
(1) Provided by LBNL. Assumes 2 tractor/loader/backhoes at 28 hp and 50 hp (average 39 hp), 1 aerial lift, 1 sweeper/scrubber, and 3 lawnmowers between 26 hp and 29 hp (average 27.5 hp).
(2) Load factors taken from Table D-7: Original OFFROAD and New Load Factors (LF) by Equipment Type.
(3) See Table K-1, Existing Richmond Field Station Phase 1 Source Operation Input Assumptions for Emission Rate Calculations.
(4) Emission factors from CalEEMod Appendix D tables for the year 2014.

Table K-3
Natural Gas Boiler Criteria Emission Estimates

Pollutant					PM		PM_{10}		$PM_{2.5}$		NO_X		CO		SO_2		VOC		CO_2		CH_4		N_2O		CO_2e	
Emission Factor (lbs/MMscf)					7.60 (1)		7.60 (2)		7.60 (2)		18.72 (a)		84 (4)		0.6 (1)		5.5 (1)		120,162 (b)		2.27 (c)		0.23 (c)		120,280 (d)	
					Emission Estimates																					
Source	Modeling ID	Maximum Hourly Fuel Usage (8) (MMBtu/hr)	Daily Operation (8) (hrs/day)	Annual Fuel Usage (8) (MMBtu/yr)	Maximum Daily (e) (lbs/day)	Annual Average (f) (tons/yr)	Maximum Daily (e) (lbs/day)	Annual Average (f) (tons/yr)	Maximum Daily (e) (lbs/day)	Annual Average (f) (tons/yr)	Maximum Daily (e) (lbs/day)	Annual Average (f) (tons/yr)	Maximum Daily (e) (lbs/day)	Annual Average (f) (tons/yr)	Maximum Daily (e) (lbs/day)	Annual Average (f) (tons/yr)	Maximum Daily (e) (lbs/day)	Annual Average (f) (tons/yr)	Maximum Daily (e) (lbs/day)	Annual Average (f) (tons/yr)	Maximum Daily (e) (lbs/day)	Annual Average (f) (tons/yr)	Maximum Daily (e) (lbs/day)	Annual Average (f) (tons/yr)	Maximum Daily (e) (lbs/day)	Annual Average (f) (tons/yr)
Natural Gas Boiler - Building 400a	NGB_400a	1.35	24	675	0.24	2.5E-03	0.24	2.5E-03	0.24	2.5E-03	0.59	6.2E-03	2.67	0.028	0.019	2.0E-04	0.17	1.8E-03	3,817	39.8	0.072	7.5E-04	7.2E-03	7.5E-05	3,821	39.8
Natural Gas Boiler - Building 400b	NGB_400b	1.46	24	730	0.26	2.7E-03	0.26	2.7E-03	0.26	2.7E-03	0.64	6.7E-03	2.89	0.030	0.021	2.1E-04	0.19	2.0E-03	4,128	43.0	0.078	8.1E-04	7.8E-03	8.1E-05	4,132	43.0
Natural Gas Boiler - Building 400c	NGB_400c	1.46	24	730	0.26	2.7E-03	0.26	2.7E-03	0.26	2.7E-03	0.64	6.7E-03	2.89	0.030	0.021	2.1E-04	0.19	2.0E-03	4,128	43.0	0.078	8.1E-04	7.8E-03	8.1E-05	4,132	43.0
Natural Gas Boiler - Building 400d	NGB_400d	1.5	24	750	0.27	2.8E-03	0.27	2.8E-03	0.27	2.8E-03	0.66	6.9E-03	2.96	0.031	0.021	2.2E-04	0.19	2.0E-03	4,241	44.2	0.080	8.3E-04	8.0E-03	8.3E-05	4,245	44.2
Natural Gas Boiler - Building 451	NGB_451	0.65	24	325	0.12	1.2E-03	0.12	1.2E-03	0.12	1.2E-03	0.29	3.0E-03	1.28	0.013	9.2E-03	9.6E-05	0.084	8.8E-04	1,838	19.1	0.035	3.6E-04	3.5E-03	3.6E-05	1,840	19.2
Natural Gas Boiler - Building 452	NGB_452	0.399	24	199	0.071	7.4E-04	0.071	7.4E-04	0.071	7.4E-04	0.18	1.8E-03	0.79	8.2E-03	5.6E-03	5.9E-05	0.052	5.4E-04	1,128	11.7	0.021	2.2E-04	2.1E-03	2.2E-05	1,129	11.8
Natural Gas Boiler - Building 454	NGB_454	0.45	24	225	0.080	8.4E-04	0.080	8.4E-04	0.080	8.4E-04	0.20	2.1E-03	0.89	9.3E-03	6.4E-03	6.6E-05	0.058	6.1E-04	1,272	13.3	0.024	2.5E-04	2.4E-03	2.5E-05	1,274	13.3
Natural Gas Boiler - Building 472	NGB_472	0.375	24	187	0.067	7.0E-04	0.067	7.0E-04	0.067	7.0E-04	0.17	1.7E-03	0.74	7.7E-03	5.3E-03	5.5E-05	0.049	5.1E-04	1,060	11.0	0.020	2.1E-04	2.0E-03	2.1E-05	1,061	11.1
Natural Gas Boiler - Building 477	NGB_477	0.6	24	300	0.11	1.1E-03	0.11	1.1E-03	0.11	1.1E-03	0.26	2.8E-03	1.19	0.012	8.5E-03	8.8E-05	0.078	8.1E-04	1,696	17.7	0.032	3.3E-04	3.2E-03	3.3E-05	1,698	17.7
Natural Gas Boiler - Building 478a	NGB_478a	0.502	24	251	0.090	9.3E-04	0.090	9.3E-04	0.090	9.3E-04	0.22	2.3E-03	0.99	0.010	7.1E-03	7.4E-05	0.065	6.8E-04	1,419	14.8	0.027	2.8E-04	2.7E-03	2.8E-05	1,421	14.8
Natural Gas Boiler - Building 478b	NGB_478b	0.502	24	251	0.090	9.3E-04	0.090	9.3E-04	0.090	9.3E-04	0.22	2.3E-03	0.99	0.010	7.1E-03	7.4E-05	0.065	6.8E-04	1,419	14.8	0.027	2.8E-04	2.7E-03	2.8E-05	1,421	14.8
Natural Gas Boiler - Building 478c	NGB_478c	1.966	24	983	0.35	3.7E-03	0.35	3.7E-03	0.35	3.7E-03	0.87	9.0E-03	3.89	0.040	0.028	2.9E-04	0.25	2.6E-03	5,559	57.9	0.10	1.1E-03	0.010	1.1E-04	5,564	58.0
Natural Gas Boiler - Building 480	NGB_480	0.45	24	225	0.080	8.4E-04	0.080	8.4E-04	0.080	8.4E-04	0.20	2.1E-03	0.89	9.3E-03	6.4E-03	6.6E-05	0.058	6.1E-04	1,272	13.3	0.024	2.5E-04	2.4E-03	2.5E-05	1,274	13.3
Natural Gas Boiler - Building 484	NGB_484	1.008	24	504	0.18	1.9E-03	0.18	1.9E-03	0.18	1.9E-03	0.44	4.6E-03	1.99	0.021	0.014	1.5E-04	0.13	1.4E-03	2,850	29.7	0.054	5.6E-04	5.4E-03	5.6E-05	2,853	29.7
Total					**0.24**	**2.5E-03**	**0.24**	**2.5E-03**	**0.24**	**2.5E-03**	**0.59**	**6.2E-03**	**2.67**	**0.028**	**0.019**	**2.0E-04**	**0.17**	**1.8E-03**	**3,817**	**39.8**	**0.072**	**7.5E-04**	**7.2E-03**	**7.5E-05**	**3,821**	**39.8**

Notes:

(a) Emission factor (lbs/MMscf) = (NO_2 or CO emission limit [ppmv @ 3% O_2]) x (10^{-6}) x (NO_2 or CO molecular weight [lbs/lb-mol]) x (lb-mol/385.44 ft^3) x (natural gas f-factor [8,710 dscf/MMBtu]) x (20.9% O_2/[20.9% O_2 . 3% O_2]) x (heat content [Btu/scf])

BAAQMD NO_X emission limit (ppmv @ 3% O_2) =	15	(3)
BAAQMD CO emission limit (ppmv @ 3% O_2) =	400	(3)
NO_2 molecular weight (lbs/lb-mol) =	46	
CO molecular weight (lbs/lb-mol) =	28.01	
Natural gas heat content (Btu/scf) =	1,028	(5)

(b) CO_2 emission factor (lbs/MMscf) = (CO_2 emission factor [kg CO_2/MMBtu]) x (default high heat value (MMBtu/scf)) x (10^6 scf/MMscf) x (lb/0.453592 kg)

CO_2 emission factor (kg/MMBtu) =	53.02	(5)
Default high heat value (MMBtu/scf) =	1.028E-03	(5)

(c) CH_4 or N_2O emission factor (lbs/MMscf) = (CH_4 or N_2O emission factor [kg/MMBtu]) x (lb/0.453592 kg) x (natural gas heat content [Btu/scf])

CH_4 emission factor (kg/MMBtu) =	1.0E-03	(6)
N_2O emission factor (kg/MMBtu) =	1.0E-04	(6)
Natural gas heat content (Btu/scf) =	1,028	(5)

(d) CO_2e emission factor (lbs/MMscf) = (CO_2 emission factor [lbs/MMscf]) + (CH_4 emission factor [lbs/MMscf] x CH_4 global warming potential) + (N_2O emission factor [lbs/MMscf] x N_2O global warming potential)

Global warming potential of CH_4 =	21	(7)
Global warming potential of N_2O =	310	(7)

(e) Daily emissions estimate (lbs/day) = (Emission factor [lbs/MMscf]) x (maximum hourly heat input [MMBtu/hr]) x (daily hours of operation [hrs/day]) / (natural gas heat content [Btu/scf])

Natural gas heat content (Btu/scf) =	1,020	(5)

(f) Annual emissions estimate (tons/yr) = (emission factor [lbs/MMscf]) x (annual heat input [MMBtu/yr]) / (natural gas heat content [Btu/scf]) x (tons/2,000 lbs)

Natural gas heat content (Btu/scf) =	1,020	(5)

References:

(1) AP-42 Chapter 1.4 (July 1998), Table 1.4-2 "Emission Factors for Criteria Pollutants and Greenhouse Gases from Natural Gas Combustion".
(2) Assumes that 100% of PM is $PM_{2.5}$. Therefore, 100% of PM_{10} is $PM_{2.5}$.
(3) BAAQMD Emission Limits 307.2, 307.3, and 307.4 from Section 9-7-307..
(4) AP-42 Chapter 1.4 (July 1998), Table 1.4-1 "Emission Factors for NO_X and CO from Natural Gas Combustion".
(5) 40 CFR Part 98 Subpart C, Table C-1, Default CO_2 Emission Factors and High Heat Values for Various Types of Fuel.
(6) 40 CFR Part 98 Subpart C, Table C-2, Default CH_4 and N_2O Emission Factors for Various Types of Fuel.
(7) 40 CFR Part 98 Subpart A, Table A-1, Global Warming Potentials.
(8) See Table K-1, Existing Richmond Field Station Phase 1 Source Operation Input Assumptions for Emission Rate Calculations.

Table K-4
Emergency Diesel Generator Criteria Emission Estimates

Pollutant				Min HP	Max HP	PM		PM_{10}		$PM_{2.5}$		NO_X		CO		SO_2		VOC		CO_2		CH_4		CO_2e	
Emission Factor - Tier 4 Interim (g/hp-hr) [1]				75	99	0.015 [1]		0.015 [1]		0.015 [1]		2.5 [2]		3.7 [2]		-- [3]		0.14 [2]		-- [4]		--		--	
						Emission Estimates																			
Source	Modeling ID	Generator Power Rating [5] (BHP)	Diesel Fuel Usage [5] (gal/hr)	Load Factor [6]	Annual Operation [5] (hrs/yr)	Maximum Daily [a] (lbs/day)	Annual Average [b] (tons/yr)	Maximum Daily [a] (lbs/day)	Annual Average [b] (tons/yr)	Maximum Daily [a] (lbs/day)	Annual Average [b] (tons/yr)	Maximum Daily [a] (lbs/day)	Annual Average [b] (tons/yr)	Maximum Daily [a] (lbs/day)	Annual Average [b] (tons/yr)	Maximum Daily [c] (lbs/day)	Annual Average [b] (tons/yr)	Maximum Daily [a] (lbs/day)	Annual Average [b] (tons/yr)	Maximum Daily [d] (lbs/day)	Annual Average [b] (tons/yr)	Maximum Daily [9] (lbs/day)	Annual Average [b] (tons/yr)	Maximum Daily [e] (lbs/day)	Annual Average [b] (tons/yr)
Existing standby generator - B194	DG_B194	88	4.4	0.74	25.15	4.3E-03	2.7E-05	4.3E-03	2.7E-05	4.3E-03	2.7E-05	0.71	4.5E-03	1.06	6.6E-03	1.9E-03	1.2E-05	0.040	2.5E-04	198	1.25	3.6E-03	2.3E-05	198	1.25
Existing standby generator - NRLF	DG_NRLF2	88	4.4	0.74	25.15	4.3E-03	2.7E-05	4.3E-03	2.7E-05	4.3E-03	2.7E-05	0.71	4.5E-03	1.06	6.6E-03	1.9E-03	1.2E-05	0.040	2.5E-04	198	1.25	3.6E-03	2.3E-05	198	1.25
Existing Fire Pump NRLF	FP_NRLF2	88	4.4	0.74	25.15	4.3E-03	2.7E-05	4.3E-03	2.7E-05	4.3E-03	2.7E-05	0.71	4.5E-03	1.06	6.6E-03	1.9E-03	1.2E-05	0.040	2.5E-04	198	1.25	3.6E-03	2.3E-05	198	1.25
Total						**0.013**	**8.1E-05**	**0.013**	**8.1E-05**	**0.013**	**8.1E-05**	**2.14**	**0.013**	**3.17**	**0.020**	**5.6E-03**	**3.5E-05**	**0.12**	**7.5E-04**	**594**	**3.74**	**0.011**	**6.8E-05**	**594**	**3.74**

Notes:

(a) Maximum daily emission estimate (lbs/day) = (Emission factor [g/hp-hr]) x (generator power [hp]) x (load factor) x (maximum hours per day [hrs/day]) x (lb/453.59g)
Daily hours of operation (hrs/day) = 2 (5)

(b) Annual average emission estimate (tons/yr) = (Daily emissions [lbs/day]) / (daily hours of operation [hrs/day]) x (annual hours of operation [hrs/yr]) x (ton/2,000 lbs)
Daily hours of operation (hrs/day) = 2 (5)

(c) Maximum daily emissions estimate (lbs/day) = (Fuel sulfur content [ppmw] / 1,000,000) x (generator fuel consumption [gal/hr]) x (daily hours of operation [hrs/day]) x (diesel density [lbs/gal]) x ([SO_2 molecular weight {lbs/lb-mol}] / [sulfur molecular weight {lbs/lb-mol}])
Fuel sulfur content (ppmw) = 15 (7)
Daily hours of operation (hrs/day) = 2 (5)
Diesel density (lbs/gal) = 7
SO_2 molecular weight (lbs/lb-mol) = 64
Sulfur molecular weight (lbs/lb-mol) = 32

(d) Maximum daily emissions estimate (lbs/day) = (Fuel carbon content [%] / 100) x (generator fuel consumption [gal/hr]) x (daily hours of operation [hrs/day]) x (diesel density [lbs/gal]) x ([CO_2 molecular weight {lbs/lb-mol}] / [carbon molecular weight {lbs/lb-mol}])
Fuel carbon content (%) = 87 (8)
Daily hours of operation (hrs/day) = 2 (5)
Diesel density (lbs/gal) = 7
CO_2 molecular weight (lbs/lb-mol) = 44.0
Carbon molecular weight (lbs/lb-mol) = 12.0

(e) CO_2e emissions (lbs/day) = (CO_2 emissions [lbs/day]) + (CH_4 emissions [lbs/day] x CH_4 global warming potential) + (N_2O emissions [lbs/day] x N_2O global warming potential)
CH_4 Global Warming Potential (GWP) = 21 (10)
N_2O Global Warming Potential (GWP) = 310 (10)

References:

(1) Interim Tier IV emission factors are assumed.
(2) CalEEMod Appendix D, Default Data Tables. Table 3.5, OFFROAD Emission Factor Based on Engine Tier. Assumes Tier 4 Final for LBNL-owned small engines (Buildings 9 and 8), and Tier 4 Interim for the Building 6&7 engine.
(3) Sulfur dioxide emissions calculated on a sulfur mass balance basis, assuming 100% of the fuel sulfur content is emitted as SO_2.
(4) Carbon dioxide emissions calculated on a carbon mass balance basis, conservatively assuming 100% of the fuel carbon content is emitted as CO_2.
(5) See Table K-1, Existing Richmond Field Station Phase 1 Source Operation Input Assumptions for Emission Rate Calculations.
(6) Default load factor for generators in URBEMIS emissions model.
(7) California Code of Regulations Title 13, Division 3, Chapter 5, Article 2, Standards for Diesel Fuel.
(8) AP-42 Chapter 3.3 (October 1996) and 3.4 (October 1996), Footnote to criteria emission factor table.
(9) Assumes methane is 9% of VOC, based on footnote f of Table 3.4-1 in AP-42, Chapter 3.4. VOC emission factor is shown as ROG/TOG in CalEEMod Appendix D ,Table 3.5.
(10) 40 CFR Part 98 Subpart A, Table A-1, Global Warming Potentials.

Table K-5

Gasoline Fueling Emission Estimates

Source		Gasoline Fueling	Diesel Fueling
Annual Gasoline Throughput (Mgal/yr)	(1)	4.0	1.2
Daily Gasoline Throughput (Mgal/day)	(1)	0.011	0.003
Tank height (ft)	(2)	4.0	20.0
Tank equivalent diameter (ft)	(a)	5.7	10.0
Small tank standing loss factor a	(4)	1.379	1.379
Small tank standing loss factor b	(4)	0.152	0.152
Small tank working loss factor f	(4)	9.099	9.099

VOC Source		Emission Factor (lbs/Mgal)	Maximum Daily Emissions Estimate [(b)] (lbs/day)	Annual Average Emissions Estimate [(c)] (tons/yr)	Emission Factor (lbs/Mgal)	Maximum Daily Emissions Estimate [(a)] (lbs/day)	Annual Average Emissions Estimate [(b)] (tons/yr)
Storage Tank Loss VOC [(a)]	(b)	37.10	0.41	0.074	577.99	8.1E-04	1.5E-04
Vehicle Refueling Displacement	(4)	1.1	0.012	2.2E-03	1.1	2.4E-05	4.4E-06
Vehicle Refueling Spillage	(4)	0.7	7.7E-03	1.4E-03	0.7	1.5E-05	2.8E-06
Total VOC		38.9	0.43	0.078	579.8	8.5E-04	1.6E-04

Notes:

(a) Equivalent diameter = 2 x Side 1 of rectangular tank (L_1, ft) x Side 2 of rectangular tank (L_2, ft) / (Side 1 of rectangular tank [L_1, ft]+ Side 2 of rectangular tank [L_2, ft]) (3)

Side 1 of rectangular tank L_1 (ft) = 4 (2)

Side 2 of rectangular tank L_2 (ft) = 10 (2)

(b) VOC Emission Factor (lbs/Mgal) =(a x [tank height {ft} x tank diameter $\{ft\}^2$ / annual gasoline throughput {Mgal/yr}] / [1 + {b x tank height {ft}}] + f (4)

(c) Daily emissions estimate (lbs/day) =(Emission factor [lbs/trip]) x (number of vehicle trips per day)

(d) Annual emissions estimate (lbs/day) =(Emission factor [lbs/trip]) x (number of vehicle trips per year) x (ton/2,000 lbs)

References:

(1) See Table K-1, Existing Richmond Field Station Phase 1 Source Operation Input Assumptions for Emission Rate Calculations.

(2) Provided by the University.

(3) Taken from http://www.aqmd.gov/aer/Updates/SuppInstruforLiqdOrgStgeTanks.pdf. Loss factors are for Gasoline RVP 10.

(4) Taken from http://www.aqmd.gov/aer/Updates/GuideExManuallyRptTankEmis.pdf.

Table K-6
Existing Richmond Field Station Phase 1 Source Operations Criteria Pollutant Emissions Summary - Annual Average Daily Emission Rates (1)

Source	Annual Operation (days/yr)	TAC		Criteria												Greenhouse Gases							
		DPM		PM_{10}		$PM_{2.5}$		NO_X		CO		SO_2		VOC		CO_2		CH_4		N_2O		CO_2e	
		(lbs/day)	(tons/yr)	(lbs/day)	(tons/yr)	(lbs/day)	(tons/yr)	(lbs/day)	(tons/yr)	(lbs/day)	(tons/yr)	(lbs/day)	(tons/yr)	(lbs/day)	(tons/yr)	(lbs/day)	(tons/yr)	(lbs/day)	(tons/yr)	(lbs/day)	(tons/yr)	(lbs/day)	(tons/yr)
Stationary Sources																							
Diesel generators	260	6.2E-04	8.1E-05	6.2E-04	8.1E-05	6.2E-04	8.1E-05	0.10	1.3E-02	0.15	2.0E-02	2.7E-04	3.5E-05	5.8E-03	7.5E-04	28.7	3.74	5.2E-04	6.8E-05	0	0	28.8	3.74
Natural Gas Boilers	260	--	--	1.9E-02	2.5E-03	1.9E-02	2.5E-03	4.8E-02	6.2E-03	0.21	2.8E-02	1.5E-03	2.0E-04	1.4E-02	1.8E-03	306	39.8	5.8E-03	7.5E-04	5.8E-04	7.5E-05	306	39.8
Laboratory Chemicals	260	--	--	--	--	--	--	--	--	1.7E-03	2.2E-04	--	--	0.32	4.1E-02	--	--	--	--	--	--	--	--
Gasoline filling	260	--	--	--	--	--	--	--	--	--	--	--	--	0.60	7.8E-02	--	--	--	--	--	--	--	--
Total Onsite Stationary Source Emissions	**--**	**6.2E-04**	**8.1E-05**	**2.0E-02**	**2.6E-03**	**2.0E-02**	**2.6E-03**	**0.15**	**2.0E-02**	**0.37**	**4.8E-02**	**1.8E-03**	**2.3E-04**	**0.94**	**0.12**	**335**	**43.5**	**6.3E-03**	**8.2E-04**	**5.8E-04**	**7.5E-05**	**335**	**43.5**
Onsite Offroad Vehicle Emission Sources																							
Aerial Lifts	260	1.0E-02	1.3E-03	1.0E-02	1.3E-03	1.0E-02	1.3E-03	0.13	1.7E-02	0.12	1.6E-02	1.8E-04	2.3E-05	3.8E-02	5.0E-03	14.3	1.86	--	--	--	--	14.3	1.86
Tractors/Loaders/Backhoes	260	1.9E-02	2.5E-03	1.9E-02	2.5E-03	1.9E-02	2.5E-03	0.25	3.3E-02	0.28	3.7E-02	3.4E-04	4.5E-05	7.3E-02	9.4E-03	27.8	3.62	--	--	--	--	27.8	3.62
Sweepers/Scrubbers	260	1.2E-02	1.6E-03	1.2E-02	1.6E-03	1.2E-02	1.6E-03	0.15	2.0E-02	0.17	2.2E-02	2.0E-04	2.6E-05	4.7E-02	6.1E-03	16.4	2.13	--	--	--	--	16.4	2.13
Lawnmowers	260	5.2E-02	6.7E-03	5.2E-02	6.7E-03	5.2E-02	6.7E-03	0.79	0.10	76.3	9.92	2.9E-03	3.8E-04	1.17	0.15	120	15.6	--	--	--	--	120	15.6
Onsite Offroad Equipment	**--**	**9.4E-02**	**1.2E-02**	**9.4E-02**	**1.2E-02**	**9.4E-02**	**1.2E-02**	**1.33**	**0.17**	**76.9**	**10.00**	**3.7E-03**	**4.8E-04**	**1.33**	**0.17**	**179**	**23.2**	**0**	**0**	**0**	**0**	**179**	**23.2**
Total Phase 1 Project Summary	**--**	**9.4E-02**	**1.2E-02**	**0.11**	**1.5E-02**	**0.11**	**1.5E-02**	**1.48**	**0.19**	**77.3**	**10.0**	**5.5E-03**	**7.1E-04**	**2.27**	**0.29**	**513**	**66.7**	**6.3E-03**	**8.2E-04**	**5.8E-04**	**7.5E-05**	**514**	**66.8**
Onsite Stationary Exhaust	**--**	**6.2E-04**	**8.1E-05**	**2.0E-02**	**2.6E-03**	**2.0E-02**	**2.6E-03**	**0.15**	**2.0E-02**	**0.37**	**4.8E-02**	**1.8E-03**	**2.3E-04**	**0.94**	**0.12**	**335**	**43.5**	**6.3E-03**	**8.2E-04**	**5.8E-04**	**7.5E-05**	**335**	**43.5**
Onsite Offroad Exhaust	**--**	**9.4E-02**	**1.2E-02**	**9.4E-02**	**1.2E-02**	**9.4E-02**	**1.2E-02**	**1.33**	**0.17**	**76.9**	**10.00**	**3.7E-03**	**4.8E-04**	**1.33**	**0.17**	**179**	**23.2**	**0**	**0**	**0**	**0**	**179**	**23.2**

References:

(1) Daily emission rates are annual average daily emission rates, which are calculated by dividing the annual emission rate by the annual days of operation, and converting form tons to pounds. Annual days of operation is set to 5 days per week, 52 weeks per year.

Table K-7
Onsite Employee Vehicle TAC Emission Estimates

Parameter		Value	Total
Gasoline Refueling VOC Emission Factor (lbs/Mgal)	(2)	38.9	
Annual Gasoline Throughput (Mgal/yr)	(3)	4.0	
Daily Gasoline Throughput (Mgal/day)	(3)	0.011	

TAC	CAS	TAC Percent of Gasoline VOC (1)	Maximum Hourly Emissions Estimate (a) (lbs/hr)	Annual Average Emissions Estimate (b) (tons/yr)	Maximum Daily Emissions Estimate (lbs/hr)	Annual Average Emissions Estimate (tons/yr)
Benzene	71-43-2	1.80	7.7E-04	1.4E-03	7.7E-04	1.4E-03
Ethylbenzene	100-41-4	1.40	6.0E-04	1.1E-03	6.0E-04	1.1E-03
n-Hexane	110-54-3	1.00	4.3E-04	7.8E-04	4.3E-04	7.8E-04
Toluene	108-88-3	7.00	3.0E-03	5.4E-03	3.0E-03	5.4E-03
m-Xylene	108-38-3	7.00	3.0E-03	5.4E-03	3.0E-03	5.4E-03

Notes:

(a) Maximum hourly emissions estimate (lbs/hr) = (TAC percent of gasoline VOC [%] / 100) x (gasoline refueling VOC emission factor [lbs/Mgal]) x (daily gasoline throughput [Mgal/day]) / (daily hours of operation [hrs/day])

Daily hours of operation (hrs/day) = 10 (3)

(b) Annual emissions estimate (tons/yr) = (TAC percent of gasoline VOC [%] / 100) x (gasoline refueling VOC emission factor [lbs/Mgal]) x (annual gasoline throughput [Mgal/day])

References:

(1) California Air Resources Board Speciation Database. TAC emission fractions are derived from the individual speciation profiles listed. Profiles chosen to best represent the project vehicle fleet and existing gasoline formulation.

(2) Emission Factors source: EMFAC 2011 (Model Years to 2034). Onsite speed set to 15 mile per hour to conservatively estimate onsite emissions. No tire and brake wear emission factors are provided at 15 miles per hour.

(3) See Table K-1, Existing Richmond Field Station Phase 1 Source Operation Input Assumptions for Emission Rate Calculations.

Table K-8

Natural Gas Boiler TAC Emission Estimates

Source		Natural Gas Boiler - Building 400a	Natural Gas Boiler - Building 400b	Natural Gas Boiler - Building 400c	Natural Gas Boiler - Building 400d	Natural Gas Boiler - Building 451	Natural Gas Boiler - Building 452	Natural Gas Boiler - Building 454
Maximum Hourly Fuel Usage (MMBtu/hr)	(1)	1.35	1.46	1.46	1.5	0.65	0.399	0.45
Daily Hours of Operation (hrs/day)	(1)	24	24	24	24	24	24	24
Annual Fuel Usage (MMBtu/yr)	(1)	675	730	730	750	325	199	225
Modeling ID		NGB_400a	NGB_400b	NGB_400c	NGB_400d	NGB_451	NGB_452	NGB_454

TAC	CAS	Emission Factor (lbs/MMscf)	Maximum Hourly [(a)] (lbs/hr)	Annual Average [(b)] (tons/yr)	Maximum Hourly [(a)] (lbs/hr)	Annual Average [(b)] (tons/yr)	Maximum Hourly [(a)] (lbs/hr)	Annual Average [(b)] (tons/yr)	Maximum Hourly [(a)] (lbs/hr)	Annual Average [(b)] (tons/yr)	Maximum Hourly [(a)] (lbs/hr)	Annual Average [(b)] (tons/yr)	Maximum Hourly [(a)] (lbs/hr)	Annual Average [(b)] (tons/yr)	Maximum Hourly [(a)] (lbs/hr)	Annual Average [(b)] (tons/yr)
7,12-Dimethylbenz(a)anthracene	57-97-6	1.6E-05 (2)	2.1E-08	5.3E-09	2.3E-08	5.7E-09	2.3E-08	5.7E-09	2.4E-08	5.9E-09	1.0E-08	2.5E-09	6.3E-09	1.6E-09	7.1E-09	1.8E-09
Acetaldehyde	75-07-0	8.9E-03 (3)	1.2E-05	2.9E-06	1.3E-05	3.2E-06	1.3E-05	3.2E-06	1.3E-05	3.3E-06	5.7E-06	1.4E-06	3.5E-06	8.7E-07	3.9E-06	9.8E-07
Benzene	71-43-2	4.3E-03 (3)	5.7E-06	1.4E-06	6.2E-06	1.5E-06	6.2E-06	1.5E-06	6.3E-06	1.6E-06	2.7E-06	6.9E-07	1.7E-06	4.2E-07	1.9E-06	4.8E-07
Dichlorobenzene	25321-22-6	1.2E-03 (4)	1.6E-06	4.0E-07	1.7E-06	4.3E-07	1.7E-06	4.3E-07	1.8E-06	4.4E-07	7.6E-07	1.9E-07	4.7E-07	1.2E-07	5.3E-07	1.3E-07
Ethylbenzene	100-41-4	6.9E-03 (5)	9.1E-06	2.3E-06	9.9E-06	2.5E-06	9.9E-06	2.5E-06	1.0E-05	2.5E-06	4.4E-06	1.1E-06	2.7E-06	6.7E-07	3.0E-06	7.6E-07
Fluoranthene	206-44-0	3.0E-06 (2)	4.0E-09	9.9E-10	4.3E-09	1.1E-09	4.3E-09	1.1E-09	4.4E-09	1.1E-09	1.9E-09	4.8E-10	1.2E-09	2.9E-10	1.3E-09	3.3E-10
Formaldehyde	50-00-0	2.2E-01 (3)	2.9E-04	7.3E-05	3.2E-04	7.9E-05	3.2E-04	7.9E-05	3.3E-04	8.1E-05	1.4E-04	3.5E-05	8.6E-05	2.2E-05	9.8E-05	2.4E-05
n-Hexane	110-54-3	4.6E-03 (5)	6.1E-06	1.5E-06	6.6E-06	1.6E-06	6.6E-06	1.6E-06	6.8E-06	1.7E-06	2.9E-06	7.3E-07	1.8E-06	4.5E-07	2.0E-06	5.1E-07
Naphthalene	91-20-3	3.0E-04 (5)	4.0E-07	9.9E-08	4.3E-07	1.1E-07	4.3E-07	1.1E-07	4.4E-07	1.1E-07	1.9E-07	4.8E-08	1.2E-07	2.9E-08	1.3E-07	3.3E-08
Propylene	115-07-1	5.3E-01 (5)	7.0E-04	1.8E-04	7.6E-04	1.9E-04	7.6E-04	1.9E-04	7.8E-04	1.9E-04	3.4E-04	8.4E-05	2.1E-04	5.2E-05	2.3E-04	5.8E-05
Toluene	108-88-3	2.7E-02 (5)	3.5E-05	8.8E-06	3.8E-05	9.5E-06	3.8E-05	9.5E-06	3.9E-05	9.7E-06	1.7E-05	4.2E-06	1.0E-05	2.6E-06	1.2E-05	2.9E-06
Xylenes	1330-20-7	2.0E-02 (5)	2.6E-05	6.5E-06	2.8E-05	7.0E-06	2.8E-05	7.0E-06	2.9E-05	7.2E-06	1.3E-05	3.1E-06	7.7E-06	1.9E-06	8.7E-06	2.2E-06
Arsenic	7440-38-2	2.0E-04 (4)	2.6E-07	6.6E-08	2.9E-07	7.2E-08	2.9E-07	7.2E-08	2.9E-07	7.4E-08	1.3E-07	3.2E-08	7.8E-08	2.0E-08	8.8E-08	2.2E-08
Beryllium	7440-41-7	1.2E-05 (4)	1.6E-08	4.0E-09	1.7E-08	4.3E-09	1.7E-08	4.3E-09	1.8E-08	4.4E-09	7.6E-09	1.9E-09	4.7E-09	1.2E-09	5.3E-09	1.3E-09
Cadmium	7440-43-9	1.1E-03 (4)	1.5E-06	3.6E-07	1.6E-06	3.9E-07	1.6E-06	3.9E-07	1.6E-06	4.0E-07	7.0E-07	1.8E-07	4.3E-07	1.1E-07	4.9E-07	1.2E-07
Chromium VI	18540-29-9	2.4E-04 (6)	3.2E-07	7.9E-08	3.4E-07	8.5E-08	3.4E-07	8.5E-08	3.5E-07	8.7E-08	1.5E-07	3.8E-08	9.3E-08	2.3E-08	1.1E-07	2.6E-08
Cobalt	7440-48-4	8.4E-05 (4)	1.1E-07	2.8E-08	1.2E-07	3.0E-08	1.2E-07	3.0E-08	1.2E-07	3.1E-08	5.4E-08	1.3E-08	3.3E-08	8.2E-09	3.7E-08	9.3E-09
Copper	7440-50-8	8.5E-04 (4)	1.1E-06	2.8E-07	1.2E-06	3.0E-07	1.2E-06	3.0E-07	1.3E-06	3.1E-07	5.4E-07	1.4E-07	3.3E-07	8.3E-08	3.8E-07	9.4E-08
Lead	7439-92-1	5.0E-04 (4)	6.6E-07	1.7E-07	7.2E-07	1.8E-07	7.2E-07	1.8E-07	7.4E-07	1.8E-07	3.2E-07	8.0E-08	2.0E-07	4.9E-08	2.2E-07	5.5E-08
Manganese	7439-96-5	3.8E-04 (4)	5.0E-07	1.3E-07	5.4E-07	1.4E-07	5.4E-07	1.4E-07	5.6E-07	1.4E-07	2.4E-07	6.1E-08	1.5E-07	3.7E-08	1.7E-07	4.2E-08
Mercury	7439-97-6	2.6E-04 (4)	3.4E-07	8.6E-08	3.7E-07	9.3E-08	3.7E-07	9.3E-08	3.8E-07	9.6E-08	1.7E-07	4.1E-08	1.0E-07	2.5E-08	1.1E-07	2.9E-08
Nickel	7440-02-0	2.1E-03 (4)	2.8E-06	6.9E-07	3.0E-06	7.5E-07	3.0E-06	7.5E-07	3.1E-06	7.7E-07	1.3E-06	3.3E-07	8.2E-07	2.1E-07	9.3E-07	2.3E-07
Selenium	7782-49-2	2.4E-05 (4)	3.2E-08	7.9E-09	3.4E-08	8.6E-09	3.4E-08	8.6E-09	3.5E-08	8.8E-09	1.5E-08	3.8E-09	9.4E-09	2.3E-09	1.1E-08	2.6E-09

Notes:

(a) Maximum hourly emissions estimate (lbs/hr) = (Emission factor [lbs/MMscf]) x (maximum hourly heat input [MMBtu/hr])/ (natural gas heat content [Btu/scf])

Natural gas heat content (Btu/scf) = 1,020 (2)

(b) Annual emissions estimate (tons/yr) = (Emission factor [lbs/MMscf]) x (annual heat input [MMBtu/yr]) / (natural gas heat content [Btu/scf]) x (tons/2,000 lbs)

Natural gas heat content (Btu/scf) = 1,020 (2)

References:

(1) See Table K-1, Existing Richmond Field Station Phase 1 Source Operation Input Assumptions for Emission Rate Calculations.
(2) AP-42 Chapter 1.4 (July 1998), Table 1.4-3 "Emission Factors For Speciated Organic Compounds from Natural Gas Combustion".
(3) California Air Toxics Emission Factor (CATEF) Database under Natural Gas Boilers.
(4) AP-42 Chapter 1.4 (July 1998), Table 1.4-4 "Emission Factors For Metals from Natural Gas Combustion".
(5) Ventura Air Quality Management District emission factor database.
(6) The AP-42 total chromium emission factor was multiplied by 17% to correct for emissions of hexavalent chromium per EPA assumptions when regulating combustion sources under 40 CFR Part 63 Subpart DDDD.

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Table K-8

Natural Gas Boiler TAC Emission Estimates

Source		Natural Gas Boiler - Building 472	Natural Gas Boiler - Building 477	Natural Gas Boiler - Building 478a	Natural Gas Boiler - Building 478b	Natural Gas Boiler - Building 478c	Natural Gas Boiler - Building 480	Natural Gas Boiler - Building 484	Total
Maximum Hourly Fuel Usage (MMBtu/hr)	(1)	0.375	0.6	0.502	0.502	1.966	0.45	1.008	
Daily Hours of Operation (hrs/day)	(1)	24	24	24	24	24	24	24	
Annual Fuel Usage (MMBtu/yr)	(1)	187	300	251	251	983	225	504	
Modeling ID		NGB_472	NGB_477	NGB_478a	NGB_478b	NGB_478c	NGB_480	NGB_484	

TAC	CAS	Emission Factor (lbs/MMscf)	Maximum Hourly [a] (lbs/hr)	Annual Average [b] (tons/yr)	Maximum Hourly [a] (lbs/hr)	Annual Average [b] (tons/yr)	Maximum Hourly [a] (lbs/hr)	Annual Average [b] (tons/yr)	Maximum Hourly [a] (lbs/hr)	Annual Average [b] (tons/yr)	Maximum Hourly [a] (lbs/hr)	Annual Average [b] (tons/yr)	Maximum Hourly [a] (lbs/hr)	Annual Average [b] (tons/yr)	Maximum Hourly [a] (lbs/hr)	Annual Average [b] (tons/yr)	Maximum Hourly Emissions Estimate (lbs/hr)	Annual Average Emissions Estimate (tons/yr)
7,12-Dimethylbenz(a)anthracene	57-97-6	1.6E-05 [2]	5.9E-09	1.5E-09	9.4E-09	2.4E-09	7.9E-09	2.0E-09	7.9E-09	2.0E-09	3.1E-08	7.7E-09	7.1E-09	1.8E-09	1.6E-08	4.0E-09	2.0E-07	5.0E-08
Acetaldehyde	75-07-0	8.9E-03 [3]	3.3E-06	8.2E-07	5.2E-06	1.3E-06	4.4E-06	1.1E-06	4.4E-06	1.1E-06	1.7E-05	4.3E-06	3.9E-06	9.8E-07	8.8E-06	2.2E-06	1.1E-04	2.8E-05
Benzene	71-43-2	4.3E-03 [3]	1.6E-06	4.0E-07	2.5E-06	6.3E-07	2.1E-06	5.3E-07	2.1E-06	5.3E-07	8.3E-06	2.1E-06	1.9E-06	4.8E-07	4.3E-06	1.1E-06	5.4E-05	1.3E-05
Dichlorobenzene	25321-22-6	1.2E-03 [4]	4.4E-07	1.1E-07	7.1E-07	1.8E-07	5.9E-07	1.5E-07	5.9E-07	1.5E-07	2.3E-06	5.8E-07	5.3E-07	1.3E-07	1.2E-06	3.0E-07	1.5E-05	3.7E-06
Ethylbenzene	100-41-4	6.9E-03 [5]	2.5E-06	6.3E-07	4.1E-06	1.0E-06	3.4E-06	8.5E-07	3.4E-06	8.5E-07	1.3E-05	3.3E-06	3.0E-06	7.6E-07	6.8E-06	1.7E-06	8.6E-05	2.1E-05
Fluoranthene	206-44-0	3.0E-06 [2]	1.1E-09	2.8E-10	1.8E-09	4.4E-10	1.5E-09	3.7E-10	1.5E-09	3.7E-10	5.8E-09	1.4E-09	1.3E-09	3.3E-10	3.0E-09	7.4E-10	3.7E-08	9.3E-09
Formaldehyde	50-00-0	2.2E-01 [3]	8.1E-05	2.0E-05	1.3E-04	3.2E-05	1.1E-04	2.7E-05	1.1E-04	2.7E-05	4.3E-04	1.1E-04	9.8E-05	2.4E-05	2.2E-04	5.5E-05	2.7E-03	6.9E-04
n-Hexane	110-54-3	4.6E-03 [5]	1.7E-06	4.2E-07	2.7E-06	6.8E-07	2.3E-06	5.7E-07	2.3E-06	5.7E-07	8.9E-06	2.2E-06	2.0E-06	5.1E-07	4.5E-06	1.1E-06	5.7E-05	1.4E-05
Naphthalene	91-20-3	3.0E-04 [5]	1.1E-07	2.8E-08	1.8E-07	4.4E-08	1.5E-07	3.7E-08	1.5E-07	3.7E-08	5.8E-07	1.4E-07	1.3E-07	3.3E-08	3.0E-07	7.4E-08	3.7E-06	9.3E-07
Propylene	115-07-1	5.3E-01 [5]	1.9E-04	4.9E-05	3.1E-04	7.8E-05	2.6E-04	6.5E-05	2.6E-04	6.5E-05	1.0E-03	2.6E-04	2.3E-04	5.8E-05	5.2E-04	1.3E-04	6.6E-03	1.6E-03
Toluene	108-88-3	2.7E-02 [5]	9.7E-06	2.4E-06	1.6E-05	3.9E-06	1.3E-05	3.3E-06	1.3E-05	3.3E-06	5.1E-05	1.3E-05	1.2E-05	2.9E-06	2.6E-05	6.5E-06	3.3E-04	8.2E-05
Xylenes	1330-20-7	2.0E-02 [5]	7.2E-06	1.8E-06	1.2E-05	2.9E-06	9.7E-06	2.4E-06	9.7E-06	2.4E-06	3.8E-05	9.5E-06	8.7E-06	2.2E-06	1.9E-05	4.9E-06	2.4E-04	6.1E-05
Arsenic	7440-38-2	2.0E-04 [4]	7.4E-08	1.8E-08	1.2E-07	2.9E-08	9.8E-08	2.5E-08	9.8E-08	2.5E-08	3.9E-07	9.6E-08	8.8E-08	2.2E-08	2.0E-07	4.9E-08	2.5E-06	6.2E-07
Beryllium	7440-41-7	1.2E-05 [4]	4.4E-09	1.1E-09	7.1E-09	1.8E-09	5.9E-09	1.5E-09	5.9E-09	1.5E-09	2.3E-08	5.8E-09	5.3E-09	1.3E-09	1.2E-08	3.0E-09	1.5E-07	3.7E-08
Cadmium	7440-43-9	1.1E-03 [4]	4.0E-07	1.0E-07	6.5E-07	1.6E-07	5.4E-07	1.4E-07	5.4E-07	1.4E-07	2.1E-06	5.3E-07	4.9E-07	1.2E-07	1.1E-06	2.7E-07	1.4E-05	3.4E-06
Chromium VI	18540-29-9	2.4E-04 [6]	8.8E-08	2.2E-08	1.4E-07	3.5E-08	1.2E-07	2.9E-08	1.2E-07	2.9E-08	4.6E-07	1.1E-07	1.1E-07	2.6E-08	2.4E-07	5.9E-08	3.0E-06	7.4E-07
Cobalt	7440-48-4	8.4E-05 [4]	3.1E-08	7.7E-09	4.9E-08	1.2E-08	4.1E-08	1.0E-08	4.1E-08	1.0E-08	1.6E-07	4.0E-08	3.7E-08	9.3E-09	8.3E-08	2.1E-08	1.0E-06	2.6E-07
Copper	7440-50-8	8.5E-04 [4]	3.1E-07	7.8E-08	5.0E-07	1.2E-07	4.2E-07	1.0E-07	4.2E-07	1.0E-07	1.6E-06	4.1E-07	3.8E-07	9.4E-08	8.4E-07	2.1E-07	1.1E-05	2.6E-06
Lead	7439-92-1	5.0E-04 [4]	1.8E-07	4.6E-08	2.9E-07	7.4E-08	2.5E-07	6.2E-08	2.5E-07	6.2E-08	9.6E-07	2.4E-07	2.2E-07	5.5E-08	4.9E-07	1.2E-07	6.2E-06	1.6E-06
Manganese	7439-96-5	3.8E-04 [4]	1.4E-07	3.5E-08	2.2E-07	5.6E-08	1.9E-07	4.7E-08	1.9E-07	4.7E-08	7.3E-07	1.8E-07	1.7E-07	4.2E-08	3.8E-07	9.4E-08	4.7E-06	1.2E-06
Mercury	7439-97-6	2.6E-04 [4]	9.6E-08	2.4E-08	1.5E-07	3.8E-08	1.3E-07	3.2E-08	1.3E-07	3.2E-08	5.0E-07	1.3E-07	1.1E-07	2.9E-08	2.6E-07	6.4E-08	3.2E-06	8.1E-07
Nickel	7440-02-0	2.1E-03 [4]	7.7E-07	1.9E-07	1.2E-06	3.1E-07	1.0E-06	2.6E-07	1.0E-06	2.6E-07	4.0E-06	1.0E-06	9.3E-07	2.3E-07	2.1E-06	5.2E-07	2.6E-05	6.5E-06
Selenium	7782-49-2	2.4E-05 [4]	8.8E-09	2.2E-09	1.4E-08	3.5E-09	1.2E-08	3.0E-09	1.2E-08	3.0E-09	4.6E-08	1.2E-08	1.1E-08	2.6E-09	2.4E-08	5.9E-09	3.0E-07	7.5E-08

Notes:

(a) Maximum hourly emissions estimate (lbs/hr) = (Emission factor [lbs/MMscf]) x (maximum hourly heat input [MMBtu/hr])/ (natural gas heat content [Btu/scf])

Natural gas heat content (Btu/scf) = 1020 (2)

(b) Annual emissions estimate (tons/yr) = (Emission factor [lbs/MMscf]) x (annual heat input [MMBtu/yr]) / (natural gas heat content [Btu/scf]) x (tons/2,000 lbs)

Natural gas heat content (Btu/scf) = 1020 (2)

References:

(1) See Table K-1, Existing Richmond Field Station Phase 1 Source Operation Input Assumptions for Emission Rate Calculations.
(2) AP-42 Chapter 1.4 (July 1998), Table 1.4-3 "Emission Factors For Speciated Organic Compounds from Natural Gas Combustion".
(3) California Air Toxics Emission Factor (CATEF) Database under Natural Gas Boilers.
(4) AP-42 Chapter 1.4 (July 1998), Table 1.4-4 "Emission Factors For Metals from Natural Gas Combustion".
(5) Ventura Air Quality Management District emission factor database.
The AP-42 total chromium emission factor was multiplied by 17% to correct for emissions of hexavalent chromium per EPA assumptions when regulating combustion sources under 40 CFR Part 63 Subpart DDDD.

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Table K-9
Emergency Diesel Generator TAC Emission Estimates

Source		Existing standby generator - B194	Existing standby generator - NRLF	Existing Fire Pump - NRLF	Total
BHP	(1)	88	88	88	
Diesel Fuel Combustion (gal/hr)	(1)	4.4	4.4	4.4	
Load Factor	(2)	0.74	0.74	0.74	
Annual Operation (hrs/yr)	(1)	25.15	25.15	25.15	
Modeling ID		DG_B194	DG_NRLF2	FP_NRLF2	

TAC	CAS	Emission Factor (lbs/10^3 gal)	Maximum Hourly (lbs/hr)	Annual Average [a] (tons/yr)	Maximum Hourly (lbs/hr)	Annual Average [a] (tons/yr)	Maximum Hourly (lbs/hr)	Annual Average [a] (tons/yr)	Maximum Daily Emissions Estimate (lbs/hr)	Annual Average Emissions Estimate (tons/yr)
DPM	9901	-- [3]	2.1E-03 [b]	2.7E-05	2.1E-03 [b]	2.7E-05	2.1E-03 [b]	2.7E-05	6.4E-03	8.1E-05
1,3-Butadiene	106-99-0	2.17E-01 [4]	7.1E-04 [c]	9.0E-06	7.1E-04 [c]	9.0E-06	7.1E-04 [c]	9.0E-06	2.1E-03	2.7E-05
Acetaldehyde	75-07-0	3.47E-03 [5]	1.1E-05 [c]	1.4E-07	1.1E-05 [c]	1.4E-07	1.1E-05 [c]	1.4E-07	3.4E-05	4.3E-07
Benzene	71-43-2	1.93E-01 [5]	6.3E-04 [c]	8.0E-06	6.3E-04 [c]	8.0E-06	6.3E-04 [c]	8.0E-06	1.9E-03	2.4E-05
Benzo(a)anthracene	56-55-3	-- [6]	--	--	--	--	--	--	0	0
Benzo(b)fluoranthene	205-99-2	-- [6]	--	--	--	--	--	--	0	0
Benzo(k)fluoranthene	207-08-9	-- [6]	--	--	--	--	--	--	0	0
Chlorobenzene	108-90-7	2.00E-04 [4]	6.6E-07 [c]	8.3E-09	6.6E-07 [c]	8.3E-09	6.6E-07 [c]	8.3E-09	2.0E-06	2.5E-08
Chrysene	218-01-9	-- [6]	--	--	--	--	--	--	0	0
Dibenz(a,h)anthracene	53-70-3	-- [6]	--	--	--	--	--	--	0	0
Ethylbenzene	100-41-4	6.76E-03 [5]	2.2E-05 [c]	2.8E-07	2.2E-05 [c]	2.8E-07	2.2E-05 [c]	2.8E-07	6.7E-05	8.4E-07
Formaldehyde	50-00-0	5.06E-02 [5]	1.7E-04 [c]	2.1E-06	1.7E-04 [c]	2.1E-06	1.7E-04 [c]	2.1E-06	5.0E-04	6.3E-06
n-Hexane	110-54-3	1.39E-03 [5]	4.6E-06 [c]	5.7E-08	4.6E-06 [c]	5.7E-08	4.6E-06 [c]	5.7E-08	1.4E-05	1.7E-07
Hydrogen Chloride	7647-01-0	1.86E-01 [4]	6.1E-04 [c]	7.7E-06	6.1E-04 [c]	7.7E-06	6.1E-04 [c]	7.7E-06	1.8E-03	2.3E-05
Indeno(1,2,3-cd)pyrene	193-39-5	-- [6]	--	--	--	--	--	--	0	0
Naphthalene	91-20-3	1.60E-02 [5]	5.2E-05 [c]	6.6E-07	5.2E-05 [c]	6.6E-07	5.2E-05 [c]	6.6E-07	1.6E-04	2.0E-06
Propylene	115-07-1	3.41E-01 [5]	1.1E-03 [c]	1.4E-05	1.1E-03 [c]	1.4E-05	1.1E-03 [c]	1.4E-05	3.4E-03	4.2E-05
Toluene	108-88-3	6.12E-02 [5]	2.0E-04 [c]	2.5E-06	2.0E-04 [c]	2.5E-06	2.0E-04 [c]	2.5E-06	6.0E-04	7.6E-06
Xylenes	1330-20-7	4.24E-02 [4]	1.4E-04 [c]	1.8E-06	1.4E-04 [c]	1.8E-06	1.4E-04 [c]	1.8E-06	4.2E-04	5.3E-06
Arsenic	7440-38-2	1.60E-03 [4]	5.3E-06 [c]	6.6E-08	5.3E-06 [c]	6.6E-08	5.3E-06 [c]	6.6E-08	1.6E-05	2.0E-07
Cadmium	7440-43-9	1.50E-03 [4]	4.9E-06 [c]	6.2E-08	4.9E-06 [c]	6.2E-08	4.9E-06 [c]	6.2E-08	1.5E-05	1.9E-07
Chromium VI	18540-29-9	1.00E-04 [7]	3.3E-07 [c]	4.1E-09	3.3E-07 [c]	4.1E-09	3.3E-07 [c]	4.1E-09	9.9E-07	1.2E-08
Copper	7440-50-8	4.10E-03 [4]	1.3E-05 [c]	1.7E-07	1.3E-05 [c]	1.7E-07	1.3E-05 [c]	1.7E-07	4.0E-05	5.1E-07
Lead	7439-92-1	8.30E-03 [4]	2.7E-05 [c]	3.4E-07	2.7E-05 [c]	3.4E-07	2.7E-05 [c]	3.4E-07	8.2E-05	1.0E-06
Manganese	7439-96-5	3.10E-03 [4]	1.0E-05 [c]	1.3E-07	1.0E-05 [c]	1.3E-07	1.0E-05 [c]	1.3E-07	3.1E-05	3.8E-07
Mercury	7439-97-6	2.00E-03 [4]	6.6E-06 [c]	8.3E-08	6.6E-06 [c]	8.3E-08	6.6E-06 [c]	8.3E-08	2.0E-05	2.5E-07
Nickel	7440-02-0	3.90E-03 [4]	1.3E-05 [c]	1.6E-07	1.3E-05 [c]	1.6E-07	1.3E-05 [c]	1.6E-07	3.8E-05	4.8E-07
Selenium	7782-49-2	2.20E-03 [4]	7.2E-06 [c]	9.1E-08	7.2E-06 [c]	9.1E-08	7.2E-06 [c]	9.1E-08	2.2E-05	2.7E-07

Modeling ID		DG_B194	DG_NRLF2	FP_NRLF2
Diesel Particulate Emission factor (g/hp-hr)	(6)	0.015	0.015	0.015

Notes:

(a) Annual average emission estimate (tons/yr) = (Maximum hourly emissions estimate [lbs/hr]) x (annual hours of operation [hrs/yr]) x (ton/2,000 lbs)
(b) Maximum hourly diesel particulate emissions estimate (lbs/hr) = (Emission factor [g/hp-hr]) x (engine horsepower [hp]) x (load factor) / (453.59 [g/lb])
(c) Maximum hourly emissions estimate (lbs/hr) = (Emission factor [lbs/10^3 gal]) x (load factor) x (fuel usage [gal/hr]) x (0.001 gal/10^3 gal)

References:

(1) See Table K-1, Existing Richmond Field Station Phase 1 Source Operation Input Assumptions for Emission Rate Calculations.
(2) Default load factor for generators in URBEMIS emission model.
(3) See diesel particulate matter emission factors at the bottom of the table.
(4) Ventura County Air Pollution Control District AB 2588 Combustion Emission Factors Database, May 2001.
(5) California Toxic Emission Factor (CATEF) Database, except for Diesel PM. The emission factors for each TAC are averaged for diesel internal combustion engines operating at less than 13% oxygen in the exhaust. Per vendor information, the percent oxygen in the exhaust is less than 13% at loads greater than 50%. It is assumed that the generator would be run at 50% load or greater.
(6) Polycyclic Aromatic Hydrocarbons (PAHs) are assumed to be included in the particulate matter emission factor. PAHs that are not specifically listed in this table, but may be included in the particulate matter emission factor, include Acenaphthylene, Anthracene, Acenaphthene, Benzo(a)anthracene, Benzo(a)pyrene, Benzo(b)fluoranthene, Benzo(k)fluoranthene, Benzo(g,h,i)perylene, Chrysene, Dibenz(a,h)anthracene, Fluoranthene, Fluorene, Indeno(1,2,3-cd)pyrene, Phenanthrene, and Pyrene. For purposes of this inventory, it is assumed that all particulate is represented as Diesel Particulate Matter (DPM).
(7) The AP-42 total chromium emission factor was multiplied by 17% to correct for emissions of hexavalent chromium per EPA assumptions when regulating combustion sources under 40 CFR Part 63 Subpart DDDD.

Table K-10
Total Estimated Air Emissions of Laboratory Non-Radionuclide Liquid Chemicals

Source		Lab Hood Exhaust Stack - Building 154		Lab Hood Exhaust Stack - Building 158		Lab Hood Exhaust Stack - Building 167		Lab Hood Exhaust Stack - Building 450		Lab Hood Exhaust Stack - Building 473		Lab Hood Exhaust Stack - Building 474		Lab Hood Exhaust Stack - Building 478		Lab Hood Exhaust Stack - Building 480		Total	
Modeling ID		LAB_B154		LAB_B158		LAB_B167		LAB_B450		LAB_B473		LAB_B474		LAB_B478		LAB_B480			
TAC	**CAS**	**Maximum Hourly [b] (lbs/hr)**	**Annual Average [2] (tons/yr)**	**Maximum Hourly [b] (lbs/hr)**	**Annual Average [2] (tons/yr)**	**Maximum Hourly [b] (lbs/hr)**	**Annual Average [2] (tons/yr)**	**Maximum Hourly [b] (lbs/hr)**	**Annual Average [2] (tons/yr)**	**Maximum Hourly [b] (lbs/hr)**	**Annual Average [2] (tons/yr)**	**Maximum Hourly [b] (lbs/hr)**	**Annual Average [2] (tons/yr)**	**Maximum Hourly [b] (lbs/hr)**	**Annual Average [2] (tons/yr)**	**Maximum Hourly [b] (lbs/hr)**	**Annual Average [2] (tons/yr)**	**Maximum Daily (lbs/hr)**	**Annual Average (tons/yr)**
1,2-Epoxybutane	106-88-7	2.4E-08	6.1E-09	2.4E-08	6.1E-09	2.4E-08	6.1E-09	2.4E-08	6.1E-09	2.4E-08	6.1E-09	2.4E-08	6.1E-09	2.4E-08	6.1E-09	2.4E-08	6.1E-09	1.9E-07	4.8E-08
Acrylic acid	79-10-7	--	--	--	--	2.0E-03	4.9E-04	--	--	--	--	--	--	--	--	--	--	2.0E-03	4.9E-04
Benzene	71-43-2	2.6E-04	6.5E-05	2.6E-04	6.5E-05	2.6E-04	6.5E-05	2.6E-04	6.5E-05	2.6E-04	6.5E-05	2.6E-04	6.5E-05	2.6E-04	6.5E-05	2.6E-04	6.5E-05	2.1E-03	5.2E-04
Chloroform	67-66-3	9.6E-04	2.4E-04	9.6E-04	2.4E-04	9.6E-04	2.4E-04	9.6E-04	2.4E-04	9.6E-04	2.4E-04	4.0E-03	1.0E-03	9.6E-04	2.4E-04	9.6E-04	2.4E-04	0.011	2.7E-03
Dimethyl formamide	68-12-2	6.3E-06	1.6E-06	6.3E-06	1.6E-06	6.3E-06	1.6E-06	6.3E-06	1.6E-06	6.3E-06	1.6E-06	6.3E-06	1.6E-06	6.3E-06	1.6E-06	6.3E-06	1.6E-06	5.1E-05	1.3E-05
Ethylene glycol	107-21-1	1.2E-06	2.9E-07	1.2E-06	2.9E-07	1.1E-05	2.6E-06	1.2E-06	2.9E-07	1.2E-06	2.9E-07	1.2E-06	2.9E-07	1.2E-06	2.9E-07	3.5E-06	8.9E-07	2.1E-05	5.3E-06
Formaldehyde	50-00-0	1.4E-04	3.6E-05	1.4E-04	3.6E-05	1.4E-04	3.6E-05	1.4E-04	3.6E-05	1.4E-04	3.6E-05	1.4E-04	3.6E-05	1.4E-04	3.6E-05	1.4E-04	3.6E-05	1.1E-03	2.9E-04
n-Hexane	110-54-3	3.6E-03	9.1E-04	3.6E-03	9.1E-04	3.6E-03	9.1E-04	3.6E-03	9.1E-04	3.6E-03	9.1E-04	3.6E-03	9.1E-04	3.6E-03	9.1E-04	3.6E-03	9.1E-04	0.029	7.3E-03
Hydrogen Chloride	7647-01-0	1.0E-03	2.5E-04	1.0E-03	2.5E-04	1.0E-03	2.5E-04	1.0E-03	2.5E-04	1.0E-03	2.5E-04	1.0E-03	2.5E-04	1.0E-03	2.5E-04	1.0E-03	2.5E-04	8.0E-03	2.0E-03
Isopropyl alcohol	67-63-0	2.4E-03	6.0E-04	2.4E-03	6.0E-04	1.1E-03	2.7E-04	1.6E-03	4.0E-04	6.2E-03	1.6E-03	1.1E-03	2.7E-04	2.4E-03	6.0E-04	1.1E-03	2.7E-04	0.018	4.6E-03
Methanol	67-56-1	2.1E-03	5.2E-04	2.1E-03	5.2E-04	2.1E-03	5.2E-04	2.1E-03	5.2E-04	2.1E-03	5.2E-04	3.2E-03	8.2E-04	2.1E-03	5.2E-04	2.1E-03	5.2E-04	0.018	4.4E-03
Methylene chloride [Dichloromethane]	75-09-2	8.3E-03	2.1E-03	8.3E-03	2.1E-03	8.3E-03	2.1E-03	8.3E-03	2.1E-03	8.3E-03	2.1E-03	8.3E-03	2.1E-03	8.3E-03	2.1E-03	8.3E-03	2.1E-03	0.067	0.017
Nitric acid	7697-37-2	2.1E-04	5.4E-05	2.1E-04	5.4E-05	2.1E-04	5.4E-05	2.1E-04	5.4E-05	2.1E-04	5.4E-05	2.1E-04	5.4E-05	2.1E-04	5.4E-05	2.1E-04	5.4E-05	1.7E-03	4.3E-04
Phenol	108-95-2	1.1E-05	2.7E-06	1.1E-05	2.7E-06	1.1E-05	2.7E-06	1.1E-05	2.7E-06	1.1E-05	2.7E-06	1.1E-05	2.7E-06	1.1E-05	2.7E-06	1.1E-05	2.7E-06	8.6E-05	2.2E-05
Sulfuric acid	7664-93-9	8.4E-06	2.1E-06	8.4E-06	2.1E-06	8.4E-06	2.1E-06	8.4E-06	2.1E-06	8.4E-06	2.1E-06	8.4E-06	2.1E-06	8.4E-06	2.1E-06	8.4E-06	2.1E-06	6.7E-05	1.7E-05
Toluene	108-88-3	8.3E-04	2.1E-04	8.3E-04	2.1E-04	8.3E-04	2.1E-04	8.3E-04	2.1E-04	8.3E-04	2.1E-04	8.3E-04	2.1E-04	1.9E-03	4.9E-04	8.3E-04	2.1E-04	7.8E-03	1.9E-03
Triethylamine	121-44-8	3.8E-05	9.6E-06	3.8E-05	9.6E-06	3.8E-05	9.6E-06	3.8E-05	9.6E-06	3.8E-05	9.6E-06	3.8E-05	9.6E-06	3.8E-05	9.6E-06	3.8E-05	9.6E-06	3.1E-04	7.7E-05
Carbon Monoxide	630-08-0	1.1E-04	2.8E-05	1.1E-04	2.8E-05	1.1E-04	2.8E-05	1.1E-04	2.8E-05	1.1E-04	2.8E-05	1.1E-04	2.8E-05	1.1E-04	2.8E-05	1.1E-04	2.8E-05	8.8E-04	2.2E-04
Total - All Chemicals Listed		**0.020**	**5.0E-03**	**0.020**	**5.0E-03**	**0.021**	**5.2E-03**	**0.019**	**4.8E-03**	**0.024**	**6.0E-03**	**0.023**	**5.8E-03**	**0.021**	**5.3E-03**	**0.019**	**4.7E-03**	**0.17**	**0.042**

Notes:

(b) Maximum hourly emissions estimate (lbs/hr) = (Annual average emissions [tons/year]) / (annual operation [days/year]) / (daily operation [hrs/day]) x (2,000 lbs/ton) x (conversion factor)

Annual operation for all buildings (days/year) =	260	(1)
Daily operation for all buildings (hrs/day) =	10	(1)
Conversion factor =	5.18	(3)

(c) Annual average emissions estimate (tons/yr) = (Phase I emissions fraction [tons/gsf/yr]) x (building size [gsf])

References:

(1) See Table K-1, Existing Richmond Field Station Phase 1 Source Operation Input Assumptions for Emission Rate Calculations.

(2) RFS Laboratory emissions calculated as part of the cumulative assessment using a method similar to that used for the Phase 1 assessment. See Appendix M.

(3) Based in studies comparing maximum to average emission rates for laboratories. See text for further information.

Table K-11
Existing Richmond Field Station Phase 1 Source Operations TAC Emissions Summary

TAC	CAS	Natural Gas Boilers		Diesel Generators		Laboratory Buildings		Vehicle Refueling Station		Offroad Vehicle Exhaust		Total	
		(lbs/hr)	(tons/yr)	(lbs/hr)	(tons/yr)	(lbs/hr)	(tons/yr)	(lbs/hr)	(tons/yr)	(lbs/hr)	(tons/yr)	(lbs/hr)	(tons/yr)
DPM (1)	9901	--	--	6.4E-03	8.1E-05	--	--	--	--	0.12	0.012	0.13	0.012
1,3-Butadiene	106-99-0	--	--	2.1E-03	2.7E-05	--	--	--	--	--	--	2.1E-03	2.7E-05
1,2-Epoxybutane	106-88-7	--	--	--	--	1.9E-07	4.8E-08	--	--	--	--	1.9E-07	4.8E-08
7,12-Dimethylbenz(a)anthracene	57-97-6	2.0E-07	5.0E-08	--	--	--	--	--	--	--	--	2.0E-07	5.0E-08
Acetaldehyde	75-07-0	1.1E-04	2.8E-05	3.4E-05	4.3E-07	--	--	--	--	--	--	1.4E-04	2.8E-05
Acrylic acid	79-10-7	--	--	--	--	2.0E-03	4.9E-04	--	--	--	--	2.0E-03	4.9E-04
Arsenic	7440-38-2	2.5E-06	6.2E-07	1.6E-05	2.0E-07	--	--	--	--	--	--	1.8E-05	8.2E-07
Benzene	71-43-2	5.4E-05	1.3E-05	1.9E-03	2.4E-05	2.1E-03	5.2E-04	7.7E-04	1.4E-03	--	--	4.8E-03	2.0E-03
Beryllium	7440-41-7	1.5E-07	3.7E-08	--	--	--	--	--	--	--	--	1.5E-07	3.7E-08
Cadmium	7440-43-9	1.4E-05	3.4E-06	1.5E-05	1.9E-07	--	--	--	--	--	--	2.8E-05	3.6E-06
Chlorobenzene	108-90-7	--	--	2.0E-06	2.5E-08	--	--	--	--	--	--	2.0E-06	2.5E-08
Chloroform	67-66-3	--	--	--	--	0.011	2.7E-03	--	--	--	--	0.011	2.7E-03
Chromium VI	18540-29-9	3.0E-06	7.4E-07	9.9E-07	1.2E-08	--	--	--	--	--	--	3.9E-06	7.5E-07
Cobalt	7440-48-4	1.0E-06	2.6E-07	--	--	--	--	--	--	--	--	1.0E-06	2.6E-07
Copper	7440-50-8	1.1E-05	2.6E-06	4.0E-05	5.1E-07	--	--	--	--	--	--	5.1E-05	3.1E-06
Dichlorobenzene	25321-22-6	1.5E-05	3.7E-06	--	--	--	--	--	--	--	--	1.5E-05	3.7E-06
Dimethyl formamide	68-12-2	--	--	--	--	5.1E-05	1.3E-05	--	--	--	--	5.1E-05	1.3E-05
Ethylbenzene	100-41-4	8.6E-05	2.1E-05	6.7E-05	8.4E-07	--	--	6.0E-04	1.1E-03	--	--	7.5E-04	1.1E-03
Ethylene glycol	107-21-1	--	--	--	--	2.1E-05	5.3E-06	--	--	--	--	2.1E-05	5.3E-06
Fluoranthene	206-44-0	3.7E-08	9.3E-09	--	--	--	--	--	--	--	--	3.7E-08	9.3E-09
Formaldehyde	50-00-0	2.7E-03	6.9E-04	5.0E-04	6.3E-06	1.1E-03	2.9E-04	--	--	--	--	4.4E-03	9.8E-04
Hydrogen Chloride	7647-01-0	--	--	1.8E-03	2.3E-05	8.0E-03	2.0E-03	--	--	--	--	9.8E-03	2.0E-03
Isopropyl alcohol	67-63-0	--	--	--	--	0.018	4.6E-03	--	--	--	--	0.018	4.6E-03
Lead	7439-92-1	6.2E-06	1.6E-06	8.2E-05	1.0E-06	--	--	--	--	--	--	8.8E-05	2.6E-06
Manganese	7439-96-5	4.7E-06	1.2E-06	3.1E-05	3.8E-07	--	--	--	--	--	--	3.5E-05	1.6E-06
Mercury	7439-97-6	3.2E-06	8.1E-07	2.0E-05	2.5E-07	--	--	--	--	--	--	2.3E-05	1.1E-06
Methanol	67-56-1	--	--	--	--	0.018	4.4E-03	--	--	--	--	0.018	4.4E-03
Methylene chloride [Dichloromethane]	75-09-2	--	--	--	--	0.067	0.017	--	--	--	--	0.067	0.017
Naphthalene	91-20-3	3.7E-06	9.3E-07	1.6E-04	2.0E-06	--	--	--	--	--	--	1.6E-04	2.9E-06
n-Hexane	110-54-3	5.7E-05	1.4E-05	1.4E-05	1.7E-07	0.029	7.3E-03	4.3E-04	7.8E-04	--	--	0.030	8.1E-03
Nickel	7440-02-0	2.6E-05	6.5E-06	3.8E-05	4.8E-07	--	--	--	--	--	--	6.5E-05	7.0E-06
Nitric acid	7697-37-2	--	--	--	--	1.7E-03	4.3E-04	--	--	--	--	1.7E-03	4.3E-04
Phenol	108-95-2	--	--	--	--	8.6E-05	2.2E-05	--	--	--	--	8.6E-05	2.2E-05
Propylene	115-07-1	6.6E-03	1.6E-03	3.4E-03	4.2E-05	--	--	--	--	--	--	9.9E-03	1.7E-03
Selenium	7782-49-2	3.0E-07	7.5E-08	2.2E-05	2.7E-07	--	--	--	--	--	--	2.2E-05	3.5E-07
Sulfuric acid	7664-93-9	--	--	--	--	6.7E-05	1.7E-05	--	--	--	--	6.7E-05	1.7E-05
Toluene	108-88-3	3.3E-04	8.2E-05	6.0E-04	7.6E-06	7.8E-03	1.9E-03	3.0E-03	5.4E-03	--	--	0.012	7.5E-03
Triethylamine	121-44-8	--	--	--	--	3.1E-04	7.7E-05	--	--	--	--	3.1E-04	7.7E-05
m-Xylene	108-38-3	--	--	--	--	--	--	3.0E-03	5.4E-03	--	--	3.0E-03	5.4E-03
Xylenes	1330-20-7	2.4E-04	6.1E-05	4.2E-04	5.3E-06	--	--	--	--	--	--	6.6E-04	6.6E-05
NO_2	10102-44-0	0.025	6.2E-03	1.07	0.013	--	--	--	--	1.72	0.17	2.82	0.19
SO_2	7446-09-5	7.9E-04	2.0E-04	2.8E-03	3.5E-05	--	--	--	--	4.8E-03	4.8E-04	8.3E-03	7.1E-04
CO	630-08-0	0.11	0.028	1.58	0.020	8.8E-04	2.2E-04	--	--	100.0	10.00	102	10.0

References:

(1) Assumes all PM_{10} emissions from diesel combustion equals diesel particulate matter (DPM).

(2) NO_2 emissions are shown as NO_X emissions.

Appendix L

Emissions Estimates – Existing Richmond Field Station Sources – LRDP

Table L-1
Existing Richmond Field Station LRDP Source Operation Input Assumptions for Emission Rate Calculations

Source		Diesel Emergency Engines		Natural Gas Boilers		
		Engine Size [1] (BHP)	Fuel Usage (gal/hr)	Maximum Heat Input [1] (MMBtu/hr)	Daily Operation (hrs/day)	Annual Fuel Usage [2] (MMBtu/yr)
Building 112	[3]	87.5	4.4 [a]	1.75	24	875
Building 194	[3]	87.5	4.4 [a]	--	--	--
Building 275	[3]	--	--	0.3	24	150
Building 400a	(PH1 - BR1)	--	--	1.35	24	675
Building 400b	(PH2 - BR17)	--	--	1.46	24	730
Building 400c	(PH2 - BR18)	--	--	1.46	24	730
Building 400d	(PH2 - B/3-3)	--	--	1.5	24	750
Building 451	[3]	--	--	0.65	24	325
Building 452	[3]	--	--	0.399	24	199
Building 454	[3]	--	--	0.45	24	225
Building 472	[3]	--	--	0.375	24	187
Building 477	[3]	--	--	0.6	24	300
Building 478a	[3]	--	--	0.502	24	251
Building 478b	[3]	--	--	0.502	24	251
Building 478c	[3]	--	--	1.966	24	983
Building 480	[3]	--	--	0.45	24	225
Building 484	[3]	--	--	1.008	24	504
Building 400	(emergency engine)	87.5	4.4 [a]	--	--	--
Building 400f	(fire pump engine)	87.5	4.4 [a]	--	--	--
Total		350	17.8	14.722	--	7,360 [1]

Facility Data			
Source	Source Parameter	Short Term Input (units)	Annual Input (units)
	Facility Operation (Laboratory)	10 (hrs/day) [5]	260 (days/yr) [6]
	Emergency Engine Usage	2 (hrs/day) [7]	25.15 (hrs/yr) [7]
	Gasoline Tank Throughput	0.022 (Mgal/day)	8 (Mgal/yr)
	Diesel Tank Throughput	0.007 (Mgal/day)	2.4 (Mgal/yr)
	Offroad Vehicle Usage	10 (hrs/day)	400 (hrs/yr)

Notes:

(a) Engine fuel consumption (gal/hr) = (Engine size [hp]) x (average brake-specific fuel consumption [Btu/hp-hr]) / (liquid fuel higher heating value [Btu/gal])

Average brake-specific fuel consumption (Btu/hp-hr) = 7,000 (1)

Liquid fuel higher heating value (Btu/gal) = 138,000 (4)

References:

(1) Provided by the University.
(2) Total annual RFS natural gas usage apportioned to individual buildings based on the maximum hourly heat input.
(3) Buildings only included to properly apportion annual natural gas usage to individual buildings. Buildings assumed to be removed during Phase 1.
(4) ULSD higher heating value.
(5) Conservatively assumes laboratory work and offroad equipment usage is conducted over 10 hours per day.
(6) Assumes employee-based operations will generally be active 5 days per week, 52 weeks per year.
(7) Hourly value conservatively assumes a maximum of 2 hours per day of operation for maintenance and testing. Annual value is based on the average historical emergency engine usage from the LBNL LRDP.

Table L-2
Summary of Existing Onsite Off-Road Exhaust Criteria Pollutant Emission Estimates

Pollutant	Vehicle Type	Quantity	Horsepower [1]	Load Factor [2]	Daily hours of operation [3]	Annual hours of operation [3]	Emission Factor [4] (g/hp-hr)	Maximum Daily Emissions Estimate [a] (lbs/day)	Annual Average Emissions Estimate [b] (tons/yr)
ROG	Aerial Lifts	1.0	48	0.31	10	400	1.5	0.50	9.9E-03
	Tractors/Loaders/Backhoes	2.0	39	0.37	10	400	1.5	0.94	1.9E-02
	Sweepers/Scrubbers	1.0	37	0.46	10	400	1.6	0.61	1.2E-02
	Lawnmowers	3.0	28	1.0	10	400	8.4	15	0.30
	Total ROG Emissions							**17**	**0.34**
NO_X	Aerial Lifts	1.0	48	0.31	10	400	5.1	1.7	3.3E-02
	Tractors/Loaders/Backhoes	2.0	39	0.37	10	400	5.2	3.3	6.6E-02
	Sweepers/Scrubbers	1.0	37	0.46	10	400	5.3	2.0	4.0E-02
	Lawnmowers	3.0	28	1.0	10	400	5.7	10	0.21
	Total NO_X Emissions							**17**	**0.34**
CO	Aerial Lifts	1.0	48	0.31	10	400	4.9	1.6	3.2E-02
	Tractors/Loaders/Backhoes	2.0	39	0.37	10	400	5.8	3.7	7.4E-02
	Sweepers/Scrubbers	1.0	37	0.46	10	400	5.9	2.2	4.4E-02
	Lawnmowers	3.0	28	1.0	10	400	545	992	20
	Total CO Emissions							**1,000**	**20**
SO_2	Aerial Lifts	1.0	48	0.31	10	400	7.0E-03	2.3E-03	4.6E-05
	Tractors/Loaders/Backhoes	2.0	39	0.37	10	400	7.0E-03	4.5E-03	8.9E-05
	Sweepers/Scrubbers	1.0	37	0.46	10	400	7.0E-03	2.6E-03	5.3E-05
	Lawnmowers	3.0	28	1.0	10	400	2.1E-02	3.8E-02	7.6E-04
	Total SO_2 Emissions							**4.8E-02**	**9.5E-04**
PM_{10}	Aerial Lifts	1.0	48	0.31	10	400	0.40	0.13	2.7E-03
	Tractors/Loaders/Backhoes	2.0	39	0.37	10	400	0.40	0.25	5.0E-03
	Sweepers/Scrubbers	1.0	37	0.46	10	400	0.43	0.16	3.2E-03
	Lawnmowers	3.0	28	1.0	10	400	0.37	0.67	1.3E-02
	Total PM_{10} Emissions							**1.2**	**2.4E-02**
$PM_{2.5}$	Aerial Lifts	1.0	48	0.31	10	400	0.40	0.13	2.7E-03
	Tractors/Loaders/Backhoes	2.0	39	0.37	10	400	0.40	0.25	5.0E-03
	Sweepers/Scrubbers	1.0	37	0.46	10	400	0.43	0.16	3.2E-03
	Lawnmowers	3.0	28	1.0	10	400	0.37	0.67	1.3E-02
	Total $PM_{2.5}$ Emissions							**1.2**	**2.4E-02**
CO_2	Aerial Lifts	1.0	48	0.31	10	400	568	186	3.7
	Tractors/Loaders/Backhoes	2.0	39	0.37	10	400	568	362	7.2
	Sweepers/Scrubbers	1.0	37	0.46	10	400	568	213	4.3
	Lawnmowers	3.0	28	1.0	10	400	859	1,562	31
	Total CO_2 Emissions							**2,323**	**46**
CH_4	Aerial Lifts	1.0	48	0.31	10	400	0.14	4.5E-02	8.9E-04
	Tractors/Loaders/Backhoes	2.0	39	0.37	10	400	0.13	8.5E-02	1.7E-03
	Sweepers/Scrubbers	1.0	37	0.46	10	400	0.15	5.4E-02	1.1E-03
	Lawnmowers	3.0	28	1.0	10	400	0.47	0.85	1.7E-02
	Total CH_4 Emissions							**1.0**	**2.1E-02**

Notes:
(a) Maximum daily emissions estimate (lbs/day) = (Equipment horsepower [hp]) x (load factor) x (daily hours of operation [hrs/day]) x (emission factor [g/hp-hr]) x (lb/453.59 g)
(b) Annual average emissions estimate (tons/yr) = (Equipment horsepower [hp]) x (load factor) x (annual hours of operation [hrs/yr]) x (emission factor [g/hp-hr]) x (lb/453.59 g) x (ton/2,000 lbs)

References:
(1) Provided by LBNL. Assumes 2 tractor/loader/backhoes at 28 hp and 50 hp (average 39 hp), 1 aerial lift, 1 sweeper/scrubber, and 3 lawnmowers between 26 hp and 29 hp (average 27.5 hp).
(2) Load factors taken from Table D-7: Original OFFROAD and New Load Factors (LF) by Equipment Type.
(3) See Table L-1, Existing Richmond Field Station LRDP Source Operation Input Assumptions for Emission Rate Calculations.
(4) Emission factors from CalEEMod Appendix D tables for the year 2014.

Table L-3
Natural Gas Boiler Criteria Emission Estimates

Pollutant					PM		PM_{10}		$PM_{2.5}$		NO_X		CO		SO_2		VOC		CO_2		CH_4		N_2O		CO_2e	
Emission Factor (lbs/MMscf)					7.60 (1)		7.60 (2)		7.60 (2)		18.72 (a)		84 (4)		0.6 (1)		5.5 (1)		120,162 (b)		2.27 (c)		0.23 (c)		120,280 (d)	
					Emission Estimates																					
Source	Modeling ID	Maximum Hourly Fuel Usage (8) (MMBtu/hr)	Daily Operation (8) (hrs/day)	Annual Fuel Usage (8) (MMBtu/yr)	Maximum Daily (e) (lbs/day)	Annual Average (f) (tons/yr)	Maximum Daily (e) (lbs/day)	Annual Average (f) (tons/yr)	Maximum Daily (e) (lbs/day)	Annual Average (f) (tons/yr)	Maximum Daily (e) (lbs/day)	Annual Average (f) (tons/yr)	Maximum Daily (e) (lbs/day)	Annual Average (f) (tons/yr)	Maximum Daily (e) (lbs/day)	Annual Average (f) (tons/yr)	Maximum Daily (e) (lbs/day)	Annual Average (f) (tons/yr)	Maximum Daily (e) (lbs/day)	Annual Average (f) (tons/yr)	Maximum Daily (e) (lbs/day)	Annual Average (f) (tons/yr)	Maximum Daily (e) (lbs/day)	Annual Average (f) (tons/yr)	Maximum Daily (e) (lbs/day)	Annual Average (f) (tons/yr)
Natural Gas Boiler - Building 400a	NGB_400a	1.35	24	675	0.24	2.5E-03	0.24	2.5E-03	0.24	2.5E-03	0.59	6.2E-03	2.67	0.028	0.019	2.0E-04	0.17	1.8E-03	3,817	39.8	0.072	7.5E-04	7.2E-03	7.5E-05	3,821	39.8
Natural Gas Boiler - Building 400b	NGB_400b	1.46	24	730	0.26	2.7E-03	0.26	2.7E-03	0.26	2.7E-03	0.64	6.7E-03	2.89	0.030	0.021	2.1E-04	0.19	2.0E-03	4,128	43.0	0.078	8.1E-04	7.8E-03	8.1E-05	4,132	43.0
Natural Gas Boiler - Building 400c	NGB_400c	1.46	24	730	0.26	2.7E-03	0.26	2.7E-03	0.26	2.7E-03	0.64	6.7E-03	2.89	0.030	0.021	2.1E-04	0.19	2.0E-03	4,128	43.0	0.078	8.1E-04	7.8E-03	8.1E-05	4,132	43.0
Natural Gas Boiler - Building 400d	NGB_400d	1.5	24	750	0.27	2.8E-03	0.27	2.8E-03	0.27	2.8E-03	0.66	6.9E-03	2.96	0.031	0.021	2.2E-04	0.19	2.0E-03	4,241	44.2	0.080	8.3E-04	8.0E-03	8.3E-05	4,245	44.2
Total					**1.03**	**0.011**	**1.03**	**0.011**	**1.03**	**0.011**	**2.54**	**0.026**	**11.4**	**0.12**	**0.081**	**8.5E-04**	**0.75**	**7.8E-03**	**16,314**	**170**	**0.31**	**3.2E-03**	**0.031**	**3.2E-04**	**16,330**	**170**

Notes:

(a) Emission factor (lbs/MMscf) = (NO_2 or CO emission limit [ppmv @ 3% O_2]) x (10^{-6}) x (NO_2 or CO molecular weight [lbs/lb-mol]) x (lb-mol/385.44 ft^3) x (natural gas f-factor [8,710 dscf/MMBtu]) x (20.9% O_2/[20.9% O_2 - 3% O_2]) x (heat content [Btu/scf])

BAAQMD NO_X emission limit (ppmv @ 3% O_2) =	15	(3)
BAAQMD CO emission limit (ppmv @ 3% O_2) =	400	(3)
NO_2 molecular weight (lbs/lb-mol) =	46	
CO molecular weight (lbs/lb-mol) =	28.01	
Natural gas heat content (Btu/scf) =	1,028	(5)

(b) CO_2 emission factor (lbs/MMscf) = (CO_2 emission factor [kg CO_2/MMBtu]) x (default high heat value (MMBtu/scf)) x (10^6 scf/MMscf) x (lb/0.453592 kg)

CO_2 emission factor (kg/MMBtu) =	53.02	(5)
Default high heat value (MMBtu/scf) =	1.028E-03	(5)

(c) CH_4 or N_2O emission factor (lbs/MMscf) = (CH_4 or N_2O emission factor [kg/MMBtu]) x (lb/0.453592 kg) x (natural gas heat content [Btu/scf])

CH_4 emission factor (kg/MMBtu) =	1.0E-03	(6)
N_2O emission factor (kg/MMBtu) =	1.0E-04	(6)
Natural gas heat content (Btu/scf) =	1,028	(5)

(d) CO_2e emission factor (lbs/MMscf) = (CO_2 emission factor [lbs/MMscf]) + (CH_4 emission factor [lbs/MMscf] x CH_4 global warming potential)
+ (N_2O emission factor [lbs/MMscf] x N_2O global warming potential)

Global warming potential of CH_4 =	21	(7)
Global warming potential of N_2O =	310	(7)

(e) Daily emissions estimate (lbs/day) = (Emission factor [lbs/MMscf]) x (maximum hourly heat input [MMBtu/hr]) x (daily hours of operation [hrs/day]) / (natural gas heat content [Btu/scf])

Natural gas heat content (Btu/scf) =	1,020	(5)

(f) Annual emissions estimate (tons/yr) = (emission factor [lbs/MMscf]) x (annual heat input [MMBtu/yr]) / (natural gas heat content [Btu/scf]) x (tons/2,000 lbs)

Natural gas heat content (Btu/scf) =	1,020	(5)

References:

(1) AP-42 Chapter 1.4 (July 1998), Table 1.4-2 "Emission Factors for Criteria Pollutants and Greenhouse Gases from Natural Gas Combustion".
(2) Assumes that 100% of PM is $PM_{2.5}$. Therefore, 100% of PM_{10} is $PM_{2.5}$.
(3) BAAQMD Emission Limits 307.2, 307.3, and 307.4 from Section 9-7-307..
(4) AP-42 Chapter 1.4 (July 1998), Table 1.4-1 "Emission Factors for NO_x and CO from Natural Gas Combustion".
(5) 40 CFR Part 98 Subpart C, Table C-1, Default CO_2 Emission Factors and High Heat Values for Various Types of Fuel.
(6) 40 CFR Part 98 Subpart C, Table C-2, Default CH_4 and N_2O Emission Factors for Various Types of Fuel.
(7) 40 CFR Part 98 Subpart A, Table A-1, Global Warming Potentials.
(8) See Table L-1, Existing Richmond Field Station LRDP Source Operation Input Assumptions for Emission Rate Calculations.

Table L-4
Emergency Diesel Generator Criteria Emission Estimates

Pollutant				Min HP	Max HP	PM		PM_{10}		$PM_{2.5}$		NO_X		CO		SO_2		VOC		CO_2		CH_4		CO_2e	
Emission Factor - Tier 4 Interim (g/hp-hr) (1)				75	99	0.015 (1)		0.015 (1)		0.015 (1)		2.5 (2)		3.7 (2)		-- (3)		0.14 (2)		-- (4)		--		--	
						Emission Estimates																			
Source	Modeling ID	Generator Power Rating (5) (BHP)	Diesel Fuel Usage (5) (gal/hr)	Load Factor (6)	Annual Operation (5) (hrs/yr)	Maximum Daily (a) (lbs/day)	Annual Average (b) (tons/yr)	Maximum Daily (a) (lbs/day)	Annual Average (b) (tons/yr)	Maximum Daily (a) (lbs/day)	Annual Average (b) (tons/yr)	Maximum Daily (a) (lbs/day)	Annual Average (b) (tons/yr)	Maximum Daily (a) (lbs/day)	Annual Average (b) (tons/yr)	Maximum Daily (c) (lbs/day)	Annual Average (b) (tons/yr)	Maximum Daily (a) (lbs/day)	Annual Average (b) (tons/yr)	Maximum Daily (d) (lbs/day)	Annual Average (b) (tons/yr)	Maximum Daily (9) (lbs/day)	Annual Average (b) (tons/yr)	Maximum Daily (e) (lbs/day)	Annual Average (b) (tons/yr)
Existing standby generator - NRLF	DG_NRLF2	88	4.4	0.74	25.15	4.3E-03	2.7E-05	4.3E-03	2.7E-05	4.3E-03	2.7E-05	0.71	4.5E-03	1.06	6.6E-03	1.9E-03	1.2E-05	0.040	2.5E-04	198	1.25	3.6E-03	2.3E-05	198	1.25
Existing Fire Pump NRLF	FP_NRLF2	88	4.4	0.74	25.15	4.3E-03	2.7E-05	4.3E-03	2.7E-05	4.3E-03	2.7E-05	0.71	4.5E-03	1.06	6.6E-03	1.9E-03	1.2E-05	0.040	2.5E-04	198	1.25	3.6E-03	2.3E-05	198	1.25
Total						**8.6E-03**	**5.4E-05**	**8.6E-03**	**5.4E-05**	**8.6E-03**	**5.4E-05**	**1.43**	**9.0E-03**	**2.11**	**0.013**	**3.7E-03**	**2.3E-05**	**0.080**	**5.0E-04**	**396**	**2.49**	**7.2E-03**	**4.5E-05**	**396**	**2.49**

Notes:

(a) Maximum daily emission estimate (lbs/day) = (Emission factor [g/hp-hr]) x (generator power [hp]) x (load factor) x (maximum hours per day [hrs/day]) x (lb/453.59g)
Daily hours of operation (hrs/day) = 2 (5)

(b) Annual average emission estimate (tons/yr) = (Daily emissions [lbs/day]) / (daily hours of operation [hrs/day]) x (annual hours of operation [hrs/yr]) x (ton/2,000 lbs)
Daily hours of operation (hrs/day) = 2 (5)

(c) Maximum daily emissions estimate (lbs/day) = (Fuel sulfur content [ppmw] / 1,000,000) x (generator fuel consumption [gal/hr]) x (daily hours of operation [hrs/day]) x (diesel density [lbs/gal]) x ([SO_2 molecular weight {lbs/lb-mol}] / [sulfur molecular weight {lbs/lb-mol}])
Fuel sulfur content (ppmw) = 15 (7)
Daily hours of operation (hrs/day) = 2 (5)
Diesel density (lbs/gal) = 7
SO_2 molecular weight (lbs/lb-mol) = 64
Sulfur molecular weight (lbs/lb-mol) = 32

(d) Maximum daily emissions estimate (lbs/day) = (Fuel carbon content [%] / 100) x (generator fuel consumption [gal/hr]) x (daily hours of operation [hrs/day]) x (diesel density [lbs/gal]) x ([CO_2 molecular weight {lbs/lb-mol}] / [carbon molecular weight {lbs/lb-mol}])
Fuel carbon content (%) = 87 (8)
Daily hours of operation (hrs/day) = 2 (5)
Diesel density (lbs/gal) = 7
CO_2 molecular weight (lbs/lb-mol) = 44.0
Carbon molecular weight (lbs/lb-mol) = 12.0

(e) CO_2e emissions (lbs/day) = (CO_2 emissions [lbs/day]) + (CH_4 emissions [lbs/day] x CH_4 global warming potential) + (N_2O emissions [lbs/day] x N_2O global warming potential)
CH_4 Global Warming Potential (GWP) = 21 (10)
N_2O Global Warming Potential (GWP) = 310 (10)

References:

(1) Interim Tier IV emission factors are assumed.
(2) CalEEMod Appendix D, Default Data Tables. Table 3.5, OFFROAD Emission Factor Based on Engine Tier. Assumes Tier 4 Final for LBNL-owned small engines (Buildings 9 and 8), and Tier 4 Interim for the Building 6&7 engine.
(3) Sulfur dioxide emissions calculated on a sulfur mass balance basis, assuming 100% of the fuel sulfur content is emitted as SO_2.
(4) Carbon dioxide emissions calculated on a carbon mass balance basis, conservatively assuming 100% of the fuel carbon content is emitted as CO_2.
(5) See Table L-1, Existing Richmond Field Station LRDP Source Operation Input Assumptions for Emission Rate Calculations.
(6) Default load factor for generators in URBEMIS emissions model.
(7) California Code of Regulations Title 13, Division 3, Chapter 5, Article 2, Standards for Diesel Fuel.
(8) AP-42 Chapter 3.3 (October 1996) and 3.4 (October 1996), Footnote to criteria emission factor table.
(9) Assumes methane is 9% of VOC, based on footnote f of Table 3.4-1 in AP-42, Chapter 3.4. VOC emission factor is shown as ROG/TOG in CalEEMod Appendix D ,Table 3.5.
(10) 40 CFR Part 98 Subpart A, Table A-1, Global Warming Potentials.

Table L-5

Gasoline Fueling Emission Estimates

Source		Gasoline Fueling	Diesel Fueling
Annual Gasoline Throughput (Mgal/yr)	(1)	8.0	2.4
Daily Gasoline Throughput (Mgal/day)	(1)	0.022	0.007
Tank height (ft)	(2)	4.0	20.0
Tank equivalent diameter (ft)	(a)	5.7	10.0
Small tank standing loss factor a	(4)	1.379	1.379
Small tank standing loss factor b	(4)	0.152	0.152
Small tank working loss factor f	(4)	9.099	9.099

VOC Source		Emission Factor (lbs/Mgal)	Maximum Daily Emissions Estimate [(b)] (lbs/day)	Annual Average Emissions Estimate [(c)] (tons/yr)	Emission Factor (lbs/Mgal)	Maximum Daily Emissions Estimate [(a)] (lbs/day)	Annual Average Emissions Estimate [(b)] (tons/yr)
Storage Tank Loss VOC [(a)]	(b)	23.10	0.51	0.092	293.55	2.0E-03	3.7E-04
Vehicle Refueling Displacement	(4)	1.1	0.024	4.4E-03	1.1	9.6E-05	1.8E-05
Vehicle Refueling Spillage	(4)	0.7	0.015	2.8E-03	0.7	6.1E-05	1.1E-05
Total VOC		24.9	0.55	0.100	295.3	2.2E-03	4.0E-04

Notes:

(a) Equivalent diameter = 2 x Side 1 of rectangular tank (L_1, ft) x Side 2 of rectangular tank (L_2, ft) / (Side 1 of rectangular tank [L_1, ft]+ Side 2 of rectangular tank [L_2, ft]) (3)

Side 1 of rectangular tank L_1 (ft) = 4 (2)

Side 2 of rectangular tank L_2 (ft) = 10 (2)

(b) VOC Emission Factor (lbs/Mgal) =(a x [tank height {ft} x tank diameter $\{ft\}^2$ / annual gasoline throughput {Mgal/yr}] / [1 + {b x tank height {ft}}] + f (4)

(c) Daily emissions estimate (lbs/day) =(Emission factor [lbs/trip]) x (number of vehicle trips per day)

(d) Annual emissions estimate (lbs/day) =(Emission factor [lbs/trip]) x (number of vehicle trips per year) x (ton/2,000 lbs)

References:

(1) See Table L-1, Existing Richmond Field Station LRDP Source Operation Input Assumptions for Emission Rate Calculations.

(2) Provided by the University.

(3) Taken from http://www.aqmd.gov/aer/Updates/SuppInstruforLiqdOrgStgeTanks.pdf. Loss factors are for Gasoline RVP 10.

(4) Taken from http://www.aqmd.gov/aer/Updates/GuideExManuallyRptTankEmis.pdf.

Table L-6
Existing Richmond Field Station LRDP Source Operations Criteria Pollutant Emissions Summary - Annual Average Daily Emission Rates (1)

Source	Annual Operation (days/yr)	TAC		Criteria												Greenhouse Gases							
		DPM		PM_{10}		$PM_{2.5}$		NO_X		CO		SO_2		VOC		CO_2		CH_4		N_2O		CO_2e	
		(lbs/day)	(tons/yr)	(lbs/day)	(tons/yr)	(lbs/day)	(tons/yr)	(lbs/day)	(tons/yr)	(lbs/day)	(tons/yr)	(lbs/day)	(tons/yr)	(lbs/day)	(tons/yr)	(lbs/day)	(tons/yr)	(lbs/day)	(tons/yr)	(lbs/day)	(tons/yr)	(lbs/day)	(tons/yr)
Stationary Sources																							
Diesel generators	260	4.1E-04	5.4E-05	4.1E-04	5.4E-05	4.1E-04	5.4E-05	6.9E-02	9.0E-03	0.10	1.3E-02	1.8E-04	2.3E-05	3.9E-03	5.0E-04	19.2	2.49	3.5E-04	4.5E-05	0	0	19.2	2.49
Natural Gas Boilers	260	--	--	8.3E-02	1.1E-02	8.3E-02	1.1E-02	0.20	2.6E-02	0.91	0.12	6.5E-03	8.5E-04	6.0E-02	7.8E-03	1,307	170	2.5E-02	3.2E-03	2.5E-03	3.2E-04	1,308	170
Gasoline filling	260	--	--	--	--	--	--	--	--	--	--	--	--	0.77	0.10	--	--	--	--	--	--	--	--
Total Onsite Stationary Source Emissions	**--**	**4.1E-04**	**5.4E-05**	**8.3E-02**	**1.1E-02**	**8.3E-02**	**1.1E-02**	**0.27**	**3.5E-02**	**1.02**	**0.13**	**6.7E-03**	**8.7E-04**	**0.83**	**0.11**	**1,326**	**172**	**2.5E-02**	**3.2E-03**	**2.5E-03**	**3.2E-04**	**1,327**	**173**
Onsite Offroad Vehicle Emission Sources																							
Aerial Lifts	260	2.0E-02	2.7E-03	2.0E-02	2.7E-03	2.0E-02	2.7E-03	0.26	3.3E-02	0.25	3.2E-02	3.5E-04	4.6E-05	7.6E-02	9.9E-03	28.7	3.73	--	--	--	--	28.7	3.73
Tractors/Loaders/Backhoes	260	3.9E-02	5.0E-03	3.9E-02	5.0E-03	3.9E-02	5.0E-03	0.51	6.6E-02	0.57	7.4E-02	6.9E-04	8.9E-05	0.15	1.9E-02	55.6	7.23	--	--	--	--	55.6	7.23
Sweepers/Scrubbers	260	2.5E-02	3.2E-03	2.5E-02	3.2E-03	2.5E-02	3.2E-03	0.30	4.0E-02	0.34	4.4E-02	4.0E-04	5.3E-05	9.3E-02	1.2E-02	32.8	4.26	--	--	--	--	32.8	4.26
Lawnmowers	260	0.10	1.3E-02	0.10	1.3E-02	0.10	1.3E-02	1.58	0.21	153	19.8	5.9E-03	7.6E-04	2.34	0.30	240	31.2	--	--	--	--	240	31.2
Onsite Offroad Equipment	**--**	**0.19**	**2.4E-02**	**0.19**	**2.4E-02**	**0.19**	**2.4E-02**	**2.65**	**0.34**	**154**	**20.0**	**7.3E-03**	**9.5E-04**	**2.65**	**0.34**	**357**	**46.5**	**0**	**0**	**0**	**0**	**357**	**46.5**
Total Phase 1 Project Summary	**--**	**0.19**	**2.4E-02**	**0.27**	**3.5E-02**	**0.27**	**3.5E-02**	**2.92**	**0.38**	**155**	**20.1**	**1.4E-02**	**1.8E-03**	**3.49**	**0.45**	**1,684**	**219**	**2.5E-02**	**3.2E-03**	**2.5E-03**	**3.2E-04**	**1,685**	**219**
Onsite Stationary Exhaust	**--**	**4.1E-04**	**5.4E-05**	**8.3E-02**	**1.1E-02**	**8.3E-02**	**1.1E-02**	**0.27**	**3.5E-02**	**1.02**	**0.13**	**6.7E-03**	**8.7E-04**	**0.83**	**0.11**	**1,326**	**172**	**2.5E-02**	**3.2E-03**	**2.5E-03**	**3.2E-04**	**1,327**	**173**
Onsite Offroad Exhaust	**--**	**0.19**	**2.4E-02**	**0.19**	**2.4E-02**	**0.19**	**2.4E-02**	**2.65**	**0.34**	**154**	**20.0**	**7.3E-03**	**9.5E-04**	**2.65**	**0.34**	**357**	**46.5**	**0**	**0**	**0**	**0**	**357**	**46.5**

References:

(1) Daily emission rates are annual average daily emission rates, which are calculated by dividing the annual emission rate by the annual days of operation, and converting form tons to pounds. Annual days of operation is set to 5 days per week, 52 weeks per year.

Table L-7
Onsite Employee Vehicle TAC Emission Estimates

Parameter		Value	Total
Gasoline Refueling VOC Emission Factor (lbs/Mgal)	(2)	24.9	
Annual Gasoline Throughput (Mgal/yr)	(3)	8.0	
Daily Gasoline Throughput (Mgal/day)	(3)	0.022	

TAC	CAS	TAC Percent of Gasoline VOC (1)	Maximum Hourly Emissions Estimate (a) (lbs/hr)	Annual Average Emissions Estimate (b) (tons/yr)	Maximum Daily Emissions Estimate (lbs/hr)	Annual Average Emissions Estimate (tons/yr)
Benzene	71-43-2	1.80	9.8E-04	1.8E-03	9.8E-04	1.8E-03
Ethylbenzene	100-41-4	1.40	7.6E-04	1.4E-03	7.6E-04	1.4E-03
n-Hexane	110-54-3	1.00	5.5E-04	1.0E-03	5.5E-04	1.0E-03
Toluene	108-88-3	7.00	3.8E-03	7.0E-03	3.8E-03	7.0E-03
m-Xylene	108-38-3	7.00	3.8E-03	7.0E-03	3.8E-03	7.0E-03

Notes:

(a) Maximum hourly emissions estimate (lbs/hr) = (TAC percent of gasoline VOC [%] / 100) x (gasoline refueling VOC emission factor [lbs/Mgal]) x (daily gasoline throughput [Mgal/day]) / (daily hours of operation [hrs/day])

Daily hours of operation (hrs/day) = 10 (3)

(b) Annual emissions estimate (tons/yr) = (TAC percent of gasoline VOC [%] / 100) x (gasoline refueling VOC emission factor [lbs/Mgal]) x (annual gasoline throughput [Mgal/day])

References:

(1) California Air Resources Board Speciation Database. TAC emission fractions are derived from the individual speciation profiles listed. Profiles chosen to best represent the project vehicle fleet and existing gasoline formulation.

(2) Emission Factors source: EMFAC 2011 (Model Years to 2034). Onsite speed set to 15 mile per hour to conservatively estimate onsite emissions. No tire and brake wear emission factors are provided at 15 miles per hour.

(3) See Table L-1, Existing Richmond Field Station LRDP Source Operation Input Assumptions for Emission Rate Calculations.

Table L-8
Natural Gas Boiler TAC Emission Estimates

Source		Natural Gas Boiler - Building 400a	Natural Gas Boiler - Building 400b	Natural Gas Boiler - Building 400c	Natural Gas Boiler - Building 400d	Total
Maximum Hourly Fuel Usage (MMBtu/hr)	(1)	1.35	1.46	1.46	1.5	
Daily Hours of Operation (hrs/day)	(1)	24	24	24	24	
Annual Fuel Usage (MMBtu/yr)	(1)	675	730	730	750	
Modeling ID		NGB_400a	NGB_400b	NGB_400c	NGB_400d	

TAC	CAS	Emission Factor (lbs/MMscf)	Maximum Hourly (a) (lbs/hr)	Annual Average (b) (tons/yr)	Maximum Hourly (a) (lbs/hr)	Annual Average (b) (tons/yr)	Maximum Hourly (a) (lbs/hr)	Annual Average (b) (tons/yr)	Maximum Hourly (a) (lbs/hr)	Annual Average (b) (tons/yr)	Maximum Hourly Emissions Estimate (lbs/hr)	Annual Average Emissions Estimate (tons/yr)
7,12-Dimethylbenz(a)anthracene	57-97-6	1.6E-05 (2)	2.1E-08	5.3E-09	2.3E-08	5.7E-09	2.3E-08	5.7E-09	2.4E-08	5.9E-09	9.1E-08	2.3E-08
Acetaldehyde	75-07-0	8.9E-03 (3)	1.2E-05	2.9E-06	1.3E-05	3.2E-06	1.3E-05	3.2E-06	1.3E-05	3.3E-06	5.0E-05	1.3E-05
Benzene	71-43-2	4.3E-03 (3)	5.7E-06	1.4E-06	6.2E-06	1.5E-06	6.2E-06	1.5E-06	6.3E-06	1.6E-06	2.4E-05	6.1E-06
Dichlorobenzene	25321-22-6	1.2E-03 (4)	1.6E-06	4.0E-07	1.7E-06	4.3E-07	1.7E-06	4.3E-07	1.8E-06	4.4E-07	6.8E-06	1.7E-06
Ethylbenzene	100-41-4	6.9E-03 (5)	9.1E-06	2.3E-06	9.9E-06	2.5E-06	9.9E-06	2.5E-06	1.0E-05	2.5E-06	3.9E-05	9.8E-06
Fluoranthene	206-44-0	3.0E-06 (2)	4.0E-09	9.9E-10	4.3E-09	1.1E-09	4.3E-09	1.1E-09	4.4E-09	1.1E-09	1.7E-08	4.2E-09
Formaldehyde	50-00-0	2.2E-01 (3)	2.9E-04	7.3E-05	3.2E-04	7.9E-05	3.2E-04	7.9E-05	3.3E-04	8.1E-05	1.3E-03	3.1E-04
n-Hexane	110-54-3	4.6E-03 (5)	6.1E-06	1.5E-06	6.6E-06	1.6E-06	6.6E-06	1.6E-06	6.8E-06	1.7E-06	2.6E-05	6.5E-06
Naphthalene	91-20-3	3.0E-04 (5)	4.0E-07	9.9E-08	4.3E-07	1.1E-07	4.3E-07	1.1E-07	4.4E-07	1.1E-07	1.7E-06	4.2E-07
Propylene	115-07-1	5.3E-01 (5)	7.0E-04	1.8E-04	7.6E-04	1.9E-04	7.6E-04	1.9E-04	7.8E-04	1.9E-04	3.0E-03	7.5E-04
Toluene	108-88-3	2.7E-02 (5)	3.5E-05	8.8E-06	3.8E-05	9.5E-06	3.8E-05	9.5E-06	3.9E-05	9.7E-06	1.5E-04	3.7E-05
Xylenes	1330-20-7	2.0E-02 (5)	2.6E-05	6.5E-06	2.8E-05	7.0E-06	2.8E-05	7.0E-06	2.9E-05	7.2E-06	1.1E-04	2.8E-05
Arsenic	7440-38-2	2.0E-04 (4)	2.6E-07	6.6E-08	2.9E-07	7.2E-08	2.9E-07	7.2E-08	2.9E-07	7.4E-08	1.1E-06	2.8E-07
Beryllium	7440-41-7	1.2E-05 (4)	1.6E-08	4.0E-09	1.7E-08	4.3E-09	1.7E-08	4.3E-09	1.8E-08	4.4E-09	6.8E-08	1.7E-08
Cadmium	7440-43-9	1.1E-03 (4)	1.5E-06	3.6E-07	1.6E-06	3.9E-07	1.6E-06	3.9E-07	1.6E-06	4.0E-07	6.2E-06	1.6E-06
Chromium VI	18540-29-9	2.4E-04 (6)	3.2E-07	7.9E-08	3.4E-07	8.5E-08	3.4E-07	8.5E-08	3.5E-07	8.7E-08	1.3E-06	3.4E-07
Cobalt	7440-48-4	8.4E-05 (4)	1.1E-07	2.8E-08	1.2E-07	3.0E-08	1.2E-07	3.0E-08	1.2E-07	3.1E-08	4.8E-07	1.2E-07
Copper	7440-50-8	8.5E-04 (4)	1.1E-06	2.8E-07	1.2E-06	3.0E-07	1.2E-06	3.0E-07	1.3E-06	3.1E-07	4.8E-06	1.2E-06
Lead	7439-92-1	5.0E-04 (4)	6.6E-07	1.7E-07	7.2E-07	1.8E-07	7.2E-07	1.8E-07	7.4E-07	1.8E-07	2.8E-06	7.1E-07
Manganese	7439-96-5	3.8E-04 (4)	5.0E-07	1.3E-07	5.4E-07	1.4E-07	5.4E-07	1.4E-07	5.6E-07	1.4E-07	2.1E-06	5.4E-07
Mercury	7439-97-6	2.6E-04 (4)	3.4E-07	8.6E-08	3.7E-07	9.3E-08	3.7E-07	9.3E-08	3.8E-07	9.6E-08	1.5E-06	3.7E-07
Nickel	7440-02-0	2.1E-03 (4)	2.8E-06	6.9E-07	3.0E-06	7.5E-07	3.0E-06	7.5E-07	3.1E-06	7.7E-07	1.2E-05	3.0E-06
Selenium	7782-49-2	2.4E-05 (4)	3.2E-08	7.9E-09	3.4E-08	8.6E-09	3.4E-08	8.6E-09	3.5E-08	8.8E-09	1.4E-07	3.4E-08

Notes:

(a) Maximum hourly emissions estimate (lbs/hr) = (Emission factor [lbs/MMscf]) x (maximum hourly heat input [MMBtu/hr])/ (natural gas heat content [Btu/scf])
Natural gas heat content (Btu/scf) = 1,020 (2)

(b) Annual emissions estimate (tons/yr) = (Emission factor [lbs/MMscf]) x (annual heat input [MMBtu/yr]) / (natural gas heat content [Btu/scf]) x (tons/2,000 lbs)
Natural gas heat content (Btu/scf) = 1,020 (2)

References:

(1) See Table L-1, Existing Richmond Field Station LRDP Source Operation Input Assumptions for Emission Rate Calculations.
(2) AP-42 Chapter 1.4 (July 1998), Table 1.4-3 "Emission Factors For Speciated Organic Compounds from Natural Gas Combustion".
(3) California Air Toxics Emission Factor (CATEF) Database under Natural Gas Boilers.
(4) AP-42 Chapter 1.4 (July 1998), Table 1.4-4 "Emission Factors For Metals from Natural Gas Combustion".
(5) Ventura Air Quality Management District emission factor database.
(6) The AP-42 total chromium emission factor was multiplied by 17% to correct for emissions of hexavalent chromium per EPA assumptions when regulating combustion sources under 40 CFR Part 63 Subpart DDDD.

Table L-9
Emergency Diesel Generator TAC Emission Estimates

Source		Existing standby generator - NRLF	Existing Fire Pump - NRLF	Total
BHP	(1)	88	88	
Diesel Fuel Combustion (gal/hr)	(1)	4.4	4.4	
Load Factor	(2)	0.74	0.74	
Annual Operation (hrs/yr)	(1)	25.15	25.15	
Modeling ID		DG_NRLF2	FP_NRLF2	

TAC	CAS	Emission Factor (lbs/10^3 gal)	Maximum Hourly (lbs/hr)	Annual Average [(a)] (tons/yr)	Maximum Hourly (lbs/hr)	Annual Average [(a)] (tons/yr)	Maximum Daily Emissions Estimate (lbs/hr)	Annual Average Emissions Estimate (tons/yr)
DPM	9901	-- (3)	2.1E-03 (b)	2.7E-05	2.1E-03 (b)	2.7E-05	4.3E-03	5.4E-05
1,3-Butadiene	106-99-0	2.17E-01 (4)	7.1E-04 (c)	9.0E-06	7.1E-04 (c)	9.0E-06	1.4E-03	1.8E-05
Acetaldehyde	75-07-0	3.47E-03 (5)	1.1E-05 (c)	1.4E-07	1.1E-05 (c)	1.4E-07	2.3E-05	2.9E-07
Benzene	71-43-2	1.93E-01 (5)	6.3E-04 (c)	8.0E-06	6.3E-04 (c)	8.0E-06	1.3E-03	1.6E-05
Benzo(a)anthracene	56-55-3	-- (6)	--	--	--	--	0	0
Benzo(b)fluoranthene	205-99-2	-- (6)	--	--	--	--	0	0
Benzo(k)fluoranthene	207-08-9	-- (6)	--	--	--	--	0	0
Chlorobenzene	108-90-7	2.00E-04 (4)	6.6E-07 (c)	8.3E-09	6.6E-07 (c)	8.3E-09	1.3E-06	1.7E-08
Chrysene	218-01-9	-- (6)	--	--	--	--	0	0
Dibenz(a,h)anthracene	53-70-3	-- (6)	--	--	--	--	0	0
Ethylbenzene	100-41-4	6.76E-03 (5)	2.2E-05 (c)	2.8E-07	2.2E-05 (c)	2.8E-07	4.4E-05	5.6E-07
Formaldehyde	50-00-0	5.06E-02 (5)	1.7E-04 (c)	2.1E-06	1.7E-04 (c)	2.1E-06	3.3E-04	4.2E-06
n-Hexane	110-54-3	1.39E-03 (5)	4.6E-06 (c)	5.7E-08	4.6E-06 (c)	5.7E-08	9.1E-06	1.1E-07
Hydrogen Chloride	7647-01-0	1.86E-01 (4)	6.1E-04 (c)	7.7E-06	6.1E-04 (c)	7.7E-06	1.2E-03	1.5E-05
Indeno(1,2,3-cd)pyrene	193-39-5	-- (6)	--	--	--	--	0	0
Naphthalene	91-20-3	1.60E-02 (5)	5.2E-05 (c)	6.6E-07	5.2E-05 (c)	6.6E-07	1.0E-04	1.3E-06
Propylene	115-07-1	3.41E-01 (5)	1.1E-03 (c)	1.4E-05	1.1E-03 (c)	1.4E-05	2.2E-03	2.8E-05
Toluene	108-88-3	6.12E-02 (5)	2.0E-04 (c)	2.5E-06	2.0E-04 (c)	2.5E-06	4.0E-04	5.1E-06
Xylenes	1330-20-7	4.24E-02 (4)	1.4E-04 (c)	1.8E-06	1.4E-04 (c)	1.8E-06	2.8E-04	3.5E-06
Arsenic	7440-38-2	1.60E-03 (4)	5.3E-06 (c)	6.6E-08	5.3E-06 (c)	6.6E-08	1.1E-05	1.3E-07
Cadmium	7440-43-9	1.50E-03 (4)	4.9E-06 (c)	6.2E-08	4.9E-06 (c)	6.2E-08	9.9E-06	1.2E-07
Chromium VI	18540-29-9	1.00E-04 (7)	3.3E-07 (c)	4.1E-09	3.3E-07 (c)	4.1E-09	6.6E-07	8.3E-09
Copper	7440-50-8	4.10E-03 (4)	1.3E-05 (c)	1.7E-07	1.3E-05 (c)	1.7E-07	2.7E-05	3.4E-07
Lead	7439-92-1	8.30E-03 (4)	2.7E-05 (c)	3.4E-07	2.7E-05 (c)	3.4E-07	5.5E-05	6.9E-07
Manganese	7439-96-5	3.10E-03 (4)	1.0E-05 (c)	1.3E-07	1.0E-05 (c)	1.3E-07	2.0E-05	2.6E-07
Mercury	7439-97-6	2.00E-03 (4)	6.6E-06 (c)	8.3E-08	6.6E-06 (c)	8.3E-08	1.3E-05	1.7E-07
Nickel	7440-02-0	3.90E-03 (4)	1.3E-05 (c)	1.6E-07	1.3E-05 (c)	1.6E-07	2.6E-05	3.2E-07
Selenium	7782-49-2	2.20E-03 (4)	7.2E-06 (c)	9.1E-08	7.2E-06 (c)	9.1E-08	1.4E-05	1.8E-07

Modeling ID		DG_NRLF2	FP_NRLF2
Diesel Particulate Emission factor (g/hp-hr)	(6)	0.015	0.015

Notes:

(a) Annual average emission estimate (tons/yr) = (Maximum hourly emissions estimate [lbs/hr]) x (annual hours of operation [hrs/yr]) x (ton/2,000 lbs)
(b) Maximum hourly diesel particulate emissions estimate (lbs/hr) = (Emission factor [g/hp-hr]) x (engine horsepower [hp]) x (load factor) / (453.59 [g/lb])
(c) Maximum hourly emissions estimate (lbs/hr) = (Emission factor [lbs/10^3 gal]) x (load factor) x (fuel usage [gal/hr]) x (0.001 gal/10^3 gal)

References:

(1) See Table L-1, Existing Richmond Field Station LRDP Source Operation Input Assumptions for Emission Rate Calculations.
(2) Default load factor for generators in URBEMIS emission model.
(3) See diesel particulate matter emission factors at the bottom of the table.
(4) Ventura County Air Pollution Control District AB 2588 Combustion Emission Factors Database, May 2001.
(5) California Toxic Emission Factor (CATEF) Database, except for Diesel PM. The emission factors for each TAC are averaged for diesel internal combustion engines operating at less than 13% oxygen in the exhaust. Per vendor information, the percent oxygen in the exhaust is less than 13% at loads greater than 50%. It is assumed that the generator would be run at 50% load or greater.
(6) Polycyclic Aromatic Hydrocarbons (PAHs) are assumed to be included in the particulate matter emission factor. PAHs that are not specifically listed in this table, but may be included in the particulate matter emission factor, include Acenaphthylene, Anthracene, Acenaphthene, Benzo(a)anthracene, Benzo(a)pyrene, Benzo(b)fluoranthene, Benzo(k)fluoranthene, Benzo(g,h,i)perylene, Chrysene, Dibenz(a,h)anthracene, Fluoranthene, Fluorene, Indeno(1,2,3-cd)pyrene, Phenanthrene, and Pyrene. For purposes of this inventory, it is assumed that all particulate is represented as Diesel Particulate Matter (DPM).
(7) The AP-42 total chromium emission factor was multiplied by 17% to correct for emissions of hexavalent chromium per EPA assumptions when regulating combustion sources under 40 CFR Part 63 Subpart DDDD.

Table L-10
Existing Richmond Field Station LRDP Source Operations TAC Emissions Summary

TAC	CAS	Natural Gas Boilers		Diesel Generators		Vehicle Refueling Station		Offroad Vehicle Exhaust		Total	
		(lbs/hr)	(tons/yr)	(lbs/hr)	(tons/yr)	(lbs/hr)	(tons/yr)	(lbs/hr)	(tons/yr)	(lbs/hr)	(tons/yr)
DPM (1)	9901	--	--	4.3E-03	5.4E-05	--	--	0.12	0.024	0.13	0.024
1,3-Butadiene	106-99-0	--	--	1.4E-03	1.8E-05	--	--	--	--	1.4E-03	1.8E-05
7,12-Dimethylbenz(a)anthracene	57-97-6	9.1E-08	2.3E-08	--	--	--	--	--	--	9.1E-08	2.3E-08
Acetaldehyde	75-07-0	5.0E-05	1.3E-05	2.3E-05	2.9E-07	--	--	--	--	7.3E-05	1.3E-05
Arsenic	7440-38-2	1.1E-06	2.8E-07	1.1E-05	1.3E-07	--	--	--	--	1.2E-05	4.1E-07
Benzene	71-43-2	2.4E-05	6.1E-06	1.3E-03	1.6E-05	9.8E-04	1.8E-03	--	--	2.3E-03	1.8E-03
Beryllium	7440-41-7	6.8E-08	1.7E-08	--	--	--	--	--	--	6.8E-08	1.7E-08
Cadmium	7440-43-9	6.2E-06	1.6E-06	9.9E-06	1.2E-07	--	--	--	--	1.6E-05	1.7E-06
Chlorobenzene	108-90-7	--	--	1.3E-06	1.7E-08	--	--	--	--	1.3E-06	1.7E-08
Chromium VI	18540-29-9	1.3E-06	3.4E-07	6.6E-07	8.3E-09	--	--	--	--	2.0E-06	3.4E-07
Cobalt	7440-48-4	4.8E-07	1.2E-07	--	--	--	--	--	--	4.8E-07	1.2E-07
Copper	7440-50-8	4.8E-06	1.2E-06	2.7E-05	3.4E-07	--	--	--	--	3.2E-05	1.5E-06
Dichlorobenzene	25321-22-6	6.8E-06	1.7E-06	--	--	--	--	--	--	6.8E-06	1.7E-06
Ethylbenzene	100-41-4	3.9E-05	9.8E-06	4.4E-05	5.6E-07	7.6E-04	1.4E-03	--	--	8.5E-04	1.4E-03
Fluoranthene	206-44-0	1.7E-08	4.2E-09	--	--	--	--	--	--	1.7E-08	4.2E-09
Formaldehyde	50-00-0	1.3E-03	3.1E-04	3.3E-04	4.2E-06	--	--	--	--	1.6E-03	3.2E-04
Hydrogen Chloride	7647-01-0	--	--	1.2E-03	1.5E-05	--	--	--	--	1.2E-03	1.5E-05
Lead	7439-92-1	2.8E-06	7.1E-07	5.5E-05	6.9E-07	--	--	--	--	5.7E-05	1.4E-06
Manganese	7439-96-5	2.1E-06	5.4E-07	2.0E-05	2.6E-07	--	--	--	--	2.3E-05	7.9E-07
Mercury	7439-97-6	1.5E-06	3.7E-07	1.3E-05	1.7E-07	--	--	--	--	1.5E-05	5.3E-07
Naphthalene	91-20-3	1.7E-06	4.2E-07	1.0E-04	1.3E-06	--	--	--	--	1.1E-04	1.7E-06
n-Hexane	110-54-3	2.6E-05	6.5E-06	9.1E-06	1.1E-07	5.5E-04	1.0E-03	--	--	5.8E-04	1.0E-03
Nickel	7440-02-0	1.2E-05	3.0E-06	2.6E-05	3.2E-07	--	--	--	--	3.7E-05	3.3E-06
Propylene	115-07-1	3.0E-03	7.5E-04	2.2E-03	2.8E-05	--	--	--	--	5.2E-03	7.8E-04
Selenium	7782-49-2	1.4E-07	3.4E-08	1.4E-05	1.8E-07	--	--	--	--	1.5E-05	2.2E-07
Toluene	108-88-3	1.5E-04	3.7E-05	4.0E-04	5.1E-06	3.8E-03	7.0E-03	--	--	4.4E-03	7.0E-03
m-Xylene	108-38-3	--	--	--	--	3.8E-03	7.0E-03	--	--	3.8E-03	7.0E-03
Xylenes	1330-20-7	1.1E-04	2.8E-05	2.8E-04	3.5E-06	--	--	--	--	3.9E-04	3.1E-05
NO_2	10102-44-0	0.11	0.026	0.71	9.0E-03	--	--	1.72	0.34	2.54	0.38
SO_2	7446-09-5	3.4E-03	8.5E-04	1.9E-03	2.3E-05	--	--	4.8E-03	9.5E-04	0.010	1.8E-03
CO	630-08-0	0.48	0.12	1.06	0.013	--	--	100.0	20.0	101	20.1

References:

(1) Assumes all PM_{10} emissions from diesel combustion equals diesel particulate matter (DPM).

(2) NO_2 emissions are shown as NO_X emissions.

Appendix M

Emissions Estimates – Existing Richmond Field Station Laboratories

Table M-1
Total Estimated Air Emissions of Laboratory Non-Radionuclide Liquid Chemicals(1)
Proposed Richmond Bay Campus Long Range Development Plan, Richmond, California

CAS Number	Chemical Name	Estimated Emissions (grams/year)	Estimated Emissions (lbs/year)
106-88-7	1,2-Epoxybutane	0.04	0.00
79-10-7	Acrylic acid	446.86	0.99
71-43-2	Benzene	468.94	1.03
630-08-0	Carbon Monoxide	199.63	0.44
67-66-3	Chloroform	2,457.38	5.42
107-21-1	Ethylene glycol	4.79	0.01
50-00-0	Formaldehyde	260.90	0.58
110-54-3	Hexane	6,608.96	14.57
7647-01-0	Hydrochloric acid	1,817.09	4.01
67-63-0	Isopropyl alcohol	4,144.21	9.14
67-56-1	Methanol	4,010.89	8.84
75-09-2	Methylene chloride [Dichloromethane]	15,154.78	33.42
68-12-2	N,N-Dimethyl Formamide	11.56	0.03
7697-37-2	Nitric acid	388.64	0.86
108-95-2	Phenol	19.69	0.04
7664-93-9	Sulfuric acid	15.25	0.03
108-88-3	Toluene	1,765.64	3.89
121-44-8	Triethylamine	70.00	0.15
	Total - All Chemicals Listed	**37,845.26**	**83.45**

Notes:
(1) Estimation methods continued in Appendix M.

Calculation of Liquid Chemical Emissions
Richmond Field Station Existing Laboratory Usage Scenario
Proposed Richmond Bay Campus Long Range Development Plan, Richmond, California
Emission Estimation Approach for Liquids

Step 1: Pour Liquid Into Receiving Container (i.e. Beaker)

Emissions based on quantity poured.

Loss (grams/liter) = 0.02887 * (S*VP*MW)/T From U.S. EPA AP-42 Section 5.2, converted from lbs/10^3 gal to gram/liter and VP in mmHg instead of psia.

where:
S = Saturation Factor (1.45 [unitless]) - From U.S. EPA AP-42 Table 5.2-1
VP = Vapor Pressure at room temperature (mmHg; assume 532 degrees Rankin)
MW = Molecular Weight (grams/mole)
T = Room Temperature (assume 532 degrees Rankin)

Assumptions: Liquid is poured when at room temperature.
Receiving vessel is an open beaker.

Step 2: Stir Liquid in Receiving Container (i.e. Beaker)

Emissions based on number of batches..

Loss (grams/30 min. batch) = $(0.002289*t*A*U^{0.78}*MW^{0.67}*VP)/(R*T)$ From: *Risk Management Program Guidance for Offsite Consequence Analysis*
United States Environmental Protection Agency
Emergency Response (Document 550-B-99-009)
April 1999

where:
t = Batch time in seconds (=1,800)
A = Surface Area (100 cm^2)
U = Surface Wind Speed (0.51 meters/second)
MW = Molecular Weight (grams/mole)
VP = Vapor Pressure at elevated temperature (mmHg)
R = Gas Constant (82.05 atm-cm^3/mole-deg K)
T = Temperature During Use (degrees Kelvin)

Assumptions: If VP(295 K) is > 100 mmHg, no heating is assumed.
*If VP(295 K) is < 100 mmHg, VP(as used) = 2 * VP(298 K), up to 100 mmHg maximum.*
Vessel used is an open beaker.
Diameter of beaker is such that A = 100 cm^2.
Assume that beaker contains pure chemical.
Assume that use occurs within a laboratory fume hood.
Assume fume hood face velocity of 100 ft/min (OSHA recommendation).
Assume batch (use) time of 30 minutes.
For calculation purposes, assume T = 295 deg K. Conservative because temperatures above room temperature would only decrease predicted emission rate.

Calculation of Liquid Chemical Emissions
Richmond Field Station Existing Laboratory Usage Scenario
Proposed Richmond Bay Campus Long Range Development Plan, Richmond, California

Calculation Constants

Name	Value	Comment
TempAmbC	21.85	Assumed room temperature in degrees C
TempAmbK	295	Assumed room temperature in degrees K
TempAmbR	532	Assumed room temperature in degrees R
MaxPressBar	0.133	Maximum adjusted vapor pressure in Bars
MaxPressHg	100	Maximum adjusted vapor pressure in mmHg
SatFactor	1.45	Saturation factor for pouring emissions
SurfaceArea	100	Vessel surface area in cm^2
WindSpeed	0.51	Surface Wind Speed (meters/second)
GasConstant	82.05	Gas constant R (atm-cm^3/mole-deg K)

Calculation of Liquid Chemical Emissions
Richmond Field Station Existing Laboratory Usage Scenario
Proposed Richmond Bay Campus Long Range Development Plan, Richmond, California
Chemical Inventory Data (Table M-2)

Conservatively assume specific gravity of 0.7 for laboratory liquids (0.649 liter/lb) when units are in pounds

Batch Assumptions:	*Annual Usage*	*Assumed Annual Batches*
	< 0.01 liter	*1*
	0.01-0.1 liter	*5*
	0.1-1.0 liter	*10*
	1.0-10 liter	*25*
	>10 liter	*100*

This list of chemicals comes from LBNL inventory data with solids & gases removed		*Entered Data*		*Calculated*	*Recalculated*	*Calculated*	*Entered Data*		*Calculated*
		Inventory Amount		**Inventory Amount (liters)**	**Inventory Amount (liters)**	**Annual Usage * (liters/yr)**	**Building**	**Room**	**Estimated No. of Batches (per year)**
CAS No.	**Compound Name**	**Quantity**	**Units**						
106-88-7	1,2-EPOXYBUTANE	0.1	G	**Units**	0.00006	0.00007	112	r	1
79-10-7	ACRYLIC ACID	2	GAL	7.57000	--	8.88441	167	c	25
71-43-2	BENZENE	4	L	4.00000	--	4.69453	112	fc	25
67-66-3	CHLOROFORM	4	L	4.00000	--	4.69453	112	fc	25
67-66-3	CHLOROFORM	1	L	1.00000	--	1.17363	112	fc	25
67-66-3	CHLOROFORM	1	L	1.00000	--	1.17363	474	fc	25
107-21-1	ETHYLENE GLYCOL	8	GAL	30.28000	--	35.53762	167	c	100
107-21-1	ETHYLENE GLYCOL	4	GAL	15.14000	--	17.76881	197	c	100
107-21-1	ETHYLENE GLYCOL	1	GAL	3.78500	--	4.44220	480	fc	25
50-00-0	FORMALDEHYDE	4	L	4.00000	--	4.69453	112	s	25
50-00-0	FORMALDEHYDE	20	ML	0.02000	--	0.02347	112		5
7647-01-0	HYDROCHLORIC ACID (Hydrogen chloride)	5	L	5.00000	--	5.86817	112	s	25
7647-01-0	HYDROCHLORIC ACID (Hydrogen chloride)	500	ML	0.50000	--	0.58682	112	fc	10
7647-01-0	HYDROCHLORIC ACID (Hydrogen chloride)	2.5	L	2.50000	--	2.93408	112	c	25
7647-01-0	HYDROCHLORIC ACID (Hydrogen chloride)	1	GAL	3.78500	--	4.44220	276	fc	25
67-63-0	ISOPROPYL ALCOHOL (Isopropanol)	16	OZ	0.47318	--	0.55534	450	b	10
67-63-0	ISOPROPYL ALCOHOL (Isopropanol)	2	GAL	7.57000	--	8.88441	112	fc	25
67-63-0	ISOPROPYL ALCOHOL (Isopropanol)	1	GAL	3.78500	--	4.44220	158	c	25
67-63-0	ISOPROPYL ALCOHOL (Isopropanol)	12	L	12.00000	--	14.08360	112	fc	100
67-63-0	ISOPROPYL ALCOHOL (Isopropanol)	16	OZ	0.47318	--	0.55534	116	s	10
67-63-0	ISOPROPYL ALCOHOL (Isopropanol)	128	OZ	3.78541	--	4.44268	154	b	25
67-63-0	ISOPROPYL ALCOHOL (Isopropanol)	1	GAL	3.78500	--	4.44220	275	c	25
67-63-0	ISOPROPYL ALCOHOL (Isopropanol)	16	OZ	0.47318	--	0.55534	276	fc	10
67-63-0	ISOPROPYL ALCOHOL (Isopropanol)	10	L	10.00000	--	11.73633	473	fh	100
67-63-0	ISOPROPYL ALCOHOL (Isopropanol)	3.5	L	3.50000	--	4.10772	478	c	25
67-56-1	METHANOL	5	L	5.00000	--	5.86817	112	fc	25
67-56-1	METHANOL	200	ML	0.20000	--	0.23473	112	fc	10
67-56-1	METHANOL	20	L	20.00000	--	23.47267	112	fc	100
67-56-1	METHANOL	12	L	12.00000	--	14.08360	112	fc	100
67-56-1	METHANOL	1	L	1.00000	--	1.17363	474	fc	25
67-56-1	METHANOL	15	ML	0.01500	--	0.01760	112	r	5
67-56-1	METHANOL	100	ML	0.10000	--	0.11736	112	c	10
67-56-1	METHANOL	10	L	10.00000	--	11.73633	152		100
75-09-2	METHYLENE CHLORIDE (Dichloromethane)	32	L	32.00000	--	37.55627	112	fc	100
75-09-2	METHYLENE CHLORIDE (Dichloromethane)	40	L	40.00000	--	46.94534	112	fc	100
68-12-2	N,N-DIMETHYL FORMAMIDE	100	ML	0.10000	--	0.11736	112	fc	10
110-54-3	n-HEXANE	10	L	10.00000	--	11.73633	112	fc	100
110-54-3	n-HEXANE	1	L	1.00000	--	1.17363	112		25
110-54-3	n-HEXANE	4	L	4.00000	--	4.69453	112	fh	25
110-54-3	n-HEXANE	20	L	20.00000	--	23.47267	112	fc	100
7697-37-2	NITRIC ACID	2500	ML	2.50000	--	2.93408	112	s	25
108-95-2	PHENOL	100	ML	0.10000	--	0.11736	112		10
7664-93-9	SULFURIC ACID AND OLEUM	500	ML	0.50000	--	0.58682	112	s	10
7664-93-9	SULFURIC ACID AND OLEUM	2.5	L	2.50000	--	2.93408	112	fc	25
108-88-3	TOLUENE	12	PT	5.67811	--	6.66402	112	fc	25
108-88-3	TOLUENE	20	L	20.00000	--	23.47267	112	fc	100
108-88-3	TOLUENE	4	L	4.00000	--	4.69453	478	c	25
108-88-3	TOLUENE	1	GAL	3.78500	--	4.44220	275	b	25
121-44-8	TRIETHYLAMINE	100	ML	0.10000	--	0.11736	112	c	10

* Equals inventory x (365 days per yr/311 days)
[311 days = 95th percentile lowest turnover rate for historic use]

Golder Associates

Calculation of Liquid Chemical Emissions
Richmond Field Station Existing Laboratory Usage Scenario
Proposed Richmond Bay Campus Long Range Development Plan, Richmond, California
Vapor Pressure Data (Table M-3)

Antoine Equation: $VP = 10^{[A - (B/(T+C))]}$

where: VP = Vapor Pressure (mmHg or bar, depending on source of A, B, C)
T = Temperature (K or C depending on source of A, B, C)
A, B, C = Antoine coefficients (Reference Temperature should be near 295 deg K)

This list of chemicals comes from LBNL inventory data with solids & gases removed Must be identical to Chemical Inventory worksheet		*Must be entered manually* For Antoine Eq. @ 295 K				or	*Entered manually* Literature		*Entered manually*	*Calculated values*		*Calculated*
		Antoine Coefficients										
CAS No.	**Compound Name**	**A**	**B**	**C**	**VP Units**		**VP @ Ref Temp (mmHg)**	**Ref Temp (K)**	**Vapor Pressure Reference**	**Vapor Pressure at Ref**	**Vapor Pressure at Ref (VP Units)**	**Adjusted Vapor Pressure[a] (mmHg)**
106-88-7	1,2-EPOXYBUTANE						140	294	MSDS	140.000	mmHg	140.00
79-10-7	ACRYLIC ACID	5.65204	648.629	154.683	mmHg				LBNL Data File	95.011	mmHg	100.00
71-43-2	BENZENE	6.90565	1211.033	220.79	mmHg				LBNL Data File	82.145	mmHg	100.00
67-66-3	CHLOROFORM	6.4934	929.44	196.03	mmHg				LBNL Data File	168.875	mmHg	168.88
67-66-3	CHLOROFORM	6.4934	929.44	196.03	mmHg				LBNL Data File	168.875	mmHg	168.88
67-66-3	CHLOROFORM	6.4934	929.44	196.03	mmHg				LBNL Data File	168.875	mmHg	168.88
107-21-1	ETHYLENE GLYCOL	8.0908	2088.9	203.5	mmHg				LBNL Data File	0.066	mmHg	0.13
107-21-1	ETHYLENE GLYCOL	8.0908	2088.9	203.5	mmHg				LBNL Data File	0.066	mmHg	0.13
107-21-1	ETHYLENE GLYCOL	8.0908	2088.9	203.5	mmHg				LBNL Data File	0.066	mmHg	0.13
50-00-0	FORMALDEHYDE						87.9	294	MSDS, 37% soln.	87.900	mmHg	100.00
50-00-0	FORMALDEHYDE						87.9	294	MSDS, 37% soln.	87.900	mmHg	100.00
7647-01-0	HYDROCHLORIC ACID (Hydrogen chloride)						190	298	MSDS	190.000	mmHg	190.00
7647-01-0	HYDROCHLORIC ACID (Hydrogen chloride)						190	298	MSDS	190.000	mmHg	190.00
7647-01-0	HYDROCHLORIC ACID (Hydrogen chloride)						190	298	MSDS	190.000	mmHg	190.00
7647-01-0	HYDROCHLORIC ACID (Hydrogen chloride)						190	298	MSDS	190.000	mmHg	190.00
67-63-0	ISOPROPYL ALCOHOL (Isopropanol)	8.11778	1580.92	219.61	mmHg				LBNL Data File	37.191	mmHg	74.38
67-63-0	ISOPROPYL ALCOHOL (Isopropanol)	8.11778	1580.92	219.61	mmHg				LBNL Data File	37.191	mmHg	74.38
67-63-0	ISOPROPYL ALCOHOL (Isopropanol)	8.11778	1580.92	219.61	mmHg				LBNL Data File	37.191	mmHg	74.38
67-63-0	ISOPROPYL ALCOHOL (Isopropanol)	8.11778	1580.92	219.61	mmHg				LBNL Data File	37.191	mmHg	74.38
67-63-0	ISOPROPYL ALCOHOL (Isopropanol)	8.11778	1580.92	219.61	mmHg				LBNL Data File	37.191	mmHg	74.38
67-63-0	ISOPROPYL ALCOHOL (Isopropanol)	8.11778	1580.92	219.61	mmHg				LBNL Data File	37.191	mmHg	74.38
67-63-0	ISOPROPYL ALCOHOL (Isopropanol)	8.11778	1580.92	219.61	mmHg				LBNL Data File	37.191	mmHg	74.38
67-63-0	ISOPROPYL ALCOHOL (Isopropanol)	8.11778	1580.92	219.61	mmHg				LBNL Data File	37.191	mmHg	74.38
67-63-0	ISOPROPYL ALCOHOL (Isopropanol)	8.11778	1580.92	219.61	mmHg				LBNL Data File	37.191	mmHg	74.38
67-56-1	METHANOL	7.8975	1474.08	229.13	mmHg				LBNL Data File	105.731	mmHg	105.73
67-56-1	METHANOL	7.8975	1474.08	229.13	mmHg				LBNL Data File	105.731	mmHg	105.73
67-56-1	METHANOL	7.8975	1474.08	229.13	mmHg				LBNL Data File	105.731	mmHg	105.73
67-56-1	METHANOL	7.8975	1474.08	229.13	mmHg				LBNL Data File	105.731	mmHg	105.73
67-56-1	METHANOL	7.8975	1474.08	229.13	mmHg				LBNL Data File	105.731	mmHg	105.73
67-56-1	METHANOL	7.8975	1474.08	229.13	mmHg				LBNL Data File	105.731	mmHg	105.73
67-56-1	METHANOL	7.8975	1474.08	229.13	mmHg				LBNL Data File	105.731	mmHg	105.73
67-56-1	METHANOL	7.8975	1474.08	229.13	mmHg				LBNL Data File	105.731	mmHg	105.73
75-09-2	METHYLENE CHLORIDE (Dichloromethane)	7.4092	1325.9	252.6	mmHg				LBNL Data File	378.515	mmHg	378.52
75-09-2	METHYLENE CHLORIDE (Dichloromethane)	7.4092	1325.9	252.6	mmHg				LBNL Data File	378.515	mmHg	378.52
68-12-2	N,N-DIMETHYL FORMAMIDE	6.928	1400.87	196.43	mmHg				LBNL Data File	3.238	mmHg	6.48
110-54-3	n-HEXANE	6.87601	1171.17	224.41	mmHg				LBNL Data File	131.881	mmHg	131.88
110-54-3	n-HEXANE	6.87601	1171.17	224.41	mmHg				LBNL Data File	131.881	mmHg	131.88
110-54-3	n-HEXANE	6.87601	1171.17	224.41	mmHg				LBNL Data File	131.881	mmHg	131.88
110-54-3	n-HEXANE	6.87601	1171.17	224.41	mmHg				LBNL Data File	131.881	mmHg	131.88
7697-37-2	NITRIC ACID						48	293	MSDS	48.000	mmHg	96.00
108-95-2	PHENOL						4.65	328	MSDS	4.654	mmHg	9.31
7664-93-9	SULFURIC ACID AND OLEUM						1	419	MSDS	1.000	mmHg	2.00
7664-93-9	SULFURIC ACID AND OLEUM						1	419	MSDS	1.000	mmHg	2.00
108-88-3	TOLUENE	6.95464	1344.8	219.48	mmHg				LBNL Data File	24.109	mmHg	48.22
108-88-3	TOLUENE	6.95464	1344.8	219.48	mmHg				LBNL Data File	24.109	mmHg	48.22
108-88-3	TOLUENE	6.95464	1344.8	219.48	mmHg				LBNL Data File	24.109	mmHg	48.22
108-88-3	TOLUENE	6.95464	1344.8	219.48	mmHg				LBNL Data File	24.109	mmHg	48.22
121-44-8	TRIETHYLAMINE	5.8588	695.7	144.8	mmHg				LBNL Data File	48.326	mmHg	96.65

a. If VP (@ ref temp) < 100 mmHg, then VP = Lesser of twice the VP (@ ref temp) or 100 mmHg
If VP (@ ref temp) >= 100 mmHg, then not adjusted

Calculation of Liquid Chemical Emissions
Richmond Field Station Existing Laboratory Usage Scenario
Proposed Richmond Bay Campus Long Range Development Plan, Richmond, California
Pouring Emissions Estimates (Table M-4)

S = Saturation Factor = 1.45
VP = Vapor Pressure = Chemical-specific
MW = Molecular Weight = Chemical-specific
T = Ambient Temperature (R) = 532

Loss (grams/liter) = 0.02887 * (S*VP*MW)/T
(limited to 700 g/liter)

This list of chemicals comes from LBNL inventory data with solids & gases removed Must be identical to Chemical Inventory worksheet		*MW entered manually*		*Calculated value from separate worksheet*	*Calculated*	*From separate worksheet*	*Calculated*
CAS No.	**Compound Name**	**MW (g/mole)**	**MW Reference**	**VP (@ Ref Temp) (mmHg)**	**Pouring Loss Emission Factor (grams/liter)**	**Annual Usage (liters/yr)**	**Annual Emissions (grams/yr)**
106-88-7	1,2-EPOXYBUTANE	72.11	MSDS	140.0	0.79438	0.00007	0.00006
79-10-7	ACRYLIC ACID	72.06	LBNL Data File	95.0	0.53873	8.88441	4.78631
71-43-2	BENZENE	78.1	LBNL Data File	82.1	0.50482	4.69453	2.36989
67-66-3	CHLOROFORM	119.4	LBNL Data File	168.9	1.58662	4.69453	7.44844
67-66-3	CHLOROFORM	119.4	LBNL Data File	168.9	1.58662	1.17363	1.86211
67-66-3	CHLOROFORM	119.4	LBNL Data File	168.9	1.58662	1.17363	1.86211
107-21-1	ETHYLENE GLYCOL	62.07	LBNL Data File	0.1	0.00032	35.53762	0.01150
107-21-1	ETHYLENE GLYCOL	62.07	LBNL Data File	0.1	0.00032	17.76881	0.00575
107-21-1	ETHYLENE GLYCOL	63.07	LBNL Data File	0.1	0.00033	4.44220	0.00146
50-00-0	FORMALDEHYDE	30.03	LBNL Data File	87.9	0.20771	4.69453	0.97508
50-00-0	FORMALDEHYDE	30.03	LBNL Data File	87.9	0.20771	0.02347	0.00488
7647-01-0	HYDROCHLORIC ACID (Hydrogen chloride)	36.47	LBNL Data File	190.0	0.54525	5.86817	3.19959
7647-01-0	HYDROCHLORIC ACID (Hydrogen chloride)	36.47	LBNL Data File	190.0	0.54525	0.58682	0.31996
7647-01-0	HYDROCHLORIC ACID (Hydrogen chloride)	36.47	LBNL Data File	190.0	0.54525	2.93408	1.59980
7647-01-0	HYDROCHLORIC ACID (Hydrogen chloride)	36.47	LBNL Data File	190.0	0.54525	4.44220	2.42209
67-63-0	ISOPROPYL ALCOHOL (Isopropanol)	60.1	LBNL Data File	37.2	0.17588	0.55534	0.09767
67-63-0	ISOPROPYL ALCOHOL (Isopropanol)	60.1	LBNL Data File	37.2	0.17588	8.88441	1.56260
67-63-0	ISOPROPYL ALCOHOL (Isopropanol)	60.1	LBNL Data File	37.2	0.17588	4.44220	0.78130
67-63-0	ISOPROPYL ALCOHOL (Isopropanol)	60.1	LBNL Data File	37.2	0.17588	14.08360	2.47705
67-63-0	ISOPROPYL ALCOHOL (Isopropanol)	60.1	LBNL Data File	37.2	0.17588	0.55534	0.09767
67-63-0	ISOPROPYL ALCOHOL (Isopropanol)	60.1	LBNL Data File	37.2	0.17588	4.44268	0.78139
67-63-0	ISOPROPYL ALCOHOL (Isopropanol)	60.1	LBNL Data File	37.2	0.17588	4.44220	0.78130
67-63-0	ISOPROPYL ALCOHOL (Isopropanol)	60.1	LBNL Data File	37.2	0.17588	0.55534	0.09767
67-63-0	ISOPROPYL ALCOHOL (Isopropanol)	60.1	LBNL Data File	37.2	0.17588	11.73633	2.06421
67-63-0	ISOPROPYL ALCOHOL (Isopropanol)	60.1	LBNL Data File	37.2	0.17588	4.10772	0.72247
67-56-1	METHANOL	32.1	LBNL Data File	105.7	0.26706	5.86817	1.56716
67-56-1	METHANOL	32.1	LBNL Data File	105.7	0.26706	0.23473	0.06269
67-56-1	METHANOL	32.1	LBNL Data File	105.7	0.26706	23.47267	6.26865
67-56-1	METHANOL	32.1	LBNL Data File	105.7	0.26706	14.08360	3.76119
67-56-1	METHANOL	32.1	LBNL Data File	105.7	0.26706	1.17363	0.31343
67-56-1	METHANOL	32.1	LBNL Data File	105.7	0.26706	0.01760	0.00470
67-56-1	METHANOL	32.1	LBNL Data File	105.7	0.26706	0.11736	0.03134
67-56-1	METHANOL	32.1	LBNL Data File	105.7	0.26706	11.73633	3.13432
75-09-2	METHYLENE CHLORIDE (Dichloromethane)	84.9	LBNL Data File	378.5	2.52868	37.55627	94.96783
75-09-2	METHYLENE CHLORIDE (Dichloromethane)	84.9	LBNL Data File	378.5	2.52868	46.94534	118.70979
68-12-2	N,N-DIMETHYL FORMAMIDE	73.1	LBNL Data File	3.2	0.01862	0.11736	0.00219
110-54-3	n-HEXANE	86.17	LBNL Data File	131.9	0.89422	11.73633	10.49481
110-54-3	n-HEXANE	86.17	LBNL Data File	131.9	0.89422	1.17363	1.04948
110-54-3	n-HEXANE	86.17	LBNL Data File	131.9	0.89422	4.69453	4.19792
110-54-3	n-HEXANE	86.17	LBNL Data File	131.9	0.89422	23.47267	20.98962
7697-37-2	NITRIC ACID	63.02	LBNL Data File	48.0	0.23803	2.93408	0.69839
108-95-2	PHENOL	94.11	MSDS	4.7	0.03447	0.11736	0.00405
7664-93-9	SULFURIC ACID AND OLEUM	98.08	NIST	1.0	0.00772	0.58682	0.00453
7664-93-9	SULFURIC ACID AND OLEUM	98.08	NIST	1.0	0.00772	2.93408	0.02264
108-88-3	TOLUENE	92.1	LBNL Data File	24.1	0.17472	6.66402	1.16436
108-88-3	TOLUENE	92.1	LBNL Data File	24.1	0.17472	23.47267	4.10122
108-88-3	TOLUENE	92.1	LBNL Data File	24.1	0.17472	4.69453	0.82024
108-88-3	TOLUENE	92.1	LBNL Data File	24.1	0.17472	4.44220	0.77616
121-44-8	TRIETHYLAMINE	101	LBNL Data File	48.3	0.38407	0.11736	0.04508

Calculation of Liquid Chemical Emissions
Richmond Field Station Existing Laboratory Usage Scenario
Proposed Richmond Bay Campus Long Range Development Plan, Richmond, California
Emissions from Evaporation During Use (Table M-5)

A = Surface Area (cm^2) = 100
U = Wind Speed (m/s) = 0.51
MW = Molecular Weight (g/mole) = Chemical-specific
VP = Vapor Pressure (mmHg) = Chemical-specific
R = Gas Constant (atm-cm^3/mole-deg K) = 82.05
T = Ambient Temperature (K) = 295

Loss (grams/batch) = $(4.120*A*U^{0.78}*MW^{0.67}*VP)/(R*T)$

This list of chemicals comes from merging the purchase and inventory lists Must be identical to Total Usage worksheet		*MW entered manually*		*From previous worksheet*	*From previous worksheet*	*Calculated*	*Calculated*
CAS No.	**Compound Name**	**MW (g/mole)**	**MW Reference**	**Adjusted Vapor Pressure (mmHg)**	**Assumed No. of Batches (per yr)**	**Estimated Loss Emission Factor (grams/batch)**	**Estimated Emissions (grams/yr)**
106-88-7	1,2-EPOXYBUTANE	72.11	MSDS	140	1	24.768	0.04
79-10-7	ACRYLIC ACID	72.06	LBNL Data File	100	25	17.683	442.08
71-43-2	BENZENE	78.1	LBNL Data File	100	25	18.663	466.57
67-66-3	CHLOROFORM	119.4	LBNL Data File	169	25	41.885	1047.13
67-66-3	CHLOROFORM	119.4	LBNL Data File	169	25	41.885	699.54
67-66-3	CHLOROFORM	119.4	LBNL Data File	169	25	41.885	699.54
107-21-1	ETHYLENE GLYCOL	62.07	LBNL Data File	0	100	0.021	2.12
107-21-1	ETHYLENE GLYCOL	62.07	LBNL Data File	0	100	0.021	2.12
107-21-1	ETHYLENE GLYCOL	63.07	LBNL Data File	0	25	0.021	0.54
50-00-0	FORMALDEHYDE	30.03	LBNL Data File	100	25	9.837	245.93
50-00-0	FORMALDEHYDE	30.03	LBNL Data File	100	5	9.837	13.99
7647-01-0	HYDROCHLORIC ACID (Hydrogen chloride)	36.47	LBNL Data File	190	25	21.289	532.22
7647-01-0	HYDROCHLORIC ACID (Hydrogen chloride)	36.47	LBNL Data File	190	10	21.289	212.89
7647-01-0	HYDROCHLORIC ACID (Hydrogen chloride)	36.47	LBNL Data File	190	25	21.289	532.22
7647-01-0	HYDROCHLORIC ACID (Hydrogen chloride)	36.47	LBNL Data File	190	25	21.289	532.22
67-63-0	ISOPROPYL ALCOHOL (Isopropanol)	60.1	LBNL Data File	74	10	11.647	116.47
67-63-0	ISOPROPYL ALCOHOL (Isopropanol)	60.1	LBNL Data File	74	25	11.647	291.18
67-63-0	ISOPROPYL ALCOHOL (Isopropanol)	60.1	LBNL Data File	74	25	11.647	291.18
67-63-0	ISOPROPYL ALCOHOL (Isopropanol)	60.1	LBNL Data File	74	100	11.647	1164.72
67-63-0	ISOPROPYL ALCOHOL (Isopropanol)	60.1	LBNL Data File	74	10	11.647	116.47
67-63-0	ISOPROPYL ALCOHOL (Isopropanol)	60.1	LBNL Data File	74	25	11.647	291.18
67-63-0	ISOPROPYL ALCOHOL (Isopropanol)	60.1	LBNL Data File	74	25	11.647	291.18
67-63-0	ISOPROPYL ALCOHOL (Isopropanol)	60.1	LBNL Data File	74	10	11.647	116.47
67-63-0	ISOPROPYL ALCOHOL (Isopropanol)	60.1	LBNL Data File	74	100	11.647	1164.72
67-63-0	ISOPROPYL ALCOHOL (Isopropanol)	60.1	LBNL Data File	74	25	11.647	291.18
67-56-1	METHANOL	32.1	LBNL Data File	106	25	10.876	271.90
67-56-1	METHANOL	32.1	LBNL Data File	106	10	10.876	108.76
67-56-1	METHANOL	32.1	LBNL Data File	106	100	10.876	1087.58
67-56-1	METHANOL	32.1	LBNL Data File	106	100	10.876	1087.58
67-56-1	METHANOL	32.1	LBNL Data File	106	25	10.876	271.90
67-56-1	METHANOL	32.1	LBNL Data File	106	5	10.876	10.49
67-56-1	METHANOL	32.1	LBNL Data File	106	10	10.876	69.95
67-56-1	METHANOL	32.1	LBNL Data File	106	100	10.876	1087.58
75-09-2	METHYLENE CHLORIDE (Dichloromethane)	84.9	LBNL Data File	379	100	74.706	7470.55
75-09-2	METHYLENE CHLORIDE (Dichloromethane)	84.9	LBNL Data File	379	100	74.706	7470.55
68-12-2	N,N-DIMETHYL FORMAMIDE	73.1	LBNL Data File	6	10	1.156	11.56
110-54-3	n-HEXANE	86.17	LBNL Data File	132	100	26.289	2628.89
110-54-3	n-HEXANE	86.17	LBNL Data File	132	25	26.289	657.22
110-54-3	n-HEXANE	86.17	LBNL Data File	132	25	26.289	657.22
110-54-3	n-HEXANE	86.17	LBNL Data File	132	100	26.289	2628.89
7697-37-2	NITRIC ACID	63.02	LBNL Data File	96	25	15.518	387.94
108-95-2	PHENOL	94.11	MSDS	9	10	1.968	19.68
7664-93-9	SULFURIC ACID AND OLEUM	98.08	NIST	2	10	0.435	4.35
7664-93-9	SULFURIC ACID AND OLEUM	98.08	NIST	2	25	0.435	10.87
108-88-3	TOLUENE	92.1	LBNL Data File	48	25	10.050	251.25
108-88-3	TOLUENE	92.1	LBNL Data File	48	100	10.050	1005.02
108-88-3	TOLUENE	92.1	LBNL Data File	48	25	10.050	251.25
108-88-3	TOLUENE	92.1	LBNL Data File	48	25	10.050	251.25
121-44-8	TRIETHYLAMINE	101	LBNL Data File	97	10	21.429	69.95

Calculation of Liquid Chemical Emissions
Richmond Field Station Existing Laboratory Usage Scenario
Proposed Richmond Bay Campus Long Range Development Plan, Richmond, California
Total Estimated Emissions (Table M-6)

Limit total annual emissions to inventory usage quantity. Assume 1,000 grams/liter when converting liters used to grams.

This list of chemicals comes from merging the purchase and inventory lists Must be identical to Total Usage worksheet		*From previous worksheet (A3)*	*From previous worksheet (A4)*	*Chemical Often Used For Cleaning or Drying?*	*Calculated - Sum of Pouring & Stirring Emissions*
CAS No.	**Compound Name**	**Pouring Annual Emissions (grams/yr)**	**Stirring Annual Emissions (grams/yr)**	**(Yes/No) ***	**Total Annual Emissions * (grams/yr)**
106-88-7	1,2-EPOXYBUTANE	0.000	0.04	No	0.04
79-10-7	ACRYLIC ACID	4.786	442.08	No	446.86
71-43-2	BENZENE	2.370	466.57	No	468.94
67-66-3	CHLOROFORM	7.448	1047.13	No	1054.58
67-66-3	CHLOROFORM	1.862	699.54	No	701.40
67-66-3	CHLOROFORM	1.862	699.54	No	701.40
107-21-1	ETHYLENE GLYCOL	0.011	2.12	No	2.13
107-21-1	ETHYLENE GLYCOL	0.006	2.12	No	2.13
107-21-1	ETHYLENE GLYCOL	0.001	0.54	No	0.54
50-00-0	FORMALDEHYDE	0.975	245.93	No	246.90
50-00-0	FORMALDEHYDE	0.005	13.99	No	14.00
7647-01-0	HYDROCHLORIC ACID (Hydrogen chloride)	3.200	532.22	No	535.42
7647-01-0	HYDROCHLORIC ACID (Hydrogen chloride)	0.320	212.89	No	213.21
7647-01-0	HYDROCHLORIC ACID (Hydrogen chloride)	1.600	532.22	No	533.82
7647-01-0	HYDROCHLORIC ACID (Hydrogen chloride)	2.422	532.22	No	534.64
67-63-0	ISOPROPYL ALCOHOL (Isopropanol)	0.098	116.47	No	116.57
67-63-0	ISOPROPYL ALCOHOL (Isopropanol)	1.563	291.18	No	292.74
67-63-0	ISOPROPYL ALCOHOL (Isopropanol)	0.781	291.18	No	291.96
67-63-0	ISOPROPYL ALCOHOL (Isopropanol)	2.477	1164.72	No	1167.19
67-63-0	ISOPROPYL ALCOHOL (Isopropanol)	0.098	116.47	No	116.57
67-63-0	ISOPROPYL ALCOHOL (Isopropanol)	0.781	291.18	No	291.96
67-63-0	ISOPROPYL ALCOHOL (Isopropanol)	0.781	291.18	No	291.96
67-63-0	ISOPROPYL ALCOHOL (Isopropanol)	0.098	116.47	No	116.57
67-63-0	ISOPROPYL ALCOHOL (Isopropanol)	2.064	1164.72	No	1166.78
67-63-0	ISOPROPYL ALCOHOL (Isopropanol)	0.722	291.18	No	291.90
67-56-1	METHANOL	1.567	271.90	No	273.46
67-56-1	METHANOL	0.063	108.76	No	108.82
67-56-1	METHANOL	6.269	1087.58	No	1093.85
67-56-1	METHANOL	3.761	1087.58	No	1091.35
67-56-1	METHANOL	0.313	271.90	No	272.21
67-56-1	METHANOL	0.005	10.49	No	10.50
67-56-1	METHANOL	0.031	69.95	No	69.99
67-56-1	METHANOL	3.134	1087.58	No	1090.72
75-09-2	METHYLENE CHLORIDE (Dichloromethane)	94.968	7470.55	No	7565.52
75-09-2	METHYLENE CHLORIDE (Dichloromethane)	118.710	7470.55	No	7589.26
68-12-2	N,N-DIMETHYL FORMAMIDE	0.002	11.56	No	11.56
110-54-3	n-HEXANE	10.495	2628.89	No	2639.39
110-54-3	n-HEXANE	1.049	657.22	No	658.27
110-54-3	n-HEXANE	4.198	657.22	No	661.42
110-54-3	n-HEXANE	20.990	2628.89	No	2649.88
7697-37-2	NITRIC ACID	0.698	387.94	No	388.64
108-95-2	PHENOL	0.004	19.68	No	19.69
7664-93-9	SULFURIC ACID AND OLEUM	0.005	4.35	No	4.35
7664-93-9	SULFURIC ACID AND OLEUM	0.023	10.87	No	10.89
108-88-3	TOLUENE	1.164	251.25	No	252.42
108-88-3	TOLUENE	4.101	1005.02	No	1009.12
108-88-3	TOLUENE	0.820	251.25	No	252.07
108-88-3	TOLUENE	0.776	251.25	No	252.03
121-44-8	TRIETHYLAMINE	0.045	69.95	No	70.00

* Chemicals identified as being frequently used to clean, dry, or sterilize glassware and surfaces assigned emissions of at least 50% of usage.

Calculation of Gas Chemical Emissions
Richmond Field Station Existing Laboratory Usage Scenario
Proposed Richmond Bay Campus Long Range Development Plan, Richmond, California
Total Estimated Gas Emissions (Table M-7)

G = Gas Constant (L/mol) = 22.4

This list of chemicals comes from LBNL inventory data with solids & gases removed		*Entered Manually*	*Entered Manually*	*Entered Manually*	*Entered Manually*	*Entered Data*	*Calculated*
				From LBNL provided data	*From LBNL provided data*		
CAS No.	**Compound Name**	**MW (grams/mol)**	**MW Reference**	**Concentration (%)**	**Max Amount (liters/yr)**	**Building**	**Total Annual Emissions (grams/yr)**
630-08-0	CARBON MONOXIDE	28.01	MSDS	0.400	103.00	112	0.52
630-08-0	CARBON MONOXIDE	28.01	MSDS	100.00	103.00	112	128.80
630-08-0	CARBON MONOXIDE	28.01	MSDS	99.30	56.6337	112	70.32

* Chemicals identified as being frequently used to clean, dry, or sterilize glassware and surfaces assigned emissions of at least 50% of usage.

Appendix N

Emissions Estimates – Hypothetical Phase 2 Operations (includes Phase 1 Sources)

Table N-1
Hypothetical Phase 2 Operations Input Assumptions for Emission Rate Calculations - Including Phase 1 Sources

Source	*Building Size (gsf)*	*Diesel Emergency Generators*		*Natural Gas Boilers*			*Cooling Towers*		
		Engine Size (BHP)	Fuel Usage (gal/hr)	Maximum Heat Input (MMBtu/hr)	Daily Operation (hrs/day)	Annual Fuel Usage (MMBtu/yr)	Number of Cells	Cell Size (tons/cell)	Total Recirc. Rate (gpm)
Buildings 6 and 7	253,954	--	--	24 (4)	24	42,000 (4)	6 (4)	500 (4)	9,000 (b)
Building 6	--	440 (3)	22.3 (a)	--	--	--	--	--	--
Building 7	--	440 (3)	22.3 (a)	--	--	--	--	--	--
Building 8	110,510	440 (4)	22.3 (a)	12 (4)	24	21,000 (4)	3 (4)	500 (4)	4,500 (b)
Building 9	137,451	440 (4)	22.3 (a)	12 (4)	24	21,000 (4)	3 (4)	500 (4)	4,500 (b)
Building 10	117,700	410 (4)	20.8 (a)	11 (4)	24	15,267	3	500 (4)	4,500 (b)
Building 11	67,280	240 (4)	12.2 (a)	6 (4)	24	8,328	2	400 (4)	2,400 (b)
Total	686,895	2410	122.2	65	--	660,000 (5)	--	--	24,900

Source	Source Parameter		Short Term Input (units)	Annual Input (units)
Employee and Facility Data				
	Number of Employees		10,000 (4)	--
	Average Building Occupancy		10 (hrs/day) (6)	260 (days/yr) (7)
	Emergency Generator Usage		2 (hrs/day) (8)	25.15 (hrs/yr) (8)
	Cooling Tower Usage		24 (hrs/day)	6,360 (hrs/yr) (9)
Vehicle Data				
	Vehicle Trips	**Daily Operation (hrs/day)**	**Maximum Daily (trips/day)**	**Average Annual (trips/yr)**
	Employee Trips	16	3,453 (10)	897,702 (11)
	Delivery Truck Trips	16	14 (12)	3,558 (13)
	LBNL - RBC Shuttle Trips	13 (14)	13 (14)	3,380 (14)
	BART - RBC Shuttle Trips	13 (14)	25 (14)	6,500 (14)
	Total trips		3,504	911,140
	Vehicle Idling Times and Round Trip Distances	**Onsite Idling Time (min/trip)**	**Onsite Round Trip Distance (mi/trip)**	**Offsite Round Trip Distance (mi/trip)**
	Employee Vehicles	0 (15)	0.858 (16)	20.4 (c)
	Delivery Trucks	0.08 (20)	0.559 (16)	14.0 (21)
	LBNL - RBC Shuttle	0.08 (22)	0.698 (16)	15.5 (23)
	BART - RBC Shuttle	0.08 (22)	0.698 (16)	8 (23)
	Employee Offsite Round Trip Distance - Modeling (mi/trip)			0.858 (16)
	Delivery Truck Offsite Round Trip Distance - Modeling (mi/trip)			0.705 (16)
	LBNL - RBC Shuttle Round Trip Distance - Modeling (mi/trip)			0.967 (16)
	BART - RBC Shuttle Round Trip Distance (mi/trip)			0.967 (16)
	Average Vehicle Weights			**Average Weight (tons)**
	Employee Vehicles			2.4 (24)
	Delivery Trucks			13 (25)
	LBNL - RBC Shuttle			4.2 (26)
	BART - RBC Shuttle			4.2 (26)
	Mean Vehicle Weight Calculation		**Daily Basis (tons)**	**Annual Basis (tons)**
	Employee Mean Vehicle Weight portion (ton)		2.36 (d)	2.36 (d)
	Delivery Truck Mean Vehicle Weight Portion (ton)		0.051 (d)	0.051 (d)
	LBNL - RBC Shuttle Mean Vehicle Weight Portion (ton)		0.016 (d)	0.016 (d)
	BART - RBC Shuttle Mean Vehicle Weight Portion (ton)		0.030 (d)	0.030 (d)
	Mean Vehicle Weight - sum of weight portions (ton)		2.46	2.46
Additional Site-Specific Data and Constants Used for Emission Calculations				
	Cooling Towers - Equivalent Ton Water Usage (gpm/ton)		3	(e)
	Cooling Towers - Total Dissolved Solids Concentration (ppm)		536	(27)
	Roads - P = No. of Days with Precip. > 0.01 in. (days/yr)		62	(28)

Table N-1 (continued)
Hypothetical Phase 2 Operations Input Assumptions for Emission Rate Calculations - Including Phase 1 Sources

Notes:

(a) Engine fuel consumption (gal/hr) = (Engine size [hp]) x (average brake-specific fuel consumption [Btu/hp-hr]) / (liquid fuel higher heating value [Btu/gal])

Average brake-specific fuel consumption (Btu/hp-hr) =	7,000	(1)
Liquid fuel higher heating value (Btu/gal) =	138,000	(2)

(b) Recirculation rate (gpm) = (Number of cooling tower cells) x (heat removal equivalent tons per cell [tons/cell]) x (equivalent ton water usage [gpm/ton])

(c) Offsite round trip distance (mi/trip) = {(Primary trip length [mi]) x (primary trip percentage [%]) + (primary trip length [mi]) x (diverted trip percentage [%]) x (diverted trip percentage of primary trip length [%]) + (pass-by trip percentage [%]) x (pass-by trip length [mi])} x 2 - (onsite round trip distance [mi/trip])

Primary trip length (mi) =	12.4	(17)
Primary trip percentage (%) =	82	(18)
Diverted trip percentage of primary trip length (%) =	25	(19)
Diverted trip percentage (%) =	15	(18)
Pass-by trip length (mi) =	0.1	(19)
Pass-by trip percentage (%) =	3	(18)

(d) Mean vehicle weight portions (tons) = (Individual vehicle trips [trips/day or trips/yr]) / (total vehicle trips [trips/day or trips/yr]) x (individual vehicle average weight [tons])

(e) Equivalent ton water usage (gpm/ton) = (15,000 Btu/hr/ton) x (hr/60 min) x (gal/8.337 lbs) / (1 Btu/lb-°F) / (10 °F temperature differential)

References:

(1) AP-42 Chapter 3.3 (October 1996), Footnote to Table 3.3-1, "Emission Factors for Uncontrolled Gasoline and Diesel Industrial Engines".
(2) ULSD higher heating value.
(3) Buildings 6 & 7 will have two separate generators, totaling 880 hp.
(4) January 17, 2013 responses from the University.
(5) The annual fuel usage is described in the project description.
(6) Assumes laboratory work is conducted over 10 hours per day. This conservatively estimates hourly emissions .
(7) Assumes employees will generally be visiting the site 5 days per week, 52 weeks per year. This provides a conservative value to calculation the annual employee vehicle trips.
(8) Hourly value conservatively assumes a maximum of 2 hours per day of operation for maintenance and testing. Annual value is based on the average historical emergency engine usage from the previous LBNL LRDP.
(9) January 31, 2013 I.R. responses. Assumes cooling tower fans are off 2,400 hours per year, and only operate at full speed 260 hours per year.
(10) January 17, 2013 response from the University - population increase by approx. 1,000 over the current 300. Assume 1,300 trips per day for Phase 1, scaled up to account for Phase 2 buildings.
(11) Assumes daily worker trips will occur 5 days per week, 52 weeks per year.
(12) Assumption based on Phase 1 analysis.
(13) January 31, 2013 I.R. responses. Assumes that the 10 weekly trips will occur over 5 days per week, 52 weeks per year for Phase 1, scaled up to account for Phase 2 buildings.
(14) Shuttle schedule provided by the University. Assumes shuttle trips occur 5 days per week, 52 weeks per year.
(15) It is assumed that employee vehicles will have negligible idling time.
(16) Onsite and offsite modeling trip distances approximated using the AERMOD modeling software.
(17) CalEEMod Appendix D Table 4.2 "Mobile Trip Characteristics Dependent on Location", Bay Area AQMD. Light duty employee vehicle route is based on the urban home to work (H-W) trip length. Trip lengths in CalEEMod are one way.
(18) CalEEMod Appendix D Table 4.3 "Mobile Trip Rates, Trip Purpose, Trip Type by Land Use", Commercial Land Use Type, Research and Development Land Use Sub Type.
(19) CalEEMod Appendix A Section 5.1, Vehicle Trips. "For pass-by trip links the trip length will be 0.1 miles and diverted trip links the trip length will be 25% of the primary trip length".
(20) Assumes 5 minutes at idle time consistent with California Code of Regulations Section 2485, Airborne Toxic Control Measure to Limit Diesel-Fueled Commercial Motor Vehicle Idling.
(21) CalEEMod Appendix D Table 4.2 "Mobile Trip Characteristics Dependent on Location", Bay Area AQMD. Delivery truck route is based on the urban commercial-NW route. Trip lengths in CalEEMod are one way.
(22) Conservative estimate of idling time for each shuttle drop-off event.
(23) Shuttle bus routes and schedules provided by the University.
(24) CalEEMod Appendix D Table 4.1 "Road Characteristics". Average vehicle weight for Bay Area AQMD.
(25) Based on the EMFAC vehicle class used for estimating emissions: T6 instate small, which has the higher VMT of all comparable categories, and is representative of delivery trucks. Max GVWR = 26,000 lbs. Also assumes that RBC would not be the final destination for deliveries, so only a nominal difference between loaded and unloaded weights is used.
(26) Ford E150 XLT - 5,700 lb curb weight, plus 15 passengers at ~180 lbs/person.
(27) From CRT project emissions calculations, provided by Impact Sciences.
(28) Comparative Climatic Data, National Climatic Data Center, NOAA, 2011. 84 year average for San Francisco AP, CA.

Table N-2
Summary of Offsite On-Road Exhaust Criteria Pollutant Emission Estimates

Pollutant	Vehicle Type	EMFAC Vehicle Class	Maximum Daily Round-Trips [1] (trips/day)	Total Annual Round-Trips [1] (trips/yr)	Round-Trip Distance [1] (miles)	Emission Factors [2] (lbs/VMT)	Maximum Daily Emissions Estimate [a] (lbs/day)	Annual Average Emissions Estimate [b] (tons/yr)
ROG	Delivery Trucks	T6 Instate Small	14	3,558	14	3.9E-04	7.5E-02	9.8E-03
	LBNL - RBC Shuttle	MDV	13	3,380	16	3.7E-04	7.5E-02	9.8E-03
	BART - RBC Shuttle	MDV	25	6,500	8.0	3.7E-04	7.5E-02	9.7E-03
	Employees	LDA	3,453	897,702	20	1.5E-04	10	1.3
	Total ROG Emissions						**10**	**1.4**
NO_X	Delivery Trucks	T6 Instate Small	14	3,558	14	5.1E-03	0.98	0.13
	LBNL - RBC Shuttle	MDV	13	3,380	16	6.6E-04	0.13	1.7E-02
	BART - RBC Shuttle	MDV	25	6,500	8.0	6.6E-04	0.13	1.7E-02
	Employees	LDA	3,453	897,702	20	1.9E-04	14	1.8
	Total NO_X Emissions						**15**	**1.9**
CO	Delivery Trucks	T6 Instate Small	14	3,558	14	1.3E-03	0.26	3.3E-02
	LBNL - RBC Shuttle	MDV	13	3,380	16	4.6E-03	0.92	0.12
	BART - RBC Shuttle	MDV	25	6,500	8.0	4.6E-03	0.92	0.12
	Employees	LDA	3,453	897,702	20	1.9E-03	135	18
	Total CO Emissions						**137**	**18**
SO_2	Delivery Trucks	T6 Instate Small	14	3,558	14	2.5E-05	4.8E-03	6.2E-04
	LBNL - RBC Shuttle	MDV	13	3,380	16	1.3E-05	2.6E-03	3.4E-04
	BART - RBC Shuttle	MDV	25	6,500	8.0	1.3E-05	2.6E-03	3.4E-04
	Employees	LDA	3,453	897,702	20	7.5E-06	0.53	6.9E-02
	Total SO_2 Emissions						**0.54**	**7.0E-02**
PM_{10} Exhaust	Delivery Trucks	T6 Instate Small	14	3,558	14	1.9E-04	3.7E-02	4.8E-03
	LBNL - RBC Shuttle	MDV	13	3,380	16	4.7E-06	9.4E-04	1.2E-04
	BART - RBC Shuttle	MDV	25	6,500	8.0	4.7E-06	9.3E-04	1.2E-04
	Employees	LDA	3,453	897,702	20	3.8E-06	0.27	3.5E-02
	Total PM_{10} Emissions						**0.31**	**4.0E-02**
PM_{10} Tire/Brake	Delivery Trucks	T6 Instate Small	14	3,558	14	3.1E-04	6.0E-02	7.8E-03
	LBNL - RBC Shuttle	MDV	13	3,380	16	9.9E-05	2.0E-02	2.6E-03
	BART - RBC Shuttle	MDV	25	6,500	8.0	9.9E-05	2.0E-02	2.6E-03
	Employees	LDA	3,453	897,702	20	9.9E-05	7.0	0.90
	Total PM_{10} Emissions						**7.1**	**0.92**
$PM_{2.5}$ Exhaust	Delivery Trucks	T6 Instate Small	14	3,558	14	1.8E-04	3.4E-02	4.4E-03
	LBNL - RBC Shuttle	MDV	13	3,380	16	4.3E-06	8.7E-04	1.1E-04
	BART - RBC Shuttle	MDV	25	6,500	8.0	4.3E-06	8.6E-04	1.1E-04
	Employees	LDA	3,453	897,702	20	3.5E-06	0.25	3.2E-02
	Total $PM_{2.5}$ Emissions						**0.28**	**3.7E-02**
$PM_{2.5}$ Tire/Brake	Delivery Trucks	T6 Instate Small	14	3,558	14	1.3E-04	2.5E-02	3.2E-03
	LBNL - RBC Shuttle	MDV	13	3,380	16	3.9E-05	7.9E-03	1.0E-03
	BART - RBC Shuttle	MDV	25	6,500	8.0	3.9E-05	7.8E-03	1.0E-03
	Employees	LDA	3,453	897,702	20	3.9E-05	2.8	0.36
	Total $PM_{2.5}$ Emissions						**2.8**	**0.36**
CO_2	Delivery Trucks	T6 Instate Small	14	3,558	14	2.4	466	61
	LBNL - RBC Shuttle	MDV	13	3,380	16	1.1	221	29
	BART - RBC Shuttle	MDV	25	6,500	8.0	1.1	219	28
	Employees	LDA	3,453	897,702	20	0.56	39,754	5,168
	Total CO_2 Emissions						**40,659**	**5,286**

Notes:
(a) Maximum daily emissions estimate (lbs/day) = (Maximum daily round-trips [trips/day]) x (round-trip distance [miles]) x (emission factor [lbs/VMT])
(b) Annual average emissions estimate (tons/yr) = (Annual round-trips [trips/yr]) x (round-trip distance [miles]) x (emission factor [lbs/VMT]) x (ton/2,000 lbs)

References:
(1) See Table N-1, Hypothetical Phase 2 Operations Input Assumptions for Emission Rate Calculations - Including Phase 1 Sources.
(2) Emission Factors source: Emfac 2011 (Model Years to 2034), typical speed distribution. Carbon dioxide emission factors are representative of post-Low Carbon Fuel Standard implementation.

Table N-3
Summary of Onsite On-Road Exhaust Criteria Pollutant Emission Estimates

Pollutant	Vehicle Type	EMFAC Vehicle Class	Maximum Daily Round-Trips [1] (trips/day)	Total Annual Round-Trips [1] (trips/yr)	Round-Trip Distance [1] (miles)	Emission Factor [2] (lbs/VMT)	Maximum Daily Emissions Estimate [a] (lbs/day)	Annual Average Emissions Estimate [b] (tons/yr)
ROG	Delivery Trucks	T6 Instate Small	14	3,558	0.56	2.1E-03	1.6E-02	2.1E-03
	LBNL - RBC Shuttle	MDV	13	3,380	0.70	4.7E-04	4.2E-03	5.5E-04
	BART - RBC Shuttle	MDV	25	6,500	0.70	4.7E-04	8.1E-03	1.1E-03
	Employees	LDA	3,453	897,702	0.86	1.6E-04	0.47	6.2E-02
	Total ROG Emissions						**0.50**	**6.5E-02**
NO_X	Delivery Trucks	T6 Instate Small	14	3,558	0.56	1.1E-02	8.6E-02	1.1E-02
	LBNL - RBC Shuttle	MDV	13	3,380	0.70	1.0E-03	9.4E-03	1.2E-03
	BART - RBC Shuttle	MDV	25	6,500	0.70	1.0E-03	1.8E-02	2.3E-03
	Employees	LDA	3,453	897,702	0.86	2.9E-04	0.87	0.11
	Total NO_X Emissions						**0.98**	**0.13**
CO	Delivery Trucks	T6 Instate Small	14	3,558	0.56	3.9E-03	3.0E-02	3.9E-03
	LBNL - RBC Shuttle	MDV	13	3,380	0.70	8.0E-03	7.3E-02	9.5E-03
	BART - RBC Shuttle	MDV	25	6,500	0.70	8.0E-03	0.14	1.8E-02
	Employees	LDA	3,453	897,702	0.86	3.3E-03	9.8	1.3
	Total CO Emissions						**10**	**1.3**
SO_2	Delivery Trucks	T6 Instate Small	14	3,558	0.56	0	0	0
	LBNL - RBC Shuttle	MDV	13	3,380	0.70	0	0	0
	BART - RBC Shuttle	MDV	25	6,500	0.70	0	0	0
	Employees	LDA	3,453	897,702	0.86	0	0	0
	Total SO_2 Emissions						**0**	**0**
PM_{10} Exhaust	Delivery Trucks	T6 Instate Small	14	3,558	0.56	2.8E-04	2.2E-03	2.8E-04
	LBNL - RBC Shuttle	MDV	13	3,380	0.70	1.9E-05	1.7E-04	2.2E-05
	BART - RBC Shuttle	MDV	25	6,500	0.70	1.9E-05	3.3E-04	4.3E-05
	Employees	LDA	3,453	897,702	0.86	1.6E-05	4.6E-02	6.0E-03
	Total PM_{10} Emissions						**4.9E-02**	**6.3E-03**
PM_{10} Tire/Brake	Delivery Trucks	T6 Instate Small	14	3,558	0.56	0	0	0
	LBNL - RBC Shuttle	MDV	13	3,380	0.70	0	0	0
	BART - RBC Shuttle	MDV	25	6,500	0.70	0	0	0
	Employees	LDA	3,453	897,702	0.86	0	0	0
	Total PM_{10} Emissions						**0**	**0**
$PM_{2.5}$ Exhaust	Delivery Trucks	T6 Instate Small	14	3,558	0.56	2.6E-04	2.0E-03	2.6E-04
	LBNL - RBC Shuttle	MDV	13	3,380	0.70	1.7E-05	1.6E-04	2.0E-05
	BART - RBC Shuttle	MDV	25	6,500	0.70	1.7E-05	3.0E-04	3.9E-05
	Employees	LDA	3,453	897,702	0.86	1.4E-05	4.3E-02	5.6E-03
	Total $PM_{2.5}$ Emissions						**4.5E-02**	**5.9E-03**
$PM_{2.5}$ Tire/Brake	Delivery Trucks	T6 Instate Small	14	3,558	0.56	0	0	0
	LBNL - RBC Shuttle	MDV	13	3,380	0.70	0	0	0
	BART - RBC Shuttle	MDV	25	6,500	0.70	0	0	0
	Employees	LDA	3,453	897,702	0.86	0	0	0
	Total $PM_{2.5}$ Emissions						**0**	**0**
CO_2	Delivery Trucks	T6 Instate Small	14	3,558	0.56	4.4	34	4.4
	LBNL - RBC Shuttle	MDV	13	3,380	0.70	2.6	24	3.1
	BART - RBC Shuttle	MDV	25	6,500	0.70	2.6	46	5.9
	Employees	LDA	3,453	897,702	0.86	1.3	3,949	513
	Total CO_2 Emissions						**4,052**	**527**

Notes:
(a) Maximum daily emissions estimate (lbs/day) = (Maximum daily round-trips [trips/day]) x (round-trip distance [miles]) x (emission factor [lbs/VMT])
(b) Annual average emissions estimate (tons/yr) = (Annual round-trips [trips/yr]) x (round-trip distance [miles]) x (emission factor [lbs/VMT]) x (ton/2,000 lbs)

References:
(1) See Table N-1, Hypothetical Phase 2 Operations Input Assumptions for Emission Rate Calculations - Including Phase 1 Sources.
(2) Emission Factors source: EMFAC 2011 (Model Years to 2034), 10 mph speed to represent average onsite speeds. Carbon dioxide emission factors are representative of post-Low Carbon Fuel Standard implementation.

Table N-4
Summary of Onsite Idling Exhaust Criteria Pollutant Emission Estimates

Pollutant	Vehicle Type	EMFAC Vehicle Class	Maximum Daily Round-Trips [1] (trips/day)	Total Annual Round-Trips [1] (trips/yr)	Idle Time per Trip [1] (hrs/trip)	Idle Emission Factor [2] (lbs/idle-hour)	Maximum Daily Emissions Estimate [a] (lbs/day)	Annual Average Emissions Estimate [b] (tons/yr)
ROG	Delivery Trucks	T6 Instate Small	14	3,558	8.3E-02	4.3E-03	4.9E-03	6.4E-04
	LBNL - RBC Shuttle	MDV	13	3,380	8.3E-02	3.6E-03	3.9E-03	5.1E-04
	BART - RBC Shuttle	MDV	25	6,500	8.3E-02	3.6E-03	7.5E-03	9.7E-04
	Employees	LDA	3,453	897,702	0	1.2E-03	0	0
	Total ROG Emissions						**1.6E-02**	**2.1E-03**
NO_X	Delivery Trucks	T6 Instate Small	14	3,558	8.3E-02	0.15	0.17	2.2E-02
	LBNL - RBC Shuttle	MDV	13	3,380	8.3E-02	6.0E-03	6.5E-03	8.4E-04
	BART - RBC Shuttle	MDV	25	6,500	8.3E-02	6.0E-03	1.2E-02	1.6E-03
	Employees	LDA	3,453	897,702	0	1.7E-03	0	0
	Total NO_X Emissions						**0.19**	**2.4E-02**
CO	Delivery Trucks	T6 Instate Small	14	3,558	8.3E-02	4.9E-02	5.6E-02	7.3E-03
	LBNL - RBC Shuttle	MDV	13	3,380	8.3E-02	4.7E-02	5.1E-02	6.6E-03
	BART - RBC Shuttle	MDV	25	6,500	8.3E-02	4.7E-02	9.8E-02	1.3E-02
	Employees	LDA	3,453	897,702	0	1.9E-02	0	0
	Total CO Emissions						**0.21**	**2.7E-02**
SO_2	Delivery Trucks	T6 Instate Small	14	3,558	8.3E-02	1.6E-04	1.8E-04	2.4E-05
	LBNL - RBC Shuttle	MDV	13	3,380	8.3E-02	0	0	0
	BART - RBC Shuttle	MDV	25	6,500	8.3E-02	0	0	0
	Employees	LDA	3,453	897,702	0	0	0	0
	Total SO_2 Emissions						**1.8E-04**	**2.4E-05**
PM_{10} Exhaust	Delivery Trucks	T6 Instate Small	14	3,558	8.3E-02	4.8E-04	5.4E-04	7.0E-05
	LBNL - RBC Shuttle	MDV	13	3,380	8.3E-02	1.5E-04	1.6E-04	2.1E-05
	BART - RBC Shuttle	MDV	25	6,500	8.3E-02	1.5E-04	3.1E-04	4.1E-05
	Employees	LDA	3,453	897,702	0	1.2E-04	0	0
	Total PM_{10} Emissions						**1.0E-03**	**1.3E-04**
$PM_{2.5}$ Exhaust	Delivery Trucks	T6 Instate Small	14	3,558	8.3E-02	4.4E-04	5.0E-04	6.5E-05
	LBNL - RBC Shuttle	MDV	13	3,380	8.3E-02	1.4E-04	1.5E-04	2.0E-05
	BART - RBC Shuttle	MDV	25	6,500	8.3E-02	1.4E-04	2.9E-04	3.8E-05
	Employees	LDA	3,453	897,702	0	1.1E-04	0	0
	Total $PM_{2.5}$ Emissions						**9.4E-04**	**1.2E-04**
CO_2	Delivery Trucks	T6 Instate Small	14	3,558	8.3E-02	16	18	2.3
	LBNL - RBC Shuttle	MDV	13	3,380	8.3E-02	18	19	2.5
	BART - RBC Shuttle	MDV	25	6,500	8.3E-02	18	37	4.8
	Employees	LDA	3,453	897,702	0	9.1	0	0
	Total CO_2 Emissions						**74**	**9.6**

Notes:
(a) Maximum daily emissions estimate (lbs/day) = (Maximum daily round-trips [trips/day]) x (idle time per trip [hrs/trip]) x (emission factor [lbs/idle-hr])
(b) Annual average emissions estimate (tons/yr) = (Annual round-trips [trips/yr]) x (idle time per trip [hrs/trip]) x (emission factor [lbs/idle-hr]) x (ton/2,000 lbs)

References:
(1) See Table N-1, Hypothetical Phase 2 Operations Input Assumptions for Emission Rate Calculations - Including Phase 1 Sources.
(2) Emission Factors source: EMFAC 2011 (Model Years to 2034). Emissions for Light Duty Vehicle Idling assumed to be negligible, and thus not quantified.
Carbon dioxide emission factors are representative of post-Low Carbon Fuel Standard implementation.

Table N-5

Onsite Parking Lot Emission Estimates

Source		Parking Lot (total)
EMFAC Vehicle Class	(1)	LDA
Number of Vehicle Trips per Day	(2)	3,453
Number of Vehicle Trips per Year	(2)	897,702
Modeling ID		LOT_EX

Pollutant	Emission Factor (3) (lbs/trip)	Maximum Daily Emissions Estimate (a) (lbs/day)	Annual Average Emissions Estimate (b) (tons/yr)
PM_{10}	6.97E-06	0.024	3.1E-03
$PM_{2.5}$	6.45E-06	0.022	2.9E-03
NO_X	2.62E-04	0.91	0.12
CO	4.37E-03	15.1	1.96
SO_2	1.70E-06	5.9E-03	7.6E-04
ROG	7.14E-04	2.47	0.32
CO_2	0.16	562	73.0

Notes:

(a) Daily emissions estimate (lbs/day) =(Emission factor [lbs/trip]) x (number of vehicle trips per day)

(b) Annual emissions estimate (lbs/day) =(Emission factor [lbs/trip]) x (number of vehicle trips per year) x (ton/2,000 lbs)

References:

(1) LDA represents light-duty employee vehicles.

(2) See Table N-1, Hypothetical Phase 2 Operations Input Assumptions for Emission Rate Calculations - Including Phase 1 Sources.

(3) EMFAC 2011. Emission factors are based on the stationary starting exhaust, diurnal, hot soak, and resting loss vehicle portions of the LDA class emissions, on a per trip basis.

Table N-6
Onsite Paved Road Dust Emission Estimates

Parameter		Employee Vehicles	Delivery Trucks	LBNL - RBC Shuttle	BART - RBC Shuttle	Total
Onsite Roundtrip Distance (mi/trip)	(1)	0.9	0.6	0.7	0.7	
Maximum Daily Trips (trips/day)	(1)	3,453	14	13	25	
Annual Trips (trips/yr)	(1)	897,702	3,558	3,380	6,500	

Pollutant	Daily Emission Factor [a] (lbs/VMT)	Annual Emission Factor [b] (lbs/VMT)	Maximum Daily Emissions Estimate [c] (lbs/day)	Annual Average Emissions Estimate [d] (tons/yr)	Maximum Daily Emissions Estimate [c] (lbs/day)	Annual Average Emissions Estimate [d] (tons/yr)	Maximum Daily Emissions Estimate [c] (lbs/day)	Annual Average Emissions Estimate [d] (tons/yr)	Maximum Daily Emissions Estimate [c] (lbs/day)	Annual Average Emissions Estimate [d] (tons/yr)	Maximum Daily Emissions Estimate (lbs/day)	Annual Average Emissions Estimate (tons/yr)
PM	9.8E-03	9.4E-03	28.9	3.60	0.075	9.3E-03	0.089	0.011	0.17	0.021	29.3	3.64
PM_{10}	2.0E-03	1.9E-03	5.79	0.72	0.015	1.9E-03	0.018	2.2E-03	0.034	4.2E-03	5.86	0.73
$PM_{2.5}$	4.8E-04	4.6E-04	1.42	0.18	3.7E-03	4.6E-04	4.4E-03	5.4E-04	8.4E-03	1.0E-03	1.44	0.18

Notes:

(a) Maximum daily emission factor (lbs/VMT) = $(k \times (sL)^{0.91} \times (W)^{1.02})$

k = aerodynamic particle size multiplier (PM) =	0.011	(2)
k = aerodynamic particle size multiplier (PM_{10}) =	0.0022	(2)
k = aerodynamic particle size multiplier ($PM_{2.5}$) =	0.00054	(2)
sL = surface material silt content (g/m^2) =	0.32	(3)
W = mean vehicle weight (tons) =	2.5	(4)

(b) Annual emission factor (lbs/VMT) = $(k \times (sL)^{0.91} \times (W)^{1.02}) \times ((1-P)/4N)$

k = aerodynamic particle size multiplier (PM) =	0.011	(2)
k = aerodynamic particle size multiplier (PM_{10}) =	0.0022	(2)
k = aerodynamic particle size multiplier ($PM_{2.5}$) =	0.00054	(2)
sL = surface material silt content (g/m^2) =	0.32	(3)
W = mean vehicle weight (tons) =	2.5	(4)
P = number of wet days (0.01 inches of precip.) =	62	(1)
N = number of days in averaging period =	365	

(c) Maximum daily emissions estimate (lbs/day) = (Emission factor [lbs/VMT]) x (maximum daily vehicle trips [trips/day]) x (onsite roundtrip distance [mi/trip]) x (1 - [control efficiency {%}] / 100)

Control efficiency (%) = 0% (5)

(d) Annual emissions estimate (tons/yr) = (Emission factor [lbs/VMT]) x (annual vehicle trips [trips/yr]) x (onsite roundtrip distance [mi/trip]) x (ton/2,000 lbs) x (1 - [control efficiency {%}] / 100)

Control efficiency (%) = 0% (5)

References:

(1) See Table N-1, Hypothetical Phase 2 Operations Input Assumptions for Emission Rate Calculations - Including Phase 1 Sources.
(2) AP-42 Chapter 13.2.1 (January, 2011), Table 13.2.1-1 "Particle Size Multipliers for Paved Road Equation".
(3) Section 7.9 of the CARB Emission Inventory Methodology. Assumes offsite roads are equivalent to local roads as shown in Table 3 (silt loading of 0.32 g/m^2).
(4) Mean vehicle weight is calculated as the weighted average of the individual vehicle weights (average of unloaded and loaded weight), weighted based on the individual annual truck trips divided by total annual truck trips.
(5) Engineering estimate.

Table N-7
Offsite Paved Road Dust Emission Estimates

Parameter		Employee Vehicles	Delivery Trucks	LBNL - RBC Shuttle	BART - RBC Shuttle	Total
Offsite Roundtrip Distance (mi/trip)	(1)	20	14	16	8	
Maximum Daily Trips (trips/day)	(1)	3,453	14	13	25	
Annual Trips (trips/yr)	(1)	897,702	3,558	3,380	6,500	

Pollutant	Daily Emission Factor (a) (lbs/VMT)	Annual Emission Factor (b) (lbs/VMT)	Maximum Daily Emissions Estimate (c) (lbs/day)	Annual Average Emissions Estimate (d) (tons/yr)	Maximum Daily Emissions Estimate (c) (lbs/day)	Annual Average Emissions Estimate (d) (tons/yr)	Maximum Daily Emissions Estimate (c) (lbs/day)	Annual Average Emissions Estimate (d) (tons/yr)	Maximum Daily Emissions Estimate (c) (lbs/day)	Annual Average Emissions Estimate (d) (tons/yr)	Maximum Daily Emissions Estimate (lbs/day)	Annual Average Emissions Estimate (tons/yr)
PM	1.3E-03	1.2E-03	89.6	11.2	0.24	0.030	0.26	0.032	0.25	0.032	90.4	11.2
PM_{10}	2.5E-04	2.4E-04	17.9	2.23	0.049	6.1E-03	0.051	6.4E-03	0.051	6.3E-03	18.1	2.25
$PM_{2.5}$	6.2E-05	6.0E-05	4.40	0.55	0.012	1.5E-03	0.013	1.6E-03	0.012	1.6E-03	4.44	0.55

Notes:

(a) Maximum daily emission factor (lbs/VMT) = $(k \times (sL)^{0.91} \times (W)^{1.02})$

k = aerodynamic particle size multiplier (PM) =	0.011	(2)
k = aerodynamic particle size multiplier (PM_{10}) =	0.0022	(2)
k = aerodynamic particle size multiplier ($PM_{2.5}$) =	0.00054	(2)
sL = surface material silt content (g/m^2) =	0.035	(3)
W = mean vehicle weight (tons) =	2.4	(3)

(b) Annual emission factor (lbs/VMT) = $(k \times (sL)^{0.91} \times (W)^{1.02}) \times ((1-P)/4N)$

k = aerodynamic particle size multiplier (PM) =	0.011	(2)
k = aerodynamic particle size multiplier (PM_{10}) =	0.0022	(2)
k = aerodynamic particle size multiplier ($PM_{2.5}$) =	0.00054	(2)
sL = surface material silt content (g/m^2) =	0.035	(3)
W = mean vehicle weight (tons) =	2.4	(3)
P = number of wet days (0.01 inches of precip.) =	62	(1)
N = number of days in averaging period =	365	

(c) Maximum daily emissions estimate (lbs/day) = (Emission factor [lbs/VMT]) x (maximum daily vehicle trips [trips/day]) x (offsite roundtrip distance [mi/trip]) x (1 - [control efficiency {%}] / 100)

Control efficiency (%) = 0% (4)

(d) Annual emissions estimate (tons/yr) = (Emission factor [lbs/VMT]) x (annual vehicle trips [trips/yr]) x (offsite roundtrip distance [mi/trip]) x (ton/2,000 lbs) x (1 - [control efficiency {%}] / 100)

Control efficiency (%) = 0% (4)

References:

(1) See Table N-1, Hypothetical Phase 2 Operations Input Assumptions for Emission Rate Calculations - Including Phase 1 Sources.
(2) AP-42 Chapter 13.2.1 (January, 2011), Table 13.2.1-1 "Particle Size Multipliers for Paved Road Equation".
(3) Section 7.9 of the CARB Emission Inventory Methodology. Assumes offsite roads are equivalent to major/collector roads as shown in Table 3 (silt loading of 0.035 g/m^2).
(4) Engineering estimate.

Table N-8
Natural Gas Boiler Criteria Emission Estimates

Pollutant					PM		PM_{10}		$PM_{2.5}$		NO_X		CO		SO_2		VOC		CO_2		CH_4		N_2O		CO_2e	
Emission Factor (lbs/MMscf)					7.60 (1)		7.60 (2)		7.60 (2)		18.72 (a)		84 (4)		0.6 (1)		5.5 (1)		120,162 (b)		2.27 (c)		0.23 (c)		120,280 (d)	
					Emission Estimates																					
Source	Modeling ID	Maximum Hourly Fuel Usage (8) (MMBtu/hr)	Daily Operation (8) (hrs/day)	Annual Fuel Usage (8) (MMBtu/yr)	Maximum Daily (e) (lbs/day)	Annual Average (f) (tons/yr)	Maximum Daily (e) (lbs/day)	Annual Average (f) (tons/yr)	Maximum Daily (e) (lbs/day)	Annual Average (f) (tons/yr)	Maximum Daily (e) (lbs/day)	Annual Average (f) (tons/yr)	Maximum Daily (e) (lbs/day)	Annual Average (f) (tons/yr)	Maximum Daily (e) (lbs/day)	Annual Average (f) (tons/yr)	Maximum Daily (e) (lbs/day)	Annual Average (f) (tons/yr)	Maximum Daily (e) (lbs/day)	Annual Average (f) (tons/yr)	Maximum Daily (e) (lbs/day)	Annual Average (f) (tons/yr)	Maximum Daily (e) (lbs/day)	Annual Average (f) (tons/yr)	Maximum Daily (e) (lbs/day)	Annual Average (f) (tons/yr)
Natural Gas Boiler - Buildings 6 and 7	NGB_B6_7	24	24	42,000	4.26	0.16	4.26	0.16	4.26	0.16	10.5	0.39	47.1	1.73	0.34	0.012	3.08	0.11	67,328	2,474	1.27	0.047	0.13	4.7E-03	67,394	2,476
Natural Gas Boiler - Building 8	NGB_B8	12	24	21,000	2.13	0.078	2.13	0.078	2.13	0.078	5.24	0.19	23.5	0.86	0.17	6.2E-03	1.54	0.057	33,664	1,237	0.63	0.023	0.063	2.3E-03	33,697	1,238
Natural Gas Boiler - Building 9	NGB_B9	12	24	21,000	2.13	0.078	2.13	0.078	2.13	0.078	5.24	0.19	23.5	0.86	0.17	6.2E-03	1.54	0.057	33,664	1,237	0.63	0.023	0.063	2.3E-03	33,697	1,238
Natural Gas Boiler - Building 10	NGB_B10	11	24	15,267	1.95	0.057	1.95	0.057	1.95	0.057	4.81	0.14	21.6	0.63	0.15	4.5E-03	1.41	0.041	30,859	899	0.58	0.017	0.058	1.7E-03	30,889	900
Natural Gas Boiler - Building 11	NGB_B11	6	24	8,328	1.06	0.031	1.06	0.031	1.06	0.031	2.62	0.076	11.8	0.34	0.084	2.4E-03	0.77	0.022	16,832	491	0.32	9.3E-03	0.032	9.3E-04	16,849	491
Total					**11.5**	**0.40**	**11.5**	**0.40**	**11.5**	**0.40**	**28.4**	**0.99**	**127**	**4.43**	**0.91**	**0.032**	**8.35**	**0.29**	**182,347**	**6,338**	**3.44**	**0.12**	**0.34**	**0.012**	**182,526**	**6,344**

Notes:

(a) Emission factor (lbs/MMscf) = (NO_2 or CO emission limit [ppmv @ 3% O_2]) x (10^{-6}) x (NO_2 or CO molecular weight [lbs/lb-mol]) x (lb-mol/385.44 ft^3) x (natural gas f-factor [8,710 dscf/MMBtu]) x (20.9% O_2/[20.9% O_2 - 3% O_2]) x (heat content [Btu/scf])

BAAQMD NO_X emission limit (ppmv @ 3% O_2) =	15	(3)
BAAQMD CO emission limit (ppmv @ 3% O_2) =	400	(3)
NO_2 molecular weight (lbs/lb-mol) =	46	
CO molecular weight (lbs/lb-mol) =	28.01	
Natural gas heat content (Btu/scf) =	1,028	(5)

(b) CO_2 emission factor (lbs/MMscf) = (CO_2 emission factor [kg CO_2/MMBtu]) x (default high heat value (MMBtu/scf)) x (10^6 scf/MMscf) x (lb/0.453592 kg)

CO_2 emission factor (kg/MMBtu) =	53.02	(5)
Default high heat value (MMBtu/scf) =	1.028E-03	(5)

(c) CH_4 or N_2O emission factor (lbs/MMscf) = (CH_4 or N_2O emission factor [kg/MMBtu]) x (lb/0.453592 kg) x (natural gas heat content [Btu/scf])

CH_4 emission factor (kg/MMBtu) =	1.0E-03	(6)
N_2O emission factor (kg/MMBtu) =	1.0E-04	(6)
Natural gas heat content (Btu/scf) =	1,028	(5)

(d) CO_2e emission factor (lbs/MMscf) = (CO_2 emission factor [lbs/MMscf]) + (CH_4 emission factor [lbs/MMscf] x CH_4 global warming potential)
+ (N_2O emission factor [lbs/MMscf] x N_2O global warming potential)

Global warming potential of CH_4 =	21	(7)
Global warming potential of N_2O =	310	(7)

(e) Daily emissions estimate (lbs/day) = (Emission factor [lbs/MMscf]) x (maximum hourly heat input [MMBtu/hr]) x (daily hours of operation [hrs/day]) / (natural gas heat content [Btu/scf])

Natural gas heat content (Btu/scf) =	1,028	(5)

(f) Annual emissions estimate (tons/yr) = (emission factor [lbs/MMscf]) x (annual heat input [MMBtu/yr]) / (natural gas heat content [Btu/scf]) x (tons/2,000 lbs)

Natural gas heat content (Btu/scf) =	1,020	(5)

References:

(1) AP-42 Chapter 1.4 (July 1998), Table 1.4-2 "Emission Factors for Criteria Pollutants and Greenhouse Gases from Natural Gas Combustion".
(2) Assumes that 100% of PM is $PM_{2.5}$. Therefore, 100% of PM_{10} is $PM_{2.5}$.
(3) BAAQMD Emission Limits 307.2, 307.3, and 307.4 from Section 9-7-307..
(4) AP-42 Chapter 1.4 (July 1998), Table 1.4-1 "Emission Factors for NO_X and CO from Natural Gas Combustion".
(5) 40 CFR Part 98 Subpart C, Table C-1, Default CO_2 Emission Factors and High Heat Values for Various Types of Fuel.
(6) 40 CFR Part 98 Subpart C, Table C-2, Default CH_4 and N_2O Emission Factors for Various Types of Fuel.
(7) 40 CFR Part 98 Subpart A, Table A-1, Global Warming Potentials.
(8) See Table N-1, Hypothetical Phase 2 Operations Input Assumptions for Emission Rate Calculations - Including Phase 1 Sources.

Table N-9
Emergency Diesel Generator Criteria Emission Estimates

Pollutant				Min HP	Max HP	PM		PM_{10}		$PM_{2.5}$		NO_X		CO		SO_2		VOC		CO_2		CH_4		CO_2e	
Emission Factor - Phase 1 Tier 4 Final (g/hp-hr) (1)				440		0.01 (1)		0.01 (1)		0.01 (1)		0.3 (2)		2.2 (2)		-- (3)		0.14 (2)		-- (4)		--		--	
Emission Factor - Tier 4 Final (g/hp-hr) (1)				100	174	0.015 (1)		0.015 (1)		0.015 (1)		0.3 (2)		3.7 (2)		-- (3)		0.14 (2)		-- (4)		--		--	
Emission Factor - Tier 4 Final (g/hp-hr) (1)				175	749	0.015 (1)		0.015 (1)		0.015 (1)		0.3 (2)		2.2 (2)		-- (3)		0.14 (2)		-- (4)		--		--	
Emission Factor - Tier 4 Final (g/hp-hr) (1)				750	2,000	0.03 (1)		0.03 (1)		0.03 (1)		2.6 (2)		2.2 (2)		-- (3)		0.14 (2)		-- (4)		--		--	
Emission Factor - Phase 1 Tier 4 Interim (g/hp-hr) (1)				440		0.015 (2)		0.015 (2)		0.015 (2)		1.5 (2)		2.6 (2)		-- (3)		0.14 (2)		-- (4)		--		--	
						Tier 4 Final - Emission Estimates																			
Source	Modeling ID	Generator Power Rating (5) (BHP)	Diesel Fuel Usage (5) (gal/hr)	Load Factor (6)	Annual Operation (5) (hrs/yr)	Maximum Daily (a) (lbs/day)	Annual Average (b) (tons/yr)	Maximum Daily (a) (lbs/day)	Annual Average (b) (tons/yr)	Maximum Daily (a) (lbs/day)	Annual Average (b) (tons/yr)	Maximum Daily (a) (lbs/day)	Annual Average (b) (tons/yr)	Maximum Daily (a) (lbs/day)	Annual Average (b) (tons/yr)	Maximum Daily (c) (lbs/day)	Annual Average (b) (tons/yr)	Maximum Daily (a) (lbs/day)	Annual Average (b) (tons/yr)	Maximum Daily (d) (lbs/day)	Annual Average (b) (tons/yr)	Maximum Daily (9) (lbs/day)	Annual Average (b) (tons/yr)	Maximum Daily (e) (lbs/day)	Annual Average (b) (tons/yr)
Diesel Generator - Building 8	DG_B8	440	22.3	0.74	25.15	0.014	9.0E-05	0.014	9.0E-05	0.014	9.0E-05	0.43	2.7E-03	3.16	0.020	9.4E-03	5.9E-05	0.20	1.3E-03	996	6.26	0.018	1.1E-04	996	6.27
Diesel Generator - Building 9	DG_B9	440	22.3	0.74	25.15	0.014	9.0E-05	0.014	9.0E-05	0.014	9.0E-05	0.43	2.7E-03	3.16	0.020	9.4E-03	5.9E-05	0.20	1.3E-03	996	6.26	0.018	1.1E-04	996	6.27
Diesel Generator - Building 10	DG_B10	410	20.8	0.74	25.15	0.020	1.3E-04	0.020	1.3E-04	0.020	1.3E-04	0.40	2.5E-03	2.94	0.019	8.7E-03	5.5E-05	0.19	1.2E-03	928	5.84	0.017	1.1E-04	929	5.84
Diesel Generator - Building 11	DG_B11	240	12.2	0.74	25.15	0.012	7.4E-05	0.012	7.4E-05	0.012	7.4E-05	0.23	1.5E-03	1.72	0.011	5.1E-03	3.2E-05	0.11	6.9E-04	543	3.42	9.9E-03	6.2E-05	544	3.42
						Tier 4 Interim - Emission Estimates																			
Diesel Generator - Building 6	DG_B6	440	22.3	0.74	25.15	0.022	1.4E-04	0.022	1.4E-04	0.022	1.4E-04	2.15	0.014	3.73	0.023	9.4E-03	5.9E-05	0.20	1.3E-03	996	6.26	0.018	1.1E-04	996	6.27
Diesel Generator - Building 7	DG_B7	440	22.3	0.74	25.15	0.022	1.4E-04	0.022	1.4E-04	0.022	1.4E-04	2.15	0.014	3.73	0.023	9.4E-03	5.9E-05	0.20	1.3E-03	996	6.26	0.018	1.1E-04	996	6.27
Total						**0.10**	**6.5E-04**	**0.10**	**6.5E-04**	**0.10**	**6.5E-04**	**5.80**	**0.036**	**18.4**	**0.12**	**0.051**	**3.2E-04**	**1.10**	**6.9E-03**	**5,456**	**34.3**	**0.099**	**6.2E-04**	**5,458**	**34.3**

Notes:

(a) Maximum daily emission estimate (lbs/day) = (Emission factor [g/hp-hr]) x (generator power [hp]) x (load factor) x (maximum hours per day [hrs/day]) x (lb/453.59g)
Daily hours of operation (hrs/day) = 2 (5)

(b) Annual average emission estimate (tons/yr) = (Daily emissions [lbs/day]) / (daily hours of operation [hrs/day]) x (annual hours of operation [hrs/yr]) x (ton/2,000 lbs)
Daily hours of operation (hrs/day) = 2 (5)

(c) Maximum daily emissions estimate (lbs/day) = (Fuel sulfur content [ppmw] / 1,000,000) x (generator fuel consumption [gal/hr]) x (daily hours of operation [hrs/day]) x (diesel density [lbs/gal]) x ([SO_2 molecular weight {lbs/lb-mol}] / [sulfur molecular weight {lbs/lb-mol}])
Fuel sulfur content (ppmw) = 15 (7)
Daily hours of operation (hrs/day) = 2 (5)
Diesel density (lbs/gal) = 7
SO_2 molecular weight (lbs/lb-mol) = 64
Sulfur molecular weight (lbs/lb-mol) = 32

(d) Maximum daily emissions estimate (lbs/day) = (Fuel carbon content [%] / 100) x (generator fuel consumption [gal/hr]) x (daily hours of operation [hrs/day]) x (diesel density [lbs/gal]) x ([CO_2 molecular weight {lbs/lb-mol}] / [carbon molecular weight {lbs/lb-mol}])
Fuel carbon content (%) = 87 (8)
Daily hours of operation (hrs/day) = 2 (5)
Diesel density (lbs/gal) = 7
CO_2 molecular weight (lbs/lb-mol) = 44.0
Carbon molecular weight (lbs/lb-mol) = 12.0

(e) CO_2e emissions (lbs/day) = (CO_2 emissions [lbs/day]) + (CH_4 emissions [lbs/day] x CH_4 global warming potential) + (N_2O emissions [lbs/day] x N_2O global warming potential)
CH_4 Global Warming Potential (GWP) = 21 (10)
N_2O Global Warming Potential (GWP) = 310 (10)

References:

(1) The University has committed to purchasing engines for buildings 7 and 8 that achieve 0.01 g/hp-hr particulate matter emissions. Buildings 6 and 7 will not be under the control of LBNL, so interim Tier IV emission factors are assumed. All other engines will be based on Tier IV emission factors. Assumes all PM is PM2.5.
(2) CalEEMod Appendix D, Default Data Tables. Table 3.5, OFFROAD Emission Factor Based on Engine Tier. Assumes Tier 4 Final for LBNL-owned small engines (Buildings 9 and 8), and Tier 4 Interim for the Building 6&7 engine.
(3) Sulfur dioxide emissions calculated on a sulfur mass balance basis, assuming 100% of the fuel sulfur content is emitted as SO_2.
(4) Carbon dioxide emissions calculated on a carbon mass balance basis, conservatively assuming 100% of the fuel carbon content is emitted as CO_2.
(5) See Table N-1, Hypothetical Phase 2 Operations Input Assumptions for Emission Rate Calculations - Including Phase 1 Sources.
(6) Default load factor for generators in URBEMIS emissions model.
(7) California Code of Regulations Title 13, Division 3, Chapter 5, Article 2, Standards for Diesel Fuel.
(8) AP-42 Chapter 3.3 (October 1996) and 3.4 (October 1996), Footnote to criteria emission factor table.
(9) Assumes methane is 9% of VOC, based on footnote f of Table 3.4-1 in AP-42, Chapter 3.4. VOC emission factor is shown as ROG/TOG in CalEEMod Appendix D ,Table 3.5.
(10) 40 CFR Part 98 Subpart A, Table A-1, Global Warming Potentials.

Table N-10

Cooling Tower Particulate Emission Estimates

Pollutant					PM		PM_{10}		$PM_{2.5}$	
					Emission Estimates					
Source	Modeling ID	Total Circulation Water Rate [1] (gpm)	Drift Loss of Circulating Water [2] (%)	Annual Operation [1] (hrs/yr)	Maximum Daily [a] (lbs/day)	Annual Average [b] (tons/yr)	Maximum Daily [c] (lbs/day)	Annual Average [b] (tons/yr)	Maximum Daily [d] (lbs/day)	Annual Average [b] (tons/yr)
Cooling Tower - Building 8	CTB8C#	4,500	0.005	6,360	1.45	0.19	1.29	0.17	0.77	0.10
Cooling Tower - Building 9	CTB9C#	4,500	0.005	6,360	1.45	0.19	1.29	0.17	0.77	0.10
Cooling Tower - Building 10	CTB10C#	4,500	0.005	6,360	1.45	0.19	1.29	0.17	0.77	0.10
Cooling Tower - Building 11	CTB11C#	2,400	0.005	6,360	0.77	0.10	0.69	0.091	0.41	0.055
Cooling Tower - Buildings 6 and 7	CTB6_7C#	9000	0.005	6,360	2.90	0.38	2.58	0.34	1.55	0.21
Total					**8.01**	**1.06**	**7.14**	**0.95**	**4.28**	**0.57**

Notes:

(a) Maximum daily emissions estimate (lbs/day) = (Circulation water rate [gpm]) x (density of water [lbs/gal]) x (total dissolved solids concentration [ppmw]) x (10^{-6}) x (drift loss of circulating water [%] / 100) x (60 min/hr) x (daily hours of operation [hrs/day])

Total dissolved solids concentration (ppmw) = 536 (1)

Density of water (lbs/gal) = 8.34

Daily hours of operation (hrs/day) = 24 (1)

(b) Annual emissions estimate (tons/yr) = (Daily emissions [lbs/day]) / (daily hours of operation [hrs/day]) x (annual hours of operation [hrs/yr]) x (ton/2,000 lbs)

Daily hours of operation (hrs/day) = 24 (1)

(c) Maximum daily emissions estimate (lbs/day) = (PM emissions estimate [lbs/day]) x (percent of PM_{10} emissions [%] / 100)

Percent of PM_{10} emissions (%) = 89.0 (3)

(d) Maximum daily emissions estimate (lbs/day) = (PM_{10} emissions estimate [lbs/day]) x ($PM_{2.5}$ fraction of PM_{10})

$PM_{2.5}$ fraction of PM_{10} = 0.6 (4)

References:

(1) See Table N-1, Hypothetical Phase 2 Operations Input Assumptions for Emission Rate Calculations - Including Phase 1 Sources.

(2) Engineering judgment based on past work with industrial cooling towers.

(3) From the technical paper "Calculating Realistic PM10 Emissions from Cooling Towers", by Joel Reisman and Gordon Frisbie. The percent PM_{10} is based on total dissolved content.

(4) From Appendix A - Updated CEIDARS Table with PM2.5 Fractions to the CEQA handbook, supplemental information.

Table N-11
Hypothetical Phase 2 Operations Criteria Pollutant Emissions Summary - Annual Average Daily Emission Rates (1)

Source	Annual Operation (days/yr)	TAC		Criteria												Greenhouse Gases							
		DPM		PM_{10}		$PM_{2.5}$		NO_X		CO		SO_2		VOC		CO_2		CH_4		N_2O		CO_2e	
		(lbs/day)	(tons/yr)	(lbs/day)	(tons/yr)	(lbs/day)	(tons/yr)	(lbs/day)	(tons/yr)	(lbs/day)	(tons/yr)	(lbs/day)	(tons/yr)	(lbs/day)	(tons/yr)	(lbs/day)	(tons/yr)	(lbs/day)	(tons/yr)	(lbs/day)	(tons/yr)	(lbs/day)	(tons/yr)
Stationary Sources																							
Diesel generators	260	5.0E-03	6.5E-04	5.0E-03	6.5E-04	5.0E-03	6.5E-04	0.28	3.6E-02	0.89	0.12	2.5E-03	3.2E-04	5.3E-02	6.9E-03	264	34.3	4.8E-03	6.2E-04	0	0	264	34.3
Natural Gas Boilers	260	--	--	3.08	0.40	3.08	0.40	7.59	0.99	34.1	4.43	0.24	3.2E-02	2.23	0.29	48,751	6,338	0.92	0.12	9.2E-02	1.2E-02	48,799	6,344
Cooling Towers	260	--	--	7.27	0.95	4.36	0.57	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Total Onsite Stationary Source Emissions	**--**	**5.0E-03**	**6.5E-04**	**10.4**	**1.35**	**7.45**	**0.97**	**7.87**	**1.02**	**35.0**	**4.55**	**0.25**	**3.2E-02**	**2.28**	**0.30**	**49,015**	**6,372**	**0.92**	**0.12**	**9.2E-02**	**1.2E-02**	**49,063**	**6,378**
Onsite On-Road Vehicle Emission Sources																							
Onsite On-Road Exhaust - Delivery Trucks	260	2.2E-03	2.8E-04	2.2E-03	2.8E-04	2.0E-03	2.6E-04	8.6E-02	1.1E-02	3.0E-02	3.9E-03	0	0	1.6E-02	2.1E-03	33.5	4.36	--	--	--	--	33.5	4.36
Onsite On-Road Exhaust - LBNL-RBC Shuttle	260	--	--	1.7E-04	2.2E-05	1.6E-04	2.0E-05	9.4E-03	1.2E-03	7.3E-02	9.5E-03	0	0	4.2E-03	5.5E-04	23.7	3.08	--	--	--	--	23.7	3.08
Onsite On-Road Exhaust - BART-RBC Shuttle	260	--	--	3.3E-04	4.3E-05	3.0E-04	3.9E-05	1.8E-02	2.3E-03	0.14	1.8E-02	0	0	8.1E-03	1.1E-03	45.6	5.93	--	--	--	--	45.6	5.93
Onsite On-Road Exhaust - Employee Vehicles	260	--	--	4.6E-02	6.0E-03	4.3E-02	5.6E-03	0.87	0.11	9.76	1.27	0	0	0.47	6.2E-02	3,949	513	--	--	--	--	3,949	513
Onsite On-Road Dust - Delivery Trucks	260	--	--	1.4E-02	1.9E-03	3.5E-03	4.6E-04	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Onsite On-Road Dust - LBNL-RBC Shuttle	260	--	--	1.7E-02	2.2E-03	4.2E-03	5.4E-04	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Onsite On-Road Dust - BART-RBC Shuttle	260	--	--	3.3E-02	4.2E-03	8.0E-03	1.0E-03	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Onsite On-Road Dust - Employee Vehicles	260	--	--	5.54	0.72	1.36	0.18	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Onsite Idling Exhaust - Delivery Trucks	260	5.4E-04	7.0E-05	5.4E-04	7.0E-05	5.0E-04	6.5E-05	0.17	2.2E-02	5.6E-02	7.3E-03	1.8E-04	2.4E-05	4.9E-03	6.4E-04	17.8	2.32	--	--	--	--	17.8	2.32
Onsite Idling Exhaust - LBNL-RBC Shuttle	260	--	--	1.6E-04	2.1E-05	1.5E-04	2.0E-05	6.5E-03	8.4E-04	5.1E-02	6.6E-03	0	0	3.9E-03	5.1E-04	19.1	2.49	--	--	--	--	19.1	2.49
Onsite Idling Exhaust - BART-RBC Shuttle	260	--	--	3.1E-04	4.1E-05	2.9E-04	3.8E-05	1.2E-02	1.6E-03	9.8E-02	1.3E-02	0	0	7.5E-03	9.7E-04	36.8	4.79	--	--	--	--	36.8	4.79
Total Onsite Vehicle Parking Lot Emissions	**260**	**--**	**--**	**2.4E-02**	**3.1E-03**	**2.2E-02**	**2.9E-03**	**0.91**	**0.12**	**15.1**	**1.96**	**5.9E-03**	**7.6E-04**	**2.47**	**0.32**	**562**	**73.0**	**--**	**--**	**--**	**--**	**562**	**73.0**
Total Onsite On-Road Vehicle Emissions	**--**	**2.7E-03**	**3.5E-04**	**5.68**	**0.74**	**1.44**	**0.19**	**2.07**	**0.27**	**25.3**	**3.29**	**6.1E-03**	**7.9E-04**	**2.99**	**0.39**	**4,687**	**609**	**--**	**--**	**--**	**--**	**4,687**	**609**
Offsite On-Road Emissions																							
Offsite On-Road Exhaust - Delivery Trucks	260	3.7E-02	4.8E-03	9.7E-02	1.3E-02	5.9E-02	7.6E-03	0.98	0.13	0.26	3.3E-02	4.8E-03	6.2E-04	7.5E-02	9.8E-03	466	60.5	--	--	--	--	466	60.5
Offsite On-Road Exhaust - LBNL-RBC Shuttle	260	--	--	2.1E-02	2.7E-03	8.8E-03	1.1E-03	0.13	1.7E-02	0.92	0.12	2.6E-03	3.4E-04	7.5E-02	9.8E-03	221	28.7	--	--	--	--	221	28.7
Offsite On-Road Exhaust - BART-RBC Shuttle	260	--	--	2.1E-02	2.7E-03	8.7E-03	1.1E-03	0.13	1.7E-02	0.92	0.12	2.6E-03	3.4E-04	7.5E-02	9.7E-03	219	28.5	--	--	--	--	219	28.5
Offsite On-Road Exhaust - Employee Vehicles	260	--	--	7.22	0.94	3.01	0.39	13.7	1.77	135	17.5	0.53	6.9E-02	10.2	1.33	39,754	5,168	--	--	--	--	39,754	5,168
Offsite On-Road Dust - Delivery Trucks	260	--	--	4.7E-02	6.1E-03	1.1E-02	1.5E-03	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Offsite On-Road Dust - LBNL-RBC Shuttle	260	--	--	4.9E-02	6.4E-03	1.2E-02	1.6E-03	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Offsite On-Road Dust - BART-RBC Shuttle	260	--	--	4.9E-02	6.3E-03	1.2E-02	1.6E-03	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Offsite On-Road Dust - Employee Vehicles	260	--	--	17.2	2.23	4.21	0.55	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Total Offsite On-Road Vehicle Emissions	**--**	**3.7E-02**	**4.8E-03**	**24.7**	**3.21**	**7.33**	**0.95**	**14.9**	**1.94**	**137**	**17.8**	**0.54**	**7.0E-02**	**10.5**	**1.36**	**40,659**	**5,286**	**--**	**--**	**--**	**--**	**40,659**	**5,286**
Total Phase 1 Project Summary	**--**	**4.5E-02**	**5.8E-03**	**40.7**	**5.29**	**16.2**	**2.11**	**24.8**	**3.23**	**197**	**25.6**	**0.79**	**0.10**	**15.7**	**2.05**	**94,362**	**12,267**	**0.92**	**0.12**	**9.2E-02**	**1.2E-02**	**94,409**	**12,273**
Onsite Stationary Exhaust	**--**	**5.0E-03**	**6.5E-04**	**10.4**	**1.35**	**7.45**	**0.97**	**7.87**	**1.02**	**35.0**	**4.55**	**0.25**	**3.2E-02**	**2.28**	**0.30**	**49,015**	**6,372**	**0.92**	**0.12**	**9.2E-02**	**1.2E-02**	**49,063**	**6,378**
Onsite Mobile Exhaust	**--**	**2.7E-03**	**3.5E-04**	**7.4E-02**	**9.6E-03**	**6.8E-02**	**8.9E-03**	**2.07**	**0.27**	**25.3**	**3.29**	**6.1E-03**	**7.9E-04**	**2.99**	**0.39**	**4,687**	**609**	**0**	**0**	**0**	**0**	**4,687**	**609**
Onsite Fugitive Dust	**--**	**0**	**0**	**5.61**	**0.73**	**1.38**	**0.18**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**
Offsite Mobile Exhaust	**--**	**3.7E-02**	**4.8E-03**	**7.36**	**0.96**	**3.08**	**0.40**	**14.9**	**1.94**	**137**	**17.8**	**0.54**	**7.0E-02**	**10.5**	**1.36**	**40,659**	**5,286**	**0**	**0**	**0**	**0**	**40,659**	**5,286**
Offsite Fugitive Dust	**--**	**0**	**0**	**17.3**	**2.25**	**4.25**	**0.55**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**

References:

(1) Daily emission rates are annual average daily emission rates, which are calculated by dividing the annual emission rate by the annual days of operation, and converting form tons to pounds. Annual days of operation is set to 5 days per week, 52 weeks per year.

Table N-12
Onsite Employee Vehicle TAC Emission Estimates

Parameter		Parking Lot Emissions					Onroad Emissions
		Hot Soak / Running Evaporative	Resting Evaporative / Diurnal	Starting	Idling	Total	Running
Organic Speciation Profile	(1)	660	661	664	2105		2105
LDA TOG Emission Factor	(2)	8.19E-04 (lbs/vehicle)	1.52E-04 (lbs/vehicle)	3.33E-04 (lbs/vehicle)	1.99E-03 (lbs/hr)		1.74E-04 (lbs/VMT)
Maximum Daily Vehicle Trips (trips/day)	(3)	3,453	3,453	3,453	3,453		3,453
Annual Vehicle Trips (trips/yr)	(3)	897,702	897,702	897,702	897,702		897,702

TAC	CAS	TAC Emission Fraction of TOG (1)	Maximum Hourly Emissions Estimate (a) (lbs/hr)	Annual Average Emissions Estimate (b) (tons/yr)	TAC Emission Fraction of TOG (1)	Maximum Hourly Emissions Estimate (a) (lbs/hr)	Annual Average Emissions Estimate (b) (tons/yr)	TAC Emission Fraction of TOG (1)	Maximum Hourly Emissions Estimate (a) (lbs/hr)	Annual Average Emissions Estimate (b) (tons/yr)	TAC Emission Fraction of TOG (1)	Maximum Hourly Emissions Estimate (c) (lbs/hr)	Annual Average Emissions Estimate (d) (tons/yr)	Maximum Hourly Emissions Estimate (lbs/hr)	Annual Average Emissions Estimate (tons/yr)	TAC Emission Fraction of TOG (1)	Maximum Hourly Emissions Estimate (e) (lbs/hr)	Annual Average Emissions Estimate (f) (tons/yr)
1,3-Butadiene	106-99-0	No Data	--	--	No Data	--	--	7.0E-03	5.0E-04	1.0E-03	5.5E-03	0	0	5.0E-04	1.0E-03	5.5E-03	1.8E-04	3.7E-04
2-Butanone	78-93-3	No Data	--	--	No Data	--	--	6.0E-04	4.3E-05	9.0E-05	2.0E-04	0	0	4.3E-05	9.0E-05	2.0E-04	6.4E-06	1.3E-05
Acetaldehyde	75-07-0	No Data	--	--	No Data	--	--	5.2E-03	3.7E-04	7.8E-04	2.8E-03	0	0	3.7E-04	7.8E-04	2.8E-03	9.0E-05	1.9E-04
Acrolein	107-02-8	No Data	--	--	No Data	--	--	1.1E-03	7.9E-05	1.6E-04	1.3E-03	0	0	7.9E-05	1.6E-04	1.3E-03	4.2E-05	8.7E-05
Benzene	71-43-2	0.010	1.8E-03	3.7E-03	3.6E-03	1.2E-04	2.5E-04	0.024	1.7E-03	3.6E-03	0.025	0	0	3.6E-03	7.6E-03	0.025	7.9E-04	1.7E-03
Ethylbenzene	100-41-4	0.016	2.9E-03	6.0E-03	1.2E-03	3.9E-05	8.2E-05	0.016	1.1E-03	2.4E-03	0.011	0	0	4.1E-03	8.5E-03	0.011	3.4E-04	7.0E-04
Formaldehyde	50-00-0	No Data	--	--	No Data	--	--	0.013	9.0E-04	1.9E-03	0.016	0	0	9.0E-04	1.9E-03	0.016	5.1E-04	1.1E-03
Methanol	67-56-1	1.0E-04	1.8E-05	3.7E-05	No Data	--	--	2.9E-03	2.1E-04	4.3E-04	1.2E-03	0	0	2.3E-04	4.7E-04	1.2E-03	3.9E-05	8.0E-05
Naphthalene	91-20-3	1.4E-03	2.5E-04	5.1E-04	No Data	--	--	7.0E-04	5.0E-05	1.0E-04	5.0E-04	0	0	3.0E-04	6.2E-04	5.0E-04	1.6E-05	3.3E-05
n-Hexane	110-54-3	7.6E-03	1.3E-03	2.8E-03	0.015	5.1E-04	1.1E-03	0.018	1.3E-03	2.7E-03	0.016	0	0	3.1E-03	6.5E-03	0.016	5.1E-04	1.1E-03
Propylene	115-07-1	No Data	--	--	No Data	--	--	0.033	2.4E-03	5.0E-03	0.031	0	0	2.4E-03	5.0E-03	0.031	9.8E-04	2.0E-03
Styrene	100-42-5	No Data	--	--	No Data	--	--	2.6E-03	1.9E-04	3.9E-04	1.2E-03	0	0	1.9E-04	3.9E-04	1.2E-03	3.9E-05	8.0E-05
Toluene	108-88-3	0.051	9.0E-03	0.019	0.017	5.6E-04	1.2E-03	0.074	5.3E-03	0.011	0.058	0	0	0.015	0.031	0.058	1.9E-03	3.9E-03
m-Xylene	108-38-3	0.027	4.8E-03	9.9E-03	3.4E-03	1.1E-04	2.3E-04	0.053	3.8E-03	7.9E-03	0.036	0	0	8.7E-03	0.018	0.036	1.1E-03	2.4E-03
o-Xylene	95-47-6	0.016	2.8E-03	5.9E-03	1.3E-03	4.3E-05	8.9E-05	0.018	1.3E-03	2.7E-03	0.012	0	0	4.2E-03	8.7E-03	0.012	4.0E-04	8.3E-04
p-Xylene	106-42-3	0.014	2.5E-03	5.1E-03	1.1E-03	3.6E-05	7.5E-05	No Data	--	--	No Data	--	--	2.5E-03	5.2E-03	No Data	--	--

Notes:

(a) Maximum hourly emissions estimate (lbs/hr) = (Emission factor [lbs/vehicle]) x (maximum daily vehicle trips [trips/day]) x (TAC emission fraction) / (daily hours of operation [hrs/day])
Daily hours of operation (hrs/day) = 16 (3)

(b) Annual emissions estimate (tons/yr) = (Emission factor [lbs/vehicle]) x (annual vehicle trips [trips/yr]) x (ton/2,000 lbs) x (TAC emission fraction)

(c) Maximum hourly emissions estimate (lbs/hr) = (Emission factor [lbs/hr]) x (maximum daily vehicle trips [trips/day]) x (idling time per trip [hrs/trip]) x (TAC emission fraction) / (daily hours of operation [hrs/day])
Idling time per trip (hrs/trip) = 0 (3)
Daily hours of operation (hrs/day) = 16 (3)

(d) Annual emissions estimate (tons/yr) = (Emission factor [lbs/hr]) x (annual vehicle trips [trips/yr]) x (idling time per trip [hrs/trip]) x (ton/2,000 lbs) x (TAC emission fraction)
Idling time per trip (hrs/trip) = 0 (3)

(e) Maximum hourly emissions estimate (lbs/hr) = (Emission factor [lbs/VMT]) x (maximum daily vehicle trips [trips/day]) x (onsite roundtrip distance [mi/trip]) x (TAC emission fraction) / (daily hours of operation [hrs/day])
Onsite roundtrip distance (mi/trip) = 0.86 (3)
Daily hours of operation (hrs/day) = 16 (3)

(f) Annual emissions estimate (tons/yr) = (Emission factor [lbs/VMT]) x (annual vehicle trips [trips/yr]) x (onsite roundtrip distance [mi/trip]) x (ton/2,000 lbs) x (TAC emission fraction)
Onsite roundtrip distance (mi/trip) = 0.86 (3)

References:

(1) California Air Resources Board Speciation Database. TAC emission fractions are derived from the individual speciation profiles listed. Profiles chosen to best represent the project vehicle fleet and existing gasoline formulation.
(2) Emission Factors source: EMFAC 2011 (Model Years to 2034). Onsite speed set to 15 mile per hour to conservatively estimate onsite emissions. No tire and brake wear emission factors are provided at 15 miles per hour.
(3) See Table N-1, Hypothetical Phase 2 Operations Input Assumptions for Emission Rate Calculations - Including Phase 1 Sources.

Table N-13
Offsite Employee Vehicle TAC Emission Estimates

Parameter		Onroad Emissions						Total
		Running		Tire Wear		Brake Wear		
Speciation Profile	(1)	2105	(organic)	472	(particulate)	473	(particulate)	
LDA Emission Factor (lbs/VMT)	(2)	6.64E-05	(TOG)	1.8E-05	(PM_{10})	8.1E-05	(PM_{10})	
Maximum Daily Vehicle Trips (trips/day)	(3)	3,453		3,453		3,453		
Annual Vehicle Trips (trips/yr)	(3)	897,702		897,702		897,702		

TAC	CAS	TAC Emission Fraction of TOG (1)	Maximum Hourly Emissions Estimate (a) (lbs/hr)	Annual Average Emissions Estimate (b) (tons/yr)	TAC Emission Fraction of PM_{10} (1)	Maximum Hourly Emissions Estimate (a) (lbs/hr)	Annual Average Emissions Estimate (b) (tons/yr)	TAC Emission Fraction of PM_{10} (1)	Maximum Hourly Emissions Estimate (a) (lbs/hr)	Annual Average Emissions Estimate (b) (tons/yr)	Maximum Hourly Emissions Estimate (lbs/hr)	Annual Average Emissions Estimate (tons/yr)
1,3-Butadiene	106-99-0	5.5E-03	1.6E-03	3.3E-03	--	--	--	--	--	--	1.6E-03	3.3E-03
2-Butanone	78-93-3	2.0E-04	5.8E-05	1.2E-04	--	--	--	--	--	--	5.8E-05	1.2E-04
Acetaldehyde	75-07-0	2.8E-03	8.2E-04	1.7E-03	--	--	--	--	--	--	8.2E-04	1.7E-03
Acrolein	107-02-8	1.3E-03	3.8E-04	7.9E-04	--	--	--	--	--	--	3.8E-04	7.9E-04
Benzene	71-43-2	0.025	7.2E-03	0.015	--	--	--	--	--	--	7.2E-03	0.015
Ethylbenzene	100-41-4	0.011	3.1E-03	6.4E-03	--	--	--	--	--	--	3.1E-03	6.4E-03
Formaldehyde	50-00-0	0.016	4.6E-03	9.6E-03	--	--	--	--	--	--	4.6E-03	9.6E-03
Methanol	67-56-1	1.2E-03	3.5E-04	7.3E-04	--	--	--	--	--	--	3.5E-04	7.3E-04
Naphthalene	91-20-3	5.0E-04	1.5E-04	3.0E-04	--	--	--	--	--	--	1.5E-04	3.0E-04
n-Hexane	110-54-3	0.016	4.7E-03	9.7E-03	--	--	--	--	--	--	4.7E-03	9.7E-03
Propylene	115-07-1	0.031	8.9E-03	0.019	--	--	--	--	--	--	8.9E-03	0.019
Styrene	100-42-5	1.2E-03	3.5E-04	7.3E-04	--	--	--	--	--	--	3.5E-04	7.3E-04
Toluene	108-88-3	0.058	0.017	0.035	--	--	--	--	--	--	0.017	0.035
m-Xylene	108-38-3	0.036	0.010	0.022	--	--	--	--	--	--	0.010	0.022
o-Xylene	95-47-6	0.012	3.6E-03	7.5E-03	--	--	--	--	--	--	3.6E-03	7.5E-03
Lead	7439-92-1	--	--	--	1.6E-04	1.2E-05	2.6E-05	5.0E-05	1.8E-05	3.7E-05	3.0E-05	6.3E-05
Manganese	7439-96-5	--	--	--	1.0E-04	7.8E-06	1.6E-05	1.7E-03	6.1E-04	1.3E-03	6.1E-04	1.3E-03
Nickel	7440-02-0	--	--	--	5.0E-05	3.9E-06	8.1E-06	6.6E-04	2.4E-04	4.9E-04	2.4E-04	5.0E-04
Arsenic	7440-38-2	--	--	--	No Data	--	--	1.0E-05	3.6E-06	7.4E-06	3.6E-06	7.4E-06
Copper	7440-50-8	--	--	--	4.9E-04	3.8E-05	7.9E-05	0.011	4.1E-03	8.5E-03	4.1E-03	8.6E-03
Vanadium	7440-62-2	--	--	--	No Data	--	--	6.6E-04	2.4E-04	4.9E-04	2.4E-04	4.9E-04
Bromine	7726-95-6	--	--	--	1.5E-05	1.2E-06	2.4E-06	4.0E-05	1.4E-05	3.0E-05	1.5E-05	3.2E-05
Selenium	7782-49-2	--	--	--	2.0E-05	1.6E-06	3.2E-06	2.0E-05	7.1E-06	1.5E-05	8.7E-06	1.8E-05
Chlorine	7782-50-5	--	--	--	7.8E-03	6.1E-04	1.3E-03	1.5E-03	5.4E-04	1.1E-03	1.1E-03	2.4E-03

Notes:

(a) Maximum hourly emissions estimate (lbs/hr) = (Emission factor [lbs/VMT]) x (maximum daily vehicle trips [trips/day]) x (offsite roundtrip distance [mi/trip]) x (TAC emission fraction) / (daily hours of operation [hrs/day])

Offsite roundtrip distance (mi/trip) = 20.4 (3)

Daily hours of operation (hrs/day) = 16 (3)

(b) Annual emissions estimate (tons/yr) = (Emission factor [lbs/VMT]) x (annual vehicle trips [trips/yr]) x (offsite roundtrip distance [mi/trip]) x (ton/2,000 lbs) x (TAC emission fraction)

Offsite roundtrip distance (mi/trip) = 20.4 (3)

References:

(1) California Air Resources Board Speciation Database. TAC emission fractions are derived from the individual speciation profiles listed. Profiles chosen to best represent the project vehicle fleet and existing gasoline formulation.

(2) Emission Factors source: EMFAC 2011 (Model Years to 2034).

(3) See Table N-1, Hypothetical Phase 2 Operations Input Assumptions for Emission Rate Calculations - Including Phase 1 Sources.

Table N-14
Onsite Shuttle TAC Emission Estimates

Parameter		LBNL - RBC Shuttle		BART - RBC Shuttle		Total
		Idling	Running	Idling	Running	
Organic Speciation Profile	(1)	2105	2105	2105	2105	
MDV TOG Emission Factor	(2)	5.47E-03 (lbs/hr)	4.75E-04 (lbs/VMT)	5.47E-03 (lbs/hr)	4.75E-04 (lbs/VMT)	
Maximum Daily Vehicle Trips (trips/day)	(3)	13	13	25	25	
Annual Vehicle Trips (trips/yr)	(3)	3,380	3,380	6,500	6,500	
Idling Time per Trip (hrs/trip)	(3)	0.083	--	0.083	--	
Daily Hours of Operation (hrs/day)	(3)	13	13	13	13	
Onsite Roundtrip[Distance (mi/trip)	(3)	--	0.698	--	0.698	

TAC	CAS	TAC Emission Fraction of TOG (1)	Maximum Hourly Emissions Estimate (a) (lbs/hr)	Annual Average Emissions Estimate (b) (tons/yr)	TAC Emission Fraction of TOG (1)	Maximum Hourly Emissions Estimate (c) (lbs/hr)	Annual Average Emissions Estimate (d) (tons/yr)	TAC Emission Fraction of TOG (1)	Maximum Hourly Emissions Estimate (a) (lbs/hr)	Annual Average Emissions Estimate (b) (tons/yr)	TAC Emission Fraction of TOG (1)	Maximum Hourly Emissions Estimate (c) (lbs/hr)	Annual Average Emissions Estimate (d) (tons/yr)	Maximum Hourly Emissions Estimate (lbs/hr)	Annual Average Emissions Estimate (tons/yr)
1,3-Butadiene	106-99-0	5.5E-03	2.5E-06	4.2E-06	5.5E-03	1.8E-06	3.1E-06	5.5E-03	4.8E-06	8.2E-06	5.5E-03	3.5E-06	5.9E-06	1.3E-05	2.1E-05
2-Butanone	78-93-3	2.0E-04	9.1E-08	1.5E-07	2.0E-04	6.6E-08	1.1E-07	2.0E-04	1.8E-07	3.0E-07	2.0E-04	1.3E-07	2.2E-07	4.6E-07	7.8E-07
Acetaldehyde	75-07-0	2.8E-03	1.3E-06	2.2E-06	2.8E-03	9.3E-07	1.6E-06	2.8E-03	2.5E-06	4.1E-06	2.8E-03	1.8E-06	3.0E-06	6.4E-06	1.1E-05
Acrolein	107-02-8	1.3E-03	5.9E-07	1.0E-06	1.3E-03	4.3E-07	7.3E-07	1.3E-03	1.1E-06	1.9E-06	1.3E-03	8.3E-07	1.4E-06	3.0E-06	5.1E-06
Benzene	71-43-2	0.025	1.1E-05	1.9E-05	0.025	8.2E-06	1.4E-05	0.025	2.2E-05	3.7E-05	0.025	1.6E-05	2.7E-05	5.7E-05	9.6E-05
Ethylbenzene	100-41-4	0.011	4.8E-06	8.1E-06	0.011	3.5E-06	5.9E-06	0.011	9.2E-06	1.6E-05	0.011	6.7E-06	1.1E-05	2.4E-05	4.1E-05
Formaldehyde	50-00-0	0.016	7.2E-06	1.2E-05	0.016	5.2E-06	8.9E-06	0.016	1.4E-05	2.3E-05	0.016	1.0E-05	1.7E-05	3.6E-05	6.2E-05
Methanol	67-56-1	1.2E-03	5.5E-07	9.2E-07	1.2E-03	4.0E-07	6.7E-07	1.2E-03	1.1E-06	1.8E-06	1.2E-03	7.7E-07	1.3E-06	2.8E-06	4.7E-06
Naphthalene	91-20-3	5.0E-04	2.3E-07	3.9E-07	5.0E-04	1.7E-07	2.8E-07	5.0E-04	4.4E-07	7.4E-07	5.0E-04	3.2E-07	5.4E-07	1.2E-06	1.9E-06
n-Hexane	110-54-3	0.016	7.3E-06	1.2E-05	0.016	5.3E-06	9.0E-06	0.016	1.4E-05	2.4E-05	0.016	1.0E-05	1.7E-05	3.7E-05	6.2E-05
Propylene	115-07-1	0.031	1.4E-05	2.4E-05	0.031	1.0E-05	1.7E-05	0.031	2.7E-05	4.5E-05	0.031	2.0E-05	3.3E-05	7.0E-05	1.2E-04
Styrene	100-42-5	1.2E-03	5.5E-07	9.2E-07	1.2E-03	4.0E-07	6.7E-07	1.2E-03	1.1E-06	1.8E-06	1.2E-03	7.7E-07	1.3E-06	2.8E-06	4.7E-06
Toluene	108-88-3	0.058	2.6E-05	4.4E-05	0.058	1.9E-05	3.2E-05	0.058	5.1E-05	8.5E-05	0.058	3.7E-05	6.2E-05	1.3E-04	2.2E-04
m-Xylene	108-38-3	0.036	1.6E-05	2.7E-05	0.036	1.2E-05	2.0E-05	0.036	3.1E-05	5.3E-05	0.036	2.3E-05	3.8E-05	8.2E-05	1.4E-04
o-Xylene	95-47-6	0.012	5.7E-06	9.6E-06	0.012	4.1E-06	7.0E-06	0.012	1.1E-05	1.8E-05	0.012	7.9E-06	1.3E-05	2.9E-05	4.8E-05

Notes:

(a) Maximum hourly emissions estimate (lbs/hr) = (Emission factor [lbs/hr]) x (maximum daily vehicle trips [trips/day]) x (idling time per trip [hrs/trip]) x (TAC emission fraction) / (daily hours of operation [hrs/day])

(b) Annual emissions estimate (tons/yr) = (Emission factor [lbs/hr]) x (annual vehicle trips [trips/yr]) x (idling time per trip [hrs/trip]) x (ton/2,000 lbs) x (TAC emission fraction)

(c) Maximum hourly emissions estimate (lbs/hr) = (Emission factor [lbs/VMT]) x (maximum daily vehicle trips [trips/day]) x (onsite roundtrip distance [mi/trip]) x (TAC emission fraction) / (daily hours of operation [hrs/day])
Offsite roundtrip distance (mi/trip) = 0.86 (3)

(d) Annual emissions estimate (tons/yr) = (Emission factor [lbs/VMT]) x (annual vehicle trips [trips/yr]) x (onsite roundtrip distance [mi/trip]) x (ton/2,000 lbs) x (TAC emission fraction)
Offsite roundtrip distance (mi/trip) = 0.86 (3)

References:

(1) California Air Resources Board Speciation Database. TAC emission fractions are derived from the individual speciation profiles listed. Profiles chosen to best represent the project vehicle fleet and existing gasoline formulation.

(2) Emission Factors source: EMFAC 2011 (Model Years to 2034). Onsite speed set to 15 mile per hour to conservatively estimate onsite emissions. No tire and brake wear emission factors are provided at 15 miles per hour.

(3) See Table N-1, Hypothetical Phase 2 Operations Input Assumptions for Emission Rate Calculations - Including Phase 1 Sources.

Table N-15
Offsite Shuttle TAC Emission Estimates

Parameter		LBNL - RBC Shuttle									BART - RBC Shuttle									
		Running		Tire Wear		Brake Wear		Total	Running		Tire Wear		Brake Wear		Total
Speciation Profile	(1)	2105	(organic)	472	(particulate)	473	(particulate)		2105	(organic)	472	(particulate)	473	(particulate)	
MDV Emission Factor (lbs/VMT)	(2)	1.79E-04	(TOG)	1.8E-05	(PM_{10})	8.1E-05	(PM_{10})		1.79E-04	(TOG)	1.8E-05	(PM_{10})	8.1E-05	(PM_{10})	
Maximum Daily Vehicle Trips (trips/day)	(3)	13		13		13			25		25		25		
Annual Vehicle Trips (trips/yr)	(3)	3,380		3,380		3,380			6,500		6,500		6,500		
Daily Hours of Operation (hrs/day)	(3)	13		13		13			13		13		13		
Offsite Roundtrip[Distance (mi/trip)	(3)	15.5		15.5		15.5			8.0		8.0		8.0		

TAC	CAS	TAC Emission Fraction of TOG (1)	Maximum Hourly Emissions Estimate (a) (lbs/hr)	Annual Average Emissions Estimate (b) (tons/yr)	TAC Emission Fraction of PM_{10} (1)	Maximum Hourly Emissions Estimate (a) (lbs/hr)	Annual Average Emissions Estimate (b) (tons/yr)	TAC Emission Fraction of PM_{10} (1)	Maximum Hourly Emissions Estimate (a) (lbs/hr)	Annual Average Emissions Estimate (b) (tons/yr)	Maximum Hourly Emissions Estimate (lbs/hr)	Annual Average Emissions Estimate (tons/yr)	TAC Emission Fraction of TOG (1)	Maximum Hourly Emissions Estimate (a) (lbs/hr)	Annual Average Emissions Estimate (b) (tons/yr)	TAC Emission Fraction of PM_{10} (1)	Maximum Hourly Emissions Estimate (a) (lbs/hr)	Annual Average Emissions Estimate (b) (tons/yr)	TAC Emission Fraction of PM_{10} (1)	Maximum Hourly Emissions Estimate (a) (lbs/hr)	Annual Average Emissions Estimate (b) (tons/yr)	Maximum Hourly Emissions Estimate (lbs/hr)	Annual Average Emissions Estimate (tons/yr)
1,3-Butadiene	106-99-0	5.5E-03	1.5E-05	2.6E-05	--	--	--	--	--	--	1.5E-05	2.6E-05	5.5E-03	1.5E-05	2.6E-05	--	--	--	--	--	--	1.5E-05	2.6E-05
2-Butanone	78-93-3	2.0E-04	5.6E-07	9.4E-07	--	--	--	--	--	--	5.6E-07	9.4E-07	2.0E-04	5.5E-07	9.3E-07	--	--	--	--	--	--	5.5E-07	9.3E-07
Acetaldehyde	75-07-0	2.8E-03	7.8E-06	1.3E-05	--	--	--	--	--	--	7.8E-06	1.3E-05	2.8E-03	7.7E-06	1.3E-05	--	--	--	--	--	--	7.7E-06	1.3E-05
Acrolein	107-02-8	1.3E-03	3.6E-06	6.1E-06	--	--	--	--	--	--	3.6E-06	6.1E-06	1.3E-03	3.6E-06	6.1E-06	--	--	--	--	--	--	3.6E-06	6.1E-06
Benzene	71-43-2	0.025	6.9E-05	1.2E-04	--	--	--	--	--	--	6.9E-05	1.2E-04	0.025	6.8E-05	1.2E-04	--	--	--	--	--	--	6.8E-05	1.2E-04
Ethylbenzene	100-41-4	0.011	2.9E-05	4.9E-05	--	--	--	--	--	--	2.9E-05	4.9E-05	0.011	2.9E-05	4.9E-05	--	--	--	--	--	--	2.9E-05	4.9E-05
Formaldehyde	50-00-0	0.016	4.4E-05	7.4E-05	--	--	--	--	--	--	4.4E-05	7.4E-05	0.016	4.4E-05	7.4E-05	--	--	--	--	--	--	4.4E-05	7.4E-05
Methanol	67-56-1	1.2E-03	3.3E-06	5.6E-06	--	--	--	--	--	--	3.3E-06	5.6E-06	1.2E-03	3.3E-06	5.6E-06	--	--	--	--	--	--	3.3E-06	5.6E-06
Naphthalene	91-20-3	5.0E-04	1.4E-06	2.3E-06	--	--	--	--	--	--	1.4E-06	2.3E-06	5.0E-04	1.4E-06	2.3E-06	--	--	--	--	--	--	1.4E-06	2.3E-06
n-Hexane	110-54-3	0.016	4.4E-05	7.5E-05	--	--	--	--	--	--	4.4E-05	7.5E-05	0.016	4.4E-05	7.5E-05	--	--	--	--	--	--	4.4E-05	7.5E-05
Propylene	115-07-1	0.031	8.5E-05	1.4E-04	--	--	--	--	--	--	8.5E-05	1.4E-04	0.031	8.4E-05	1.4E-04	--	--	--	--	--	--	8.4E-05	1.4E-04
Styrene	100-42-5	1.2E-03	3.3E-06	5.6E-06	--	--	--	--	--	--	3.3E-06	5.6E-06	1.2E-03	3.3E-06	5.6E-06	--	--	--	--	--	--	3.3E-06	5.6E-06
Toluene	108-88-3	0.058	1.6E-04	2.7E-04	--	--	--	--	--	--	1.6E-04	2.7E-04	0.058	1.6E-04	2.7E-04	--	--	--	--	--	--	1.6E-04	2.7E-04
m-Xylene	108-38-3	0.036	9.9E-05	1.7E-04	--	--	--	--	--	--	9.9E-05	1.7E-04	0.036	9.8E-05	1.7E-04	--	--	--	--	--	--	9.8E-05	1.7E-04
o-Xylene	95-47-6	0.012	3.4E-05	5.8E-05	--	--	--	--	--	--	3.4E-05	5.8E-05	0.012	3.4E-05	5.8E-05	--	--	--	--	--	--	3.4E-05	5.8E-05
Lead	7439-92-1	--	--	--	1.6E-04	4.4E-08	7.4E-08	5.0E-05	6.3E-08	1.1E-07	1.1E-07	1.8E-07	--	--	--	1.6E-04	4.3E-08	7.3E-08	5.0E-05	6.2E-08	1.1E-07	1.1E-07	1.8E-07
Manganese	7439-96-5	--	--	--	1.0E-04	2.7E-08	4.6E-08	1.7E-03	2.1E-06	3.6E-06	2.2E-06	3.7E-06	--	--	--	1.0E-04	2.7E-08	4.6E-08	1.7E-03	2.1E-06	3.6E-06	2.1E-06	3.6E-06
Nickel	7440-02-0	--	--	--	5.0E-05	1.4E-08	2.3E-08	6.6E-04	8.3E-07	1.4E-06	8.4E-07	1.4E-06	--	--	--	5.0E-05	1.4E-08	2.3E-08	6.6E-04	8.2E-07	1.4E-06	8.4E-07	1.4E-06
Arsenic	7440-38-2	--	--	--	No Data	--	--	1.0E-05	1.3E-08	2.1E-08	1.3E-08	2.1E-08	--	--	--	No Data	--	--	1.0E-05	1.2E-08	2.1E-08	1.2E-08	2.1E-08
Copper	7440-50-8	--	--	--	4.9E-04	1.3E-07	2.3E-07	0.011	1.4E-05	2.4E-05	1.5E-05	2.5E-05	--	--	--	4.9E-04	1.3E-07	2.2E-07	0.011	1.4E-05	2.4E-05	1.4E-05	2.4E-05
Vanadium	7440-62-2	--	--	--	No Data	--	--	6.6E-04	8.3E-07	1.4E-06	8.3E-07	1.4E-06	--	--	--	No Data	--	--	6.6E-04	8.2E-07	1.4E-06	8.2E-07	1.4E-06
Bromine	7726-95-6	--	--	--	1.5E-05	4.1E-09	6.9E-09	4.0E-05	5.0E-08	8.5E-08	5.4E-08	9.2E-08	--	--	--	1.5E-05	4.1E-09	6.9E-09	4.0E-05	5.0E-08	8.4E-08	5.4E-08	9.1E-08
Selenium	7782-49-2	--	--	--	2.0E-05	5.5E-09	9.2E-09	2.0E-05	2.5E-08	4.2E-08	3.1E-08	5.2E-08	--	--	--	2.0E-05	5.4E-09	9.2E-09	2.0E-05	2.5E-08	4.2E-08	3.0E-08	5.1E-08
Chlorine	7782-50-5	--	--	--	7.8E-03	2.1E-06	3.6E-06	1.5E-03	1.9E-06	3.2E-06	4.0E-06	6.8E-06	--	--	--	7.8E-03	2.1E-06	3.6E-06	1.5E-03	1.9E-06	3.2E-06	4.0E-06	6.7E-06

Notes:

(a) Maximum hourly emissions estimate (lbs/hr) = (Emission factor [lbs/VMT]) x (maximum daily vehicle trips [trips/day]) x (offsite roundtrip distance [mi/trip]) x (TAC emission fraction) / (daily hours of operation [hrs/day])

(b) Annual emissions estimate (tons/yr) = (Emission factor [lbs/VMT]) x (annual vehicle trips [trips/yr]) x (offsite roundtrip distance [mi/trip]) x (ton/2,000 lbs) x (TAC emission fraction)

References:

(1) California Air Resources Board Speciation Database. TAC emission fractions are derived from the individual speciation profiles listed. Profiles chosen to best represent the project vehicle fleet and existing gasoline formulation.

(2) Emission Factors source: EMFAC 2011 (Model Years to 2034).

(3) See Table N-1, Hypothetical Phase 2 Operations Input Assumptions for Emission Rate Calculations - Including Phase 1 Sources.

Table N-16
Natural Gas Boiler TAC Emission Estimates

Source		Natural Gas Boiler - Buildings 6 and 7	Natural Gas Boiler - Building 8	Natural Gas Boiler - Building 9	Natural Gas Boiler - Building 10	Natural Gas Boiler - Building 11	Total
Maximum Hourly Fuel Usage (MMBtu/hr)	(1)	24	12	12	11	6	
Daily Hours of Operation (hrs/day)	(1)	24	24	24	24	24	
Annual Fuel Usage (MMBtu/yr)	(1)	42,000	21,000	21,000	15,267	8,328	
Modeling ID		NGB_B6_7	NGB_B8	NGB_B9	NGB_B10	NGB_B11	

TAC	CAS	Emission Factor (lbs/MMscf)	Maximum Hourly (a) (lbs/hr)	Annual Average (b) (tons/yr)	Maximum Hourly (a) (lbs/hr)	Annual Average (b) (tons/yr)	Maximum Hourly (a) (lbs/hr)	Annual Average (b) (tons/yr)	Maximum Hourly (a) (lbs/hr)	Annual Average (b) (tons/yr)	Maximum Hourly (a) (lbs/hr)	Annual Average (b) (tons/yr)	Maximum Hourly Emissions Estimate (lbs/hr)	Annual Average Emissions Estimate (tons/yr)
7,12-Dimethylbenz(a)anthracene	57-97-6	1.6E-05 (2)	3.8E-07	3.3E-07	1.9E-07	1.6E-07	1.9E-07	1.6E-07	1.7E-07	1.2E-07	9.4E-08	6.5E-08	1.0E-06	8.4E-07
Acetaldehyde	75-07-0	8.9E-03 (3)	2.1E-04	1.8E-04	1.0E-04	9.1E-05	1.0E-04	9.1E-05	9.6E-05	6.6E-05	5.2E-05	3.6E-05	5.7E-04	4.7E-04
Benzene	71-43-2	4.3E-03 (3)	1.0E-04	8.9E-05	5.1E-05	4.4E-05	5.1E-05	4.4E-05	4.6E-05	3.2E-05	2.5E-05	1.8E-05	2.7E-04	2.3E-04
Dichlorobenzene	25321-22-6	1.2E-03 (4)	2.8E-05	2.5E-05	1.4E-05	1.2E-05	1.4E-05	1.2E-05	1.3E-05	9.0E-06	7.1E-06	4.9E-06	7.6E-05	6.3E-05
Ethylbenzene	100-41-4	6.9E-03 (5)	1.6E-04	1.4E-04	8.1E-05	7.1E-05	8.1E-05	7.1E-05	7.4E-05	5.2E-05	4.1E-05	2.8E-05	4.4E-04	3.6E-04
Fluoranthene	206-44-0	3.0E-06 (2)	7.1E-08	6.2E-08	3.5E-08	3.1E-08	3.5E-08	3.1E-08	3.2E-08	2.2E-08	1.8E-08	1.2E-08	1.9E-07	1.6E-07
Formaldehyde	50-00-0	2.2E-01 (3)	5.2E-03	4.6E-03	2.6E-03	2.3E-03	2.6E-03	2.3E-03	2.4E-03	1.7E-03	1.3E-03	9.0E-04	0.014	0.012
n-Hexane	110-54-3	4.6E-03 (5)	1.1E-04	9.5E-05	5.4E-05	4.7E-05	5.4E-05	4.7E-05	5.0E-05	3.4E-05	2.7E-05	1.9E-05	2.9E-04	2.4E-04
Naphthalene	91-20-3	3.0E-04 (5)	7.1E-06	6.2E-06	3.5E-06	3.1E-06	3.5E-06	3.1E-06	3.2E-06	2.2E-06	1.8E-06	1.2E-06	1.9E-05	1.6E-05
Propylene	115-07-1	5.3E-01 (5)	0.012	0.011	6.2E-03	5.5E-03	6.2E-03	5.5E-03	5.7E-03	4.0E-03	3.1E-03	2.2E-03	0.034	0.028
Toluene	108-88-3	2.7E-02 (5)	6.2E-04	5.5E-04	3.1E-04	2.7E-04	3.1E-04	2.7E-04	2.9E-04	2.0E-04	1.6E-04	1.1E-04	1.7E-03	1.4E-03
Xylenes	1330-20-7	2.0E-02 (5)	4.6E-04	4.1E-04	2.3E-04	2.0E-04	2.3E-04	2.0E-04	2.1E-04	1.5E-04	1.2E-04	8.0E-05	1.3E-03	1.0E-03
Arsenic	7440-38-2	2.0E-04 (4)	4.7E-06	4.1E-06	2.4E-06	2.1E-06	2.4E-06	2.1E-06	2.2E-06	1.5E-06	1.2E-06	8.2E-07	1.3E-05	1.1E-05
Beryllium	7440-41-7	1.2E-05 (4)	2.8E-07	2.5E-07	1.4E-07	1.2E-07	1.4E-07	1.2E-07	1.3E-07	9.0E-08	7.1E-08	4.9E-08	7.6E-07	6.3E-07
Cadmium	7440-43-9	1.1E-03 (4)	2.6E-05	2.3E-05	1.3E-05	1.1E-05	1.3E-05	1.1E-05	1.2E-05	8.2E-06	6.5E-06	4.5E-06	7.0E-05	5.8E-05
Chromium VI	18540-29-9	2.4E-04 (6)	5.6E-06	4.9E-06	2.8E-06	2.5E-06	2.8E-06	2.5E-06	2.6E-06	1.8E-06	1.4E-06	9.7E-07	1.5E-05	1.3E-05
Cobalt	7440-48-4	8.4E-05 (4)	2.0E-06	1.7E-06	9.9E-07	8.6E-07	9.9E-07	8.6E-07	9.1E-07	6.3E-07	4.9E-07	3.4E-07	5.4E-06	4.4E-06
Copper	7440-50-8	8.5E-04 (4)	2.0E-05	1.8E-05	1.0E-05	8.8E-06	1.0E-05	8.8E-06	9.2E-06	6.4E-06	5.0E-06	3.5E-06	5.4E-05	4.5E-05
Lead	7439-92-1	5.0E-04 (4)	1.2E-05	1.0E-05	5.9E-06	5.1E-06	5.9E-06	5.1E-06	5.4E-06	3.7E-06	2.9E-06	2.0E-06	3.2E-05	2.6E-05
Manganese	7439-96-5	3.8E-04 (4)	8.9E-06	7.8E-06	4.5E-06	3.9E-06	4.5E-06	3.9E-06	4.1E-06	2.8E-06	2.2E-06	1.6E-06	2.4E-05	2.0E-05
Mercury	7439-97-6	2.6E-04 (4)	6.1E-06	5.4E-06	3.1E-06	2.7E-06	3.1E-06	2.7E-06	2.8E-06	1.9E-06	1.5E-06	1.1E-06	1.7E-05	1.4E-05
Nickel	7440-02-0	2.1E-03 (4)	4.9E-05	4.3E-05	2.5E-05	2.2E-05	2.5E-05	2.2E-05	2.3E-05	1.6E-05	1.2E-05	8.6E-06	1.3E-04	1.1E-04
Selenium	7782-49-2	2.4E-05 (4)	5.6E-07	4.9E-07	2.8E-07	2.5E-07	2.8E-07	2.5E-07	2.6E-07	1.8E-07	1.4E-07	9.8E-08	1.5E-06	1.3E-06

Notes:

(a) Maximum hourly emissions estimate (lbs/hr) = (Emission factor [lbs/MMscf]) x (maximum hourly heat input [MMBtu/hr])/ (natural gas heat content [Btu/scf])

Natural gas heat content (Btu/scf) = 1,020 (2)

(b) Annual emissions estimate (tons/yr) = (Emission factor [lbs/MMscf]) x (annual heat input [MMBtu/yr]) / (natural gas heat content [Btu/scf]) x (tons/2,000 lbs)

Natural gas heat content (Btu/scf) = 1,020 (2)

References:

(1) See Table N-1, Hypothetical Phase 2 Operations Input Assumptions for Emission Rate Calculations - Including Phase 1 Sources.
(2) AP-42 Chapter 1.4 (July 1998), Table 1.4-3 "Emission Factors For Speciated Organic Compounds from Natural Gas Combustion".
(3) California Air Toxics Emission Factor (CATEF) Database under Natural Gas Boilers.
(4) AP-42 Chapter 1.4 (July 1998), Table 1.4-4 "Emission Factors For Metals from Natural Gas Combustion".
(5) Ventura Air Quality Management District emission factor database.
(6) The AP-42 total chromium emission factor was multiplied by 17% to correct for emissions of hexavalent chromium per EPA assumptions when regulating combustion sources under 40 CFR Part 63 Subpart DDDD.

Table N-17
Emergency Diesel Generator TAC Emission Estimates

Source		Diesel Generator - Building 6	Diesel Generator - Building 7	Diesel Generator - Building 8	Diesel Generator - Building 9	Diesel Generator - Building 10	Diesel Generator - Building 11	Total
BHP	(1)	440	440	440	440	410	240	
Diesel Fuel Combustion (gal/hr)	(1)	22.3	22.3	22.3	22.3	20.8	12.2	
Load Factor	(2)	0.74	0.74	0.74	0.74	0.74	0.74	
Annual Operation (hrs/yr)	(1)	25.15	25.15	25.15	25.15	25.15	25.15	
Modeling ID		DG_B6	DG_B7	DG_B8	DG_B9	DG_B10	DG_B11	

TAC	CAS	Emission Factor (lbs/10^3 gal)	Maximum Hourly (lbs/hr)	Annual Average [a] (tons/yr)	Maximum Hourly (lbs/hr)	Annual Average [a] (tons/yr)	Maximum Hourly (lbs/hr)	Annual Average [a] (tons/yr)	Maximum Hourly (lbs/hr)	Annual Average [a] (tons/yr)	Maximum Hourly (lbs/hr)	Annual Average [a] (tons/yr)	Maximum Hourly (lbs/hr)	Annual Average [a] (tons/yr)	Maximum Hourly Emissions Estimate (lbs/hr)	Annual Average Emissions Estimate (tons/yr)
DPM	9901	-- [3]	0.011 [b]	1.4E-04	0.011 [b]	1.4E-04	7.2E-03 [b]	9.0E-05	7.2E-03 [b]	9.0E-05	0.010 [b]	1.3E-04	5.9E-03 [b]	7.4E-05	0.052	6.5E-04
1,3-Butadiene	106-99-0	2.17E-01 [4]	3.6E-03 [c]	4.5E-05	3.6E-03 [c]	4.5E-05	3.6E-03 [c]	4.5E-05	3.6E-03 [c]	4.5E-05	3.3E-03 [c]	4.2E-05	2.0E-03 [c]	2.5E-05	0.020	2.5E-04
Acetaldehyde	75-07-0	3.47E-03 [5]	5.7E-05 [c]	7.2E-07	5.7E-05 [c]	7.2E-07	5.7E-05 [c]	7.2E-07	5.7E-05 [c]	7.2E-07	5.3E-05 [c]	6.7E-07	3.1E-05 [c]	3.9E-07	3.1E-04	3.9E-06
Benzene	71-43-2	1.93E-01 [5]	3.2E-03 [c]	4.0E-05	3.2E-03 [c]	4.0E-05	3.2E-03 [c]	4.0E-05	3.2E-03 [c]	4.0E-05	3.0E-03 [c]	3.7E-05	1.7E-03 [c]	2.2E-05	0.017	2.2E-04
Benzo(a)anthracene	56-55-3	-- [6]	--	--	--	--	--	--	--	--	--	--	--	--	0	0
Benzo(b)fluoranthene	205-99-2	-- [6]	--	--	--	--	--	--	--	--	--	--	--	--	0	0
Benzo(k)fluoranthene	207-08-9	-- [6]	--	--	--	--	--	--	--	--	--	--	--	--	0	0
Chlorobenzene	108-90-7	2.00E-04 [4]	3.3E-06 [c]	4.2E-08	3.3E-06 [c]	4.2E-08	3.3E-06 [c]	4.2E-08	3.3E-06 [c]	4.2E-08	3.1E-06 [c]	3.9E-08	1.8E-06 [c]	2.3E-08	1.8E-05	2.3E-07
Chrysene	218-01-9	-- [6]	--	--	--	--	--	--	--	--	--	--	--	--	0	0
Dibenz(a,h)anthracene	53-70-3	-- [6]	--	--	--	--	--	--	--	--	--	--	--	--	0	0
Ethylbenzene	100-41-4	6.76E-03 [5]	1.1E-04 [c]	1.4E-06	1.1E-04 [c]	1.4E-06	1.1E-04 [c]	1.4E-06	1.1E-04 [c]	1.4E-06	1.0E-04 [c]	1.3E-06	6.1E-05 [c]	7.7E-07	6.1E-04	7.7E-06
Formaldehyde	50-00-0	5.06E-02 [5]	8.3E-04 [c]	1.0E-05	8.3E-04 [c]	1.0E-05	8.3E-04 [c]	1.0E-05	8.3E-04 [c]	1.0E-05	7.8E-04 [c]	9.8E-06	4.6E-04 [c]	5.7E-06	4.6E-03	5.8E-05
n-Hexane	110-54-3	1.39E-03 [5]	2.3E-05 [c]	2.9E-07	2.3E-05 [c]	2.9E-07	2.3E-05 [c]	2.9E-07	2.3E-05 [c]	2.9E-07	2.1E-05 [c]	2.7E-07	1.3E-05 [c]	1.6E-07	1.3E-04	1.6E-06
Hydrogen Chloride	7647-01-0	1.86E-01 [4]	3.1E-03 [c]	3.9E-05	3.1E-03 [c]	3.9E-05	3.1E-03 [c]	3.9E-05	3.1E-03 [c]	3.9E-05	2.9E-03 [c]	3.6E-05	1.7E-03 [c]	2.1E-05	0.017	2.1E-04
Indeno(1,2,3-cd)pyrene	193-39-5	-- [6]	--	--	--	--	--	--	--	--	--	--	--	--	0	0
Naphthalene	91-20-3	1.60E-02 [5]	2.6E-04 [c]	3.3E-06	2.6E-04 [c]	3.3E-06	2.6E-04 [c]	3.3E-06	2.6E-04 [c]	3.3E-06	2.5E-04 [c]	3.1E-06	1.4E-04 [c]	1.8E-06	1.4E-03	1.8E-05
Propylene	115-07-1	3.41E-01 [5]	5.6E-03 [c]	7.1E-05	5.6E-03 [c]	7.1E-05	5.6E-03 [c]	7.1E-05	5.6E-03 [c]	7.1E-05	5.2E-03 [c]	6.6E-05	3.1E-03 [c]	3.9E-05	0.031	3.9E-04
Toluene	108-88-3	6.12E-02 [5]	1.0E-03 [c]	1.3E-05	1.0E-03 [c]	1.3E-05	1.0E-03 [c]	1.3E-05	1.0E-03 [c]	1.3E-05	9.4E-04 [c]	1.2E-05	5.5E-04 [c]	6.9E-06	5.5E-03	7.0E-05
Xylenes	1330-20-7	4.24E-02 [4]	7.0E-04 [c]	8.8E-06	7.0E-04 [c]	8.8E-06	7.0E-04 [c]	8.8E-06	7.0E-04 [c]	8.8E-06	6.5E-04 [c]	8.2E-06	3.8E-04 [c]	4.8E-06	3.8E-03	4.8E-05
Arsenic	7440-38-2	1.60E-03 [4]	2.6E-05 [c]	3.3E-07	2.6E-05 [c]	3.3E-07	2.6E-05 [c]	3.3E-07	2.6E-05 [c]	3.3E-07	2.5E-05 [c]	3.1E-07	1.4E-05 [c]	1.8E-07	1.4E-04	1.8E-06
Cadmium	7440-43-9	1.50E-03 [4]	2.5E-05 [c]	3.1E-07	2.5E-05 [c]	3.1E-07	2.5E-05 [c]	3.1E-07	2.5E-05 [c]	3.1E-07	2.3E-05 [c]	2.9E-07	1.4E-05 [c]	1.7E-07	1.4E-04	1.7E-06
Chromium VI	18540-29-9	1.00E-04 [7]	1.7E-06 [c]	2.1E-08	1.7E-06 [c]	2.1E-08	1.7E-06 [c]	2.1E-08	1.7E-06 [c]	2.1E-08	1.5E-06 [c]	1.9E-08	9.0E-07 [c]	1.1E-08	9.0E-06	1.1E-07
Copper	7440-50-8	4.10E-03 [4]	6.8E-05 [c]	8.5E-07	6.8E-05 [c]	8.5E-07	6.8E-05 [c]	8.5E-07	6.8E-05 [c]	8.5E-07	6.3E-05 [c]	7.9E-07	3.7E-05 [c]	4.6E-07	3.7E-04	4.7E-06
Lead	7439-92-1	8.30E-03 [4]	1.4E-04 [c]	1.7E-06	1.4E-04 [c]	1.7E-06	1.4E-04 [c]	1.7E-06	1.4E-04 [c]	1.7E-06	1.3E-04 [c]	1.6E-06	7.5E-05 [c]	9.4E-07	7.5E-04	9.4E-06
Manganese	7439-96-5	3.10E-03 [4]	5.1E-05 [c]	6.4E-07	5.1E-05 [c]	6.4E-07	5.1E-05 [c]	6.4E-07	5.1E-05 [c]	6.4E-07	4.8E-05 [c]	6.0E-07	2.8E-05 [c]	3.5E-07	2.8E-04	3.5E-06
Mercury	7439-97-6	2.00E-03 [4]	3.3E-05 [c]	4.2E-07	3.3E-05 [c]	4.2E-07	3.3E-05 [c]	4.2E-07	3.3E-05 [c]	4.2E-07	3.1E-05 [c]	3.9E-07	1.8E-05 [c]	2.3E-07	1.8E-04	2.3E-06
Nickel	7440-02-0	3.90E-03 [4]	6.4E-05 [c]	8.1E-07	6.4E-05 [c]	8.1E-07	6.4E-05 [c]	8.1E-07	6.4E-05 [c]	8.1E-07	6.0E-05 [c]	7.5E-07	3.5E-05 [c]	4.4E-07	3.5E-04	4.4E-06
Selenium	7782-49-2	2.20E-03 [4]	3.6E-05 [c]	4.6E-07	3.6E-05 [c]	4.6E-07	3.6E-05 [c]	4.6E-07	3.6E-05 [c]	4.6E-07	3.4E-05 [c]	4.3E-07	2.0E-05 [c]	2.5E-07	2.0E-04	2.5E-06

Modeling ID		DG_B6	DG_B7	DG_B8	DG_B9	DG_B10	DG_B11
Diesel Particulate Emission factor (g/hp-hr)	(6)	0.015	0.015	0.01	0.01	0.015	0.015

Notes:

(a) Annual average emission estimate (tons/yr) = (Maximum hourly emissions estimate [lbs/hr]) x (annual hours of operation [hrs/yr]) x (ton/2,000 lbs)

(b) Maximum hourly diesel particulate emissions estimate (lbs/hr) = (Emission factor [g/hp-hr]) x (engine horsepower [hp]) x (load factor) / (453.59 [g/lb])

(c) Maximum hourly emissions estimate (lbs/hr) = (Emission factor [lbs/10^3 gal]) x (load factor) x (fuel usage [gal/hr]) x (0.001 gal/10^3 gal)

References:

(1) See Table N-1, Hypothetical Phase 2 Operations Input Assumptions for Emission Rate Calculations - Including Phase 1 Sources.

(2) Default load factor for generators in URBEMIS emission model.

(3) See diesel particulate matter emission factors at the bottom of the table.

(4) Ventura County Air Pollution Control District AB 2588 Combustion Emission Factors Database, May 2001.

(5) California Toxic Emission Factor (CATEF) Database, except for Diesel PM. The emission factors for each TAC are averaged for diesel internal combustion engines operating at less than 13% oxygen in the exhaust. Per vendor information, the percent oxygen in the exhaust is less than 13% at loads greater than 50%. It is assumed that the generator would be run at 50% load or greater.

(6) Polycyclic Aromatic Hydrocarbons (PAHs) are assumed to be included in the particulate matter emission factor. PAHs that are not specifically listed in this table, but may be included in the particulate matter emission factor, include Acenaphthylene, Anthracene, Acenaphthene, Benzo(a)anthracene, Benzo(a)pyrene, Benzo(b)fluoranthene, Benzo(k)fluoranthene, Benzo(g,h,i)perylene, Chrysene, Dibenz(a,h)anthracene, Fluoranthene, Fluorene, Indeno(1,2,3-cd)pyrene, Phenanthrene, and Pyrene. For purposes of this inventory, it is assumed that all particulate is represented as Diesel Particulate Matter (DPM).

(7) The AP-42 total chromium emission factor was multiplied by 17% to correct for emissions of hexavalent chromium per EPA assumptions when regulating combustion sources under 40 CFR Part 63 Subpart DDDD.

Table N-18
Cooling Tower Particulate Emission Estimates

Pollutant				Bromine	
				Emissions Estimates	
Source	Modeling ID	PM_{10} Emission Rate [1] (lbs/day)	Annual Operation [1] (hrs/yr)	Maximum Daily [a] (lbs/hr)	Annual Average [b] (tons/yr)
Cooling Tower - Building 8	CTB8C#	1.29	6,360	1.0E-04	3.2E-04
Cooling Tower - Building 9	CTB9C#	1.29	6,360	1.0E-04	3.2E-04
Cooling Tower - Building 10	CTB10C#	1.29	6,360	1.0E-04	3.2E-04
Cooling Tower - Building 11	CTB11C#	0.69	6,360	5.3E-05	1.7E-04
Cooling Tower - Buildings 6 and 7	CTB6_7C#	2.58	6,360	2.0E-04	6.4E-04
Total				**5.5E-04**	**1.8E-03**

Notes:

(a) Maximum daily emissions estimate (lbs/day) = (PM_{10} emission rate [lbs/day]) x (ChemTreat CL-4910 bromine concentration [ppm]) / (total dissolved solids concentration [ppm]) / (daily hours of operation [hrs/day])

ChemTreat CL-4910 bromine concentration (ppm) =	1	(2)
Total dissolved solids concentration (ppmw) =	536	(3)
Daily hours of operation (hrs/day) =	24	(3)

(b) Annual emissions estimate (tons/yr) = (Hourly emissions [lbs/hr]) x (annual hours of operation [hrs/yr]) x (ton/2,000 lbs)

References:

(1) See Table N-10, Cooling Tower Particulate Emission Estimates.
(2) Provided by ChemTreat.
(3) See Table N-1, Hypothetical Phase 2 Operations Input Assumptions for Emission Rate Calculations - Including Phase 1 Sources.

Table N-19
Total Estimated Air Emissions of Laboratory Non-Radionuclide Liquid Chemicals

Source				Lab Hood Exhaust Stack - Buildings 6 and 7		Lab Hood Exhaust Stack - Building 8		Lab Hood Exhaust Stack - Building 9		Lab Hood Exhaust Stack - Building 10		Lab Hood Exhaust Stack - Building 11		Total	
Building size (gsf)			(1)	253,954		110,510		137,451		117,700		67,280			
Modeling ID				LAB_B6_7		LAB_B8		LAB_B9		LAB_B10		LAB_B11			
TAC	**CAS**	**Total Phase I Emissions (2) (tons/yr)**	**Phase I Emissions Fraction (a) (tons/gsf/yr)**	**Maximum Hourly (b) (lbs/hr)**	**Annual Average (2) (tons/yr)**	**Maximum Hourly (b) (lbs/hr)**	**Annual Average (2) (tons/yr)**	**Maximum Hourly (b) (lbs/hr)**	**Annual Average (2) (tons/yr)**	**Maximum Hourly (b) (lbs/hr)**	**Annual Average (c) (tons/yr)**	**Maximum Hourly (b) (lbs/hr)**	**Annual Average (c) (tons/yr)**	**Maximum Hourly (lbs/hr)**	**Annual Average (tons/yr)**
1,3-Butadiene	106-99-0	3.2E-04	6.3E-10	--	--	1.3E-03	3.2E-04	--	--	2.9E-04	7.4E-05	1.7E-04	4.2E-05	1.7E-03	4.3E-04
1,4-Dioxane	123-91-1	3.4E-03	6.8E-09	--	--	0.012	3.1E-03	1.4E-03	3.5E-04	3.2E-03	8.0E-04	1.8E-03	4.6E-04	0.019	4.7E-03
Acetaldehyde	75-07-0	1.6E-04	3.2E-10	--	--	6.3E-04	1.6E-04	--	--	1.5E-04	3.7E-05	8.5E-05	2.1E-05	8.7E-04	2.2E-04
Acrolein	107-02-8	7.7E-05	1.5E-10	3.1E-04	7.7E-05	--	--	--	--	7.2E-05	1.8E-05	4.1E-05	1.0E-05	4.2E-04	1.1E-04
Acrylic acid	79-10-7	1.1E-05	2.2E-11	--	--	4.4E-05	1.1E-05	--	--	1.0E-05	2.6E-06	5.9E-06	1.5E-06	6.0E-05	1.5E-05
Aniline	62-53-3	2.7E-06	5.4E-12	9.7E-07	2.4E-07	9.7E-06	2.4E-06	--	--	2.5E-06	6.3E-07	1.4E-06	3.6E-07	1.5E-05	3.7E-06
Benzene	71-43-2	2.1E-03	4.3E-09	2.1E-03	5.1E-04	4.4E-03	1.1E-03	2.1E-03	5.1E-04	2.0E-03	5.0E-04	1.1E-03	2.9E-04	0.012	2.9E-03
Benzyl chloride	100-44-7	5.7E-06	1.1E-11	--	--	2.3E-05	5.7E-06	--	--	5.3E-06	1.3E-06	3.0E-06	7.6E-07	3.1E-05	7.8E-06
Bromine	7726-95-6	1.2E-06	2.5E-12	--	--	4.9E-06	1.2E-06	--	--	1.2E-06	2.9E-07	6.6E-07	1.7E-07	6.8E-06	1.7E-06
Carbon tetrachloride	56-23-5	3.2E-04	6.5E-10	1.3E-03	3.2E-04	--	--	--	--	3.0E-04	7.6E-05	1.7E-04	4.4E-05	1.8E-03	4.4E-04
Chloroform	67-66-3	0.051	1.0E-07	0.082	0.020	0.074	0.018	0.049	0.012	0.048	0.012	0.027	6.9E-03	0.28	0.070
Diethanolamine	111-42-2	3.3E-09	6.6E-15	7.6E-09	1.9E-09	1.9E-09	4.7E-10	3.8E-09	9.5E-10	3.1E-09	7.8E-10	1.8E-09	4.5E-10	1.8E-08	4.6E-09
Dimethyl formamide	68-12-2	5.7E-04	1.1E-09	1.4E-03	3.6E-04	7.9E-04	2.0E-04	5.1E-05	1.3E-05	5.3E-04	1.3E-04	3.0E-04	7.6E-05	3.1E-03	7.8E-04
Epichlorohydrin	106-89-8	1.6E-05	3.2E-11	--	--	6.5E-05	1.6E-05	--	--	1.5E-05	3.8E-06	8.7E-06	2.2E-06	8.9E-05	2.2E-05
Ethylbenzene	100-41-4	1.0E-04	2.0E-10	--	--	4.0E-04	1.0E-04	--	--	9.3E-05	2.3E-05	5.3E-05	1.3E-05	5.5E-04	1.4E-04
Ethylene dichloride [EDC]	107-06-2	2.3E-03	4.6E-09	--	--	9.2E-03	2.3E-03	--	--	2.1E-03	5.4E-04	1.2E-03	3.1E-04	0.013	3.1E-03
Ethylene glycol	107-21-1	6.0E-06	1.2E-11	1.2E-05	3.0E-06	4.7E-06	1.2E-06	7.0E-06	1.8E-06	5.6E-06	1.4E-06	3.2E-06	8.0E-07	3.3E-05	8.2E-06
Ethylene glycol monomethyl ether	109-86-4	8.5E-05	1.7E-10	--	--	3.4E-04	8.5E-05	--	--	7.9E-05	2.0E-05	4.5E-05	1.1E-05	4.6E-04	1.2E-04
Formaldehyde	50-00-0	0.014	2.7E-08	0.043	0.011	3.5E-03	8.7E-04	7.5E-03	1.9E-03	0.013	3.2E-03	7.3E-03	1.8E-03	0.074	0.019
Glutaraldehyde	111-30-8	4.9E-05	9.8E-11	1.4E-04	3.6E-05	1.3E-05	3.3E-06	3.9E-05	9.8E-06	4.6E-05	1.1E-05	2.6E-05	6.6E-06	2.7E-04	6.7E-05
n-Hexane	110-54-3	0.044	8.8E-08	0.027	6.9E-03	0.14	0.035	8.7E-03	2.2E-03	0.041	0.010	0.024	5.9E-03	0.24	0.060
Hydrogen Chloride	7647-01-0	0.042	8.3E-08	0.090	0.023	0.049	0.012	0.028	7.0E-03	0.039	9.8E-03	0.022	5.6E-03	0.23	0.057
Hydrogen fluoride	7664-39-3	4.1E-05	8.2E-11	1.6E-04	4.1E-05	--	--	--	--	3.9E-05	9.7E-06	2.2E-05	5.5E-06	2.3E-04	5.7E-05
Isopropyl alcohol	67-63-0	0.039	7.8E-08	0.063	0.016	0.047	0.012	0.046	0.012	0.036	9.1E-03	0.021	5.2E-03	0.21	0.053
Lindane [gamma-Hexachlorocyclohexane]	58-89-9	1.3E-10	2.6E-16	5.2E-10	1.3E-10	--	--	--	--	1.2E-10	3.1E-11	7.0E-11	1.8E-11	7.2E-10	1.8E-10
m-Cresol	108-39-4	1.3E-06	2.6E-12	2.6E-06	6.5E-07	2.6E-06	6.5E-07	--	--	1.2E-06	3.1E-07	7.0E-07	1.7E-07	7.1E-06	1.8E-06
Methanol	67-56-1	0.050	1.0E-07	0.061	0.015	0.13	0.033	8.4E-03	2.1E-03	0.047	0.012	0.027	6.7E-03	0.27	0.068
2-Butanone	78-93-3	1.1E-03	2.1E-09	--	--	4.3E-03	1.1E-03	--	--	1.0E-03	2.5E-04	5.7E-04	1.4E-04	5.9E-03	1.5E-03
Methyl tert-butyl ether	1634-04-4	7.5E-04	1.5E-09	3.1E-04	7.7E-05	2.7E-03	6.7E-04	--	--	7.0E-04	1.8E-04	4.0E-04	1.0E-04	4.1E-03	1.0E-03
Methylene chloride [Dichloromethane]	75-09-2	0.056	1.1E-07	4.6E-03	1.2E-03	0.22	0.055	3.1E-04	7.7E-05	0.052	0.013	0.030	7.5E-03	0.30	0.076
Nitric acid	7697-37-2	2.1E-03	4.1E-09	--	--	6.5E-03	1.6E-03	1.7E-03	4.3E-04	1.9E-03	4.8E-04	1.1E-03	2.8E-04	0.011	2.8E-03
Tetrachloroehtene	127-18-4	2.6E-04	5.2E-10	--	--	1.0E-03	2.6E-04	--	--	2.4E-04	6.1E-05	1.4E-04	3.5E-05	1.4E-03	3.6E-04
Phosphoric acid	7664-38-2	5.9E-06	1.2E-11	7.5E-06	1.9E-06	1.0E-05	2.5E-06	6.0E-06	1.5E-06	5.5E-06	1.4E-06	3.2E-06	7.9E-07	3.2E-05	8.1E-06
Propylene glycol monomethyl ether	107-98-2	1.1E-05	2.1E-11	--	--	2.1E-05	5.3E-06	2.1E-05	5.3E-06	1.0E-05	2.5E-06	5.7E-06	1.4E-06	5.8E-05	1.5E-05
Propylene oxide	75-56-9	4.7E-07	9.3E-13	1.9E-06	4.7E-07	--	--	--	--	4.4E-07	1.1E-07	2.5E-07	6.2E-08	2.5E-06	6.4E-07
Styrene	100-42-5	3.0E-05	6.0E-11	--	--	1.2E-04	3.0E-05	--	--	2.8E-05	7.0E-06	1.6E-05	4.0E-06	1.6E-04	4.1E-05
Sulfuric acid	7664-93-9	2.1E-04	4.1E-10	3.4E-04	8.6E-05	4.1E-04	1.0E-04	6.7E-05	1.7E-05	1.9E-04	4.8E-05	1.1E-04	2.8E-05	1.1E-03	2.8E-04
Toluene	108-88-3	5.1E-03	1.0E-08	8.3E-03	2.1E-03	0.012	3.0E-03	3.1E-04	7.7E-05	4.8E-03	1.2E-03	2.7E-03	6.9E-04	0.028	7.0E-03
Trichloroethylene	79-01-6	1.2E-03	2.3E-09	1.2E-03	2.9E-04	3.5E-03	8.8E-04	--	--	1.1E-03	2.7E-04	6.2E-04	1.6E-04	6.4E-03	1.6E-03
Triethylamine	121-44-8	1.4E-03	2.8E-09	1.2E-03	3.1E-04	4.4E-03	1.1E-03	--	--	1.3E-03	3.3E-04	7.5E-04	1.9E-04	7.7E-03	1.9E-03
Xylenes	1330-20-7	9.6E-04	1.9E-09	3.8E-03	9.6E-04	--	--	--	--	8.9E-04	2.2E-04	5.1E-04	1.3E-04	5.2E-03	1.3E-03
Total - All Chemicals Listed		**0.32**	**6.3E-07**	**0.39**	**0.098**	**0.72**	**0.18**	**0.15**	**0.039**	**0.30**	**0.075**	**0.17**	**0.043**	**1.74**	**0.44**

Notes:

(a) Phase I emissions fraction (tons/gsf/yr) = (Phase I emissions [tons/yr]) / (total Phase I building gsf)

Total Phase I building gsf = 501,915 (1)

(b) Maximum hourly emissions estimate (lbs/hr) = (Annual average emissions [tons/year]) / (annual operation [days/year]) / (daily operation [hrs/day]) x (2,000 lbs/ton) x (conversion factor)

Annual operation for all buildings (days/year) = 260 (1)

Daily operation for all buildings (hrs/day) = 10 (1)

Conversion factor = 5.18 (3)

(c) Annual average emissions estimate (tons/yr) = (Phase I emissions fraction [tons/gsf/yr]) x (building size [gsf])

References:

(1) See Table N-1, Hypothetical Phase 2 Operations Input Assumptions for Emission Rate Calculations - Including Phase 1 Sources.

(2) Phase 1 Laboratory emissions calculated as part of the Phase 1 assessment. See Appendix G.

(3) Based in studies comparing maximum to average emission rates for laboratories. See text for further information.

Table N-20
Hypothetical Phase 2 Operations TAC Emissions Summary

TAC	CAS	Natural Gas Boilers		Diesel Generators		Cooling Towers		Laboratory Buildings		Onsite Onroad Exhaust		Offsite Onroad Exhaust		Total	
		(lbs/hr)	(tons/yr)	(lbs/hr)	(tons/yr)	(lbs/hr)	(tons/yr)	(lbs/hr)	(tons/yr)	(lbs/hr)	(tons/yr)	(lbs/hr)	(tons/yr)	(lbs/hr)	(tons/yr)
DPM (1)	9901	--	--	0.052	6.5E-04	--	--	--	--	1.7E-04	3.5E-04	2.3E-03	4.8E-03	0.054	5.8E-03
1,3-Butadiene	106-99-0	--	--	0.020	2.5E-04	--	--	1.7E-03	4.3E-04	6.9E-04	1.4E-03	1.6E-03	3.4E-03	0.024	5.5E-03
1,4-Dioxane	123-91-1	--	--	--	--	--	--	0.019	4.7E-03	--	--	--	--	0.019	4.7E-03
2-Butanone	78-93-3	--	--	--	--	--	--	5.9E-03	1.5E-03	5.0E-05	1.0E-04	5.9E-05	1.2E-04	6.0E-03	1.7E-03
7,12-Dimethylbenz(a)anthracene	57-97-6	1.0E-06	8.4E-07	--	--	--	--	--	--	--	--	--	--	1.0E-06	8.4E-07
Acetaldehyde	75-07-0	5.7E-04	4.7E-04	3.1E-04	3.9E-06	--	--	8.7E-04	2.2E-04	4.7E-04	9.7E-04	8.3E-04	1.7E-03	3.0E-03	3.4E-03
Acrolein	107-02-8	--	--	--	--	--	--	4.2E-04	1.1E-04	1.2E-04	2.6E-04	3.8E-04	8.0E-04	9.3E-04	1.2E-03
Acrylic acid	79-10-7	--	--	--	--	--	--	6.0E-05	1.5E-05	--	--	--	--	6.0E-05	1.5E-05
Aniline	62-53-3	--	--	--	--	--	--	1.5E-05	3.7E-06	--	--	--	--	1.5E-05	3.7E-06
Arsenic	7440-38-2	1.3E-05	1.1E-05	1.4E-04	1.8E-06	--	--	--	--	--	--	3.6E-06	7.4E-06	1.6E-04	2.0E-05
Benzene	71-43-2	2.7E-04	2.3E-04	0.017	2.2E-04	--	--	0.012	2.9E-03	4.5E-03	9.3E-03	7.3E-03	0.015	0.041	0.028
Benzyl chloride	100-44-7	--	--	--	--	--	--	3.1E-05	7.8E-06	--	--	--	--	3.1E-05	7.8E-06
Beryllium	7440-41-7	7.6E-07	6.3E-07	--	--	--	--	--	--	--	--	--	--	7.6E-07	6.3E-07
Bromine	7726-95-6	--	--	--	--	5.5E-04	1.8E-03	6.8E-06	1.7E-06	--	--	1.5E-05	3.2E-05	5.8E-04	1.8E-03
Cadmium	7440-43-9	7.0E-05	5.8E-05	1.4E-04	1.7E-06	--	--	--	--	--	--	--	--	2.1E-04	6.0E-05
Carbon tetrachloride	56-23-5	--	--	--	--	--	--	1.8E-03	4.4E-04	--	--	--	--	1.8E-03	4.4E-04
Chlorine	7782-50-5	--	--	--	--	--	--	--	--	--	--	1.1E-03	2.4E-03	1.1E-03	2.4E-03
Chlorobenzene	108-90-7	--	--	1.8E-05	2.3E-07	--	--	--	--	--	--	--	--	1.8E-05	2.3E-07
Chloroform	67-66-3	--	--	--	--	--	--	0.28	0.070	--	--	--	--	0.28	0.070
Chromium VI	18540-29-9	1.5E-05	1.3E-05	9.0E-06	1.1E-07	--	--	--	--	--	--	--	--	2.4E-05	1.3E-05
Cobalt	7440-48-4	5.4E-06	4.4E-06	--	--	--	--	--	--	--	--	--	--	5.4E-06	4.4E-06
Copper	7440-50-8	5.4E-05	4.5E-05	3.7E-04	4.7E-06	--	--	--	--	--	--	4.2E-03	8.6E-03	4.6E-03	8.7E-03
Dichlorobenzene	25321-22-6	7.6E-05	6.3E-05	--	--	--	--	--	--	--	--	--	--	7.6E-05	6.3E-05
Diethanolamine	111-42-2	--	--	--	--	--	--	1.8E-08	4.6E-09	--	--	--	--	1.8E-08	4.6E-09
Dimethyl formamide	68-12-2	--	--	--	--	--	--	3.1E-03	7.8E-04	--	--	--	--	3.1E-03	7.8E-04
Epichlorohydrin	106-89-8	--	--	--	--	--	--	8.9E-05	2.2E-05	--	--	--	--	8.9E-05	2.2E-05
Ethylbenzene	100-41-4	4.4E-04	3.6E-04	6.1E-04	7.7E-06	--	--	5.5E-04	1.4E-04	4.4E-03	9.2E-03	3.1E-03	6.4E-03	9.1E-03	0.016
Ethylene dichloride [EDC]	107-06-2	--	--	--	--	--	--	0.013	3.1E-03	--	--	--	--	0.013	3.1E-03
Ethylene glycol	107-21-1	--	--	--	--	--	--	3.3E-05	8.2E-06	--	--	--	--	3.3E-05	8.2E-06
Ethylene glycol monomethyl ether	109-86-4	--	--	--	--	--	--	4.6E-04	1.2E-04	--	--	--	--	4.6E-04	1.2E-04
Fluoranthene	206-44-0	1.9E-07	1.6E-07	--	--	--	--	--	--	--	--	--	--	1.9E-07	1.6E-07
Formaldehyde	50-00-0	0.014	0.012	4.6E-03	5.8E-05	--	--	0.074	0.019	1.4E-03	3.0E-03	4.7E-03	9.7E-03	0.099	0.043
Glutaraldehyde	111-30-8	--	--	--	--	--	--	2.7E-04	6.7E-05	--	--	--	--	2.7E-04	6.7E-05
Hydrogen Chloride	7647-01-0	--	--	0.017	2.1E-04	--	--	0.23	0.057	--	--	--	--	0.25	0.058
Hydrogen fluoride	7664-39-3	--	--	--	--	--	--	2.3E-04	5.7E-05	--	--	--	--	2.3E-04	5.7E-05
Isopropyl alcohol	67-63-0	--	--	--	--	--	--	0.21	0.053	--	--	--	--	0.21	0.053
Lead	7439-92-1	3.2E-05	2.6E-05	7.5E-04	9.4E-06	--	--	--	--	--	--	3.0E-05	6.3E-05	8.1E-04	9.9E-05
Lindane [gamma-Hexachlorocyclohexane]	58-89-9	--	--	--	--	--	--	7.2E-10	1.8E-10	--	--	--	--	7.2E-10	1.8E-10
Manganese	7439-96-5	2.4E-05	2.0E-05	2.8E-04	3.5E-06	--	--	--	--	--	--	6.2E-04	1.3E-03	9.2E-04	1.3E-03
m-Cresol	108-39-4	--	--	--	--	--	--	7.1E-06	1.8E-06	--	--	--	--	7.1E-06	1.8E-06
Mercury	7439-97-6	1.7E-05	1.4E-05	1.8E-04	2.3E-06	--	--	--	--	--	--	--	--	2.0E-04	1.6E-05
Methanol	67-56-1	--	--	--	--	--	--	0.27	0.068	2.7E-04	5.5E-04	3.5E-04	7.4E-04	0.27	0.070
Methyl tert-butyl ether	1634-04-4	--	--	--	--	--	--	4.1E-03	1.0E-03	--	--	--	--	4.1E-03	1.0E-03
Methylene chloride [Dichloromethane]	75-09-2	--	--	--	--	--	--	0.30	0.076	--	--	--	--	0.30	0.076
Naphthalene	91-20-3	1.9E-05	1.6E-05	1.4E-03	1.8E-05	--	--	--	--	3.1E-04	6.5E-04	1.5E-04	3.1E-04	1.9E-03	9.9E-04
n-Hexane	110-54-3	2.9E-04	2.4E-04	1.3E-04	1.6E-06	--	--	0.24	0.060	3.7E-03	7.7E-03	4.7E-03	9.8E-03	0.25	0.078
Nickel	7440-02-0	1.3E-04	1.1E-04	3.5E-04	4.4E-06	--	--	--	--	--	--	2.4E-04	5.0E-04	7.3E-04	6.1E-04
Nitric acid	7697-37-2	--	--	--	--	--	--	0.011	2.8E-03	--	--	--	--	0.011	2.8E-03
Phosphoric acid	7664-38-2	--	--	--	--	--	--	3.2E-05	8.1E-06	--	--	--	--	3.2E-05	8.1E-06
Propylene	115-07-1	0.034	0.028	0.031	3.9E-04	--	--	--	--	3.4E-03	7.1E-03	9.0E-03	0.019	0.077	0.054
Propylene glycol monomethyl ether	107-98-2	--	--	--	--	--	--	5.8E-05	1.5E-05	--	--	--	--	5.8E-05	1.5E-05
Propylene oxide	75-56-9	--	--	--	--	--	--	2.5E-06	6.4E-07	--	--	--	--	2.5E-06	6.4E-07
Selenium	7782-49-2	1.5E-06	1.3E-06	2.0E-04	2.5E-06	--	--	--	--	--	--	8.7E-06	1.8E-05	2.1E-04	2.2E-05
Styrene	100-42-5	--	--	--	--	--	--	1.6E-04	4.1E-05	2.3E-04	4.7E-04	3.5E-04	7.4E-04	7.5E-04	1.2E-03
Sulfuric acid	7664-93-9	--	--	--	--	--	--	1.1E-03	2.8E-04	--	--	--	--	1.1E-03	2.8E-04
Tetrachloroehtene	127-18-4	--	--	--	--	--	--	1.4E-03	3.6E-04	--	--	--	--	1.4E-03	3.6E-04
Toluene	108-88-3	1.7E-03	1.4E-03	5.5E-03	7.0E-05	--	--	0.028	7.0E-03	0.017	0.035	0.017	0.035	0.069	0.079
Trichloroethylene	79-01-6	--	--	--	--	--	--	6.4E-03	1.6E-03	--	--	--	--	6.4E-03	1.6E-03
Triethylamine	121-44-8	--	--	--	--	--	--	7.7E-03	1.9E-03	--	--	--	--	7.7E-03	1.9E-03
Vanadium	7440-62-2	--	--	--	--	--	--	--	--	--	--	2.4E-04	4.9E-04	2.4E-04	4.9E-04
m-Xylene	108-38-3	--	--	--	--	--	--	--	--	9.9E-03	0.021	0.011	0.022	0.020	0.042
o-Xylene	95-47-6	--	--	--	--	--	--	--	--	4.6E-03	9.6E-03	3.7E-03	7.6E-03	8.3E-03	0.017
p-Xylene	106-42-3	--	--	--	--	--	--	--	--	2.5E-03	5.2E-03	--	--	2.5E-03	5.2E-03
Xylenes	1330-20-7	1.3E-03	1.0E-03	3.8E-03	4.8E-05	--	--	5.2E-03	1.3E-03	--	--	--	--	0.010	2.4E-03
NO_2	10102-44-0	1.18	0.99	2.90	0.036	--	--	--	--	0.13	0.27	0.040	0.084	4.26	1.38
SO_2	7446-09-5	0.038	0.032	0.026	3.2E-04	--	--	--	--	3.8E-04	7.9E-04	1.4E-03	3.0E-03	0.065	0.036
CO	630-08-0	5.31	4.43	9.22	0.12	--	--	--	--	1.58	3.29	0.36	0.76	16.5	8.60

References:

(1) Assumes all PM_{10} emissions from mobile source combustion equals diesel particulate matter (DPM).

(2) NO_2 emissions are shown as NO_X emissions.

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Appendix C

Biological Resources

Richmond Field Station
Grassland Constraints Analysis

FINAL

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April 17, 2013

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Richmond Field Station
Grassland Constraints Analysis

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SUMMARY
The University of California proposes to establish a new major research campus at properties it owns in Richmond, California, including the Richmond Field Station (RFS), for consolidation of biosciences programs of the Lawrence Berkeley National Laboratory (LBNL) and for development of additional research-related facilities for both LBNL and UC Berkeley (UCB). The University proposes to rename a subset of the properties as the "Richmond Bay Campus" ("RBC").

The RFS, a satellite property for UCB which is located in the City of Richmond in the western portion of Contra Costa County, supports a coastal terrace prairie grassland vegetation community, which is a unique natural vegetation community in the region. Since 1993, numerous vegetation community studies have been conducted and restoration and management activities have taken place within the RFS site.

Wildlife Research Associates and Jane Valerius Environmental Consulting were commissioned by the University to conduct a constraints analysis of the coastal terrace prairie grassland. The intent of this analysis is to compile available information, consider these resources present on-site and provide some insight into environmental issues that should be addressed during environmental review processes under the National Environmental Policy Act (NEPA) and California Environmental Quality Act (CEQA). As part of the analysis of the current condition of the coastal terrace prairie grassland on the RFS site, we evaluated these meadow areas based on a variety of Special Status vegetation criteria established by the California Department of Fish and Wildlife (CDFW), as well as on other parameters that are unique to the site. The habitat value affecting qualifiers (e.g., size of the meadow, whether it is spatially isolated, hydrologically changed, etc.) are evaluated per meadow, which provides a more precise description of the existing grasslands values. Based on this review, potential impacts from the proposed development can be better addressed during the NEPA and CEQA process.

Located on the eastern edge of the San Francisco Bay, in the City of Richmond, the RFS is bounded by Meade Street, which runs parallel to Interstate 580 to the north, by Meeker Slough/Regatta Boulevard to the west and by South 46th Street to the east. The East Bay Regional Park District Bay Trail traverses the western portion of the property along the West Stege saltmarsh. The entire RFS campus encompasses 162 acres, of which 42 acres are undeveloped meadows that support grasslands. The site topography consists of gently south-facing, sloping lands with poorly drained clay soils.

The coastal terrace prairie grassland has undergone on-site restoration as part of the mitigation required for impacts of on-going remediation of historic contamination at the site. A collaborative effort between Jepson Herbarium and other UCB staff and faculty, the Watershed Project Staff, and local restoration experts, resulted in creation of grassland goals and objectives for the area identified for mitigation restoration. In 2003, the restoration was begun and monitoring occurred for four years. In 2007 a grassland maintenance regime that included mowing schedules per season, with appropriate heights to ensure survivorship of perennial grasses was instigated.

This analysis is an update describing existing conditions on the site and new vegetation classifications. We ranked the quality of coastal terrace prairie grassland habitat based on presence of absolute cover of California oatgrass (>25%) and/or purple needlegrass (5%) as described by the membership rule of the series in the Manual of California Vegetation (Sawyer, et al. 2009).

Coastal Terrace Prairie Grasslands Constraints
In general, lands used for mitigation cannot be impacted with future projects. Therefore, the southern portion of the Big Meadow and central portion of the West Meadow cannot be impacted due to their designation as mitigation lands, because remediation of the Western Stege Marsh in 2003 required unavoidable paving of a portion of historic grassland to create asphalt mixing pads for sediments removed from the marsh (The Watershed Project 2007, p. 4 of 77). On-site restoration of an ecosystem that has been degraded, damaged, or destroyed is often used as in-kind mitigation for impacts to sensitive communities and mitigation ratios have been developed for similar vegetation communities.

According to David Amme (2005), there are no other sites that match the soils and hydrology that occur at the RFS. If insufficient acreage occurs on the RFS site to mitigate for impacts to the coastal terrace prairie, then off-site creation mitigation may potentially be required, which would also require consultation with the agencies during the CEQA review. Such opportunities would have to be further investigated.

A buffer or set back should be developed between any buildings and the coastal terrace prairie grassland so that factors associated with construction and structures (i.e., soil compaction, high flow runoff from the roofs, etc.) do not impact the edges of the prairie grasslands. These factors potentially impacting the grasslands would have to be investigated and addressed during the CEQA review.

A geotechnical study would be required to determine adverse effect to the soils and hydrology in the Big Meadow if trenching, excavation or underground tunneling is proposed that will disrupt the soil profile. The grasses can reach 3 to 4 feet in rooting depth and California oatgrass is associated with mesic sites so any alteration of the hydrology, whether surface or groundwater, could have an adverse impact.

Although green roofs, similar in concept to the replanting of a concrete berm, often use native plant species, they are typically species that are adapted to shallow soils, usually less than 12 inches in depth, and are fragile in windy areas. In addition, the slopes of berms would require complex drainage and watering systems to prevent water from taking the path of least resistance and to remain on the berm long enough for adequate moisture.

Wildlife Constraints
Removal of the Eucalyptus grove may result in impacts to the monarch butterfly habitat, which is limited in the San Francisco Bay Area. Further analysis would be required to consider possible alternative species plantings that may also provide monarch habitat.

Removal of the Eucalyptus grove and existing shrubs may result in impacts to nesting birds if conducted during the nesting season (March through August). It is recommended that removal occur outside the nesting season.

Removal of existing buildings may impact roosting bats. A bat habitat assessment evaluating the potential for roosting is required prior to any removal and can be conducted at any time of the year. If suitable roosting habitat is determined to be present, it is recommended that removal of such habitat occur outside the hibernation season (October through February) and the maternity season (April through August).

1.0 INTRODUCTION

Wildlife Research Associates and Jane Valerius Environmental Consulting were commissioned to conduct a constraints analysis of the coastal terrace prairie grassland. The purpose of this constraints analysis is to assist the University of California, Berkeley (UCB) and Lawrence Berkeley National Laboratory (LBNL) with the identification of key environmental issues that should be analyzed during the planning and preliminary analysis of proposed development at the University of California Richmond Field Station, located in the southern portion of the City of Richmond, Contra Costa County, with regards to biological resources. This constraints analysis primarily focuses on environmental compliance with respect to the coastal terrace prairie grassland, a vegetation community that is unique to this portion of the western Contra Costa County.

Considered one of the largest and best-preserved remaining areas of native coastal grasslands once prevalent throughout the San Francisco Bay Area (Tetra Tech and Sea Engineering 2007), the coastal terrace prairie grassland at RFS, as described by *A Manual of California Vegetation* (Sawyer, et al. 2009), which provides a standardized, systematic classification and description of vegetation in the California, is made up of two vegetation alliances. These alliances are the California oatgrass prairie (*Danthonia californica*) (#41.050.00) and purple needlegrass grassland (*Nassella pulchra*) (#41.150.00) and are identified in the California Natural Diversity Data Base, run by the California Department of Fish and Wildlife (CDFW), as coastal terrace prairie grassland and valley needlegrass grassland, respectively.

The intent of this analysis is to compile available information, consider these resources present on-site and provide some insight into environmental issues that will need to be addressed during the environmental review and permitting process. As part of the analysis of the current condition of the coastal terrace prairie grassland on the RFS site, we evaluated these meadow areas based on a variety of Special Status vegetation criteria established by the CDFW, as well as on other parameters that are unique to the site. The habitat value affecting qualifiers (e.g., size of the meadow, whether it is spatially isolated, hydrologically altered, etc.) are evaluated per meadow, which provides a more precise description of the existing grasslands values. Based on this review, potential impacts from the proposed development can be better addressed and the grassland areas that are identified with higher values than other areas can be better protected. Specifically, the purpose is to (1) determine whether there are potential liabilities or "fatal flaws" that would preclude or prohibit project implementation and (2) assess the project and recommended alternatives from an environmental permitting/compliance perspective including potential permitting and mitigation requirements, timelines and costs.

1.1 Existing Area Description

The Richmond Field Station, located at 1301 South 46th Street in Richmond California, is currently owned by the University of California Regents for use by the UCB campus. Once part of the larger Rancho San Pablo, the RFS is located on the eastern edge of the San Francisco Bay, in the south central portion of the City of Richmond (Figure 1). The RFS is bounded by Meade Street, which runs parallel to Interstate 580 to the north, by Meeker Slough/Regatta Boulevard to the west and by South 46th Street to the east. The East Bay Regional Park District Bay Trail traverses the southern portion of the property along the Western Stege saltmarsh. Totaling 162 acres, the upland habitat encompasses 96 acres, which is comprised of industrial-zoned land used primarily for research and education (Tetra Tech and Sea Engineering 2007). Of these 96 acres, approximately 42 acres are undeveloped meadows that support grasslands.

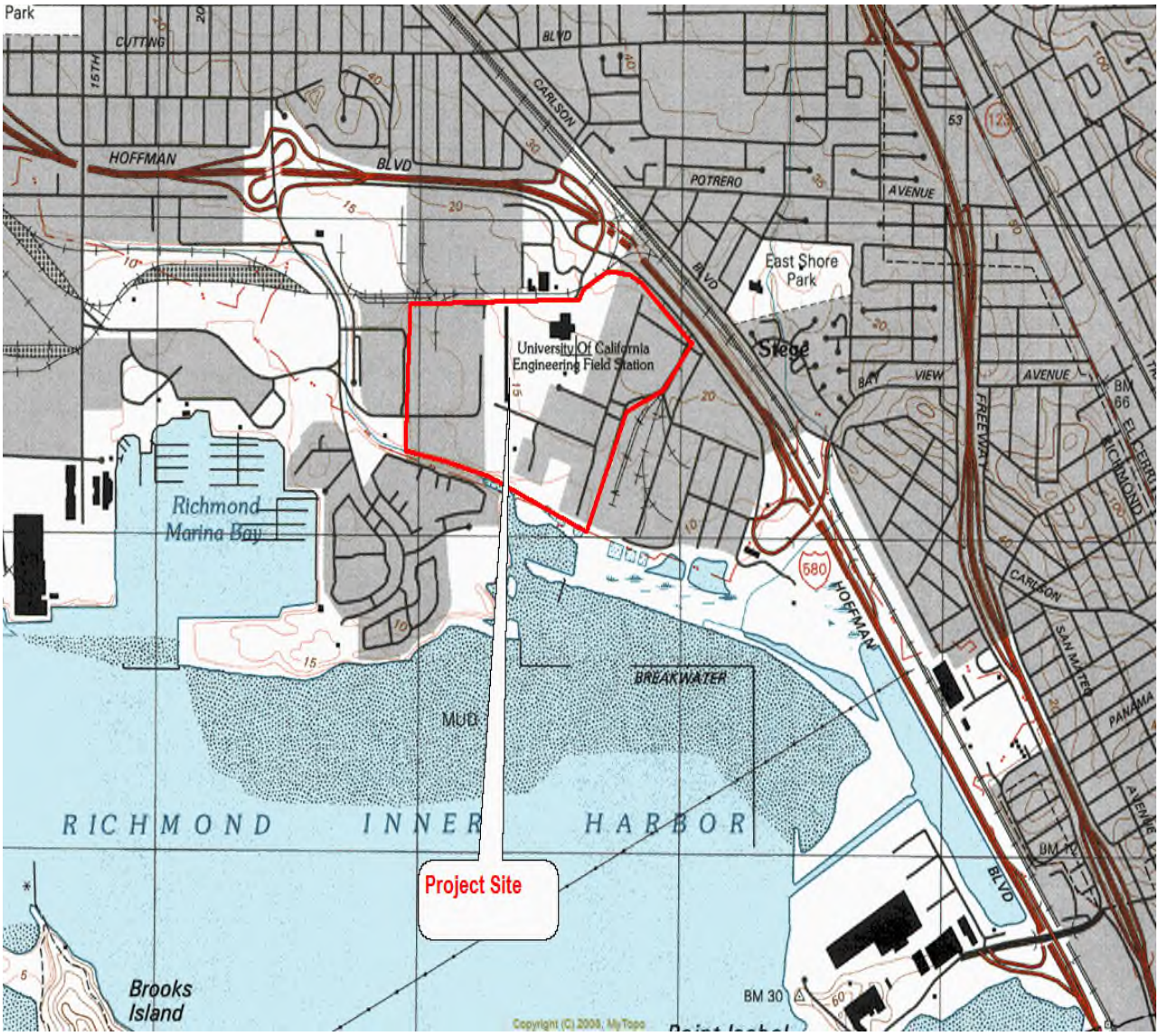

Figure 1 – Richmond Field Station Project Site

The undeveloped meadows, comprised of 13 discrete areas, are located primarily along the western portion of the RFS with the largest (Big Meadow) being 13 acres, as shown Figure 2 of the *Richmond Field Station Final Botanical Survey Report* (URS 2007) (Figure 2). All other meadows range in size between 1-5 acres. For purposes of this report, the property consists of those lands within the 96 acre property boundaries which comprise grasslands and seasonal wetlands.

The soil is a mixture of poorly drained clay of the Clear Lake –Cropley Association, that often forms a perched water table in the winter rainy season and has a high shrink-swell potential, and the Joice-Reyes association, that is very poorly drained saline mucks and silty clays on saltwater marshes and tidal flats (USDA 1977).

1.2 Background Studies

As described in the *Richmond Research Center Master Plan Environmental Impact Report: Existing Conditions of Grassland Resources* (David Amme Associates 1993), biological studies have been conducted at the RFS since 1963. Among the research completed are small mammal enclosure experiments, and inventories of flowering plants, reptiles, amphibians, mammals and birds. In the report, the study area was divided into three discrete areas, 1) the area east of the eucalyptus grove, 2) the area west of the eucalyptus grove, and 3) the created land south of the chain-link fence (now located south of the existing EPA building) (David Amme Associates 1993).

After conducting field surveys in October and November 1993, Amme further refined these three areas into grasslands that were classified into four categories and are described as follows (David Amme Associates 1993):

- Disturbed/closely mowed grassland – this vegetation type is directly related to mowing regime and is dominated by California oatgrass with purple needlegrass in fewer numbers.
- Disturbed/exotic grassland – this vegetation type is dominated by exotic grasses and weeds and existed where recent soil disturbance and compaction occurred.
- Disturbed coastal prairie – this vegetation type contains between 10 to 50% cover of native prairie plant species mixed with exotic weeds and grasses depending on the site, moisture regime or mowing frequency. In areas of irregular topography vernal standing water was evident. Small mounds of soil deposition allow for native perennial grasses and forbs
- Least disturbed coastal prairie – this vegetation type contains 50% cover of native prairie species. In some areas native vegetation constitutes up to 100% of vegetative cover.

Although coastal terrace prairie has been reported in other localities in Contra Costa County, the RFS site was identified as unique in that it represented the only coastal prairie grassland on lowland clay soils (David Amme Associates 1993). As a result, this original study concluded that the remnant coastal prairie grassland was scientifically and ecologically invaluable and virtually impossible to recreate (David Amme Associates 1993).

Since 1993, the science of restoration has progressed and evidence of restoration can be seen at the RFS. As mitigation for loss of an historic grassland area that was used for staging facilities as part of the marsh soil remediation for the Stege Marsh in 2003, as described in the *Berkeley*

0 500 1,000 1,500 2,000 Feet

URS	N	Richmond Field Station - UC Berkeley Project - 17325753.00	Study Area	Figure 2

Richmond Field Station Remediation and Restoration Project Habitat Restoration Progress Report 2003 – 2007 (The Watershed Project 2007), portions of the coastal terrace prairie on the RFS were restored. A collaborative effort between Jepson Herbarium and other UCB staff and faculty, the Watershed Project Staff and local restoration experts resulted in creation of grassland goals and objectives for the area identified for mitigation restoration.

The area chosen for restoration was within the 19-acres located in the western portion of the RFS, as depicted in Figure 10 of the *Richmond Field Station Working Paper* (UC Berkeley 2002). Within these 19 acres, UC Berkeley Chancellor Chang-Lin Tien (Tien 1996), describing a master plan for the Field Station that was never completed, identified 8.7-acres of coastal terrace prairie grassland "situated in the center of one of the largest contiguous open areas on the property" that would be set aside as a "valuable reserve." Chancellor Tien further stated that the Master Plan incorporated measures for protection of the habitat, such as no development of the coastal prairie grassland area and establishment of the area as a valuable reserve. The letter further identifies preservation measures, such as guidelines to protect the grassland, fencing to discourage human intrusion, preservation of a grassland corridor along the western boundary of the Richmond Field Station property between the prime grassland and the marsh and shoreline open space (Tien 1996).

Although the Richmond Field Station master plan was never completed, the preservation principle was carried forward. The *Richmond Field Station Working Paper* (UC Berkeley 2002), created to establish a land use framework for RFS that reflects "an optimal balance of program needs and environmental stewardship," further expands on Chancellor Tien's letter and proposes to preserve 19 acres of grassland and seasonal wetlands that occur in the western portion of the RFS (Figure 10, UC Berkeley 2002). Under the Recommended Development Principles in this paper is, "*Principle 1. Preserve the most valuable native grassland and wetland habitat areas on the site and link these to the salt marsh via a grassland corridor."*

Specific details on the mitigation requirements, goals, objectives and methods are described in the *Habitat Restoration Progress Report 2003 – 2007* (The Watershed Project 2007). The grassland resources at the RFS have been identified as areas of Unique Restoration Opportunities in the Baylands Ecosystem Habitat Goals Report (http://www.sfei.org/sfbaygoals/docs/goals1999/outline.html) completed through the Wetlands Ecosystems Goals Project (Tetra Tech and Sea Engineering 2007).

In 2004, to ensure control of non-native and invasive species in the mitigation restoration area, a pilot program of hand removal was instigated in the upland grassland plots identified for mitigation (The Watershed Project 2007). Various control methods were analyzed and included hand removal and mulching (with 3-6 inches of sterile rice straw), herbicide treatment (1.5 % glyphosate), herbicide treatment (1.5% glyphosate) and mulch (with 3-6 inches of sterile rice straw) and hand removal (Blasland, Bouck & Lee, Inc. 2004). Control efforts were further refined and presented in the *Richmond Field Station Remediation and Restoration Project Habitat Restoration Progress Report 2003 – 2007* (The Watershed Project 2007), with specific techniques identified per invasive species.

The results of the four years of monitoring of the coastal terrace prairie grassland, which was conducted prior to controlling invasive species, provided ocular estimates of invasive non-native species ranging between 60-70% of absolute cover for Harding grass, with an additional 15% of other invasive plant species (The Watershed Project 2007). Following treatments and 2 years of revegetation in the Big Meadow, non-native cover dropped to 25% with an average of 48% cover of natives, with the remainder being covered by mulch or bare soil, with high survivorship

(>60%) being reported (The Watershed Project 2007). The overall survivorship of planting the West Meadow was less (<30%), due to compacted substrate and fragments of cement and other debris (The Watershed Project 2007).

In 2007, URS recommended a native grassland maintenance and exotic plant control mowing regime that included mowing in the spring and summer, at an appropriate height of 6 to 8 inches to ensure survivorship of perennial grasses (URS 2007).

1.3 Regulatory Considerations

This vegetation community and individual plants are not protected under the Federal Endangered Species Act. At the State level, the CDFW has designated some plant communities as "sensitive natural communities" (CDFG 2013). The primary purpose of the classification is to assist in the location and determination of significance and rarity of various vegetation types. Thus, ranking of natural communities by their rarity and threat is an important facet of the classification. In the List of California Terrestrial Natural Communities Recognized by The California Natural Diversity Database (CNDDB) April 2013 Edition document, as in previous CNDDB community lists, asterisks (*) denote special communities that are either known or believed to be of high priority for inventory in CNDDB. Lead and trustee agencies may request that impacts to these communities be addressed in environmental documents. Local agencies may also have policies requiring avoidance of rare community types. Our professional experience and industry standards have shown that mitigation is typically required (LSA Associates 2006; WRA 2008), and varies between restoration of degraded habitats on-site to creation of new habitats located off-site.

Although no specific mitigation requirements are established for impacting coastal terrace prairie grassland under CEQA, industry standards have shown that mitigation ratios of 1:1 for on-site restoration are typical (LSA Associates 2006; WRA 2008). Restoration, as defined by The Society for Ecological Restoration (www.ser.org) and quoted by Stromberg, et.al. (2007), is, "…the process of assisting the recovery of an ecosystem that has been degraded, damaged, or destroyed." An ecosystem has recovered and is considered restored through a variety of parameters, such as, a) it contains a characteristic assemblage of the species that occur in the reference ecosystem and that provide appropriate community structure, b) the physical environment of the restored ecosystem is capable of sustaining reproducing populations of the species necessary for its continued stability, c) it apparently functions normally for its ecological stage of development, and signs of dysfunction are absent, d) it is suitably integrated into a larger ecological matrix or landscape, with which it interacts through abiotic and biotic flows and exchanges, and e) it is sufficiently resilient to endure the normal periodic stress events in the local environment that serve to maintain the integrity of the ecosystem, among others.

If insufficient acreage occurs on the RFS site to mitigate for impacts to the coastal terrace prairie, then off-site creation mitigation may potentially be required, which would also require consultation with the agencies during the CEQA review. Therefore, the requirements for off-site creation are unknown at this time.

2.0 METHODS AND LIMITATIONS

For this constraints analysis, we reviewed the following reports (chronological order) and articles prepared for the RFS:

- Richmond Field Station Final Botanical Survey Report - URS 2007
- Current Conditions Report, University of California, Berkeley, Richmond Field Station, Richmond, California - Tetra Tech EM Inc and Sea Engineering Inc. 2007
- Final Report for the University of California, Berkeley Richmond Field Station Remediation and Restoration Project Habitat Restoration Progress Report (2003 – 2007), and Appendices – The Watershed Project 2007.
- UC Richmond Field Station's Remnant Coastal Terrace Grassland – Amme 2005
- Invasive/Exotic Vegetation Management Program – Blasland, Bouck and Lee, 2004
- West Stege Marsh Upland Revegetation Plan (2003-5) U.C. Berkeley Field Station Aquatic Outreach Institute 2004
- Invasive/Exotic Vegetation Management Program. University of California, Berkeley, Richmond Field Station - BBL, Inc. January 2004.
- Richmond Field Station Remediation Project: Initial Study California Environmental Quality Act – URS 2003
- Richmond Field Station Working Paper - U.C. Berkeley 2002
- Baylands Ecosystem Habitat Goals: A report of the habitat recommendations - San Francisco Bay Area Wetlands Ecosystem Goals Project 1999.
- Letter to Honorable Tom Bates, Member of the Assembly - Chancellor Tien, C. 1996.
- Richmond Research Center Master Plan. Environmental Impact Report. Existing Opportunities and Constraints Report - Brady & Associates Planners and Landscape Architects 1994.
- Richmond Research Center Master Plan, Environmental Impact Report: Existing Conditions of Grassland Resources - Amme 1993
- Native Perennial Grass Establishment and Management – Paul Kephart and David Amme 1992.
- The Natural Areas of the University of California Richmond Field Station - Gutstein 1989.

Two site visits were conducted, on April 19 and May 15, 2012, by Wildlife Research Associates ecologist Trish Tatarian, and Jane Valerius Environmental Consulting botanist and plant ecologist Jane Valerius. The site visits were conducted to ground truth and update the results of the *Richmond Field Station Final Botanical Survey Report* (URS 2007), in which coastal terrace prairie grassland was identified and mapped based on the presence of either California oat grass or purple needle grass, as well as with ≥6 other East Bay California Native Plant Society (EBCNPS) ranked A or B plant species. This update reflects the latest rankings of grassland habitats adopted by the agencies.

2.1 Standardized Grassland Evaluation

To update the results from the URS (2007) report, we ranked the quality of coastal terrace prairie grassland habitat based on presence of absolute cover of purple needlegrass (5%) and/or California oatgrass (>25%), as described by the membership rule of the series in the Manual of California Vegetation (MCV) (Sawyer, et al. 2009) (Appendix A), and was not dependent on the presence of other native plant species. The rankings at the RFS meadows are as follows:

High Quality: California oatgrass (>50%) and/or purple needlegrass (20%)
Medium Quality: California oatgrass (25-50%) and/or purple needlegrass (5-19%)
Low Quality: California oatgrass (0-24%) and/or purple needlegrass (0-4%)

To determine absolute cover, Jane Valerius conducted reléve surveys (Mueller-Dombois, et al. 1974; CNPS 2000), which entailed focused walking transects through the known vegetative community/alliance (i.e., California oatgrass). Relevés can be used in vegetation studies as a practical, relatively fast means of collecting information on vegetation. We assumed, based on the information provided on soils and other site factors presented in the Richmond Field Station Final Botanical Survey Report (URS 2007), that the sampling was homogeneous for coastal terrace prairie grassland and we were able to focus on the percent cover of each species to determine if the plot (i.e., meadow allocation) supported the minimum percentage of individuals to allow it to qualify for either California oatgrass or purple needle grass.

This reléve methodology allowed us the quickest way to analyze and evaluate the areas using the membership rules from MCV (Sawyer et al 2009). This method consisted of subjective sampling, and was qualitative, allowing us to estimate species cover based on basal area rather than measure it, but also allowed for quantitative measurements for the two target species: California oatgrass and purple needlegrass.

2.2 Qualitative Grassland Evaluation Criteria

We further evaluated the quality of the coastal terrace prairie grasslands beyond the membership rule of the series in the MCV (Sawyer, et al. 2009). We used the California Department of Fish and Game (CDFG) method for *Addressing High Priority Vegetation Types* (http://www.dfg.ca.gov/biogeodata/vegcamp/natural_comm_background.asp), which allows for judgment of quality based on a flexible set of criteria such as the range of existing sustainable occurrences of this element or vegetation type based on site quality, defensibility, size, and surrounding landscapes. These criteria vary based on the type of vegetation or natural community and the range of existing occurrences known. For example, high quality natural vegetation will have the following characteristics:

- lack of invasive exotic species,
- no evidence of human-caused disturbance such as roads or excessive livestock grazing, or high-grade logging,
- evidence of reproduction present (sprouts, seedlings, adult individuals of reproductive age), and
- no significant insect or disease damage, etc.

We also used criteria for evaluating impacts to Natural Communities (DFG *Protocols for Surveying and Evaluating Impacts to Special Status Natural Communities* - http://www.dfg.ca.gov/biogeodata/cnddb/pdfs/Protocols_for_Surveying_and_Evaluating_Impacts.pdf), but did not evaluate potential impacts to the community from a specific project. We evaluated the quality of the grassland community based on the following:

- consideration of nearby populations and total species distribution;
- the consideration of nearby occurrences of special status communities and natural community distribution; and
- analysis of potential threats, including those from invasive species, to the plants and natural communities.

Based on the above criteria and evaluations, the following value affecting qualifiers were used for the coastal terrace prairie at the RFS, using the background reports stated above for baseline information. The Big Meadow was used as the control meadow for the following qualifiers:

- Acreage – Larger, contiguous areas have more value than smaller, disconnected areas. We evaluated the meadows from the potential effects from eucalyptus trees, which are non-native, provide a very high canopy cover, and are allelopathic (i.e., chemical leachates from leaves and bark cause understorey suppression) reducing the viability of native herbaceous grasses. As a result, eucalyptus trees were removed from the acreages of meadows available.
- Location to eucalyptus grove – areas located east of the eucalyptus grove are smaller in size, shaded and surrounded by development and receive landscaping/maintenance mowing regime. All of these factors reduce the value and integrity of the grassland areas. Areas to the west of the eucalyptus are larger in acreage, are spatially connected, are not shaded, have less development and invasive plant control mowing regime.
- Management Regime (mowing) - a) *Exotic plant control* -The URS (2007) report recommended that exotic plant species be controlled by mowing, which entailed spring and summer mowing at a height of 6-8 inches.
  b) *Landscaping/maintenance* – landscape mowing which typically occurs once a month, reduces the non-vegetative reproduction (i.e., seed source).
- Previous disturbances (1993-2012) – such as soil deposition, are based on Amme (1993).
- Wetlands present - Wetlands were identified based on Current Conditions Report (Tetra Tech and Sea Engineering 2007).
- Hydrology alteration – coastal terrace prairie grassland requires wetland mesic soil conditions. If the hydrology is altered (i.e., channelized for directing locational flow for purposes of draining a meadow) to reduce the mesic conditions, then the value for the community is reduced.
- Reproduction present/absent – 2012 surveys not conducted during the flowering season.
- Insect/disease -
- Species diversity – Species composition is based on the URS (2007) report.
- Threats – a) *Invasive species* (Shrub/Herbaceous) – invasive control required for coyote bush and Harding grass
  b) *Disconnected spatially* – trees located between meadows that reduce seed dispersal
  c) *Surrounded by development* – buildings reduce seed dispersal, roadways are not considered barriers other than hydrologic alteration from channelization
  d) *Wind isolated* – prevailing wind direction occurs from the south and southeast from Richardson Bay.

In summary, at the landscape level, on the east side of the eucalyptus groves, the barriers between the meadows (i.e., Eucalyptus Meadow, North Meadow Far North Meadow, etc.) include the trees and the buildings. On the west side, at the landscape level, these barriers are not present between the meadows.

To provide further ranking of these criteria per meadow, we assigned the number “1” when it was beneficial for grasslands (i.e., wetlands present) and a “0” when it was not beneficial (e.g., hydrology altered). For the standardized evaluation of vegetative presence, we rate high quality with “3” and low quality with “1”. The following are the rankings.

Table 1: Qualitative Criteria Rankings

Standardized evaluation based on % cover	**H=3, M=2, L=1**	
Acreage [a]	**>3 = 1**	**<3 = 0**
Location to eucalyptus grove	**W = 1**	**E = 0**
Management Regime (mowing) [b]		
Exotic plant control	**Y = 1**	**N=0**
Landscaping/ maintenance	Y = 0	N= 1
Previous disturbances (1993-2012) [c]	**Y=0**	**N=1**
Wetlands Present [d]	**Y=1**	**N=0**
Hydrology altered	**N=1**	**Y=0**
Reproduction present	**Y=1**	**N=0**
Insect/disease	**n/a**	**n/a**
Species diversity [e]	**>6 =1**	**<6 = 0**
Threats		
Invasive species (Shrub/Herbaceous)	n/a	n/a
Disconnected spatially	Y=0	N=1
Surrounded by development [f]	Y=0	N=1
Wind isolated	Y=0	N=1

Note: Value 1 = beneficial to grasslands
Value 0 = not beneficial to grasslands

3.0 EXISTING CONDITIONS

3.1 Setting

The 162-acre RFS parcel is located within the San Francisco Bay Coastal Bioregion (Welsh 1994). This bioregion is located within central California and is located on the east side of the San Francisco Bay. Habitats within this bioregion include both mesic (moist) habitats, such as saltwater and freshwater marsh along the bay, and xeric (dry) habitats, such as chaparral and coastal sage scrub in the hills, and are typical of a Mediterranean type climate. Annual winter precipitation has averaged 25.4 inches over the past 200 years (Welsh 1994). The dominant prevailing wind directions in this portion of the San Francisco Bay are from the south southeast, as measured at the Richmond Pier (http://www.windfinder.com/windstats/windstatistic_richmond_pier.htm).

The Richmond Field Station, located at 1301 South 46th Street in Richmond California, is currently owned by the U.C. Regents for the use by the UCB campus. Once part of the larger Rancho San Pablo, the RFS is located in the eastern edge of the San Francisco Bay, in the City of Richmond (Figure 1). The RFS is bounded by Meade Street off Interstate 580 to the north, by Meeker Lough/Regatta Boulevard to the west and by South 46th Street to the east. The East Bay Regional Park District Bat Trail traverses the western portion of the property. Totaling 162 acres, the upland habitat encompasses 96 acres, which is comprised of industrial-zoned land used primarily for research and education. Of these 96 acres, approximately 42 acres are undeveloped meadows that support native grasslands.

Aerial analysis on Google Earth shows that in 1939 the area was surveyed and sidewalks appear to be installed but no grading had occurred. Structures and eucalyptus trees are present on the main portion of the RFS at this time.

3.2 Vegetation Communities

Several vegetation communities, as described by Holland (1986), occur on the RFS site. This classification of overall community identification will provide an easier understanding for the reader and provides an umbrella that is encompassing the specific alliances, as described in Sawyer, et al. (2009). The communities described below refer to those that are located within the 96-acre portion of the RFS and are based on descriptions from the *Manual of California Vegetation* (Sawyer, et al. 2009).

Coastal terrace prairie is typically found within a belt extending from the coast to a few kilometers and usually contains significant amounts of both native and exotic perennial species. California oatgrass (*Danthonia californica*) is the characteristic species in the northern and more coastal part of coastal prairie grassland with purple needle grass (*Nasella pulchra*) also being abundant in this region (D'Antonio, et al. 2000).

3.2.1 Coastal Terrace Prairie Grassland

<u>*Danthonia californica* Herbaceous Alliance or California oat grass prairie</u> – California oat grass prairie is defined as being dominant or co-dominant in the herbaceous layer with a variety of other native and non-native species and must comprise greater than 50% relative cover or 25% absolute cover in the herbaceous layer (Sawyer et al. 2009). California oatgrass is a perennial bunchgrass with loosely clustered, coarse stem or culms. This species is supported in a habitat that is seasonally or permanently saturated with a shallow water table. Water chemistry can

include both freshwater and saline water. It can occur in valley bottoms, and the lower portions of alluvial slopes as well as in uplands on coastal bluffs, terraces, slopes and ridges. The national list of wetland plants (NWPL 2012 (http://rsgisias.crrel.usace.army.mil/NWPL/doc/proc_2012/ERDC-CRREL_TR-12-11_NWPL_2012.pdf) lists California oatgrass as a facultative species. Often considered part of coastal prairie, this alliance extends from coastal terraces to inland bald hills. Species dominance varies at a fine scale. It often mixes with tree series at a coarser scale, such as Douglas-fir - tanoak series, Oregon white oak series, Redwood series.

California oatgrass is one of the only perennial bunchgrasses with long-lived seed and a stand can be rapidly revived from a latent seed bank with mowing, weeding and clearing. This species establishes very slowly but is a persistent grower and it roots can eventually reach down to 3 or 4 feet. It thrives in rich, loamy and clay soils (Amme 2003b).

Nasella pulchra Herbaceous Alliance or Purple needle grass grassland – Purple needle grass is dominant or characteristically present in the herbaceous layer and occurs with other perennial grasses and usually has 10% relative cover or 5% absolute cover in the herbaceous layer (Sawyer, et al. 2009). Purple needle grass is a native, cool-season perennial bunch grass that expands when tussocks fragment. The plant produces large quantities of viable seed, but seedling establishment is generally low (Sawyer, et al. 2009). This species occurs in all topographic locations, typically on soils with a high clay content. Vegetative growth of purple needlegrass is greatest from March through late May or early June, depending on onset of drought. Flowers begin to develop in early May, and seed is mature and dispersed by late July. Stands of this once extensive series now typically include non-native annual species mixed with the perennial grasses and herbs. Purple needle grass regenerates primarily by tillering (i.e. root spreading) and, similar to bulbs and rhizomes, fragmentation of bunches. Fragmentation is an important form of regeneration for purple needle grass; it is an adaptation that allows recovery from defoliation by high-intensity, short-duration grazing and/or fire. Ripgut, soft chess, and foxtail chess are common, as are slender oats, wild oats, and Italian ryegrass. Foothill needlegrass, nodding needlegrass, and purple needlegrass occur sympatrically, but do not typically mix. The species tend to segregate based on substrate and slope factors.

Purple needlegrass is a species with wide ecological tolerance and excellent restoration potential (Ludlow, et al. 2007). It is a long-lived bunchgrass and thrives on sunny, south-facing slopes and plain of the foothill grassland. It stays green into the early summer and gradually becomes dormant in mid to late summer. This species also forms a deep root system 3 to 4 feet deep. Purple needle grass has good seedling vigor and can be seeded or planted by plugs (Amme 2003a).

Recruitment of purple needle grass has been shown to be reduced by the adverse environment created by high densities of non-native annual species (Dyer and Rice 1997). Successful attempts to increase populations of purple needle grass must involve management to reduce the negative effects or competition of non-natives through effective management techniques such as weeding and grazing.

3.2.2 Standard Grassland Evaluation

From a botanical analysis, using the MCV (Sawyer, et al. 2009) requirements for % of absolute cover for a vegetation alliance alone, our evaluation resulted in two of the meadows meeting the high quality habitats standard, compared to the URS (2007) evaluation, in which three meadows were evaluated as being high quality habitat. The habitat quality evaluation of on-site meadows, past and present, are presented in Table 2. However, we further identified five meadows as being moderate quality habitat, whereas URS (2007) did not have any; nor did they identify any low quality habitat. Our analysis identified seven meadows with low quality habitat based on a botanical presence of absolute cover of either *Danthonia* or *Nassella*. The differences between the two habitat ratings are discussed in the methods section, and reveal the changes in vegetation classification in the past five years.

Table 2: Comparison of evaluations of the meadows habitat quality – Richmond Field Station, Richmond, CA.

Meadows	Acreage	Quality of Habitat		
		D. Amme Associates (1993)[1]	URS (2007)[2]	Wildlife Research Associates (2012)[3]
Northwest	3	Disturbed/closely mowed	None	Medium
West	4	Disturbed/exotic/disturbed coastal prairie	High	High
EPA South	1	Disturbed/exotic	None	Low
EPA North	2	Disturbed coastal prairie/closely mowed	High	Medium
Big *	13	Disturbed coastal Prairie/Least disturbed coastal prairie	High	High
Central	2.8	Disturbed/closely mowed	None	Medium
Gull	1	Disturbed/closely mowed	None	Low
North	5	Disturbed/closely mowed	None	Low
Eucalyptus	5	Disturbed/closely mowed	None	Medium
Far North	1	Disturbed/closely mowed	None	Low
East	1	Disturbed/closely mowed	none	Low
Northeast	1	Disturbed/closely mowed	none	Low
580	2	Disturbed/closely mowed	none	Low

Note – Quality of Habitat Evaluated Based on:

1 = vegetation surveys conducted outside flowering season.

2 = grassland and presence of > 6 native plant species.

3 = % of species absolute cover, with *High Quality*: California oatgrass (>50%) and/or purple needlegrass (20%); *Medium Quality*: California oatgrass (25-50%) and/or purple needlegrass (5-19%), and *Low Quality*: California oatgrass (0-24%) and/or purple needlegrass (0-4%)

*= the Northern portion of the Big Meadow, which is disturbed, is not included in the 13 acres.

In 1993, several areas were identified as disturbed coastal prairie, specifically a portion in the west central area of the Big Meadow, the central portion of the West Meadow and a strip of disturbed/closely mowed grassland surrounding the disturbed coastal prairie and a block that is shown as recent disturbance of the EPA Meadow N (David Amme Associates 1993).

In our analysis we also identified the northern portion of the Big Meadow, which is not part of the 13 acres identified above (URS 2007), as being disturbed grassland, lacking any native species. Please refer to the *Richmond Field Station Habitat Enhancement and Mitigation Analysis* (Wildlife Research Associates 2013) for further analysis.

The EPA Meadow S area is also identified as an area that has been disturbed, has uneven or higher elevations, and where native grasses and plants are lacking and would be a good candidate for coastal prairie grassland creation. The URS (2007) maps also show that this area lacks native grasses and sensitive plants, although California oatgrass and sun cups (*Camissonia ovata*) are mapped in this area (URS 2007).

3.2.3 Qualitative Grassland Evaluation

After evaluating the meadows based on the standardized criteria of percent cover, as explained in Chapter 2, Table 3 provides a synopsis of the refinement of the habitat qualities of the meadows.

Table 3: Meadow Qualitative Evaluations - Richmond Field Station, Richmond, CA

Meadow characteristics	Big Meadow	Northwest	West	EPA north	EPA south	North	580	Central	Eucalyptus	Gull	East	Northeast	Far North
Acreage [a]	13	3	4	2	1	3.9	1	2.5	1.8	1	1	1	1
Location to eucalyptus grove	W	W	SW	SW	SW	E	NE	S	E	E	E	E	N
Management Regime (mowing) [b]													
Exotic plant control	Y	N	Y	Y	N	N	N	N	N	N	N	N	N
Landscaping/ maintenance	N	N	N	N	N	Y	Y	Y	Y	Y	Y	Y	Y
Previous disturbances (1993-2012) [c]	Y	Y	N	Y	Y	N	N	N	N	N	N	N	N
Potential* Wetlands Present** [d] ***(visual obs.)	Y	Y	Y	Y	N	N	N	N	N	N	N	N	N
Hydrology altered	N	N	N	N	N	Y	Y	N	Y	Y	Y	Y	na
Reproduction present/absent	P	P	P	P	P	A	A	A	A	na	na	na	na
Insect/disease	na	na	na	na	na	na	na	na	na	na	na	na	na
Species diversity [e]	6+	4	6+	6+	1	3	1	1	2	1	2	2	0
Threats													
Invasive species (Shrub/Herbaceous)	S	S	S	H	S	H	H	H	H	H	H	H	H
Disconnected spatially	N	N	N	N	N	Y	Y	Y	Y	Y	Y	Y	Y
Surrounded by development [f]	N	N	N	N	N	N	Y	Y	N	Y	Y	Y	N
Wind isolated	N	N	N	N	N	Y	Y	N	Y	Y	Y	Y	Y

Notes:
a = URS (2007) acreages and modified for removal of eucalyptus trees in Eucalyptus Meadow, North Meadow and Central Meadow.
b = URS (2007) recommended mowing regimes.
c = Previous disturbances, such as recent soil deposition from ~1993, are based on Amme (1993).
d = Wetlands were identified based on Current Conditions Report (Tetra Tech and Sea Engineers 2007) and visual observations in the field in 2012.
e = Species diversity was based on the URS (2007) report and includes those native species that were identified by the EBCNPS for Ranks A and B, excluding the two grass species, *Nassella* sp. and *Danthonia* sp.
f = Development is classified for this report as buildings and does not include roadways.

The following is a description per meadow identifying the criteria and qualities present in each meadow. These evaluations are then applied in the *Richmond Field Station Habitat Enhancement and Mitigation Analysis* (Wildlife Research Associates 2013). A synopsis of these attributes is presented in Table 4 (page 22).

Big Meadow: Big Meadow, approximately 13.3 acres in size (URS 2007), is the largest of the grassland areas on the RFS site. It has the highest plant species diversity and is being managed via a mowing regime to maintain and increase the native grasses and forbs. This area has benefited from exotic species control and is rated as a high quality grassland area for the site based on the percent cover of plants. It is composed primarily of coastal terrace prairie grassland; however, the northern portion, located outside the URS (2007) designated 13 acre, is comprised of low quality habitat. It has been moderately disturbed due to subdivision work conducted in the early 1900s (Amme 1993). Despite this historical disturbance, the coastal terrace prairie is more or less intact. The Big Meadow has high presence of California oatgrass and purple needlegrass in addition to seventeen (17) species of listed sensitive plants, 10 of which are EBCNPS Rank A or B (URS 2007), along with many common native species. The remnant coastal terrace prairie grassland in Big Meadow is largely undisturbed, is scientifically and ecologically invaluable, and is virtually impossible to recreate from a non-coastal terrace prairie habitat (Amme 1993). In summary, the qualitative evaluations presented in Table 3 are as follows:

- Large area (relative to other areas on site)
- West of the Eucalyptus grove - is an open area with no shade from trees.
- Highest species diversity of all the other areas on site.
- Invasive exotics are controlled via mowing program
- Not channelized
- Good reproduction of natives.
- Not disconnect spatially
- Not surrounded by development
- Not wind isolated.
- Wetlands present.

Due to these factors, Big Meadow is designated as high quality grassland habitat (Table 4)

Northwest Meadow: Northwest Meadow, approximately three acres in size, is located west of the Eucalyptus grove and west of the Big Meadow. Although it is separated from the Big Meadow by the Fog Buildings is it spatially connected and contiguous to the Big Meadow and West Meadow. According to the URS (2007) report, adjacent roadwork and building construction has somewhat disturbed this site. Seven listed plant species (EBCNPS Rank A, B or C) were mapped for this area in addition to California oatgrass and purple Needlegrass and other, common native plants. Only 4 of the 7 listed plant species were Rank A or B so this area did not meet the URS criteria for defining high quality grassland habitat. However, since 2007 the presence of California oatgrass and purple Needlegrass has increased in this area making it a high quality grassland habitat based on the membership rules as defined by the Manual of California Vegetation (Sawyer, et al. 2009). In summary, the qualitative evaluations presented in Table 3 are as follows:

- Located west of the Eucalyptus grove in the relatively undeveloped portion of the campus and in an open area with not shade from trees
- High species diversity.
- Not channelized

- Good reproduction of natives.
- Not disconnect spatially
- Not surrounded by development
- Not wind isolated.
- Wetlands present.

Due to these factors, Northwest Meadow is designated as high quality grassland habitat (Table 4)

West Meadow: West Meadow, approximately four acres in size, is located west of the Eucalyptus grove and is connected spatially to the Big Meadow, Northwest Meadow and EPA Meadows North and South. This grassland is composed of both disturbed/exotic grassland and disturbed coastal prairie, with an isolated patch of minimally disturbed coastal prairie (URS 2007). A small concrete foundation is present in the middle of the site along with coyote bush which is invading into the grassland area. Eleven species of EBCNPS listed sensitive plants and 6 EBCNPS Rank A or B plant species were mapped for this area in addition to California oatgrass and purple Needlegrass. Based on the URS (2007) the West Meadow has received some disturbance but because there are 6 EBCNPS Rank A or B plants present, the site met the URS (2007) definition of high quality grassland habitat. In summary, the qualitative evaluations presented in Table 3 are as follows:

- Located west of the Eucalyptus grove in the relatively undeveloped portion of the campus and in an open area with not shade from trees
- High species diversity.
- Invasive exotics are controlled via mowing program
- Not channelized
- Good reproduction of natives.
- Not disconnect spatially
- Not surrounded by development
- Not wind isolated.
- Wetlands present.

Due to these factors, West Meadow is designated as high quality grassland habitat (Table 4)

EPA Meadow North: EPA Meadow North, approximately two acres in size, is located in the western portion of the campus southwest of the Eucalyptus grove. EPA Meadow N is a regularly mowed grassland with one small structure present on the site. The grassland in EPA Meadow N is somewhat disturbed and 12 sensitive plant species occur at this location in addition to California oatgrass and purple Needlegrass. The site also supports 6 other EBCNPS Rank A or B plant species sot that this area meets the URS operational definition of high quality grassland habitat. In summary, the qualitative evaluations presented in Table 3 are as follows:

- Located west of the Eucalyptus grove in the relatively undeveloped portion of the campus and in an open area with no shade from trees
- High species diversity.
- Invasive exotics are controlled via mowing program
- Not channelized
- Good reproduction of natives.
- Not disconnect spatially
- Not surrounded by development

- Not wind isolated.
- Wetlands present.

Due to these factors, EPA Meadow North is designated as high quality grassland habitat (Table 4)

EPA Meadow South: EPA Meadow S, approximately one acre in size, is located south of the EPA Laboratory. This area is regularly mowed (URS 2007) and the soils in this area have been partially disturbed in the past as evidenced by mounding and uneven grades in this area. California oatgrass and purple needlegrass occur on the site but in low cover. Brown-headed rush (*Juncus phaeocephalus*), an EBCNPS Rank B species also occurs in proximity to the site along with 3 species of sensitive plants. The site does not meet the URS (2007) operational definition of high quality grassland habitat. This site is dominated primarily by non-native species along with coyote bush which is invading into the grassland area along with non-native blackberry. In summary, the qualitative evaluations presented in Table 3 are as follows:

- The grassland area is small and highly disturbed with uneven grades and areas where soil material has been dumped.
- Presence of invasive herbaceous and shrub species.
- Low species diversity.

Due to these factors, EPA Meadow South is designated as medium quality grassland habitat (Table 4).

North Meadow: North Meadow, approximately five acres in size, is the second largest grassland on the RFS site. This area is located east of the Eucalyptus grove and east of the Big Meadow. According to the URS (2007) report this area is regularly mowed and while the site has experienced disturbance, one EBCNPS Rank B and 6 EBCNPS listed sensitive plants occur on the site in addition to California oatgrass and purple needlegrass. This site did not meet the URS criteria of a high quality grassland habitat because it lacked the 6 or greater EBCNPS ranked A or B plant species. In summary, the qualitative evaluations presented in Table 3 are as follows:

- Located east of the Eucalyptus grove in the more developed portion of the campus.
- Receives higher maintenance (mowing regime) for landscaping purposes and not specifically for exotic control.
- Hydrology channelized
- Presence of invasive, herbaceous species;
- Disconnect spatially
- Wind isolated.

Due to these factors, North Meadow is designated as low quality grassland habitat (Table 4).

580 Meadow: 580 Meadow, approximately two acres in size, is located in the far northeastern corner of the campus, east of the Eucalyptus grove. A complex of buildings occurs along its west boundary with Interstate 580 and a rail line along the northeast boundary and Robin Drive on its south boundary. It is located in an area with a long history of industrial use and has been disturbed since the turn of the twentieth century (URS, 2003 & 2007). This meadow is composed of regularly mown grassland and non-native plants with a few stands of coyote bush. This site has experienced disturbance and four listed sensitive plants occur on the site. The site did not meet the URS operational definition of high quality grassland habitat, since only one EBCNPS

Rank B plant species occurs in this area in addition to California oatgrass and purple needlegrass. In summary, the qualitative evaluations presented in Table 3 are as follows:

- Small size.
- Located east of the Eucalyptus grove in the more developed portion of the campus.
- Receives higher maintenance (mowing regime) for landscaping purposes and not specifically for exotic control.
- Hydrology channelized
- Presence of invasive, herbaceous species;
- Disconnect spatially.
- Surrounded by development.
- Wind isolated.

Due to these factors, 580 Meadow is designated as low quality grassland habitat (Table 4).

Central Meadow: Central Meadow is composed of a 2.5-acre open area and is located south of the Eucalyptus grove and in the developed eastern campus area. The 0.3-acre area included in the URS (2007) report was dropped from this analysis due to the eucalyptus cover. This site is regularly mowed and has experienced disturbance because part of it was used as a staging area during the remediation project (URS 2007). Six EBCNPS listed sensitive plants were mapped in this area in addition to California oatgrass and purples needled grass. However, only 3 EBCNPS Rank B plant species were mapped so that this area does not meet the URS operational definition of high quality grassland habitat. In summary, the qualitative evaluations presented in Table 3 are as follows:

- Located in the eastern, more developed portion of the campus.
- Receives higher maintenance (mowing regime) for landscaping purposes and not specifically for exotic control.
- Presence of invasive, herbaceous species;
- Disconnect spatially.
- Surrounded by development.

Due to these factors, Central Meadow is designated as low quality grassland habitat (Table 4).

Eucalyptus Meadow: Eucalyptus Meadow was identified as a five acres site in the URS 2007 report but this includes 3.24 acres of Eucalyptus trees leaving only 1.76 acres of open grassland. This area is regularly mowed and has several structures, an access road bisecting the meadow and several small parking lots. This site has experienced disturbance in the past (URS 2007). Six listed sensitive plants were mapped for the site, however the site does not meet the URS operational definition of high quality grassland habitat, since only three EBCNPS Rank A or B plant species occur in addition to California oatgrass and purple needlegrass. In summary, the qualitative evaluations presented in Table 3 are as follows:

- Located in the eastern, more developed portion of the campus.
- The grassland area is small, isolated and surrounded by Eucalyptus trees.
- Receives higher maintenance (mowing regime) for landscaping purposes and not specifically for exotic control.
- Presence of invasive, herbaceous species;
- Hydrology channelized.
- Disconnect spatially.

- Surrounded by development.

Due to these factors, Eucalyptus Meadow is designated as low quality grassland habitat (Table 4).

Gull Meadow: Gull Meadow, approximately one acre in size, is located east of the Eucalyptus grove in the more developed portion of the campus. Its few open areas are regularly mowed and the meadow has been disturbed by the construction of a small complex of structures and a parking lot. California oatgrass and an isolated patch of small-bract sedge (*Carex subbracteata*) occur on the site. Two listed sensitive plants occur on the site in limited numbers. This site has experienced extensive disturbance and site does not meet the URS operational definition of high quality grassland habitat. In summary, the qualitative evaluations presented in Table 3 are as follows:

- Located in the eastern, more developed portion of the campus.
- The grassland area is small, isolated, and altered by past disturbance.
- Receives higher maintenance (mowing regime) for landscaping purposes and not specifically for exotic control.
- Presence of invasive, herbaceous species;
- Hydrology channelized.
- Disconnect spatially.
- Surrounded by development.
- Wind isolated.

Due to these factors, Gull Meadow is designated as low quality grassland habitat (Table 4)

East Meadow: East Meadow, approximately one acre in size, is located in the more developed eastern portion of the campus east of the Eucalyptus grove. This site is regularly mowed and has been previously disturbed with the construction of a parking lot, and two structures. Four EBCNPS listed sensitive plants and 3 EBCNPS Rank B plant species occur on the site in addition to California oatgrass and purple needlegrass. The site does not meet the URS operational definition of high quality grassland habitat. In summary, the qualitative evaluations presented in Table 3 are as follows:

- Located in the eastern, more developed portion of the campus.
- The grassland area is small, isolated, and altered by past disturbance.
- Receives higher maintenance (mowing regime) for landscaping purposes and not specifically for exotic control.
- Presence of invasive, herbaceous species;
- Hydrology channelized.
- Disconnect spatially.
- Surrounded by development.
- Wind isolated.

Due to these factors, East Meadow is designated as low quality grassland habitat (Table 4).

Northeast Meadow: Northeast Meadow, approximately one acre in size, is located in the more developed eastern portion of the campus east of the Eucalyptus grove. It is regularly mowed and has been disturbed in the past. A parking lot, a several small structures and a large paved area are present on the site and topsoil in a portion of the site appears to have been removed (URS 2007). Four EBCNPS listed sensitive plants and one EBCNPS Rank B plant species occur here in

addition to California oatgrass and purple needlegrass. The site does not meet the URS operational definition of high quality grassland habitat. In summary, the qualitative evaluations presented in Table 3 are as follows:

- Located in the eastern, more developed portion of the campus.
- The grassland area is small, isolated, and altered by past disturbance.
- Receives higher maintenance (mowing regime) for landscaping purposes and not specifically for exotic control.
- Presence of invasive, herbaceous species;
- Hydrology channelized.
- Disconnect spatially.
- Surrounded by development.
- Wind isolated.

Due to these factors, Northeast Meadow is designated as low quality grassland habitat (Table 4).

Far North Meadow: Far North Meadow, approximately one acre in size, is located in the northeastern corner of the campus outside of the RFS boundary fence. Interstate 580 and a rail line are the northwest boundary, three RFS buildings are near its east boundary, and Eucalyptus Meadow forms the south boundary. It is located in an area with a long history of industrial use and has been thoroughly disturbed since the turn of the twentieth century (URS 2003). This meadow is overgrown with non-native herbaceous species and no listed plants were observed in this area. In summary, the qualitative evaluations presented in Table 3 are as follows:

- The grassland area is small, isolated, and altered by past disturbance.
- Receives higher maintenance (mowing regime) for landscaping purposes and not specifically for exotic control.
- Presence of invasive, herbaceous species.
- No coastal grass species present.
- Dominance by non-native plants.
- Disconnect spatially.
- Wind isolated.

Due to these factors, Far North Meadow is designated as low quality grassland habitat (Table 4).

Based on the above criteria and evaluations, the meadows are ranked as to their quality of habitats, whether certain attributes are beneficial to the grassland meadow or not beneficial, and are presented in Table 4 Quality of Meadow Habitat.

Table 4: Quality of Meadow Habitat - Richmond Field Station, Richmond, CA

Quality of Meadow	Big Meadow	Northwest	West	EPA north	EPA south	North	580	Central	Eucalyptus	Gull	East	Northeast	Far North
Standardized evaluation	3	2	3	2	1	1	1	2	2	1	1	1	1
Acreage	1	1	1	0	0	1	0	0	0	0	0	0	0
Location to eucalyptus grove	1	1	1	1	1	0	0	0	0	0	0	0	0
Management Regime (mowing)													
Exotic plant control	1	0	1	1	0	0	0	0	0	0	0	0	0
Landscaping/ maintenance	1	1	1	1	1	0	0	0	0	0	0	0	0
Previous disturbances (1993-2012)	0	0	1	0	0	1	1	1	1	1	1	1	1
Wetlands Present	1	1	1	1	0	0	0	0	0	0	0	0	0
Hydrology altered	1	1	1	1	1	0	0	1	0	0	0	0	0
Reproduction present	1	1	1	1	1	0	0	0	0	0	0	0	0
Insect/disease	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Species diversity	1	0	1	1	0	0	0	0	0	0	0	0	0
Threats													
Invasive species	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Disconnected spatially	1	1	1	1	1	0	0	0	0	0	0	0	0
Surrounded by development	1	1	1	1	1	1	0	0	1	0	0	0	1
Wind isolated	1	1	1	1	0	0	0	0	0	0	0	0	0
TOTAL	**14**	**11**	**15**	**12**	**7**	**4**	**2**	**4**	**4**	**2**	**2**	**2**	**3**
High	√	√	√	√									
Medium					√								
Low						√	√	√	√	√	√	√	√

Ranking Values (based on a maximum value of 15)
High = 11 or greater
Medium = 6 to 10
Low = 1 to 5

3.3 Wildlife Habitats

Several wildlife habitats, which include vegetation communities and anthropogenic structures, occur within the 96-acre property; however, the descriptions below pertain only to those habitats discussed in this constraints analysis, mainly the grasslands.

The value of a site to wildlife is influenced by a combination of the physical and biological features of the immediate environment. Species diversity is a function of diversity of abiotic and biotic conditions and is greatly affected by human use of the land. The wildlife habitat quality of an area, therefore, is ultimately determined by the type, size, and diversity of vegetation communities present and their degree of disturbance. Wildlife habitats are typically distinguished by vegetation type, with varying combinations of plant species providing different resources for use by wildlife. The following is a discussion of the wildlife species supported by the on-site habitats, as described by *A Guide to Wildlife Habitats of California* (Mayer and Laudenslayer 1989).

3.3.1 Grassland

Grassland habitat, including native and non-native grasslands, attract reptiles and amphibians, such as northern alligator lizard (*Gerrhonotus multicarinatus*), western fence lizard (*Sceloporus occidentalis*), and Pacific slender salamander (*Batrachoseps attenuatus*), which feed on invertebrates found within and beneath fallen logs or other debris within the vegetation community. This habitat also attracts avian seed-eating and insect-eating species of birds and mammals. California quail (*Lophortyx californicus*), mourning dove (*Zenaidura macroura*), and meadowlark (*Sturnella neglecta*) are a few seed-eaters that nest and forage in grasslands. One type of grassland bird guild (those that nest and forage in grasslands) includes California horned lark (*Eremophila alpestris actia*), savannah sparrow (*Passerculus sandwichensis*), and western meadowlark, all species of conservation and management concern, and can be indicators of the health of the habitat. During previous studies, two of the three species, savannah sparrow and western meadowlark, were reported occurring in the grasslands between 1987 and 1989 (Gustein 1989). Insect-eaters such as scrub jays (*Aphelocoma coerulescens*), barn swallows (*Hirundo rustica*), and mockingbirds (*Mimus polyglottus*) use the habitat for foraging only. Grasslands are important foraging grounds for aerial and ground foraging insect-eating bat species such as myotis (*Myotis* spp.) and pallid bat (*Antrozous pallidus*). A large number of other mammal species such as California vole (*Microtus californicus*), Botta's pocket gopher (*Thomomys bottae*), California ground squirrel (*Spermophilus beecheyi*) and black-tailed jackrabbit (*Lepus californicus*) also forage and nest within grasslands and have been reported on the site (Gustein 1989). Small rodents attract raptors (birds of prey) such as owls that hunt at night, as well as day-hunting raptors such as red-tailed hawks (*Buteo jamaicensis*), northern harrier (*Circus cyaneus*) and white-shouldered kite (*Elanus leucurus*), among others, which have been reported on the site (Gustein 1989). Black-tailed deer (*Odoicoileus hemionus californicus*) use grassland for grazing and, if the grass is tall enough, for nesting at night.

One invertebrate species, the Ohlone tiger beetle (*Cincidela ohlone*), is a specialist of the coastal terrace prairie grassland habitat. However, this species occurs in coastal terrace prairie habitats located south of San Francisco Bay and does not occur in the Richmond Area (CNDDB 2012).

3.4 Wildlife Movement Corridors

Wildlife movement includes migration (*i.e.*, usually one way per season), inter-population movement (*i.e.*, long-term genetic flow) and small travel pathways (*i.e.,* daily movement corridors within an animal's territory). While small travel pathways usually facilitate movement for daily home range activities such as foraging or escape from predators, they also provide connection between outlying populations and the main corridor, permitting an increase in gene flow between populations.

These linkages between habitat types can extend for miles between primary habitat areas and occur on a large scale throughout California. Habitat linkages facilitate movement between populations located in discrete areas and populations located within larger habitat areas. The mosaic of habitats found within a large-scale landscape results in wildlife populations that consist of discrete sub-populations comprising a large single population, often referred to as a meta-population. Even where patches of pristine habitat are fragmented, such as occurs with coastal terrace prairie grassland and other grasslands, the movement between wildlife populations is facilitated through habitat linkages, migration corridors and movement corridors. Depending on the condition of the corridor, genetic flow between populations may be high in frequency, thus allowing high genetic diversity within the population, or may below in frequency. Potentially low frequency genetic flow may lead to complete isolation and, if pressures are strong, potential extinction (McCullough 1996; Whittaker 1998).

As a vegetative community, the coastal terrace prairie grassland is isolated to the RFS; however, other grasslands (both native and non-native) occur in the general area and provide much of the same habitat value for wildlife as the coastal terrace prairies grassland. As a result, the grassland at the RFS provides the western most habitat available along the Inner Richmond Harbor. Movement corridors within the project area include the Stege saltmarsh on the southern border, the slough that runs along the western border, and the meadows located on the western portion of the site. The eucalyptus grove provides a movement corridor for those species that do not like to be exposed, such as California quail and brown towhees. The developed habitat provides an area for movement for raccoons, skunks and opossums.

Impacts and mitigation measures for these grasslands will be evaluated during the NEPA and CEQA process and are not part of this report. All opportunities for potential enhancement, restoration and creation will be also evaluated during that review.

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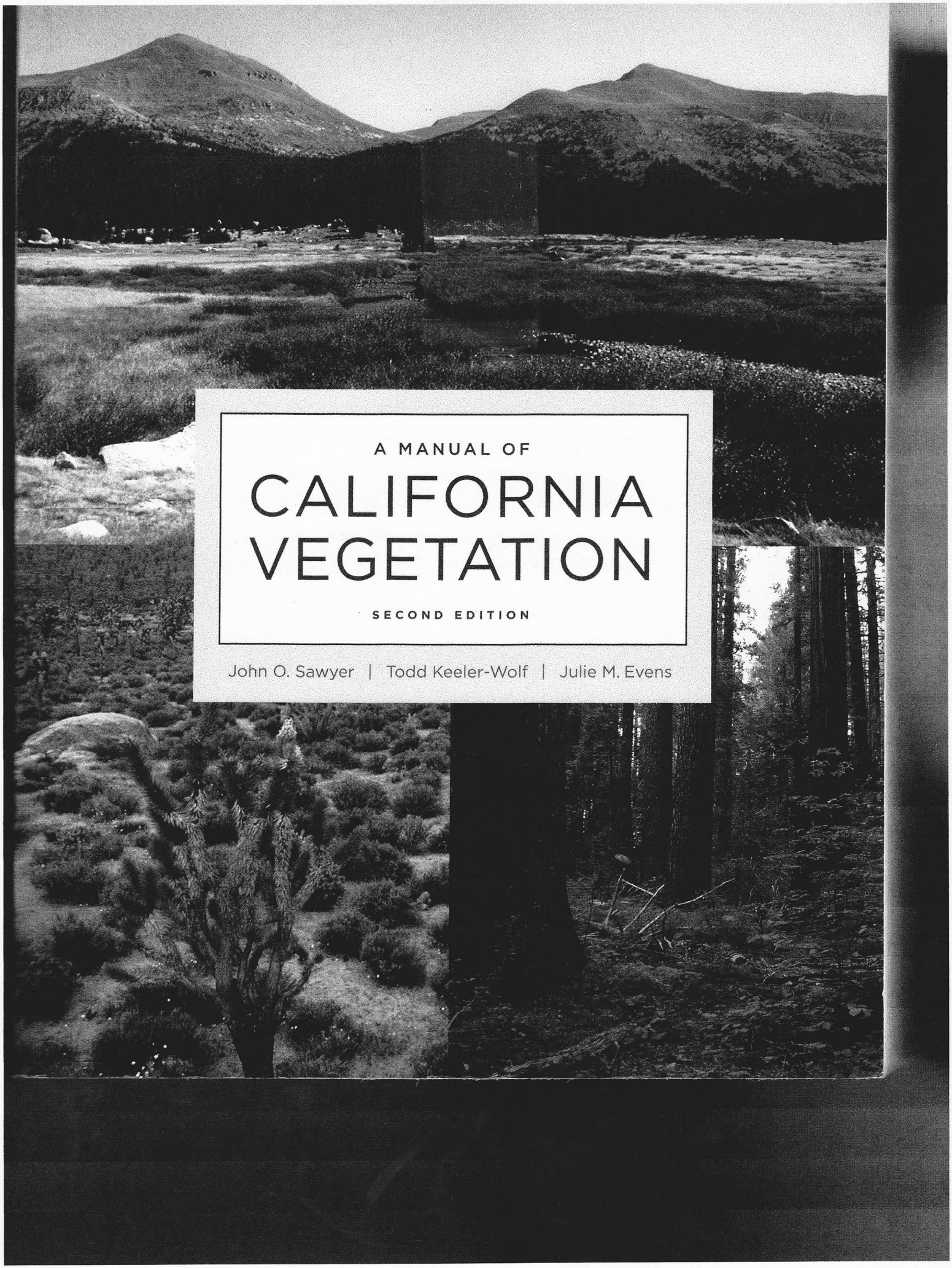
Fig. 3: Northwest Meadow looking north.

Fig. 4: EPA Meadow South looking northeast.

Fig. 5: West Meadow looking south.

APPENDIX A: Manual of California Vegetation Membership Rules



A MANUAL OF

CALIFORNIA VEGETATION

SECOND EDITION

John O. Sawyer | Todd Keeler-Wolf | Julie M. Evens

Danthonia californica Herbaceous Alliance

California oat grass prairie

***Danthonia californica* is dominant or co-dominant in the herbaceous layer** with *Aira caryophyllea, Anthoxanthum odoratum, Arrhenatherum elatius, Bromus carinatus, Carex tumulicola, D. pilosa, Epilobium* spp., *Festuca* spp., *Holcus lanatus, Iris douglasiana, Juncus arcticus, Lolium perenne, Muhlenbergia filiformis, Melica californica, Nassella pulchra, Plantago lanceolata, Poa pratensis, P. secunda, Potentilla gracilis, Pteridium aquilinum, Ranunculus californicus, R. occidentalis, Rumex acetosella,* and *Sisyrinchium bellum*. Emergent trees and shrubs such as *Baccharis pilularis* or *Lupinus rivularis* may be present at low cover. Herbs < 1 m; canopy is open to intermittent.

Habitats: Coastal bluffs, valley bottoms, floodplains, terraces, slopes, ridge tops. The USFWS Wetland Inventory (1996 national list) recognizes *Danthonia californica* as a FACW plant. **Elevation:** 0–2200 m.

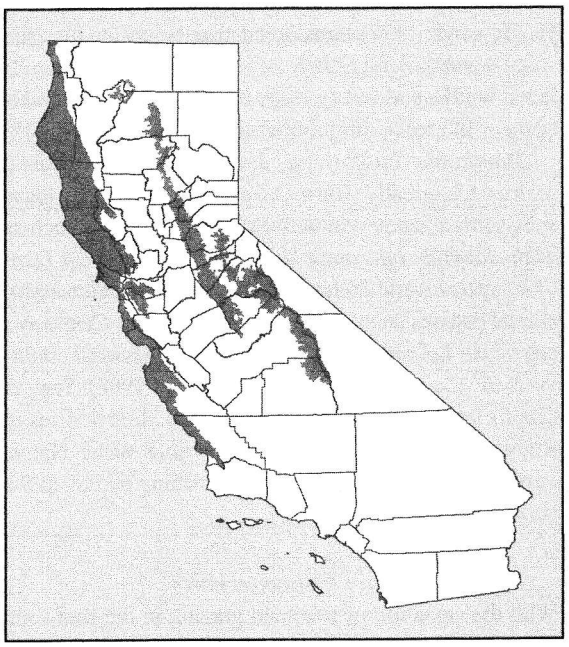
Rarity ranking: G4 S3. **MCV:** California oat grass series. **NVCS:** *Danthonia californica* herbaceous alliance. **Calveg:** Perennial grass/herbs. **Holland:** Bald Hills grassland, Coastal terrace prairies, Great Basin grassland. **Munz:** Coastal prairie. **WHR:** Perennial grassland.

Membership Rules

Danthonia californica > 50% relative cover in the herbaceous canopy (Keeler-Wolf et al. 2003a).

Life History Traits of Principal Species

Life forms	Polycarpic perennial; herb
Seed storage	Transient
Seed longevity	Short
Mode of dispersal	Animal; wind
Germination agents	None
Mode of sprouting	Underground structures (culms)
Survivability after fire/disturbance	Fire-hardy; high sprouter
Disturbance-stimulated flowering	No
Reproductive range	Life of plant
Recruitment	Medium
Regional variation	Low



Danthonia californica generally > 25% absolute cover in the herbaceous layer (S. Smith 1998).

Remarks

Danthonia californica is a perennial bunchgrass with loosely clustered, coarse culms. Seedlings establish on bare soil. Plants are tolerant of moderate grazing (Heady et al. 1963). It occurs in coastal prairies and woodlands. It also can dominate inland meadows at low and montane elevations.

Perennial grasslands with rich, moist soils along the central coast are referred to as coastal prairie (Ford and Hayes 2007). On the north coast north of Marin Co., the coastal prairie occurs in two settings: terrace prairies along the coastline, and the Bald Hills prairies on inland ridges and hilltops. Stands with similar species composition also occur inland in California where annual rainfall is greater than 100 cm. We include grasslands on these two settings in this alliance. The type was also extensive in the Rogue,

Nassella pulchra Herbaceous Alliance

Purple needle grass grassland

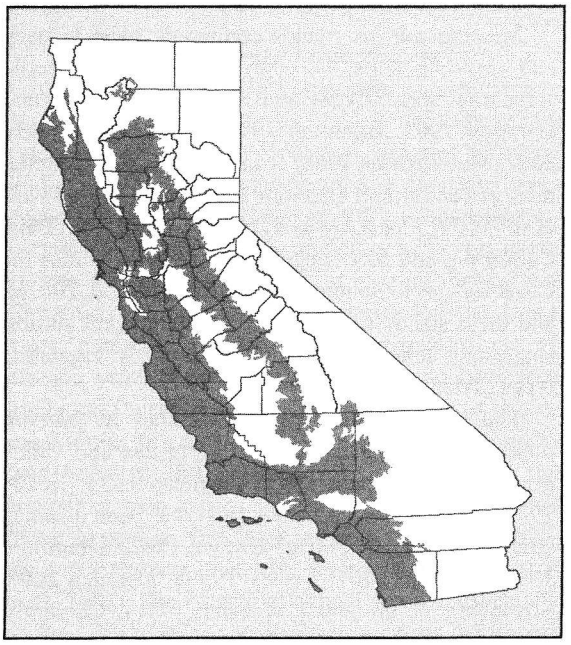
***Nassella pulchra* is dominant or characteristically present in the herbaceous layer** with other perennial grasses, including *Elymus glaucus, Festuca californica, Hordeum brachyantherum, Koeleria macrantha, Lolium perenne, Melica californica, M. imperfecta, N. lepida, N. cernua,* and *Poa secunda,* and with perennials, such as *Calochortus* spp., *Calystegia* spp., *Sanicula* spp., and *Sisyrinchium bellum.* Annual herbs, including *Astragalus* spp., *Avena barbata, A. fatua, Bromus hordeaceus, B. rubens, Clarkia* spp., *Cryptantha* spp., *Eremocarpus setigerus, Erodium* spp., *Hirschfeldia incana, Holocarpha virgata, Lasthenia* spp., *Lepidium nitidum, Lupinus* spp., *Plantago* spp., and *Trifolium* spp., are common. Emergent *Artemisia californica, Eriogonum fasciculatum, Hazardia squarrosa,* and other shrubs and trees may be present at low cover. Herbs < 1 m; cover is open to continuous.

Habitats: Valley and foothill areas on all topographic locations. Inland soils are deep with high clay content, or shallow and rocky near the coast. **Elevation:** 0–1300 m.

Rarity ranking: *G4 S3?*. **MCV:** Purple needlegrass series. **NVCS:** *Nassella pulchra* herbaceous alliance. **Calveg:** Perennial grass/herbs. **Holland:** Valley needlegrass grassland. **Munz:** Valley grassland. **WHR:** Perennial grassland.

Life History Traits of Principal Species

Life forms	Polycarpic perennial; herb
Seed storage	Transient
Seed longevity	Short
Mode of dispersal	Animals; gravity; wind
Germination agents	None
Mode of sprouting	Buds on large branches or trunks (basal buds, tillers)
Survivability after fire/ disturbance	Fire-hardy; high sprouter
Disturbance-stimulated flowering	No
Reproductive range	Long-lived
Recruitment	High
Regional variation	Medium



Membership Rules

Nassella pulchra usually > 10% relative cover of the herbaceous layer (Evens and San 2005, Klein and Evens 2005, Keeler-Wolf and Evens 2006).

Nassella pulchra > 5% absolute cover as a characteristic to dominant species in the herbaceous layer (Klein et al. 2007).

Remarks

Nassella pulchra is a native, cool-season perennial bunch grass that expands when tussocks fragment. Plants produce large quantities of viable seed, but seedling establishment is generally low. Seedlings appear to establish more successfully on ground that is bare. *N. pulchra* varies with seasonal weather conditions, and the wet growing season favors plants (Steinberg 2002c, Stromberg et al. 2007). *N. cernua* sometimes occurs in the same area as this species, especially in southern California, but they do not typically mix (Steinberg 2002c). These needle grasses tend to segregate based on substrate and slope factors (Kellogg and

WETLAND DELINEATION REPORT FOR PORTIONS OF THE RICHMOND FIELD STATION
RICHMOND, CALIFORNIA

July 2013

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Berkeley, CA 94720

Prepared by:

Tetra Tech, Inc.

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A Photo Log
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LIST OF ACRONYMS

Acronym or Abbreviation	Full Phrase
asl	above sea level
FAC	facultative
FACU	facultative upland
FACW	facultative wetland
NRCS	US Department of Agriculture, Natural Resources Conservation Service
NWI	National Wetland Inventory
OBL	obligate
RBC	Richmond Bay Campus
RFS	Richmond Field Station
UC	University of California
UPL	upland
USACE	United States Army Corps of Engineers
USDA	United States Department of Agriculture

SECTION 1
INTRODUCTION

1.1 BACKGROUND

The Richmond Field Station (RFS) is an off-site academic teaching and research facility owned by the University of California (UC) and managed by UC Berkeley since 1950. The RFS was selected as the preferred site for a second campus for consolidation of biosciences projects and activities managed by the Lawrence Berkeley National Laboratory. The proposed name of the new facility is the Richmond Bay Campus (RBC). The subject of the wetland delineation is 16 acres that comprise a subset of the initial development footprint for the RBC.

The purpose of this report is to provide results of wetland delineation activities on a 16-acre portion of the initial development footprint for the RBC. Wetlands are defined as those areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions (USACE 1987). Explicit in the definition are positive wetland indicators of three environmental parameters: hydrology, soil, and vegetation (USACE 1987). The three criteria are evaluated using US Army Corps of Engineers (USACE) wetland delineation forms completed in the field. Wetlands generally include swamps, marshes, bogs, and similar areas. As a subset of waters of the United States, jurisdictional wetlands are subject to Section 404 of the Clean Water Act and/or or Section 10 of the Rivers and Harbors Act. Jurisdictional wetlands typically include: traditional navigable waters, wetlands adjacent to navigable waters, non-navigable tributaries of traditional navigable waters that are relatively permanent, and wetlands that abut such tributaries (EPA 2007).

As shown in this report, one area within the 16-acre footprint was found to meet the above wetland definition, which is consistent with both the Clean Water Act and the 10 CFR Part 1022 wetland definitions. As presented in Section 3.3, this wetland does not appear to fall under the jurisdiction of the USACE.

1.2 PROJECT LOCATION

The RBC project site is at 1301 South 46th Street in the City of Richmond, Contra Costa County, California (37.919° N, -122.33° W). The 133-acre RBC project site is bounded on the west by a Pacific Gas and Electric (PG&E) service station, the north by Regatta Boulevard, the northeast by Meade Street, the east by the western side of South 46th Street, and the south by the San Francisco Bay. Interstate 580 (I-580) runs parallel to Meade Street along the northeastern boundary of the RBC project site (Figure 1-1).

1.3 PROJECT STUDY AREA

The project study area is a subset of the RBC project site bordered on the east by South 46th Street, the south by the Western Stege Marsh, the west by Avocet Way, and the north by Lark Drive (Figure 1-2). The southern portion of the project study area is approximately 10 feet above sea level (asl). Current redevelopment plans for the project study area include three buildings totaling 600,000 gross square feet, parking areas, and landscaping.

1.4 GENERAL SITE CONDITIONS

1.4.1 Ecological Features

Habitat types observed in the vicinity of the RBC site include native coastal terrace grasslands, coastal scrub, tidal marsh, tidal mudflats, and open slough channels associated with Western Stege Marsh (south of and outside the project study area). The marsh includes native cordgrass (*Spartina foliosa*) and other vegetation that provides habitat for the endangered California clapper rail (*Rallus longirostris obsoletus*).

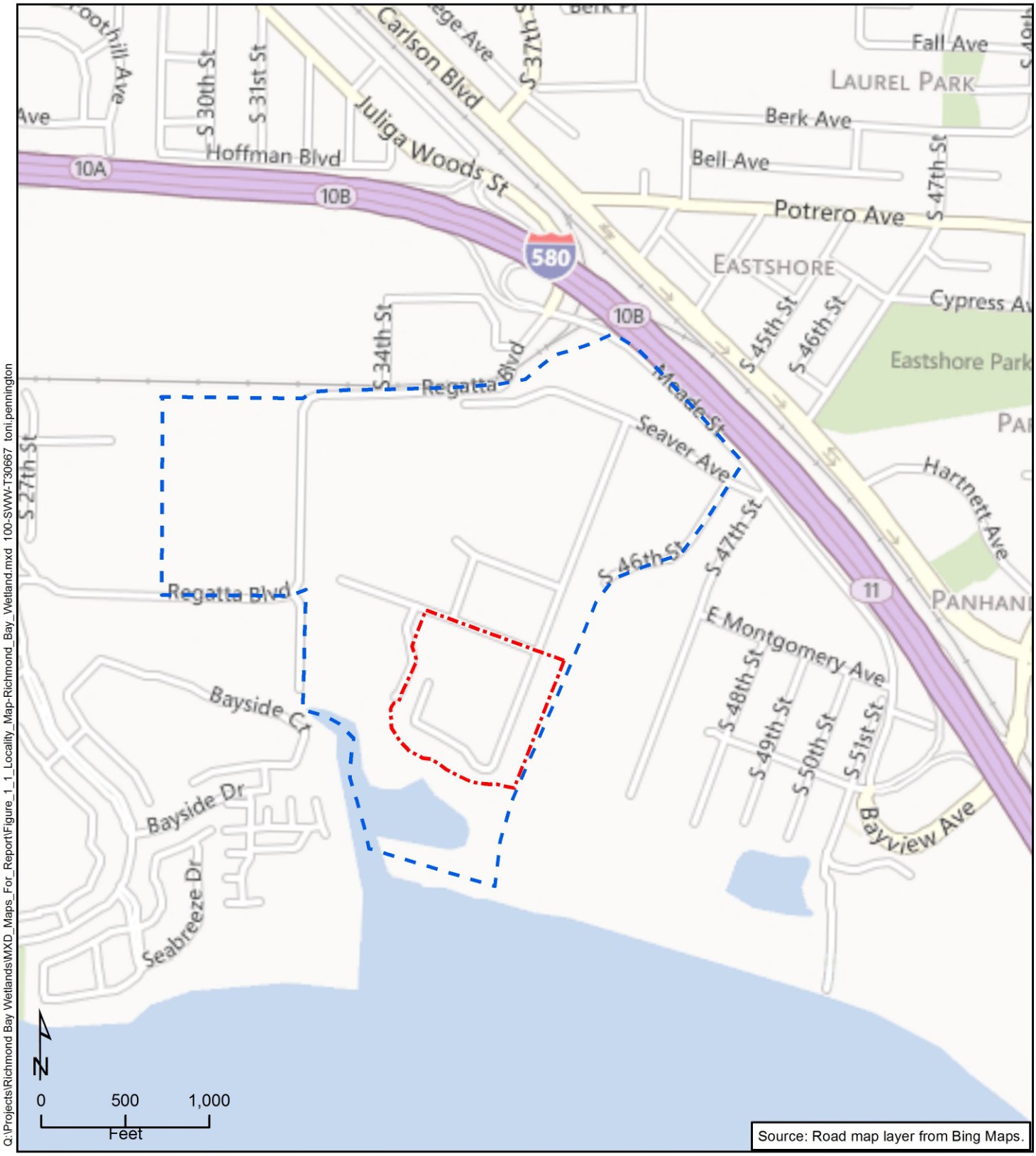
Within the project study area, the grassland habitat area includes both native and nonnative plant species, which provide primary habitat, such as nesting and foraging, and secondary habitat, such as movement corridors. Manmade landscaping and nonnative grasslands are also found. Monarch butterflies (*Danaus plexippus*) a California sensitive species, use eucalyptus trees in the central portion of the site for cover and thermal regulation during the winter months.

1.4.2 Precipitation

Table 1-1 lists the average and measured precipitation data (WETS table) (NRCS 2013a). Precipitation data in the days preceding the site visits was obtained from the California Department of Water Resources Data Exchange Center (Station ID: RHL). An initial investigation of the project study area was done on January 4, 2013, with focused field evaluations on February 13 and 15, 2013. In the week prior to the January 4 site visit, 0.04 inch of precipitation was recorded. In the week prior to the February 13 and 15 site visits, no precipitation was recorded.

1.4.3 Soils

Two soil types were identified from the US Department of Agriculture, Natural Resources Conservation Service (NRCS) Custom Soil Report for Contra Costa County, California: Urban Land and Clear Lake Clay (NRCS 2013b, NRCS 2013c). Clear Lake Clay is considered to have hydric properties, meaning soil map unit components are likely to meet



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Richmond Bay Campus Site

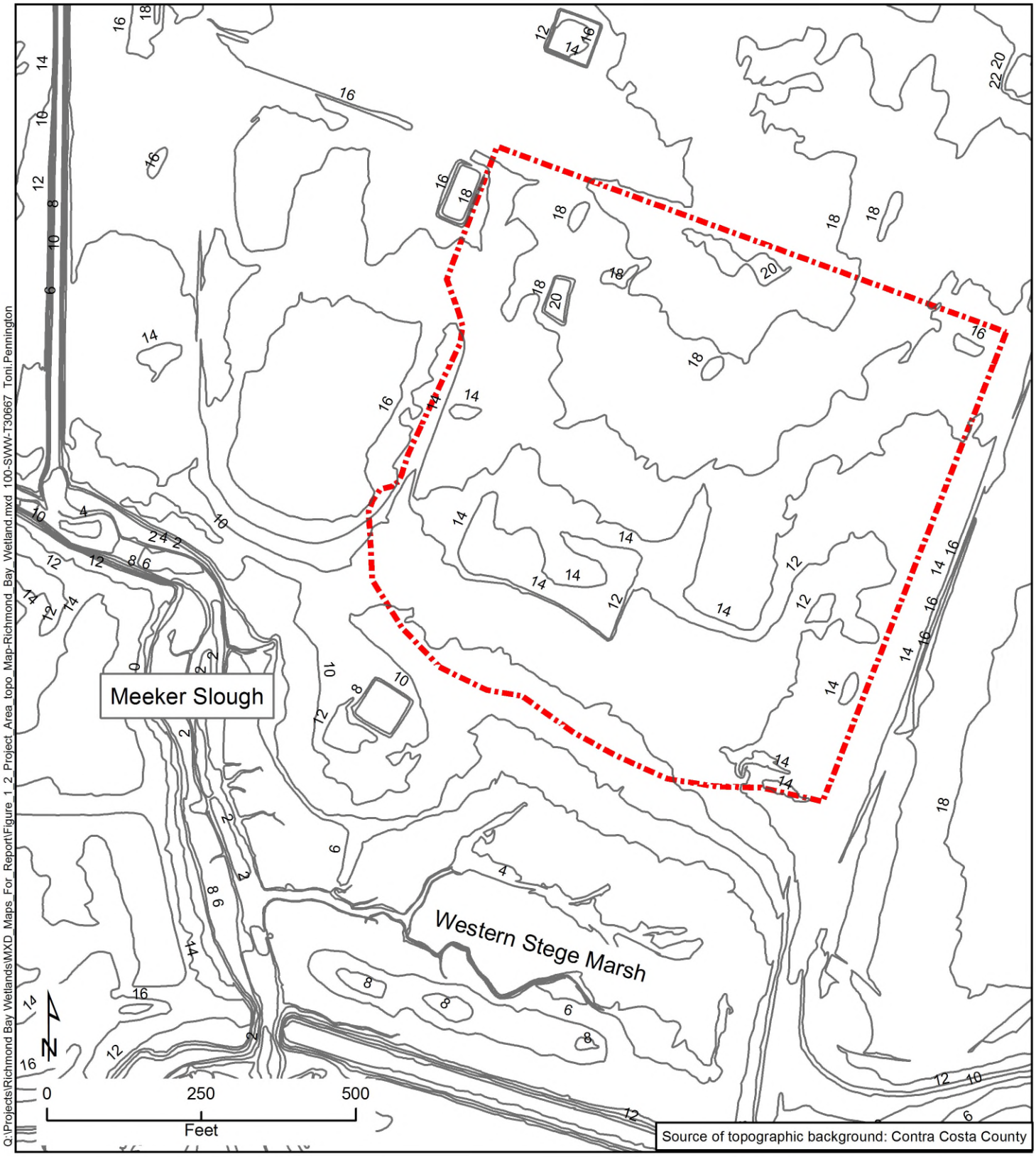
Project Study Area

TETRA TECH

Locality Map

Richmond Field Station
Wetland Delineation
Richmond, California

Figure 1-1



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2 ft. contour intervals

Project Study Area

TETRA TECH

Project Study Area

Richmond Field Station
Wetland Delineation
Richmond, California

Figure 1-2

Table 1-1
Precipitation Data

Month	Temperature (°F)			Precipitation (Inches)				
				Avg	30% Chance Will Have		Avg # of Days w/.1 or More	Avg Total Snowfall
	Avg Daily Max	Avg Daily Min	Avg		Less Than	More Than		
January	57.7	42.7	50.2	4.71	2.09	5.75	7	0.0
February	61.8	45.4	53.6	4.24	1.72	5.15	7	0.0
March	63.9	47.1	55.5	3.55	1.31	4.29	6	0.0
April	67.3	49.0	58.2	1.35	0.57	1.64	3	0.0
May	69.3	51.8	60.6	0.54	0.01	0.52	1	0.0
June	71.7	54.6	63.1	0.17	0.00	0.16	0	0.0
July	71.5	55.8	63.6	0.07	0.00	0.00	0	0.0
August	72.0	56.5	64.3	0.10	0.00	0.00	0	0.0
September	74.1	56.5	65.3	0.27	0.00	0.00	0	0.0
October	72.3	53.3	62.8	1.40	0.45	1.71	2	0.0
November	64.4	47.9	56.2	3.31	1.15	3.98	5	0.0
December	58.1	42.9	50.5	3.35	1.85	4.16	6	0.0

Creation Date: 08/29/2002
Latitude: 3756 Longitude: 12221 Elevation: 00060
State FIPS/County (FIPS): 06013 County Name: Contra Costa
Start yr – 1971 End yr. - 2000
Source: WETS Station, Richmond, CA7114; NRCS 2013a
% – percent # – number
Avg – average w/ – with

the hydric soil definition but field indicators are necessary for verification (NRCS 2013b). Clear Lake Clay is typically found on 0 to 2 percent slopes and is considered poorly drained (NRCS 2013b).

1.4.4 Land Uses

Land uses are primarily dedicated to research buildings, roadways, parking lots, and landscaped and undeveloped open areas. The adjacent lands include industrial/office uses, I-580, and low to medium density residential neighborhoods. The adjacent property to the east is the location of former chemical production operations, currently owned by Cherokee Simeon Venture I, LLC. Western Stege Marsh is immediately to the south of the RBC site and drains into San Francisco Bay. The Western Stege Marsh Project Restoration Area is a 9.40-acre compensatory mitigation wetland characterized by salt grass (*Distichlis spicata*), Pacific cordgrass (*Spartina foliosa*), and pickleweed (*Salicornia virginica*).

1.5 SITE DISTURBANCE

Historic and recent disturbance has resulted in significantly disturbed soils at the RBC site. Historic disturbance includes significant infill of Western Stege Marsh and original site development in the 1950s. Large quantities of pyrite cinders were deposited on the RBC site from prior to 1950 through 2002. Remedial activities have included removal of approximately 28,000 cubic yards of contaminated soil and marsh sediment, excavation of

an area at the outfall of a storm drain in Meeker Slough, and removal of an additional 3,300 cubic yards of contaminated soils from six upland areas.

Recent disturbance at the site includes regular maintenance of drainage swales that drain water from across the property. This has resulted in frequent soil disturbance that likely affects hydric soil indicators. Many of the dominant plant species are weedy invasives such as Harding grass (*Phalaris aquatica*) and sweet fennel (*Foeniculum vulgare*). These opportunistic species are not considered hydrophytic (Lichvar and Kartesz 2012); however, they may be taking advantage of increased soil moisture when native perennials are not yet established.

SECTION 2
METHODS

2.1 SAMPLE SCHEDULE

The project study area was visited by Tetra Tech biologist Shannon Lindquist on January 4, 2013 to assess the condition of the existing habitats. All habitat types were noted with particular consideration given to the presence of potential wetland features (e.g., a seasonal wetland, vegetated channels, and lined swales).

Tetra Tech biologists Toni Pennington and Darlene Siegel did the wetland delineation on February 13 and 15, 2013.

2.2 SAMPLING PROTOCOLS

This wetland delineation followed the 1987 *Corps of Engineers Wetland Delineation Manual* (USACE manual) (USACE 1987) and the *Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Arid West Region (Version 2.)*. National Wetland Inventory (NWI) (USFWS 2013) maps and the California Wetlands Portal were reviewed to determine if wetlands had been previously identified in the project study area. According to these sources, no wetlands are known to be in the project study area; however, the Western Stege Marsh, a jurisdictional water body, is immediately south of the project study area.

During the January site visit, the area was qualitatively surveyed to identify potential wetlands and other waters of the US. At that time, standing water was observed in stormwater drainages. During the formal delineation upland and wetland plots were sampled to characterize community distinctions and to facilitate wetland boundary determinations according to USACE (1987). In general, test pits were dug at locations with clear breaks of topography, vegetation, or hydrologic features. Sample points were positioned to be distinctly in wetland and upland communities, and then as necessary to identify where one or more parameters disappeared in the transitional zone between the two habitat types. At each sample plot, indicators of vegetation, hydrology, and soils were documented. Where all three wetland criteria were positive, the area was identified as a wetland (USACE 1987). Wetland determination data forms are in Appendix B.

Vegetation strata were surveyed using circular plots: 30-foot diameter for tree and woody vine stratum, 15-foot-diameter for shrub and sapling, and 5-foot diameter for herbaceous strata. Dominant plants were identified to the species level with total percent cover estimated for each stratum. All plant species were documented and dominants were calculated based on their percent cover in each stratum. Lichvar and Kartesz (2012) was used to determine a plant's indicator status (facultative upland [FACU], facultative [FAC], facultative wetland [FACW], or obligate [OBL]). Plants not listed in Lichvar and Kartesz (2012) were considered upland (UPL) plant species.

Soil test pits were dug to a standard depth of 16 inches for determination of wetland hydrology and hydric soil indicators. No standing water, saturated soils, or high water table was observed. Soil horizons and textures were identified for each sample plot and soil matrix and redoximorphic features, if present, were determined using Munsell® Soil Color Charts (Munsell 2009) and WTI (2010). All potential wetlands were mapped to sub-meter accuracy with a Trimble GeoExplorer 6000 Series Geo XH global positioning (GPS) unit. Data were post-processed and transferred to global information system (GIS) shapefiles using Pathfinder 5.0 and were then overlain onto topographic base maps using ArcMap 10.

2.3 ADDITIONAL DATA SOURCES

Additional resources used included results of a recent botanical survey at the RFS ([URS] 2007), the National Wetlands Plant List (Lichvar and Kartesz 2012), and soil surveys for Contra Costa County (NRCS 2013b).

SECTION 3
DESCRIPTION OF WETLANDS AND OTHER WATERS OF THE UNITED STATES

Based on the site visit in January, two areas were targeted for the formal delineation in February. Specific sample points were targeted for investigation as they had been previously determined as potential wetlands or other waters of the United States. A total of seven sample points were collected within the project study area, and one was collected just outside the project study area (Figure 3-1) to determine whether all wetland indicators were present. We found 1) two vegetated drainage channels with evidence of recent water flow and 2) a small herbaceous wetland swale downstream of the drainage channel (Figure 3-2).

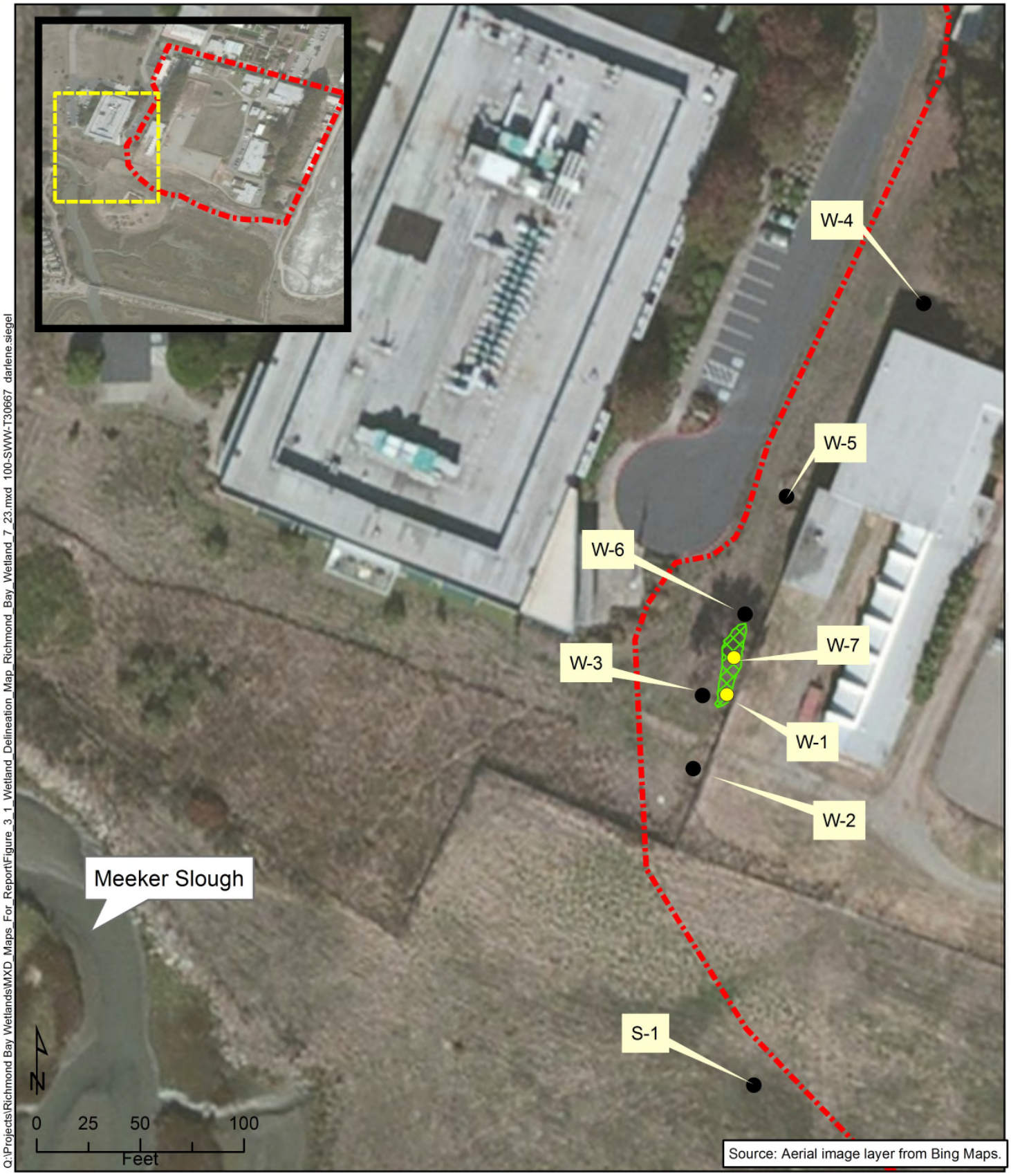
3.1 DRAINAGE CHANNELS

An asphalt-lined channel, located on the east side of the project study area, drains water from adjacent buildings (see inset graphic on Figure 3-2). Water moves south-southwest to a culvert under a driveway after which it daylights once before continuing underground to an outlet located outside the project area.

A vegetated channel is north of Building 128, between Building 275 and a fence line (Figure 3-2 and Photo 1, Appendix A). The channel appears to drain water from around Building 275 and carries water south for approximately 230 feet, turns west and drains to a box culvert at the northwest corner of Building 128 (Photo 2, Appendix A). From there, water flows due south (Photo 3, Appendix A) for approximately 180 feet to a 300-square-foot herbaceous wetland swale. The channel is periodically maintained to convey water. Sample points W-4, W-5, and W-6 were along this channel (Figure 3-1). Again, wetland determination data forms are in Appendix B.

3.1.1 Vegetation

Common plant species observed along this drainage channel included: Harding grass (*Phalaris aquatica*), bur clover (*Medicago polymorpha*), doves foot geranium (*Geranium molle*), narrow leaf plantain (*Plantago lanceolata*), and spring vetch (*Vinca sativa*). The dominant plant species along the channel, Harding grass, is FACU, which is not considered a vegetation indicator for wetlands.



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Legend

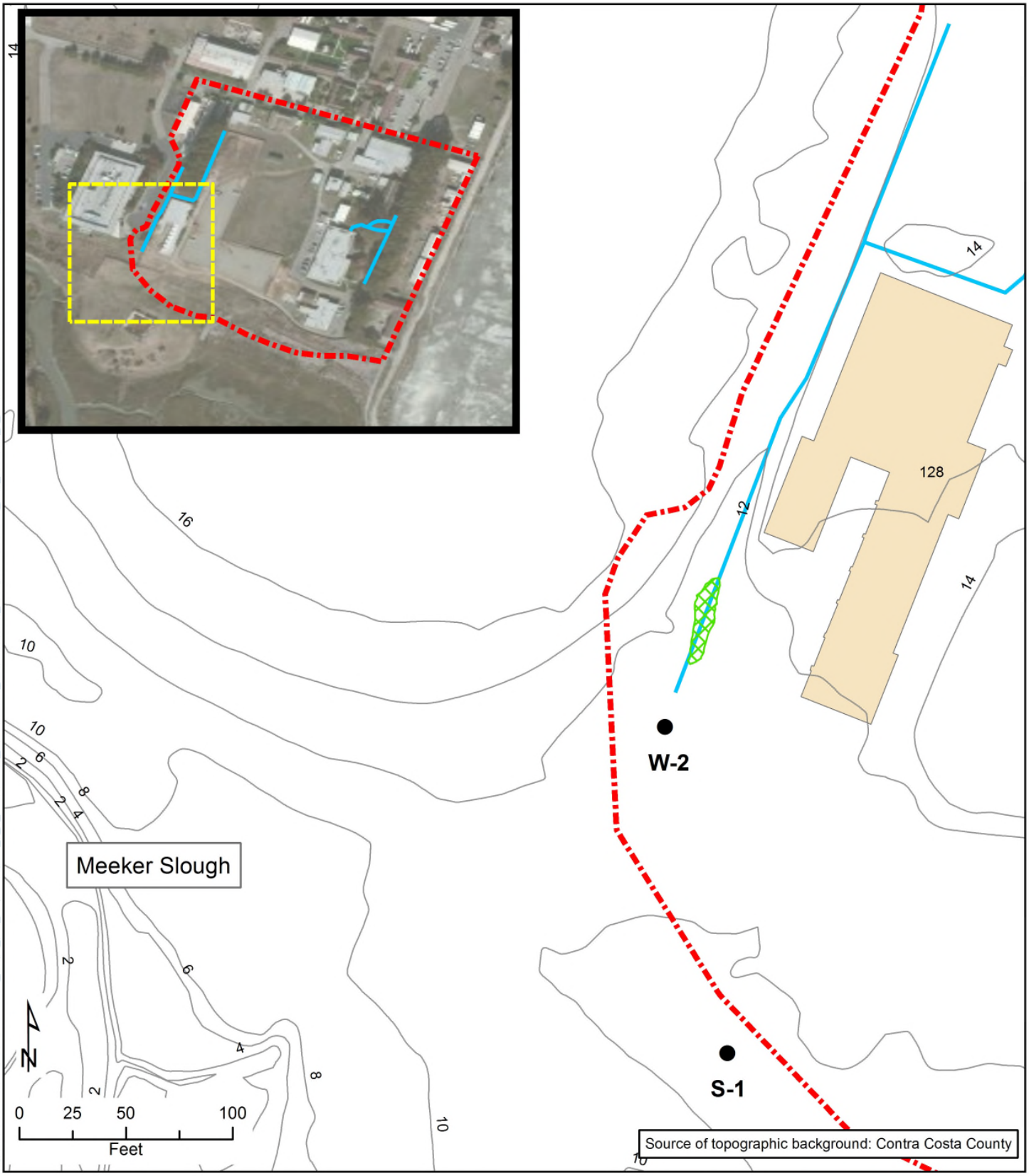
- Project Study Area
- Herbaceous Wetland
- Wetland Sample Point
- Non-wetland Sample Point
- Enlarged Area

TETRA TECH

Wetland Delineation Map

Richmond Field Station
Wetland Delineation
Richmond, California

Figure 3-1



Q:\Projects\Richmond Bay Wetlands\MXD_Maps_For_Report\Figure_3_2_Preliminary_jurisdictional_determination_Analysis-Richmond_Bay_Wetland_7_23.mxd 100-SWW-T30667 darlene.siegel

Legend

- Non-wetland Sample Point
- Drainage Channel
- 2 ft. Contour Intervals
- Building
- Project Study Area
- Enlarged Area
- Herbaceous Wetland (Non-Jurisdictional)

TETRA TECH

Preliminary Jurisdictional Determination Analysis

Richmond Field Station
Wetland Delineation
Richmond, California

Figure 3-2

3.1.2 Soils

Soils in this vicinity are delineated by the NRCS as Clear Lake Clay and Urban Land (NRCS 2013b). The description for Clear Lake Clay in the Custom Soil Resource Report is somewhat incongruent with field observations. We found relatively loamy soils at sample point W-4 with four color layers in the matrix profile, including a redox dark surface (F6) which is a hydric indicator for wetlands. Despite this indicator, all three criteria were not observed.

3.1.3 Hydrology

The channel conveys water that drains from adjacent buildings. Water is conveyed along an open swale (Photo 1, Appendix A), to an underground culvert (Photo 2, Appendix A), then daylights again and joins another underground culvert (Photo 3, Appendix A). Despite this, there were no indicators of wetland hydrology at sample point W-4. Wetland hydrology indicators were observed at sample points W-5 (water marks and sediment deposits) and W-6 (water-stained leaves). Standing water was observed during the January 2013 site visit, but no standing water was observed during the February 2013 wetland delineation.

3.2 HERBACEOUS WETLAND SWALE

A 300-square-foot herbaceous wetland swale was observed in the southwest corner of the project study area (Photos 4 and 5, Appendix A) (Figure 3-1). The area is periodically maintained to convey water. No standing water was observed during the February wetland delineation.

Sample points W-1 and W-7 were collected in this wetland and sample points W-3 and W-6 were collected immediately adjacent to, but outside the wetland. Sample point W-2 was taken below a culvert that drains the wetland; however all three wetland indicators were not met at this sample point. Sample point S-1 was collected to the southeast of the wetland and outside the project study area. During the January preliminary site visit, it appeared water could accumulate in the vicinity of sample point S-1; however no hydric indicators were found during the February wetland delineation (Figure 3-1).

3.2.1 Vegetation

The dominant plant species observed in the wetland swale was brown-headed rush, *Juncus phaeocephalus* (FACW), which is a vegetation indicator for wetlands. The *J. phaeocephalus* was not in flower, so identification was largely based on previous documentation of the species at the RFS (URS 2007). Without flowers, it could be mistaken for *J. effusus*; however, *J. effusus* is also FACW, so the indicator for hydric vegetation would remain the same.

3.2.2 Soils

Soils in the wetland swale are mapped as Urban Land (NRCS 2013b). We found clay loam soils of 7.5 YR 3/1 throughout the matrix in sample points W-1 and W-8 with prominent redoximorphic features (redox dark surface [F6]), a profile indicative of hydric soils and indicator of wetlands.

3.2.3 Hydrology

The source of water to the wetland swale is largely from the drainage channel from the north. The second culvert (Photo 3, Appendix A) appears to also convey water from the east, as indicated by the location of known underground water conveyances (Figure 3-2). Water is conveyed from the wetland swale, to the south, through a third culvert (Photo 5, Appendix A) where it flows to another open swale for approximately 20 feet. Beyond this point, there is very little evidence of an open swale. Another underground culvert carries water off the project study area to Western Stege Marsh (Figure 3-2). There were no indicators of wetland hydrology below the wetland swale.

3.3 PRELIMINARY WETLAND BOUNDARY AND JURISDICTIONAL DETERMINATION

Based on the information in Section 3.1, the drainage channel does not possess the required three wetland indicators and is not a wetland.

The boundary of the wetland swale was based on the dominance of FACW vegetation, hydric soils, and wetland hydrology indicators compared to adjacent upland vegetation, soils, and hydrology. Within the wetland, *J. phaeocephalus* was found growing in a distinct circular area with water-stained leaves around the perimeter. Soils within the wetland swale were somewhat problematic as the area is known to be regularly maintained for water conveyance; however, there was sufficient evidence for redox dark surfaces (hydric soil indicator F6). The paired upland sample points (W-3 and W-6) were dominated by FACU plant species (largely Harding grass) with brownish soils (10YR 3/2) and no hydrology indicators. Due to topographic variation (gradual slope to the southeast) below the third culvert and lack of sufficient moisture, the wetland swale is not directly hydrologically connected to the navigable waters of Meeker Slough. Also, the wetland swale is not adjacent to Meeker Slough or other navigable waters. As a result, the wetland swale does not appear to be jurisdictional.

Sample point W-2 was collected below the wetland swale and the third culvert (Figure 3-2). The site was dominated by Harding grass (FACU) and, despite being located below a culvert, there were no soil or hydrology indicators at the time of survey. Sample point S-1, collected further southeast of the wetland swale, did not provide evidence for hydric vegetation, soils, or hydrology during the February 2013 site visit (Figure 3-2).

In general, it appears that water moves from the drainage channel along the western side of the project area, through two culverts to the wetland swale, and out below the third culvert. Below this, there is a slight topographic slope toward the southeast (away from Meeker Slough) in the vicinity of sample point S-1 (Figure 3-2). The area surrounding S-1 is a slight artificial depression that appears to be an artifact of the construction activities for the remediation and restoration of the site. While this depression appears to trap runoff from above, it does not pond for sufficient duration to form all three hydric indicators, nor does it appear to allow water to drain to navigable waters. As a result, the depression surrounding sample point S-1 does not possess the required three wetland indicators and is not a wetland.

3.4 DISCLAIMER

This report documents the investigation, best professional judgment, and conclusions of the investigators. It should be considered a Preliminary Jurisdictional Determination and used at your own risk until it has been approved in writing by the US Army Corps of Engineers, San Francisco District, Regulatory Program.

SECTION 4
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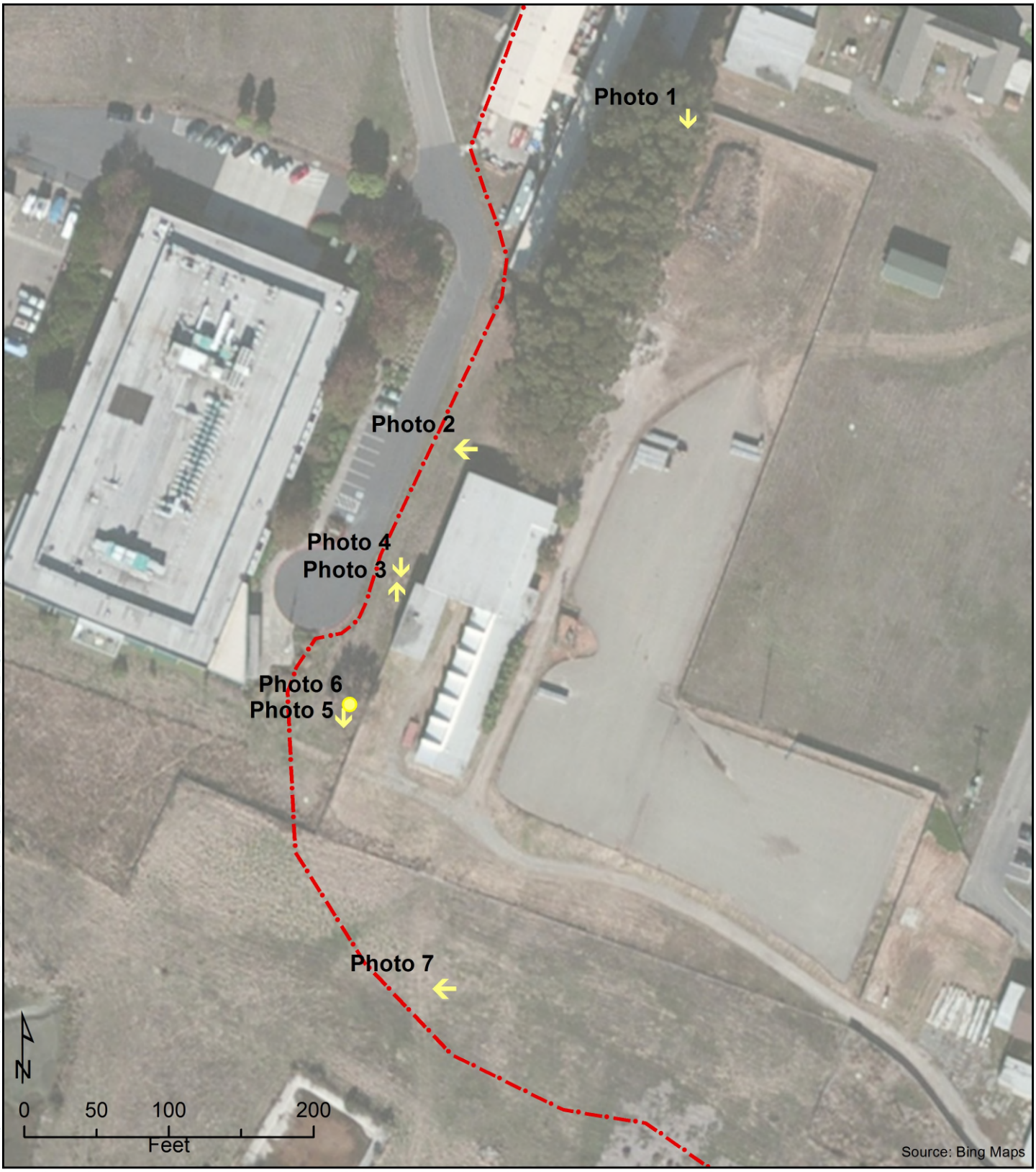
Appendix A

Photo Log



Q:\Projects\Richmond Bay Wetlands\MXD_Maps_For_Report\Figure_A_1_Appendix A_Photo_Log_Location_Map.mxd TtEMI-OAK toni.pennington

Location and direction of photo points referenced in the report and Appendix A

Photo Log Location Map

Legend

Project Study Area

TETRA TECH

Richmond Field Station
Wetland Delineation
Richmond, CA

Figure A-1

Photo 1. Drainage channel that flows south parallel to Building 275 (facing south).

Photo 2. Drainage shown in Photo 1, as it turns west at Building 128 and flows into a box culvert (facing west).

Photo 3. Box culvert west of Building 128. Channel flows underground from previous culvert and exits here where it combines with wetland swale (facing north).

Photo 4. Wetland swale from Photo 3 continues to flow as a channel to the fence line (facing south).

Photo 5. Wetland swale from previous photo flows into a culvert to pass under Heron Drive and continues as a narrow channel (facing south).

Photo 6. Wetland swale (300 square feet).

Photo 7. Sample point S-1 located south of Building 128 and Heron Drive, in a nonnative grassland habitat (facing west). During the January 2013 site visit, hydric vegetation in the area suggested a potential depressional wetland; however, no hydric soils or wetland hydrology indicators were recorded during the February 2013 delineation.

Appendix B

Wetland Determination Data Forms

WETLAND DETERMINATION DATA FORM – Arid West Region

Project/Site: Phase I RBC City/County: Contra Costa Sampling Date: 2/13/13

Applicant/Owner: UC Berkeley State: CA Sampling Point: S-1

Investigator(s): Pennington, Siegel Section, Township, Range: NW1/4 SW1/4 S20, T1NR4W

Landform (hillslope, terrace, etc.): Flat Local relief (concave, convex, none): None Slope (%): <1

Subregion (LRR): C Lat: 37.9124529741 Long: -122.336346409 Datum: WGS 84

Soil Map Unit Name: Urban Land NWI classification: None

Are climatic / hydrologic conditions on the site typical for this time of year? Yes X No _____ (If no, explain in Remarks.)

Are Vegetation _____, Soil X, or Hydrology _____ significantly disturbed? Are "Normal Circumstances" present? Yes X No _____

Are Vegetation _____, Soil _____, or Hydrology _____ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes _____	No X	**Is the Sampled Area within a Wetland?** **Yes** _____ **No** X
Hydric Soil Present?	Yes _____	No X	
Wetland Hydrology Present?	Yes _____	No X	

Remarks:

Area has been significantly altered within the last nine years.

VEGETATION – Use scientific names of plants.

Tree Stratum (Plot size: 30 ft.)	Absolute % Cover	Dominant Species?	Indicator Status
1.			
2.			
3.			
4.			
	0 = Total Cover		
Sapling/Shrub Stratum (Plot size: 15 ft.)			
1.			
2.			
3.			
4.			
5.			
	0 = Total Cover		
Herb Stratum (Plot size: 5 ft.)			
1. Lotus corniculatus	25	Y	FAC
2. Plantago lanceolata	10	N	FAC
3. Rumex crispus	15	N	FAC
4. Geranium molle	15	N	UPL
5. Helminthotheca echiodes	5	N	FACU
6. Phalaris aquatica	25	Y	FACU
7. Distichlis spicata	10	N	FAC
8.			
	100 = Total Cover		
Woody Vine Stratum (Plot size: 30 ft.)			
1.			
2.			
	0 = Total Cover		

% Bare Ground in Herb Stratum 0 % Cover of Biotic Crust _____

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 1 (A)

Total Number of Dominant Species Across All Strata: 2 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 50% (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:	
OBL species	0	x 1 =	0
FACW species	0	x 2 =	0
FAC species	60	x 3 =	180
FACU species	30	x 4 =	120
UPL species	15	x 5 =	75
Column Totals:	105 (A)		375 (B)

Prevalence Index = B/A = 3.57

Hydrophytic Vegetation Indicators:

☒ Dominance Test is >50%

___ Prevalence Index is ≤3.0[1]

___ Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)

___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? **Yes** _____ **No** X

Remarks:

SOIL

Sampling Point: S-1

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox %	Type[1]	Loc[2]	Texture	Remarks
0-16	10YR 3/1	100						

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

___ Histosol (A1)
___ Histic Epipedon (A2)
___ Black Histic (A3)
___ Hydrogen Sulfide (A4)
___ Stratified Layers (A5) (**LRR C**)
___ 1 cm Muck (A9) (**LRR D**)
___ Depleted Below Dark Surface (A11)
___ Thick Dark Surface (A12)
___ Sandy Mucky Mineral (S1)
___ Sandy Gleyed Matrix (S4)
___ Sandy Redox (S5)
___ Stripped Matrix (S6)
___ Loamy Mucky Mineral (F1)
___ Loamy Gleyed Matrix (F2)
___ Depleted Matrix (F3)
___ Redox Dark Surface (F6)
___ Depleted Dark Surface (F7)
___ Redox Depressions (F8)
___ Vernal Pools (F9)

Indicators for Problematic Hydric Soils[3]:

___ 1 cm Muck (A9) (**LRR C**)
___ 2 cm Muck (A10) (**LRR B**)
___ Reduced Vertic (F18)
___ Red Parent Material (TF2)
___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if present):

Type: _____

Depth (inches): _____

Hydric Soil Present? **Yes** _____ **No** X

Remarks:

Filled in 2002 with approximately 4 ft. top soil. Historic aerials indicate inundation by Stege Marsh in 1939, but substantial fill prior to 1960's and further manipulation of the area in 2004.

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one required; check all that apply)

___ Surface Water (A1)
___ High Water Table (A2)
___ Saturation (A3)
___ Water Marks (B1) (**Nonriverine**)
___ Sediment Deposits (B2) (**Nonriverine**)
___ Drift Deposits (B3) (**Nonriverine**)
___ Surface Soil Cracks (B6)
___ Inundation Visible on Aerial Imagery (B7)
___ Water-Stained Leaves (B9)
___ Salt Crust (B11)
___ Biotic Crust (B12)
___ Aquatic Invertebrates (B13)
___ Hydrogen Sulfide Odor (C1)
___ Oxidized Rhizospheres along Living Roots (C3)
___ Presence of Reduced Iron (C4)
___ Recent Iron Reduction in Tilled Soils (C6)
___ Thin Muck Surface (C7)
___ Other (Explain in Remarks)

Secondary Indicators (2 or more required)

___ Water Marks (B1) (**Riverine**)
___ Sediment Deposits (B2) (**Riverine**)
___ Drift Deposits (B3) (**Riverine**)
___ Drainage Patterns (B10)
___ Dry-Season Water Table (C2)
___ Crayfish Burrows (C8)
___ Saturation Visible on Aerial Imagery (C9)
___ Shallow Aquitard (D3)
___ FAC-Neutral Test (D5)

Field Observations:

Surface Water Present? Yes _____ No X Depth (inches): _____

Water Table Present? Yes _____ No X Depth (inches): _____

Saturation Present? (includes capillary fringe) Yes _____ No X Depth (inches): _____

Wetland Hydrology Present? **Yes** _____ **No** X

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

WETLAND DETERMINATION DATA FORM – Arid West Region

Project/Site: Phase I RBC City/County: Contra Costa Sampling Date: 2/13/13

Applicant/Owner: UC Berkeley State: CA Sampling Point: W-1

Investigator(s): Pennington, Siegel Section, Township, Range: NW1/4 SW1/4 S20, T1NR4W

Landform (hillslope, terrace, etc.): Flat Local relief (concave, convex, none): Concave Slope (%): 0

Subregion (LRR): C Lat: 37.9129699332 Long: -122.336403839 Datum: WGS 84

Soil Map Unit Name: Urban Land NWI classification: None

Are climatic / hydrologic conditions on the site typical for this time of year? Yes X No _____ (If no, explain in Remarks.)

Are Vegetation _____, Soil X, or Hydrology _____ significantly disturbed? Are "Normal Circumstances" present? Yes X No _____

Are Vegetation _____, Soil _____, or Hydrology _____ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes X	No _____	**Is the Sampled Area within a Wetland?** **Yes** X **No** _____
Hydric Soil Present?	Yes X	No _____	
Wetland Hydrology Present?	Yes X	No _____	

Remarks:

Low area that drains adjacent upland areas and parking lot to the west. Drains through culverts to the south. Receiving area has no significant wetland indicators. Area is periodically maintained for water conveyance.

VEGETATION – Use scientific names of plants.

Tree Stratum (Plot size: 30 ft.)	Absolute % Cover	Dominant Species?	Indicator Status
1.			
2.			
3.			
4.			
	0 = Total Cover		
Sapling/Shrub Stratum (Plot size: 15 ft.)			
1.			
2.			
3.			
4.			
5.			
	0 = Total Cover		
Herb Stratum (Plot size: 5 ft.)			
1. Phalaris aquatica	10	N	FACU
2. Lotus corniculatus	5	N	FAC
3. Medicago polymorpha	5	N	FACU
4. Geranium molle	10	N	UPL
5. Vinca sativa	5	N	UPL
6. Juncus phacocephalus	65	Y	FACW
7.			
8.			
	130 = Total Cover		
Woody Vine Stratum (Plot size: 30 ft.)			
1.			
2.			
	0 = Total Cover		

% Bare Ground in Herb Stratum 0 % Cover of Biotic Crust _____

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 1 (A)

Total Number of Dominant Species Across All Strata: 1 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 100 (A/B)

Prevalence Index worksheet:

Total % Cover of:	Multiply by:
OBL species _____	x 1 = _____
FACW species _____	x 2 = _____
FAC species _____	x 3 = _____
FACU species _____	x 4 = _____
UPL species _____	x 5 = _____
Column Totals: _____ (A)	_____ (B)

Prevalence Index = B/A = _____

Hydrophytic Vegetation Indicators:

- [✔] Dominance Test is >50%
- ___ Prevalence Index is ≤3.0[1]
- ___ Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
- ___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? **Yes** X **No** _____

Remarks:

J. phaeorephalris conspicuous, but isolated. Juncus spp. was not in flower, however, J. phaeoephalus previously reported on site. Eucalyptus polyanthemos growing adjacent to, but not in the wetland.

SOIL

Sampling Point: W-1

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox %	Type[1]	Loc[2]	Texture	Remarks
0-8	7.5 YR 3/1	92	5 YR 3/4	8	C	M	CL	
8-16	7.5 YR 3/1	100					CL	

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

- ___ Histosol (A1)
- ___ Histic Epipedon (A2)
- ___ Black Histic (A3)
- ___ Hydrogen Sulfide (A4)
- ___ Stratified Layers (A5) (**LRR C**)
- ___ 1 cm Muck (A9) (**LRR D**)
- ___ Depleted Below Dark Surface (A11)
- ___ Thick Dark Surface (A12)
- ___ Sandy Mucky Mineral (S1)
- ___ Sandy Gleyed Matrix (S4)
- ___ Sandy Redox (S5)
- ___ Stripped Matrix (S6)
- ___ Loamy Mucky Mineral (F1)
- ___ Loamy Gleyed Matrix (F2)
- ___ Depleted Matrix (F3)
- ✔ Redox Dark Surface (F6)
- ___ Depleted Dark Surface (F7)
- ___ Redox Depressions (F8)
- ___ Vernal Pools (F9)

Indicators for Problematic Hydric Soils[3]:

- ___ 1 cm Muck (A9) (**LRR C**)
- ___ 2 cm Muck (A10) (**LRR B**)
- ___ Reduced Vertic (F18)
- ___ Red Parent Material (TF2)
- ___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if present):

Type: _____

Depth (inches): _____

Hydric Soil Present? **Yes** X **No** ___

Remarks:

Area commonly maintained for water conveyance; seasonally ponded due to run-off from adjacent roof tops.

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one required; check all that apply)

- ___ Surface Water (A1)
- ___ High Water Table (A2)
- ___ Saturation (A3)
- ___ Water Marks (B1) (**Nonriverine**)
- ___ Sediment Deposits (B2) (**Nonriverine**)
- ___ Drift Deposits (B3) (**Nonriverine**)
- ___ Surface Soil Cracks (B6)
- ___ Inundation Visible on Aerial Imagery (B7)
- ✔ Water-Stained Leaves (B9)
- ___ Salt Crust (B11)
- ___ Biotic Crust (B12)
- ___ Aquatic Invertebrates (B13)
- ___ Hydrogen Sulfide Odor (C1)
- ___ Oxidized Rhizospheres along Living Roots (C3)
- ___ Presence of Reduced Iron (C4)
- ___ Recent Iron Reduction in Tilled Soils (C6)
- ___ Thin Muck Surface (C7)
- ___ Other (Explain in Remarks)

Secondary Indicators (2 or more required)

- ___ Water Marks (B1) (**Riverine**)
- ___ Sediment Deposits (B2) (**Riverine**)
- ___ Drift Deposits (B3) (**Riverine**)
- ___ Drainage Patterns (B10)
- ___ Dry-Season Water Table (C2)
- ___ Crayfish Burrows (C8)
- ___ Saturation Visible on Aerial Imagery (C9)
- ___ Shallow Aquitard (D3)
- ___ FAC-Neutral Test (D5)

Field Observations:

Surface Water Present? Yes ___ No X Depth (inches): _____

Water Table Present? Yes ___ No X Depth (inches): _____

Saturation Present? (includes capillary fringe) Yes ___ No X Depth (inches): _____

Wetland Hydrology Present? **Yes** X **No** ___

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Standing water observed above this area 1/4/13

Remarks:

Ponded water reported to occur during the rainy season (Oct - March for this area). None observed during this site visit. 0.24 inches recorded within last 7 days (Contra Costa Co. Flood Control and Water Conservation District - Gage 21).

WETLAND DETERMINATION DATA FORM – Arid West Region

Project/Site: Phase I RBC City/County: Contra Costa Sampling Date: 2/13/13

Applicant/Owner: UC Berkeley State: CA Sampling Point: W-2

Investigator(s): Pennington, Siegel Section, Township, Range: NW1/4 SW1/4 S20, T1NR4W

Landform (hillslope, terrace, etc.): Flat Local relief (concave, convex, none): None Slope (%): <1

Subregion (LRR): C Lat: 37.9128709279 Long: -122.336458151 Datum: WGS 84

Soil Map Unit Name: Urban Land NWI classification: None

Are climatic / hydrologic conditions on the site typical for this time of year? Yes X No _____ (If no, explain in Remarks.)

Are Vegetation _____, Soil _____, or Hydrology _____ significantly disturbed? Are "Normal Circumstances" present? Yes X No _____

Are Vegetation _____, Soil _____, or Hydrology _____ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes _____	No X	**Is the Sampled Area within a Wetland?** **Yes** _____ **No** X
Hydric Soil Present?	Yes _____	No X	
Wetland Hydrology Present?	Yes _____	No X	

Remarks:

VEGETATION – Use scientific names of plants.

Tree Stratum (Plot size: 30 ft.)	Absolute % Cover	Dominant Species?	Indicator Status
1.			
2.			
3.			
4.			
	0 = Total Cover		
Sapling/Shrub Stratum (Plot size: 15 ft.)			
1.			
2.			
3.			
4.			
5.			
	0 = Total Cover		
Herb Stratum (Plot size: 5 ft.)			
1. Vinca sativa	10	N	UPL
2. Helminthotheca echiodes	10	N	FACU
3. Medicago polymorpha	5	N	FACU
4. Geranium molle	5	N	UPL
5. Phalaris aquatica	90	Y	FACU
6. Foeniculum vulgare	5	N	UPL
7.			
8.			
	125 = Total Cover		
Woody Vine Stratum (Plot size: 30 ft.)			
1.			
2.			
	0 = Total Cover		

% Bare Ground in Herb Stratum 0 % Cover of Biotic Crust _____

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 0 (A)

Total Number of Dominant Species Across All Strata: 1 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 0 (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:	
OBL species	0	x 1 =	0
FACW species	0	x 2 =	0
FAC species	0	x 3 =	0
FACU species	105	x 4 =	420
UPL species	20	x 5 =	100
Column Totals:	125 (A)		520 (B)

Prevalence Index = B/A = 4.16

Hydrophytic Vegetation Indicators:

- [ ] Dominance Test is >50%
- [ ] Prevalence Index is ≤3.0[1]
- [ ] Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
- [ ] Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? **Yes** _____ **No** X

Remarks:

SOIL

Sampling Point: W-2

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox %	Type[1]	Loc[2]	Texture	Remarks
0-18	10YR 3/1	100					CL	

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

___ Histosol (A1)
___ Histic Epipedon (A2)
___ Black Histic (A3)
___ Hydrogen Sulfide (A4)
___ Stratified Layers (A5) (**LRR C**)
___ 1 cm Muck (A9) (**LRR D**)
___ Depleted Below Dark Surface (A11)
___ Thick Dark Surface (A12)
___ Sandy Mucky Mineral (S1)
___ Sandy Gleyed Matrix (S4)
___ Sandy Redox (S5)
___ Stripped Matrix (S6)
___ Loamy Mucky Mineral (F1)
___ Loamy Gleyed Matrix (F2)
___ Depleted Matrix (F3)
___ Redox Dark Surface (F6)
___ Depleted Dark Surface (F7)
___ Redox Depressions (F8)
___ Vernal Pools (F9)

Indicators for Problematic Hydric Soils[3]:

___ 1 cm Muck (A9) (**LRR C**)
___ 2 cm Muck (A10) (**LRR B**)
___ Reduced Vertic (F18)
___ Red Parent Material (TF2)
___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if present):

Type: _____

Depth (inches): _____

Hydric Soil Present? **Yes** ____ **No** X

Remarks:

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one required; check all that apply)

___ Surface Water (A1)
___ High Water Table (A2)
___ Saturation (A3)
___ Water Marks (B1) (**Nonriverine**)
___ Sediment Deposits (B2) (**Nonriverine**)
___ Drift Deposits (B3) (**Nonriverine**)
___ Surface Soil Cracks (B6)
___ Inundation Visible on Aerial Imagery (B7)
___ Water-Stained Leaves (B9)
___ Salt Crust (B11)
___ Biotic Crust (B12)
___ Aquatic Invertebrates (B13)
___ Hydrogen Sulfide Odor (C1)
___ Oxidized Rhizospheres along Living Roots (C3)
___ Presence of Reduced Iron (C4)
___ Recent Iron Reduction in Tilled Soils (C6)
___ Thin Muck Surface (C7)
___ Other (Explain in Remarks)

Secondary Indicators (2 or more required)

___ Water Marks (B1) (**Riverine**)
___ Sediment Deposits (B2) (**Riverine**)
___ Drift Deposits (B3) (**Riverine**)
___ Drainage Patterns (B10)
___ Dry-Season Water Table (C2)
___ Crayfish Burrows (C8)
___ Saturation Visible on Aerial Imagery (C9)
___ Shallow Aquitard (D3)
___ FAC-Neutral Test (D5)

Field Observations:

Surface Water Present? Yes ____ No X Depth (inches): _____

Water Table Present? Yes ____ No X Depth (inches): _____

Saturation Present? (includes capillary fringe) Yes ____ No X Depth (inches): _____

Wetland Hydrology Present? **Yes** ____ **No** X

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

Drained area below small culvert; below sample point W-1; however, no hydraulic indicators. Standing water may occur during wet season, but no evidence of long duration ponding.

WETLAND DETERMINATION DATA FORM – Arid West Region

Project/Site: Phase I RBC City/County: Contra Costa Sampling Date: 2/13/13

Applicant/Owner: UC Berkeley State: CA Sampling Point: W-3

Investigator(s): Pennington, Siegel Section, Township, Range: NW1/4 SW1/4 S20, T1NR4W

Landform (hillslope, terrace, etc.): Flat Local relief (concave, convex, none): None Slope (%): <1

Subregion (LRR): C Lat: 37.9129680169 Long: -122.336444924 Datum: WGS 84

Soil Map Unit Name: Urban Land NWI classification: None

Are climatic / hydrologic conditions on the site typical for this time of year? Yes X No _____ (If no, explain in Remarks.)

Are Vegetation _____, Soil _____, or Hydrology _____ significantly disturbed? Are "Normal Circumstances" present? Yes X No _____

Are Vegetation _____, Soil _____, or Hydrology _____ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes _____	No X	**Is the Sampled Area within a Wetland?** **Yes** _____ **No** X
Hydric Soil Present?	Yes _____	No X	
Wetland Hydrology Present?	Yes _____	No X	

Remarks:

VEGETATION – Use scientific names of plants.

Tree Stratum (Plot size: 30 ft.)	Absolute % Cover	Dominant Species?	Indicator Status
1. Eucalyptus polyanthemos	25	Y	UPL
2.			
3.			
4.			
	25	= Total Cover	

Sapling/Shrub Stratum (Plot size: 15 ft.)			
1.			
2.			
3.			
4.			
5.			
	0	= Total Cover	

Herb Stratum (Plot size: 5 ft.)			
1. Phalaris aquatica	80	Y	FACU
2. Lotus cornicalatus	5	N	FAC
3. Helminthotheca echioides	5	N	FACU
4. Vinca sativa	5	N	UPL
5. Geranium molle	8	N	UPL
6. Medicago polymorpha	8	N	FACU
7.			
8.			
	111	= Total Cover	

Woody Vine Stratum (Plot size: 30 ft.)			
1.			
2.			
	0	= Total Cover	

% Bare Ground in Herb Stratum 0 % Cover of Biotic Crust _____

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 0 (A)

Total Number of Dominant Species Across All Strata: 2 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 0 (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:	
OBL species	0	x 1 =	0
FACW species	0	x 2 =	0
FAC species	5	x 3 =	15
FACU species	93	x 4 =	372
UPL species	38	x 5 =	190
Column Totals:	136 (A)		577 (B)

Prevalence Index = B/A = 4.24

Hydrophytic Vegetation Indicators:

☐ Dominance Test is >50%

___ Prevalence Index is ≤3.0[1]

___ Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)

___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? **Yes** _____ **No** X

Remarks:

SOIL

Sampling Point: W-3

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox %	Type[1]	Loc[2]	Texture	Remarks
0-16	10YR 3/2	100					CL	

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

___ Histosol (A1)
___ Histic Epipedon (A2)
___ Black Histic (A3)
___ Hydrogen Sulfide (A4)
___ Stratified Layers (A5) (**LRR C**)
___ 1 cm Muck (A9) (**LRR D**)
___ Depleted Below Dark Surface (A11)
___ Thick Dark Surface (A12)
___ Sandy Mucky Mineral (S1)
___ Sandy Gleyed Matrix (S4)
___ Sandy Redox (S5)
___ Stripped Matrix (S6)
___ Loamy Mucky Mineral (F1)
___ Loamy Gleyed Matrix (F2)
___ Depleted Matrix (F3)
___ Redox Dark Surface (F6)
___ Depleted Dark Surface (F7)
___ Redox Depressions (F8)
___ Vernal Pools (F9)

Indicators for Problematic Hydric Soils[3]:

___ 1 cm Muck (A9) (**LRR C**)
___ 2 cm Muck (A10) (**LRR B**)
___ Reduced Vertic (F18)
___ Red Parent Material (TF2)
___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if present):

Type: _____

Depth (inches): _____

Hydric Soil Present? **Yes** _____ **No** X

Remarks:

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one required; check all that apply)

___ Surface Water (A1)
___ High Water Table (A2)
___ Saturation (A3)
___ Water Marks (B1) (**Nonriverine**)
___ Sediment Deposits (B2) (**Nonriverine**)
___ Drift Deposits (B3) (**Nonriverine**)
___ Surface Soil Cracks (B6)
___ Inundation Visible on Aerial Imagery (B7)
___ Water-Stained Leaves (B9)
___ Salt Crust (B11)
___ Biotic Crust (B12)
___ Aquatic Invertebrates (B13)
___ Hydrogen Sulfide Odor (C1)
___ Oxidized Rhizospheres along Living Roots (C3)
___ Presence of Reduced Iron (C4)
___ Recent Iron Reduction in Tilled Soils (C6)
___ Thin Muck Surface (C7)
___ Other (Explain in Remarks)

Secondary Indicators (2 or more required)

___ Water Marks (B1) (**Riverine**)
___ Sediment Deposits (B2) (**Riverine**)
___ Drift Deposits (B3) (**Riverine**)
___ Drainage Patterns (B10)
___ Dry-Season Water Table (C2)
___ Crayfish Burrows (C8)
___ Saturation Visible on Aerial Imagery (C9)
___ Shallow Aquitard (D3)
___ FAC-Neutral Test (D5)

Field Observations:

Surface Water Present? Yes _____ No X Depth (inches): _____

Water Table Present? Yes _____ No X Depth (inches): _____

Saturation Present? (includes capillary fringe) Yes _____ No X Depth (inches): _____

Wetland Hydrology Present? **Yes** _____ **No** X

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

WETLAND DETERMINATION DATA FORM – Arid West Region

Project/Site: Phase I RBC City/County: Contra Costa Sampling Date: 2/13/13

Applicant/Owner: UC Berkeley State: CA Sampling Point: W-4

Investigator(s): Pennington, Siegel Section, Township, Range: NW1/4 SW1/4 S20, T1NR4W

Landform (hillslope, terrace, etc.): Flat Local relief (concave, convex, none): None Slope (%): <1

Subregion (LRR): C Lat: 37.9134929656 Long: -122.336087861 Datum: _____

Soil Map Unit Name: Clear Lake Clay NWI classification: None

Are climatic / hydrologic conditions on the site typical for this time of year? Yes X No _____ (If no, explain in Remarks.)

Are Vegetation _____, Soil X, or Hydrology _____ significantly disturbed? Are "Normal Circumstances" present? Yes X No _____

Are Vegetation _____, Soil _____, or Hydrology _____ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes _____	No X	**Is the Sampled Area within a Wetland?** **Yes** _____ **No** X
Hydric Soil Present?	Yes X	No _____	
Wetland Hydrology Present?	Yes _____	No X	

Remarks:

Area is periodically maintained for water conveyance. Drains water from adjacent roof tops.

VEGETATION – Use scientific names of plants.

Tree Stratum (Plot size: 30 ft.)	Absolute % Cover	Dominant Species?	Indicator Status
1. Eucalyptus polyanthemos	5	Y	UPL
2.			
3.			
4.			
	5 = Total Cover		
Sapling/Shrub Stratum (Plot size: 15 ft.)			
1.			
2.			
3.			
4.			
5.			
	0 = Total Cover		
Herb Stratum (Plot size: 5 ft.)			
1. Medicago polymorpha	5	N	FACU
2. Geranium molle	5	N	UPL
3. Phalaris aquatica	90	Y	FACU
4. Plantago lanceolata	10	N	FAC
5. Helminthotheca echiodes	5	N	FACU
6. Vinca sativa	5	N	UPL
7.			
8.			
	120 = Total Cover		
Woody Vine Stratum (Plot size: 30 ft.)			
1.			
2.			
	0 = Total Cover		

% Bare Ground in Herb Stratum 0 % Cover of Biotic Crust _____

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 0 (A)

Total Number of Dominant Species Across All Strata: 2 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 0 (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:	
OBL species	0	x 1 =	0
FACW species	0	x 2 =	0
FAC species	0	x 3 =	0
FACU species	100	x 4 =	400
UPL species	15	x 5 =	75
Column Totals:	120 (A)		475 (B)

Prevalence Index = B/A = 3.95

Hydrophytic Vegetation Indicators:

☐ Dominance Test is >50%

___ Prevalence Index is ≤3.0[1]

___ Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)

___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? **Yes** _____ **No** X

Remarks:

SOIL

Sampling Point: W-4

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox %	Type[1]	Loc[2]	Texture	Remarks
0-3	10YR 3/2	100					L	
3-9	10 YR 3/1	65	7.5 YR 5/2	45	LL		LL	
9-10	10 YR 3/1	95	5 YR 4/4	5			SCL	
10-16	10 YR 3/1	90	5 YR 4/4	10			SCL	

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

- ___ Histosol (A1)
- ___ Histic Epipedon (A2)
- ___ Black Histic (A3)
- ___ Hydrogen Sulfide (A4)
- ___ Stratified Layers (A5) (**LRR C**)
- ___ 1 cm Muck (A9) (**LRR D**)
- ___ Depleted Below Dark Surface (A11)
- ___ Thick Dark Surface (A12)
- ___ Sandy Mucky Mineral (S1)
- ___ Sandy Gleyed Matrix (S4)
- ___ Sandy Redox (S5)
- ___ Stripped Matrix (S6)
- ___ Loamy Mucky Mineral (F1)
- ___ Loamy Gleyed Matrix (F2)
- ___ Depleted Matrix (F3)
- ✔ Redox Dark Surface (F6)
- ___ Depleted Dark Surface (F7)
- ___ Redox Depressions (F8)
- ___ Vernal Pools (F9)

Indicators for Problematic Hydric Soils[3]:

- ___ 1 cm Muck (A9) (**LRR C**)
- ___ 2 cm Muck (A10) (**LRR B**)
- ___ Reduced Vertic (F18)
- ___ Red Parent Material (TF2)
- ___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if present):

Type: _____

Depth (inches): _____

Hydric Soil Present? **Yes** X **No** ___

Remarks:

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one required; check all that apply)

- ___ Surface Water (A1)
- ___ High Water Table (A2)
- ___ Saturation (A3)
- ___ Water Marks (B1) (**Nonriverine**)
- ___ Sediment Deposits (B2) (**Nonriverine**)
- ___ Drift Deposits (B3) (**Nonriverine**)
- ___ Surface Soil Cracks (B6)
- ___ Inundation Visible on Aerial Imagery (B7)
- ___ Water-Stained Leaves (B9)
- ___ Salt Crust (B11)
- ___ Biotic Crust (B12)
- ___ Aquatic Invertebrates (B13)
- ___ Hydrogen Sulfide Odor (C1)
- ___ Oxidized Rhizospheres along Living Roots (C3)
- ___ Presence of Reduced Iron (C4)
- ___ Recent Iron Reduction in Tilled Soils (C6)
- ___ Thin Muck Surface (C7)
- ___ Other (Explain in Remarks)

Secondary Indicators (2 or more required)

- ___ Water Marks (B1) (**Riverine**)
- ___ Sediment Deposits (B2) (**Riverine**)
- ___ Drift Deposits (B3) (**Riverine**)
- ___ Drainage Patterns (B10)
- ___ Dry-Season Water Table (C2)
- ___ Crayfish Burrows (C8)
- ___ Saturation Visible on Aerial Imagery (C9)
- ___ Shallow Aquitard (D3)
- ___ FAC-Neutral Test (D5)

Field Observations:

Surface Water Present? Yes ___ No X Depth (inches): _____

Water Table Present? Yes ___ No X Depth (inches): _____

Saturation Present? (includes capillary fringe) Yes ___ No X Depth (inches): _____

Wetland Hydrology Present? **Yes** ___ **No** X

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

The sample point is in the immediate vicinity of a culvert that drains water from adjacent roof tops; however, no evidence of ponding during the site visit.

WETLAND DETERMINATION DATA FORM – Arid West Region

Project/Site: Phase I RBC City/County: Contra Costa Sampling Date: 2/13/13

Applicant/Owner: UC Berkeley State: CA Sampling Point: W-5

Investigator(s): Pennington, Siegel Section, Township, Range: NW1/4 SW1/4 S20, T1NR4W

Landform (hillslope, terrace, etc.): Flat Local relief (concave, convex, none): Concave Slope (%): <1

Subregion (LRR): C Lat: 37.9132336613 Long: -122.336310776 Datum: WGS 84

Soil Map Unit Name: Clear Lake Clay NWI classification: None

Are climatic / hydrologic conditions on the site typical for this time of year? Yes X No _____ (If no, explain in Remarks.)

Are Vegetation _____, Soil X, or Hydrology _____ significantly disturbed? Are "Normal Circumstances" present? Yes X No _____

Are Vegetation _____, Soil _____, or Hydrology _____ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes _____	No X	**Is the Sampled Area within a Wetland?** **Yes** _____ **No** X
Hydric Soil Present?	Yes X	No _____	
Wetland Hydrology Present?	Yes X	No _____	

Remarks:

Areas is periodically maintained for water conveyance. Drains water from adjacent roof tops.

VEGETATION – Use scientific names of plants.

Tree Stratum (Plot size: 30 ft.)	Absolute % Cover	Dominant Species?	Indicator Status
1.			
2.			
3.			
4.			
	0 = Total Cover		
Sapling/Shrub Stratum (Plot size: 15 ft.)			
1.			
2.			
3.			
4.			
5.			
	0 = Total Cover		
Herb Stratum (Plot size: 5 ft.)			
1. Phalaris aquatica	95	Y	FACU
2. Medicago polymorpha	5	N	FACU
3. Geranium molle	5	N	UPL
4. Plantago lanceolata	5	N	FAC
5.			
6.			
7.			
8.			
	110 = Total Cover		
Woody Vine Stratum (Plot size: 30 ft.)			
1.			
2.			
	0 = Total Cover		

% Bare Ground in Herb Stratum 0 % Cover of Biotic Crust _____

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 0 (A)

Total Number of Dominant Species Across All Strata: 1 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 50 (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:
OBL species	0	x 1 = _____
FACW species	0	x 2 = _____
FAC species	1	x 3 = _____
FACU species	100	x 4 = 400
UPL species	5	x 5 = 25
Column Totals:	105 (A)	425 (B)

Prevalence Index = B/A = 4.04

Hydrophytic Vegetation Indicators:

- [x] Dominance Test is >50%
- ___ Prevalence Index is ≤3.0[1]
- ___ Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
- ___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? **Yes** _____ **No** X

Remarks:

SOIL

Sampling Point: W-5

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox %	Type[1]	Loc[2]	Texture	Remarks
0-4	10YR 4/1	95	5 YR 4/6	5	C	M	CL	
4-16	10 YR 4/1	98	5 YR 4/6	2	C	M	CL	

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

- ___ Histosol (A1)
- ___ Histic Epipedon (A2)
- ___ Black Histic (A3)
- ___ Hydrogen Sulfide (A4)
- ___ Stratified Layers (A5) (**LRR C**)
- ___ 1 cm Muck (A9) (**LRR D**)
- ___ Depleted Below Dark Surface (A11)
- ___ Thick Dark Surface (A12)
- ___ Sandy Mucky Mineral (S1)
- ___ Sandy Gleyed Matrix (S4)
- ___ Sandy Redox (S5)
- ___ Stripped Matrix (S6)
- ___ Loamy Mucky Mineral (F1)
- ___ Loamy Gleyed Matrix (F2)
- ✔ Depleted Matrix (F3)
- ___ Redox Dark Surface (F6)
- ___ Depleted Dark Surface (F7)
- ___ Redox Depressions (F8)
- ___ Vernal Pools (F9)

Indicators for Problematic Hydric Soils[3]:

- ___ 1 cm Muck (A9) (**LRR C**)
- ___ 2 cm Muck (A10) (**LRR B**)
- ___ Reduced Vertic (F18)
- ___ Red Parent Material (TF2)
- ___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if present):

Type: _____

Depth (inches): _____

Hydric Soil Present? Yes X No ___

Remarks:

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one required; check all that apply)

- ___ Surface Water (A1)
- ___ High Water Table (A2)
- ___ Saturation (A3)
- ✔ Water Marks (B1) (**Nonriverine**)
- ✔ Sediment Deposits (B2) (**Nonriverine**)
- ___ Drift Deposits (B3) (**Nonriverine**)
- ___ Surface Soil Cracks (B6)
- ___ Inundation Visible on Aerial Imagery (B7)
- ___ Water-Stained Leaves (B9)
- ___ Salt Crust (B11)
- ___ Biotic Crust (B12)
- ___ Aquatic Invertebrates (B13)
- ___ Hydrogen Sulfide Odor (C1)
- ___ Oxidized Rhizospheres along Living Roots (C3)
- ___ Presence of Reduced Iron (C4)
- ___ Recent Iron Reduction in Tilled Soils (C6)
- ___ Thin Muck Surface (C7)
- ___ Other (Explain in Remarks)

Secondary Indicators (2 or more required)

- ___ Water Marks (B1) (**Riverine**)
- ___ Sediment Deposits (B2) (**Riverine**)
- ___ Drift Deposits (B3) (**Riverine**)
- ___ Drainage Patterns (B10)
- ___ Dry-Season Water Table (C2)
- ___ Crayfish Burrows (C8)
- ___ Saturation Visible on Aerial Imagery (C9)
- ___ Shallow Aquitard (D3)
- ___ FAC-Neutral Test (D5)

Field Observations:

Surface Water Present? Yes ___ No X Depth (inches): _____

Water Table Present? Yes ___ No X Depth (inches): _____

Saturation Present? (includes capillary fringe) Yes ___ No X Depth (inches): _____

Wetland Hydrology Present? Yes X No ___

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

WETLAND DETERMINATION DATA FORM – Arid West Region

Project/Site: Phase I RBC City/County: Contra Costa Sampling Date: 2/15/13

Applicant/Owner: UC Berkeley State: CA Sampling Point: W-6

Investigator(s): Pennington, Siegel Section, Township, Range: NW1/4 SW1/4 S20, T1NR4W

Landform (hillslope, terrace, etc.): Flat Local relief (concave, convex, none): Concave Slope (%): <1

Subregion (LRR): C Lat: 37.9130765936 Long: -122.33637623 Datum: WGS 84

Soil Map Unit Name: Urban Land NWI classification: None

Are climatic / hydrologic conditions on the site typical for this time of year? Yes X No _____ (If no, explain in Remarks.)

Are Vegetation _____, Soil X, or Hydrology _____ significantly disturbed? Are "Normal Circumstances" present? Yes X No _____

Are Vegetation _____, Soil _____, or Hydrology _____ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes _____	No X	**Is the Sampled Area within a Wetland?** **Yes** _____ **No** X
Hydric Soil Present?	Yes _____	No X	
Wetland Hydrology Present?	Yes X	No _____	

Remarks:

Areas is periodically maintained for water conveyance. Drains water from adjacent roof tops.

VEGETATION – Use scientific names of plants.

Tree Stratum (Plot size: 30 ft.)	Absolute % Cover	Dominant Species?	Indicator Status
1.			
2.			
3.			
4.			
	0	= Total Cover	

Sapling/Shrub Stratum (Plot size: 15 ft.)			
1.			
2.			
3.			
4.			
5.			
	0	= Total Cover	

Herb Stratum (Plot size: 5 ft.)			
1. Phalaris aquatica	95	Y	FACU
2. Geranium molle	5	N	UPL
3. Helminthotheca echiodes	5	N	FACU
4. Plantago lanceolata	5	N	FAC
5.			
6.			
7.			
8.			
	110	= Total Cover	

Woody Vine Stratum (Plot size: 30 ft.)			
1.			
2.			
	0	= Total Cover	

% Bare Ground in Herb Stratum 0 % Cover of Biotic Crust _____

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 0 (A)

Total Number of Dominant Species Across All Strata: 1 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 50 (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:	
OBL species	0	x 1 =	0
FACW species	0	x 2 =	0
FAC species	1	x 3 =	15
FACU species	100	x 4 =	400
UPL species	5	x 5 =	25
Column Totals:	110 (A)		440 (B)

Prevalence Index = B/A = 4.0

Hydrophytic Vegetation Indicators:

- [x] Dominance Test is >50%
- [ ] Prevalence Index is ≤3.0[1]
- [ ] Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
- [ ] Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? **Yes** _____ **No** X

Remarks:

SOIL

Sampling Point: W-6

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox %	Type[1]	Loc[2]	Texture	Remarks
0-8	10YR 3/1	100					CL	
8-16	10 YR 4/1	92	7.5 YR 5/1	8	C	M	CL	

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

- ___ Histosol (A1)
- ___ Histic Epipedon (A2)
- ___ Black Histic (A3)
- ___ Hydrogen Sulfide (A4)
- ___ Stratified Layers (A5) (**LRR C**)
- ___ 1 cm Muck (A9) (**LRR D**)
- ___ Depleted Below Dark Surface (A11)
- ___ Thick Dark Surface (A12)
- ___ Sandy Mucky Mineral (S1)
- ___ Sandy Gleyed Matrix (S4)
- ___ Sandy Redox (S5)
- ___ Stripped Matrix (S6)
- ___ Loamy Mucky Mineral (F1)
- ___ Loamy Gleyed Matrix (F2)
- ___ Depleted Matrix (F3)
- ___ Redox Dark Surface (F6)
- ___ Depleted Dark Surface (F7)
- ___ Redox Depressions (F8)
- ___ Vernal Pools (F9)

Indicators for Problematic Hydric Soils[3]:

- ___ 1 cm Muck (A9) (**LRR C**)
- ___ 2 cm Muck (A10) (**LRR B**)
- ___ Reduced Vertic (F18)
- ___ Red Parent Material (TF2)
- ☑ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if present):

Type: _____

Depth (inches): _____

Hydric Soil Present? **Yes** ___ **No** X

Remarks:

Soils are disturbed due to regular maintenance. Otherwise F8 conditions might be expected.

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one required; check all that apply)

- ___ Surface Water (A1)
- ___ High Water Table (A2)
- ___ Saturation (A3)
- ___ Water Marks (B1) (**Nonriverine**)
- ___ Sediment Deposits (B2) (**Nonriverine**)
- ___ Drift Deposits (B3) (**Nonriverine**)
- ___ Surface Soil Cracks (B6)
- ___ Inundation Visible on Aerial Imagery (B7)
- ☑ Water-Stained Leaves (B9)
- ___ Salt Crust (B11)
- ___ Biotic Crust (B12)
- ___ Aquatic Invertebrates (B13)
- ___ Hydrogen Sulfide Odor (C1)
- ___ Oxidized Rhizospheres along Living Roots (C3)
- ___ Presence of Reduced Iron (C4)
- ___ Recent Iron Reduction in Tilled Soils (C6)
- ___ Thin Muck Surface (C7)
- ___ Other (Explain in Remarks)

Secondary Indicators (2 or more required)

- ___ Water Marks (B1) (**Riverine**)
- ___ Sediment Deposits (B2) (**Riverine**)
- ___ Drift Deposits (B3) (**Riverine**)
- ___ Drainage Patterns (B10)
- ___ Dry-Season Water Table (C2)
- ___ Crayfish Burrows (C8)
- ___ Saturation Visible on Aerial Imagery (C9)
- ___ Shallow Aquitard (D3)
- ___ FAC-Neutral Test (D5)

Field Observations:

Surface Water Present? Yes ___ No X Depth (inches): _____

Water Table Present? Yes ___ No X Depth (inches): _____

Saturation Present? (includes capillary fringe) Yes ___ No X Depth (inches): _____

Wetland Hydrology Present? **Yes** X **No** ___

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

WETLAND DETERMINATION DATA FORM – Arid West Region

Project/Site: Phase I RBC City/County: Contra Costa Sampling Date: 2/15/13

Applicant/Owner: UC Berkeley State: CA Sampling Point: W-7

Investigator(s): Pennington, Siegel Section, Township, Range: NW1/4 SW1/4 S20, T1NR4W

Landform (hillslope, terrace, etc.): Flat Local relief (concave, convex, none): Concave Slope (%): <1

Subregion (LRR): C Lat: 37.913018875 Long: -122.336392944 Datum: WGS 84

Soil Map Unit Name: Urban Land NWI classification: None

Are climatic / hydrologic conditions on the site typical for this time of year? Yes X No _____ (If no, explain in Remarks.)

Are Vegetation _____, Soil _____, or Hydrology _____ significantly disturbed? Are "Normal Circumstances" present? Yes X No _____

Are Vegetation _____, Soil _____, or Hydrology _____ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes X	No _____	**Is the Sampled Area within a Wetland?** **Yes** X **No** _____
Hydric Soil Present?	Yes X	No _____	
Wetland Hydrology Present?	Yes X	No _____	

Remarks:

Areas is periodically maintained for water conveyance. Drains water from adjacent roof tops.

VEGETATION – Use scientific names of plants.

Tree Stratum (Plot size: 30 ft.)	Absolute % Cover	Dominant Species?	Indicator Status
1.			
2.			
3.			
4.			
	0 = Total Cover		
Sapling/Shrub Stratum (Plot size: 15 ft.)			
1.			
2.			
3.			
4.			
5.			
	0 = Total Cover		
Herb Stratum (Plot size: 5 ft.)			
1. Juncus phaecephalus	90	Y	FACW
2. Vinca sativa	5	N	UPL
3. Helminthotheca echiodes	5	N	FACU
4.			
5.			
6.			
7.			
8.			
	100 = Total Cover		
Woody Vine Stratum (Plot size: 30 ft.)			
1.			
2.			
	0 = Total Cover		

% Bare Ground in Herb Stratum 0 % Cover of Biotic Crust _____

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 1 (A)

Total Number of Dominant Species Across All Strata: 1 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 100 (A/B)

Prevalence Index worksheet:

Total % Cover of:	Multiply by:
OBL species _____	x 1 = _____
FACW species _____	x 2 = _____
FAC species _____	x 3 = _____
FACU species _____	x 4 = _____
UPL species _____	x 5 = _____
Column Totals: _____ (A)	_____ (B)

Prevalence Index = B/A = _____

Hydrophytic Vegetation Indicators:

- [x] Dominance Test is >50%
- [ ] Prevalence Index is ≤3.0[1]
- [ ] Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
- [ ] Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? **Yes** X **No** _____

Remarks:

Eucalyptus polyanthemos growing adjacent to, but not inside the wetland.

SOIL

Sampling Point: W-7

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox %	Type[1]	Loc[2]	Texture	Remarks
0-8	7.5 YR 3/1	95	5 YR 3/4	5	C	M	CL	
8-10	7.5 YR 3/1	65	5 YR 3/4	35	C	M	CL	
10-16	7.5 YR 3/1	90	5 YR 3/4	10	C	M	CL	

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

- ___ Histosol (A1)
- ___ Histic Epipedon (A2)
- ___ Black Histic (A3)
- ___ Hydrogen Sulfide (A4)
- ___ Stratified Layers (A5) (**LRR C**)
- ___ 1 cm Muck (A9) (**LRR D**)
- ___ Depleted Below Dark Surface (A11)
- ___ Thick Dark Surface (A12)
- ___ Sandy Mucky Mineral (S1)
- ___ Sandy Gleyed Matrix (S4)
- ___ Sandy Redox (S5)
- ___ Stripped Matrix (S6)
- ___ Loamy Mucky Mineral (F1)
- ___ Loamy Gleyed Matrix (F2)
- ___ Depleted Matrix (F3)
- ✔ Redox Dark Surface (F6)
- ___ Depleted Dark Surface (F7)
- ___ Redox Depressions (F8)
- ___ Vernal Pools (F9)

Indicators for Problematic Hydric Soils[3]:

- ___ 1 cm Muck (A9) (**LRR C**)
- ___ 2 cm Muck (A10) (**LRR B**)
- ___ Reduced Vertic (F18)
- ___ Red Parent Material (TF2)
- ___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if present):

Type: _____

Depth (inches): _____

Hydric Soil Present? Yes X No ___

Remarks:

Area commonly maintained for water conveyance; seasonally ponded due to run-off from adjacent roof tops.

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one required; check all that apply)

- ___ Surface Water (A1)
- ___ High Water Table (A2)
- ___ Saturation (A3)
- ___ Water Marks (B1) (**Nonriverine**)
- ___ Sediment Deposits (B2) (**Nonriverine**)
- ___ Drift Deposits (B3) (**Nonriverine**)
- ___ Surface Soil Cracks (B6)
- ___ Inundation Visible on Aerial Imagery (B7)
- ✔ Water-Stained Leaves (B9)
- ___ Salt Crust (B11)
- ___ Biotic Crust (B12)
- ___ Aquatic Invertebrates (B13)
- ___ Hydrogen Sulfide Odor (C1)
- ___ Oxidized Rhizospheres along Living Roots (C3)
- ___ Presence of Reduced Iron (C4)
- ___ Recent Iron Reduction in Tilled Soils (C6)
- ___ Thin Muck Surface (C7)
- ___ Other (Explain in Remarks)

Secondary Indicators (2 or more required)

- ___ Water Marks (B1) (**Riverine**)
- ___ Sediment Deposits (B2) (**Riverine**)
- ___ Drift Deposits (B3) (**Riverine**)
- ___ Drainage Patterns (B10)
- ___ Dry-Season Water Table (C2)
- ___ Crayfish Burrows (C8)
- ___ Saturation Visible on Aerial Imagery (C9)
- ___ Shallow Aquitard (D3)
- ___ FAC-Neutral Test (D5)

Field Observations:

Surface Water Present? Yes ___ No X Depth (inches): _____

Water Table Present? Yes ___ No X Depth (inches): _____

Saturation Present? (includes capillary fringe) Yes ___ No X Depth (inches): _____

Wetland Hydrology Present? Yes X No ___

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

Appendix D

Cultural Resources

CULTURAL RESOURCES INVENTORY REPORT

FOR

PORTIONS OF THE RICHMOND PROPERTIES

RICHMOND, CONTRA COSTA COUNTY, CALIFORNIA

March 2013

PREPARED FOR:
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MANAGEMENT SUMMARY

This report presents the results of the cultural resources investigation, which included the identification of archaeological resources and cultural landscape features, for portions of the University of California's Richmond properties in Richmond, Contra Costa County, California. Within the 133-acre area comprised of these properties, the University of California proposes to consolidate the biosciences programs of the Lawrence Berkeley National Laboratory and to develop additional facilities for use by both the Lawrence Berkeley National Laboratory and University of California, Berkeley, and other institutional or industry counterparts for research and development focused on energy, environment, and health. The Phase 1 development plan would construct the first three buildings within a smaller 16-acre area on these properties.

Due to the involvement of the United States Department of Energy, the proposed Phase 1 development is a federal undertaking as defined by Section 106 of the National Historic Preservation Act and its implementing regulations, 36 Code of Federal Regulations Part 800. Therefore, only the smaller 16-acre area is subject to Section 106 regulations in order to take into account the effect of the undertaking on any historic property (i.e., district, site, building, structure, or object) that is included in or eligible for inclusion in the National Register of Historic Places. This cultural resources investigation was conducted to identify archaeological resources and cultural landscape features that may meet the definition of a historic property under the National Historic Preservation Act, per 36 CFR 800.4. Built environment resources, such as buildings and structures, are addressed in a separate historic properties survey report. The United States Department of Energy is the lead federal agency under Section 106.

This investigation also complies with the California Environmental Quality Act (Title 14 of the California Code of Regulations 15064.5). The 133-acre is subject to programmatic-level analysis under CEQA, while the smaller 16-acre area (where specific project construction will occur) will be subject to project-level analysis under CEQA. The University of California is the lead agency under CEQA.

This investigation included background research for the 133-acre area, which is considered the Study Area. The Area of Potential Effects is the smaller 16-acre area, which is considered the Phase 1 development plan area. Since the Area of Potential Effects is subject to Section 106 regulations, this area required a field survey as well as background research. Pursuant to Section 106 of the National Historic Preservation Act, 36 Code of Federal Regulations Part 800.4, this report documents the methods used to identify all historic properties within the Area of Potential Effects. Findings for this report are based on the following:

- A cultural resources records search and historic map review for the Study Area at the Northwest Information Center of the California Historic Resource Inventory System at California State University, Sonoma;
- the initiation of Section 106 consultation with Native American groups and individuals identified by the Native American Heritage Commission (36 CFR Part 800.2(a));
- an inventory survey of the Area of Potential Effects; and,
- documentation of newly identified cultural resources (i.e., archaeological resources and cultural landscape features) within the Area of Potential Effects on California Department of Parks and Recreation 523 forms.

The results of the records search indicate that there is one previously recorded prehistoric shellmound, CA-CC0-157, within the Study Area. The field survey resulted in the identification of two newly identified historic period cultural resources within the Area of Potential Effects, GANDA-622-01 (Eucalyptus Stands 1 and 2), which consists of historic period landscape features, and GANDA-ISO-622-01, an isolated historic period bottle. These resources were formally recorded on Department of Parks and Recreation 523 forms, but not evaluated for their potential for eligibility for listing in the National Register of Historic Places and California Register of Historical Resources.

This inventory report includes the methods and results of background research consisting of a records search and a literature review; geoarchaeological, prehistoric, ethnographic, and historical background information; a field survey; a geoarchaeological sensitivity analysis; and consultation with the Native American Heritage Commission and potentially interested Native American groups and individuals; as well as recommendations for any subsequent archaeological work to meet the requirements of Section 106 and 36 Code of Federal Regulations 800.4. This investigation addresses only archaeological resources and cultural landscape features within the Area of Potential Effects. The identification and evaluation of the built environment resources have been addressed in a separate report.

While this investigation did not result in the identification of any newly or previously documented prehistoric archaeological resources within the Area of Potential Effects, the geoarchaeological analysis, environmental setting, and close proximity of several prehistoric shellmounds to the Area of Potential Effects and Study Area indicate that the Area of Potential Effects has a high sensitivity for the presence of buried and surface prehistoric resources. In addition, there is evidence of historic use of the site based on results of the background research and field survey; therefore, there is the potential for the presence of historic period archaeological resources as well.

This cultural resources investigation adheres to the California Office of Historic Preservation's *Archaeological Resource Management Reports Recommended Contents and Format* (1990); the *Secretary of the Interior's Standards and Guidelines for Archaeology and Historic Preservation* (48 CFR 44716); and the United States Army Corps of Engineers' *Guidelines for Compliance with Section 106 of the National Historic Preservation Act* (2012).

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1.0 INTRODUCTION

The University of California (UC or the University) proposes to establish a new major research campus at properties it owns in Richmond, California. The new campus would consolidate biosciences programs of the Lawrence Berkeley National Laboratory (LBNL) and develop additional facilities for use by both LBNL and UC Berkeley and other institutional or industry counterparts for energy, environment, and health research. The approximately 133-acre site is located at 1301 South 46th Street in the South Shoreline area of the City of Richmond (Figures 1 and 2), approximately five miles northwest of the UC Berkeley campus and the LBNL site in Berkeley. The University is developing Phase 1 development plans that would result in the demolition of 25 existing structures totaling approximately 107,000 gross square feet (gsf). Phase 1 would then consolidate existing LBNL bioscience programs currently in leased space into three new buildings totaling up to 600,000 gsf with an occupancy of approximately 1,000 average daily population (adp). Phase 1 development work would occur in a smaller 16-acre area within the larger 133-acre project area.

The National Historic Preservation Act (NHPA) of 1966, as amended, requires that every federal agency consider the effect of its undertakings on historic properties. The United States Department of Energy (DOE) is the lead federal agency for the Phase 1 development plan. The Phase 1 development plan is an undertaking as defined in 36 Code of Federal Regulations (CFR) §800.16(y) with the potential to cause effects on historical properties (36 CFR §800.3(a)). As such, DOE will address Section 106 of the NHPA to take into account the effect of the undertaking on any historic property (i.e., district, site, building, structure, or object) that is included in or eligible for inclusion in the National Register of Historic Places (NRHP). This investigation was conducted to identify archaeological resources and cultural landscape features that may meet the definition of a historic property under the NHPA, as per 36 CFR 800.4. This investigation meets the requirements for compliance with the California Environmental Quality Act (CEQA) (Title 14 CCR 15064.5). The 133-acre is subject to programmatic-level analysis under CEQA, while the smaller 16-acre area (where specific project construction would occur) is subject to project-level analysis under CEQA. The University of California is the lead agency under CEQA.

This report includes the methods and results of background research that consists of a records search and a literature review; prehistoric, ethnographic, and historic background information; a field survey; a geoarchaeological sensitivity analysis; and consultation with the Native American Heritage Commission (NAHC) and potentially interested Native American groups and individuals, as well as recommendations for complying with the requirements of Section 106 and 36 CFR 800. This investigation addresses only archaeological resources within the APE. The identification and evaluation of the built environment resources have been addressed in a separate report (Tetra Tech 2013a [Draft] *Historic Properties Survey for Portions of Richmond Field Station*).

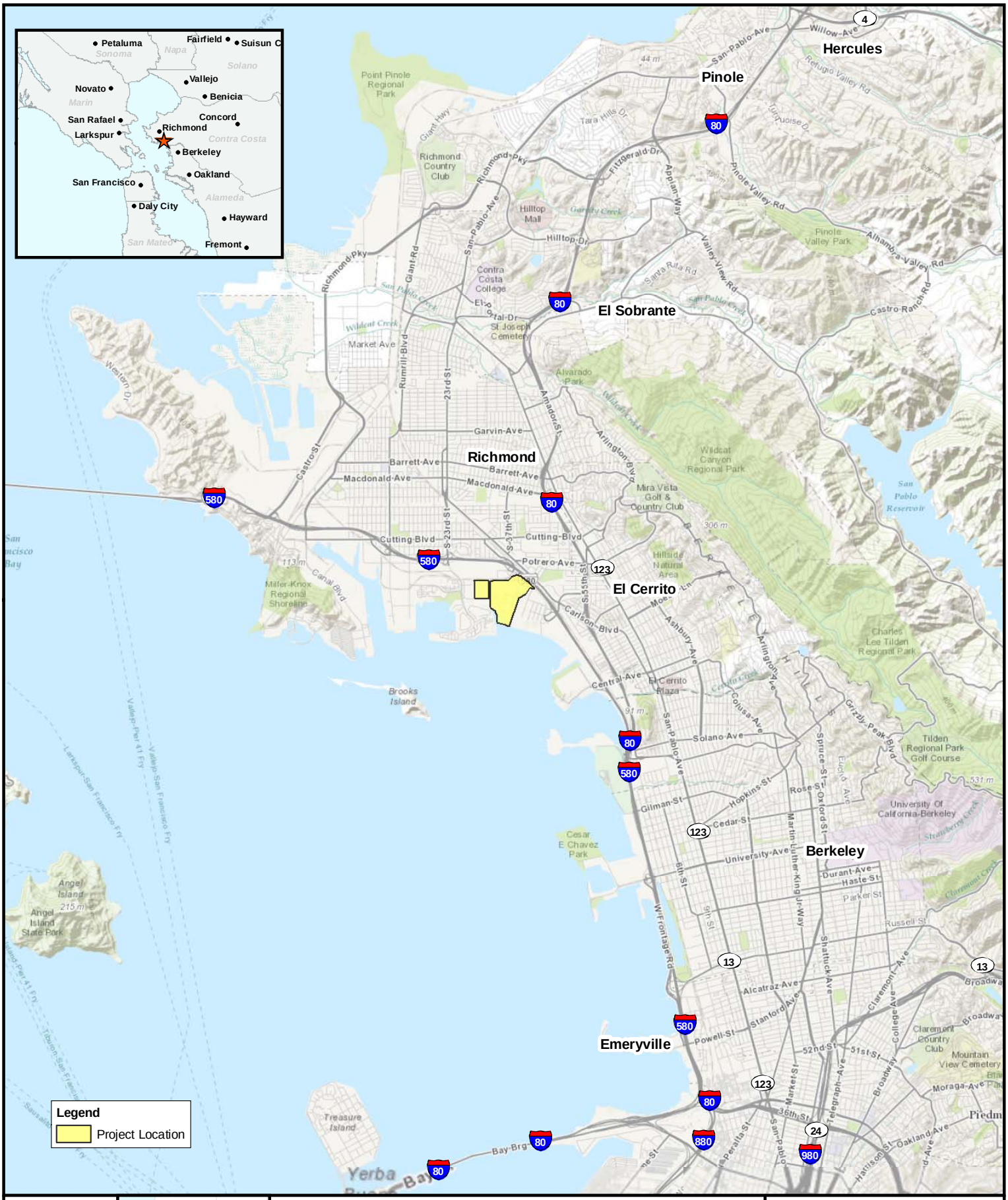
Archaeologists who conducted this investigation meet the Secretary of Interior's Professional Qualification Standards and agree to comply with the Secretary of Interior's Professional Qualification Standards for the Guidelines for Archaeology and Historic Preservation (1983; 48 CFR 44716).

DEFINITION OF THE AREA OF POTENTIAL EFFECTS - PHASE 1 DEVELOPMENT AREA

The Area of Potential Effects (APE) encompasses the Phase 1 development area, which is the 16-acre portion where building demolition and site preparation work would occur (Figures 3 and 4). Because the DOE is implementing the Phase 1 development plan, the APE is subject to Section 106 regulations. It is also subject to project-level CEQA analysis. The redevelopment includes demolishing 25 existing structures and removing approximately 170 immature and mature eucalyptus and pine trees as part of the Phase 1 site preparation work. The remainder of the existing trees would not be disturbed, and approximately 75 immature drought-resistant trees would be planted as a feature of the Phase 1 development. The southern portion of the Phase 1 site is in an area that is potentially subject to water inundation due to sea level rise, a tsunami, or a 100-year flood. In order to protect the Phase 1 facilities from potential inundation, the base elevation of the Phase 1 area would be increased from an average of approximately 10 feet above sea level (asl) to approximately 15 feet asl, and the base elevation of the facilities would be constructed at 15 feet asl. This will require adding approximately 70,000 cubic yards of soil at varying depths over an area of approximately 12 acres. The proposed depth of ground disturbance is not currently defined but is expected to be extensive due to the removal of trees, buildings, and preparations for development.

DEFINITION OF THE STUDY AREA

The Study Area encompasses the larger 133-acre site (Figure 3), which consists of developed upland areas with buildings used for academic teaching and research activities and spaces leased by private entities, a north-south oriented planting of eucalyptus trees in the central portion of the site, areas of coastal grasslands, a tidal salt marsh (known as the Western Stege Marsh), and a transition zone between the upland areas and the marsh. Grasslands occur in a number of meadows and comprise about 14 acres of the site. The Bay Trail is south of the site. The University purchased the original Richmond Field Station landholdings in 1950. From 1870 to 1950, much of the property belonged to the California Cap Company, which manufactured explosives. The southeast portion of the uplands area was used for explosive manufacturing from the 1870s until the University acquired the land (Tetra Tech 2013b). The portion of the Study Area outside of the APE (described above) is not subject to Section 106 regulations. However, Section 106 may be completed on a project-by-project basis if future activities outside the APE but within the Study Area constitute a federal undertaking per Section 106 regulations. This larger area outside the APE but within the Study Area is also subject to programmatic-level analysis under CEQA.



0 1 2 3 Mi

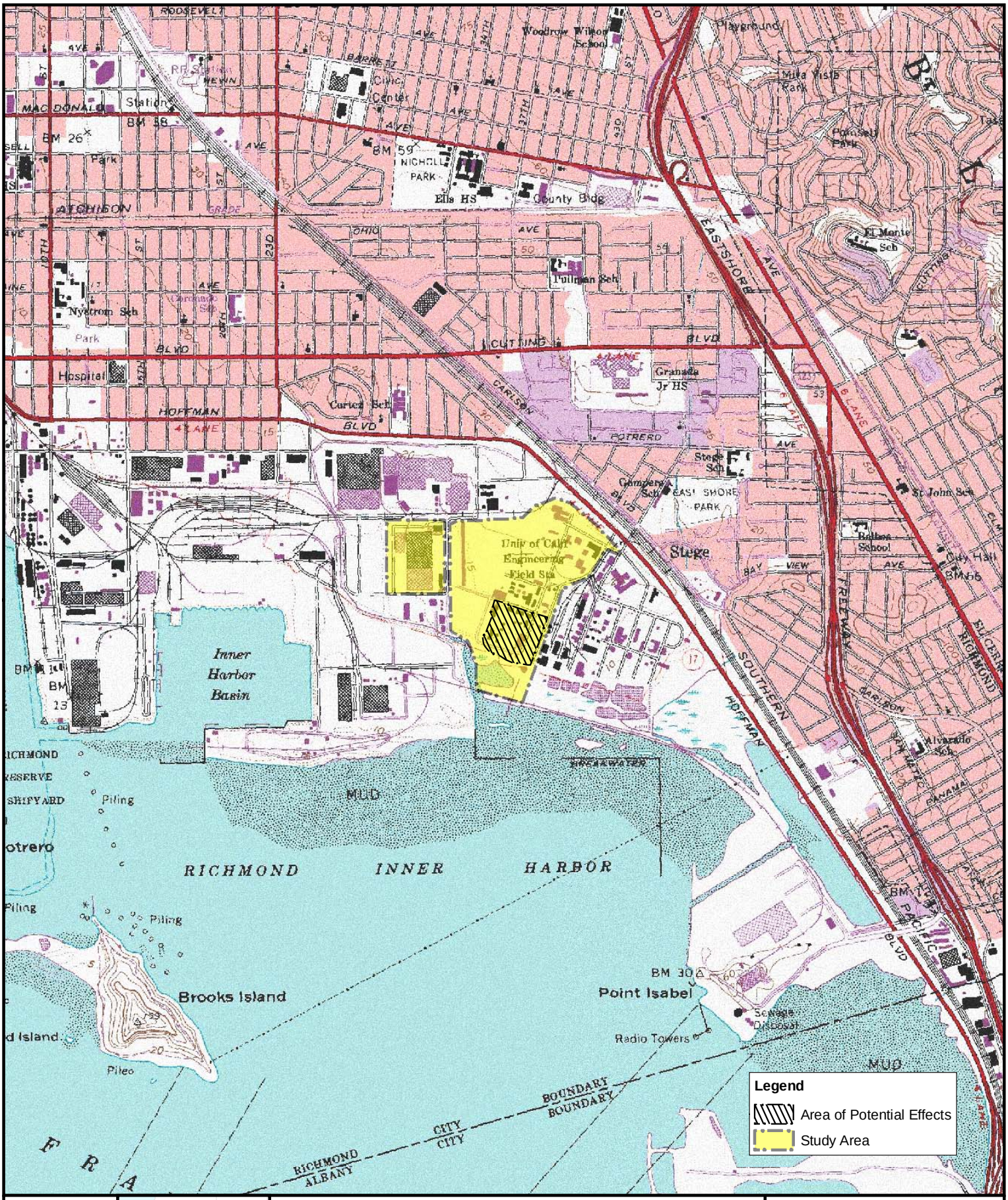
0 1 2 3 4 5 Km

USGS 7.5' Quad: RICHMOND (1993)
Legal Description: T01N R04W Sec 19, 20

1:95,040
One In = 1.5 Mi

Figure 1
Project Vicinity
Portions of the Richmond Properties

Contra Costa County, CA



0 1,000 2,000 3,000 4,000 ft

0 300 600 900 1,200 m

USGS 7.5' Quad: RICHMOND (1993)
Legal Description: T01N R04W Sec 19, 20

1:24,000
One In = 2,000 Ft

Figure 2
Project Location Map
Portions of the Richmond Properties

Contra Costa County, CA

GANDA

0 250 500 750 1,000 ft

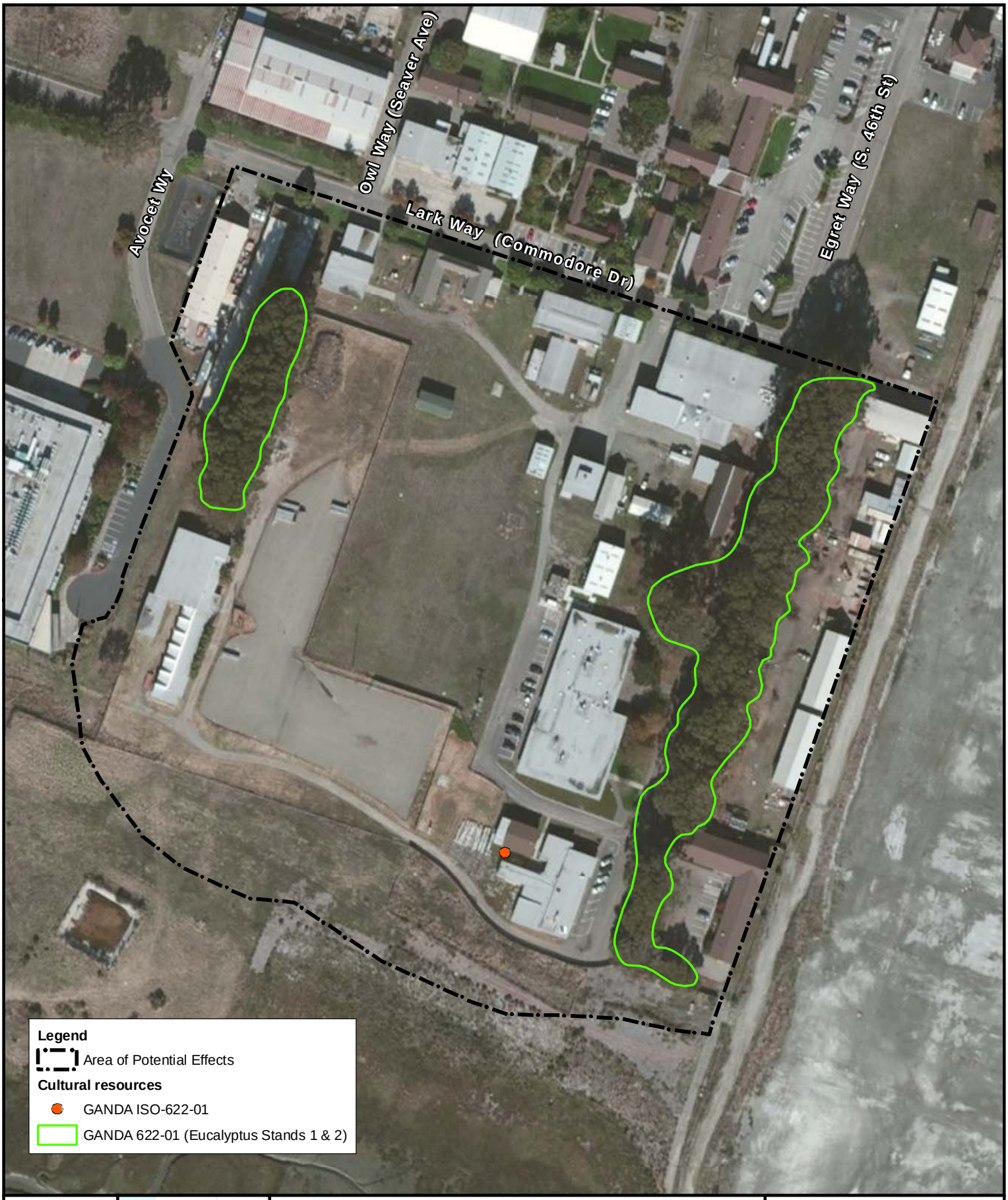
0 75 150 225 300 m

USGS 7.5' Quad: RICHMOND (1993)
Legal Description: T01N R04W Sec 19, 20

1:6,000
One In = 500 Ft

Figure 3
Study Area and
Area of Potential Effects
Portions of the Richmond Properties

Contra Costa County, CA



GANDA

0 75 150 225 300 Ft

0 25 50 75 100 M

USGS 7.5' Quad: RICHMOND (1993)
Legal Description: T01N R04W Sec 19, 20

1:1,800
One In = 150 Ft

Figure 4
Area of Potential Effects
Portions of the Richmond Properties

Contra Costa County, CA

PROJECT LOCATION

The approximately 133-acre site is located at 1301 South 46th Street in the South Shoreline area of the City of Richmond, approximately 5 miles northwest of the UC Berkeley campus and the LBNL site in Berkeley. The site is a portion of the UC-owned properties in Richmond, composed of four parcels: a parcel that contains the currently developed upland portion known as the Richmond Field Station (RFS); a recently acquired developed parcel along Regatta Boulevard immediately west of the upland area; and two parcels that comprise tidal lands and open waters in San Francisco Bay. The site is located within Township 1 North/Range 4 West/Sections 19 and 20, Mount Diablo Base Line and Meridian, as depicted on the Richmond (1993) 7.5' topographical quadrangle maps (Figure 3) (Tetra Tech 2013b).

The 133-acre site is bounded on the west by a PG&E service station, on the north by railroad tracks and Regatta Boulevard, on the east by South 46th Street, and on the south by the San Francisco Bay. Interstate 580 (I-580) runs parallel to Meade Street along the northeastern boundary of the site. Land uses surrounding the site include industrial/office uses and a major interstate freeway, with low-/medium-density residential neighborhoods. Regatta Boulevard, along the northern boundary, is adjacent to a railroad spur and a business complex developed with one- to two-story buildings. Bio-Rad Laboratories, a private research equipment manufacturing company, is located immediately west of the site. The adjacent property to the east is the location of former chemical production operations previously owned by several entities, including Stauffer and Zeneca, and currently owned by Cherokee Simeon Venture I, LLC.

The Marina Bay residential neighborhood, across Meeker Slough, and southwest of the site, consists of a mix of multi- and single-family residences. Low- and medium-density residential uses are also located across I-580, north of the Meade Street boundary of the site.

PROJECT DESCRIPTION

The University proposes to establish a new major research campus for consolidation of biosciences programs of the LBNL and for development of additional facilities for research and development focused on energy, environment, and health by LBNL, UC Berkeley, and synergistic institutional or industry counterparts.

The University is preparing a Long Range Development Plan (LRDP) in support of the research and academic goals for this proposed new research campus. An LRDP is defined by statute (Public Resources Code [PRC] 21080.09) as a "physical development and land use plan to meet the academic and institutional objectives for a particular campus or medical center of public higher education." The proposed 2013 LRDP addresses sustainability, land use, access and circulation, utilities and infrastructure, and open space and landscaping, and provides a policy and design framework to guide the development of up to 5.4 million square feet of new research, development, and support space at the site. Design principles in the proposed LRDP feature preservation of the site's important natural open spaces including the San Francisco Bay, marsh, and coastal grasslands. The proposed 2013 LRDP will guide the growth and development of the campus through the year 2050.

The University is also developing Phase 1 development plans that would construct the first three new buildings within a 16-acre area. Two of these buildings would be approximately 110,000 to 150,000 gsf each, and the third building would be up to 300,000 gsf for a total of up to 600,000 gsf. These new buildings would house the following institutions:

- LBNL's Joint Genome Institute (JGI) which UC LBNL manages for the US Department of Energy (DOE)
- Joint BioEnergy Institute (JBEI), a multi-institutional partnership led by UC LBNL

- Advanced Biofuels Process Demonstration Unit (ABPDU), which UC LBNL manages for DOE
- Knowledge Base (KBase), a multi-institutional collaboration led by UC LBNL

In addition, the facilities would house other LBNL biosciences projects and activities, and a conference facility, a dining facility, and various support facilities. Construction of Phase 1 would commence in 2014, and the buildings would be occupied starting in 2017 or 2018. Development of Phase 1 would add approximately 1,000 to the adp of the site, increasing the adp from 300 to 1,300 (Tetra Tech 2013b).

2.0 REGULATORY CONTEXT

The regulatory framework that mandates consideration of cultural resources in project planning includes federal, state, and local governments. Cultural resources include prehistoric and historic archaeological sites, districts, and objects; and locations of important historic events or sites of traditional and/or cultural importance to various groups. Cultural resources may be determined significant or potentially significant in terms of national, state, or local criteria, either individually or in combination. Resource evaluation criteria are determined by the compliance requirements of each specific project.

FEDERAL REGULATIONS

Section 106 of the National Historic Preservation Act (NHPA)

Section 106 of the NHPA requires federal agencies, and those they fund or have approval authority over, to consider the effects of their actions on properties that may be eligible for listing or are listed in the National Register of Historic Places (NRHP). To determine whether an undertaking could affect NRHP eligible properties, cultural resources (including archaeological, historical, and architectural properties) must be inventoried and evaluated for listing in the NRHP. Although compliance with Section 106 is the responsibility of the lead federal agency, others can undertake the work necessary to comply with Section 106. The Section 106 process entails five primary steps, listed below.

1. Initiate consultation and public involvement.

2. Identify and evaluate historic properties within the APE.

3. Assess effects of the project on historic properties.

4. If there are historic properties that will be affected, consult with the State Historic Preservation Officer (SHPO) regarding adverse effects on historic properties. This consultation will result in a memorandum of agreement (MOA), if determined appropriate.

5. Proceed in accordance with the MOA, if appropriate.

National Register of Historic Places (NRHP) Criteria for Evaluation

An archaeological site's significance is determined in part using the NRHP's Criteria for Evaluation at 36 CFR 60.4, which state that "the quality of significance in American history, architecture, archeology, engineering, and culture is present in districts, sites, buildings, structures, and objects that possess integrity of location, design, setting, materials, workmanship, feeling, and association" and meet one or more of the following criteria:

a) associated with events that made a significant contribution to the broad patterns of our history (Criterion A);

b) associated with the lives of persons significant to our past (Criterion B);

c) embodies the distinctive characteristics of a type, period, or method of construction; or that represents the work of a master, or that possesses high artistic values; or that represent a

significant and distinguishable entity whose components may lack individual distinction (Criterion C); and/or

d) has yielded, or may be likely to yield, information important in prehistory or history (Criterion D).

Archaeologists generally evaluate archaeological resources using Criterion D in order to determine their potential to yield information. Criterion D emphasizes the importance of the information encompassed in an archaeological site, rather than its inherent value as a surviving example of a particular architectural type, or its historical association with an important person or event. If the SHPO determines that a cultural resource is eligible for inclusion to the NRHP, then it is automatically eligible for the California Register of Historical Resources (CRHR). If a resource does not have the level of integrity necessitated by the NRHP, it may still be eligible for the CRHR, which allows for a lower level of integrity (see below).

National Register of Historic Places (NRHP) Seven Aspects of Integrity

Cultural resources integrity is determined using the NRHP's seven aspects of integrity at 36 CFR 60.4, which state that a historic property must not only be shown to be significant under the NRHP criteria, but it also must retain historic integrity. The seven aspects of integrity include location, design, setting, materials, workmanship, feeling, and association. A property must meet one or more of the Criteria for Evaluation before a determination can be made about its integrity (National Register Bulletin 15).

STATE REGULATIONS

California Environment Quality Act (CEQA)

The CEQA Statute and Guidelines include procedures for identifying, analyzing, and disclosing potential adverse impacts to historical resources, which include all resources listed in or formally determined eligible for the NRHP, the CRHR, or local registers. CEQA further defines a "historical resource" as a resource that meets any of the following criteria:

- A resource listed in, or determined to be eligible for listing in, the National Register of Historic Places or California Register of Historical Resources.

- A resource included in a local register of historical resources, as defined in Section 5020.1(k) of the Public Resources Code, unless the preponderance of evidence demonstrates that it is not historically or culturally significant.

- A resource identified as significant (i.e., rated 1-5) in a historical resource survey meeting the requirements of Public Resource Code Section 5024.1(g) (Department of Parks and Recreation Form 523), unless the preponderance of evidence demonstrates that it is not historically or culturally significant.

- Any object, building, structure, site, area, place, record, or manuscript which a lead agency determines to be historically significant or significant in the architectural, engineering, scientific, economic, agricultural, educational, social, political, military, or cultural annals of California, provided the determination is supported by substantial evidence in light of the whole record. Generally, a resource is considered "historically significant" if it meets the criteria for listing on the CRHR (CEQA Guidelines Section 15064.5).

California Register of Historical Resources (CRHR) Criteria of Evaluation

The CRHR is a listing of State of California resources that are significant within the context of California's history, and includes all resources listed in or formally determined eligible for the NRHP. The CRHR is a state-wide program of similar scope to the NRHP. In addition, properties designated under municipal or county ordinances are also eligible for listing in the CRHR. A historic resource must be significant at the local, state, or national level under one or more of the following criteria defined in the California Code of Regulations Title 14, Chapter 11.5, Section 4850:

1. It is associated with events or patterns of events that have made a significant contribution to the broad patterns of local or regional history, or the cultural heritage of California or the United States; or

2. It is associated with the lives of persons important to local, California, or national history; or

3. It embodies the distinctive characteristics of a type, period, region, or method of construction, or represents the work of a master, or possesses high artistic values; or

4. It has yielded, or has the potential to yield, information important to the prehistory or history of the local area, California, or the nation.

The CRHR criteria are similar to NRHP criteria, and are tied to CEQA.

Regulations Concerning Discovery of Human Remains

California Public Resources Code §5097.98 (Notification of Native American human remains, descendants; disposition of human remains and associated grave goods) mandates that the lead agency adhere to the following regulations when a project results in the identification or disturbance of Native American human remains:

a) Whenever the Native American Heritage Commission receives notification of a discovery of Native American human remains from a county coroner pursuant to subdivision (c) of Section 7050.5 of the Health and Safety Code, it shall immediately notify those persons it believes to be most likely descended from the deceased Native American. The descendants may, with the permission of the owner of the land or his or her authorized representative, inspect the site of the discovery of the Native American remains and may recommend to the owner or the person responsible for the excavation work means for treating or disposing of, with appropriate dignity, the human remains and any associated grave goods. The descendants shall complete their inspection and make their recommendation within 24 hours of their notification by the commission. The recommendation may include the scientific removal and nondestructive analysis of human remains and items associated with Native American burials.

b) Whenever the Native American Heritage Commission is unable to identify a descendent, or the descendent identified fails to make a recommendation, or the landowner or his or her authorized representative rejects the recommendation of the descendent, and the mediation provided for in subdivision (k) of Section 5097.94 fails to provide measures acceptable to the landowner, the landowner or his or her authorized representative shall reinter the human remains and items associated with Native American burials with appropriate dignity on the property, in a location not subject to further subsurface disturbance.

c) Notwithstanding the provisions of Section 5097.9, the provisions of this section, including those actions taken by the landowner or his or her authorized representative to implement this section, and any action taken to implement an agreement developed pursuant to subdivision (l) of Section 5097.94, shall be exempt from the requirements of the California Environmental Quality Act [Division 13 (commencing with Section 21000)].

d) Notwithstanding the provisions of Section 30244, the provisions of this section, including those actions taken by the landowner or his or her authorized representative to implement this section, and any action taken to implement an agreement developed pursuant to subdivision (1) of Section 5097.94, shall be exempt from the requirements of the California Coastal Act of 1976 [Division 20 (commencing with Section 30000)].

3.0 BACKGROUND

The following is a summary of the environmental, prehistoric, ethnographic, and historic background pertaining to Contra Costa County and the project vicinity. This section also presents the existing setting and context used to assess the sensitivity for prehistoric and historic cultural resources within the APE and Study Area.

EXISTING ENVIRONMENT

The project area is located along the San Francisco Bay shoreline in the southeastern portion of the City of Richmond. Land use adjacent to the APE consists of industrial/office and low- to medium-density residential areas, along with a major interstate freeway. The APE is bordered to the south by marshes and tidal flats of the bay. The two upland parcels within the APE are currently developed with approximately 80 one- and two-story buildings, roadways, parking lots, and landscaped areas. The uplands area, which has been the location of a variety of industrial enterprises dating back to the mid-19th century, also contains previously disturbed, currently undeveloped open space.

Climate

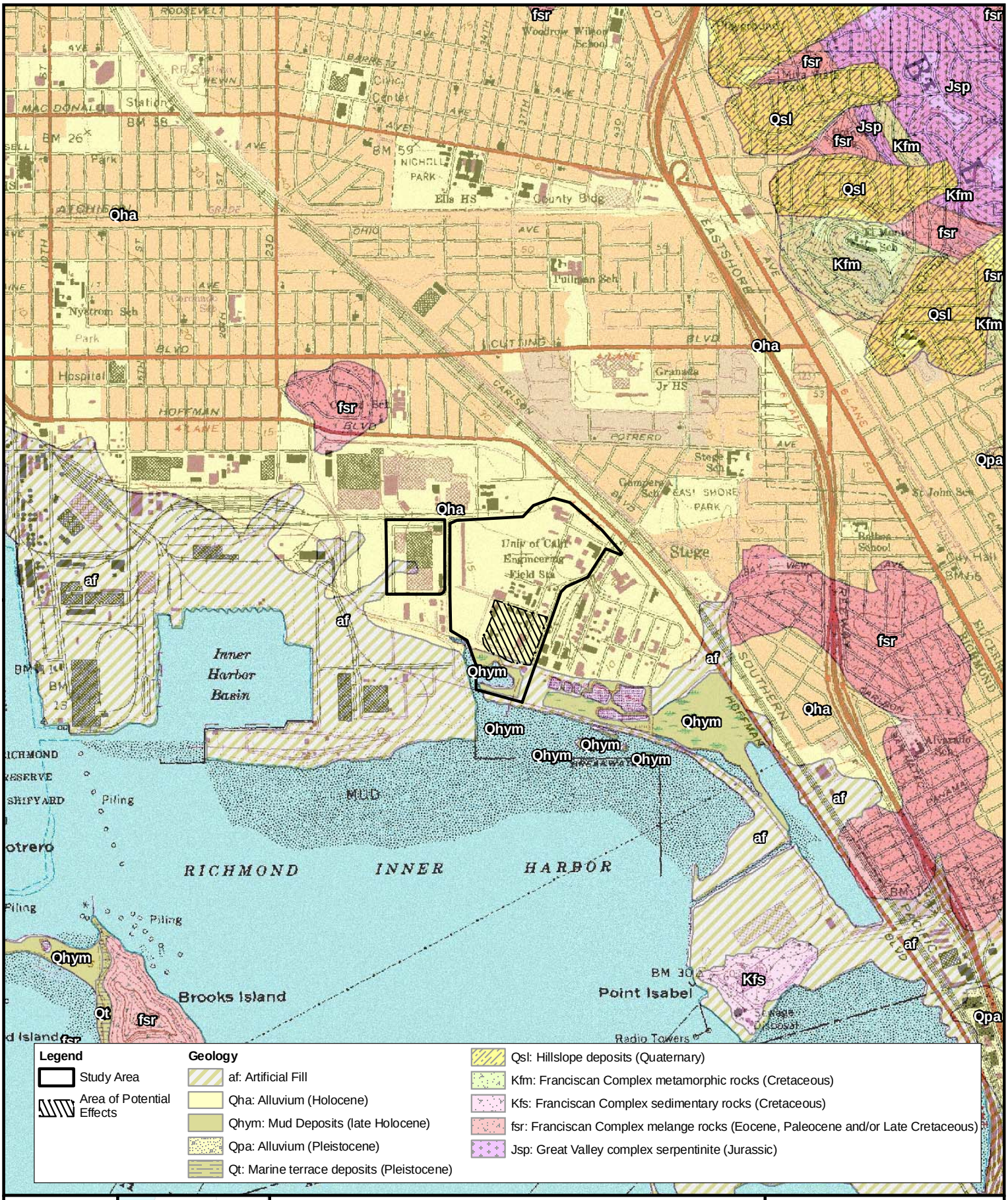
The project area is characterized by a Mediterranean climate, with cool moist winters and hot dry summers influenced by the moderating effects of the San Francisco Bay and the Pacific Ocean. The average yearly high temperature is 90 degrees Fahrenheit and the average yearly low is 31 degrees Fahrenheit. The average yearly precipitation is approximately 38 inches, in the form of rain occurring mostly between the months of November and March (US Climate Data 2012).

Geology

The Study Area and APE are located on Holocene age alluvium mapped as (Qha=Quaternary Holocene alluvium) (Figure 5) which consists of clay to sand and gravel sized sediments derived from upland streams, as well as eolian (wind) derived silt and sand deposition. The alluvium is interdigitated with late Holocene estuarine muds (Qhym=Quaternary Holocene young mud). This geological setting suggests a bay shoreline environment during the late Holocene (last 5,000 years), which is consistent with the local and regional archaeological record as being a resource rich environment that was heavily utilized and occupied by prehistoric and contact period Native American populations.

PREHISTORIC CONTEXT

Archaeological investigations in California and elsewhere seek to explain past human culture, continuity, and change. Archaeological interpretation of material remains can address many aspects of past human behavior, including when people occupied an area and at which time of the year; the technological and natural resources available; social organization; settlement patterns; relationships with neighboring groups in terms of trade, competition, and conflict; ceremonial systems; and external environmental issues. Prior to the use of dating techniques such as radiocarbon dating and obsidian hydration, the archaeological record was largely defined by artifact collections and mortuary practices identified during large-scale excavations. Current archaeological research helps to explain a wide array of questions regarding prehistoric human culture and adaptive responses, as well as the ongoing issue of chronology.



GANDA

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0 300 600 900 1,200 m

USGS 7.5' Quad: RICHMOND (1993)
Legal Description: T01N R04W Sec 19, 20

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One In = 2,000 Ft

Figure 5
Underlying Geology
Portions of the Richmond Properties

Contra Costa County, CA

Moratto (2004), Fredrickson (1973), and other researchers (Milliken et al. 2007), have divided the prehistory of this region into seven general time periods. These periods represent patterns developed from archaeological data recovered from archaeological investigations of the San Francisco Bay Area counties. The periods include the Paleo-Indian, Lower Archaic, Middle Archaic, Initial Upper Archaic, Late Upper Archaic, Lower Emergent, and Terminal Late periods. These are briefly described below.

Paleo-Indian Period (11550 to 8550 calibrated Before Present [cal BP]) [1]

The oldest site from the Paleo-Indian Period representing the Central Valley and greater San Francisco Bay Area is located in King County, in the southern San Joaquin Valley. This site, CA-KIN-32, also referred to as the Witt site at Tulare Lake, yielded radiocarbon dates from human remains of approximately 9,429 to 13,852 years before present (cal BP). Archaeological investigations at Los Vaqueros Reservoir Watershed in southeast Contra Costa County have produced an artifact assemblage dating to 9,800 years cal BP (Ziesing 1997), which indicates a considerably longer span of prehistoric occupation than what had been previously accepted. These sites are typically situated near shoreline or marshes, or along pluvial lake shores, and are usually buried deep beneath Holocene alluvial deposits. According to Milliken et al. (2007:114), most, if not all of the archaeological material from this time period has either been eroded away or buried by alluvial deposits and therefore, is rarely represented in the archaeological record.

Early Holocene (Lower Archaic Period) (8550 to 5550 cal BP)

Similar to the Paleo-Indian Period, most of the archaeological discoveries for the Lower Archaic Period are represented by isolated finds (Rosenthal et al. 2007:147). Examples from this period include artifacts recovered from CA-CCO-637 and CA-CCO-696 in the Los Vaqueros Reservoir Watershed. Pestles with wooden mortars were encountered at CA-CCO-637 and have been dated to 6570 cal BP (Rosenthal et al. 2007:153; Milliken et al. 2007:115), and a charcoal sample excavated from the deepest component of CA-CCO-696 revealed a date of 9870 cal BP. Associated artifacts at this site also included a wide-stemmed projectile point of Napa Glass Mountain obsidian and plant remains including acorns and wild cucumbers (Rosenthal et al. 2007:152).

In general the Lower Archaic Period is associated with artifacts such as wide-stemmed point types (Borax Lake Wide Stem) and milling implements (i.e., handstones and milling slabs) signifying the increased use of, and reliance on, plant resources. Furthermore, social systems appear to have been developing and becoming more elaborate during this time period.

Early Period (Middle Archaic Period) (5500 to 2500 cal BP)

Distinct cultural adaptations are demonstrated at sites dating to the Middle Archaic Period. Cultural materials from this period are typically described as originating from the foothills or valley traditions. Artifact assemblages for the foothill tradition are composed of flaked stone dart points and cobble tools similar to those of the Lower Archaic. These sites are also characterized by rock-filled hearths and ovens, and "cairn capped" graves (Rosenthal et al. 2007). Middle Archaic sites of the valley tradition are fairly well represented in the archaeological record and are prevalent throughout Contra Costa County. For example, artifact assemblages and paleobotanical studies from sites CA-CCO-18/548 and CA-CCO-637 have produced data regarding extremely diverse technological and dietary remains suggesting the emergence of organized subsistence and increased occupation along river

[1] "cal BP" means calibrated years before present, present starts at 1950.

corridors (Rosenthal et al. 2007). Tabular pendants, incised slate, and perforated stone plummets are rare, but have been identified across a broad geographical area during this time period.

Some of the oldest documented sites in the San Francisco Bay Area are from the Middle Archaic Period and are located in Contra Costa and Alameda counties. These prehistoric sites include, CA-CCO-637 (described above) in the Los Vaqueros Reservoir Watershed, CA-CCO-308 in San Ramon Valley, and CA-ALA-483 in the Livermore Valley, which contained deeply buried deposits of mortar and pestle assemblages (Miliken et al. 2007). Also associated with this time period are three important shellmounds, CA-ALA-307, CA-CCO-295, and CA-MRN-152, located in the central San Francisco Bay Area (Milliken et al. 2007). Twenty-three radiocarbon dates were taken from CA-ALA-307 (West Berkeley site), the earliest yielded a timeframe spanning 4,980 to 4,840 cal BP (Lighfoot and Luby 2002:270). Elliptical house floors with postholes were encountered at the Rossmoor site (CA-CCO-309), in southern Contra Costa County, which may indicate a shift towards sedentism or semisedentism during this period (Miliken et al 2007). It is important to note that both the *Olivella* and *Haliotis* (commonly known as abalone) rectangular beads are represented in the Bay Area during the Early Period from approximately 4,780 years ago and continued in use until 2,800 years ago (Milliken et al 2007). The fishing net sinker is also a typical period marker for the Middle Archaic period.

The Middle Archaic Period is also associated with the Windmiller Pattern or cultural sequence for this period (Rosenthal et al. 2007). However, the advent, spatial distribution, and variation across the regional landscape of the Windmiller Pattern are not clearly defined at this time. Situated in riverine, marshland, or valley floor settings, as well as on small knolls above prehistoric seasonal floodplains, most Windmiller Pattern sites contain ventrally extended burials that are oriented to the west. These sites generally contain large amounts of mortuary artifacts which indicate social hierarchy, and often include large projectile points and a variety of fishing gear such as net weights, bone hooks, and spear points. The presence of faunal remains throughout the archaeological record suggests a hunting economy that included both large and small mammals (Rosenthal et al. 2007).

The high frequency of mortars and pestles in delta area sites indicates a shift to a more intensive subsistence strategy based on the acorn as a dietary staple, or at least an intensification of the use of the mortar and pestle technology. However, the types of plant foods that the population was procuring do not change during this time period, simply the method used to process the resources. The increased efficiency in food processing may have allowed for a more sedentary lifestyle (Rosenthal et al. 2007:155). There is also archaeological evidence for the advent of other technologies such as cordage, twined basketry, basketry awls, simple pottery, and other baked clay objects, stone plummets, bird bone tubes, and shell beads in the Middle Archaic sites. The presence of exotic items, such as obsidian and shell ornaments, point to a complex exchange system with other native groups throughout California.

Lower Middle Period (Initial Upper Archaic) (2450 cal BP to AD 430)

The archaeological record of the Upper Archaic Period demonstrates a substantial shift in occupation, settlement, and artifact assemblages. It is suggested that this time period marks some of the most distinct representations of California's early occupation by prehistoric peoples. Assemblages change dramatically during this time period, particularly in the form of bead type changes represented in the archaeological record of the San Francisco and North Bay areas.

Split beveled and tiny saucer *Olivella* beads replaced the rectangular shell beads that were widely used over the preceding 3,000 years. Mortuaries that date to this period contain fewer grave goods, and cut *Olivella* beads are less common than spire-lopped *Olivella* beads (Milliken et al. 2007). Defined as the M1 Bead Horizon, artifact types of this period include: *Olivella* saucer beads, circular *Haliotis*

ornaments, new forms of bone tools (including those for coiled basketry), barbless fish spears, elk femur spatulas, tubes, and whistles. Stone net sinkers disappear from the archaeological record during this period.

The representative cultural pattern for the Initial Upper Archaic is the Berkeley Pattern. Spanning about 2,500 to 1,300 years ago, this pattern resembles earlier cultural ones, but shows an increase in larger and more frequent settlements across the landscape. Fredrickson (1973) defined the Berkeley Pattern by the economic adaptive strategies developed around the extensive and rich resources of the Bay Area during this time period. There were numerous marshes, tidal wetlands, streams, and inland grasslands and oak wooded areas that offered an abundant resource base, perhaps due to the slightly wetter period of prehistory during the late Holocene. Out of the Berkeley Pattern emerged larger occupation sites located near water sources, with the presence of projectile points and atlatls (Fredrickson 1989).

Berkeley Pattern assemblages generally show a decrease in the presence of milling slabs and handstones and a shift to the mortar-and-pestle technology, indicating an increased dependence on acorns as a staple, or again, an increased reliance on that particular technology. However, millingstone technology continues to be used in the North Bay region during this time (Milliken et al. 2007:115). While gathered resources gained importance during this period, the continued presence of projectile points and atlatls (spear-throwers) in the archaeological record indicates that hunting was still an important activity (Fredrickson 1973).

Artifact assemblages from this period are also noted for especially well developed bone tool industry, twined basketry, and such technological innovations as ribbon flaking of stone artifacts. Populations generally increased and status differentiation and social stratification is more prevalent in the artifact assemblages, as evidenced in the forms of grave goods and wealth items, such as shell beads and ornaments. Flexed burials replaced extended burials during this time. The Berkeley Pattern may represent the spread of ancestral Utians (proto-Miwok and Costonoans) from their hypothesized lower Sacramento Valley/Delta homeland to surrounding regions.

Upper Middle Period (Late Upper Archaic) (cal AD 430 to 1050)

The beginning of the Upper Middle Period is marked by another significant cultural disruption, as evidenced by trade network collapse and site abandonment. This precipitates a series of *Olivella* bead types with a relatively narrow chronological range, one supplanting the next through time, allowing for a clear chronological picture of the archaeological record. The following information is adapted from Milliken et al. (2007), and highlights the most recent findings regarding San Francisco Bay Area cultural chronology based on bead types.

- *M2:* New shapes of *Haliotis* pendants, ceremonial blades, fishtail charmstones, and mica ornaments appear.
    - M2a: The rough-edged, full saddle *Olivella* beads with very small perforations (marker for M2a) replace the *Olivella* saucer beads.
    - M2b: marked by mixed *Olivella* saddle beads.
- M3: mixed *Olivella* saddle beads replaced by small, square saddle *Olivella* beads "occasionally with small, poorly shaped *Olivella* saucer beads, often in off village single component cemeteries" (Milliken et al. 2007:116); single barbed bone fish spears, ear spools, and large mortars also appear in the archaeological record.

- M4: "de-evolution of saddle bead into a variety of wide and tall, bisymmetrical forms and distinctive *Haliotis* ornament styles, such as unperforated rectangles and perforated ovals" (Milliken et al. 2007:116). Most graves lack grave goods and there are few sites dated to the particular time period.

In addition, bone artifacts are represented in the Upper Middle Period and include a diverse assemblage of tools and other items. The relative importance of hunting is apparent, based on an increased volume of projectile points as compared to the previous period. There is a marked degree of social complexity and semi-permanent settlements become common. Complex, long-distance exchange networks develop during this period as well (Moratto 2004).

Initial Late Period (Lower Emergent) (cal AD 1050 to 1500)

According to Milliken et al. (2007), the Middle Period is defined by "collectors who buried their dead with diverse, numerous but fairly simple ornaments," whereas the Late Period concerns "collectors who invested large amounts of time in the creation of finely wrought wealth objects" (Milliken et al. 2007:116). This transition suggests a shift in use of time, and likely an increasingly sedentary nature of the prehistoric settlement patterns, along with the increased importance of ceremonialism and the idea of wealth distribution and status amongst the population.

The people who occupied Contra Costa County during this time practiced extensive elaboration of ceremonial and social organization, including the development of social stratification. Exchange networks became well established and proliferated. Local populations became more dependent on the acorn, as evidenced by the prevalence of mortars, pestles, and hopper mortars throughout the archaeological record.

Other important artifacts that are representative of this time period include smoking pipes, harpoons, baked clay composition of pottery vessels and figurines, coiled basketry, clamshell disks and pine nut beads, and the use of small projectile points, especially Gunther series points that denote adoption of the bow-and-arrow (Moratto 2004). This period is also represented by the presence of Bead Horizon L1, characterized by *Olivella* callus cup beads, banjo *Haliotis* ornaments, and flanged pipes, as well as the bow-and-arrow (Milliken et al. 2007).

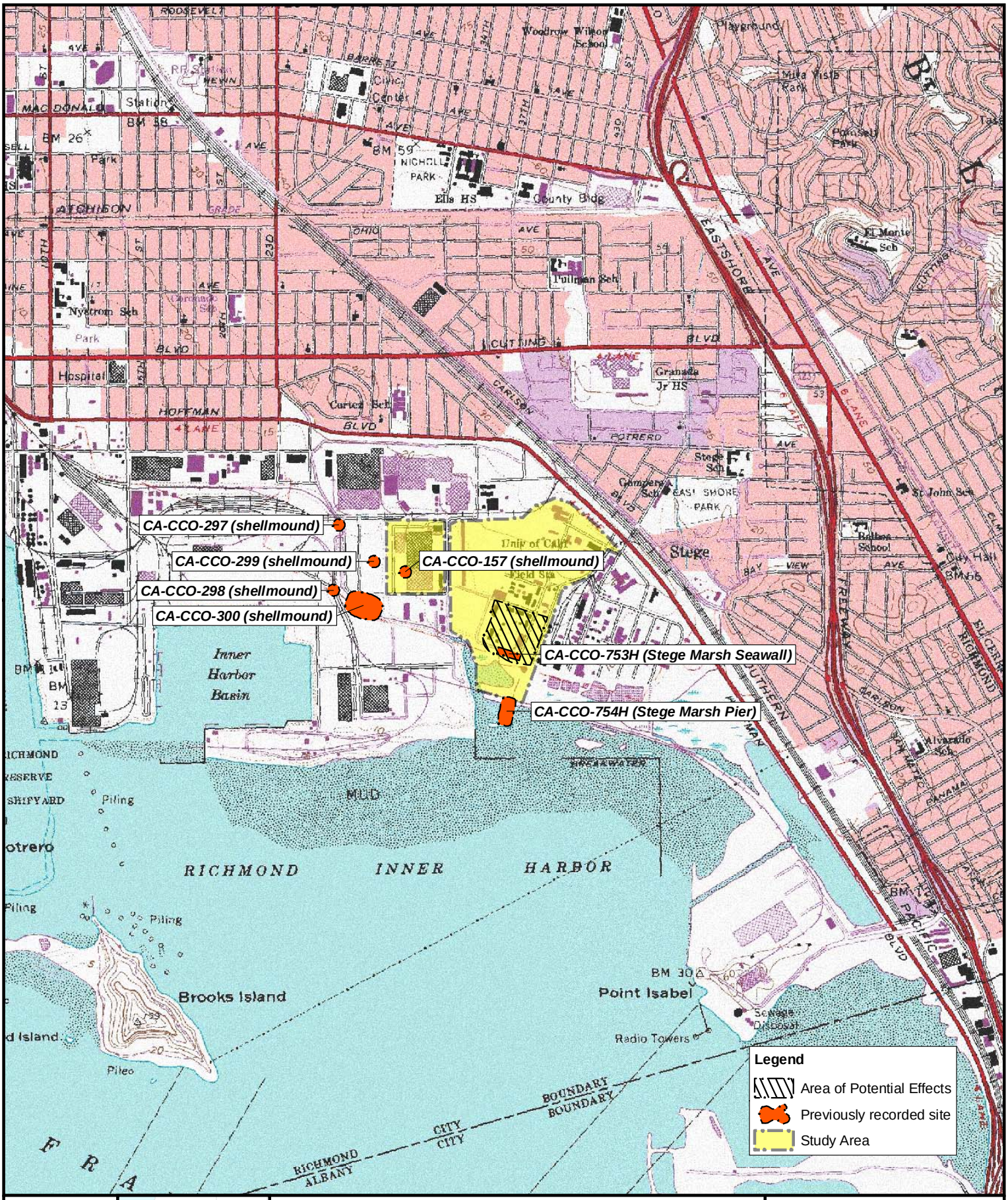
Terminal Late Period (cal AD 1500 to 1700)

Cultural adaptations grew more complex in terms of settlement patterns, indicating a shift to a more sedentary lifestyle. This was likely based on, or resulting from, a dynamic combination of population pressures, competition for resources, and population movements, which, in turn, led to an increase in ceremonialism, trade networks, technological change, and social stratification and organization. Some researchers suggest that increasing pressure on the region's carrying capacity, population size in relationship to abundance of resources, at the time of contact with European settlers was the reason behind the rapid increase in cultural complexity at the end of the Late Period (Milliken et al. 2007). In the archaeological record, this period is represented by the presence of callus-cupped *Olivellas,* replaced by clam shell disc beads and lipped beads, and larger amounts of spire-lopped O*livellas* than in previous time periods (Milliken et al. 2007).

Archaeology of the APE

In 1915, L. L. Loud originally recorded CA-CCO-157 (Loud's No. 299) as an approximately 350-foot wide by 250-foot long shellmound situated on the end of a slough around 800 feet from the San Francisco Bay's historic shoreline. What remains of the archaeological site is unknown and it is currently located underneath a warehouse and paved parking lot at 3200 Regatta Boulevard in

Richmond (Banks 1985a). This resource is located within the Study Area (Figure 6). In addition, there are four additional shellmounds located between 0.08 and 0.18 miles from the APE. These include: CCO-297, CCO-298, CCO-299, and CCO-300, also shown on Figure 6. These prehistoric shellmounds were all recorded within close proximity to the APE, along the historic shoreline by Nels Nelson in the early 20th century (Banks 1985a, 1985b, 1985c, 1985d, 1985e). These were prehistoric sites that generally demonstrated long periods of intense occupation, with an abundance of marine shellfish dietary debris, with human remains often associated with the sites, and served as long term habitation sites during the middle and late prehistoric periods. See the records search section below for a more detailed description of these resources.



GANDA

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0 300 600 900 1,200 m

USGS 7.5' Quad: RICHMOND (1993)
Legal Description: T01N R04W Sec 19, 20

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One In = 2,000 Ft

Figure 6
Previously Recorded Cultural Resources in the Project Vicinity Portions of the Richmond Properties

Contra Costa County, CA

ETHNOGRAPHIC CONTEXT

The Study Area is located within the area that is ethnographically attributed to the Ohlone (also known as Costanoan). The term "Costanoan" derives from the Spanish word Costaños or "coast people" and refers to an ethno-linguistic group of people that lived along the San Francisco peninsula before contact with European Americans. Ethnographic and ethnohistoric information about the Ohlone derives primarily from the accounts of early explorers and missionaries. The territory of the Ohlone is purported to have extended from the Central Coast Ranges between San Pablo Bay in the north and Monterey in the south. The Ohlone tribal territory boundary in the east is not precisely known but is understood to extend to the Mount Diablo Range (Kroeber 1925:462; Moratto 2004).

The Ohlone spoke a language considered to be one of the eight major subdivisions of the Miwok-Costanoan, as categorized by linguistics, which belonged to the Utian family within the Penutian language family (Shipley 1978:82-84). Linguistic evidence suggests that the Ohlone entered the San Francisco and Monterey Bay areas about 1500 cal BP (Levy 1978:486). The Ohlone were politically organized by tribelets, each having a designated territory. A tribelet consisted of one or more villages and camps in a territory designated by physiographic features. Tribelets generally had 200 to 250 members (Levy 1978:485; Margolin 1978:1). Each tribelet consisted of villages every three to five miles (as noted by early Spanish explorers) that contained an average of 60 to 90 persons (Milliken 1995:19). The current study area is located within the *Huchiun* tribelet ethnographic territory, where *Chochenyo/East Bay Costanoan* was the common spoken language (Levy 1978:485; Margolin 1978:2).

The acorn was among the most important food resources for Ohlone, who preferred tanbark oak, valley oak, and California black oak, all abundant in the area. The large stands of oak trees created a readily accessible staple. Acorns could be stored in granaries and used through the winter months. The acorns were ground into meal and leached to remove tannins. Other important food resources were buckeye nuts, which were leached and made into a mush, and the seeds of dock, gray pine, and tarweed, all of which were roasted in baskets with hot coals before being eaten. The Ohlone gathered berries and fruits including gooseberries, blackberries, madrone berries, and wild grapes along with root resources such as wild onion, cattail, and wild carrot (Levy 1978:491).

Shellfish and marine mammals were important resources in the Ohlone diet in general, particularly for coastal populations. Midden deposits found in shellmounds throughout the Bay Area attest to the importance of shellfish in the Ohlone diet. The Emeryville Shellmound (CA-ALA-309) is nearby, this was once a complex of mounds and was documented by Nels Nelson (1909); it is located approximately 2.5 miles south of the Study Area on the east shore of San Francisco Bay. Terrestrial mammals were also important to coastal and inland Ohlone populations including rabbits, black-tailed deer, tule elk and pronghorn sheep which were hunted and trapped using drive and snare methods. Hunting parties were communal, often bulk harvesting meat for immediate consumption or for winter storage for the various village groups (Lightfoot and Parrish 2009:212). Migratory waterfowl, particularly geese, ducks, and coots, were the most important avian resources and were captured with nets. Additionally, local quail were caught in traps. The Ohlone fished for salmon, sturgeon, and lampreys, and built tule balsas (rafts) to move about the waterways. The Ohlone traded with surrounding tribes such as the Miwok (to the northeast), and the Northern Valley Yokuts (to the east). Mussels, abalone shells, dried abalone, and salt were exchanged for piñon nuts with the Yokuts. *Olivella* shells were traded with the Sierra Miwok and bows with the Plains Miwok (Levy 1978:488).

Between 1770 and 1797, six missions were set up within the Ohlone territory (Margolin 1978:160). In 1770, the Ohlone population was estimated to be between 7,000 and 10,000 (Moratto 2004). Based on mission records, Milliken estimates that there were 2.5 people per square mile (Milliken et al. 1993:25). As a result of numerous stressors including the introduction of European diseases; the loss of traditional lifeways, including their settlement and subsistence practices; reduced birth rates; and

poor working and living conditions that they were forced to endure the Ohlone population dramatically and rapidly declined to fewer than 2,000 by 1832 (Milliken 1995). For native peoples who lived in tribelets, the loss of this many members would destabilize what little remained of their traditional social structure. By the time of secularization in 1834, there were no traditionally functioning tribal groups left within the project vicinity.

Since the 1980s, the modern Ohlone community has undergone a period of revitalization based on familial ties and former rancheria affiliations. Although they have yet to receive formal recognition from the federal government, the Ohlone are becoming increasingly organized as a political unit in the San Francisco Bay Area. Today, the Ohlone continue to live in and around Alameda and Contra Costa counties and despite more than a century of adversity, they continue to engage in traditional cultural practices and advocate for the preservation of their heritage.

HISTORIC CONTEXT

The historic context of the Study Area is influenced by four eras, including the Contact Period, Mission Period, Rancho Period, and American Period.

Contact Period (A.D. 1542 - 1769)

In 1542, Juan Sebastian Cabrillo was the first of the Europeans explorers to sail along the California coast. The goal of this expedition was to explore the new territory and to find suitable locations for establishing Franciscan missions; during this expedition they rediscovered the Bay of Monterey, described by sailors a hundred years earlier. Several accounts of this expedition exist including those of Fray Juan Crespi (Bolton 1971), Miguel Costansó (Browning 1992), and Pedro Fages (Priestley 1937). A Spanish expedition, led by Pedro Fages in 1772, reentered the San Francisco Bay Area returning from a southern expedition to Monterey. The explorers first saw the land that became Contra Costa County from San Francisco, and thus named the area "opposite coast" (Hoover et al. 1990).

Mission Period (A.D. 1769 – 1822)

The arrival of the Spanish and the subsequent establishment of the missions had a dramatic effect on native lifeways. The destruction of native culture resulted from the disruption of social systems, changes in subsistence and settlement patterns, the alteration of the landscape with the introduction of European plants and animals, and the devastation of Native American populations with the introduction of European diseases. The California missions of the San Francisco Bay Area that were established in the Ohlone territory are as follows: Mission San Francisco de Asis in 1776, Mission Santa Clara de Asis in 1777, Mission San José in 1797, Mission San Rafael Arcangel in 1817, and Mission San Francisco Solano in Sonoma in 1823. As the populations of Ohlone, who were originally brought to the Santa Clara de Asis, San Francisco de Asis, and San José missions, fled or died of disease, the Spanish were forced to search for replacement neophytes (Milliken 1995).

Rancho Period (A.D. 1822 – 1850)

In 1821, Mexico declared independence from Spain, and in 1822, California became a Mexican Territory. Following the secularization of the missions in 1834, representatives of the Mexican government distributed very large land grants to various individuals. Native Americans continued to work as laborers for new landowners (Beck and Haase 1977). During 1821 and 1846 when California was under the control of the Mexican Government, Contra Costa County was divided into the numerous ranchos, including Rancho San Pablo, Rancho San Ramón, Rancho El Sobrante de San Ramón, Rancho Sobrante, Rancho La Boca de la Cañada del Pinole, Rancho El Pinole, Rancho Los Medranos, Rancho Laguna de los Palos Colorados, and Rancho Arroyo de las Nueces y Bolbones

(Hoover et al. 1990). The current project area is located within Rancho San Pablo (Hatoff et al. 2003). A detailed description of the rancho is below:

Rancho San Pablo

Spain sought to solidify its claim to the territory by colonizing Alta California by encouraging settlement with large land grants. The closest land grant to the Study Area, Rancho San Pablo, was provisionally granted to Francisco Castro in 1823. Castro was born in Mexico and in 1800, relocated to Alta California where he served as a soldier for 13 years. In 1822, he became a member of the Governor's Council and acted as a *diputado*, or official representative, of the expedition led by Father Jose Altamira to the land north of the San Francisco Bay. The following year, he was provisionally granted Rancho San Pablo, where he lived until his death in 1831. His widow and eleven children inherited the estate and received official confirmation of the land grant in 1834 (Hoover et al. 1990).

American Period (A.D. 1850 to present)

The discovery of gold in the Sierra Nevada by Euro-americans ignited a major population increase in the northern half of California, as immigrants poured into the territory seeking gold and the opportunities it presented. The significant influx of people had a major impact on the environment and the remaining indigenous populations. Beginning in 1849, the Gold Rush created a shortage of ranch workers who rushed off to seek their fortunes. This loss of a ranch workforce, along with a huge increase in Euro-americans squatting on these lands, would later contribute to the disintegration of the Mexican land grants and eventual division and sale of land grant property.

Although rancho owners tried to maintain their property rights during the Gold Rush, by continuing to develop their cattle ranch industry, their lands were overrun by settlers or squatters as California ushered in the Gold Rush and ultimately and officially became a state in September 1850. The courts immediately reviewed Spanish and Mexican land grants, which were either confirmed or denied. Contra Costa became one of the state's original 27 counties in 1850 (Hoover et al. 1990). During the 1850s, the county grew rapidly resulting in the construction of roads, docks, railroads, canals, and shipping areas adjacent to the San Francisco Bay. In 1852, Castro divided the rancho into eight sections given to his heirs, who quickly sold the land to American settlers in the county. (Hatoff et al. 2003).

In 1876, the restaurateur Richard Stege purchased 600 acres of land within the former Rancho San Pablo. Stege established an estate on his new property, which included four frog ponds to raise red-legged frogs for restaurants in San Francisco, and a landing pier (located just south of the APE and dismantled in 2003) used by visitors to his estate and later by ships transporting grain to San Francisco (Hatoff et al. 2003).

Around the same time, chemical and explosive industries, including the Hercules Power Company and Stauffer Chemicals, began settling in the immediate vicinity. In 1880, Letts Oliver acquired the Stege property and established the California Cap Company to manufacture a new detonator, which he designed to be safer than those imported from Europe. The manufacturing plant featured over 150 buildings as well as trees to protect nearby residents in the event of an explosion. A wood seawall (located within the project vicinity and dismantled in 2003) was also constructed to serve as a wave barrier between the plant and the bay. The California Cap Company continued operations at the plant until 1948 (Hatoff et al. 2003).

In 1950, the University of California purchased the property from the California Cap Company and allowed the College of Engineering at the Berkeley campus to use it for off-site research. It renamed the property as the Richmond Field Station, remodeled existing buildings, and also constructed several new buildings to house administrative offices or specific research projects. The college also

filled in the area south of the seawall in order to construct a "hydrate pond" and a separate pond for sewage treatment research. (Hatoff et al. 2003). In 2002, the University of California conducted remediation of the shoreline to remove elevated concentrations of chemicals in the marsh sediments. The shoreline had been identified by the Regional Water Quality Control Board (RWQCB) as a high-priority "toxic hotspot" due to the release of mercury and pyrite cinders by the California Cap Company and adjacent manufacturing plants in the late 19th and early to mid-20th centuries. The above ground features of the cultural resources CA-CCO-754H (Stege Marsh Pier) and CA-CCO-753H (Stege Marsh Seawall) were removed during the remediation process, leaving remnants of these resources in place. These resources were evaluated and recommended ineligible for listing in the NRHP and CRHR (Hatoff et al. 2003). The University continues to own and operate the research facility (Hatoff et al. 2003).

4.0 PREFIELD RESEARCH AND CONSULTATION METHODS AND RESULTS

The methods used to conduct the records search, historic map review, and pedestrian survey for this inventory, and the results of those efforts are described in detail below.

RECORDS SEARCH METHODS

A GANDA cultural resource specialist conducted a records search at the Northwest Information Center (NWIC) of the California Historical Resources Information System (CHRIS) at Sonoma State University, Rohnert Park, on January 16, 2013 (File No. 12-0713). The NWIC is a repository of all cultural resources site records, previously conducted cultural resources investigations, and historic information concerning cultural resources for 16 counties, including Contra Costa County. The records search was conducted to compile information regarding the locations of previously recorded archaeological sites and previously conducted studies within a 0.25-mile radius of the Study Area which encompasses the APE. In addition, this information was used to assess the archaeological sensitivity of the Study Area and the APE. The following sources were consulted during the records search:

- NWIC base map: United States Geological Survey (USGS) 7.5-minute series topographic quadrangle for Richmond (1993).
- Survey reports from previous cultural resources investigations and cultural resources site records to identify previously recorded archaeological sites located within a 0.25-mile radius of the Study Area and the APE.
- California Office of Historic Preservation (OHP) resources, including the *California Inventory of Historic Resources* (1976), the *OHP Archaeological Determinations of Eligibility* for Contra Costa County (2012a), and the *OHP Historic Properties Directory* for Contra Costa County (2012b), which combines cultural resources listed as California Points of Historic Interest, listed as California Historical Landmarks, and listed in or determined eligible for listing in the NRHP or the CRHR.

RECORDS SEARCH RESULTS

Cultural Resources Investigations

The records search indicates that 29 cultural resources investigations have been completed within a 0.25-mile radius of the Study Area and the APE, four of which have been completed within the APE (Table 1).

Table 1. Previous Cultural Resource Investigations Located within the APE.

Study No.	Author/Date	Investigation Type	Associated Cultural Resources Recorded within the APE
S-02442	Banks 1980	Intensive level archaeological survey with limited testing excavation	None
S-11762	Holman 1989a	Intensive level archaeological survey	None

Study No.	Author/Date	Investigation Type	Associated Cultural Resources Recorded within the APE
S-11763	Holman 1989b	Built Environment reconnaissance survey	Several buildings over 45 years old were identified during the field survey but were not recorded on DPR 523 forms or evaluated for listing in the NRHP
S-26851	Hatoff et al. 2003	Archaeological monitoring	Two cultural resources were identified within the APE during the field survey: CA-CCO-754H/ P-07-002555 (Stege Marsh Pier/Richmond Field Station Pier/California Cap Company Pier) CA-CCO-753H/ P-07-002591 (Stege Marsh Seawall)

The following discussion provides information regarding the cultural resource investigations conducted within the APE and the cultural resources identified:

S-02442

Conducted in 1980 (Banks 1980), this archaeological survey covered a six acre parcel that included the Study Area and the APE. It consisted of a pedestrian survey of the parcel, the examination of three geotechnical auger borings that had been drilled to a depth of 30-60 feet before the survey began, and the drilling of two new hand-auger units. The location of the three previously-drilled augers is unknown and did not result in the discovery of cultural resources. The two new hand-auger units conducted by archaeologists, were located within the Study Area but outside the APE and were excavated to a depth of approximately 55 centimeters (Auger Unit #1) and approximately 105 centimeters (Auger Unit #2). This investigation did not result in the identification of cultural resources (Banks 1980).

S-11762

This archaeological survey, conducted in 1989, encompassed both the Study Area and the APE. The Study Area and the APE were surveyed using 20-foot (or less) transects, and the ground surface, including two existing trenches, was visually inspected. The survey did not result in the identification of cultural resources (Holman 1989a).

S-11763

Conducted in 1989, this reconnaissance field survey included the Study Area and the APE for the purpose of identifying built environment resources over 45 years old. Several buildings were identified, but they were not recorded on DPR 523 forms or evaluated for listing in the NRHP (Holman 1989b).

S-26851

Archaeological monitoring was conducted in 2003 within the southern portion of the APE. The monitoring resulted in the identification of one cultural resource, CA-CCO-753H (Stege Marsh Seawall) within the APE. Subsurface portions of CA-CCO-753H may still be present and buried to the west of the 2004 excavation. However, this resource was evaluated and recommended ineligible for listing in the NRHP and CRHR (Hatoff et al. 2003).

Cultural Resources

As a result of the 29 cultural resources investigations conducted within 0.25 mile of the APE, seven cultural resources, including five prehistoric shellmounds and a historic-period pier and seawall, were recorded. One of these cultural resources, CA-CCO-157 (Loud's No. 299) is located within the Study Area and several others are located within close proximity to the Study Area (Table 2) (Figure 6). Subsurface remnants of CA-CCO-753H (Stege Marsh Seawall) are located within the APE but have been evaluated and recommended as ineligible for listing in the NRHP and CRHR.

Table **2**. Previously Recorded Cultural Resources Located within 0.25 Miles of the APE.

Trinomial/ Primary No.	Resource Name	Resource Type/Age	Proximity to the APE and Survey Area	NRHP Eligibility Status
CA-CCO-157/ P-07-000099	Loud's No. 299	prehistoric shellmound	Within the Study Area, adjacent to the APE	Not evaluated
CA-CCO-297/ P-07-000174	Nelson's No. 297	prehistoric shellmound	Outside the APE, approx. 0.16 mile to the west	Not evaluated
CA-CCO-298/ P-07-000175	Nelson's No. 298/Loud's No. 298	prehistoric shellmound	Outside the Study Area and APE, approx. 0.18 mile to the west	Not evaluated
CA-CCO-299/ P-07-000176	Nelson's No. 299/Loud's No. 297	prehistoric shellmound	Outside the Study Area and APE, approx. 0.08 mile to the west	Not evaluated
CA-CCO-300/ P-07-000177	Nelson's No. 300/Loud's No. 300	prehistoric shellmound	Outside the Study Area and APE, approx. 0.10 mile to the west	Not evaluated
CA-CCO-754H/ P-07-002555	Stege Marsh Pier/Richmond Field Station Pier/California Cap Company Pier	Wood pier (late 19th or early 20th century)	Outside the Study Area and APE, approx. 50 feet to the south	Not evaluated
CA-CCO-753H/ P-07-002591	Stege Marsh Seawall	Seawall (late 19th or early 20th century)	Remnants located within the APE	Recommended ineligible

The following discussion provides information regarding the known resources located within the Study Area and the APE:

CA-CCO-157 (Loud's No. 299)
In 1915, L. L. Loud originally recorded this resource as an approximate 350-foot wide by 250-foot long shellmound situated on the end of a slough around 800 feet from the San Francisco Bay's historic shoreline. What remains of this resource is currently located underneath a warehouse and paved parking lot at 3200 Regatta Boulevard in Richmond (Banks 1985a). This resource is located within the Study Area but outside of the APE.

CA-CCO-753H (Stege Marsh Seawall)
Constructed in the late 19th or early 20th centuries, this segment of the Stege Marsh Seawall consists of an approximate 18-foot long wood beam mounted in place by two sets of round wood poles. Seventeen 1-foot by 3-inch wood planks form the back of the seawall. According to the monitoring report (S-26851), the other portion of the seawall has been dismantled (Lee 2002a). This resource was located within the Study Area and the APE, and subsurface portions of it may still be present and buried. This resource was evaluated and recommended ineligible for listing in the NRHP and CRHR (Hatoff et al. 2003).

HISTORIC MAP REVIEW

Historic maps showing features such as towns, railways, wagon roads, creeks, rivers, power lines, and reclamation and irrigation districts were reviewed in order to provide additional information to assess the sensitivity for the presence of historic-period resources within the Study Area and the APE. Historic maps were available at various online archives, such as the David Rumsey Map Collection and Calisphere. Results of the historic map review depict a historic period road system and railroad spurs within the Study Area and the APE. These roads and railroad are mapped on the 1947, 1959, and 1968 Richmond USGS topographic maps. These historic roads appear to be associated with the development of the explosive manufacturing plant in the late 19th or early- to mid-20th centuries and will be addressed as a part of the built environment analysis (Tetra Tech 2013a).

GEOARCHAEOLOGICAL ANALYSIS

Background research included a review of geology maps for archaeological and environmental information regarding the geology underlying the Study Area and the APE (Figure 5). This information was used to assess the sensitivity of the APE for buried archaeological resources, along with an understanding of the distribution and environmental setting of archaeological sites recorded nearby. Figure 5 illustrates that the APE is underlain primarily by Holocene aged alluvial deposits that were once along the San Francisco Bay shoreline. In addition, due to the proximity of the former bay shoreline, abundance of natural marine and estuarine resources, and the documented prehistoric shellmounds recorded within and adjacent to the Study Area, there is a clear sensitivity of the Study Area and APE for the presence of buried and at or near surface prehistoric archaeological sites.

NATIVE AMERICAN CONSULTATION

As part of the consultation process with Native American organizations and individuals, GANDA archaeologist Cassidy DeBaker, M.A., contacted the Native American Heritage Commission (NAHC) on January 24, 2013. DeBaker requested information about sacred lands that may be within the Study Area and APE and a list of interested Native American groups and individuals for Alameda County (Appendix A). To date, a response has not been received from the NAHC.

5.0 FIELD METHODS AND RESULTS

SURVEY METHODS

On January 24, 2013, archaeologist Kruger Frank, B.A., conducted a pedestrian survey of the approximately 16-acre APE, within the larger Study Area (Figure 3). The survey location was identified on an aerial map provided by Tetra Tech. Approximately 70 percent of the 16 acres is developed, consisting of buildings, roads, parking lots, and a large stock pile of soil. The remaining 30 percent of land consists of a large grassy field, lawns, landscaping, dirt driveways/parking lots, and wetlands. A small southern portion of the APE was inaccessible, because it was located within a fenced area marked with signs for hazardous waste and habitat restoration areas. K. Frank used conventional survey methods adapted to accommodate the undeveloped areas of the surrounding environment. K. Frank surveyed all land that was not paved or developed using two to five meter transects, roughly north to south. Some areas were spot-checked with a trowel, and gopher holes and recent ground disturbances were thoroughly inspected. The ground visibility was between 5 to 10 percent in the undeveloped portions of the APE, and the soil consisted of fill with the presence of some native black silty loam. K. Frank used a sub-meter accurate Trimble GXT hand held Global Positioning System (GPS) unit to take control points in the APE and to map the location of one isolated historic period bottle and two stands of Eucalyptus trees identified during the survey. In addition, K. Frank documented the APE using a digital camera.

SURVEY RESULTS

As a result of the field survey, no previously recorded or newly identified prehistoric archaeological resources were observed. Remnants of the previously recorded historic period resource within the APE, CA-CCO-753H (Stege Marsh Seawall) were not relocated. In addition, this area was inaccessible due to fact that it is located in the fenced area marked as hazardous waste and habitat restoration. The survey did result in the identification of two previously unrecorded historic period resources, including two stands of Eucalyptus trees, GANDA-622-01 (Figure 7), and one isolated bottle, GANDA-ISO-622-01 (
Figure 8), which were identified within the APE and are described below. DPR 523 forms have been prepared for these resources and are presented in Appendix B.

<u>GANDA 622-01 (Eucalyptus Stands 1 and 2)</u>
This landscape feature consists of two historic period Eucalyptus stands located within the APE (Figure 7). Eucalyptus Stand 1 is located on the east side of the APE, along the east side of S. 46th Street (Egret Way). Eucalyptus Stand 2 is located on the northwest side of the APE, east of Avocet Way. According to the technical report for the Richmond Field Station Remediation Project (S-26851), Richard Stege purchased 600 acres of land and established an estate in 1876. Around the same time, chemical and explosive companies also began buying land in the area and constructing manufacturing plants. In 1880, the California Cap Company was established at the Stege property, and trees were planted to serve as a buffer between the manufacturing facility and nearby residents (Hatoff et al. 2003). It is possible that the Eucalyptus stands are the same trees planted in the 1880s. The University purchased the property in 1950s and reused many of the existing buildings (Hatoff et al. 2003). It also may have retained the Eucalyptus stands.

Figure 7. View south toward Eucalyptus Stand 1 along Egret Way (left) and view northeast toward Eucalyptus Stand 2 from Avocet Way (right).

GANDA ISO-622-01

This isolated resource consists of a late 19th to early 20th century complete aqua whiskey bottle, which was identified in the southern portion of the APE, on the south side of Building 110 (Figure 8). The bottle was not collected during the field survey.

Figure 8. Photograph of GANDA ISO-622-01.

6.0 FINDINGS STATEMENT

As per the requirements of Section 106 of the NHPA and 36 CFR 800.4 and CEQA [Title 14 CCR 15064.5], this report presents the results of an archaeological inventory of the Study Area and APE. This investigation resulted in the identification of two newly identified historic period resources within the APE: 1) GANDA-622-01 (Eucalyptus Stands 1 and 2), which are likely associated with extant historic period buildings; and 2) GANDA-ISO-622-01, an isolated historic period bottle. It is recommended that GANDA-622-01 (Eucalyptus Stands 1 and 2) be evaluated for its potential eligibility for listing in the NRHP in conjunction with the extant historic structures as these landscape features are associated with those buildings and part of the overall historic landscape of the APE. As an isolated artifact that lacks association within the larger historic context of the APE, this resource is not potentially eligible for listing in the NRHP.

No prehistoric archaeological resources have been identified within the APE. However, much of the ground surface within the APE is obscured by historic and modern development. In the Study Area, there is one previously recorded prehistoric shellmound that is also currently obscured by buildings. In addition, there are three other previously recorded prehistoric shellmounds recorded within adjacent to the Study Area, and the geoarchaeological analysis and environmental setting of the APE and Study Area indicate that the APE has a very high sensitivity for buried, surface, or near surface prehistoric resources. Prior to ground disturbance within the APE, it is recommended that a testing program be conducted to complete the identification of prehistoric resources within the horizontal and vertical APE. In addition, based on the results of the background research, understanding of the historic use of the APE, and the identification of historic period materials and landscape features within the APE, there appears to be sensitivity for the presence of historic period archaeological resources, but not the degree that additional identification efforts are recommended.

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2012 http://alabamamaps.ua.edu/historicalmaps/us_states/california/topos/15index.htm (last accessed in February 2013).

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Appendix A

Native American Correspondence

GARCIA AND ASSOCIATES 1 SAUNDERS AVENUE PHONE 415.458.5803
SAN ANSELMO, CA 94960 FAX 415.458.5829

January 24, 2013

Native American Heritage Commission
915 Capitol Mall, Room 364
Sacramento, CA 95814
(916) 653-4082 (office)
(916) 657-5390 (fax)
nahc@pacbell.net

Subject: Cultural Resources Study for the Richmond Field Station

Dear Native American Heritage Commission,

Garcia and Associates (GANDA) is conducting a cultural resources investigation for the Richmond Field Station Project in Contra Costa County to determine if the project might affect any cultural resources. Please review the Sacred Lands File for any Native American cultural resources that may be within or adjacent to the project area. The project area is located in Sections 19 and 20, Township 01 North, Range 04 West of the Richmond (1993) CA 7.5 minute USGS Quadrangle (please see attached map).

We also request a list of Native American individuals and organizations that may have knowledge of cultural resources in the project area. If you have any questions, please contact me at the address and phone number above or via email (cdebaker@garciaandassociates.com). I look forward to hearing from you.

Thank you.

Sincerely,

Cassidy DeBaker, Archaeologist
415.458.5803 office
415.250.1687 cell
Garcia and Associates

Attachments (1)

GANDA

Appendix B

Department of Parks and Recreation (DPR) 523 Forms

State of California - The Resources Agency DEPARTMENT OF PARKS AND RECREATION **PRIMARY RECORD**	Primary # HRI # Trinomial: NRHP Status Code	
Other Listings Review Code	Reviewer	Date

 ***Resource Name or #:** GANDA 622-01 (Eucalyptus Stands 1 and 2)

P1. Other Identifier:

***P2. Location:** ☒ **Not for Publication** ☐ **Unrestricted** ***a. County** Contra Costa

***b. USGS 7.5' Quad** Richmond, Calif. **Date** 1995 **T**3S **; R**5W **;** SE ¼ NW ¼ and SW ¼ NW ¼ **of Sec** 20; Mount Diablo **B.M.**

c. Address 1301 South 46th Street **City** Richmond **Zip** 94804

d. UTM: Zone 10N; *NAD 83:* 558553mE/4196376mN (north end of Stand 1) 558380mE/4196466mN (north end of Stand 2)

e. Other Locational Data: From the entrance station of the Berkeley Field Station on Seaver Avenue (Owl Way), continue east on Seaver Avenue for 700 feet until reaching South 46th Street (Egret Way). To reach Stand 1, make a left and continue south down South 46th Street for approximately 0.30 mile and stop at the intersection of Lark Way (Commodore Drive) and South 46th Street. To reach Stand 2, continue west (right) on Lark Way for approximately 560 feet and stop at Seaver Avenue. From here continue on foot south for approximately 100 feet.

***P3a. Description:** This historic-period resource consists of two stands of Eucalyptus trees (Stand 1 and Stand 2), which are located in the northeast and northwest portions of the project area. Stand 1 is located in the northeast portion of the project area starting on the south side of Lark Way (Commodore Drive) and continuing more than 700 feet along the east side of South 46th Street (Egret Way). Stand 2 is located in the northwest portion of the project area also starting on the south side of Lark Way (Commodore Drive) and continuing more than 270 feet south parallel to Avocet Way. Both tree stands represent landscape features that are likely associated with the California Cap Company.

***P3b. Resource Attributes:** AH3. Landscaping/orchards

***P4. Resources Present:** ☐Building ☐Structure ☐Object ☒Site ☐District ☐Element of District ☐Other (Isolates, etc.)

P5a. Photograph:

P5b. Description of Photo:
Overview of the northern extent of Eucalyptus Stand 1, facing south along South 46th Street (Egret Way).

***P6. Date Constructed/Age and Sources:** ☒Historic ☐Prehistoric ☐Both

***P7. Owner and Address:**
University of California, Berkeley
Berkeley, CA 94720

***P8. Recorded by:**
Kruger Frank
Garcia and Associates (GANDA)
1 Saunders Avenue
San Anselmo, CA 94960

***P9. Date Recorded:** January 24, 2013

***P10. Survey Type:** Pedestrian Survey

***P11. Report Citation:**
Garcia and Associates (GANDA). Draft Cultural Resources Inventory and Evaluation Report for the Richmond Bay Campus Project, Richmond, Contra Costa County, California. Prepared for Tetra Tech. February 2013.

***Attachments:** ☐NONE ☒Location Map ☐Sketch Map ☒Continuation Sheet ☐Building, Structure, and Object Record ☒Archaeological Record ☐District Record ☐Linear Feature Record ☐Milling Station Record ☐Rock Art Record ☐Artifact Record ☐Photograph Record ☐ Other

ARCHAEOLOGICAL SITE RECORD

 ***Resource Name or #:** GANDA 622-01 (Eucalyptus Stands 1 and 2)

***A1. Dimensions:** Tree Stand 1: **a. Length** 770 feet (N-S) × **b. Width** 30 feet (E-W)
Tree Stand 2: **a. Length** 300 feet (N-S) × **b. Width** 30 feet (E-W)

Method of Measurement: ☐ Paced ☐ Taped ☐ Visual estimate ☒ Other: GPS data collected with a Trimble Geo XT.

Method of Determination: ☐ Artifacts ☒ Features ☐ Soil ☐Vegetation ☐ Topography
☐ Cut bank ☐ Animal burrow ☐ Excavation ☐Property boundary ☐ Other (Explain):

Reliability of Determination: ☒ High ☐ Medium ☐ Low Explain:

Limitations: ☒ Restricted access ☒Paved/built over ☒ Site limits incompletely defined
☐ Disturbances ☐ Vegetation ☐ Other (Explain):

A2. Depth: ☒None ☐ Unknown Method of Determination: Monitored excavation.

***A3. Human Remains:** ☐ Present ☐ Absent ☒Possible ☐Unknown (Explain):

***A4. Features:**

Tree Stand 1: This historic-period landscape feature consists of approximately 250 mature eucalyptus trees that are located on intersection of South 46th Street (Egret Way) and Lark Way. The stand of eucalyptus trees are planted in three rows and start on the south side of Lark Way (Commodore Drive) and continue south on the east side of South 46th Street for approximately 800 feet. The overall width of the tree rows are approximately 30 feet. Most of the trees are greater than 4 feet wide and approximately 100 feet tall.

Tree Stand 2: This historic-period landscape feature consists of approximately 100 mature eucalyptus trees that are located east of Building 276 and run parallel north-south along Avocet Way. The stand of eucalyptus trees are planted in three rows and is approximately 30 feet wide. The overall length of the Eucalyptus Stand 2 is approximately 300 feet. Most of the trees are greater than 4 feet wide and are approximately 100 feet tall.

***A5. Cultural Constituents:** No artifacts were noted.

***A6. Were Specimens Collected?** ☒ No ☐ Yes

***A7. Site Condition:** ☐Good ☒ Fair ☐ Poor:

***A8. Nearest Water:** San Francisco Bay is approximately 200 meters south of Stand 1.

A9. Elevation: 5.6 meters amsl.

A10. Environmental Setting: The features are located in a highly industrialized area that is located on the former mash lands of the San Francisco Bay. The surrounding environment consists of industrial and commercial buildings and other built environment features, such as sidewalks, driveways, and roads.

A11. Historical Information: The two stands of eucalyptus trees are likely associated with the California Cap Company, which acquired the property in 1880. It built a manufacturing plant with over 150 buildings as well as trees to protect nearby residents in the event of an explosion. In 1950, the University of California (UC) purchased the property from the California Cap Company and allowed the College of Engineering at the UC Berkeley campus to use it for off-site research. It renamed the property as the Richmond Field Station, remodeled existing buildings, and also constructed several new buildings to house administrative offices or specific research projects (Hatoff et al. 2003). It is possible that the eucalyptus stands are the same trees planted in the 1880s. Both stands of trees are parallel to roads that may have replaced earlier railroad spurs, which can be identified on the 1947 Richmond, California topo map (USGS 1947).

***A12. Age:** ☐ Prehistoric ☐ Protohistoric ☐ 1542-1769 ☐ 1769-1848 ☒ 1848-1880 ☒ 1880-1914 ☐ 1914-1945
☐ Post 1945 ☐ Undetermined

A13. Interpretations: Based on the overall size of the eucalyptus trees in both stands, it is more than likely that the trees are more than 100 years old and likely associated with the California Cap Company.

A14. Remarks: None

A15. References:

Hatoff, Brian, Christopher Lee, and Jessica Kusz
2003 Richmond Field Station Remediation Project—Subunit 2A, Cultural Resources Monitoring Program for 2002, Technical Report. Prepared by URS Corporation. Prepared for University of California, Berkeley (S-26851).

United States Geological Survey (USGS)
1947 USGS *Richmond, California* 7.5-minute topographic quadrangle.

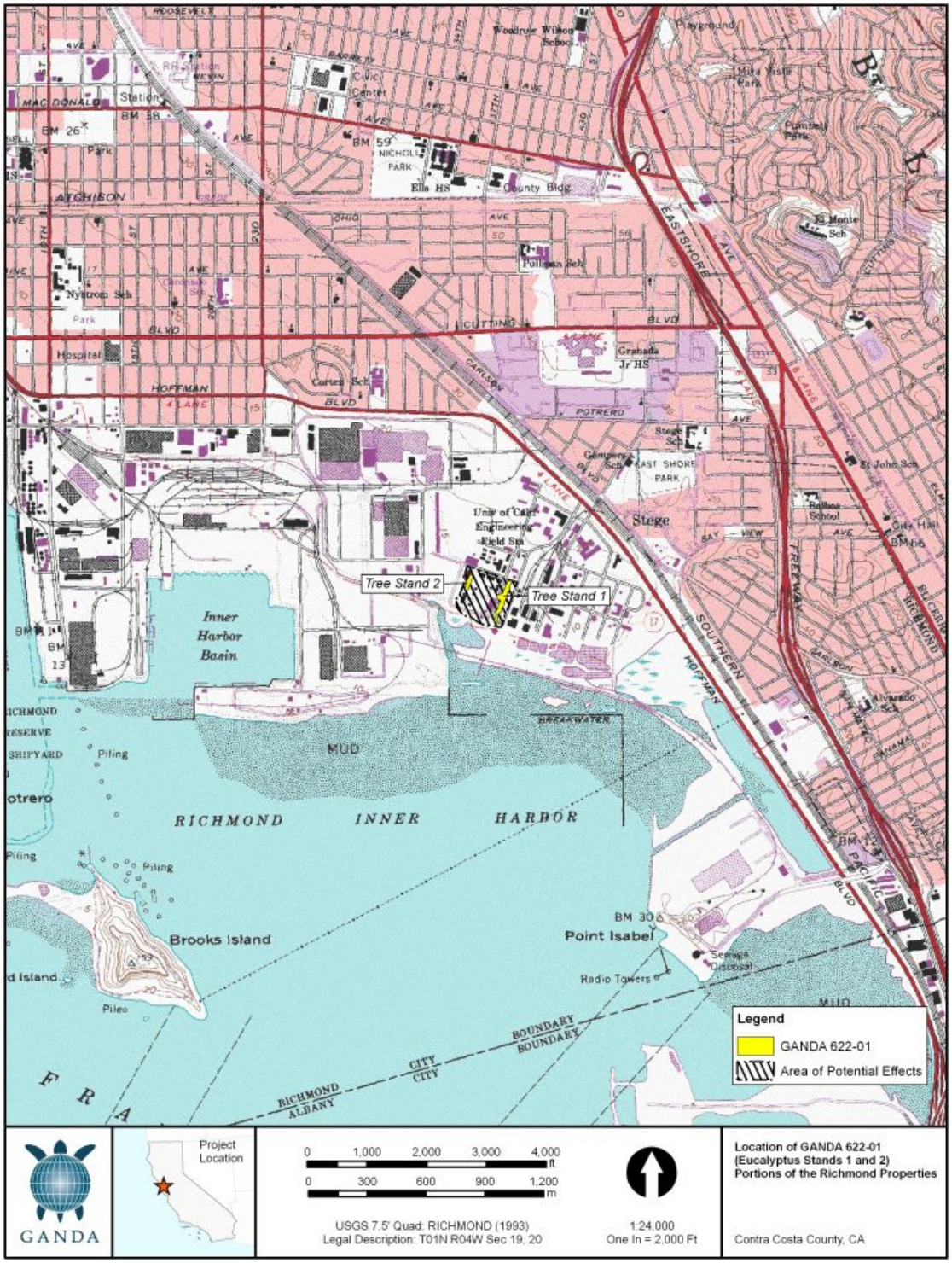
A16. Photographs:
Original Media/Negatives Kept at: Garcia and Associates, San Anselmo office.

***A17. Form Prepared by:** Kruger Frank **Date:** January 24, 2013
Affiliation and Address: Garcia and Associates, 1 Saunders Avenue, San Anselmo, CA 94960

State of California — The Resources Agency DEPARTMENT OF PARKS AND RECREATION **LOCATION MAP**	Primary # HRI# Trinomial

 ***Resource Name or #:** GANDA 622-01 (Eucalyptus Stands 1 and 2)

***Map Name:** *Richmond, California*, USGS 7.5-minute topographic quadrangle ***Scale:** 1:24000 ***Date of Map:** 1993



Additional Photographs:

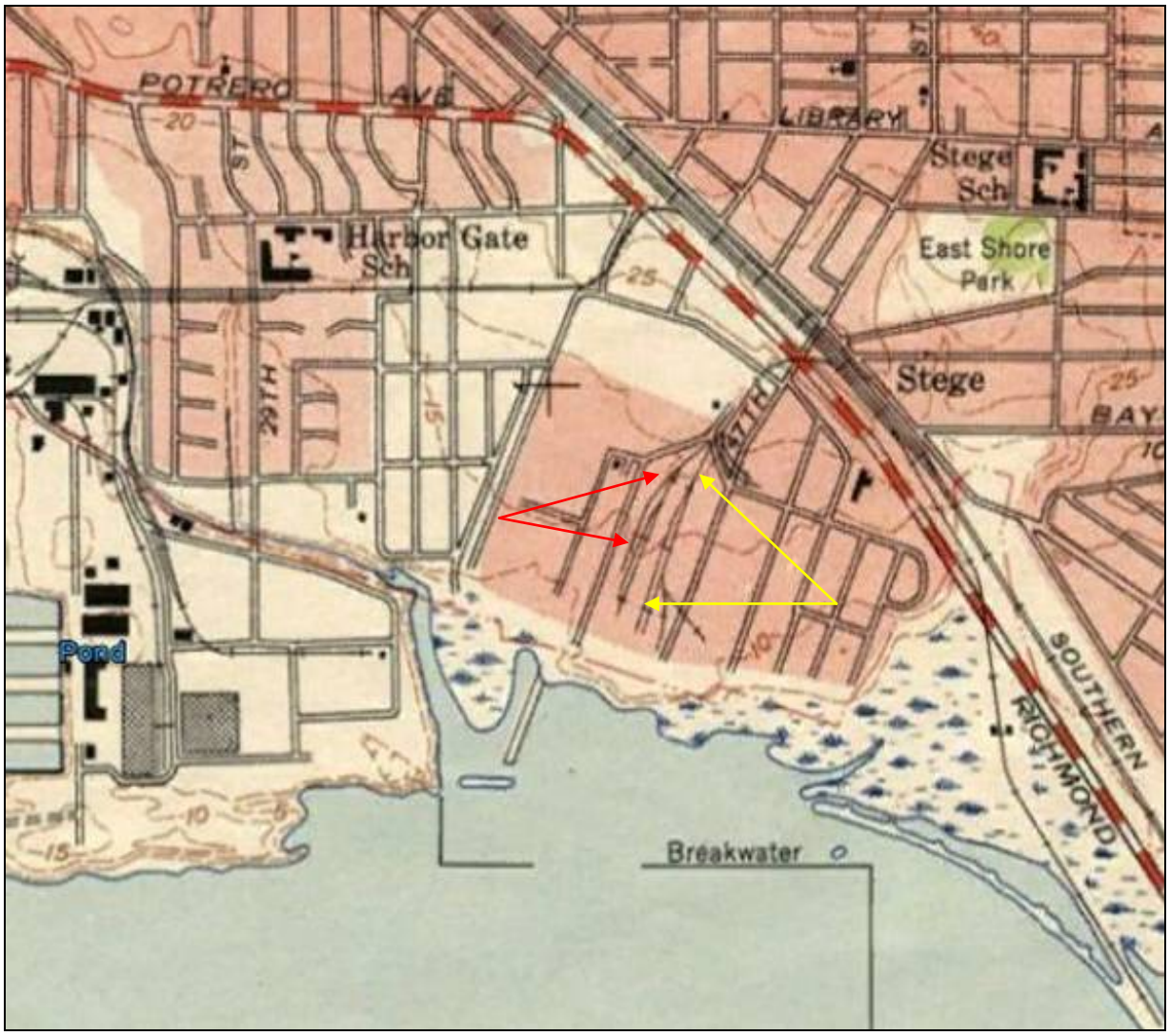
Overview of Stand 1, facing north on South 46th Street (Egret Way).

.

Close-up of relative size of eucalyptus trees at Stand 1, facing south.

Overview of Stand 2 facing south from Lark Way (Commodore Drive).

Overview of Stand 2 facing north.



Detail from the 1947 Richmond, California, 7.5-minute topographic map showing the approximate location of Stand 1 (yellow arrows) and Stand 2 (red arrows) in relation to the non-extant railroad spurs.

Aerial map depicting GANDA 622-01 (Eucalyptus Stands 1 and 2).

State of California - The Resources Agency DEPARTMENT OF PARKS AND RECREATION **PRIMARY RECORD**	Primary # HRI # Trinomial: NRHP Status Code	
Other Listings Review Code	Reviewer	Date

Page 1 **of** 3 ***Resource Name or #:** GANDA ISO-622-01

P1. Other Identifier:

***P2. Location:** ☒ **Not for Publication** ☐ **Unrestricted** ***a. County** Contra Costa

***b. USGS 7.5' Quad** Richmond, Calif. **Date** 1993 **T1N ; R**4W **; SW ¼ NW ¼ of Sec** 20 **B.M.** Mount Diablo

c. Address 1301 South 46th Street **City** Richmond **Zip** 94804

d. UTM: Zone 10N; *NAD 83:* 558472mE/4196303mN

e. Other Locational Data: From the entrance station of the Berkeley Field Station on Seaver Avenue (Owl Way), continue east on Seaver Avenue for 700 feet until reaching South 46th Street (Egret Way). Make a left and continue south down South 46th Street for approximately 0.40 mile. Park in front of Building 102 and follow the sidewalk to Building 110 to the west. The isolate is located on the south side of Building 110 at base of the wood fence.

***P3a. Description:** This historic-period resource consists of an isolated aqua whiskey bottle, which was identified along the east side of a wood fence between Building 102 and Building 110. The bottle exhibits a tooled whiskey finish that is chipped slightly and still retains the original cork. The body of the bottle exhibits numerous air bubbles and waves. The base of the bottle exhibits a slight kick-up and no maker mark. The bottle was likely manufactured in a turn mold, because there is no evidence of mold seams. The overall measurement of the bottle is 12 inches in height by 3 inches wide. The base is 2 5/8 inches wide. The bottle is likely from the late 19th century to the early 20th century, which would fit into the early days of operations of the California Cap Company.

***P3b. Resource Attributes:** AH4. (trash scatter)

***P4. Resources Present:** ☐Building ☐Structure ☐Object ☐Site ☐District ☐Element of District ☒Other (Isolates, etc.)

P5a. Photograph:

P5b. Description of Photo:
Overview of isolate location, facing west.

***P6. Date Constructed/Age and Sources:** ☒Historic ☐Prehistoric ☐Both
Likely manufactured during the late 19th century to the early 20th century

***P7. Owner and Address:**
University of California, Berkeley
Berkeley, CA 94720

***P8. Recorded by:**
Kruger Frank
Garcia and Associates (GANDA)
1 Saunders Avenue
San Anselmo, CA 94960

***P9. Date Recorded:** January 24, 2013

***P10. Survey Type:** Pedestrian Survey

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***Attachments:** ☐NONE ☒Location Map ☐Sketch Map ☒Continuation Sheet ☐Building, Structure, and Object Record ☐Archaeological Record ☐District Record ☐Linear Feature Record ☐Milling Station Record ☐Rock Art Record ☐Artifact Record ☐Photograph Record ☐ Other

State of California — The Resources Agency DEPARTMENT OF PARKS AND RECREATION **LOCATION MAP**	Primary # HRI# Trinomial

 ***Resource Name or #:** GANDA ISO-622-01

***Map Name:** *Richmond, California*, USGS 7.5-minute topographic quadrangle ***Scale:** 1:24000 ***Date of Map:** 1993

Additional Photographs:

Detail of the aqua whiskey bottle.

Detail of the bottle neck.

Detail of the tooled whiskey finish and view of cork closure.

Detail of the wavy glass and air bubbles on the body and view of slight kick-up on base.

Historic Properties Survey Report for Portions of the Richmond Field Station Richmond, California

June 2013

Prepared for:

University of California

Prepared by:

Tetra Tech, Inc.
1999 Harrison Street, Suite 500
Oakland, California 94612

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A DPR 523 Forms
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1. SUMMARY

Tetra Tech, Inc. conducted historical evaluations of the 25 buildings[1] in the proposed "Phase 1" area of the Richmond Field Station during January 2013 and of an additional 9 buildings in the area of potential effects (APE) in April 2013. Of these, 32 buildings were evaluated in terms of their eligibility for listing in the National Register of Historic Places (NRHP) and the California Register of Historical Resources (CRHR) and for their eligibility for listing as a historic district. Two of the buildings in the APE are not yet of historic age (45 years under CEQA and 50 years for the NRHP); so Tetra Tech recorded these buildings on DPR 523A forms, but did not evaluate them for historic significance. The evaluation was done in accordance with Section 106 of the National Historic Preservation Act and the implementing regulations found in 36 Code of Federal Regulations (CFR) Part 800, and in accordance with Section 15064.5(a)-(b) of the California Environmental Quality Act (CEQA) Guidelines applying the criteria outlined in Section 5024.1 of the California Public Resources Code. Tetra Tech, Inc. prepared this Historic Properties Survey Report (HPSR) to document the evaluation of the 25 buildings in the Phase 1 footprint and an additional 7 buildings in the larger APE.

This report does not include the study of pre-historic or historic archaeological resources in or near the project area; a separate cultural resource inventory report has been prepared to identify archaeological resources.

The results of the survey indicate that 32 of the 34 buildings do not meet the eligibility criteria for listing in the NRHP or the CRHR and should not be considered historic properties or historic resources either individually or as a historic district. Buildings 150 and 175 should be considered individually eligible for listing under NRHP Criterion A and CRHR Criterion 1 for their association with the California Cap Company and the period of explosives innovation and production in the East Bay. Although both buildings are associated with the California Cap Company, two buildings do not possess a concentration of buildings, structures, or objects sufficient to constitute a historic district.

[1] These buildings are within a parcel proposed for development. There are an additional 59 buildings at the Richmond Field Station, some of which are of historic age and may be eligible for listing in the National Register of Historic Place or the California Register of Historical Resources.

2. PROJECT DESCRIPTION

2.1 PROJECT LOCATION

The Richmond Field Station is adjacent to San Francisco Bay in the City of Richmond in Contra Costa County (Figure 1). The project area is in the southern portion of the Richmond Field Station (Figure 2).

2.2 PROPOSED PROJECT ACTIVITIES

The US Department of Energy (DOE) proposes to relocate and consolidate some of its off-site Lawrence Berkeley National Laboratory (LBNL) research activities to a new 110,000 to 150,000 gross-square-foot facility that DOE would construct on the 16-acre Phase 1 portion of the Richmond Field Station. DOE may also choose to occupy additional facilities that may be constructed by others at approximately the same time as the DOE building construction. Construction would occur over 4 years from 2014-2018.

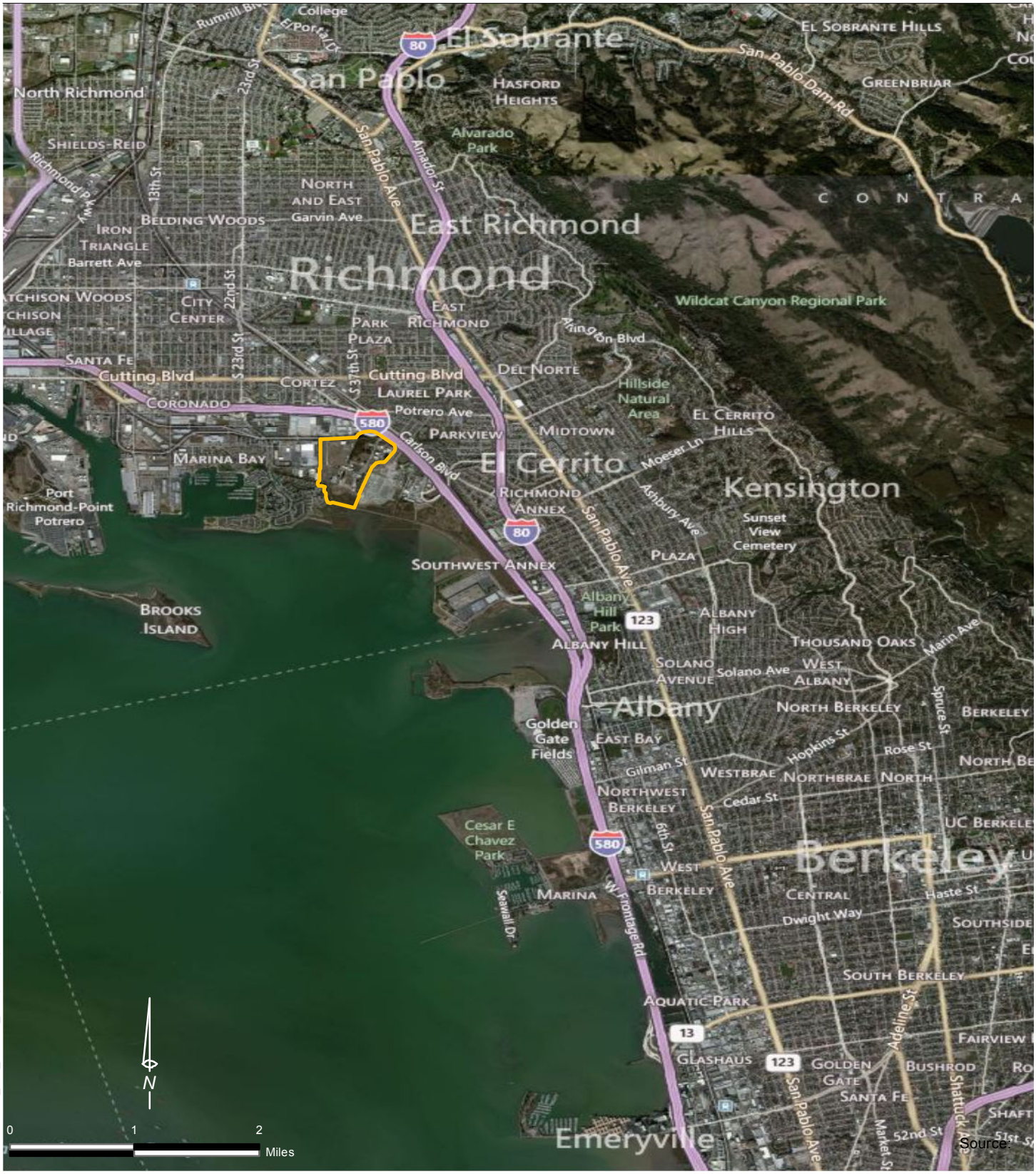
Once constructed, research at these new facilities would initially focus on cleaner biofuel development processes; an advanced understanding of the genomics of plants, microbes, and microbial communities; production of non-petroleum based essential materials and chemicals; advanced diagnostic equipment and techniques for bioscience; industrial process development; and cancer research. Existing research programs at the Richmond Field Station in sustainable transportation and earthquake engineering, among others, would continue.

Prior to construction, the 25 existing structures in the Phase 1 area, totaling approximately 107,000 gross square feet (gsf), would be demolished. Construction activities would include rerouting utilities, demolishing buildings, removing trees, landscaping, earthwork, installing utilities and stormwater infrastructure, constructing roads and parking lots, and constructing three new facilities totaling approximately 600,000 gsf. These buildings would include one three-story facility with 110,000 to 150,000 gsf, one two-story facility with 110,000 to 150,000 gsf, and one three- to four-story facility with up to 300,000 gsf.

2.3 RESEARCH METHOD

On January 4, 2013, Tetra Tech Historians/Architectural Historians inventoried and photographed the 25 buildings that are in the Phase 1 footprint. Tetra Tech researched specific buildings and the land use history of the Richmond Field Station at several repositories including the Contra Costa Historical Society archive, the Doe Memorial Library, the Earth Sciences and Map Library at UC Berkeley, and the Oakland Public Library's Oakland History Room.

On April 30, Tetra Tech's Historians/Architectural Historians inventoried and photographed the nine APE buildings across Lark Drive from the 25 buildings



R:\NEW\29511_LBL_Second_Campus\Maps\PPD\\RegionalLocation.mxd

Source:

Regional Location

Legend

Richmond Field Station

Richmond, California

TETRA TECH

Figure 1

Project Area

Project Area

Richmond, California

TETRA TECH

Figure 2

Source: Esri, DigitalGlobe, GeoEye, i-cubed, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, and the GIS User Community

R:\NEW\29511_LBL_Second_Campus\Maps\Survey Location.mxd 5/30/2013 YE

mentioned above. Seven of the nine buildings were recorded and evaluated for their historic significance. Two of the buildings, Buildings 198 and 201, have modern construction dates and were not evaluated for their historic significance.

Tetra Tech identified and prepared a historic context and identified themes under which each of the buildings would be evaluated under the CRHR and NRHP criteria on California Department of Parks and Recreation (DPR) 523 forms; the latter criteria applied because properties listed on or eligible for listing in the NRHP are automatically eligible for listing in the CRHR.

2.4 PAST HISTORIC EVALUATIONS

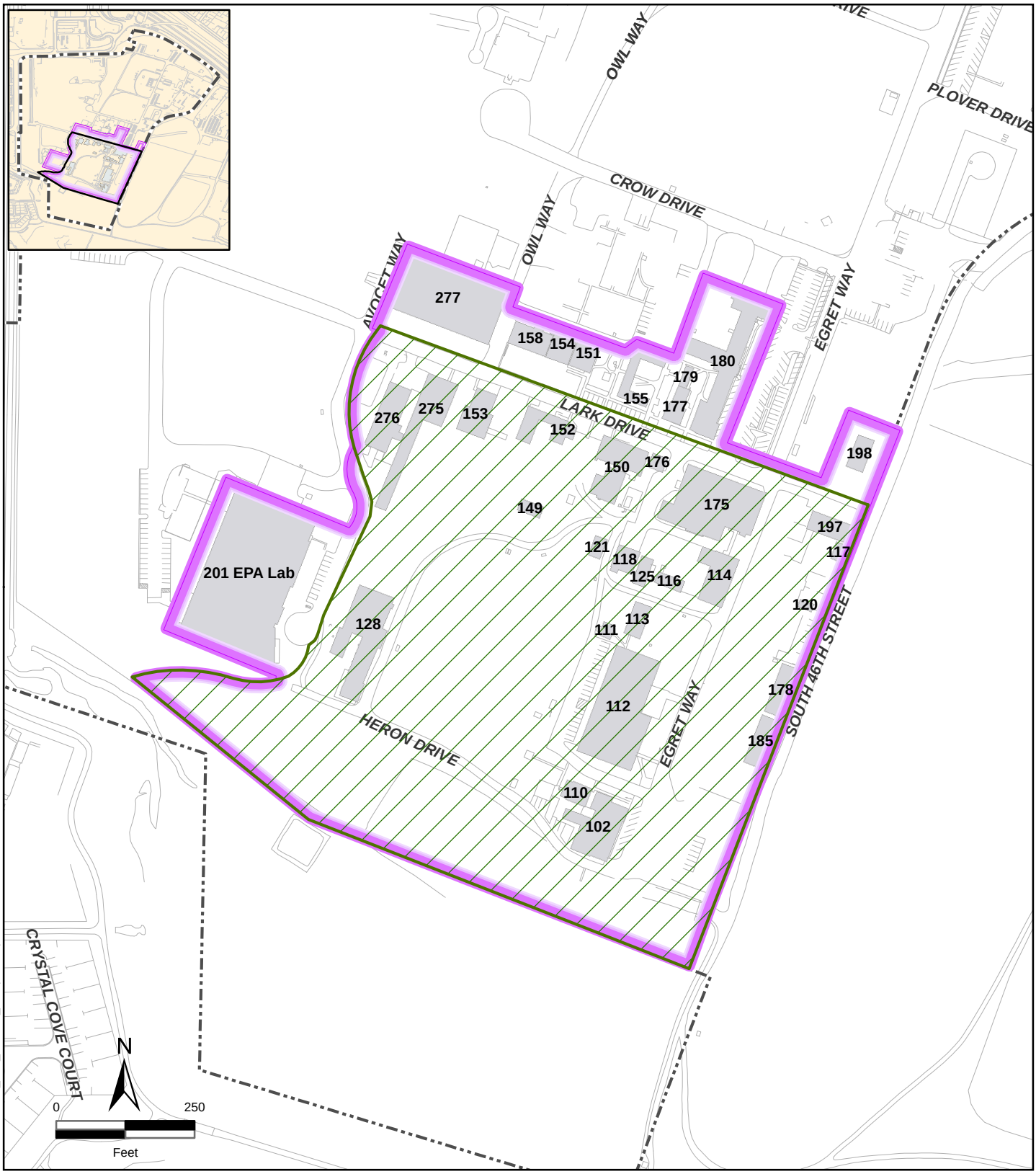
The Contra Costa County Historic Resources Inventory of 1976, updated in 1989 and 2010, lists the "California Cap Works" at 33rd Avenue and Hoffman Boulevard in Richmond as a structure of merit. This address is not within the "Phase 1" footprint, and the address and listing do not specify which building or structure at this address is included in the inventory. Contra Costa County Historical Landmarks Committee and the City of Richmond Planning Division staff explained that this inventory was conducted by local historical societies in 1976 to determine important local historical places, but that no formal evaluations were conducted for the California Cap Works buildings at 33rd Avenue and Hoffman Boulevard.[2] Listing in this inventory does not prescribe any protection to the buildings and structures listed and does not qualify them as historical resources included in a local register of historical resources, as defined in subsection 5020.1(k) of the Public Resources Code.

Holman and Associates surveyed the Richmond Field Station for cultural resources in 1989 as part of an Environmental Impact Report (Holman and Moser 1991). The boundaries for the Holman and Associates survey differed from the boundaries prescribed for this survey and Holman and Moser did not evaluate all the buildings in the current survey population using NRHP or CRHR criteria. The report simply identified that, at that time, the two buildings were over 50 years old.

2.5 AREA OF POTENTIAL EFFECTS

DOE, with assistance from Tetra Tech, established the direct APE (the area that would be directly impacted by proposed project activities) as the 16-acre project area that includes the 25 buildings to be demolished. The direct APE is bounded by South 46th Street, along Lark Drive, Avocet Way, and Heron Drive, as shown in Figure 3. The indirect APE includes the nine buildings to the north and northeast of Lark Drive and the EPA Laboratory building (Building 201) on Avocet Way. The proposed project could have indirect effects on these buildings.

[2] Christine Louie, Contra Costa County Historical Landmarks Committee personal communication with Kara Brunzell, Tetra Tech, Inc. March 11, 2013; Hector Rojas, City of Richmond Planning Division, personal communication with Kara Brunzell, Tetra Tech, Inc. March 11, 2013.



Historical Architectural Area of Potential Effects

DirectAreaPotentialEffects
Indirect Area of Potential Effects
Richmond Field Station Boundary
Road or Other Landscape Feature
Buildings

Richmond, California

TETRA TECH

Figure 3

R:\NEW\29511_LBL_Second_Campus\Maps\Area of Potential Effects.mxd 5/30/2013 - YE

Because Building 198 (constructed in 1981) and Building 201 (constructed in 1992) have not yet reached the 45-year (CRHR listing) or 50-year (NRHP listing) recommended age for eligibility, they were not evaluated for historic significance, but were recorded on DPR 523 A forms. Figure 3 shows the entire APE for historical architectural resources for the project. Table 1 lists the buildings in the direct APE, and those within the indirect APE are presented in Table 2.

Table 1
Buildings in the Direct APE

Building Number	Year Built	NRHP or CRHR Eligibility Finding
102	circa 1860	ineligible
110	circa 1910s	ineligible
111	1987	ineligible
112	1964	ineligible
113	1982	ineligible
114	circa 1930	ineligible
116	unknown	ineligible
117	unknown	ineligible
118	circa 1930s	ineligible
120	1967	ineligible
121	1982	ineligible
125	circa 1930	ineligible
128	circa 1930	ineligible
149	1982	ineligible
150	circa 1910	eligible
152	circa 1930s	ineligible
153	1959	ineligible
163	circa 1930/1963	ineligible
175	circa 1910	eligible
176	circa 1930s	ineligible
178	unknown	ineligible
185	unknown	ineligible
197	1975	ineligible
275	1956	ineligible
276	1956	ineligible

Table 2
Buildings in the Indirect APE

Building Number	Year Built	NRHP or CRHR Eligibility Finding
151	1961	ineligible
154	1958	ineligible
155	1953	ineligible
158	circa 1957	ineligible
177	circa 1920	ineligible
180	circa 1920	ineligible
198*	1981	ineligible
201*	1992	ineligible
277	1966	ineligible

*Buildings 198 and 201 are in the indirect APE but were not of historic age (45 years or older) at the time of the survey.

3. SURVEY POPULATION

3.1 DESCRIPTION OF THE BUILDINGS IN THE PHASE 1 FOOTPRINT (DIRECT APE)

3.1.1 Building 102

Building 102 is near the southern edge of the Richmond Field Station campus at the intersection of Heron Drive and Egret Way with its primary façade facing southeast. The 6,737 square-foot building is single story with an irregular plan. It was constructed circa 1860 and is currently used for research. The building has been altered since its original construction.

Building 102 was originally a produce warehouse with a rectangular plan at the corner of Heron Drive and Egret Way. When the Tonite Powder and California Cap companies were constructed along the waterfront in 1877, the warehouse was a crucial safety barrier between explosive powder and detonators. Agriculture continued to be an important local activity after the establishment of the explosive companies, and through the 1880s produce was stored in Building 102, along with explosives.[3] As the Tonite and California Cap Companies grew, less space was used for agricultural items, and the building was used entirely for California Cap Company products. By 1912, the company had its can factory and its warehouse in the building.[4] The California Cap Company labeled the building as Building 30. The California Cap Company constructed additional space on the northwest side of the building during the 1930s. During World War II, the building housed an assembly line for incendiary delayed-action bombs.[5]

After UC Berkeley's Department of Engineering took over the site in 1950, the Sanitary Engineering Research Laboratory (SERL) centered activities in and around the building and relabeled the Building 102. Professor H.B. Gotaas was in charge of SERL research during the early 1950s. Projects in the building included studies on composting, incineration, water reclamation, algae symbiosis, saltwater intrusion, and radioactive waste disposal.[6] Building 102 also housed SERL's library and administrative offices. The Department of Engineering altered the interior of the building to suit its purposes, and by the mid-1950s it housed "an unusually well-equipped chemistry and biology laboratory".[7]

Historic photographs indicate that the original building was side gabled, with its primary façade on Egret Way. The University made additions on the building four times after 1950, including construction of an addition projecting from the primary façade that has since been removed.[8] Alterations to the façade appear to have been made during the 1970s, when a flat roof replaced the original gabled roof over the

[3] Roland Oliver, "Recollections of Early Industries in Stege," August 7, 1959, p. 1.
[4] Sanborn Insurance Maps, Stege, California. 1912.
[5] Oliver, p. 1.
[6] University of California, Berkeley, Department of Engineering, "Richmond Field Station Open House," May 28, 1952, p. 1.
[7] University of California, Berkeley, Department of Engineering, "Guide for Engineering Field Station Inspection," undated, p. 7.
[8] Shackleton, 2013.

southeast wing of the building (Photographs 1 and 2). Facades on Egret and Heron Drive were altered with the replacement of stucco siding instead of wood. Windows are aluminum sashes. In 2013, the building uses include storage, a bioengineering office, and wet chemistry laboratory.

Photograph 1: Building 102, circa 1954, camera facing west.
On file at the Richmond Field Station archives

Photograph 2: Building 102, circa 1970, camera facing west.
On file at the Richmond Field Station archives

The majority of the building is topped with a flat roof, while other elements of the building's rear are topped with shed roofs. The main (southeast) façade features a broad eave overhang with large exposed roof rafters. There are several large plain columns along this elevation. Many of these columns show signs of moderate to severe deterioration. The building's walls are sided with stucco with wood trim and with horizontal wood siding. Fenestration is aluminum sliding sashes and double-hung, multi-light, wood-frame sashes. Three entrances on the primary elevation are at grade through metal swinging doors; two have windows. Another elevation features a wood paneled door with a window.

Photograph 3: Building 102
January 4, 2013, camera facing southwest

The building currently reflects the many changes of use and alterations performed over the years in its irregular footprint and multiple types of siding and fenestration (Photographs 4 and 5).

Photograph 4: Building 102, January 4, 2013, camera facing north

Photograph 5: Building 102, January 4, 2013, camera facing southwest

3.1.2 Building 110

Building 110 is near the southern edge of Richmond Field Station campus adjacent to Building 102 (Photograph 6). The vernacular building does not strongly express a particular architecture style. Constructed circa the 1910s, the building is 1,325 square feet, single story, with a rectangular plan and topped by a shallow pitch, front gabled roof. Its primary elevation faces southeast. Its moderate eaves feature exposed rafter tails on its northeast and southwest elevations. The walls are clad in horizontal wood siding. Fenestration is original, multi-light, double-hung, wood sashes. An original paneled wood entry door is centered in the southwest elevation, sheltered by a recessed entry porch and accessed by a set of wooden stairs. Plain entablature adorns the door and windows surrounding the otherwise unornamented building. An addition at the rear (northwest) of the building is topped by a shed roof. Its rear entrance is a wood paneled door with a window. This door is sheltered by a small awning and accessed by a set of wooden stairs. The building is surrounded by grassy areas, and access to the rear of the building is currently blocked by a wood fence to the south and a chain link fence to the north.

Building 110 was constructed by the California Cap Company circa the 1910s. The building was originally several hundred yards to the northeast of its current location, along Egret Way.[9] It was used as a research laboratory by the California Cap Company and labeled Building 65.[10]

After UC Berkeley's SERL took over the site in 1950, its activities were concentrated in the southeast section of the Richmond Field Station. Historic aerial photographs show that Building 110 was moved to its current location adjacent to Building 102 circa 1960 and was used for research using radioisotopes. [11] After it was moved, Building 110 housed laboratories and offices for SERL's successor, (EEHSL).[12] The building continued to be used for offices until 2008, but it is currently vacant.[13]

[9] University of California, Berkley, "Draft Environmental Impact Report, Proposed U.S. Environmental Protection Agency, Region IX Laboratory at the University of California's Richmond Field Station," Prepared by University of California, Berkeley Planning, Design and Construction Department, July 1991, p. 307.
[10] University of California, Berkeley, 2008, p.
[11] P.H. McGauhey, "The Sanitary Engineering Research Laboratory: Administration, Research and Consultation, 1950-1975 – An Interview Conducted by Malca Call," Regional Oral History Office, University of California, Berkeley, 1974, p. 71.
[12] Shackelton, 2013.
[13] University of California, Berkeley, 2008, p. 196.

Photograph 6: Building 110, January 4, 2013, camera facing south

3.1.3 Building 111

Building 111 is in the southern portion of the Richmond Field Station (Photograph 7). The utilitarian building does not express any particular architectural style. It is 507 square feet and was constructed in 1987. It is single story and rectangular in plan. The building is topped by a flat roof and constructed of concrete masonry units. It lacks fenestration, and its entrances are industrial-type metal doors on its northwest and southeast elevations.

Building 111 appears to have been constructed by UC Berkeley in 1987 on the site of an older building.[14] The land was the location of a storage shed for the California Cap Company "Building 148," that was removed prior to the construction of Building 111 that was constructed for hazardous materials storage.[15] The Watershed Project, a non-profit group whose offices are at the Richmond Field Station, has used the building for storage for the past several years.[16] The building is not of a historic age, as it was constructed 26 years ago.

[14] University of California, Berkeley, 2008, p. 196.
[15] University of California, Berkeley, 2008, p. 13.
[16] Shackleton, 2013.

Photograph 7: Building 111, January 4, 2013, camera facing northeast

3.1.4 Building 112

Building 112 is in the southern portion of the Richmond Field Station (Photograph 8). The rectangular, single-story, 16,949 square-foot building was constructed in 1964.

The building is topped with a flat roof. Its southeast (primary) and northwest (rear) elevations feature a broad eave overhang with large exposed roof rafters. The roof is supported by large plain columns. The walls are sided in stucco with wood trim. Primary fenestration is fixed and awning metal sashes, with vinyl replacement windows at the rear elevation. The primary entrance is a recessed glazed door with a transom and surround.

The building features landscaped areas in the front southeast side elevation that include mature trees along Egret Way. It is identified as the Center for Tissue Bioengineering. A small parking area is adjacent to its rear (northwest) elevation.

Building 112 was constructed in 1964 on the site of seven former California Cap Company buildings.[17] It is in the southeastern portion of the Richmond Field Station, where the early SERL activities were centered. The large building originally housed offices, classrooms, and laboratories.[18] It housed a wet chemistry laboratory as late as 2008, though at that time it was being phased out.[19] It is currently devoted to bioengineering and public health offices.[20]

[17] University of California, Berkeley, 2008, p. 149.
[18] University of California, Berkeley, 2008, p. 13.
[19] University of California, Berkeley, 2008, p. 25.
[20] Shackleton, 2013.

Photograph 8, Building 112, January 4, 2013, camera facing north

3.1.5 Building 113

Building 113 is in the southern portion of the Richmond Field Station. It is a 1,800 square-foot prefabricated building, constructed in 1982 (Photograph 9). It is single story and rectangular in plan.

The building is topped with a very shallow pitched gable roof with large vents in the gables. Its walls are corrugated steel and lack fenestration. An industrial metal entrance door is centered in its southwest elevation and its northwest elevation features a large roll-up door. The building has large vents in the walls near the ground. It is surrounded by a grassy area and shrubbery.

Building 113 was constructed in 1982 as a storage and support facility for SERL. The prefabricated steel building was assembled by Richmond Field Station maintenance workers, who also built its slab foundation.[21] Its use has continued unaltered. The building is 31 years old.

[21] University of California, Berkeley, File "Building 113," located in vertical files in Room 148, Richmond Field Station.

Photograph 9, Building 113, January 4, 2013, camera facing southeast

3.1.6 Building 114

Building 114 is in the southern portion of the Richmond Field Station on the west side of Egret Road (Photograph 10). Its primary façade faces northeast; it is an L-shaped, single story, with a one-and-one-half story wing, 4,523 square-foot building constructed circa 1930.

The one-and-one-half story building is topped with a front gabled roof that ties into a shed roof section at its southeast elevation. Rafter tails and purlins are exposed at the eaves. The walls and roof are of corrugated metal. Most of the fenestration is multi-light, fixed, wood sashes. The main entrance, centered in the northeast elevation, has a wood paneled and replacement industrial door, both with windows. There is a large sliding door at the east end of the elevation. The doors are accessed by a concrete loading dock that has a set of wooden stairs in front of the main entrance.

A single story, shed roof addition projects from the northwest end of the building. It features a large sliding door that faces northeast. Building 114, originally labeled "Building 81" was constructed circa 1930 by the California Cap Company or the Pacific Cartridge Company. It was adjacent to the Pacific Cartridge Company's factory and was a warehouse for the cartridges produced there. The original building was rectangular in plan, oriented along Heron Drive. After UC Berkeley purchased the property in 1950, it used the warehouse to store building materials for use in building maintenance on the property.[22] Aerial photographs show that the University constructed an addition at the northwest end of the building circa 1955. The building is currently used for the storage of building materials.

[22] Shackleton, 2013.

Photograph 10: Building 114, January 4, 2013, camera facing west

3.1.7 Building 116

Building 116 is in the southern portion of the Richmond Field Station (Photograph 11). It is 967 square feet and was moved to its present location in 1964. The single story building is a rectangular, Butler Company prefabricated building topped with a front gabled roof. The walls and roof are corrugated metal. Fenestration is multi-light, fixed metal sashes, some of which are wire sashes. The entrance at the south end of the southeast elevation is a paneled wood door with a window.

Building 116 was originally constructed on the UC Berkeley campus by the US Air Force. Its original construction date is unknown, but by 1961 it had outlived its purpose and the UC Regents decided to raze it. SERL had the building relocated to the Richmond Field Station at the end of 1961.[23] It has been used throughout its lifetime as a support and storage area.

[23] University of California, Berkeley, File "Building 116," located in vertical files in Room 148, Richmond Field Station.

Photograph 11: Building 116, January 4, 2013, camera facing west

3.1.8 Building 117

Building 117 is along the southeastern border of the Richmond Field Station (Photograph 12). It is a single story and rectangular in plan.

The building is topped with a front gabled roof that has exposed wood rafter tails and purlins at the eaves. The walls and roof are corrugated metal. Fenestration is fixed wood sashes. The entrance at the north end of the northwest elevation is double paneled wood doors with windows.

Building 117's construction date is unknown. Aerial photographs show it was moved to its present location circa 1990. Its materials indicate that it was constructed prior to 1950 during the California Cap Company era, but research failed to reveal its original use and location. It was used as a maintenance shop in the 1990s and is currently used for storage and support.[24]

[24] University of California, Berkeley, 2008, p. 196.

Photograph 12: Building 117, January 4, 2013, camera facing east

3.1.9 Building 118

Building 118 is in the southern portion of the Richmond Field Station (Photograph 13). It is west of Egret Way and adjacent to Building 125 with its primary façade facing northeast. The utilitarian building does not express any particular architectural style. It is 1,708 square feet and was constructed prior to 1940. It is a single story building with a rectangular plan.

The building is topped with a very shallow pitched roof with minimal eave overhang. The walls are clad in roof paper. Fenestration is a single multi-light, fixed wood sash adjacent to the primary entrance, and a single aluminum sliding sash at the rear (southwest) elevation. The primary entrance, at the east end of the northeast elevation, is a wood paneled door with a window. A large metal roll up door is centered in the façade.

The secondary entrance is sliding doors at the south end of the northwest elevation. A low shed roofed addition at the rear corner of the building has another wood paneled door, and a southwest facing window.

Building 118, originally labeled "Building 149," was constructed circa the 1930s by the California Cap Company. The building was constructed to house the fuel oil boiler for the plant. After UC Berkeley purchased the property in 1950, the building was used as a fire test research area and maintenance shop. Fire safety research studies were done at Richmond Field Station to determine the safety of a variety of products including plastics and airplane restrooms.[25] Building 118 also housed the plumbing shop for the Richmond Field Station until 2009. It is currently used as an art facility for graduate

[25] University of California, Berkeley, 2008, p. 14.

students.[26] The wood siding has been covered with roof paper. A small addition at the southwest corner was constructed in the modern period. Dates for these alterations are unknown.

Photograph 13: Building 118, January 4, 2013, camera facing southwest

3.1.10 Building 120

Building 120 is along the southeastern border of the Richmond Field Station (Photograph 14). It is set back from Egret Way adjacent to building 117. The utilitarian building does not express any architectural style. It is 269 square feet and was constructed in 1967. It is single story and rectangular in plan.

The building is topped with a shed roof. The walls and roof are corrugated metal, and the building lacks fenestration. The only entrances to the building are large openings on its northeast elevation that are covered with a metal construction fence.

This building was constructed in 1967. During the 1960s and 1970s, an incinerator burned garbage at this location.[27] Aerial photographs show that Building 120 was moved to its present location circa 1990. Research failed to reveal the building's original location. It was used as a solvent storage shed in the 1990s. Currently, drums containing waste petroleum products are stored in the building.[28]

[26] Shackleton, 2013.
[27] Shackleton, 2013.
[28] University of California, Berkeley, 2008, p. 28.

Photograph 14: Building 120, January 4, 2013, camera facing south

3.1.11 Building 121

Building 121 is in the southern portion of the Richmond Field Station (Photograph 15). The utilitarian building does not express any architectural style. It is 728 square feet and was constructed in 1982. It is single story and rectangular in plan.

The building is topped with a front gabled, fiberglass roof, with exposed rafter tails at the eaves. The walls are corrugated metal. It lacks fenestration. The only opening is a roll up garage door on the northeast elevation.

Building 121 was constructed circa 1970, as shown by aerial photographs. It was constructed as a garage for the storage of lawn equipment. The roll up garage door was added at an unknown date. The UC Berkeley Solar Powered Vehicle Club began using it for storage circa 2009.[29]

[29] Shackleton, 2013.

Photograph 15: Building 121, January 4, 2013, camera facing west

3.1.12 Building 125

Building 125 is in the southern portion of the Richmond Field Station (Photograph 16). It is west of Egret Way and between to Building 116 and Building 118 with its primary façade facing northeast. The vernacular building does not express any particular architectural style. It is 1,024 square feet and was constructed prior to 1940. It is single story and rectangular in plan.

The building is topped with a front gabled roof, and purlins are exposed at the minimal eaves on the front (northeast) and rear (southwest) elevations. Both gables are adorned with simple, decorative, stickwork trusses. The walls and roof are corrugated metal. Fenestration throughout the building is multi- light, wood sashes. The wide primary entrance is fitted with a flush door and reached by a wooden ramp leading to a small deck at the front of the building. The rear (southwest) door is flush, and accessed by a set of wooden steps.

Building 125, originally labeled "Building 24," was constructed circa 1930 by the California Cap Company. It was adjacent to the plant's mercury fulminate production facility (near Building 102) and was used as an alcohol warehouse. After UC Berkeley purchased the property in 1950, the building was used as a composting facility.[30] During the 1960s SERL used the building for a laboratory and shop. It was moved to its current location as part of an environmental remediation project in 1998. It is currently used as a bioengineering research facility.[31]

[30] University of California, Berkeley, 2008, p. 196.
[31] Shackleton, 2013.

Photograph 17: Building 125, January 4, 2013, camera facing west

3.1.13 Building 128

Building 128 is in the southwestern portion of the Richmond Field Station, along Heron Drive, adjacent to the Environmental Protection Agency building (Photographs 18 and 19). The vernacular building does not clearly express any particular architectural style. It is 10,287 square feet, constructed circa 1930, single story, and has an irregular plan.

The building is topped with a shallow, pitched, side-gabled roof. The primary façade, that faces southeast, features a partial width entry porch and several projecting bays. The building walls are sided in horizontal wood siding. Fenestration is a combination of original, multi- light wood and replacement aluminum sashes. A paneled entry door with windows is accessed by wooden stairs that lead to the porch. At the rear of this section of the building, are seven bays separated by poured concrete walls that project past the walls and above the roof. There are two rectangular plan sections at the northwest end of the primary wing. The smaller section, at the west end of the building, is topped with a shed roof. The larger section, to the north, has a very shallow, pitched, gabled roof. Both sections are accessed by large replacement roll up doors at their southwest ends.

Building 128, originally labeled "Building 4b," was constructed circa 1930 by the California Cap Company.[32] The original building consisted of what is today the southeast wing of the building and was used as a press house. The press house was where gunpowder was compressed into cakes using weights. There were several other small buildings in the vicinity that were also press houses. The heavy concrete walls at the rear of the original building are reinforced concrete blast walls, intended to limit damage in case of explosion. After UC Berkeley purchased the property in the 1950s, the University added two warehouse additions to the building. The first was the

[32] University of California, Berkeley, 2008, p. 199.

northwest section of the building, built circa 1950.[33] The smaller west section was added in 1974.[34] The building housed internal combustion laboratories and was used for detonation research. Rocket engine tests using model rockets were among the modes of research conducted in Building 128.[35] By 1980, Building 128 was altered to its current irregular footprint. During the 1980s, large machinery was installed for research into automated recycling.[36] The building is currently used as a research facility.

Photograph 18: Building 128, January 4, 2013 camera facing northeast

Photograph 19: Building 128, January 4, 2013, camera facing northeast

[33] Shackleton, 2013.
[34] University of California, Berkeley, File "Building 128," located in vertical files in Room 148, Richmond Field Station.
[35] University of California, Berkeley, File "Building 128," located in vertical files in Room 148, Richmond Field Station.
[36] Shackleton, 2013.

3.1.14 Building 149

Building 149 is in the southern portion of the Richmond Field Station (Photograph 20). Its primary façade faces southeast; it is 720 square feet and was constructed in 1982. It is single story and rectangular in plan.

The building is topped with a front gabled roof, with shallow eaves and exposed rafters on the southwest and northeast elevations. The building is clad in plain and vertical groove plywood. Fenestration is vinyl sashes. The primary entrance, on the southeast elevation, is a flush, at-grade door. A similar door is near the rear of the southwest elevation. The southeast elevation features a flush double door.

Building 149 was constructed by UC Berkeley in 1982. Originally, it was used for water technology research. It has also been used for solar research. Between 1992 and 1998, it was used as hang glider storage. It is currently being used by the UC Berkeley Concrete Canoe Club.[37] It is not of historic age, as it was constructed 31 years ago.

Photograph 20: Building 149, January 4, 2013, camera facing north

3.1.15 Building 150

Building 150 is in the southern portion of the Richmond Field Station (Photograph 21). Its primary façade faces northeast along Lark Drive. It is 5,410 square feet and was constructed in approximately 1910.

[37] Shackleton, 2013.

Photograph 21: Building 150, January 4, 2013, camera facing south

The building is single story and rectangular in plan, with additions to the rear (southwest) side. The building is topped with a shallow-pitched, side gabled roof with shallow eaves and exposed shaped wood rafter tails and purlins. Many of the original features remain and the building continues to convey original use as a shop with its sets of industrial, metal-frame, multi-light sashes, walls sided in board formed concrete, and low, open configuration.

The main entrance is centered in the primary elevation and features original flush wood double doors with multi-light windows and transoms. A concrete loading dock in front of these doors is accessed by a set of wooden stairs at its east end and a ramp at its west end.

The northwest elevation features a large roll up metal door. The rear (southwest) elevation of the building lacks the overhanging eaves with their decorative rafter tails that are found on the front and sides of the building. Fenestration at the rear is original, metal-frame, multi-light, industrial sashes.

A separate rectangular-plan addition is perpendicular to the main section of the building, at its rear (Photograph 22). It was added in 1946. This addition is topped with a shallow, pitched, gabled roof lower than the main building's roof with an eave overhang and rafter tail treatment mimicking that of the street-facing façade. Fenestration on this addition is multi-light, hung, wood sashes. A flush-mounted wood door is the entrance on the southwest elevation. It is sheltered by a shed roofed awning and accessed by a wooden staircase. An addition on the northwest side of the rear building has an even lower shed roof. The walls are clad in corrugated metal. Fenestration at this addition is horizontal sliding sashes, and the entrance is a large wood sliding door.

Photograph 22: Building 150, January 4, 2013, camera facing northwest

The California Cap Company constructed Building 150 circa 1910. The building was known as "Building 66a" and used for wire insulating. The addition at the southeast end of the building, known as "Building 66," was also constructed during the California Cap Company era. Aerial photographs show that it had been constructed by 1946. It was used for wire saturating.[38] Insulated wires were an essential element of the fuse-type blasting caps manufactured by the California Cap Company. Wire saturating was one step in the process of manufacturing insulated wire.

After UC Berkeley purchased the property in 1950, the Division of Mechanical Engineering was housed in Building 150. During the 1950s, Associate Dean E. D. Howe supervised Fluid Mechanics Test Facilities in the building.[39] Over the years the building was used as a petroleum studies facility, a machine shop, and a laboratory for UCSF.[40] Building 150 is currently used as a student art facility.

3.1.16 Building 152

Building 152 is in the southern portion of the Richmond Field Station (Photograph 23). It is on the south side of Lark Drive adjacent to Building 150, with its primary façade facing northeast. The vernacular building does not strongly express any particular architecture style. It is two stories and has an irregular plan, is 4,201 square feet, and was constructed prior to 1940.

[38] Sanborn Map, Richmond, 1949.
[39] University of California, Berkeley, Department of Engineering, "Guide for Engineering Field Station Inspection," undated, p.2.
[40] University of California, Berkeley, 2008, p. 196.

The building consists of two front gabled wings facing the street, joined by a wing that runs parallel to the street. The roof is sheathed in composition shingles. The building is clad in a combination of horizontal wood, vertical board-and-batten, and asbestos siding. Fenestration also varies, and includes vinyl replacement windows and multi-light, double hung wood sashes. An entrance at the east gable is fitted with a flush wood door and accessed by a wood deck with stairs at one end and a ramp at the other. A similar entrance at the west gable is accessed by a concrete loading dock and stairs. A single story addition at the northwest end of the building features a hipped roof covered in corrugated metal. Multi- light, fixed, wood sashes have been painted over on its southeast elevation. The entrance at the northeast elevation is a large wood sliding door with a wood paneled door adjacent to it.

A rear entrance is toward the southwest corner of the west gable, facing the inside of the "U" formed by the building's wings. It is a flush mounted wood door that is accessed via a set of wooden stairs. The west gable is several feet longer than the east gable at the rear of the building. A small gable roofed shed is to the rear of the building adjacent to its southeast corner.

Building 152 was constructed by the California Cap Company circa the 1930s. It was originally three connected buildings referred to as "Building 59," Building 60," and "Building 142". Wooden boxes were assembled and other carpentry tasks performed in "Building 59," while "Building 60" was the packing house. "Building 142" was for sawdust storage and a restroom.[41] After UC Berkeley purchased the property in 1950 the building was used for salt water research and storage. A Mineral Dressing laboratory was installed by the Department of Mineral Technology in the late 1950s, but it appears not to have been used.[42] By 1980 the building was being used primarily for storage.[43] In the 1990s Building 152 began to house graduate student Art Practice, the current use of the building.[44]

[41] University of California, Berkeley, 2008, p. 200, 202.
[42] University of California, Berkeley, File "Building 152," located in vertical files in Room 148, Richmond Field Station.
[43] University of California, Berkeley, File "Building 152," located in vertical files in Room 148, Richmond Field Station.
[44] Shackleton, 2013.

Photograph 23: Building 152, January 4, 2013, camera facing west

3.1.17 Building 153

Building 153 is in the southern portion of the Richmond Field Station. It is on the south side of Lark Drive adjacent to Building 152, with its primary façade facing northeast (Photograph 24). The vernacular building does not strongly express any particular architecture style. It is single story and rectangular in plan, 2,731 square feet, and was constructed in 1959.

The front section of the building is flat roofed. The walls are covered in stucco, and fenestration is multi-light fixed sashes. The northeast elevation lacks fenestration, but has two entry doors and two large swinging double doors. All doors are wood paneled with windows. A rear addition to the building is topped with both a flat roof and a shed roof section. An entrance at the rear of the southeast elevation is a large sliding door.

Building 153 was constructed by UC Berkeley in 1959. It was used as a modeling shop and for salt water research.[45] The Naval Architecture Department used the building for ship design over the years.[46] In 1958, the department of Nuclear Engineering was looking for space for gamma-shielding experiments, and may have moved into Building 153 for a time.[47] Aerial photography indicates that the addition at the rear (southeast) of the building was constructed in approximately 1975. It is currently used as a research facility and a shop.

[45] University of California, Berkeley, 2008, p. 196.
[46] Shackleton, 2013.
[47] University of California, Berkeley, File "Building 153," located in vertical files in Room 148, Richmond Field Station.

Photograph 25: Building 153, January 4, 2013, camera facing west

3.1.18 Building 163

Building 163 is at the southeastern edge of the Richmond Field Station (Photograph 26). The primary façades of this L-shaped building face northwest and southwest. The vernacular building does not strongly express any particular architecture style. It is single story and 6,430 square feet. The building was constructed prior to 1940.

Both wings of the building have front gabled roofs covered with composition shingles. The walls are clad in horizontal wood siding; a portion of the walls is covered with stucco. Fenestration is aluminum replacement sashes. The primary entrance is a paneled, southeast-facing, wood door. It is accessed by a concrete ramp. Other entrances are centered in each gable end and are flush wood doors. The northwest entrance is accessed by concrete steps. The southwest entrance is accessed by a set of wooden steps and sheltered by a shed roof over the entry. There is a similar entrance on the rear (southeast) elevation.

Building 163 was created when two buildings were pieced together at this location in 1996. It is two California Cap Company buildings originally constructed circa 1930. They were connected with a new section at the corner of the "L" to create Building 1963. Its site overlaps with the footprint of the U.S. Briquette Company plant and William Letts Oliver's American Lucol Company. Aerial photographs indicate that the U.S. Briquette buildings were demolished circa the 1960s after UC Berkeley took over the site. Ergonomic studies, seeking to prevent chronic disorders of the upper extremities, have been conducted in the building since the 1990s.[48] Building 163 houses offices and continues to be used as a research facility.

[48] Shackleton, 2013.

Photograph 26: Building 163, January 4, 2013, camera facing east

3.1.19 Building 175

Building 175 is in the southern portion of the Richmond Field Station at the intersection of Lark Drive and Egret Way (Photograph 27). Its primary façade faces northeast along Lark Drive. It is 16,502 square feet and was constructed in approximately 1910.

The building is single story and rectangular in plan, with additions to the rear (southwest) side. The building is topped with a shallow, pitched-side, gabled roof with shallow eaves and exposed, shaped-wood rafter tails and purlins. Many of the building's original features remain, and the building continues to convey its original use as a shop with its, walls sided in board formed concrete, and low, open configuration. Fenestration is aluminum replacement windows and small aluminum sliding sashes. The east door has been replaced with a modern glass door.

Photograph 27: Building 175, January 4, 2013, camera facing south

A large, projecting, two-story addition at the southwestern end of the building is topped with a shed roof, its walls are clad in corrugated metal. Fenestration is both multiple pane fixed windows and vinyl replacement windows. A shed roof covers an open area at the center of the rear elevation adjacent to the corrugated addition. Double paneled wood doors with windows are at the center of the façade. A raised concrete ramp leads to these doors.

Historic maps and documents show that the building that is now Building 175 was constructed in 1910, when the California Cap Company and Pacific Cartridge Company were operating simultaneously. When in use for the Pacific Cartridge Company, Building 175 was numbered both "Building 75" and "Building 76" and was the primary production facility for Pacific Cartridge. The building appears to have been used as a cartridge loading facility during the early years, where powder was loaded into shells.[49] It also housed a small office, a vault, and cleaning and annealing rooms.[50] (Metal cartridges were strengthened through heat treating, or annealing.) Both the Pacific Cartridge Company and the California Cap Company were administered from the office in Building 175 (Photograph 28 and 29). By 1916, the company was producing cartridge shells in the building, but no longer loading powder there.[51] Pacific Cartridge Company was absorbed by the California Cap Company circa 1920. The 1949 Sanborn map shows the same uses for the Building 175 but lists only California Cap on the property.[52]

[49] Sanborn Map, Stege, 1912.
[50] Sanborn Map, Stege, 1912.
[51] Sanborn Map, Richmond, 1916.
[52] Sanborn Map, Richmond, 1949.

Photograph 28: Building 175, circa 1910, from Bancroft Library's Oliver Family Photograph Collection, labeled "Exterior California Cap Company office, California"

Photograph 29: Building 175, circa 1910, from Bancroft Library's Oliver Family Photograph Collection, labeled "Pacific Cartridge Co. Exterior – Stege, Calif."

After UC Berkeley purchased the property in 1950, this building continued to house an office and hazardous chemical storage area.[53] Building 175 was the Richmond Field Station's primary facility for maintenance and administration.[54] During the early 1950s, the Department of Engineering's machine shop was also in Building 175, fabricating experimental equipment for research. By 1952, a new high-speed wind tunnel for research was being assembled in the building.[55] The University made piecemeal additions to the rear (southwest) of the building beginning in the 1950s. By 1966, Building 175 reached its current footprint and housed machine, carpenter, and welding shops, and an office.[56] The University removed the original wood frame windows and replaced them with aluminum sashes in 1969.[57] The building continued to be considered important, as indicated by a 1977 letter arguing for "one of the most important buildings at the Station and if it were lost the program impact could be catastrophic, inasmuch that the Station operations would most likely come to a halt."[58] It continued to house maintenance operations until approximately 2008, when, in spite of the building's former importance, it was left vacant. It remained vacant until 2012, when the UC Bindery moved into the building.[59]

3.1.20 Building 176

Building 176 is in the southern portion of the Richmond Field Station between Building 175 and Building 150 (Photograph 30). Its primary façade faces northeast, along Lark Drive. The vernacular building does not strongly express any particular architecture style. It is single story and square in plan, 672 square feet, and was constructed prior to 1940.

The building is topped with a front gabled roof, with a large vent on the gable ridge. The building's walls are reinforced concrete covered in stucco. The building lacks fenestration. Its only opening is a flush metal door with a small window on the primary (northeast) elevation, accessed by a sloping concrete walkway that leads from the street.

The California Cap Company constructed Building 176 circa the 1930s. It was originally referred to as "Building 73" and was used by the plant as a warehouse. After UC Berkeley purchased the property in 1950, it continued to use the building for storage. Although the building was retrofitted as an animal lab, it was never used for that purpose. In 1998, it was renovated for the use of a private company named Stratacor that works on topical anti-insect solutions.[60]

[53] University of California, Berkeley, 2008, p. 197
[54] University of California, Berkeley, 2008, p. 20.
[55] University of California, Berkeley, Department of Engineering, "Richmond Field Station Open House," May 28, 1952, p. 3.
[56] Sanborn Map, Richmond, 1966.
[57] University of California, Berkeley, File "Building 175," located in vertical files in Room 148, Richmond Field Station.
[58] University of California, Berkeley, File "Building 175," located in vertical files in Room 148, Richmond Field Station.
[59] Shackleton, 2013.
[60] Shackleton, 2013.

Photograph 30: Building 176, January 4, 2013, camera facing south

3.1.21 Building 178

Building 178 is along the southeastern border of the Richmond Field Station (Photograph 31). It is set back from Egret Way to the east adjacent to building 185. Its primary façade faces northwest. The utilitarian building does not strongly express any particular architecture style. It is single story, rectangular in plan, 3,950 square feet, and was constructed prior to 1940.

The building is topped with a side gabled roof. Its roof and walls are clad in corrugated metal. Fenestration is both aluminum sliding sashes and multiple light wood sashes. There are three entryways on the primary (northwest) elevation. Entrances at the north end and the center of the elevation are metal double doors with windows. The south entrance is a single metal door with a window. At either end of the building the entrances are accessed by sets of wooden stairs. A similar door is at the north end of the rear (southeast) elevation.

Building 178 appears to have been moved to this location circa 1990. Although UC Berkeley property records and building materials suggest a build date prior to 1950, Building 178 does not appear on aerial photographs of this location until the 1990s. Research has not uncovered its original use or location. Building 178 housed the California Conservation Corps until circa 1999, after which it served as an electrical shop and a warehouse. It is currently used for Art Practice Studies.[61]

[61] Shackleton, 2013.

Photograph 31: Building 178, January 4, 2013, camera facing northeast

3.1.22 Building 185

Building 185 is along the southeastern border of the Richmond Field Station (Photograph 32). It is set back from Egret Way to the east adjacent to building 178. Its primary façade faces northwest. The utilitarian building does not strongly express any particular architecture style. It is single story, rectangular in plan, 3,165 square feet, and constructed prior to 1940.

The building is topped with a side gabled roof. Its roof and walls are clad in corrugated metal and it lacks fenestration. Entryways, at either end of the primary (northeast) elevation, are flush wood doors. The south door is accessed by a set of wooden stairs. Another entryway is at the north end of the rear (southwest) elevation.

Building 185 appears to have been moved to this location circa 1990. Although UC Berkeley property records and building materials suggest a build date prior to 1950, Building 185 does not appear on aerial photographs of this location until the 1990s. Research has not uncovered its original use or location. The building has been a support facility since the 1990s.

Photograph 32: Building 185, January 4, 2013, camera facing northeast

3.1.23 Building 197

Building 197 is along the southeastern border of the Richmond Field Station (Photograph 33). It is set back from Egret Way to the east adjacent to building 117. Its primary façade faces northeast. The utilitarian building does not strongly express any particular architecture style. It is single story, rectangular in plan, 2,419 square feet, and constructed in 1975.

The building is topped with a very shallow-pitched, side-gabled roof. Its roof and walls are clad in corrugated metal. Fenestration is an aluminum sliding sash. Three large open bays provide access to the northern end of the primary (northeast) elevation. A large metal roll up door is at its southern end. The entrance at the south end of the northwest elevation is a flush metal door.

UC Berkeley constructed Building 197 in 1975. It has been used for support and heavy vehicle storage since its construction. Drums containing waste petroleum products are stored in the building.[62] The building is not of historic age as it is 38 years old.

[62] University of California, Berkeley, 2008, p. 28.

Photograph 33: Building 197, January 4, 2013, camera facing southeast

3.1.24 Building 275

Building 275 is in the southern portion of the Richmond Field Station. It is on the south side of Lark Drive between Building 153 and Building 276, with its primary façade facing northeast (Photograph 34). The vernacular building does not strongly express any particular architecture style. It is single story, irregular in plan, 7,914 square feet, and was constructed in 1956.

The front portion of the building, adjacent to Lark Drive, is topped with a flat roof featuring a broad eave overhang with large exposed roof members. The walls are sided in smooth stucco with vertical wood trim. Fenestration is fixed and awning metal sashes. The entrance is a flush door with a window at the east end of the primary (northeast) elevation.

An older, front-gabled building, with its front gable visible behind the flat roof, is joined to the rear of the main section of the building. Its roof and walls are clad in corrugated metal. Fenestration is multiple light fixed metal sashes. This older section of the building has no entryways.

UC Berkeley constructed building 275 in 1956. Originally, it consisted of the long narrow section currently the southwest wing of the building. It was used as a laboratory for hydraulic and coastal engineering and to test ship hull designs.[63] The facility included a towing tank for experiments. Historic aerial photographs indicate that the front (northeast) portion of the building along Lark Drive was constructed in 1966. The building currently houses offices.

[63] University of California, Berkeley, 2008, p. 14.

Photograph 34: Building 275, January 4, 2013, camera facing west

3.1.25 Building 276

Building 276 is in the southern portion of the Richmond Field Station. It is on the south side of Lark Drive adjacent to Building 276, with its primary façade facing northeast (Photograph 35). UC Berkeley constructed this building in 1956. The utilitarian building does not strongly express any particular architecture style. It is single story and rectangular in plan.

The building is topped with a front-gabled roof. Its walls are corrugated metal. Fenestration is multi-light metal sashes. The main entryway is through a flush metal industrial door. A shed roofed addition projects from the rear elevation of the building.

Photograph 35: Building 276, January 4, 2013, camera facing southwest

3.2 DESCRIPTION OF THE BUILDINGS ADJACENT TO THE PHASE 1 FOOTPRINT (INDIRECT APE)

3.2.1 Building 151

Building 151 is in the southern portion of the Richmond Field Station. It is on the north side of Lark Drive, with its primary façade facing southwest (Photograph 36). This rectangular plan 2,629 square-foot building is a Soule Steel Company prefabricated building, topped with a front gabled roof. Vents are at each gable end. The walls and roof are corrugated metal. Fenestration consists of multi-light, metal sashes. There is also a small aluminum frame window in the center of the primary façade. The main entrance consists of a metal industrial door with a glass insert at the east end. This entrance is sheltered by a metal awning and accessed by a very gradual concrete ramp that runs across the main façade of the building. The rear of the building, at the northeast, contains an overhead mounted sliding door. In 1965, a 1,600 square-foot addition was constructed on the north end of the building.

Photograph 36: Building 155, April 30, 2013, camera facing northeast

3.2.2 Building 154

Building 154 is in the southern portion of the Richmond Field Station. It is on the north side of Lark Drive between Buildings 158 and 151, with its primary façade facing southwest (Photograph 37). The 2,731 square-foot building has a rectangular footprint and is a prefabricated Dudley Steel Building topped with a front gabled roof. The walls and roof are corrugated metal. Primary fenestration consists of multi-light metal sashes. A metal industrial door with a glass insert is centered in its southwest elevation and is the main entrance. This entrance is sheltered by a metal awning and accessed by concrete stairs and a ramp. The rear of the building contains an overhead-mounted sliding door. In 1965, a 1,600 square-foot addition was constructed on the north end of the building. Photograph 38 shows the building in the 1960s.

Photograph 37: Building 154, April 30, 2013, camera facing northeast

Photograph 38, Building 154 at center between Buildings 158 and 151,circa 1965,camera facing northwest

3.2.3 Building 155

Building 155 is in the southern portion of the Richmond Field Station. It is on the north side of Lark Drive between Buildings 151 and 177 (Photograph 39). The vernacular building does not strongly express a particular architecture style. It has 1,896 square feet and one story, with an irregular “U” plan. It was constructed in 1953 by combining three buildings dating from the 1920s.

The building consists of two side gabled wings joined by a wing that runs perpendicular to the street, forming a "U" shape. The roof is sheathed in replacement composition shingles, its walls clad in horizontal wood siding. Fenestration throughout the building consists of fixed, square, wood frame windows. The windows are not original and were likely replaced during the 1950s. A paneled wood door reached by a set of wooden stairs is centered in the gable end of the southwest wing, which is the closest to Lark Drive. The southwest elevation of the northeast wing features a similar entrance. A third entrance, centered in the connecting wing and faces southeast, is fitted with a modern door and accessed by a concrete ramp.

Construction of Building 155 was pieced together from former California Cap Company Buildings, "Building 64", "Building 67", and "Building 92". The California Cap Company constructed these three buildings circa 1920.[64] The buildings were originally used for waterproofing and assembling by the California Cap Company.[65] In 1953, the University appears to have turned "Building 67" perpendicular to its original position to form a connecting wing in a single "U" shaped building. In addition to joining the three buildings, the University replaced original siding and original windows on all three buildings. At first, the southwest wing adjacent to Lark Drive was labeled Building 155, and the northeast (rear) wing was labeled Building 157. At some point, all three wings became known as Building 155.[66] In 1977, a concrete foundation was installed under the building.[67]

Photograph 39: Building 155, April 30, 2013, camera facing north

[64] University of California, Berkeley, File "Building 155," located in vertical files in Room 148, Richmond Field Station.
[65] University of California, Berkeley, 2008, p. 200 – 204.
[66] Sanborn Map, 1966.
[67] Scott Shackleton, University of California, Berkeley, Personal communication with Julia Mates, Tetra Tech 2013.

3.2.4 Building 158

Building 158 is in the southern portion of the Richmond Field Station. It is on the north side of Lark Drive, with its primary façade facing southwest (Photograph 40). The 3,343 square-foot building is a rectangular, prefabricated building topped with a front gabled roof. It features shallow eaves with exposed rafters and exposed steel purlins. The walls and roof are corrugated metal. Fenestration consists of multi-light metal sashes and replacement sliding sashes. An overhead-mounted, sliding, metal door is centered in its southwest elevation. An entrance fitted with a single metal industrial door with a glass insert is adjacent to the large door to the east. This entrance is sheltered by a metal awning and accessed at grade.

Photograph 40: Building 158, April 30, 2013, camera facing northeast

3.2.5 Building 177

Building 177 is in the southern portion of the Richmond Field Station. It is on the north side of Lark Drive, with its primary façade facing southwest (Photograph 41). The vernacular building does not strongly express any particular architectural style. It is a 2,969 square-foot, two-story building with a modified rectangular plan. It is topped by a front gabled roof; its walls are clad in horizontal wood siding. A decorative octagonal vent is centered in the front gable. Fenestration consists of replacement vinyl sashes. The building's main façade is centered in the southwest elevation and features a full width, hipped roof porch.

The two-story main wing of Building 177 is connected to a small, single-story building at the rear, the former Building 179. The single story gable at the rear (northeast) of the building features decorative stickwork at the eaves. An exterior industrial-style staircase leads to the rear portion of the main wing's second floor (Photograph 42).

Originally constructed circa 1920, Building 177 was known as “Building 72” during the California Cap Company era. “Building 72” consisted of the two-story main wing of what is today Building 177, and is depicted on Sanborn Maps as a “Rest Room.” A separate one story building to the rear, “Building 131,” was also labeled as “Women’s Rest Room” and a “Water Closet” on historic maps.

By the time the University took over the property in 1950, Building 177 had small additions added onto its facade and had become somewhat dilapidated. The University renovated the building in 1953, removing some of the additions and changing the shed roofed entry porch to a small gable roof. By 1966, Building 177 was being used as a maintenance shop. California Cap Company “Building 131” at the rear was renumbered Building 179 and continued to be used as a restroom until it was joined to Building 177. Although Building 179 is still shown on maps of the Richmond Field Station, the rear portion of the building is currently labeled Building 177. Photograph 43 shows the building as it appeared in the 1950s.

Photograph 41: Building 177, April 30, 2013, camera facing north

Photograph 42: rear of two story portion of Building 177 showing exterior stairs,January 4, 2013, camera facing southwest

Photograph 43: Building 177, (background), 1952, camera facing east

3.2.6 Building 180

Building 180 is in the southern portion of the Richmond Field Station. It is on the north side of Lark Drive, and its primary façade faces southwest (Photograph 44). The vernacular building does not strongly express any particular architectural style. It has 11,008 square feet, is single-story, and has an irregular plan. It is topped with a cross gabled roof. The primary fenestration consists of aluminum replacement sliding and awning sashes. The main entrance is centered in the southeast elevation (Photograph 45). Its aluminum framed glass door is sheltered by a flat roofed entry porch and accessed by concrete steps.

Building 180 was constructed piecemeal, combining several buildings, over decades from about the 1920s through the 1930s. As a result, the building has multiple types of wall cladding, including two sizes of brick, horizontal wood siding, and vertical groove plywood. A small two-story wing at the northeast corner of the building contains multi-light wood sash windows that have been painted over.

During the California Cap Company era, the five connected buildings that comprise what is now Building 180 were devoted to manufacturing. “Building 44,” which became the south half of Building 180’s main wing, was devoted to plugging, soldering, and concaving (Photograph 5) when originally used by the California Cap Company. Wire cutting was done in “Building 185,” which became the small two-story wing at the north end of the building (Photograph 4). The north half of the building’s main wing was “Building 170,” where plugging was done for the company. “Building 171,” currently the west wing of Building 180, was a match head manufacturing area. “Building 172” is at the center of Building 180’s main wing and was originally an office. Concrete blast walls on either side of the office protected the space from the explosives handled in Buildings 44 and 170.[68]

After the University took over and renumbered the five buildings, the space Building 180 now stands on was used for photography work and offices. Most of the building’s windows were replaced with aluminum sashes sometime during the 1980s. In 1982, restrooms and a conference room were installed in Building 180. The new restroom facility served the Sea Water Conversion complex which, prior to 1982, did not have plumbed indoor toilets.[69] It is currently used as offices.

[68] Sanborn Maps, 1949.
[69] University of California, Berkeley, File “Building 180,” located in vertical files in Room 148, Richmond Field Station.

Photograph 44: Building 180, April 30, 2013, camera facing northeast

Photograph 45: Building 180, April 30, 2013, camera facing west

3.2.7 Building 198

Building 198 is in the southern portion of the Richmond Field Station across Lark Drive from Building 197 (Photograph 46). It is an 1,800 square-foot, rectangular plan, prefabricated building, topped with a very shallow pitched, gable roof with vents in the gables. Its walls and roof are corrugated steel and the building lacks fenestration. A

large metal roll-up door is centered in its northwest elevation, while its southwest elevation features a metal industrial entrance door at grade.

Photograph 46: Building 198, April 30, 2013, camera facing northeast

3.2.8 Building 201

Building 201 is in the southwestern portion of the Richmond Field Station, along Avocet Way, on a 3.5-acre parcel. It is a single-story building and houses the U.S. Environmental Protection Agency's Region IX laboratory and office building. The building has 46,000 square feet and is a tilt-up building that is ornamented through with reveals and indentations in the tilt-up panels, with sculpting. Covered trellises surround the building's walkways, and the main entrance features a modern glass enclosure. It was constructed in 1992.

3.2.9 Building 277

Building 277 is in the southern portion of the Richmond Field Station. It is on the north side of Lark Drive, with its primary façade facing northwest (Photograph 47). It is 21,426 square feet and was constructed circa 1966. The single-story building is a rectangular plan, prefabricated building topped with a front gabled roof. The walls and roof are corrugated metal. Fenestration consists of metal sash windows that appear to have been repurposed from a vehicle. Its primary entrance is in the northwest elevation, which faces Avocet Way. A metal industrial entry door is set inside a large sliding door. Building 277 was constructed as a model basin building for salinity intrusion study. It has been used throughout its life for storage.

Photograph 47: Building 277, April 30, 2013, camera facing east

3.3 HISTORIC BACKGROUND OF RICHMOND FIELD STATION

Europeans arrived in what would become Contra Costa County in 1772, when a Spanish expedition led by Pedro Fages discovered the San Pablo Bay at the confluence of the Sacramento and San Joaquin rivers.[70] Though subsequent Spanish expeditions passed through the region, the Spanish do not appear to have settled in the present-day City of Richmond area during the Mission Period of 1769 through 1833.

In the 1820s and 1830s, the Mexican government began granting large tracts of land in the area to its citizens, including Ranchos San Pablo, San Ramon, and Pinole. The first permanent non-native settlers were Francisco Castro and his wife Maria Gabriela Berryessa. The Mexican government granted the 18,000 acre Rancho San Pablo to the Castros in 1823.[71] Americans began farming in Contra Costa County in the late 1830s, and by 1882, two-thirds of the cultivated land in the county was devoted to wheat production.[72]

Minna C. C. Quilfelt (or Quilfeldt) purchased 600 acres of Rancho San Pablo in 1852 and 1853.[73] Adjacent to San Francisco Bay in what would eventually become the southern portion of the City of Richmond, a wharf and produce warehouse were constructed on the ranch in the 1860s to ship agricultural produce to the San Francisco markets from Rancho

[70] Mildred B. Hoover,, Hero E. Rensch, Ethel G. Rensch, Douglas E. Kyle, *Historic Spots in California, Fourth Edition*, Stanford University Press, Stanford, California: 1958, p. 129.
[71] Donald Bastin, *Images of America: Richmond*, Arcadia Publishing, Charleston SC: 2003, p. 9.
[72] J.P. Munro-Fraser, *History of Contra Costa County, California,* W.A. Slocum & Co., San Francisco: 1882, p. 55 – 57.
[73] Evan Griffins, "Early History of Richmond," December 1938, El Cerrito Historical Society, website: http://www.elcerritowire.com/history/pages/EarlyRichmond.htm, accessed January 2013.

San Pablo and the Quilfelt ranch. The warehouse and wharf were used to transport cattle, grain, fruit, and in later years, the frogs' legs raised by Richard Stege for the San Francisco restaurant market.[74] German native Richard Stege settled on Rancho San Pablo in the late 1860s after stints in the gold fields and the Siberian fur trade. He married Minna Quilfelt, a widow, in 1870.[75] Minna Quilfelt Stege died in 1879, leaving the ranch to Stege and her daughter Edith. Stege began selling off portions of his ranch to raise money while continuing his frog-raising and other ventures. A town named Stege formed on Richard Stege's holdings, and by the late nineteenth century, several industries, including the California Cap Works, the United States Briquette Company, the Stauffer Chemical Works and the Stege Lumber Manufacturing Company, were operating from portions of the Stege Ranch.[76] The City of Richmond incorporated in 1905, and by 1917, it was already the largest city in Contra Costa County.[77] The town of Stege was eventually absorbed into Richmond as the latter grew.

3.4 HISTORIC CONTEXTS

3.4.1 The Explosives Industry in Contra Costa County

Swedish chemist Alfred Nobel laid the foundation for the high-explosives industry with his innovations beginning in the 1860s, inventing first a detonator and then a blasting cap. In 1867, he invented dynamite, safer, cheaper, and more powerful than nitroglycerine that had been the most commonly used explosive. Nobel licensed the Giant Powder Company to produce dynamite in California later that year. Giant was the first American company to produce dynamite, and its plant was initially in Rock House Canyon, in what is today the City of San Francisco. The California Powder Works began manufacturing dynamite in the same area in 1869.[78]

The nineteenth century explosives industry was extremely dangerous, and as San Francisco's population grew, explosives manufacturers needed to relocate. Contra Costa County across the bay was attractive since it was accessible due to its close proximity to the harbor, yet remote enough from population centers. The narrow canyons of Contra Costa County, which terminate in small bays, provided a natural geographical defense against explosions by allowing factory design that placed water between different facets of explosives manufacturing.[79]

During the 1870s, chemical and explosives manufacturers began opening near what would eventually become the City of Richmond. The Tonite Powder Company, Western Mineral Company, and California Cap Company were established at 1877, on the Stege ranch. Soon, San Francisco explosives companies followed those explosive companies across the bay to Contra Costa County. In 1880, Giant relocated to Point Pinole, changing its name to the Atlas Powder Company. The California

[74] Roland Oliver, "Recollections of Early Industries in Stege," August 7, 1959, p. 1.
[75] Munro-Fraser, p. 675.
[76] Frederick J. Hulaniski, *The History of Contra Costa County, California*. Elms Publishing Company, Berkeley, California: 1917, p. 354.
[77] Hulanski p. 288.
[78] Ida Mae Purcell, *History of Contra Costa County,* The Gillick Press, Berkeley, California" 1940, p. 645 – 646.
[79] James E. Vance, *Geography and Urban Evolution in the San Francisco Bay Area,* University of California, Berkeley: 1964, p. 27.

Powder Works soon followed, building a new factory in Hercules, named for the brand under which the company sold its powder.[80] The Vulcan Powder Works and Judson Powder works also opened in the Stege Ranch area during this era, consolidating Contra Costa County's position as the cradle of the California explosives industry. The East Bay dominated California explosives manufacturing into the twentieth century. In 1902, California had only one powder factory outside Contra Costa and Alameda counties.[81]

3.4.2 The California Cap Company

William Letts Oliver

William Letts Oliver was born in Chile to English parents in 1844. He attended the University of Edinburgh and became a mining engineer. After returning to Chile, Oliver ran an explosives factory that was nationalized by the Chilean government in 1864. After the loss of his factory, Oliver left Chile for San Francisco.[82] William Letts Oliver and his wife Carrie lived in Oakland, from about 1880, until Oliver's death in 1918.[83] The couple eventually had six children together: Roland, Edwin, Caroline, Anita, William Harold, and Albert.[84] In addition to his various professional activities, William Letts Oliver was a yachtsman and an officer of the Bohemian Grove club in the early twentieth century. He was an avid amateur photographer throughout his lifetime; UC Berkeley's Bancroft Library has a collection of 2700 negatives and prints taken by Oliver and his son.[85]

William Letts Oliver initially gained familiarity with an explosive called guncotton while manufacturing collodion for his photography hobby.[86] As early as 1870, European explosive companies were experimenting with nitrated guncotton, and, by 1875, it was manufactured in England under the name "tonite."[87] By 1877, Oliver had left Chile and was mining in the western United States. Engineers working on the Sutro Tunnel in the Comstock needed an explosive to complete the tunnel that would remain stable at the high temperatures underground, and Oliver was able to solve the problem by substituting tonite for more volatile compounds.[88]

[80] Purcell, p. 646.
[81] Richmond Record, "Contra Costa County: Under the Vitascope," Richmond:1902.
[82] Pacific Mining News, Supplement to Engineering & Mining Journal-Press, "Industrial Notes: Developing of the Blasting Cap Industry," Vol. 1, No. 7, November 1922, p. 222.
[83] United States Census Bureau, Tenth Census of the United States, 1880, National Archives and Records Administration, Washington, D.C., San Francisco, California, Roll: 79, Film: 1254079, Page: 170B.
[84] United States Census Bureau, Twelfth Census of the United States, 1900, National Archives and Records Administration, Washington, D.C., Oakland Ward 3, Alameda, California, Roll: 82, Page: 13A.
[85] Online Archive of California, "Guide to the Oliver Family Photograph Collection," UC Berkeley:2009, website: http://www.oac.cdlib.org/findaid/ark:/13030/ft0q2n99r1/ accessed February, 2013.
[86] Blasting Cap Industry," Vol. 1, No. 7, November 1922, p. 222.
[87] G.A. Price Cuxson, ed., "Society of Engineers: Transactions for 1889," E. & F. N. Spon, London: 1890, p. 95.
[88] Pacific Mining News, Supplement to Engineering & Mining Journal-Press, "Industrial Notes: Developing of the Blasting Cap Industry," Vol. 1, No. 7, November 1922, p. 222.

The California Cap Company

In 1877, William Letts Oliver was inspired by his success with tonite to leave mining and establish the Tonite Powder Company, on a portion of the former Stege Ranch.[89] In the 1870s, all blasting caps in the United States had to be imported from Europe. Not only were they expensive, but the timing of deliveries was uncertain, creating business difficulties for the powder plant. Oliver was determined to create his own caps to protect the tonite factory business. He experimented until he came up with a blasting cap that was safer to use and had better detonating qualities than imported detonators. Oliver and his partner Freeborn Fletter founded the California Cap Company. It was adjacent to the Tonite Powder Company, and was a parcel carved out of the southern portion of Stege Ranch.[90] California Cap Company, which went on to operate on the site for nearly seven decades, was the first manufacturer of blasting caps in the United States. Richard Stege, meanwhile, continued to reside on the ranch, and contracted with Tonite Powder and California Cap to transport their products to the railroad.[91] The California Cap Company was on the parcel that is currently the Richmond Field Station. The Tonite Powder Company appears to have been to the east on the parcel that became the Stauffer Chemical Company and later the Zeneca site, although its exact location is unclear.

The Tonite and California Cap factories, the first of several gunpowder and chemical companies in the region, were separated by the Stege agricultural warehouse for safety.[92] The explosives industry during this era was an extremely dangerous one. A horrific explosion in 1882, at the nearby Vulcan Powder Company caused 11 deaths and destroyed the plant.[93] Between 1882 and 1918, the Hercules and Atlas plants suffered numerous explosions that destroyed plant buildings and killed 64 workers.[94] Despite its focus on safety, the California Cap Company also had accidents. Two of its Chinese workers were killed in 1917, when one of them dropped a tray of caps. In 1941, an explosion caused a fire and critically injured a worker.[95]

William Letts Oliver continued to innovate throughout his long career in the chemical and explosives industries. In 1888, he formed the American Lucol Company adjacent to the California Cap Company property.[96] The Lucol plant was at what is currently the southeastern corner of the Richmond Field Station, at the approximate location of Building 163. Lucol manufactured a linseed oil substitute.[97] The factory was dismantled and relocated to New Jersey circa 1900.[98] In 1903, the Hotaling Briquette Works opened on Lucol's site at the southeast corner of the current Richmond Field

[89] Oliver, p. 1.
[90] Pacific Mining News, Supplement to Engineering & Mining Journal-Press, "Industrial Notes: Developing of the Blasting Cap Industry," Vol. 1, No. 7, November 1922, p. 222.
[91] Nilda Rego, "Enterprising Stege lost all and died without a penny," Time Out, March 27, 1994, p. 2, column 4.
[92] Oliver, p. 1.
[93] Munro-Fraser, p. 424.
[94] Purcell, p. 648.
[95] Contra Costa County Standard, "Stege Powder Plant Blast; One Near Death," June 6, 1941, p. 1A.
[96] Oliver, p. 1.
[97] Max Wilhelm Von Bernewitz, *Cyanide Practice, 1910 – 1913*, Dewey Publishing Company: 1913, p. 327.
[98] Oliver, p. 1.

station property.[99] Later known as the U.S. Briquette Company, the plant appears to have operated at this location until at least 1917.[100] The U.S. Briquette Company operated an explosive manufacturing plant at what is now the Richmond Field Station, but its buildings were demolished sometime in the 1960s.[101]

The Oliver family aggressively promoted their products through advertising and publishing. The California Cap Company sponsored or published articles and book-length treatises on the use of explosives. Safety was a key element of the company image, a topic of company-sponsored technical writing and a selling point in advertisements.[102] The Tonite Powder Company's product was known even outside the United States, and by the end of the nineteenth century, the powder's explosive properties were considered comparable to the finest English products.[103] Oliver's sons Roland and Edwin Letts Oliver both graduated from UC Berkeley's College of Mining in 1900. Roland Oliver seems to have spent his entire career working in the family enterprises, while Edwin worked at California Cap between mining and other ventures. The Oliver family became benefactors of the university, and in 1917, the California Cap Company donated substantial amounts of their products to the College of Mining, including 500 electric detonators, 500 delayed action exploders, and 500 blasting caps.[104]

Eventually, the Tonite factory appears to have been incorporated into the California Cap Company. The Olivers also formed an entity named Pacific Cartridge Company circa 1910. The Pacific Cartridge Company operated from the California Cap plant during World War I.[105] By 1916, there were at least a dozen buildings on the site. When Oliver died in 1918, his son Roland Oliver took over as president of California Cap Company. By 1922, Roland's brother Leslie Oliver was assistant manager of the plant and Edwin Letts Oliver was a director.[106] Roland Oliver substantially expanded the California Cap Company after he took over as president. During this era the plant grew to include 150 buildings and a horse-drawn tram line.[107]

During the 1920s, the California Cap Company was granted patents on some of its inventions, including Albert Leslie Oliver's invention of an improved electric blasting cap. One of the improvements with Oliver's blasting cap is that the flame or sparks emitted by the fuse portion of the igniter would not come in contact with the explosive charge.[108] In 1925, Edward Barnes of the California Cap Company patented a new method of manufacturing fulminate of mercury. Traditional mercury fulminating,

[99] Oliver, p. 2.
[100] Hulanksi, p. 354.
[101] University of California, Berkeley (UC Berkeley),1973. *Sanitary Engineering Research Laboratory News Quarterly,* Volume XXIII, No. 2. Richmond, California. April
[102] Halbert Powers Gillette, *Rock Excavation:Methods and Cost,* M.C. Clark, New York: 1904, x.
[103] Manual Eissler, *A Handbook on Modern Explosives,* Crosby, Lockwood & son, London: 1897, p. 117.
[104] University of California, *The University of California Chronicle,* University of California Press, January, 1917, p. 92.
[105] R.L. Polk & Company, *Richmond and Contra Costa County Directory, 1914 – 1915*, Oakland, California: 1915.
[106] Pacific Mining News, p.222.
[107] University of California, Berkeley, *Current Conditions Report,* Prepared by Tetra Tech EM Inc., November 21, 2008, p. 11; for photographs of the California Cap Company's cap test, cap containers, fuses, and tools please see the Tulane University's Digital Media website: http://lunaweb.giza.tulane.edu/luna/servlet/view/search/?&q=california cap company.
[108] United States Patent Office, Albert Leslie Oliver, of Oakland, California, Assignor to California Cap Company of Oakland, California, a Corporation, Electric Blasting Cap, Application Filed January 27, 1920, Patented May 17, 1921, 1,878,269.

which had remained virtually unchanged since 1800, was limited to small quantities due to the volatility of gasses released by the reactions. Barnes's new process removed and condensed the volatile gasses, which allowed for the safe manufacture of much larger quantities of fulminate of mercury.[109]

During the late nineteenth and early twentieth century, the California Cap Company was one of the most important local employers.[110] As the twentieth century progressed, more heavy industry came to Contra Costa County, and by 1940, the county was second only to Los Angeles in overall industrial production.[111] The nineteenth-century California Cap Company was dwarfed by the scale of some of the newer enterprises, and its physical plant and technology were aging. During World War II, California Cap was able to stay open by producing delayed action incendiary bombs that were used against Japan.[112] The California Cap Company could not survive the transition to a peacetime economy, and by 1949, the plant was closed and the Oliver family was looking for a buyer.

3.4.3 University Research/Richmond Field Station

After World War II, UC Berkeley's Engineering Department needed an off-campus location to do experiments that required more space than a laboratory. Department Chair Morrough P. O' Brien and others in the department were doing experiments with sewage, sea water, and other materials unsuited to use on a crowded campus. They wanted a location that was not too remote, and The University purchased the California Cap Company from the Oliver family, for the use of the Engineering Department, in 1950.[113]

The Richmond Field Station has been the location of research overseen by numerous UC Berkeley departments over the years. The SERL was one of the first departments to undertake research at the site. SERL focused primarily on sewage treatment technology, and researched pollution control and disposal of solid and liquid waste.[114] Other early projects at the field station included sea water distillation, heat transfer, and cyclic stress research.[115]

At first the Department of Engineering used the buildings left behind by the California Cap Company. The Department established a machine shop, computer shop, receiving facility, mail service, and other facilities in addition to laboratories in the old detonator company buildings.[116] The current Buildings 102, 110, 118, 128, 150, 152 175, and 176 all date to the Cap Company era and have been repurposed for the University's use. The university constructed new buildings as funds became available, and by the mid-

[109] United States Patent Office, Edward A. Barnes of Oakland, California, Assignor to California Cap Company, of Oakland, California, A Corporation of California, Method of Manufacturing Fulminate of Mercury, Application Filed on April 13, 1922, Serial no. 548, 921,Patented January 13, 1925, 1,523,339,
[110] Marguerite Clausen, "On the Waterfront: An Oral History of Richmond, California," Regional Oral History Office, University of California, Berkeley, 1990, p. 21.
[111] Purcell, p. 649.
[112] Oliver, p. 1.
[113] P.H. McGauhey, "The Sanitary Engineering Research Laboratory: Administration, Research and Consultation, 1950-1975 – An Interview Conducted by Malca Call," Regional Oral History Office, University of California, Berkeley, 1974, p. 70.
[114] University of California, Berkeley, 2008, p. 13.
[115] University of California, Berkeley, Department of Engineering, "Richmond Field Station Open House," May 28, 1952, p. 3 – 4.
[116] McGauhey, p. 71.

1950s, five new buildings had been completed at the Richmond Field Station.[117] By the 1970s, the department had done many experiments at the Richmond Field Station that could not have been performed on the main campus.

The Richmond Field Station has been the location of research overseen by numerous UC Berkeley departments over the years. The Sanitary Engineering Research Laboratory (SERL) was one of the first departments to do research at the site. SERL focused primarily on sewage treatment technology and researched pollution control and disposal of solid and liquid waste.[118] Other early projects at the field station included heat transfer and cyclic stress research.[119]

Another laboratory that used the Richmond Field Station was the Sea Water Conversion Laboratory (SWCL). In 1952, Congress created and funded the Office of Saline Water in order to encourage desalination studies as a solution to water shortages.[120] In response, UC Berkeley Mechanical Engineering professor Everett D. Howe formed the SWCL at the Richmond Field Station in 1958.[121]

Building 154 was constructed circa 1957 for SWCL research, and the program continued to expand under Howe's direction for the next decade. SWCL eventually encompassed most of the buildings on the north side of Lark Drive, including Buildings 151, 155, 158, 177, and 180.[122]

In 2013, the Richmond Field Station continues to accommodate UC Berkeley's engineering research projects that cannot be done on the main campus and other space-intensive adjuncts to the University. SERL was eventually renamed, and is currently known as the Environmental Engineering and Health Sciences Laboratory (EEHSL). EEHSL has continued its presence at the Richmond Field Station into the twenty-first century, operating indoor and outdoor laboratories throughout the site.[123] The Northern Research Library Facility, the Asbestos Information Center, and the Earthquake Resource Center are among the University facilities at the site.[124] The Richmond Field Station also has non-UC tenants that include the EPA Region 9 Laboratory in Building 201.[125]

[117] University of California, Berkeley, Department of Engineering, "Guide for Engineering Field Station Inspection," undated, p. 3.
[118] University of California, Berkeley, 2008, p. 13.
[119] University of California, Berkeley, Department of Engineering, "Richmond Field Station Open House", May 28, 1952, p. 3–4.
[120] Heather Cooley, Peter H. Gleick, and Gary Wolff, "Desalination, With a Grain of Salt: A California Perspective," Pacific Institute, Oakland, California: 2006, p.11.
[121] University of California (System) Academic Senate, "1991, University of California: In Memoriam," 1991, Internet website: http://texts.cdlib.org/view?docId=hb4t1nb2bd&doc.view=frames&chunk.id=div00031&toc.depth=1&toc.id=.
[122] University of California, Berkeley, Files "Building 151", "Building 154", "Building 158", "Building 177", and "Building 180," located in vertical files in Room 148, Richmond Field Station.
[123] University of California, Berkeley, 2008, p. 13.
[124] University of California, Berkeley, 2008, p. 16 – 17.
[125] University of California, Berkeley, 2008, p. 21.

4. EVALUATION OF SIGNIFICANCE

The criteria for identifying historical resources under CEQA are in Section 15064.5(a)(2)-(3) of the CEQA Guidelines, according to the criteria outlined in Section 5024.1 of the California Public Resources Code. According to this code, properties listed in or formally determined eligible for listing in the NRHP are automatically eligible for listing in the CRHR. The CRHR criteria are largely based on the NRHP criteria, which are codified in 36 CFR Part 60 and explained in guidelines published by the Keeper of the National Register.[126]

Eligibility for listing on either the NRHP or the CRHR rests on both significance and integrity. A property must have both factors to be considered eligible. Loss of integrity, if sufficiently great, would overwhelm the historical significance of a resource and render it ineligible. Likewise, a resource can have complete integrity, but if it lacks significance, it must also be considered ineligible. The application of the four criteria and the definition of integrity are discussed below.

4.1 CRITERIA OF SIGNIFICANCE

Properties may be significant at the local, state, or national level.

4.1.1 National Register of Historic Places

National historical significance is judged in part by applying NRHP Criteria A through D:

- Criterion A: Association with events or trends significant to the broad patterns of our history;
- Criterion B: Association with the lives of significant individuals;
- Criterion C: A property that embodies the distinctive characteristics of a type, period, or method of construction that represents the work of a master or that possesses high artistic values;
- Criterion D: Has yielded or is likely to yield information important to history or prehistory.[127]

Properties that are less than 50 years old may also be evaluated under Criteria Consideration G:

- Criterion G: Properties that have achieved significance within the past 50 years. The National Register Criteria for Evaluation exclude properties that achieved significance within the past 50 years unless they are of exceptional importance.

[126] The most widely accepted guidelines are contained in the U.S. Department of Interior, National Park Service, "How to Apply the National Register Criteria for Evaluation," *National Register Bulletin 15* (Washington D.C.: US Government Printing, 1991, revised 1995 through 2002).
[127] Criterion D is largely applied to archaeological sites, so is not used in evaluating most historic architectural resources.

> Fifty years is a general estimate of the time needed to develop historical perspective and to evaluate significance. This consideration guards against the listing of properties of passing contemporary interest and ensures that the NRHP is a list of truly historic places.[128]

The NRHP definition of integrity is determined through applying seven factors to the historical resource: location, design, setting, workmanship, materials, feeling, and association. These criteria can be roughly grouped into the following types of integrity considerations:

- Location and setting relate to the relationship between the property and its environment;
- Design, materials, and workmanship, as they apply to historic buildings, relate to construction methods and architectural details; and
- Feeling and association, the least objective of the seven criteria, pertain to the overall ability of the property to convey a sense of the historical tie and place where it was constructed.

4.1.2 California Register of Historical Resources

The criteria for assessing a property for listing in the CRHR closely parallel those of the NRHP. CEQA requires consideration of the possible impacts on and the evaluation of historic resources using the criteria in the CRHR. Each resource must be assessed to determine whether it meets any of the criteria below, paraphrased as:

- Criterion 1: Resources associated with important events that made a significant contribution to broad patterns of our history;
- Criterion 2: Resources associated with the lives of persons important to our past;
- Criterion 3: Resources that embody the distinctive characteristics of a type, period, or method of construction, or represents the work of a master;
- Criterion 4: Resources that yielded, or may be likely to yield, information important in prehistory or history.[129]

The CRHR definition of integrity, and its special considerations for certain properties, is slightly different than that for the NRHP. Integrity is defined as "the authenticity of an historical resource's physical identity evidenced by the survival of characteristics that existed during the resource's period of significance." The CRHR further states that

[128] The most widely accepted guidelines are in the US Department of the Interior, National Park Service, "Guidelines for Applying the National Register Criteria for Evaluation," *National Register Bulletin 15* (Washington DC: US Government Printing, 1991, revised 1995 through 2002).

[129] California Code of Regulations, Sections 4850 through 4858; Office of Historic Preservation, Instructions for Nominating Historical Resources to the California Register of Historical Resources, August, 1997; as was the case with NRHP Criterion D, Criterion 4 is largely applied to archaeological sites, so is not used in evaluating most historic architectural resources.

eligible resources must "retain enough of their historic character or appearance to be recognizable as historical resources and to convey the reasons for their significance," and the CRHR lists the same seven aspects of integrity used for evaluating properties under the NRHP criteria. The CRHR's special considerations for certain property types are limited to: 1) moved buildings, structures, or objects; 2) historical resources achieving significance within the past 50 years; and 3) reconstructed buildings.

4.2 HISTORIC EVALUATION OF BUILDINGS IN THE DIRECT APE

The California Cap Company in its heyday comprised 150 buildings on its expansive site. The University took possession of the property in 1950, initially using the existing buildings for engineering laboratories. As time passed, UC Berkeley began altering the property to suit its changing needs. Over its seven decades of ownership, the University repurposed, remodeled, moved, or demolished almost all of the buildings left behind by the California Cap Company. The University altered the property by constructing a number of new buildings. The Richmond Field Station as a whole, therefore, does not retain sufficient integrity to be listed in the NRHP or the CRHR or as a historic district.

Despite the scope of the alterations to the property, a handful of buildings have been retained from the California Cap Company period. Three of these, Buildings 102, 150, and 175, were determined, through this report, to be historically significant. Despite meeting eligibility under Criterion A/1, Building 102 has been repeatedly altered over the decades and no longer retains sufficient integrity to be eligible for listing in the NRHP or the CRHR. Only Buildings 150 and 175 have retained sufficient integrity to be individually eligible for listing.

4.2.1 Building 102

Criterion A/1: Building 102 meets Criterion A/1 for its association with events significant to national, state, and local history. It is the oldest building on the Richmond Field Station, dating to the property's ranching era. The manufacturing activities that took place in Building 102 were central to the production processes of the California Cap Company, the first blasting cap company in the United States. The company also manufactured bombs in the building that were used against the Japanese during World War II.

Criterion B/2: Because this building is associated with important individuals significant to our past, it meets this criterion. Building 102 is the oldest of the extant buildings at the Richmond Field Station, and, therefore, it is the most notably associated with California Cap Company founder William Letts Oliver. Oliver was a significant figure in the history of explosives manufacture, responsible for the invention of a high-heat explosive named "Tonite", and the first manufacturer of blasting caps in the United States. Building 102 is

the only California Cap Company building specifically discussed in a document created in 1959 by William Letts Oliver's son Roland Oliver.[130]

Criterion C/3: The building does not embody the distinctive characteristics of a type, period, region, or method of construction, or represent the work of an important creative individual or possess high artistic values. Building 102 is a utilitarian building constructed piecemeal over many decades, so the building is not eligible to the NRHP for its architecture and does not meet this criterion.

Criterion D/4: In rare instances, buildings themselves can serve as sources of important information, but this building is not a principal source of important information in this regard. As a result, it does not meet this criterion.

Despite meeting Criteria A/1 and B/2 due to Building 102's association with the California Cap Company and William Letts Oliver, the building's integrity has suffered due to repeated alterations. Only its location has remained unchanged, and its historic integrity of setting, design, materials, workmanship, feeling, and association has all been compromised. As demonstrated by a comparison of historic and contemporary photographs (Photograph 1, Photograph 2, and Photograph 3) of the building, extensive alterations to the primary façade of Building 102 have rendered it virtually indistinguishable from buildings constructed in the late twentieth century. These alterations, which include replacement of exterior siding, replacement of windows, alterations to the size of window openings, a modification of the roof from gabled to flat, and other changes, have drastically impaired the building's ability to convey historic significance. Therefore, the building is not eligible for the NRHP or the CRHR.

4.2.2 Building 110

Criterion A/1: No particular association was found between Building 110 and events significant to national, state, or local history. Although the California Cap Company was the first blasting cap manufacturer in the United States there is no indication that the research that took place in Building 110 was central to the development of the plant or its technical processes, so the building does not meet this criterion and is not eligible for inclusion in the NRHP or CRHR for historical significance.

Criterion B/2: Building 110 dates from the period when William Letts Oliver and his son Roland Oliver were making important breakthroughs in the explosives industry. However, no particular association has been found between the building and members of the Oliver family, or with other important individuals significant to our past, so the building does not meet this criterion and is not eligible for the NRHP or CRHR for association with important individuals.

Criterion C/3: The building does not embody the distinctive characteristics of a type, period, region, or method of construction, or represent the work of an important

[130] Oliver, p.1.

creative individual or possess high artistic values. Building 102 is a vernacular building of a type commonly constructed from the late nineteenth to the early twentieth century, so the building is not eligible under this criterion.

Criterion D/4: In rare instances, buildings themselves can serve as sources of important information, but this building is not a principal source of important information in this regard and does not meet this criterion.

Building 110 does not meet the significance criteria for listing in the NRHP or CRHR.

4.2.3 Building 111

Criteria A/1 and B/2: Building 111 does not meet these criteria for listing in NRHP or CRHR because it lacks historical significance. The structure has been a storage facility throughout its lifetime and lacks the strength of association necessary to be considered historically significant in relation to any particular events or persons.

Criterion C/3: The utilitarian building lacks any identifiable architectural stylistic design and does not embody distinctive architectural or engineering qualities of type, period, or method of construction. As a result, it does not meet this criterion.

Criterion D/4: In rare instances, buildings themselves can serve as sources of important information, but this building is not a principal source of important information in this regard. As a result, this building does not meet this criterion.

Criterion G: As a storage facility, Building 111 does not meet the standard of exceptional importance required for properties under 50 years old to be eligible to the NRHP.

Building 111 does not meet the significance criteria for listing in the NRHP or CRHR.

4.2.4 Building 112

Criteria A/1 and B/2: Building 112 does not meet the criteria for listing in NRHP or CRHR because it lacks historical significance. The structure has served various functions throughout its lifetime and lacks the strength of association necessary to be considered historically significant in relation to any particular events or persons.

Criterion C/3: The simple building lacks any identifiable architectural stylistic design and does not embody distinctive architectural or engineering qualities of type, period, or method of construction.

Criterion D/4: In rare instances, buildings themselves can serve as sources of important information, but this building is not a principal source of important information in this regard.

Building 112 does not meet the significance criteria for listing in the NRHP or CRHR.

4.2.5 Building 113

Criteria A/1 and B/2: Building 113 does not meet the criteria for listing in NRHP or CRHR because it lacks historical significance. The structure has been a storage facility throughout its lifetime and lacks the strength of association necessary to be considered historically significant in relation to any particular events or persons.

Criterion C/3: The utilitarian building lacks any identifiable architectural stylistic design and does not embody distinctive architectural or engineering qualities of type, period, or method of construction.

Criterion D/4: In rare instances, buildings themselves can serve as sources of important information, but this building is not a principal source of important information in this regard.

Criterion G: As a storage facility, Building 113 does not meet the standard of exceptional importance required for properties less than 50 years old to be eligible to the NRHP.

Building 113 does not meet the significance criteria for listing in the NRHP or CRHR.

4.2.6 Building 114

Criteria A/1 and B/2: Building 114 does not meet the criteria for listing in NRHP or CRHR because it lacks historical significance. The structure has primarily been used for storage throughout its lifetime and lacks the strength of association necessary to be considered historically significant in relation to any particular events or persons.

Criterion C/3: The simple building lacks any identifiable architectural stylistic design and does not embody distinctive architectural or engineering qualities of type, period, or method of construction.

Criterion D/4: In rare instances, buildings themselves can serve as sources of important information, but this building is not a principal source of important information in this regard.

Building 114 does not meet the significance criteria for listing in the NRHP or CRHR.

4.2.7 Building 116

Criteria A/1 and B/2: Building 116 does not meet the criteria for listing in NRHP or CRHR because it lacks historical significance. The structure has primarily been used for storage throughout its lifetime and lacks the strength of association necessary to be considered historically significant in relation to any particular events or persons.

Criterion C/3: The utilitarian prefabricated building lacks any identifiable architectural stylistic design and does not embody distinctive architectural or engineering qualities of type, period, or method of construction.

Criterion D/4: In rare instances, buildings themselves can serve as sources of important information, but this building is not a principal source of important information in this regard.

Building 116 does not meet the significance criteria for listing in the NRHP or CRHR.

4.2.8 Building 117

Criteria A/1 and B/2: Building 117 does not meet the criteria for listing in NRHP or CRHR because it lacks historical significance. The structure has had various functions throughout its lifetime and lacks the strength of association necessary to be considered historically significant in relation to any particular events or persons.

Criterion C/3: The utilitarian building lacks any identifiable architectural stylistic design and does not embody distinctive architectural or engineering qualities of type, period, or method of construction.

Criterion D/4: In rare instances, buildings themselves can serve as sources of important information, but this building is not a principal source of important information in this regard.

Building 117 does not meet the significance criteria for listing in the NRHP or CRHR.

4.2.9 Building 118

Criteria A/1 and B/2: Building 118 does not meet the criteria for listing in NRHP or CRHR because it lacks historical significance. The structure has had various functions throughout its lifetime and lacks the strength of association necessary to be considered historically significant in relation to any particular events or persons.

Criterion C/3: The utilitarian building lacks any identifiable architectural stylistic design and does not embody distinctive architectural or engineering qualities of type, period, or method of construction.

Criterion D/4: In rare instances, buildings themselves can serve as sources of important information, but this building is not a principal source of important information in this regard.

Building 118 does not meet the significance criteria for listing in the NRHP or CRHR.

4.2.10 Building 120

Criteria A/1 and B/2: Building 120 does not meet the criteria for listing in NRHP or CRHR because it lacks historical significance. The structure has been used for storage throughout its lifetime and lacks the strength of association necessary to be considered historically significant in relation to any particular events or persons.

Criterion C/3: The utilitarian building lacks any identifiable architectural stylistic design and does not embody distinctive architectural or engineering qualities of type, period, or method of construction.

Criterion D/4: In rare instances, buildings themselves can serve as sources of important information, but this building is not a principal source of important information in this regard.

Building 120 does not meet the significance criteria for listing in the NRHP or CRHR.

4.2.11 Building 121

Criteria A/1 and B/2: Building 121 does not meet the criteria for listing in the NRHP or CRHR because it lacks historical significance. The structure has been used for vehicle storage throughout its lifetime and lacks the strength of association necessary to be considered historically significant in relation to any particular events or persons.

Criterion C/3: The utilitarian building lacks any identifiable architectural stylistic design and does not embody distinctive architectural or engineering qualities of type, period, or method of construction.

Criterion D/4: In rare instances, buildings themselves can serve as sources of important information, but this building is not a principal source of important information in this regard.

Building 121 does not meet the significance criteria for listing in the NRHP or CRHR.

4.2.12 Building 125

Criterion A/1: No particular association was found between the Building 125 and events significant to national, state, or local history. Although the California Cap Company was the first blasting cap manufacturer in the United States there is no indication that Building 125, a warehouse building, was central to the development of the plant or its technical processes, so the building is not eligible for inclusion in the NRHP or CRHR for historical significance.

Criterion B/2: Although William Letts Oliver and his son Roland Oliver were significant in the history of the explosives industry, no particular association was found between the Oliver family and the building. It lacks the strength of association

necessary to be considered historically significant in relation to any particular persons (Criteria B/2).

Criterion C/3: The building does not embody the distinctive characteristics of a type, period, region, or method of construction, or represent the work of an important creative individual or possess high artistic values (Criterion C/3). Building 125 is a vernacular building of a type commonly constructed from the late nineteenth to the early twentieth century, so the building is not eligible to the NRHP for its architecture.

Criterion D/4: In rare instances, buildings themselves can serve as sources of important information, but this building is not a principal source of important information in this regard (Criterion D/4).

Building 125 does not meet the significance criteria for listing in the NRHP or CRHR.

4.2.13 Building 128

Criterion A/1: Building 128 does not meet the criteria for listing in the NRHP or CRHR because it lacks historical significance. Although the California Cap Company was the first blasting cap manufacturer in the United States there is no indication that Building 128, as a press house, was central to the development of the plant and its technical processes. It has had a variety of uses over its lifetime, so it lacks the strength of association to be considered historically significant in relation to any particular events in national, state, or local history to (Criterion A/1).

Criterion B/2: Although William Letts Oliver and his son Roland Oliver were significant in the history of the explosives industry, no particular association was found between the Oliver family and the building. It lacks the strength of association necessary to be considered historically significant in relation to any particular persons.

Criterion C/3: Building 128 was constructed in a utilitarian style, with materials commonly used in industrial structures during the early twentieth century. Alterations were done and additions were constructed over the years in response to changing needs. It does not embody the distinctive characteristics of a type, period, region, or method of construction, or represent the work of an important creative individual or possess high artistic values.

Criterion D/4: In rare instances, buildings themselves can serve as sources of important information, but this building is not a principal source of important information in this regard.

Building 128 does not meet the significance criteria for listing in the NRHP or CRHR.

4.2.14 Building 149

Criteria A/1 and B/2: Building 149 does not meet the criteria for listing in NRHP or CRHR because it lacks historical significance. The structure has been used for a variety of purposes throughout its lifetime and lacks the strength of association necessary to be considered historically significant in relation to any particular events or persons.

Criterion C/3: The utilitarian building lacks any identifiable architectural stylistic design and does not embody distinctive architectural or engineering qualities of type, period, or method of construction.

Criterion D/4: In rare instances, buildings themselves can serve as sources of important information, but this building is not a principal source of important information in this regard.

Criterion G: As a storage facility, Building 149 does not meet the standard of exceptional importance required for properties less than 50 years old to be eligible to the NRHP.

Building 149 does not meet the significance criteria for listing in the NRHP or CRHR.

4.2.15 Building 150

Criterion A/1: Building 150 meets Criterion A/1 because it is associated with the early explosives industry in the United States. The California Cap company was the oldest blasting manufacturer in the East Bay. Blasting caps, or detonators, were an important safety innovation, invented only a few years before California Cap was opened.[131] Several other explosives factories were opened in Contra Costa County after the Tonite Powder and California Cap companies, and from the 1880s into the twentieth century, the East Bay produced most of the explosives products in California. High-explosive powder and blasting caps were essential to mining, road-building, and other economically important activities in California. These factories also produced munitions that were used during wartime. The manufacturing activities in Building 150, specifically wire insulating and wire saturating, were central to the production processes of the California Cap Company, the first blasting cap company in the United States. Insulated wire was required for blasting caps, one of the primary products of the plant. Building 150 is closely associated with Building 175, the California Cap Company's primary building.

Criterion B/2: Although William Letts Oliver and his son Roland Oliver were significant in the history of the explosives industry, no particular association was found between the Oliver family and the building, so it lacks the strength of association necessary to be considered historically significant in relation to any particular persons.

[131] A detonator is a small explosive charge that ignites a larger charge, allowing for the use of a more stable and thus safer type of explosive.

Criterion C/3: The building does not embody the distinctive characteristics of a type, period, region, or method of construction, or represent the work of an important creative individual or possess high artistic values. Building 150 is a simple industrial building, so it is not eligible to the NRHP or CRHR for its architecture.

Criterion D/4: In rare instances, buildings themselves can serve as sources of important information, but this building is not a principal source of important information in this regard.

Eligibility for listing in either the NRHP or the CRHR rests on significance and integrity. A property must have both factors to be considered eligible. Loss of integrity, if sufficiently great, would overwhelm the historical significance of a resource and render it ineligible. Integrity of a historic resource is measured by applying seven factors: location, design, setting, workmanship, materials, feeling, and association. Building 150 has retained a sufficient level of integrity in all measures. Although the building has undergone alterations, these changes have not compromised its historic integrity. Additional square footage at the rear of the building is not visible from the street, leaving the primary façade's ability to convey its historic significance intact. Furthermore, the main addition to Building 150 was constructed to complement the primary volume of the building in 1946, within the period of significance (1910-1949) for the California Cap Company. Therefore, Building 150 continues to convey its historic significance as a California Cap Company manufacturing facility.

4.2.16 Building 152

Criterion A/1: No particular association was found between the Building 152 and events significant to national, state, or local history. Although the California Cap Company was the first blasting cap manufacturer in the United States there is no indication that the activities that took place in Building 152 were central to the development of the plant or its technical processes. The building has been used for a variety of purposes throughout its lifetime, so the building is not eligible for inclusion in the NRHP or CRHR under this criterion.

Criterion B/2: Although William Letts Oliver and his son Roland Oliver were significant in the history of the explosives industry, no particular association was found between the Oliver family and the building., so it lacks the strength of association necessary to be considered historically significant in relation to any particular persons.

Criterion C/3: The building does not embody the distinctive characteristics of a type, period, region, or method of construction, or represent the work of an important creative individual or possess high artistic values. Building 152 is a vernacular building of a type that was commonly constructed from the late nineteenth to the early twentieth century, so the building is not eligible to the NRHP or CRHR under this criterion.

Criterion D/4: In rare instances, buildings themselves can serve as sources of important information, but this building is not a principal source of important information in this regard.

Building 152 does not meet the significance criteria for listing in the NRHP or CRHR.

4.2.17 Building 153

Criteria A/1 and B/2: Building 153 does not meet the criteria for listing in NRHP or CRHR because it lacks historical significance. The structure has been used for a variety of purposes throughout its lifetime and lacks the strength of association necessary to be considered historically significant in relation to any particular events or persons.

Criterion C/3: The utilitarian building lacks any identifiable architectural stylistic design and does not embody distinctive architectural or engineering qualities of type, period, or method of construction.

Criterion D/4: In rare instances, buildings themselves can serve as sources of important information, but this building is not a principal source of important information in this regard.

Building 153 does not meet the significance criteria for listing in the NRHP or CRHR.

4.2.18 Building 163

Criteria A/1 and B/2: Building 163 does not meet the criteria for listing in NRHP or CRHR because it lacks historical significance. The structure has been used for research throughout its lifetime and lacks the strength of association necessary to be considered historically significant in relation to any particular events or persons.

Criterion C/3: The utilitarian building lacks any identifiable architectural stylistic design and does not embody distinctive architectural or engineering qualities of type, period, or method of construction.

Criterion D/4: In rare instances, buildings themselves can serve as sources of important information, but this building is not a principal source of important information in this regard.

Criterion G: As a research facility Building 163 does not meet the standard of exceptional importance required for properties less than 50 years old to be eligible to the NRHP.

Building 163 does not meet the significance criteria for listing in the NRHP or CRHR.

4.2.19 Building 175

Criterion A/1: Building 175 meets Criterion A/1 because it is associated with the early explosives industry in the United States, as it was part of the first blasting cap company in the United States. The California Cap company was also the oldest blasting manufacturer in the East Bay area. Blasting caps, or detonators, were an important safety innovation, invented only a few years before California Cap was opened.[132] Several other explosives factories were opened in Contra Costa County after the Tonite Powder and California Cap companies, and from the 1880s into the twentieth century, the East Bay produced most of the explosives products in California. High-explosive powder and blasting caps were essential to mining, road-building, and other economically important activities in California. These factories also produced munitions that were used during wartime.

The manufacturing activities in Building 175, specifically cartridge loading and cartridge production, were central to the production processes of the Pacific Cartridge Company and the California Cap Company. Building 175 was one of the plant's primary manufacturing buildings in the 1910s. The company was administered from the office in the building. The building is at what was the geographical center of the plant between 1900 and the 1940s, and it is featured in historic photographs as the Pacific Cartridge and the California Cap Company's primary building.

Criterion B/2: Although William Letts Oliver and his son Roland Oliver were significant in the history of the explosives industry, no particular association was found between the Oliver family, the architect or builder, or any person associated with the building, so it lacks the strength of association necessary to be considered historically significant in relation to any particular persons under Criterion B/2.

Criterion C/3: The building does not embody the distinctive characteristics of a type, period, region, or method of construction, or represent the work of an important creative individual or possess high artistic values. Building 175 is an industrial building with little ornamentation, so it is not eligible to the NRHP or CRHR under this criterion.

Criterion D/4: In rare instances, buildings themselves can serve as sources of important information, but this building is not a principal source of important information in this regard.

Eligibility for listing on either the NRHP or the CRHR rests on significance and integrity. A property must have both factors to be considered eligible. Loss of integrity, if sufficiently great, would overwhelm the historical significance of a resource and render it ineligible. Integrity of a historic resource is measured by applying seven factors: location, design, setting, workmanship, materials, feeling, and association. Building 175 retains a

[132] A detonator is a small explosive charge that ignites a larger charge, allowing for the use of a more stable and thus safer type of explosive.

sufficient level of integrity in all measures. Although the building has undergone alterations, including the additional square footage constructed at the rear of the building, this addition is not visible from the street, leaving the primary façade intact. The replacement of the original wood frame sashes affects the building's integrity of design and materials. However, as demonstrated by a comparison of photographs taken in 2013 (Photograph 27) and ca. 1910 (Photograph 28), Building 175 is easily recognizable from historic photographs from the California Cap Company era. Despite some alterations, the building retains its ability to convey its significance as the company's historic administration building, and thus retains sufficient integrity to be considered eligible.

4.2.20 Building 176

Criteria A/1 and B/2: Building 176 does not meet the criteria for listing in NRHP or CRHR because it lacks historical significance. The structure has been used for storage throughout its lifetime and lacks the strength of association necessary to be considered historically significant in relation to any particular events or persons.

Criterion C/3: The utilitarian building lacks any identifiable architectural stylistic design and does not embody distinctive architectural or engineering qualities of type, period, or method of construction.

Criterion D/4: In rare instances, buildings themselves can serve as sources of important information, but this building is not a principal source of important information in this regard.

Building 176 does not meet the significance criteria for listing in the NRHP or CRHR.

4.2.21 Building 178

Criteria A/1 and B/2: Building 178 does not meet the criteria for listing in the NRHP or CRHR because it lacks historical significance. The structure has had a variety of uses throughout its lifetime and lacks the strength of association necessary to be considered historically significant in relation to any particular events or persons.

Criterion C/3: The utilitarian building lacks any identifiable architectural stylistic design and does not embody distinctive architectural or engineering qualities of type, period, or method of construction.

Criterion D/4: In rare instances, buildings themselves can serve as sources of important information, but this building is not a principal source of important information in this regard.

Criterion G: As a multiple use building, Building 178 does not meet the standard of exceptional importance required for properties less than 50 years old to be eligible to the NRHP (Criterion G).

Building 178 does not meet the significance criteria for listing in the NRHP or CRHR.

4.2.22 Building 185

Criteria A/1 and B/2: Building 185 does not meet the criteria for listing in NRHP or CRHR because it lacks historical significance. The structure has been used for a variety of purposes throughout its lifetime and lacks the strength of association necessary to be considered historically significant in relation to any particular events or persons.

Criterion C/3: The utilitarian building lacks any identifiable architectural stylistic design and does not embody distinctive architectural or engineering qualities of type, period, or method of construction.

Criterion D/4: In rare instances, buildings themselves can serve as sources of important information, but this building is not a principal source of important information in this regard.

Criterion G: As a multiple use building, Building 185 does not meet the standard of exceptional importance required for properties less than 50 years old to be eligible to the NRHP under this criterion.

Building 185 does not meet the significance criteria for listing in the NRHP or CRHR.

4.2.23 Building 197

Criteria A/1 and B/2: Building 197 does not meet the criteria for listing in NRHP or CRHR because it lacks historical significance. The structure has had a variety of uses throughout its lifetime and lacks the strength of association necessary to be considered historically significant in relation to any particular events or persons.

Criterion C/3: The utilitarian building lacks any identifiable architectural stylistic design and does not embody distinctive architectural or engineering qualities of type, period, or method of construction.

Criterion D/4: In rare instances, buildings themselves can serve as sources of important information, but this building is not a principal source of important information in this regard.

Criterion G: As a storage facility, Building 197 does not meet the standard of exceptional importance required for properties less than 50 years old to be eligible under this criterion.

Building 197 does not meet the significance criteria for listing in the NRHP or CRHR.

4.2.24 Building 275

Criteria A/1 and B/2: Building 275 does not meet the criteria for listing in NRHP or CRHR because it lacks historical significance. The structure has been used for research throughout its lifetime and lacks the strength of association necessary to be considered historically significant in relation to any particular events or persons.

Criterion C/3: The utilitarian building lacks any identifiable architectural stylistic design and does not embody distinctive architectural or engineering qualities of type, period, or method of construction.

Criterion D/4: In rare instances, buildings themselves can serve as sources of important information, but this building is not a principal source of important information in this regard.

Building 275 does not meet the significance criteria for listing in the NRHP or CRHR.

4.2.25 Building 276

Criterion A/1 and B/2: Building 276 does not meet the criteria for listing in the NRHP or CRHR because it lacks historical significance. The structure has been used for research throughout its lifetime and lacks the strength of association necessary to be considered historically significant in relation to any particular events (Criterion A/1 or persons B/2).

Criteria C/3 and D/4: The utilitarian building lacks any identifiable architectural stylistic design and does not embody distinctive architectural or engineering qualities of type, period, or method of construction (Criterion C/3). In rare instances, buildings themselves can serve as sources of important information, but this building is not a principal source of important information in this regard (Criterion D/4).

Building 276 does not meet the significance criteria for listing in the NRHP or CRHR.

4.3 HISTORIC EVALUATION OF BUILDINGS IN THE INDIRECT APE

The buildings over 45 years old adjacent to the Phase 1 footprint, in the indirect APE, were evaluated for their historic significance and determined ineligible for listing in the NRHP or CRHR.

4.3.1 Building 151

Criterion A/1 and B/2: Building 151 does not meet the criteria for listing in NRHP or CRHR under Criterion A/1 because it lacks historical significance. The historical record does not indicate that Building 151 was important in local, state, or national events or trends. While academic research is important to anyone directly involved in the field, the historical record must show that the research or studies had a significant

impact on historical events and trends. The SWCL and Building 151 are not significant in this regard (Criterion A/1). None of the persons associated with Building 151 had a significant impact on local, state, or national history. Therefore, the building lacks the strength of association necessary to be considered historically significant in relation to any particular persons (Criterion B/2).

Criterion C/3 and D/4: Building 151 lacks any identifiable architectural stylistic design and does not embody distinctive architectural or engineering qualities of type, period, or method of construction and is a simple, prefabricated building (Criterion C/3). In rare instances, buildings themselves can serve as sources of important information; however, this building is not a principal source of important information in this regard (Criterion D/4).

Building 151 does not meet the significance criteria for listing in the NRHP or CRHR.

4.3.2 Building 154

Criterion A/1 and B/2: Building 154 does not meet the criteria for listing in NRHP or CRHR under Criterion A/1 because it lacks historical significance. The historical record does not indicate that Building 154 was important in local, state, or national events or trends. While academic research is important to anyone directly involved in that field, in order to be eligible for the NRHP or CRHR, the historical record must show that the research or studies had a significant impact on historical events and trends. The SWCL and Building 154 are not significant in this regard. None of the persons associated with Building 154 had a significant impact on local, state, or national history. Therefore, the building lacks the strength of association necessary to be considered historically significant in relation to any particular persons (Criterion B/2).

Criterion C/3 and D/4: Building 154 lacks any identifiable architectural stylistic design and is a simple prefabricated building. It does not embody distinctive architectural or engineering qualities of type, period, or method of construction (Criterion C/3). In rare instances, buildings themselves can serve as sources of important information; however, this building is not a principal source of important information in this regard (Criterion D/4).

Building 154 does not meet the significance criteria for listing in the NRHP or CRHR.

4.3.3 Building 155

Criterion A/1 and B/2: although the Olivers were significant in the history of the explosives industry, no particular association was found between the Oliver family and Building 155. Although the structure was used for University research by Professor Howe and others throughout its lifetime, none of the available historical evidence suggests that the building has association with persons important to the development of the desalination field. Academic research is important to those working directly in that

specific field, however none of the persons associated with Building 155 had a significant impact on local, state, or national history. The building lacks the strength of association necessary to be considered historically significant in relation to any particular persons (Criterion B/2).

Criterion C/3 and D/4: the building does not embody the distinctive characteristics of a type, period, region, or method of construction, or represent the work of an important creative individual or possess high artistic values. Building 155 is a vernacular building of a type that was commonly constructed in the early twentieth century. It has been heavily altered over the years since the University took possession in 1950, so the building is not eligible for the NRHP or CRHR for its architecture (Criterion C/3). In rare instances, buildings themselves can serve as sources of important information; however, this building is not a principal source of important information (Criterion D/4).

Building 155 does not meet the significance criteria for listing in the NRHP or CRHR.

4.3.4 Building 158

Criterion A/1 and B/2: Building 158 does not meet the criteria for listing in the NRHP or CRHR under Criterion A/1 because it lacks historical significance. The historical record does not indicate that Building 158 was important in local, state, or national events or trends. While academic research is important to anyone directly involved in the field, the historical record must show that the research or studies had a significant impact on historical events and trends in order to be eligible for the NRHP or CRHR. Building 158 is not significant in this regard (Criterion A/1). Although the structure was used for University research by Professor Howe and others throughout its lifetime, none of the available evidence suggests that the building has association with persons important to the development of the desalination field. None of the persons associated with Building 158 have had a significant impact on local, state, or national history. Therefore, the building lacks the strength of association necessary to be considered historically significant in relation to any particular persons (Criterion B/2).

Criterion C/3 and D/4: Building 158 lacks any identifiable architectural stylistic design and does not embody distinctive architectural or engineering qualities of type, period, or method of construction (Criterion C/3). In rare instances, buildings themselves can serve as sources of important information; however, this building is not a principal source of important information in this regard (Criterion D/4).

Building 158 does not meet the significance criteria for listing in the NRHP or CRHR.

4.3.5 Building 177

Criterion A/1 and B/2: no association was found between Building 177 and events significant to national, state, or local history (Criterion A/1). Although the California Cap Company was the first blasting cap manufacturer in the United States, there is no

indication that the activities that took place in Building 177 were central to the development of the plant or its technical processes. Academic research took place in the building after the University took over the property, and while academic research is important to anyone directly involved in the field, the historical record must show that the research or studies had a significant impact on historical events and trends in order to merit eligibility in the NRHP or CRHR. The historical record does not indicate that Building 177 is eligible in this regard under Criterion A/1. Although the Olivers were significant in the history of the explosives industry, no particular association was found between the Oliver family and the building. Although Building 177 was used for University research by Professor Howe and others throughout its lifetime, none of the available evidence suggests that the building has association with persons important to the development of the desalination field. As stated, academic research is important to those working directly in that specific field; however, none of the persons associated with Building 177 had a significant impact on local, state, or national history. Therefore, the building lacks the strength of association necessary to be considered historically significant in relation to any particular persons (Criterion B/2).

Criterion C/3 and D/4: the building does not embody the distinctive characteristics of a type, period, region, or method of construction, or represent the work of an important creative individual or possess high artistic values. Building 177 is a vernacular building of a type that was commonly constructed in the early twentieth century. It has been heavily altered over the years since the University took possession in 1950, and the building is not eligible for listing in the NRHP or CRHR for its architecture (Criterion C/3). In rare instances, buildings themselves can serve as sources of important information; however, this building is not a principal source of important information in this regard (Criterion D/4).

Building 177 does not meet the significance criteria for listing in the NRHP or CRHR

4.3.6 Building 180

Criterion A/1 and B/2: no association was found between Building 180 and events significant to national, state, or local history (Criterion A/1). Although the California Cap Company was the first blasting cap manufacturer in the United States, there is no indication that the activities that took place in Building 180 were central to the development of the plant or its technical processes. The building is not eligible for inclusion in the NRHP or CRHR for historical significance (Criterion A/1). Although the Olivers were significant in the history of the explosives industry, no particular association was found between the Oliver family and the building. The building was used for University research by Professor Howe and others throughout its lifetime; however, none of the available historical evidence suggests that the building has association with persons important to local, state, or national history. None of the persons associated with Building 180 have the strength of association necessary to be considered eligible under Criterion B/2.

Criterion C/3 and D/4: the building does not embody the distinctive characteristics of a type, period, region, or method of construction, or represent the work of an important creative individual or possess high artistic values. Building 180 is a combination of five buildings joined to make one building complex and has alteration dates from 1930 through 1950. The building is not eligible for the NRHP or CRHR for its architecture (Criterion C/3). In rare instances, buildings themselves can serve as sources of important information; however, this building is not a principal source of important information in this regard (Criterion D/4).

Building 180 does not meet the significance criteria for listing in the NRHP or CRHR.

4.3.7 Building 277

Criterion A/1 and B/2: Building 277 does not meet the criteria for listing in NRHP or CRHR because it lacks historical significance. The structure has primarily been used for storage throughout its lifetime and lacks the strength of association necessary to be considered historically significant in relation to any particular events or persons (Criteria A/1 and B/2).

Criterion C/3 and D/4: the utilitarian building lacks any identifiable architectural stylistic design and does not embody distinctive architectural or engineering qualities of type, period, or method of construction (Criterion C/3). In rare instances, buildings themselves can serve as sources of important information, but this building is not a principal source of important information (Criterion D/4).

Building 277 does not meet the significance criteria for listing in the NRHP or CRHR.

4.4 PERIOD OF SIGNIFICANCE FOR ANY ELIGIBLE RESOURCES

The California Cap Company operated on the site from 1877 – 1949. Although its most innovative products have been created during the nineteenth century, the plant produced cartridges during World War I and incendiary bombs during World War II. Prior to World War II, it was one of the most important local employers in Richmond. Buildings 150 and 175 were constructed in 1910 and used for the California Cap Company until 1949, when the Cap Company ceased production. The period of significance for these buildings is from their construction in 1910 until 1949, when they were no longer used for the explosives industry.

5. CONCLUSION

This report concludes that there are two buildings, Buildings 150 and 175, which are eligible for listing in the NRHP and the CRHR for their association with the California Cap Company. These two buildings could be significantly adversely impacted by demolition, alteration, removal, or a change in their historic setting. Any future projects should be analyzed to ensure that these buildings are not significantly impacted, and if there is a significant adverse impact, mitigation measures should be implemented to reduce that impact.

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7. PREPARER'S QUALIFICATIONS

Tetra Tech Historian/Architectural Historian Kara Brunzell meets the history and architectural history professional qualifications, as outlined by the federal government in Title 36, Code of Federal Regulations, Part 61. She has an MA in History/Public History from California State University, Sacramento.

Tetra Tech Historian/Architectural Historian Julia Mates meets the history and architectural history professional qualifications, as outlined by the federal government in Title 36, Code of Federal Regulations, Part 61. She has an MA in History/Public History from California State University, Sacramento.

APPENDIX A

DPR 523 FORMS

BUILDINGS IN THE DIRECT APE

State of California – The Resources Agency
DEPARTMENT OF PARKS AND RECREATION
PRIMARY RECORD

Primary # _____
HRI # _____
Trinomial _____
NRHP Status Code _____
Other Listings _____
Review Code _____ Reviewer _____ Date _____

 ***Resource Name or #** (Assigned by recorder) Richmond Field Station Building 102

P1. Other Identifier: Richmond Field Station Building 102

***P2. Location:** ☐ **Not for Publication** ☒ **Unrestricted** ***a. County** Contra Costa
and (P2b and P2c or P2d. Attach a Location Map as necessary.)
***b. USGS 7.5′ Quad** Richmond **Date** 1984 **T**___; **R** ____; __ ¼ **of Sec** ___; Diablo **B.M.**
c. Address _____ City _____ Zip_____
d. UTM: (give more than one for large and/or linear resources) Zone 10 ; 558491 mE/ 4196289 mN
e. Other Locational Data: (e.g., parcel #, directions to resource, elevation, etc., as appropriate) Assessor Parcel Number

***P3a. Description:** (Describe resource and its major elements. Include design, materials, condition, alterations, size, setting, and boundaries)
Building 102 is near the southern edge of the Richmond Field Station campus. It is situated at the intersection of Heron Drive and Egret Way with its primary façade facing southeast. The 6,737 square foot building is single story with an irregular plan. It was constructed circa 1860 and is currently used for research. The building has been altered over its lifetime.

Originally, Building 102 was a produce warehouse with a rectangular plan at the corner of Heron Drive and Egret Way. When the Tonite Powder and California Cap companies were constructed along the waterfront in 1877 the warehouse served as a crucial safety barrier between explosive powder and detonators. (See Continuation Sheet)
***P3b. Resource Attributes:** (List attributes and codes) HP15: Educational building, HP39: Other

***P4. Resources Present:** ☒ Building ☐ Structure ☐ Object ☐ Site ☐ District ☐ Element of District ☐ Other (Isolates, etc.)

P5b. Description of Photo: (View, date, accession #) Photograph 1 camera facing west, January 4, 2013.

***P6. Date Constructed/Age and Sources:**
☒ Historic ☐ Prehistoric ☐ Both
Circa 1860s
***P7. Owner and Address:**
U.C. Berkeley
1301 South 46th Street
Richmond, California 94804
***P8. Recorded by:** (Name, affiliation, address)
Kara Brunzell & Julia Mates
Tetra Tech
1999 Harrison Street, Ste 500
Oakland, CA 94612

***P9. Date Recorded:** January 4, 2013
***P10. Survey Type:** (Describe) Intensive

***P11. Report Citation:** (Cite survey report and other sources, or enter "none.") *Historic Properties Survey Report for Portions of the Richmond Field Station* prepared by Tetra Tech, Inc, 2013.

***Attachments:** NONE ☒ Location Map ☐ Sketch Map ☒ Continuation Sheet ☒ Building, Structure, and Object Record ☐ Archaeological Record ☐ District Record ☐ Linear Feature Record ☐ Milling Station Record ☐ Rock Art Record ☐ Artifact Record ☐ Photograph Record ☐ Other (list) _____

***NRHP Status Code** 6Z

***Resource Name or #** (Assigned by recorder) Richmond Field Station Building 102

B1. Historic Name: California Cap Company Building 30

B2. Common Name: Building 102

B3. Original Use: Produce warehouse B4. Present Use: Research

***B5. Architectural Style:** Vernacular

***B6. Construction History:** (Construction date, alteration, and date of alterations) Constructed circa 1860; 1877: Converted from warehouse to explosives manufacturing facility; Circa 1930: Additions to rear of building; Circa 1950: Further additions to rear of building; Circa 1970s: Façade renovation, flat roof installed

***B7. Moved?** ☒ **No** ☐ **Yes** ☐ **Unknown** **Date:** _____ **Original Location:** _____

***B8. Related Features:** _____

B9. Architect: Unknown b. Builder: Unknown

***B10. Significance: Theme** History **Area** Richmond Field Station

Period of Significance 1877 - 1949 **Property Type** industrial **Applicable Criteria** 1/A

(Discuss importance in terms of historical or architectural context as defined by theme, period, and geographic scope. Also address integrity.)

Building 102 at Richmond Field Station does not appear to meet the criteria for listing in the National Register of Historic Places (NRHP). Furthermore, the building has been evaluated in accordance with Section 15064.5(a)(2)-(3) of the CEQA Guidelines, using the criteria outlined in Section 5024.1 of the California Public Resources Code, and does not appear to meet the significance criteria as outlined in these guidelines. Therefore, the building is not eligible for listing in the California Register of Historical Resources (CRHR). (See Continuation Sheet)

B11. Additional Resource Attributes: (List attributes and codes)

***B12. References:**

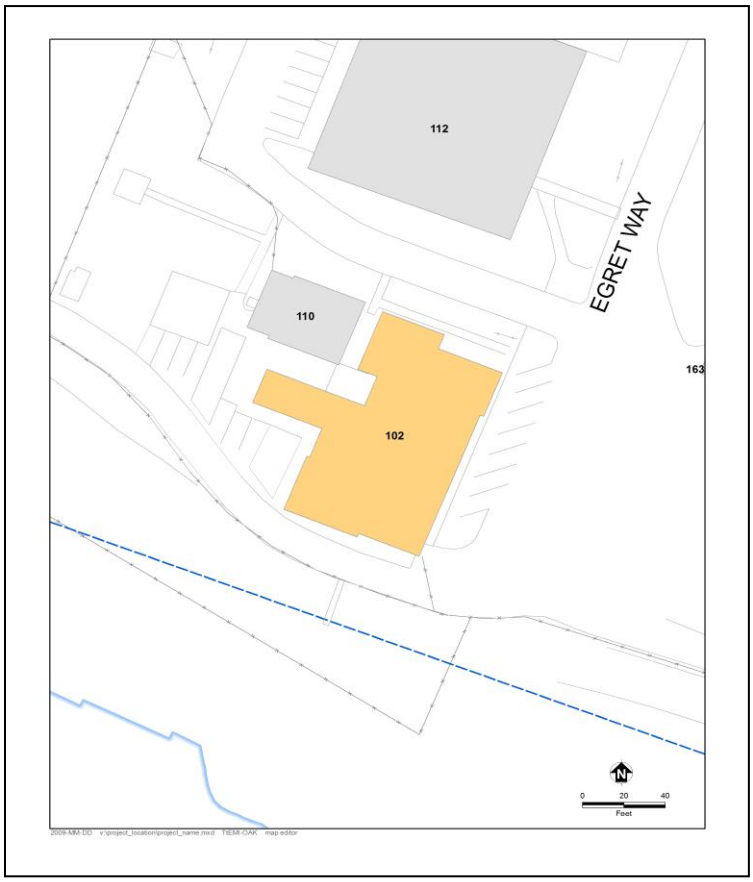
(See Footnotes)

B13. Remarks:

***B14. Evaluator:** Kara Brunzell

***Date of Evaluation:** January 2013

(This space reserved for official comments.)



P3a. Description (continued)

Agriculture continued to be an important local activity after the establishment of the plants, and through the 1880s produce was stored in the warehouse along with explosives.[1] As the Tonite and California Cap Companies grew they crowded out agriculture, and the building was taken over by California Cap. By 1912 the company had its can factory as well as its warehouse in the building.[2] The California Cap Company referred to the building as Building 30. The California Cap Company constructed additional space on the northwest side of the building during the 1930s. During World War II the building housed an assembly line for incendiary delayed action bombs.[3]

After UC Berkeley's Department of Engineering took over the site in 1950 Sanitary Engineering Research Laboratory (SERL) activities were centered in and around Building 102. Professor H.B. Gotaas was in charge of SERL research during the early 1950s. Projects included both studies on composting, incineration, water reclamation, algae symbiosis, saltwater intrusion, and radioactive waste disposal.[4] In addition to laboratories, Building 102 housed SERL's library and administrative offices. The Department altered the interior of the building to suit its purposes, and by the mid-1950s it housed "an unusually well-equipped chemistry and biology laboratory".[5]

Historic photographs indicate that the original building was side gabled, with its primary façade on Egret Way. The University made additions on the building four times after 1950, including construction of an addition projecting from the primary façade that has since been removed (Photograph 2 and Photograph 3).[6] Alterations to the façade appear to have been made during the 1970s, when a flat roof replaced the original gabled roof over the southeast wing of the building. Facades on Egret and Heron Drive were altered with the replacement of stucco siding instead of wood and aluminum sash windows. In 2013 the building uses include storage, a bioengineering offices, and wet chemistry laboratory.

The primary volume of the building, which is adjacent to the corner of Heron Drive and Egret Way, is topped with a flat roof. Sections of the building to the rear are topped with shed roofs. The primary (southeast) façade features a broad eave overhang with large exposed roof members. The roof beams rest on large plain columns. (Many of these columns show signs of moderate to severe deterioration). The building is clad in both stucco with wood trim and horizontal wood siding. Fenestration consists of a combination of aluminum sliding sashes and double-hung, multi-light, wood frame sashes. Three entryways on the primary elevation are at grade through metal industrial-type doors, two of which have windows. Another elevation features a wood paneled door with a window.

The building currently reflects the many changes of use and alterations performed over the years in its irregular footprint and multiple types of siding and fenestration (Photograph 4 and Photograph 5).

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[1] Roland Oliver, "Recollections of Early Industries in Stege", August 7, 1959, p.1.
[2] Sanborn Insurance Maps, Stege, California. 1912.
[3] Oliver, p. 1.
[4] University of California, Berkeley, Department of Engineering, "Richmond Field Station Open House", May 28, 1952, p. 1.
[5] University of California, Berkeley, Department of Engineering, "Guide for Engineering Field Station Inspection", undated, p. 7.
[6] Scott Shackleton, University of California, Berkeley, Personal communication with Julia Mates, Tetra Tech 2013.

B10. Significance (continued)

Historic Context

Europeans arrived in what would become Contra Costa County in 1772, when a Spanish expedition led by Pedro Fages discovered the San Pablo Bay and the confluence of the Sacramento and San Joaquin rivers.[7] Though subsequent Spanish expeditions passed through the region the Spanish do not appear to have settled in the area during the mission period. In the 1820s and 1830s the Mexican government began granting large tracts of land in the area to its citizens, including Ranchos San Pablo, San Ramon, and Pinole. The first permanent non-native settlers were Francisco Castro and his wife Maria Gabriela Berryessa. The Mexican government granted the 18,000 acre Rancho San Pablo to the Castros in 1823.[8] Americans began farming in Contra Costa County in the late 1830s, and by 1882 2/3 of the cultivated land in the county was devoted to wheat production.[9]

Minna C. C. Quilfelt (or Quilfeldt) purchased 600 acres of Rancho San Pablo in 1852 and 1853.[10] Adjacent to San Francisco Bay in what would eventually become the southern portion of the City of Richmond, a wharf and produce warehouse were constructed on the ranch in the 1860s to ship agricultural produce to the San Francisco markets from Rancho San Pablo as well as the Quilfelt ranch. The warehouse and wharf were used to transport cattle, grain, fruit, and in later years the frogs' legs raised by Richard Stege for the San Francisco restaurant market.[11] German native Richard Stege settled on Rancho San Pablo in the late 1860s after stints in the gold fields and the Siberian fur trade. He married Minna Quilfelt, who was a widow, in 1870.[12] Minna Quilfelt Stege died in 1879, leaving the ranch to Stege and her daughter Edith. Stege began selling off portions of his ranch to raise money while continuing his frog-raising and other ventures. A town named Stege formed on Richard Stege's holdings, and by the late nineteenth century several industries, including the California Cap Works, the United States Briquette Company, the Stauffer Chemical Works and the Stege Lumber Manufacturing Company, were operating from portions of the Stege Ranch.[13] Richmond incorporated in 1905, and by 1917 was already the largest city in Contra Costa County.[14] Stege was eventually absorbed into Richmond as the latter grew.

The Explosives Industry in Contra Costa County

Swedish chemist Alfred Nobel laid the foundation for the high-explosives industry with his innovations beginning in 1860s, inventing first a detonator and then a blasting cap. In 1867 he invented dynamite, which was safer, cheaper, and more powerful than nitroglycerine, which had been the most commonly used explosive. Nobel licensed the Giant Powder Company to produce dynamite in California later that year. Giant was the first American company to produce dynamite, and its plant was initially located in Rock House Canyon, in what is

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[7] Mildred B. Hoover, Hero E. Rensch, Ethel G. Rensch, Douglas E. Kyle, *Historic Spots in California, Fourth Edition*, Stanford University Press, Stanford, California: 1958, p. 129.

[8] Donald Bastin, *Images of America: Richmond*, Arcadia Publishing, Charleston SC: 2003, p. 9.

[9] J.P. Munro-Fraser, *History of Contra Costa County, California*, W.A. Slocum & Co., San Francisco: 1882, p. 55 – 57.

[10] Evan Griffins, "Early History of Richmond", December 1938, El Cerrito Historical Society, website: http://www.elcerritowire.com/history/pages/EarlyRichmond.htm, accessed January 2013.

[11] Roland Oliver, "Recollections of Early Industries in Stege", August 7, 1959, p. 1.

[12] J.P. Munro-Fraser, p. 675.

[13] Frederick J. Hulaniski, *The History of Contra Costa County, California*. Elms Publishing Company, Berkeley, California: 1917, p. 354.

[14] Hulanski p. 288.

B10. Significance (continued)

today the City of San Francisco. The California Powder Works began manufacturing dynamite in the same area in 1869.[15]

The nineteenth century explosives industry was extremely dangerous, and as San Francisco's population grew explosives manufacturers needed to relocate. Contra Costa County across the bay was attractive since it was accessible due to its proximity to the harbor yet remote from population centers. In addition, the narrow canyons of Contra Costa County, which terminate in small bays, provided a natural geographical defense against explosions by allowing factory design that placed water between different facets of explosives manufacturing.[16]

During the 1870s chemical and explosives manufacturers began opening in the vicinity of what would eventually become Richmond. The Tonite Powder Company, Western Mineral Company, and California Cap Company were established at 1877 on the Stege ranch. The San Francisco explosives companies soon followed those explosive companies across the bay to Contra Costa County. In 1880, Giant relocated to Point Pinole, changing its name to the Atlas Powder Company. The California Powder Works soon followed, building a new factory in Hercules, which was named for the brand under which the company sold its powder.[17] The Vulcan Powder Works and Judson Powder works also opened in the Stege Ranch area during this era, consolidating Contra Costa County's position as the cradle of the California explosives industry. The East Bay dominated California explosives manufacturing into the twentieth century. In 1902 California had only one powder factory outside Contra Costa and Alameda counties.[18]

William Letts Oliver

William Letts Oliver was born in Chile to English parents in 1844. He attended the University of Edinburgh and became a mining engineer. After returning to Chile, Oliver ran an explosives factory, which was nationalized by the Chilean government in 1864. After the loss of his factory, Oliver left Chile for San Francisco.[19] William Letts Oliver and his wife Carrie lived in Oakland, from about 1880 until Oliver's death in 1918.[20] The couple eventually had six children together: Roland, Edwin, Caroline, Anita, William Harold, and Albert.[21] In addition his various professional activities William Letts Oliver was a yachtsman and an officer of the Bohemian Grove club in the early twentieth century. An avid amateur photographer throughout his lifetime, UC Berkeley's Bancroft Library has a collection of 2700 negatives and prints taken by Oliver and his son.[22]

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[15] Ida Mae Purcell, *History of Contra Costa County,* The Gillick Press, Berkeley, California" 1940, p. 645 – 646.

[16] James E. Vance, *Geography and Urban Evolution in the San Francisco Bay Area,* University of California, Berkeley: 1964, p. 27.

[17] Purcell, p. 646.

[18] Richmond Record, "Contra Costa County: Under the Vitascope", Richmond:1902.

[19] Pacific Mining News, Supplement to Engineering & Mining Journal-Press, "Industrial Notes: Developing of the Blasting Cap Industry", Vol. 1, No. 7, November 1922, p. 222.

[20] United States Census Bureau, Tenth Census of the United States, 1880, National Archives and Records Administration, Washington, D.C., San Francisco, California, Roll: 79, Film: 1254079, Page: 170B.

[21] United States Census Bureau, Twelfth Census of the United States, 1900, National Archives and Records Administration, Washington, D.C., Oakland Ward 3, Alameda, California, Roll: 82, Page: 13A.

[22] Online Archive of California, "Guide to the Oliver Family Photograph Collection", UC Berkeley: 2009, website: http://www.oac.cdlib.org/findaid/ark:/13030/ft0q2n99r1/ accessed February, 2013.

B10. Significance (continued)

William Letts Oliver initially gained familiarity with an explosive called guncotton while manufacturing collodion for his photography hobby.[23] As early as 1870, European explosive companies were experimenting with nitrated guncotton in and by 1875 it was manufactured in England under the name "tonite."[24] By 1877 Oliver had left Chile and was mining in the western United States. Engineers working on the Sutro Tunnel in the Comstock needed an explosive that would remain stable at the high temperatures underground to complete the tunnel, and Oliver was able to solve the problem by substituting tonite for more volatile compounds.[25]

The California Cap Company

In 1877 William Letts Oliver was inspired by his success with tonite to leave mining and establish the Tonite Powder Company, on a portion of the former Stege Ranch.[26] In the 1870s all blasting caps in the United States had to be imported from Europe. Not only were they expensive, but the timing of deliveries was uncertain, creating business difficulties for the powder plant. Oliver was determined to create his own caps in order to protect the tonite factory business. He experimented until he came up with a blasting cap that was safer to use and had better detonating qualities than imported detonators. Oliver and his partner Freeborn Fletter founded the California Cap Company. It was located adjacent to the Tonite Powder Company a 160 acre parcel carved out of the southern portion of Stege Ranch.[27] California Cap Company, which went on to operate on the site for nearly seven decades, was the first manufacturer of blasting caps in the United States. Richard Stege, meanwhile, continued to reside on the ranch, and contracted with Tonite Powder and California Cap to transport their products to the railroad.[28] The California Cap Company was located on the parcel that is currently the Richmond Field Station. The Tonite Powder Company appears to have been located to the east on the parcel that became the Stauffer Chemical Company and later the Zeneca site, although its exact location is unclear.

The Tonite and California Cap factories, which were the first of several gunpowder and chemical companies in the region, were separated by the Stege agricultural warehouse for safety.[29] The explosives industry during this era was an extremely dangerous one. A horrific explosion in 1882 at the nearby Vulcan Powder Company caused 11 deaths and destroyed the plant.[30] Between 1882 and 1918 the Hercules and Atlas plants suffered numerous explosions which destroyed plant buildings and killed a total of 64 workers.[31] Despite its focus on safety, the California Cap Company had accidents as well. Two of its Chinese workers were killed in 1917 when one of them dropped a tray of caps. In 1941 an explosion caused a fire and critically injured a worker.[32]

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[23] Pacific Mining News, p. 222.
[24] G.A. Price Cuxson, ed., "Society of Engineers: Transactions for 1889", E. & F. N. Spon, London: 1890, p. 95.
[25] Pacific Mining News, p. 222.
[26] Oliver, p. 1.
[27] Pacific Mining News, p. 222.
[28] Nilda Rego, "Enterprising Stege lost all and died without a penny", Time Out, March 27, 1994, p. 2, column 4.
[29] Oliver, p. 1.
[30] Munro-Fraser, p. 424.
[31] Purcell, p. 648.
[32] Contra Costa County Standard, "Stege Powder Plant Blast; One Near Death", June 6, 1941, p. 1A.

William Letts Oliver continued to innovate throughout his long career in the chemical and explosives industries. In 1888 he formed the American Lucol Company adjacent to the California Cap Company property.[33] The Lucol plant was at what is currently the southeastern corner of the Richmond Field Station, at the approximate location of Building 163. Lucol manufactured a linseed oil substitute.[34] The factory was dismantled and relocated to New Jersey circa 1900.[35] In 1903 the Hotaling Briquette Works opened on Lucol's site at the southeast corner of the current Richmond Field station property.[36] Later known as the U.S. Briquette Company, the plant appears to have operated at this location until at least 1917.[37] The U.S. Briquette Company buildings were demolished sometime in the 1960s.

The Oliver family aggressively promoted their products both through advertising and publishing. The California Cap Company sponsored or published both articles and book-length treatises on the use of explosives. Safety was a key element of the company image, a topic of company-sponsored technical writing as well as a selling point in advertisements.[38] The Tonite Powder Company's product was known even outside the United States, and by the end of the nineteenth century the powder's explosive properties were considered comparable to the finest English products.[39] Oliver's sons Roland and Edwin Letts Oliver both graduated from UC Berkeley's College of Mining in 1900. Roland Oliver seems to have spent his entire career working in the family enterprises, while Edwin worked at California Cap between mining and other ventures. The Oliver family also became benefactors of the university, and in 1917 the California Cap Company donated substantial amounts of their products to the College of Mining including 500 electric detonators, 500 delayed action exploders, and 500 blasting caps.[40]

Eventually the Tonite factory appears to have been incorporated into the California Cap Company. The Olivers also formed an entity named Pacific Cartridge Company circa 1910. The Pacific Cartridge Company operated from the California Cap plant during World War I.[41] By 1916 there were at least a dozen buildings on the site. When Oliver died in 1918 his son Roland Oliver took over as president of California Cap Company. By 1922 Roland's brother Leslie Oliver was assistant manager of the plant and Edwin Letts Oliver was a director.[42] Roland Oliver substantially expanded the California Cap Company after he took over as president. During this era the plant grew to include 150 buildings and a horse-drawn tram line.[43]

During the late nineteenth and early twentieth century the California Cap Company was one of the most important local employers.[44] As the twentieth century progressed more heavy industry came to Contra Costa County, and by

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[33] Oliver, p. 1.
[34] Max Wilhelm Von Bernewitz, *Cyanide Practice, 1910 – 1913*, Dewey Publishing Company: 1913, p. 327.
[35] Oliver, p. 1.
[36] Oliver, p. 2.
[37] Hulanksi, p. 354.
[38] Halbert Powers Gillette, *Rock Excavation:Methods and Cost*, M.C. Clark, New York: 1904, x.
[39] Manual Eissler, *A Handbook on Modern Explosives*, Crosby, Lockwood & son, London: 1897, p. 117.
[40] University of California, *The University of California Chronicle*, University of California Press, January, 1917, p. 92.
[41] R.L. Polk & Company, *Richmond and Contra Costa County Directory, 1914 – 1915*, Oakland, California: 1915.
[42] Pacific Mining News, p.222.
[43] University of California, Berkeley, *Current Conditions Report*, Prepared by Tetra Tech EM Inc., November 21, 2008, p. 11.
[44] Marguerite Clausen, "On the Waterfront: An Oral History of Richmond, California", Regional Oral History Office, University of California, Berkeley, 1990, p. 21.

B10. Significance (continued)

1940 the county was second only to Los Angeles in overall industrial production.[45] The nineteenth-century California Cap Company was dwarfed by the scale of some of the newer enterprises, and its physical plant and technology were aging. During World War II California Cap was able to stay open by producing delayed action incendiary bombs that were used against Japan.[46] The California Cap Company could not survive the transition to a peacetime economy, however, and by 1949 the plant was closed and the Oliver family looking for a buyer.

University Research/Richmond Field Station

After World War II UC Berkeley's Engineering Department needed an off-campus location in order to perform experiments that required more space than a laboratory. Department Chair Morrough P. O' Brien and others in the department were performing experiments with sewage, sea water, and other materials unsuited to use on a crowded campus. They also wanted a location that was not too remote. The University purchased the California Cap Company from the Oliver family for the use of the Engineering Department in 1950.[47]

The Richmond Field Station has been the location of a research overseen by numerous UC Berkeley departments over the years. The Sanitary Engineering Research Laboratory (SERL) was one of the first departments to undertake research at the site. SERL focused primarily on sewage treatment technology, and also researched pollution control and disposal of solid and liquid waste.[48] Other early projects at the field station included sea water distillation, heat transfer, and cyclic stress research.[49]

At first the Department of Engineering utilized the buildings left behind by the California Cap Company. The Department established a machine shop, computer shop, receiving facility, mail service, and other facilities in addition to laboratories in the old detonator company buildings.[50] The current Buildings 102, 110, 118, 128, 150, 152 175, and 176 all date to the cap company era and have been repurposed for the Richmond Field Station. They also constructed new buildings as funds became available, and by the mid-1950s five new buildings had been completed at the Richmond Field Station.[51] By the 1970s the department had conducted many experiments at the Richmond Field Station that could not have been performed on the main campus.

Building 102

Building 102 was constructed in the 1860s as a produce warehouse. The agricultural products of the Quilfelt-Stege and San Pablo ranches were stored here before being shipped to San Francisco via the adjacent wharf. During the California Cap Company era the building was used as a can factory and bomb production facility as well as a warehouse.

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[45] Purcell, p. 649.
[46] Oliver, p. 1.
[47] P.H. McGauhey, "The Sanitary Engineering Research Laboratory: Administration, Research and Consultation, 1950-1975 – An Interview Conducted by Malca Call", Regional Oral History Office, University of California, Berkeley, 1974, p. 70.
[48] University of California, Berkeley, 2008, p. 13.
[49] University of California, Berkeley, Department of Engineering, "Richmond Field Station Open House", May 28, 1952, p. 3 – 4.
[50] McGauhey, p. 71.
[51] University of California, Berkeley, Department of Engineering, "Guide for Engineering Field Station Inspection", undated, p. 3.

After UC Berkeley took over the site activities at Building 102 included storage, a chemical laboratory, and office space. The building was also used for SERL research activities, which included the use of chemicals and radioisotopes during research activities.[52]

Evaluation

Building 102 appears to meet the criteria for listing in the NHRP/CRHR because it is associated with events significant to national, state, and local history (Criterion A/1). It is the oldest building on the Richmond Field Station, dating to the property's ranching era. The manufacturing activities that took place in Building 102 were central to the production processes of the California Cap Company, the first blasting cap company in the United States. The company also manufactured bombs that were used against the Japanese during World War II in the building.

In addition, the building is associated with important individuals significant to our past (Criterion B/2). Building 102 is the oldest of the extant buildings at the Richmond Field Station, and therefore the most notably associated with California Cap Company founder William Letts Oliver. Oliver was a significant figure in the history of explosives manufacture, responsible for the invention of a high-heat explosive named Tonite as well as the first manufacturer of blasting caps in the United States. Building 102 is the only California Cap Company building specifically discussed in a document created in 1959 by William Letts Oliver's son Roland Oliver.[53]

The building does not embody the distinctive characteristics of a type, period, region, or method of construction, or represent the work of an important creative individual or possess high artistic values (Criterion C/3). Building 102 is a utilitarian building that was constructed piecemeal over a period of many decades. Therefore the building is not eligible to the NHRP for its architecture.

In rare instances, buildings themselves can serve as sources of important information, however this building is not a principal source of important information in this regard (Criterion D/4).

Eligibility for listing on either the NRHP rests on significance and integrity. A property must have both factors to be considered eligible. Loss of integrity, if sufficiently great, would overwhelm the historical significance of a resource and render it ineligible. Despite Building 102's historical significance for the California Cap Company period, the building's integrity has suffered due to repeated alterations. Only its location has remained unchanged over the years, and its integrity of setting, design, materials, workmanship, feeling, and association have all been compromised. Therefore the building is not eligible for the NHRP or the CRHR. Although Building 102 has been found ineligible due to loss of integrity, because of its historical significance it may warrant special attention in the planning process.

[52] University of California, Berkeley, 2008, p. 25.
[53] Oliver, p.1.

Photographs:

Photograph 2: Building 102, circa 1954

Photograph 3: Building 102, circa 1970

Photograph 4: Building 102, January 4, 2013, camera facing northwest

Photograph 5: Building 102, January 4, 2013, camera facing west

State of California – The Resources Agency
DEPARTMENT OF PARKS AND RECREATION

PRIMARY RECORD

Primary # _____
HRI # _____
Trinomial _____
NRHP Status Code _____
Other Listings _____
Review Code _____ Reviewer _____ Date _____

 ***Resource Name or #** (Assigned by recorder) Richmond Field Station Building 110

P1. Other Identifier: Richmond Field Station Building 110

***P2. Location:** ☐ **Not for Publication** ☒ **Unrestricted** ***a. County** Contra Costa
and (P2b and P2c or P2d. Attach a Location Map as necessary.)
***b. USGS 7.5′ Quad** Richmond **Date** 1984 **T**___; **R** ____; __ ¼ **of Sec** ___; Diablo **B.M.**
c. Address _____ City _____ Zip _____
d. UTM: (give more than one for large and/or linear resources) Zone 10 ; 558477 mE/ 4196309 mN
e. Other Locational Data: (e.g., parcel #, directions to resource, elevation, etc., as appropriate)

***P3a. Description:** (Describe resource and its major elements. Include design, materials, condition, alterations, size, setting, and boundaries)
Building 110 is near the southern edge of Richmond Field Station campus adjacent to Building 102. The vernacular building does not strongly express a particular architecture style. Constructed circa the 1910s, the building is 1,325 square feet, single story, with a rectangular plan and topped by a shallow pitch, front gabled roof. Its primary elevation faces southeast. Its moderate eaves feature exposed rafter tails on its northeast and southwest elevations. (See Continuation Sheet)

***P3b. Resource Attributes:** (List attributes and codes) HP15: Educational building, HP39: Other

***P4. Resources Present:** ☒ Building ☐ Structure ☐ Object ☐ Site ☐ District ☐ Element of District ☐ Other (Isolates, etc.)

P5b. Description of Photo: (View, date, accession #) Photograph 1: Southeast and northeast façades of building, camera facing west, January 4, 2013.

***P6. Date Constructed/Age and Sources:**
☒ Historic ☐ Prehistoric ☐ Both
Circa 1910

***P7. Owner and Address:**
U.C. Berkeley
1301 South 46th Street
Richmond, California 94804

***P8. Recorded by:** (Name, affiliation, address)
Kara Brunzell & Julia Mates
Tetra Tech
1999 Harrison Street, Ste 500
Oakland, CA 94612

***P9. Date Recorded:** January 4, 2013

***P10. Survey Type:** (Describe) Intensive

***P11. Report Citation:** (Cite survey report and other sources, or enter "none.") *Historic Properties Survey Report for Portions of the Richmond Field Station* prepared by Tetra Tech, Inc, 2013.

***Attachments:** NONE ☒ Location Map ☐ Sketch Map ☒ Continuation Sheet ☒ Building, Structure, and Object Record ☐ Archaeological Record ☐ District Record ☐ Linear Feature Record ☐ Milling Station Record ☐ Rock Art Record ☐ Artifact Record ☐ Photograph Record ☐ Other (list) _____

***NRHP Status Code** 6Z

***Resource Name or #** (Assigned by recorder) Richmond Field Station Building 110

B1. Historic Name: California Cap Company Building 65
B2. Common Name: Building 110
B3. Original Use: Research Laboratory B4. Present Use: Vacant
***B5. Architectural Style:** Vernacular
***B6. Construction History:** (Construction date, alteration, and date of alterations) Constructed circa 1910
***B7. Moved?** ☐No ☒ Yes ☐ Unknown **Date:** circa 1960 **Original Location:** adjacent to Egret Way
***B8. Related Features:** _____
B9. Architect: Unknown b. Builder: Unknown
***B10. Significance: Theme** N/A **Area** N/A
Period of Significance N/A **Property Type** N/A **Applicable Criteria** N/A
(Discuss importance in terms of historical or architectural context as defined by theme, period, and geographic scope. Also address integrity.)

Building 110 at Richmond Field Station does not appear to meet the criteria for listing in the National Register of Historic Places (NRHP). Furthermore, the building has been evaluated in accordance with Section 15064.5(a)(2)-(3) of the CEQA Guidelines, using the criteria outlined in Section 5024.1 of the California Public Resources Code, and does not appear to meet the significance criteria as outlined in these guidelines. Therefore, the building is not eligible for listing in the California Register of Historical Resources (CRHR). (See Continuation Sheet)

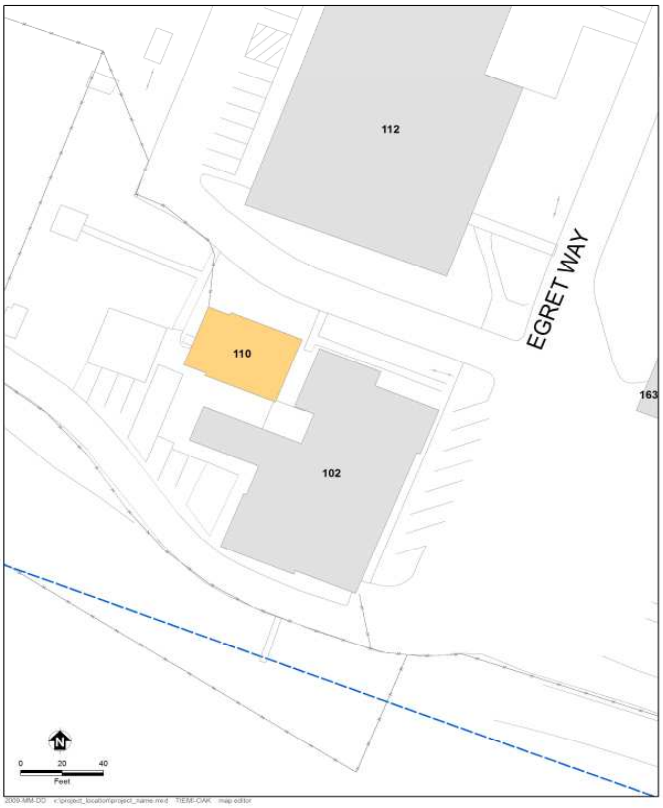
B11. Additional Resource Attributes: (List attributes and codes)

***B12. References:** See Footnotes
B13. Remarks:

***B14. Evaluator:** Kara Brunzell

***Date of Evaluation:** January 2013

(This space reserved for official comments.)



P3a. Description (continued)

The walls are clad in horizontal wood siding. Fenestration is original, multi- light, double-hung wood sashes. An original paneled wood entry door is centered in the southwest elevation. sheltered by a recessed entry porch and accessed by a set of wooden stairs. Plain entablature adorns the door and window surrounds throughout the otherwise unornamented building. An addition at the rear (northwest) of the building is topped by a shed roof. Its rear entrance is a wood paneled door with a window. This door is sheltered by a small awning and accessed by a set of wooden stairs. The building is surrounded by grassy areas, and access to the rear of the building is currently blocked by a wood fence to the south and a chain link fence to the north.

Building 110 was constructed by the California Cap Company circa the 1910s. The building was originally several hundred yards to the northeast of its current location, along Egret Way.[1] It was used as a research laboratory by the California Cap Company and labeled Building 65.[2]

After UC Berkeley's SERL took over the site in 1950 its activities were concentrated in the southeast section of the Richmond Field Station. Historic aerial photographs show that Building 110 was moved to its current location adjacent to Building 102 circa 1960 and was used for research using radioisotopes. [3] After it was moved, Building 110 housed laboratories and offices for SERL's successor, (EEHSL).[4] The building continued to be used for offices until 2008, but it is currently vacant.[5]

B10. Significance (continued)

Historic Context

Europeans arrived in what would become Contra Costa County in 1772, when a Spanish expedition led by Pedro Fages discovered the San Pablo Bay and the confluence of the Sacramento and San Joaquin rivers.[6] Though subsequent Spanish expeditions passed through the region the Spanish do not appear to have settled in the area during the mission period. In the 1820s and 1830s the Mexican government began granting large tracts of land in the area to its citizens, including Ranchos San Pablo, San Ramon, and Pinole. The first permanent non-native settlers were Francisco Castro and his wife Maria Gabriela Berryessa. The Mexican government granted the 18,000 acre Rancho San Pablo to the Castros in 1823.[7] Americans began farming in Contra Costa County in the late 1830s, and by 1882 2/3 of the cultivated land in the county was devoted to wheat production.[8]

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[1] University of California, Berkley, "Draft Environmental Impact Report, Proposed U.S. Environmental Protection Agency, Region IX Laboratory at the University of California's Richmond Field Station," Prepared by University of California, Berkeley Planning, Design and Construction Department, July 1991, p. 307.

[2] University of California, Berkeley, 2008, p.

[3] P.H. McGauhey, "The Sanitary Engineering Research Laboratory: Administration, Research and Consultation, 1950-1975 – An Interview Conducted by Malca Call," Regional Oral History Office, University of California, Berkeley, 1974, p. 71.

[4] Shackelton, 2013.

[5] University of California, Berkeley, 2008, p. 196.

[6] Mildred B. Hoover, Hero E. Rensch, Ethel G. Rensch, Douglas E. Kyle, *Historic Spots in California, Fourth Edition*, Stanford University Press, Stanford, California: 1958, p. 129.

[7] Donald Bastin, *Images of America: Richmond*, Arcadia Publishing, Charleston SC: 2003, p. 9.

[8] J.P. Munro-Fraser, *History of Contra Costa County, California*, W.A. Slocum & Co., San Francisco: 1882, p. 55 – 57.

B10. Significance (continued)

Minna C. C. Quilfelt (or Quilfeldt) purchased 600 acres of Rancho San Pablo in 1852 and 1853.[9] Adjacent to San Francisco Bay in what would eventually become the southern portion of the City of Richmond, a wharf and produce warehouse were constructed on the ranch in the 1860s to ship agricultural produce to the San Francisco markets from Rancho San Pablo as well as the Quilfelt ranch. The warehouse and wharf were used to transport cattle, grain, fruit, and in later years the frogs' legs raised by Richard Stege for the San Francisco restaurant market.[10] German native Richard Stege settled on Rancho San Pablo in the late 1860s after stints in the gold fields and the Siberian fur trade. He married Minna Quilfelt, who was a widow, in 1870.[11] Minna Quilfelt Stege died in 1879, leaving the ranch to Stege and her daughter Edith. Stege began selling off portions of his ranch to raise money while continuing his frog-raising and other ventures. A town named Stege formed on Richard Stege's holdings, and by the late nineteenth century several industries, including the California Cap Works, the United States Briquette Company, the Stauffer Chemical Works and the Stege Lumber Manufacturing Company, were operating from portions of the Stege Ranch.[12] Richmond incorporated in 1905, and by 1917 was already the largest city in Contra Costa County.[13] Stege was eventually absorbed into Richmond as the latter grew.

The Explosives Industry in Contra Costa County

Swedish chemist Alfred Nobel laid the foundation for the high-explosives industry with his innovations beginning in 1860s, inventing first a detonator and then a blasting cap. In 1867 he invented dynamite, which was safer, cheaper, and more powerful than nitroglycerine, which had been the most commonly used explosive. Nobel licensed the Giant Powder Company to produce dynamite in California later that year. Giant was the first American company to produce dynamite, and its plant was initially located in Rock House Canyon, in what is today the City of San Francisco. The California Powder Works began manufacturing dynamite in the same area in 1869.[14]

The nineteenth century explosives industry was extremely dangerous, and as San Francisco's population grew explosives manufacturers needed to relocate. Contra Costa County across the bay was attractive since it was accessible due to its proximity to the harbor yet remote from population centers. In addition, the narrow canyons of Contra Costa County, which terminate in small bays, provided a natural geographical defense against explosions by allowing factory design that placed water between different facets of explosives manufacturing.[15]

During the 1870s chemical and explosives manufacturers began opening in the vicinity of what would eventually become Richmond. The Tonite Powder Company, Western Mineral Company, and California Cap Company were established at 1877 on the Stege ranch. The San Francisco explosives companies soon followed those explosive companies across the bay to Contra Costa County. In 1880, Giant relocated to Point Pinole, changing its name to

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[9] Evan Griffins, "Early History of Richmond", December 1938, El Cerrito Historical Society, website: http://www.elcerritowire.com/history/pages/EarlyRichmond.htm, accessed January 2013.

[10] Roland Oliver, "Recollections of Early Industries in Stege", August 7, 1959, p. 1.

[11] J.P. Munro-Fraser, p. 675.

[12] Frederick J. Hulaniski, *The History of Contra Costa County, California*. Elms Publishing Company, Berkeley, California: 1917, p. 354.

[13] Hulanski p. 288.

[14] Ida Mae Purcell, *History of Contra Costa County*, The Gillick Press, Berkeley, California" 1940, p. 645 – 646.

[15] James E. Vance, *Geography and Urban Evolution in the San Francisco Bay Area*, University of California, Berkeley: 1964, p. 27.

B10. Significance (continued)

the Atlas Powder Company. The California Powder Works soon followed, building a new factory in Hercules, which was named for the brand under which the company sold its powder.[16] The Vulcan Powder Works and Judson Powder works also opened in the Stege Ranch area during this era, consolidating Contra Costa County's position as the cradle of the California explosives industry. The East Bay dominated California explosives manufacturing into the twentieth century. In 1902 California had only one powder factory outside Contra Costa and Alameda counties.[17]

William Letts Oliver

William Letts Oliver was born in Chile to English parents in 1844. He attended the University of Edinburgh and became a mining engineer. After returning to Chile, Oliver ran an explosives factory, which was nationalized by the Chilean government in 1864. After the loss of his factory, Oliver left Chile for San Francisco.[18] William Letts Oliver and his wife Carrie lived in Oakland, from about 1880 until Oliver's death in 1918.[19] The couple eventually had six children together: Roland, Edwin, Caroline, Anita, William Harold, and Albert.[20] In addition his various professional activities William Letts Oliver was a yachtsman and an officer of the Bohemian Grove club in the early twentieth century. An avid amateur photographer throughout his lifetime, UC Berkeley's Bancroft Library has a collection of 2700 negatives and prints taken by Oliver and his son.[21]

William Letts Oliver initially gained familiarity with an explosive called guncotton while manufacturing collodion for his photography hobby.[22] As early as 1870, European explosive companies were experimenting with nitrated guncotton in and by 1875 it was manufactured in England under the name "tonite."[23] By 1877 Oliver had left Chile and was mining in the western United States. Engineers working on the Sutro Tunnel in the Comstock needed an explosive that would remain stable at the high temperatures underground to complete the tunnel, and Oliver was able to solve the problem by substituting tonite for more volatile compounds.[24]

The California Cap Company

In 1877 William Letts Oliver was inspired by his success with tonite to leave mining and establish the Tonite Powder Company, on a portion of the former Stege Ranch.[25] In the 1870s all blasting caps in the United States

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[16] Purcell, p. 646.

[17] Richmond Record, "Contra Costa County: Under the Vitascope", Richmond:1902.

[18] Pacific Mining News, Supplement to Engineering & Mining Journal-Press, "Industrial Notes: Developing of the Blasting Cap Industry", Vol. 1, No. 7, November 1922, p. 222.

[19] United States Census Bureau, Tenth Census of the United States, 1880, National Archives and Records Administration, Washington, D.C., San Francisco, California, Roll: 79, Film: 1254079, Page: 170B.

[20] United States Census Bureau, Twelfth Census of the United States, 1900, National Archives and Records Administration, Washington, D.C., Oakland Ward 3, Alameda, California, Roll: 82, Page: 13A.

[21] Online Archive of California, "Guide to the Oliver Family Photograph Collection", UC Berkeley: 2009, website: http://www.oac.cdlib.org/findaid/ark:/13030/ft0q2n99r1/ accessed February, 2013.

[22] Pacific Mining News, p. 222.

[23] G.A. Price Cuxson, ed., "Society of Engineers: Transactions for 1889", E. & F. N. Spon, London: 1890, p. 95.

[24] Pacific Mining News, p. 222.

[25] Oliver, p. 1.

B10. Significance (continued)

had to be imported from Europe. Not only were they expensive, but the timing of deliveries was uncertain, creating business difficulties for the powder plant. Oliver was determined to create his own caps in order to

protect the tonite factory business. He experimented until he came up with a blasting cap that was safer to use and had better detonating qualities than imported detonators. Oliver and his partner Freeborn Fletter founded the California Cap Company. It was located adjacent to the Tonite Powder Company a 160 acre parcel carved out of the southern portion of Stege Ranch.[26] California Cap Company, which went on to operate on the site for nearly seven decades, was the first manufacturer of blasting caps in the United States. Richard Stege, meanwhile, continued to reside on the ranch, and contracted with Tonite Powder and California Cap to transport their products to the railroad.[27] The California Cap Company was located on the parcel that is currently the Richmond Field Station. The Tonite Powder Company appears to have been located to the east on the parcel that became the Stauffer Chemical Company and later the Zeneca site, although its exact location is unclear.

The Tonite and California Cap factories, which were the first of several gunpowder and chemical companies in the region, were separated by the Stege agricultural warehouse for safety.[28] The explosives industry during this era was an extremely dangerous one. A horrific explosion in 1882 at the nearby Vulcan Powder Company caused 11 deaths and destroyed the plant.[29] Between 1882 and 1918 the Hercules and Atlas plants suffered numerous explosions which destroyed plant buildings and killed a total of 64 workers.[30] Despite its focus on safety, the California Cap Company had accidents as well. Two of its Chinese workers were killed in 1917 when one of them dropped a tray of caps. In 1941 an explosion caused a fire and critically injured a worker.[31]

William Letts Oliver continued to innovate throughout his long career in the chemical and explosives industries. In 1888 he formed the American Lucol Company adjacent to the California Cap Company property.[32] The Lucol plant was at what is currently the southeastern corner of the Richmond Field Station, at the approximate location of Building 163. Lucol manufactured a linseed oil substitute.[33] The factory was dismantled and relocated to New Jersey circa 1900.[34] In 1903 the Hotaling Briquette Works opened on Lucol's site at the southeast corner of the current Richmond Field station property.[35] Later known as the U.S. Briquette Company, the plant appears to have operated at this location until at least 1917.[36] The U.S. Briquette Company buildings were demolished sometime in the 1960s.

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[26] Pacific Mining News, p. 222.
[27] Nilda Rego, "Enterprising Stege lost all and died without a penny", Time Out, March 27, 1994, p. 2, column 4.
[28] Oliver, p. 1.
[29] Munro-Fraser, p. 424.
[30] Purcell, p. 648.
[31] Contra Costa County Standard, "Stege Powder Plant Blast; One Near Death", June 6, 1941, p. 1A.
[32] Oliver, p. 1.
[33] Max Wilhelm Von Bernewitz, *Cyanide Practice, 1910 – 1913*, Dewey Publishing Company: 1913, p. 327.
[34] Oliver, p. 1.
[35] Oliver, p. 2.
[36] Hulanksi, p. 354.

B10. Significance (continued)

The Oliver family aggressively promoted their products both through advertising and publishing. The California Cap Company sponsored or published both articles and book-length treatises on the use of explosives. Safety was a key element of the company image, a topic of company-sponsored technical writing as well as a selling point in advertisements.[37] The Tonite Powder Company's product was known even outside the United States, and by the end of the nineteenth century the powder's explosive properties were considered comparable to the finest English products.[38] Oliver's sons Roland and Edwin Letts Oliver both graduated from UC Berkeley's College of Mining in 1900. Roland Oliver seems to have spent his entire career working in the family enterprises, while Edwin worked at California Cap between mining and other ventures. The Oliver family also became benefactors of the university, and in 1917 the California Cap Company donated substantial amounts of their products to the College of Mining including 500 electric detonators, 500 delayed action exploders, and 500 blasting caps.[39]

Eventually the Tonite factory appears to have been incorporated into the California Cap Company. The Olivers also formed an entity named Pacific Cartridge Company circa 1910. The Pacific Cartridge Company operated from the California Cap plant during World War I.[40] By 1916 there were at least a dozen buildings on the site. When Oliver died in 1918 his son Roland Oliver took over as president of California Cap Company. By 1922 Roland's brother Leslie Oliver was assistant manager of the plant and Edwin Letts Oliver was a director.[41] Roland Oliver substantially expanded the California Cap Company after he took over as president. During this era the plant grew to include 150 buildings and a horse-drawn tram line.[42]

During the late nineteenth and early twentieth century the California Cap Company was one of the most important local employers.[43] As the twentieth century progressed more heavy industry came to Contra Costa County, and by 1940 the county was second only to Los Angeles in overall industrial production.[44] The nineteenth-century California Cap Company was dwarfed by the scale of some of the newer enterprises, and its physical plant and technology were aging. During World War II California Cap was able to stay open by producing delayed action incendiary bombs that were used against Japan.[45] The California Cap Company could not survive the transition to a peacetime economy, however, and by 1949 the plant was closed and the Oliver family looking for a buyer.

University Research/Richmond Field Station

After World War II UC Berkeley's Engineering Department needed an off-campus location in order to perform experiments that required more space than a laboratory. Department Chair Morrough P. O' Brien and others in the department were performing experiments with sewage, sea water, and other materials unsuited to use on a

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[37] Halbert Powers Gillette, *Rock Excavation:Methods and Cost,* M.C. Clark, New York: 1904, x.
[38] Manual Eissler, *A Handbook on Modern Explosives,* Crosby, Lockwood & son, London: 1897, p. 117.
[39] University of California, *The University of California Chronicle,* University of California Press, January, 1917, p. 92.
[40] R.L. Polk & Company, *Richmond and Contra Costa County Directory, 1914 – 1915*, Oakland, California: 1915.
[41] Pacific Mining News, p.222.
[42] University of California, Berkeley, *Current Conditions Report,* Prepared by Tetra Tech EM Inc., November 21, 2008, p. 11.
[43] Marguerite Clausen, "On the Waterfront: An Oral History of Richmond, California", Regional Oral History Office, University of California, Berkeley, 1990, p. 21.
[44] Purcell, p. 649.
[45] Oliver, p. 1.

B10. Significance (continued)

crowded campus. They also wanted a location that was not too remote. The University purchased the California Cap Company from the Oliver family for the use of the Engineering Department in 1950.[46]

The Richmond Field Station has been the location of a research overseen by numerous UC Berkeley departments over the years. The Sanitary Engineering Research Laboratory (SERL) was one of the first departments to undertake research at the site. SERL focused primarily on sewage treatment technology, and also researched pollution control and disposal of solid and liquid waste.[47] Other early projects at the field station included sea water distillation, heat transfer, and cyclic stress research.[48]

At first the Department of Engineering utilized the buildings left behind by the California Cap Company. The Department established a machine shop, computer shop, receiving facility, mail service, and other facilities in addition to laboratories in the old detonator company buildings.[49] The current Buildings 102, 110, 118, 128, 150, 152 175, and 176 all date to the cap company era and have been repurposed for the Richmond Field Station. They also constructed new buildings as funds became available, and by the mid-1950s five new buildings had been completed at the Richmond Field Station.[50] By the 1970s the department had conducted many experiments at the Richmond Field Station that could not have been performed on the main campus.

Building 110

Building 110 was constructed by the California Cap Company circa 1910. The building was originally located several hundred yards to the northeast of its current location, along Egret Way.[51] It was used as a research laboratory by the California Cap Company and located adjacent to the plant's mercury fulminating area. It was labeled "Building 65".[52]

After UC Berkeley's Sanitary Engineering Research Laboratory (SERL) took over the site in 1950 its activities were concentrated in the southeast section of the Richmond Field Station. In the early 1950s Building 110 housed algae symbiosis research.[53] Historic aerial photographs demonstrate that Building 110 was moved to its current location adjacent to Building 102 circa 1960. After it was moved Building 110 housed laboratories and offices for SERL's successor the Environmental Engineering and Health Sciences Laboratory (EEHSL).[54] The building continued to be used for offices until at least 2008, but it is currently vacant.[55]

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[46] P.H. McGauhey, "The Sanitary Engineering Research Laboratory: Administration, Research and Consultation, 1950-1975 – An Interview Conducted by Malca Call", Regional Oral History Office, University of California, Berkeley, 1974, p. 70.

[47] University of California, Berkeley, 2008, p. 13.

[48] University of California, Berkeley, Department of Engineering, "Richmond Field Station Open House", May 28, 1952, p. 3 – 4.

[49] McGauhey, p. 71.

[50] University of California, Berkeley, Department of Engineering, "Guide for Engineering Field Station Inspection", undated, p. 3.

[51] University of California, Berkley, "Draft Environmental Impact Report, Proposed U.S. Environmental Protection Agency, Region IX Laboratory at the University of California's Richmond Field Station", Prepared by University of California, Berkeley Planning, Design and Construction Department, July 1991, p. 307.

[52] University of California, Berkeley, 2008, p.

[53] University of California, Berkeley, Department of Engineering, "Guide for Engineering Field Station Inspection", undated, p. 7.

[54] Shackelton, 2013.

Evaluation

The following provides an evaluation of Building 110 under each NRHP/CRHR criteria.

No particular association was found between the Building 110 and events significant to national, state, or local history (Criterion A/1). Although the California Cap Company was the first blasting cap manufacturer in the United States there is no indication that the research that took place in Building 110 was central to the development of the plant or its technical processes. Therefore the building is not eligible for inclusion in the NRHP for historical significance

Building 110 dates from the period when William Letts Oliver and his son Roland Oliver were making important breakthroughs in the explosives industry. However, no particular association has been found between the building and members of the Oliver family, or with other important individuals significant to our past (Criterion B/2). Therefore the building is not eligible under to the NRHP for association with important individuals.

The building does not embody the distinctive characteristics of a type, period, region, or method of construction, or represent the work of an important creative individual or possess high artistic values (Criterion C/3). Building 102 is a vernacular building of a type that was commonly constructed from the late nineteenth to the early twentieth century. Therefore the building is not eligible to the NHRP for its architecture.

In rare instances, buildings themselves can serve as sources of important information, however this building is not a principal source of important information in this regard (Criterion D/4).

[55] University of California, Berkeley, 2008, p. 196.

State of California – The Resources Agency
DEPARTMENT OF PARKS AND RECREATION

PRIMARY RECORD

Primary # _____
HRI # _____
Trinomial _____
NRHP Status Code _____
Other Listings _____
Review Code _____ Reviewer _____ Date _____

 ***Resource Name or #** (Assigned by recorder) Richmond Field Station Building 111

P1. Other Identifier: Richmond Field Station Building 111

***P2. Location:** ☐ **Not for Publication** ☒ **Unrestricted** ***a. County** Contra Costa
and (P2b and P2c or P2d. Attach a Location Map as necessary.)
***b. USGS 7.5′ Quad** Richmond **Date** 1984 **T**___; **R** ____; __ ¼ **of Sec** ___; Diablo **B.M.**
c. Address _____ City _____ Zip _____
d. UTM: (give more than one for large and/or linear resources) Zone 10 ; 558491 mE/ 4196401 mN
e. Other Locational Data: (e.g., parcel #, directions to resource, elevation, etc., as appropriate)

***P3a. Description:** (Describe resource and its major elements. Include design, materials, condition, alterations, size, setting, and boundaries)
Building 111 is in the southern portion of the Richmond Field Station. The utilitarian building does not express any particular architectural style. It is 507 square feet and was constructed in 1987. It is single story and rectangular in plan. The building is topped by a flat roof and constructed of concrete masonry units. It lacks fenestration, and its entrances are industrial-type metal doors on its northwest and southeast elevations.

***P3b. Resource Attributes:** (List attributes and codes) HP4: Ancillary Building

***P4. Resources Present:** ☒ Building ☐ Structure ☐ Object ☐ Site ☐ District ☐ Element of District ☐ Other (Isolates, etc.)

P5b. Description of Photo: (View, date, accession #) Photograph 1: Northwest and northeast facades of building, camera facing southeast, December 4, 2013.

***P6. Date Constructed/Age and Sources:**
☒ Historic ☐ Prehistoric ☐ Both
1987/UC Berkeley records

***P7. Owner and Address:**
U.C. Berkeley
1301 South 46th Street
Richmond, California 94804

***P8. Recorded by:** (Name, affiliation, address)
Kara Brunzell & Julia Mates
Tetra Tech
1999 Harrison Street, Ste 500
Oakland, CA 94612

***P9. Date Recorded:** January 4, 2013
***P10. Survey Type:** (Describe) Intensive

***P11. Report Citation:** (Cite survey report and other sources, or enter "none.") *Historic Properties Survey Report for Portions of the Richmond Field Station* prepared by Tetra Tech, Inc, 2013.

***Attachments:** NONE ☒ Location Map ☐ Sketch Map ☒ Continuation Sheet ☒ Building, Structure, and Object Record ☐ Archaeological Record ☐ District Record ☐ Linear Feature Record ☐ Milling Station Record ☐ Rock Art Record ☐ Artifact Record ☐ Photograph Record ☐ Other (list) _____

***NRHP Status Code** 6Z

***Resource Name or #** (Assigned by recorder) Richmond Field Station Building 111

B1. Historic Name: _____

B2. Common Name: Building 111

B3. Original Use: Storage B4. Present Use: Storage

***B5. Architectural Style:** Vernacular

***B6. Construction History:** (Construction date, alteration, and date of alterations) Constructed in 1987

***B7. Moved?** ☒ **No** ☐ **Yes** ☐ **Unknown** **Date:** _____ **Original Location:** _____

***B8. Related Features:** _____

B9. Architect: Unknown b. Builder: Unknown

***B10. Significance: Theme** N/A **Area** N/A

Period of Significance N/A **Property Type** N/A **Applicable Criteria** N/A

(Discuss importance in terms of historical or architectural context as defined by theme, period, and geographic scope. Also address integrity.)

Building 111 at Richmond Field Station does not appear to meet the criteria for listing in the National Register of Historic Places (NRHP). Furthermore, the building has been evaluated in accordance with Section 15064.5(a)(2)-(3) of the CEQA Guidelines, using the criteria outlined in Section 5024.1 of the California Public Resources Code, and does not appear to meet the significance criteria as outlined in these guidelines. Therefore, the building is not eligible for listing in the California Register of Historical Resources (CRHR). (See Continuation Sheet.)

B11. Additional Resource Attributes: (List attributes and codes)

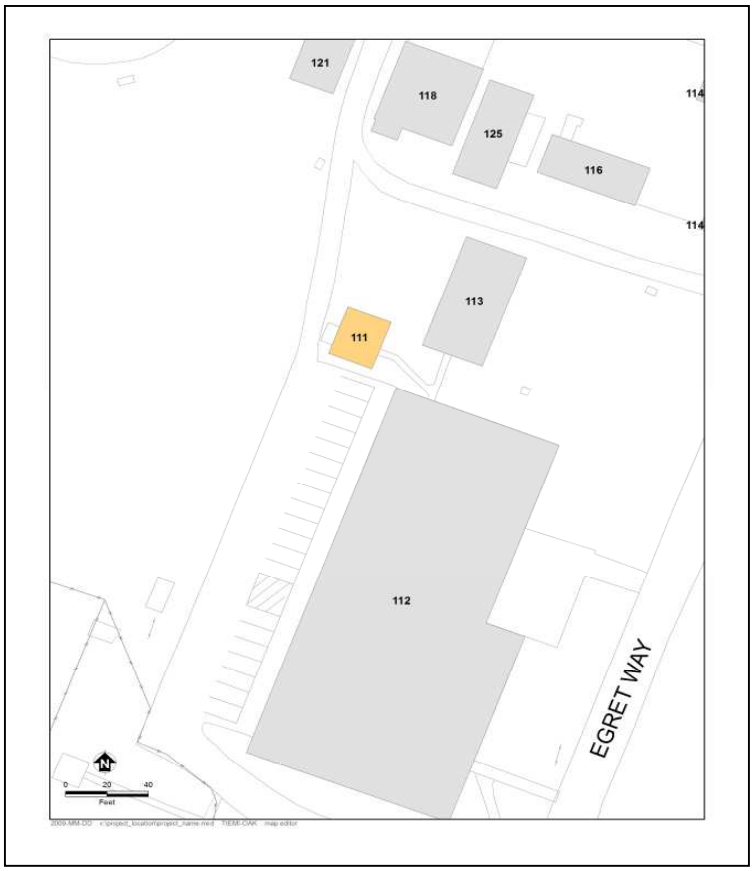
***B12. References:** See Footnotes

B13. Remarks:

***B14. Evaluator:** Kara Brunzell

***Date of Evaluation:** January 2013

(This space reserved for official comments.)



B10. Significance (continued)

Historic Context

Europeans arrived in what would become Contra Costa County in 1772, when a Spanish expedition led by Pedro Fages discovered the San Pablo Bay and the confluence of the Sacramento and San Joaquin rivers.[1] Though subsequent Spanish expeditions passed through the region the Spanish do not appear to have settled in the area during the mission period. In the 1820s and 1830s the Mexican government began granting large tracts of land in the area to its citizens, including Ranchos San Pablo, San Ramon, and Pinole. The first permanent non-native settlers were Francisco Castro and his wife Maria Gabriela Berryessa. The Mexican government granted the 18,000 acre Rancho San Pablo to the Castros in 1823.[2] Americans began farming in Contra Costa County in the late 1830s, and by 1882 2/3 of the cultivated land in the county was devoted to wheat production.[3]

Minna C. C. Quilfelt (or Quilfeldt) purchased 600 acres of Rancho San Pablo in 1852 and 1853.[4] Adjacent to San Francisco Bay in what would eventually become the southern portion of the City of Richmond, a wharf and produce warehouse were constructed on the ranch in the 1860s to ship agricultural produce to the San Francisco markets from Rancho San Pablo as well as the Quilfelt ranch. The warehouse and wharf were used to transport cattle, grain, fruit, and in later years the frogs' legs raised by Richard Stege for the San Francisco restaurant market.[5] German native Richard Stege settled on Rancho San Pablo in the late 1860s after stints in the gold fields and the Siberian fur trade. He married Minna Quilfelt, who was a widow, in 1870.[6] Minna Quilfelt Stege died in 1879, leaving the ranch to Stege and her daughter Edith. Stege began selling off portions of his ranch to raise money while continuing his frog-raising and other ventures. A town named Stege formed on Richard Stege's holdings, and by the late nineteenth century several industries, including the California Cap Works, the United States Briquette Company, the Stauffer Chemical Works and the Stege Lumber Manufacturing Company, were operating from portions of the Stege Ranch.[7] Richmond incorporated in 1905, and by 1917 was already the largest city in Contra Costa County.[8] Stege was eventually absorbed into Richmond as the latter grew.

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[8] Hulanski p. 288.

B10. Significance (continued)

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The Tonite and California Cap factories, which were the first of several gunpowder and chemical companies in the region, were separated by the Stege agricultural warehouse for safety.[23] The explosives industry during this era was an extremely dangerous one. A horrific explosion in 1882 at the nearby Vulcan Powder Company caused 11 deaths and destroyed the plant.[24] Between 1882 and 1918 the Hercules and Atlas plants suffered numerous explosions which destroyed plant buildings and killed a total of 64 workers.[25] Despite its focus on safety, the California Cap Company had accidents as well. Two of its Chinese workers were killed in 1917 when one of them dropped a tray of caps. In 1941 an explosion caused a fire and critically injured a worker.[26]

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[17] Pacific Mining News, p. 222.
[18] G.A. Price Cuxson, ed., "Society of Engineers: Transactions for 1889", E. & F. N. Spon, London: 1890, p. 95.
[19] Pacific Mining News, p. 222.
[20] Oliver, p. 1.
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[22] Nilda Rego, "Enterprising Stege lost all and died without a penny", Time Out, March 27, 1994, p. 2, column 4.
[23] Oliver, p. 1.
[24] Munro-Fraser, p. 424.
[25] Purcell, p. 648.
[26] Contra Costa County Standard, "Stege Powder Plant Blast; One Near Death", June 6, 1941, p. 1A.

B10. Significance (continued)

William Letts Oliver continued to innovate throughout his long career in the chemical and explosives industries. In 1888 he formed the American Lucol Company adjacent to the California Cap Company property.[27] The Lucol plant was at what is currently the southeastern corner of the Richmond Field Station, at the approximate location of Building 163. Lucol manufactured a linseed oil substitute.[28] The factory was dismantled and relocated to New Jersey circa 1900.[29] In 1903 the Hotaling Briquette Works opened on Lucol's site at the southeast corner of the current Richmond Field station property.[30] Later known as the U.S. Briquette Company, the plant appears to have operated at this location until at least 1917.[31] The U.S. Briquette Company buildings were demolished sometime in the 1960s.

The Oliver family aggressively promoted their products both through advertising and publishing. The California Cap Company sponsored or published both articles and book-length treatises on the use of explosives. Safety was a key element of the company image, a topic of company-sponsored technical writing as well as a selling point in advertisements.[32] The Tonite Powder Company's product was known even outside the United States, and by the end of the nineteenth century the powder's explosive properties were considered comparable to the finest English products.[33] Oliver's sons Roland and Edwin Letts Oliver both graduated from UC Berkeley's College of Mining in 1900. Roland Oliver seems to have spent his entire career working in the family enterprises, while Edwin worked at California Cap between mining and other ventures. The Oliver family also became benefactors of the university, and in 1917 the California Cap Company donated substantial amounts of their products to the College of Mining including 500 electric detonators, 500 delayed action exploders, and 500 blasting caps.[34]

Eventually the Tonite factory appears to have been incorporated into the California Cap Company. The Olivers also formed an entity named Pacific Cartridge Company circa 1910. The Pacific Cartridge Company operated from the California Cap plant during World War I.[35] By 1916 there were at least a dozen buildings on the site. When Oliver died in 1918 his son Roland Oliver took over as president of California Cap Company. By 1922 Roland's brother Leslie Oliver was assistant manager of the plant and Edwin Letts Oliver was a director.[36] Roland Oliver substantially expanded the California Cap Company after he took over as president. During this era the plant grew to include 150 buildings and a horse-drawn tram line.[37]

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[27] Oliver, p. 1.
[28] Max Wilhelm Von Bernewitz, *Cyanide Practice, 1910 – 1913*, Dewey Publishing Company: 1913, p. 327.
[29] Oliver, p. 1.
[30] Oliver, p. 2.
[31] Hulanksi, p. 354.
[32] Halbert Powers Gillette, *Rock Excavation:Methods and Cost*, M.C. Clark, New York: 1904, x.
[33] Manual Eissler, *A Handbook on Modern Explosives*, Crosby, Lockwood & son, London: 1897, p. 117.
[34] University of California, *The University of California Chronicle*, University of California Press, January, 1917, p. 92.
[35] R.L. Polk & Company, *Richmond and Contra Costa County Directory, 1914 – 1915*, Oakland, California: 1915.
[36] Pacific Mining News, p.222.
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B10. Significance (continued)

During the late nineteenth and early twentieth century the California Cap Company was one of the most important local employers.[38] As the twentieth century progressed more heavy industry came to Contra Costa County, and by 1940 the county was second only to Los Angeles in overall industrial production.[39] The nineteenth-century California Cap Company was dwarfed by the scale of some of the newer enterprises, and its physical plant and technology were aging. During World War II California Cap was able to stay open by producing delayed action incendiary bombs that were used against Japan.[40] The California Cap Company could not survive the transition to a peacetime economy, however, and by 1949 the plant was closed and the Oliver family looking for a buyer.

University Research/Richmond Field Station

After World War II UC Berkeley's Engineering Department needed an off-campus location in order to perform experiments that required more space than a laboratory. Department Chair Morrough P. O' Brien and others in the department were performing experiments with sewage, sea water, and other materials unsuited to use on a crowded campus. They also wanted a location that was not too remote. The University purchased the California Cap Company from the Oliver family for the use of the Engineering Department in 1950.[41]

The Richmond Field Station has been the location of a research overseen by numerous UC Berkeley departments over the years. The Sanitary Engineering Research Laboratory (SERL) was one of the first departments to undertake research at the site. SERL focused primarily on sewage treatment technology, and also researched pollution control and disposal of solid and liquid waste.[42] Other early projects at the field station included sea water distillation, heat transfer, and cyclic stress research.[43]

At first the Department of Engineering utilized the buildings left behind by the California Cap Company. The Department established a machine shop, computer shop, receiving facility, mail service, and other facilities in addition to laboratories in the old detonator company buildings.[44] The current Buildings 102, 110, 118, 128, 150, 152 175, and 176 all date to the cap company era and have been repurposed for the Richmond Field Station. They also constructed new buildings as funds became available, and by the mid-1950s five new buildings had been completed at the Richmond Field Station.[45] By the 1970s the department had conducted many experiments at the Richmond Field Station that could not have been performed on the main campus.

Building 111

[38] Marguerite Clausen, "On the Waterfront: An Oral History of Richmond, California", Regional Oral History Office, University of California, Berkeley, 1990, p. 21.
[39] Purcell, p. 649.
[40] Oliver, p. 1.
[41] P.H. McGauhey, "The Sanitary Engineering Research Laboratory: Administration, Research and Consultation, 1950-1975 – An Interview Conducted by Malca Call", Regional Oral History Office, University of California, Berkeley, 1974, p. 70.
[42] University of California, Berkeley, 2008, p. 13.
[43] University of California, Berkeley, Department of Engineering, "Richmond Field Station Open House", May 28, 1952, p. 3 – 4.
[44] McGauhey, p. 71.
[45] University of California, Berkeley, Department of Engineering, "Guide for Engineering Field Station Inspection", undated, p. 3.

Building 111 appears to have been constructed by UC Berkeley in 1987 on the site of an older building.[46] The site seems to have housed a storage shed, California Cap Company "Building 148", prior to the construction of Building 111. It was constructed for hazardous materials storage.[47] The Watershed Project, a non-profit group whose offices are at the Richmond Field Station, has used the building for storage for the past several years.[48] The building is not of a historic age, as it was constructed 26 years ago.

Evaluation

The following provides an evaluation of Building 111 under each NRHP/CRHR criteria.

Building 111 does not appear to meet the criteria for listing in National Register of Historic Places because it lacks historical significance. The structure has served as a storage facility throughout its lifetime and lacks the strength of association necessary to be considered historically significant in relation to any particular events or persons (Criteria A/1 and B/2).

The utilitarian building lacks any identifiable architectural stylistic design and does not embody distinctive architectural or engineering qualities of type, period, or method of construction (Criterion C/3). In rare instances, buildings themselves can serve as sources of important information, however this building is not a principal source of important information in this regard (Criterion D/4).

As a storage facility Building 111 does not meet the standard of exceptional importance required for properties under 50 years old to be eligible to the NHRP (Criterion G).

[46] University of California, Berkeley, 2008, p. 196.
[47] University of California, Berkeley, 2008, p. 13.
[48] Scott Shackleton, University of California, Berkeley, Personal communication with Julia Mates, Tetra Tech, 2013.

State of California – The Resources Agency
DEPARTMENT OF PARKS AND RECREATION
PRIMARY RECORD

Primary # _____
HRI # _____
Trinomial _____
NRHP Status Code _____
Other Listings _____
Review Code _____ Reviewer _____ Date _____

 ***Resource Name or #** (Assigned by recorder) Richmond Field Station Building 112

P1. Other Identifier: Richmond Field Station Building 112

***P2. Location:** ☐ **Not for Publication** ☒ **Unrestricted** ***a. County** Contra Costa
and (P2b and P2c or P2d. Attach a Location Map as necessary.)
***b. USGS 7.5′ Quad** Richmond **Date** 1984 **T**___; **R** ____; __ ¼ **of Sec** ___; Diablo **B.M.**
c. Address _____ City _____ Zip _____
d. UTM: (give more than one for large and/or linear resources) Zone 10 ; 558500 mE/ 4196357 mN
e. Other Locational Data: (e.g., parcel #, directions to resource, elevation, etc., as appropriate)

***P3a. Description:** (Describe resource and its major elements. Include design, materials, condition, alterations, size, setting, and boundaries)
Building 112 is in the southern portion of the Richmond Field Station. The rectangular, single-story, 16,949 square-foot building was constructed in 1964.

The building is topped with a flat roof. Its southeast (primary) and northwest (rear) elevations feature a broad eave overhang with large exposed roof rafters. The roof is supported by large plain columns. The walls are sided in stucco with wood trim. Primary fenestration is fixed and awning metal sashes, with vinyl replacement windows at the rear elevation. The primary entrance is a recessed glazed door with a transom and surround.
(See Continuation Sheet)

***P3b. Resource Attributes:** (List attributes and codes) HP15: Educational building, HP39: Other

***P4. Resources Present:** ☒ Building ☐ Structure ☐ Object ☐ Site ☐ District ☐ Element of District ☐ Other (Isolates, etc.)

P5b. Description of Photo: (View, date, accession #) Photograph 1: Southwest and southeast facades of building, camera facing north, January 4, 2013.

***P6. Date Constructed/Age and Sources:**
☒ Historic ☐ Prehistoric ☐ Both
1964/UC Berkeley records

***P7. Owner and Address:**
U.C. Berkeley
1301 South 46th Street
Richmond, California 94804

***P8. Recorded by:** (Name, affiliation, address)
Kara Brunzell & Julia Mates
Tetra Tech
1999 Harrison Street, Ste 500
Oakland, CA 94612

***P9. Date Recorded:** January 4, 2013

***P10. Survey Type:** (Describe) Intensive

***P11. Report Citation:** (Cite survey report and other sources, or enter "none.") *Historic Properties Survey Report for Portions of the Richmond Field Station* prepared by Tetra Tech, Inc, 2013.

***Attachments:** NONE ☒ Location Map ☐ Sketch Map ☒ Continuation Sheet ☒ Building, Structure, and Object Record ☐ Archaeological Record ☐ District Record ☐ Linear Feature Record ☐ Milling Station Record ☐ Rock Art Record ☐ Artifact Record ☐ Photograph Record ☐ Other (list) _____

***NRHP Status Code** 6Z

***Resource Name or #** (Assigned by recorder) Richmond Field Station Building 112

B1. Historic Name: _____

B2. Common Name: Building 112

B3. Original Use: Office B4. Present Use: Office

***B5. Architectural Style:** Vernacular

***B6. Construction History:** (Construction date, alteration, and date of alterations) Constructed in 1964

***B7. Moved?** ☒ **No** ☐ **Yes** ☐ **Unknown** **Date:** _____ **Original Location:** _____

***B8. Related Features:** _____

B9. Architect: Unknown b. Builder: Unknown

***B10. Significance: Theme** N/A **Area** N/A

Period of Significance N/A **Property Type** N/A **Applicable Criteria** N/A

(Discuss importance in terms of historical or architectural context as defined by theme, period, and geographic scope. Also address integrity.)

Building 112 at Richmond Field Station does not appear to meet the criteria for listing in the National Register of Historic Places (NRHP). Furthermore, the building has been evaluated in accordance with Section 15064.5(a)(2)-(3) of the CEQA Guidelines, using the criteria outlined in Section 5024.1 of the California Public Resources Code, and does not appear to meet the significance criteria as outlined in these guidelines. Therefore, the building is not eligible for listing in the California Register of Historical Resources (CRHR). (See Continuation Sheet.)

B11. Additional Resource Attributes: (List attributes and codes)

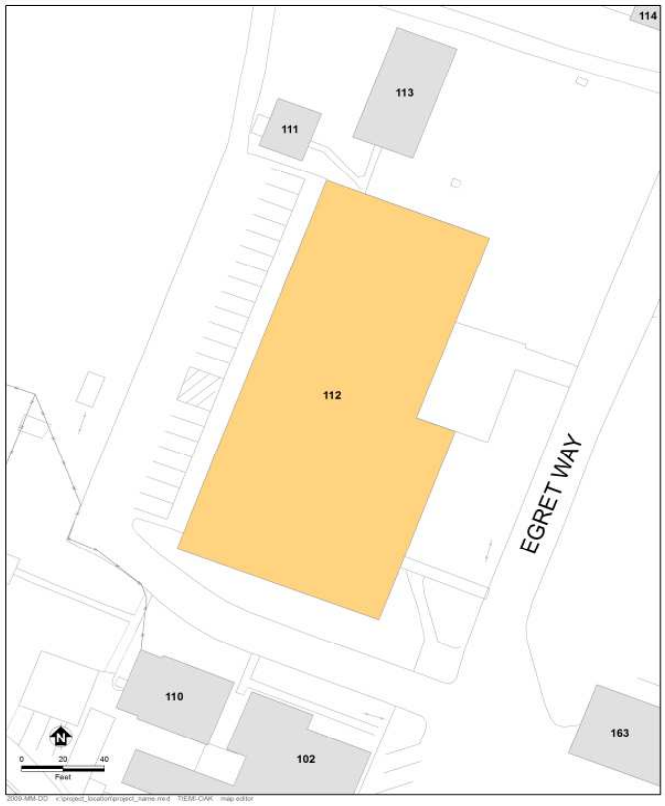
***B12. References:** See Footnotes

B13. Remarks:

***B14. Evaluator:** Kara Brunzell

***Date of Evaluation:** January 2013

(This space reserved for official comments.)



P3a. Description (continued)

The building features landscaped areas in the front southeast side elevation that include mature trees along Egret Way. It is identified as the Center for Tissue Bioengineering. A small parking area is adjacent to its rear (northwest) elevation.

B10. Significance (continued)

Historic Context

Europeans arrived in what would become Contra Costa County in 1772, when a Spanish expedition led by Pedro Fages discovered the San Pablo Bay and the confluence of the Sacramento and San Joaquin rivers.[1] Though subsequent Spanish expeditions passed through the region the Spanish do not appear to have settled in the area during the mission period. In the 1820s and 1830s the Mexican government began granting large tracts of land in the area to its citizens, including Ranchos San Pablo, San Ramon, and Pinole. The first permanent non-native settlers were Francisco Castro and his wife Maria Gabriela Berryessa. The Mexican government granted the 18,000 acre Rancho San Pablo to the Castros in 1823.[2] Americans began farming in Contra Costa County in the late 1830s, and by 1882 2/3 of the cultivated land in the county was devoted to wheat production.[3]

Minna C. C. Quilfelt (or Quilfeldt) purchased 600 acres of Rancho San Pablo in 1852 and 1853.[4] Adjacent to San Francisco Bay in what would eventually become the southern portion of the City of Richmond, a wharf and produce warehouse were constructed on the ranch in the 1860s to ship agricultural produce to the San Francisco markets from Rancho San Pablo as well as the Quilfelt ranch. The warehouse and wharf were used to transport cattle, grain, fruit, and in later years the frogs' legs raised by Richard Stege for the San Francisco restaurant market.[5] German native Richard Stege settled on Rancho San Pablo in the late 1860s after stints in the gold fields and the Siberian fur trade. He married Minna Quilfelt, who was a widow, in 1870.[6] Minna Quilfelt Stege died in 1879, leaving the ranch to Stege and her daughter Edith. Stege began selling off portions of his ranch to raise money while continuing his frog-raising and other ventures. A town named Stege formed on Richard Stege's holdings, and by the late nineteenth century several industries, including the California Cap Works, the United States Briquette Company, the Stauffer Chemical Works and the Stege Lumber Manufacturing Company, were operating from portions of the Stege Ranch.[7] Richmond incorporated in 1905, and by 1917 was already the largest city in Contra Costa County.[8] Stege was eventually absorbed into Richmond as the latter grew.

The Explosives Industry in Contra Costa County

Swedish chemist Alfred Nobel laid the foundation for the high-explosives industry with his innovations beginning in 1860s, inventing first a detonator and then a blasting cap. In 1867 he invented dynamite, which was safer,

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[1] Mildred B. Hoover, Hero E. Rensch, Ethel G. Rensch, Douglas E. Kyle, *Historic Spots in California, Fourth Edition*, Stanford University Press, Stanford, California: 1958, p. 129.

[2] Donald Bastin, *Images of America: Richmond*, Arcadia Publishing, Charleston SC: 2003, p. 9.

[3] J.P. Munro-Fraser, *History of Contra Costa County, California*, W.A. Slocum & Co., San Francisco: 1882, p. 55 – 57.

[4] Evan Griffins, "Early History of Richmond", December 1938, El Cerrito Historical Society, website: http://www.elcerritowire.com/history/pages/EarlyRichmond.htm, accessed January 2013.

[5] Roland Oliver, "Recollections of Early Industries in Stege", August 7, 1959, p. 1.

[6] J.P. Munro-Fraser, *History of Contra Costa County, California*, W.A. Slocum & Co., San Francisco: 1882, p. 675.

[7] Frederick J. Hulaniski, *The History of Contra Costa County, California*. Elms Publishing Company, Berkeley, California: 1917, p. 354.

[8] Hulanski p. 288.

cheaper, and more powerful than nitroglycerine, which had been the most commonly used explosive. Nobel licensed the Giant Powder Company to produce dynamite in California later that year. Giant was the first American company to produce dynamite, and its plant was initially located in Rock House Canyon, in what is today the City of San Francisco. The California Powder Works began manufacturing dynamite in the same area in 1869.[9]

The nineteenth century explosives industry was extremely dangerous, and as San Francisco's population grew explosives manufacturers needed to relocate. Contra Costa County across the bay was attractive since it was accessible due to its proximity to the harbor yet remote from population centers. In addition, the narrow canyons of Contra Costa County, which terminate in small bays, provided a natural geographical defense against explosions by allowing factory design that placed water between different facets of explosives manufacturing.[10]

During the 1870s chemical and explosives manufacturers began opening in the vicinity of what would eventually become Richmond. The Tonite Powder Company, Western Mineral Company, and California Cap Company were established at 1877 on the Stege ranch. The San Francisco explosives companies soon followed those explosive companies across the bay to Contra Costa County. In 1880, Giant relocated to Point Pinole, changing its name to the Atlas Powder Company. The California Powder Works soon followed, building a new factory in Hercules, which was named for the brand under which the company sold its powder.[11] The Vulcan Powder Works and Judson Powder works also opened in the Stege Ranch area during this era, consolidating Contra Costa County's position as the cradle of the California explosives industry. The East Bay dominated California explosives manufacturing into the twentieth century. In 1902 California had only one powder factory outside Contra Costa and Alameda counties.[12]

William Letts Oliver

William Letts Oliver was born in Chile to English parents in 1844. He attended the University of Edinburgh and became a mining engineer. After returning to Chile, Oliver ran an explosives factory, which was nationalized by the Chilean government in 1864. After the loss of his factory, Oliver left Chile for San Francisco.[13] William Letts Oliver and his wife Carrie lived in Oakland, from about 1880 until Oliver's death in 1918.[14] The couple eventually had six children together: Roland, Edwin, Caroline, Anita, William Harold, and Albert.[15] In addition his various professional activities William Letts Oliver was a yachtsman and an officer of the Bohemian Grove club in the early twentieth century. An avid amateur photographer throughout his lifetime, UC Berkeley's Bancroft Library has a collection of 2700 negatives and prints taken by Oliver and his son.[16]

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[9] Ida Mae Purcell, *History of Contra Costa County,* The Gillick Press, Berkeley, California" 1940, p. 645 – 646.

[10] James E. Vance, *Geography and Urban Evolution in the San Francisco Bay Area,* University of California, Berkeley: 1964, p. 27.

[11] Purcell, p. 646.

[12] Richmond Record, "Contra Costa County: Under the Vitascope", Richmond:1902.

[13] Pacific Mining News, Supplement to Engineering & Mining Journal-Press, "Industrial Notes: Developing of the Blasting Cap Industry", Vol. 1, No. 7, November 1922, p. 222.

[14] United States Census Bureau, Tenth Census of the United States, 1880, National Archives and Records Administration, Washington, D.C., San Francisco, California, Roll: 79, Film: 1254079, Page: 170B.

[15] United States Census Bureau, Twelfth Census of the United States, 1900, National Archives and Records Administration, Washington, D.C., Oakland Ward 3, Alameda, California, Roll: 82, Page: 13A.

[16] Online Archive of California, "Guide to the Oliver Family Photograph Collection", UC Berkeley:2009, website: http://www.oac.cdlib.org/findaid/ark:/13030/ft0q2n99r1/ accessed February, 2013.

William Letts Oliver initially gained familiarity with an explosive called guncotton while manufacturing collodion for his photography hobby.[17] As early as 1870, European explosive companies were experimenting with nitrated guncotton in and by 1875 it was manufactured in England under the name "tonite."[18] By 1877 Oliver had left Chile and was mining in the western United States. Engineers working on the Sutro Tunnel in the Comstock needed an explosive that would remain stable at the high temperatures underground to complete the tunnel, and Oliver was able to solve the problem by substituting tonite for more volatile compounds.[19]

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[22] Nilda Rego, "Enterprising Stege lost all and died without a penny", Time Out, March 27, 1994, p. 2, column 4.

[23] Oliver, p. 1.

[24] Munro-Fraser, p. 424.

[25] Purcell, p. 648.

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[27] Oliver, p. 1.
[28] Max Wilhelm Von Bernewitz, *Cyanide Practice, 1910 – 1913*, Dewey Publishing Company: 1913, p. 327.
[29] Oliver, p. 1.
[30] Oliver, p. 2.
[31] Hulanksi, p. 354.
[32] Halbert Powers Gillette, *Rock Excavation:Methods and Cost,* M.C. Clark, New York: 1904, x.
[33] Manual Eissler, *A Handbook on Modern Explosives,* Crosby, Lockwood & son, London: 1897, p. 117.
[34] University of California, *The University of California Chronicle,* University of California Press, January, 1917, p. 92.
[35] R.L. Polk & Company, *Richmond and Contra Costa County Directory, 1914 – 1915*, Oakland, California: 1915.
[36] Pacific Mining News, p.222.
[37] University of California, Berkeley, *Current Conditions Report,* Prepared by Tetra Tech EM Inc., November 21, 2008, p. 11.
[38] Marguerite Clausen, "On the Waterfront: An Oral History of Richmond, California", Regional Oral History Office, University of California, Berkeley, 1990, p. 21.

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Building 112

Building 112 was constructed in 1964 on the site of seven former California Cap Company buildings.[47] It is in the southeastern portion of the Richmond Field Station, where the early SERL activities were centered. The large building originally housed offices, classrooms, and laboratories.[48] It housed a wet chemistry laboratory as late as

[39] Purcell, p. 649.
[40] Oliver, p. 1.
[41] P.H. McGauhey, "The Sanitary Engineering Research Laboratory: Administration, Research and Consultation, 1950-1975 – An Interview Conducted by Malca Call", Regional Oral History Office, University of California, Berkeley, 1974, p. 70.
[42] University of California, Berkeley, 2008, p. 13.
[43] University of California, Berkeley, Department of Engineering, "Richmond Field Station Open House", May 28, 1952, p. 3 – 4.
[44] McGauhey, p. 71.
[45] University of California, Berkeley, Department of Engineering, "Guide for Engineering Field Station Inspection", undated, p. 3.
[46] University of California, Berkeley, 2008, p. 21.
[47] University of California, Berkeley, 2008, p. 149.
[48] University of California, Berkeley, 2008, p. 13.

2008, though at that time it was being phased out of use.[49] It is currently devoted to bioengineering and public health offices.[50]

Evaluation

The following provides an evaluation of Building 112 under each NRHP/CRHR criteria.

Building 112 does not appear to meet the criteria for listing in NRHP/CRHR because it lacks historical significance. The structure has served various functions throughout its lifetime and as such lacks the strength of association necessary to be considered historically significant in relation to any particular events or persons (Criteria A/1 and B/2).

The simple building lacks any identifiable architectural stylistic design and does not embody distinctive architectural or engineering qualities of type, period, or method of construction (Criterion C/3). In rare instances, buildings themselves can serve as sources of important information, however this building is not a principal source of important information in this regard (Criterion D/4).

[49] University of California, Berkeley, 2008, p. 25.
[50] Shackleton, 2013.

State of California – The Resources Agency
DEPARTMENT OF PARKS AND RECREATION
PRIMARY RECORD

Primary # _____
HRI # _____
Trinomial _____
NRHP Status Code _____
Other Listings _____
Review Code _____ Reviewer _____ Date _____

 ***Resource Name or #** (Assigned by recorder) Richmond Field Station Building 113

P1. Other Identifier: Richmond Field Station Building 113

***P2. Location:** ☐ **Not for Publication** ☒ **Unrestricted** ***a. County** Contra Costa
and (P2b and P2c or P2d. Attach a Location Map as necessary.)
***b. USGS 7.5′ Quad** Richmond **Date** 1984 **T**___; **R** ____; __ ¼ **of Sec** ___; Diablo **B.M.**
c. Address _____ City _____ Zip _____
d. UTM: (give more than one for large and/or linear resources) Zone 10 ; 558507 mE/ 4196406 mN
e. Other Locational Data: (e.g., parcel #, directions to resource, elevation, etc., as appropriate)

***P3a. Description:** (Describe resource and its major elements. Include design, materials, condition, alterations, size, setting, and boundaries)
Building 113 is in the southern portion of the Richmond Field Station. It is a 1,800 square foot prefabricated building, constructed in 1982. It is single story and rectangular in plan.
The building is topped with a very shallow pitched gable roof with large vents in the gables. Its walls are corrugated steel and lack fenestration. An industrial metal entrance door is centered in its southwest elevation and its northwest elevation features a large roll-up door. The building has large vents in the walls near the ground. It is surrounded by a grassy area and shrubbery. (See Continuation Sheet)

***P3b. Resource Attributes:** (List attributes and codes) HP4: Ancillary Building

***P4. Resources Present:** ☒ Building ☐ Structure ☐ Object ☐ Site ☐ District ☐ Element of District ☐ Other (Isolates, etc.)

P5b. Description of Photo: (View, date, accession #) Photograph 1: Northeast and northwest facades of building, camera facing south, January 4, 2012.

***P6. Date Constructed/Age and Sources:**
☒ Historic ☐ Prehistoric ☐ Both
1981/UC Berkeley records
***P7. Owner and Address:**
U.C. Berkeley
1301 South 46th Street
Richmond, California 94804
***P8. Recorded by:** (Name, affiliation, address)
Kara Brunzell & Julia Mates
Tetra Tech
1999 Harrison Street, Ste 500
Oakland, CA 94612
***P9. Date Recorded:** January 4, 2013
***P10. Survey Type:** (Describe) Intensive

***P11. Report Citation:** (Cite survey report and other sources, or enter "none.") *Historic Properties Survey Report for Portions of the Richmond Field Station* prepared by Tetra Tech, Inc, 2013.

***Attachments:** NONE ☒ Location Map ☐ Sketch Map ☒ Continuation Sheet ☒ Building, Structure, and Object Record ☐ Archaeological Record ☐ District Record ☐ Linear Feature Record ☐ Milling Station Record ☐ Rock Art Record ☐ Artifact Record ☐ Photograph Record ☐ Other (list) _____

***NRHP Status Code** 6Z

***Resource Name or #** (Assigned by recorder) Richmond Field Station Building 113

B1. Historic Name: _____

B2. Common Name: Building 113

B3. Original Use: Storage B4. Present Use: Storage

***B5. Architectural Style:** Vernacular

***B6. Construction History:** (Construction date, alteration, and date of alterations) Constructed in 1982

***B7. Moved?** ☒ **No** ☐ **Yes** ☐ **Unknown** **Date:** _____ **Original Location:** _____

***B8. Related Features:** _____

B9. Architect: Unknown b. Builder: Unknown

***B10. Significance: Theme** N/A **Area** N/A

Period of Significance N/A **Property Type** N/A **Applicable Criteria** N/A

(Discuss importance in terms of historical or architectural context as defined by theme, period, and geographic scope. Also address integrity.)

Building 113 at Richmond Field Station does not appear to meet the criteria for listing in the National Register of Historic Places (NRHP). Furthermore, the building has been evaluated in accordance with Section 15064.5(a)(2)-(3) of the CEQA Guidelines, using the criteria outlined in Section 5024.1 of the California Public Resources Code, and does not appear to meet the significance criteria as outlined in these guidelines. Therefore, the building is not eligible for listing in the California Register of Historical Resources (CRHR). (See Continuation Sheet.)

B11. Additional Resource Attributes: (List attributes and codes)

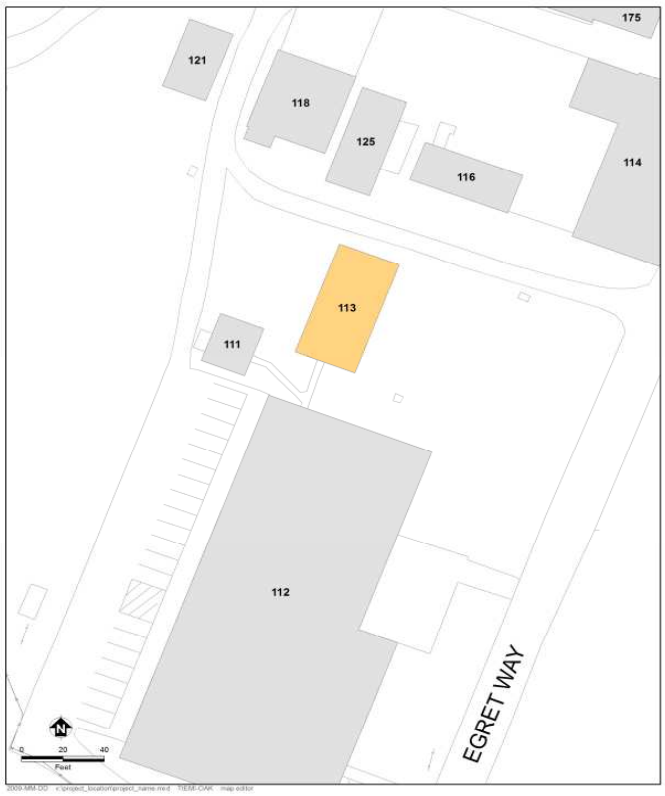
***B12. References:** See footnotes

B13. Remarks:

***B14. Evaluator:** Kara Brunzell

***Date of Evaluation:** January 2013

(This space reserved for official comments.)



P3a. Description (continued)

Building 113 was constructed in 1982 as a storage and support facility for SERL. The prefabricated steel building appears to have been assembled by Richmond Field Station maintenance workers, who also built its slab foundation.[1] Its use has continued unaltered. The building is not of historic age as it is 31 years old.

B10. Significance (continued)

Historic Context

Europeans arrived in what would become Contra Costa County in 1772, when a Spanish expedition led by Pedro Fages discovered the San Pablo Bay and the confluence of the Sacramento and San Joaquin rivers.[2] Though subsequent Spanish expeditions passed through the region the Spanish do not appear to have settled in the area during the mission period. In the 1820s and 1830s the Mexican government began granting large tracts of land in the area to its citizens, including Ranchos San Pablo, San Ramon, and Pinole. The first permanent non-native settlers were Francisco Castro and his wife Maria Gabriela Berryessa. The Mexican government granted the 18,000 acre Rancho San Pablo to the Castros in 1823.[3] Americans began farming in Contra Costa County in the late 1830s, and by 1882 2/3 of the cultivated land in the county was devoted to wheat production.[4]

Minna C. C. Quilfelt (or Quilfeldt) purchased 600 acres of Rancho San Pablo in 1852 and 1853.[5] Adjacent to San Francisco Bay in what would eventually become the southern portion of the City of Richmond, a wharf and produce warehouse were constructed on the ranch in the 1860s to ship agricultural produce to the San Francisco markets from Rancho San Pablo as well as the Quilfelt ranch. The warehouse and wharf were used to transport cattle, grain, fruit, and in later years the frogs' legs raised by Richard Stege for the San Francisco restaurant market.[6] German native Richard Stege settled on Rancho San Pablo in the late 1860s after stints in the gold fields and the Siberian fur trade. He married Minna Quilfelt, who was a widow, in 1870.[7] Minna Quilfelt Stege died in 1879, leaving the ranch to Stege and her daughter Edith. Stege began selling off portions of his ranch to raise money while continuing his frog-raising and other ventures. A town named Stege formed on Richard Stege's holdings, and by the late nineteenth century several industries, including the California Cap Works, the United States Briquette Company, the Stauffer Chemical Works and the Stege Lumber Manufacturing Company, were operating from portions of the Stege Ranch.[8] Richmond incorporated in 1905, and by 1917 was already the largest city in Contra Costa County.[9] Stege was eventually absorbed into Richmond as the latter grew.

The Explosives Industry in Contra Costa County

Swedish chemist Alfred Nobel laid the foundation for the high-explosives industry with his innovations beginning in 1860s, inventing first a detonator and then a blasting cap. In 1867 he invented dynamite, which was safer,

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[1] University of California, Berkeley, File "Building 113," located in vertical files in Room 148, Richmond Field Station.

[2] Mildred B. Hoover, Hero E. Rensch, Ethel G. Rensch, Douglas E. Kyle, *Historic Spots in California, Fourth Edition*, Stanford University Press, Stanford, California: 1958, p. 129.

[3] Donald Bastin, *Images of America: Richmond*, Arcadia Publishing, Charleston SC: 2003, p. 9.

[4] J.P. Munro-Fraser, *History of Contra Costa County, California*, W.A. Slocum & Co., San Francisco: 1882, p. 55 – 57.

[5] Evan Griffins, "Early History of Richmond", December 1938, El Cerrito Historical Society, website: http://www.elcerritowire.com/history/pages/EarlyRichmond.htm, accessed January 2013.

[6] Roland Oliver, "Recollections of Early Industries in Stege", August 7, 1959, p. 1.

[7] J.P. Munro-Fraser, p. 675.

[8] Frederick J. Hulaniski, *The History of Contra Costa County, California*. Elms Publishing Company, Berkeley, California: 1917, p. 354.

[9] Hulanski p. 288.

cheaper, and more powerful than nitroglycerine, which had been the most commonly used explosive. Nobel licensed the Giant Powder Company to produce dynamite in California later that year. Giant was the first American company to produce dynamite, and its plant was initially located in Rock House Canyon, in what is today the City of San Francisco. The California Powder Works began manufacturing dynamite in the same area in 1869.[10]

The nineteenth century explosives industry was extremely dangerous, and as San Francisco's population grew explosives manufacturers needed to relocate. Contra Costa County across the bay was attractive since it was accessible due to its proximity to the harbor yet remote from population centers. In addition, the narrow canyons of Contra Costa County, which terminate in small bays, provided a natural geographical defense against explosions by allowing factory design that placed water between different facets of explosives manufacturing.[11]

During the 1870s chemical and explosives manufacturers began opening in the vicinity of what would eventually become Richmond. The Tonite Powder Company, Western Mineral Company, and California Cap Company were established at 1877 on the Stege ranch. The San Francisco explosives companies soon followed those explosive companies across the bay to Contra Costa County. In 1880, Giant relocated to Point Pinole, changing its name to the Atlas Powder Company. The California Powder Works soon followed, building a new factory in Hercules, which was named for the brand under which the company sold its powder.[12] The Vulcan Powder Works and Judson Powder works also opened in the Stege Ranch area during this era, consolidating Contra Costa County's position as the cradle of the California explosives industry. The East Bay dominated California explosives manufacturing into the twentieth century. In 1902 California had only one powder factory outside Contra Costa and Alameda counties.[13]

William Letts Oliver

William Letts Oliver was born in Chile to English parents in 1844. He attended the University of Edinburgh and became a mining engineer. After returning to Chile, Oliver ran an explosives factory, which was nationalized by the Chilean government in 1864. After the loss of his factory, Oliver left Chile for San Francisco.[14] William Letts Oliver and his wife Carrie lived in Oakland, from about 1880 until Oliver's death in 1918.[15] The couple eventually had six children together: Roland, Edwin, Caroline, Anita, William Harold, and Albert.[16] In addition his various professional activities William Letts Oliver was a yachtsman and an officer of the Bohemian Grove club in the early twentieth century. An avid amateur photographer throughout his lifetime, UC Berkeley's Bancroft Library has a collection of 2700 negatives and prints taken by Oliver and his son.[17]

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[10] Ida Mae Purcell, *History of Contra Costa County*, The Gillick Press, Berkeley, California" 1940, p. 645 – 646.

[11] James E. Vance, *Geography and Urban Evolution in the San Francisco Bay Area*, University of California, Berkeley: 1964, p. 27.

[12] Purcell, p. 646.

[13] Richmond Record, "Contra Costa County: Under the Vitascope", Richmond:1902.

[14] Pacific Mining News, Supplement to Engineering & Mining Journal-Press, "Industrial Notes: Developing of the Blasting Cap Industry", Vol. 1, No. 7, November 1922, p. 222.

[15] United States Census Bureau, Tenth Census of the United States, 1880, National Archives and Records Administration, Washington, D.C., San Francisco, California, Roll: 79, Film: 1254079, Page: 170B.

[16] United States Census Bureau, Twelfth Census of the United States, 1900, National Archives and Records Administration, Washington, D.C., Oakland Ward 3, Alameda, California, Roll: 82, Page: 13A.

[17] Online Archive of California, "Guide to the Oliver Family Photograph Collection", UC Berkeley: 2009, website: http://www.oac.cdlib.org/findaid/ark:/13030/ft0q2n99r1/ accessed February, 2013.

William Letts Oliver initially gained familiarity with an explosive called guncotton while manufacturing collodion for his photography hobby.[18] As early as 1870, European explosive companies were experimenting with nitrated guncotton in and by 1875 it was manufactured in England under the name "tonite."[19] By 1877 Oliver had left Chile and was mining in the western United States. Engineers working on the Sutro Tunnel in the Comstock needed an explosive that would remain stable at the high temperatures underground to complete the tunnel, and Oliver was able to solve the problem by substituting tonite for more volatile compounds.[20]

The California Cap Company

In 1877 William Letts Oliver was inspired by his success with tonite to leave mining and establish the Tonite Powder Company, on a portion of the former Stege Ranch.[21] In the 1870s all blasting caps in the United States had to be imported from Europe. Not only were they expensive, but the timing of deliveries was uncertain, creating business difficulties for the powder plant. Oliver was determined to create his own caps in order to protect the tonite factory business. He experimented until he came up with a blasting cap that was safer to use and had better detonating qualities than imported detonators. Oliver and his partner Freeborn Fletter founded the California Cap Company. It was located adjacent to the Tonite Powder Company a 160 acre parcel carved out of the southern portion of Stege Ranch.[22] California Cap Company, which went on to operate on the site for nearly seven decades, was the first manufacturer of blasting caps in the United States. Richard Stege, meanwhile, continued to reside on the ranch, and contracted with Tonite Powder and California Cap to transport their products to the railroad.[23] The California Cap Company was located on the parcel that is currently the Richmond Field Station. The Tonite Powder Company appears to have been located to the east on the parcel that became the Stauffer Chemical Company and later the Zeneca site, although its exact location is unclear.

The Tonite and California Cap factories, which were the first of several gunpowder and chemical companies in the region, were separated by the Stege agricultural warehouse for safety.[24] The explosives industry during this era was an extremely dangerous one. A horrific explosion in 1882 at the nearby Vulcan Powder Company caused 11 deaths and destroyed the plant.[25] Between 1882 and 1918 the Hercules and Atlas plants suffered numerous explosions which destroyed plant buildings and killed a total of 64 workers.[26] Despite its focus on safety, the California Cap Company had accidents as well. Two of its Chinese workers were killed in 1917 when one of them dropped a tray of caps. In 1941 an explosion caused a fire and critically injured a worker.[27]

William Letts Oliver continued to innovate throughout his long career in the chemical and explosives industries. In 1888 he formed the American Lucol Company adjacent to the California Cap Company property.[28] The Lucol

[18] Pacific Mining News, p. 222.
[19] G.A. Price Cuxson, ed., "Society of Engineers: Transactions for 1889", E. & F. N. Spon, London: 1890, p. 95.
[20] Pacific Mining News, p. 222.
[21] Oliver, p. 1.
[22] Pacific Mining News, p. 222.
[23] Nilda Rego, "Enterprising Stege lost all and died without a penny", Time Out, March 27, 1994, p. 2, column 4.
[24] Oliver, p. 1.
[25] Munro-Fraser, p. 424.
[26] Purcell, p. 648.
[27] Contra Costa County Standard, "Stege Powder Plant Blast; One Near Death", June 6, 1941, p. 1A.
[28] Oliver, p. 1.

plant was at what is currently the southeastern corner of the Richmond Field Station, at the approximate location of Building 163. Lucol manufactured a linseed oil substitute.[29] The factory was dismantled and relocated to New Jersey circa 1900.[30] In 1903 the Hotaling Briquette Works opened on Lucol's site at the southeast corner of the current Richmond Field station property.[31] Later known as the U.S. Briquette Company, the plant appears to have operated at this location until at least 1917.[32] The U.S. Briquette Company buildings were demolished sometime in the 1960s.

The Oliver family aggressively promoted their products both through advertising and publishing. The California Cap Company sponsored or published both articles and book-length treatises on the use of explosives. Safety was a key element of the company image, a topic of company-sponsored technical writing as well as a selling point in advertisements.[33] The Tonite Powder Company's product was known even outside the United States, and by the end of the nineteenth century the powder's explosive properties were considered comparable to the finest English products.[34] Oliver's sons Roland and Edwin Letts Oliver both graduated from UC Berkeley's College of Mining in 1900. Roland Oliver seems to have spent his entire career working in the family enterprises, while Edwin worked at California Cap between mining and other ventures. The Oliver family also became benefactors of the university, and in 1917 the California Cap Company donated substantial amounts of their products to the College of Mining including 500 electric detonators, 500 delayed action exploders, and 500 blasting caps.[35]

Eventually the Tonite factory appears to have been incorporated into the California Cap Company. The Olivers also formed an entity named Pacific Cartridge Company circa 1910. The Pacific Cartridge Company operated from the California Cap plant during World War I.[36] By 1916 there were at least a dozen buildings on the site. When Oliver died in 1918 his son Roland Oliver took over as president of California Cap Company. By 1922 Roland's brother Leslie Oliver was assistant manager of the plant and Edwin Letts Oliver was a director.[37] Roland Oliver substantially expanded the California Cap Company after he took over as president. During this era the plant grew to include 150 buildings and a horse-drawn tram line.[38]

During the late nineteenth and early twentieth century the California Cap Company was one of the most important local employers.[39] As the twentieth century progressed more heavy industry came to Contra Costa County, and by 1940 the county was second only to Los Angeles in overall industrial production.[40] The nineteenth-century California Cap Company was dwarfed by the scale of some of the newer enterprises, and its physical plant and technology were aging. During World War II California Cap was able to stay open by producing delayed action

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[29] Max Wilhelm Von Bernewitz, *Cyanide Practice, 1910 – 1913*, Dewey Publishing Company: 1913, p. 327.
[30] Oliver, p. 1.
[31] Oliver, p. 2.
[32] Hulanksi, p. 354.
[33] Halbert Powers Gillette, *Rock Excavation:Methods and Cost*, M.C. Clark, New York: 1904, x.
[34] Manual Eissler, *A Handbook on Modern Explosives*, Crosby, Lockwood & son, London: 1897, p. 117.
[35] University of California, *The University of California Chronicle*, University of California Press, January, 1917, p. 92.
[36] R.L. Polk & Company, *Richmond and Contra Costa County Directory, 1914 – 1915*, Oakland, California: 1915.
[37] Pacific Mining News, p.222.
[38] University of California, Berkeley, *Current Conditions Report*, Prepared by Tetra Tech EM Inc., November 21, 2008, p. 11.
[39] Marguerite Clausen, "On the Waterfront: An Oral History of Richmond, California", Regional Oral History Office, University of California, Berkeley, 1990, p. 21.
[40] Purcell, p. 649.

incendiary bombs that were used against Japan.[41] The California Cap Company could not survive the transition to a peacetime economy, however, and by 1949 the plant was closed and the Oliver family looking for a buyer.

University Research/Richmond Field Station

After World War II UC Berkeley's Engineering Department needed an off-campus location in order to perform experiments that required more space than a laboratory. Department Chair Morrough P. O' Brien and others in the department were performing experiments with sewage, sea water, and other materials unsuited to use on a crowded campus. They also wanted a location that was not too remote. The University purchased the California Cap Company from the Oliver family for the use of the Engineering Department in 1950.[42]

The Richmond Field Station has been the location of a research overseen by numerous UC Berkeley departments over the years. The Sanitary Engineering Research Laboratory (SERL) was one of the first departments to undertake research at the site. SERL focused primarily on sewage treatment technology, and also researched pollution control and disposal of solid and liquid waste.[43] Other early projects at the field station included sea water distillation, heat transfer, and cyclic stress research.[44]

At first the Department of Engineering utilized the buildings left behind by the California Cap Company. The Department established a machine shop, computer shop, receiving facility, mail service, and other facilities in addition to laboratories in the old detonator company buildings.[45] The current Buildings 102, 110, 118, 128, 150, 152 175, and 176 all date to the cap company era and have been repurposed for the Richmond Field Station. They also constructed new buildings as funds became available, and by the mid-1950s five new buildings had been completed at the Richmond Field Station.[46] By the 1970s the department had conducted many experiments at the Richmond Field Station that could not have been performed on the main campus.

Evaluation

The following provides an evaluation of Building 113 under each NRHP/CRHR criteria.

Building 113 does not appear to meet the criteria for listing in NRHP/CRHR because it lacks historical significance. The structure has served as a storage facility throughout its lifetime and lacks the strength of association necessary to be considered historically significant in relation to any particular events or persons (Criteria A/1 and B/2).

The utilitarian building lacks any identifiable architectural stylistic design and does not embody distinctive architectural or engineering qualities of type, period, or method of construction (Criterion C/3). In rare instances, buildings themselves can serve as sources of important information, however this building is not a principal source of important information in this regard (Criterion D/4).

[41] Oliver, p. 1.

[42] P.H. McGauhey, "The Sanitary Engineering Research Laboratory: Administration, Research and Consultation, 1950-1975 – An Interview Conducted by Malca Call", Regional Oral History Office, University of California, Berkeley, 1974, p. 70.

[43] University of California, Berkeley, 2008, p. 13.

[44] University of California, Berkeley, Department of Engineering, "Richmond Field Station Open House", May 28, 1952, p. 3 – 4.

[45] McGauhey, p. 71.

[46] University of California, Berkeley, Department of Engineering, "Guide for Engineering Field Station Inspection", undated, p. 3.

As a storage facility, Building 113 does not meet the standard of exceptional importance required for properties under 50 years old to be eligible to the NHRP (Criterion G).

State of California – The Resources Agency
DEPARTMENT OF PARKS AND RECREATION

PRIMARY RECORD

Primary # _____
HRI # _____
Trinomial _____
NRHP Status Code _____
Other Listings _____
Review Code _____ Reviewer _____ Date _____

 ***Resource Name or #** (Assigned by recorder) Richmond Field Station Building 114

P1. Other Identifier: Richmond Field Station Building 114

***P2. Location:** ☐ **Not for Publication** ☒ **Unrestricted** ***a. County** Contra Costa
and (P2b and P2c or P2d. Attach a Location Map as necessary.)
***b. USGS 7.5′ Quad** Richmond **Date** 1984 **T**___; **R** ___; __ ¼ **of Sec** ___; Diablo **B.M.**
c. Address _____ City _____ Zip _____
d. UTM: (give more than one for large and/or linear resources) Zone 10 ; 558551 mE/ 4196433 mN
e. Other Locational Data: (e.g., parcel #, directions to resource, elevation, etc., as appropriate)

***P3a. Description:** (Describe resource and its major elements. Include design, materials, condition, alterations, size, setting, and boundaries)
Building 114 is in the southern portion of the Richmond Field Station on the west side of Egret Road. Its primary façade faces northeast; it is an L-shaped, single story, with a one-and-one-half story wing, 4,523 square foot building constructed circa 1930. The one-and-one-half story of the building is topped with a front gabled roof that ties into a shed roof section at its southeast. Rafter tails and purlins are exposed at the eaves. The walls and roof are of corrugated metal. Most of the fenestration is multi-light, fixed, wood sashes. The main entrance, centered in the northeast elevation, has a wood paneled and replacement industrial door, both with windows. There is a large sliding door at the east end of the elevation. The doors are accessed by a concrete loading dock that has a set of wooden stairs in front of the main entrance. (See Continuation Sheet)
***P3b. Resource Attributes:** (List attributes and codes) HP4: Ancillary Building

***P4. Resources Present:** ☒ Building ☐ Structure ☐ Object ☐ Site ☐ District ☐ Element of District ☐ Other (Isolates, etc.)

P5b. Description of Photo: (View, date, accession #) Photograph 1: Northeast facade of building, camera facing west, January 4, 2013
***P6. Date Constructed/Age and Sources:**
☒ Historic ☐ Prehistoric ☐ Both
Circa the 1930s/Sanborn maps
***P7. Owner and Address:**
U.C. Berkeley
1301 South 46th Street
Richmond, California 94804
***P8. Recorded by:** (Name, affiliation, address)
Kara Brunzell & Julia Mates
Tetra Tech
1999 Harrison Street, Ste 500
Oakland, CA 94612
***P9. Date Recorded:** January 4, 2013
***P10. Survey Type:** (Describe) Intensive

***P11. Report Citation:** (Cite survey report and other sources, or enter "none.") *Historic Properties Survey Report for Portions of the Richmond Field Station* prepared by Tetra Tech, Inc, 2013.

***Attachments:** NONE ☒ Location Map ☐ Sketch Map ☒ Continuation Sheet ☒ Building, Structure, and Object Record ☐ Archaeological Record ☐ District Record ☐ Linear Feature Record ☐ Milling Station Record ☐ Rock Art Record ☐ Artifact Record ☐ Photograph Record ☐ Other (list) _____

***NRHP Status Code** 6Z

***Resource Name or #** (Assigned by recorder) Richmond Field Station Building 114

B1. Historic Name: California Cap Company Building 81

B2. Common Name: Building 114

B3. Original Use: Unknown B4. Present Use: Storage

***B5. Architectural Style:** Vernacular

***B6. Construction History:** (Construction date, alteration, and date of alterations) Constructed circa 1930s
Circa 1955: northwest addition constructed

***B7. Moved?** ☒ **No** ☐ **Yes** ☐ **Unknown** **Date:** _____ **Original Location:** _____

***B8. Related Features:** _____

B9. Architect: Unknown b. Builder: Unknown

***B10. Significance: Theme** N/A **Area** N/A

Period of Significance N/A **Property Type** N/A **Applicable Criteria** N/A

(Discuss importance in terms of historical or architectural context as defined by theme, period, and geographic scope. Also address integrity.)

Building 114 at Richmond Field Station does not appear to meet the criteria for listing in the National Register of Historic Places (NRHP). Furthermore, the building has been evaluated in accordance with Section 15064.5(a)(2)-(3) of the CEQA Guidelines, using the criteria outlined in Section 5024.1 of the California Public Resources Code, and does not appear to meet the significance criteria as outlined in these guidelines. Therefore, the building is not eligible for listing in the California Register of Historical Resources (CRHR). (See Continuation Sheet.)

B11. Additional Resource Attributes: (List attributes and codes)

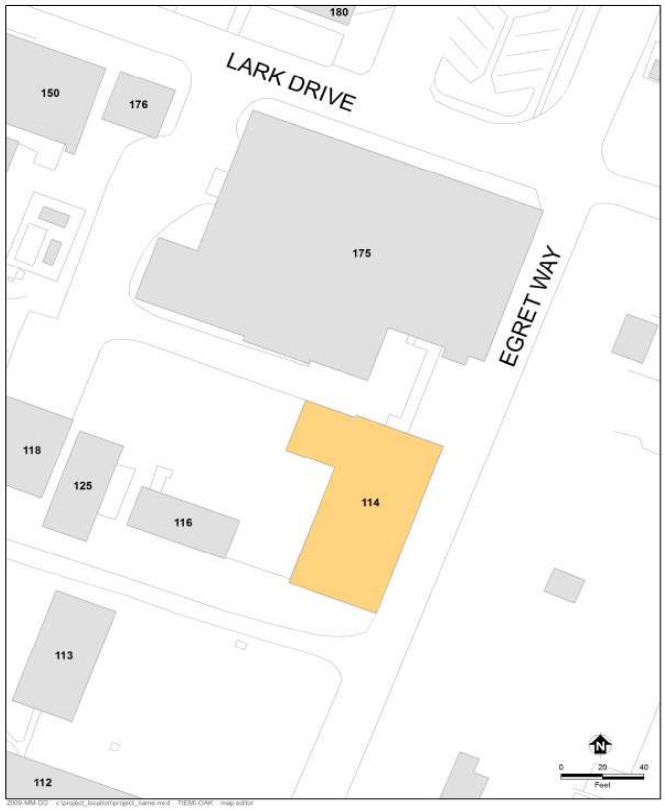
***B12. References:** See Footnotes

B13. Remarks:

***B14. Evaluator:** Kara Brunzell

***Date of Evaluation:** January 2013

(This space reserved for official comments.)



P3a. Description (continued)

A single story, shed roof addition projects from the northwest end of the building. It features a large sliding door that faces northeast. A large opening on the southeast elevation appears to be sealed from the interior.

Building 114, originally labeled "Building 81" was constructed circa 1930 by the California Cap Company or the Pacific Cartridge Company. It was adjacent to the Pacific Cartridge Company's factory and was a warehouse for the cartridges produced there. The original building was rectangular in plan, oriented along Heron Drive. After UC Berkeley purchased the property in 1950, it used the warehouse to store building materials for use in building maintenance on the property.[1] Aerial photographs show that the University constructed an addition at the northwest end of the building circa 1955. The building is currently used for building maintenance equipment.

B10. Significance (continued)

Historic Context

Europeans arrived in what would become Contra Costa County in 1772, when a Spanish expedition led by Pedro Fages discovered the San Pablo Bay and the confluence of the Sacramento and San Joaquin rivers.[2] Though subsequent Spanish expeditions passed through the region the Spanish do not appear to have settled in the area during the mission period. In the 1820s and 1830s the Mexican government began granting large tracts of land in the area to its citizens, including Ranchos San Pablo, San Ramon, and Pinole. The first permanent non-native settlers were Francisco Castro and his wife Maria Gabriela Berryessa. The Mexican government granted the 18,000 acre Rancho San Pablo to the Castros in 1823.[3] Americans began farming in Contra Costa County in the late 1830s, and by 1882 2/3 of the cultivated land in the county was devoted to wheat production.[4]

Minna C. C. Quilfelt (or Quilfeldt) purchased 600 acres of Rancho San Pablo in 1852 and 1853.[5] Adjacent to San Francisco Bay in what would eventually become the southern portion of the City of Richmond, a wharf and produce warehouse were constructed on the ranch in the 1860s to ship agricultural produce to the San Francisco markets from Rancho San Pablo as well as the Quilfelt ranch. The warehouse and wharf were used to transport cattle, grain, fruit, and in later years the frogs' legs raised by Richard Stege for the San Francisco restaurant market.[6] German native Richard Stege settled on Rancho San Pablo in the late 1860s after stints in the gold fields and the Siberian fur trade. He married Minna Quilfelt, who was a widow, in 1870.[7] Minna Quilfelt Stege died in 1879, leaving the ranch to Stege and her daughter Edith. Stege began selling off portions of his ranch to raise money while continuing his frog-raising and other ventures. A town named Stege formed on Richard Stege's holdings, and by the late nineteenth century several industries, including the California Cap Works, the United States Briquette Company, the Stauffer Chemical Works and the Stege Lumber Manufacturing Company, were

[1] Shackleton, 2013.

[2] Mildred B. Hoover, Hero E. Rensch, Ethel G. Rensch, Douglas E. Kyle, *Historic Spots in California, Fourth Edition*, Stanford University Press, Stanford, California: 1958, p. 129.

[3] Donald Bastin, *Images of America: Richmond*, Arcadia Publishing, Charleston SC: 2003, p. 9.

[4] J.P. Munro-Fraser, *History of Contra Costa County, California*, W.A. Slocum & Co., San Francisco: 1882, p. 55 – 57.

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[6] Roland Oliver, "Recollections of Early Industries in Stege", August 7, 1959, p. 1.

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operating from portions of the Stege Ranch.[8] Richmond incorporated in 1905, and by 1917 was already the largest city in Contra Costa County.[9] Stege was eventually absorbed into Richmond as the latter grew.

The Explosives Industry in Contra Costa County

Swedish chemist Alfred Nobel laid the foundation for the high-explosives industry with his innovations beginning in 1860s, inventing first a detonator and then a blasting cap. In 1867 he invented dynamite, which was safer, cheaper, and more powerful than nitroglycerine, which had been the most commonly used explosive. Nobel licensed the Giant Powder Company to produce dynamite in California later that year. Giant was the first American company to produce dynamite, and its plant was initially located in Rock House Canyon, in what is today the City of San Francisco. The California Powder Works began manufacturing dynamite in the same area in 1869.[10]

The nineteenth century explosives industry was extremely dangerous, and as San Francisco's population grew explosives manufacturers needed to relocate. Contra Costa County across the bay was attractive since it was accessible due to its proximity to the harbor yet remote from population centers. In addition, the narrow canyons of Contra Costa County, which terminate in small bays, provided a natural geographical defense against explosions by allowing factory design that placed water between different facets of explosives manufacturing.[11]

During the 1870s chemical and explosives manufacturers began opening in the vicinity of what would eventually become Richmond. The Tonite Powder Company, Western Mineral Company, and California Cap Company were established at 1877 on the Stege ranch. The San Francisco explosives companies soon followed those explosive companies across the bay to Contra Costa County. In 1880, Giant relocated to Point Pinole, changing its name to the Atlas Powder Company. The California Powder Works soon followed, building a new factory in Hercules, which was named for the brand under which the company sold its powder.[12] The Vulcan Powder Works and Judson Powder works also opened in the Stege Ranch area during this era, consolidating Contra Costa County's position as the cradle of the California explosives industry. The East Bay dominated California explosives manufacturing into the twentieth century. In 1902 California had only one powder factory outside Contra Costa and Alameda counties.[13]

William Letts Oliver

William Letts Oliver was born in Chile to English parents in 1844. He attended the University of Edinburgh and became a mining engineer. After returning to Chile, Oliver ran an explosives factory, which was nationalized by the Chilean government in 1864. After the loss of his factory, Oliver left Chile for San Francisco.[14] William Letts Oliver and his wife Carrie lived in Oakland, from about 1880 until Oliver's death in 1918.[15] The couple eventually

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[8] Frederick J. Hulaniski, *The History of Contra Costa County, California*. Elms Publishing Company, Berkeley, California: 1917, p. 354.

[9] Hulanski p. 288.

[10] Ida Mae Purcell, *History of Contra Costa County*, The Gillick Press, Berkeley, California" 1940, p. 645 – 646.

[11] James E. Vance, *Geography and Urban Evolution in the San Francisco Bay Area*, University of California, Berkeley: 1964, p. 27.

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[13] Richmond Record, "Contra Costa County: Under the Vitascope", Richmond:1902.

[14] Pacific Mining News, Supplement to Engineering & Mining Journal-Press, "Industrial Notes: Developing of the Blasting Cap Industry", Vol. 1, No. 7, November 1922, p. 222.

[15] United States Census Bureau, Tenth Census of the United States, 1880, National Archives and Records Administration, Washington, D.C., San Francisco, California, Roll: 79, Film: 1254079, Page: 170B.

had six children together: Roland, Edwin, Caroline, Anita, William Harold, and Albert.[16] In addition his various professional activities William Letts Oliver was a yachtsman and an officer of the Bohemian Grove club in the early twentieth century. An avid amateur photographer throughout his lifetime, UC Berkeley's Bancroft Library has a collection of 2700 negatives and prints taken by Oliver and his son.[17]

William Letts Oliver initially gained familiarity with an explosive called guncotton while manufacturing collodion for his photography hobby.[18] As early as 1870, European explosive companies were experimenting with nitrated guncotton in and by 1875 it was manufactured in England under the name "tonite."[19] By 1877 Oliver had left Chile and was mining in the western United States. Engineers working on the Sutro Tunnel in the Comstock needed an explosive that would remain stable at the high temperatures underground to complete the tunnel, and Oliver was able to solve the problem by substituting tonite for more volatile compounds.[20]

The California Cap Company

In 1877 William Letts Oliver was inspired by his success with tonite to leave mining and establish the Tonite Powder Company, on a portion of the former Stege Ranch.[21] In the 1870s all blasting caps in the United States had to be imported from Europe. Not only were they expensive, but the timing of deliveries was uncertain, creating business difficulties for the powder plant. Oliver was determined to create his own caps in order to protect the tonite factory business. He experimented until he came up with a blasting cap that was safer to use and had better detonating qualities than imported detonators. Oliver and his partner Freeborn Fletter founded the California Cap Company. It was located adjacent to the Tonite Powder Company a 160 acre parcel carved out of the southern portion of Stege Ranch.[22] California Cap Company, which went on to operate on the site for nearly seven decades, was the first manufacturer of blasting caps in the United States. Richard Stege, meanwhile, continued to reside on the ranch, and contracted with Tonite Powder and California Cap to transport their products to the railroad.[23] The California Cap Company was located on the parcel that is currently the Richmond Field Station. The Tonite Powder Company appears to have been located to the east on the parcel that became the Stauffer Chemical Company and later the Zeneca site, although its exact location is unclear.

The Tonite and California Cap factories, which were the first of several gunpowder and chemical companies in the region, were separated by the Stege agricultural warehouse for safety.[24] The explosives industry during this era was an extremely dangerous one. A horrific explosion in 1882 at the nearby Vulcan Powder Company caused 11 deaths and destroyed the plant.[25] Between 1882 and 1918 the Hercules and Atlas plants suffered numerous

[16] United States Census Bureau, Twelfth Census of the United States, 1900, National Archives and Records Administration, Washington, D.C., Oakland Ward 3, Alameda, California, Roll: 82, Page: 13A.

[17] Online Archive of California, "Guide to the Oliver Family Photograph Collection", UC Berkeley: 2009, website: http://www.oac.cdlib.org/findaid/ark:/13030/ft0q2n99r1/ accessed February, 2013.

[18] Pacific Mining News, p. 222.

[19] G.A. Price Cuxson, ed., "Society of Engineers: Transactions for 1889", E. & F. N. Spon, London: 1890, p. 95.

[20] Pacific Mining News, p. 222.

[21] Oliver, p. 1.

[22] Pacific Mining News, p. 222.

[23] Nilda Rego, "Enterprising Stege lost all and died without a penny", Time Out, March 27, 1994, p. 2, column 4.

[24] Oliver, p. 1.

[25] Munro-Fraser, p. 424.

explosions which destroyed plant buildings and killed a total of 64 workers.[26] Despite its focus on safety, the California Cap Company had accidents as well. Two of its Chinese workers were killed in 1917 when one of them dropped a tray of caps. In 1941 an explosion caused a fire and critically injured a worker.[27]

William Letts Oliver continued to innovate throughout his long career in the chemical and explosives industries. In 1888 he formed the American Lucol Company adjacent to the California Cap Company property.[28] The Lucol plant was at what is currently the southeastern corner of the Richmond Field Station, at the approximate location of Building 163. Lucol manufactured a linseed oil substitute.[29] The factory was dismantled and relocated to New Jersey circa 1900.[30] In 1903 the Hotaling Briquette Works opened on Lucol's site at the southeast corner of the current Richmond Field station property.[31] Later known as the U.S. Briquette Company, the plant appears to have operated at this location until at least 1917.[32] The U.S. Briquette Company buildings were demolished sometime in the 1960s.

The Oliver family aggressively promoted their products both through advertising and publishing. The California Cap Company sponsored or published both articles and book-length treatises on the use of explosives. Safety was a key element of the company image, a topic of company-sponsored technical writing as well as a selling point in advertisements.[33] The Tonite Powder Company's product was known even outside the United States, and by the end of the nineteenth century the powder's explosive properties were considered comparable to the finest English products.[34] Oliver's sons Roland and Edwin Letts Oliver both graduated from UC Berkeley's College of Mining in 1900. Roland Oliver seems to have spent his entire career working in the family enterprises, while Edwin worked at California Cap between mining and other ventures. The Oliver family also became benefactors of the university, and in 1917 the California Cap Company donated substantial amounts of their products to the College of Mining including 500 electric detonators, 500 delayed action exploders, and 500 blasting caps.[35]

Eventually the Tonite factory appears to have been incorporated into the California Cap Company. The Olivers also formed an entity named Pacific Cartridge Company circa 1910. The Pacific Cartridge Company operated from the California Cap plant during World War I.[36] By 1916 there were at least a dozen buildings on the site. When Oliver died in 1918 his son Roland Oliver took over as president of California Cap Company. By 1922 Roland's brother Leslie Oliver was assistant manager of the plant and Edwin Letts Oliver was a director.[37] Roland Oliver substantially expanded the California Cap Company after he took over as president. During this era the plant grew to include 150 buildings and a horse-drawn tram line.[38]

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[26] Purcell, p. 648.
[27] Contra Costa County Standard, "Stege Powder Plant Blast; One Near Death", June 6, 1941, p. 1A.
[28] Oliver, p. 1.
[29] Max Wilhelm Von Bernewitz, *Cyanide Practice, 1910 – 1913*, Dewey Publishing Company: 1913, p. 327.
[30] Oliver, p. 1.
[31] Oliver, p. 2.
[32] Hulanksi, p. 354.
[33] Halbert Powers Gillette, *Rock Excavation:Methods and Cost*, M.C. Clark, New York: 1904, x.
[34] Manual Eissler, *A Handbook on Modern Explosives*, Crosby, Lockwood & son, London: 1897, p. 117.
[35] University of California, *The University of California Chronicle*, University of California Press, January, 1917, p. 92.
[36] R.L. Polk & Company, *Richmond and Contra Costa County Directory, 1914 – 1915*, Oakland, California: 1915.
[37] Pacific Mining News, p.222.
[38] University of California, Berkeley, *Current Conditions Report*, Prepared by Tetra Tech EM Inc., November 21, 2008, p. 11.

During the late nineteenth and early twentieth century the California Cap Company was one of the most important local employers.[39] As the twentieth century progressed more heavy industry came to Contra Costa County, and by 1940 the county was second only to Los Angeles in overall industrial production.[40] The nineteenth-century California Cap Company was dwarfed by the scale of some of the newer enterprises, and its physical plant and technology were aging. During World War II California Cap was able to stay open by producing delayed action incendiary bombs that were used against Japan.[41] The California Cap Company could not survive the transition to a peacetime economy, however, and by 1949 the plant was closed and the Oliver family looking for a buyer.

University Research/Richmond Field Station

After World War II UC Berkeley's Engineering Department needed an off-campus location in order to perform experiments that required more space than a laboratory. Department Chair Morrough P. O' Brien and others in the department were performing experiments with sewage, sea water, and other materials unsuited to use on a crowded campus. They also wanted a location that was not too remote. The University purchased the California Cap Company from the Oliver family for the use of the Engineering Department in 1950.[42]

The Richmond Field Station has been the location of a research overseen by numerous UC Berkeley departments over the years. The Sanitary Engineering Research Laboratory (SERL) was one of the first departments to undertake research at the site. SERL focused primarily on sewage treatment technology, and also researched pollution control and disposal of solid and liquid waste.[43] Other early projects at the field station included sea water distillation, heat transfer, and cyclic stress research.[44]

At first the Department of Engineering utilized the buildings left behind by the California Cap Company. The Department established a machine shop, computer shop, receiving facility, mail service, and other facilities in addition to laboratories in the old detonator company buildings.[45] The current Buildings 102, 110, 118, 128, 150, 152 175, and 176 all date to the cap company era and have been repurposed for the Richmond Field Station. They also constructed new buildings as funds became available, and by the mid-1950s five new buildings had been completed at the Richmond Field Station.[46] By the 1970s the department had conducted many experiments at the Richmond Field Station that could not have been performed on the main campus.

Evaluation

The following provides an evaluation of Building 114 under each NRHP/CRHR criteria.

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[39] Marguerite Clausen, "On the Waterfront: An Oral History of Richmond, California", Regional Oral History Office, University of California, Berkeley, 1990, p. 21.

[40] Purcell, p. 649.

[41] Oliver, p. 1.

[42] P.H. McGauhey, "The Sanitary Engineering Research Laboratory: Administration, Research and Consultation, 1950-1975 – An Interview Conducted by Malca Call", Regional Oral History Office, University of California, Berkeley, 1974, p. 70.

[43] University of California, Berkeley, 2008, p. 13.

[44] University of California, Berkeley, Department of Engineering, "Richmond Field Station Open House", May 28, 1952, p. 3 – 4.

[45] McGauhey, p. 71.

[46] University of California, Berkeley, Department of Engineering, "Guide for Engineering Field Station Inspection", undated, p. 3.

Building 114 does not appear to meet the criteria for listing in NRHP/CRHR because it lacks historical significance. The structure has primarily been used for storage throughout its lifetime and as such lacks the strength of association necessary to be considered historically significant in relation to any particular events or persons (Criteria A/1 and B/2).

The simple building lacks any identifiable architectural stylistic design and does not embody distinctive architectural or engineering qualities of type, period, or method of construction (Criterion C/3). In rare instances, buildings themselves can serve as sources of important information, however this building is not a principal source of important information in this regard (Criterion D/4).

State of California – The Resources Agency
DEPARTMENT OF PARKS AND RECREATION

PRIMARY RECORD

Primary # _____
HRI # _____
Trinomial _____
NRHP Status Code _____
Other Listings _____
Review Code _____ Reviewer _____ Date _____

 ***Resource Name or #** (Assigned by recorder) Richmond Field Station Building 116

P1. Other Identifier: Richmond Field Station Building 116

***P2. Location:** ☐ **Not for Publication** ☒ **Unrestricted** ***a. County** Contra Costa
and (P2b and P2c or P2d. Attach a Location Map as necessary.)
***b. USGS 7.5′ Quad** Richmond **Date** 1984 **T**___; **R** ____; __ ¼ **of Sec** ___; Diablo **B.M.**
c. Address _____ City _____ Zip _____
d. UTM: (give more than one for large and/or linear resources) Zone 10 ; 558525 mE/ 4196427 mN
e. Other Locational Data: (e.g., parcel #, directions to resource, elevation, etc., as appropriate)

***P3a. Description:** (Describe resource and its major elements. Include design, materials, condition, alterations, size, setting, and boundaries)
Building 116 is in the southern portion of the Richmond Field Station. It is 967 square feet and was moved to its present location in 1964. The single story building is a rectangular, Butler Company prefabricated building topped with a front gabled roof. The walls and roof are corrugated metal. Fenestration is multi-light, fixed metal sashes, some of which are wire sashes. The entrance at the south end of the southeast elevation is a paneled wood door with a window. (See Continuation Sheet)

***P3b. Resource Attributes:** (List attributes and codes) HP4: Ancillary Building

***P4. Resources Present:** ☒ Building ☐ Structure ☐ Object ☐ Site ☐ District ☐ Element of District ☐ Other (Isolates, etc.)

P5b. Description of Photo: (View, date, accession #) Photograph 1: Southeast and northeast facades of building, camera facing southwest, January 4, 2013

***P6. Date Constructed/Age and Sources:**
☒ Historic ☐ Prehistoric ☐ Both
Unknown

***P7. Owner and Address:**
U.C. Berkeley
1301 South 46th Street
Richmond, California 94804

***P8. Recorded by:** (Name, affiliation, address)
Kara Brunzell & Julia Mates
Tetra Tech
1999 Harrison Street, Ste 500
Oakland, CA 94612

***P9. Date Recorded:** January 4, 2013

***P10. Survey Type:** (Describe) Intensive

***P11. Report Citation:** (Cite survey report and other sources, or enter "none.") *Historic Properties Survey Report for Portions of the Richmond Field Station* prepared by Tetra Tech, Inc, 2013.

***Attachments:** NONE ☒ Location Map ☐ Sketch Map ☒ Continuation Sheet ☒ Building, Structure, and Object Record ☐ Archaeological Record ☐ District Record ☐ Linear Feature Record ☐ Milling Station Record ☐ Rock Art Record ☐ Artifact Record ☐ Photograph Record ☐ Other (list) _____

***NRHP Status Code** 6Z

***Resource Name or #** (Assigned by recorder) Richmond Field Station Building 116

B1. Historic Name: _____

B2. Common Name: Building 116

B3. Original Use: Shop B4. Present Use: Shop

***B5. Architectural Style:** Vernacular

***B6. Construction History:** (Construction date, alteration, and date of alterations) Unknown

***B7. Moved?** ☐ **No** ☒ **Yes** ☐ **Unknown** **Date:** 1961 **Original Location:** UCB Campus

***B8. Related Features:** _____

B9. Architect: Unknown b. Builder: Unknown

***B10. Significance: Theme** N/A **Area** N/A

Period of Significance N/A **Property Type** N/A **Applicable Criteria** N/A

(Discuss importance in terms of historical or architectural context as defined by theme, period, and geographic scope. Also address integrity.)

Building 116 at Richmond Field Station does not appear to meet the criteria for listing in the National Register of Historic Places (NRHP). Furthermore, the building has been evaluated in accordance with Section 15064.5(a)(2)-(3) of the CEQA Guidelines, using the criteria outlined in Section 5024.1 of the California Public Resources Code, and does not appear to meet the significance criteria as outlined in these guidelines. Therefore, the building is not eligible for listing in the California Register of Historical Resources (CRHR). (See Continuation Sheet.)

B11. Additional Resource Attributes: (List attributes and codes)

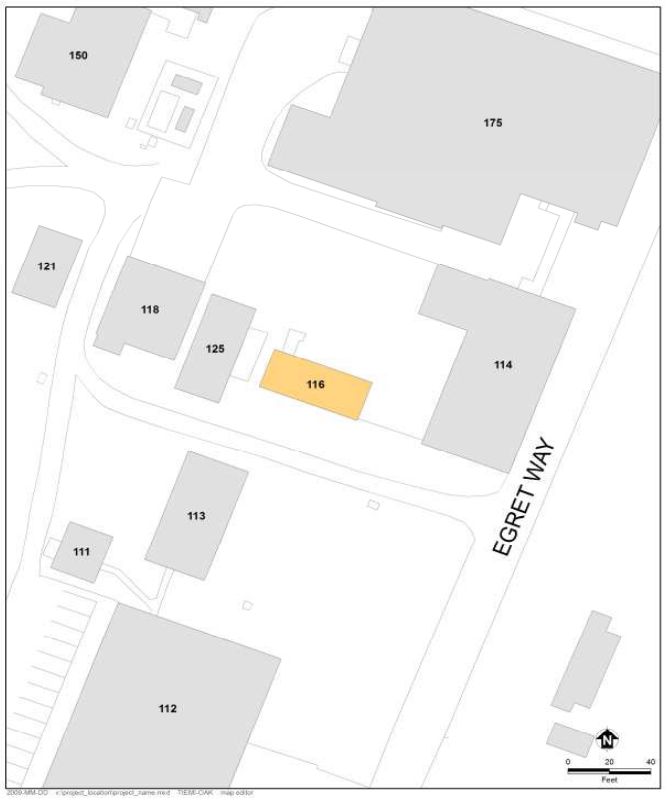
***B12. References:** See Footnotes

B13. Remarks:

***B14. Evaluator:** Kara Brunzell

***Date of Evaluation:** January 2013

(This space reserved for official comments.)



P3a. Description (continued)

Building 116 was originally constructed on the UC Berkeley campus by the US Air Force. Its original construction date is unknown, but by 1961 it had outlived its purpose and the UC Regents decided to raze it. SERL had the building relocated to the Richmond Field Station at the end of 1961.[1] It has been used throughout its lifetime as a support and storage area.

B10. Significance (continued)

Historic Context

Europeans arrived in what would become Contra Costa County in 1772, when a Spanish expedition led by Pedro Fages discovered the San Pablo Bay and the confluence of the Sacramento and San Joaquin rivers.[2] Though subsequent Spanish expeditions passed through the region the Spanish do not appear to have settled in the area during the mission period. In the 1820s and 1830s the Mexican government began granting large tracts of land in the area to its citizens, including Ranchos San Pablo, San Ramon, and Pinole. The first permanent non-native settlers were Francisco Castro and his wife Maria Gabriela Berryessa. The Mexican government granted the 18,000 acre Rancho San Pablo to the Castros in 1823.[3] Americans began farming in Contra Costa County in the late 1830s, and by 1882 2/3 of the cultivated land in the county was devoted to wheat production.[4]

Minna C. C. Quilfelt (or Quilfeldt) purchased 600 acres of Rancho San Pablo in 1852 and 1853.[5] Adjacent to San Francisco Bay in what would eventually become the southern portion of the City of Richmond, a wharf and produce warehouse were constructed on the ranch in the 1860s to ship agricultural produce to the San Francisco markets from Rancho San Pablo as well as the Quilfelt ranch. The warehouse and wharf were used to transport cattle, grain, fruit, and in later years the frogs' legs raised by Richard Stege for the San Francisco restaurant market.[6] German native Richard Stege settled on Rancho San Pablo in the late 1860s after stints in the gold fields and the Siberian fur trade. He married Minna Quilfelt, who was a widow, in 1870.[7] Minna Quilfelt Stege died in 1879, leaving the ranch to Stege and her daughter Edith. Stege began selling off portions of his ranch to raise money while continuing his frog-raising and other ventures. A town named Stege formed on Richard Stege's holdings, and by the late nineteenth century several industries, including the California Cap Works, the United States Briquette Company, the Stauffer Chemical Works and the Stege Lumber Manufacturing Company, were operating from portions of the Stege Ranch.[8] Richmond incorporated in 1905, and by 1917 was already the largest city in Contra Costa County.[9] Stege was eventually absorbed into Richmond as the latter grew.

The Explosives Industry in Contra Costa County

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[1] University of California, Berkeley, File "Building 116," located in vertical files in Room 148, Richmond Field Station.

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[15] United States Census Bureau, Tenth Census of the United States, 1880, National Archives and Records Administration, Washington, D.C., San Francisco, California, Roll: 79, Film: 1254079, Page: 170B.

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[24] Oliver, p. 1.
[25] Munro-Fraser, p. 424.
[26] Purcell, p. 648.
[27] Contra Costa County Standard, "Stege Powder Plant Blast; One Near Death", June 6, 1941, p. 1A.

William Letts Oliver continued to innovate throughout his long career in the chemical and explosives industries. In 1888 he formed the American Lucol Company adjacent to the California Cap Company property.[28] The Lucol plant was at what is currently the southeastern corner of the Richmond Field Station, at the approximate location of Building 163. Lucol manufactured a linseed oil substitute.[29] The factory was dismantled and relocated to New Jersey circa 1900.[30] In 1903 the Hotaling Briquette Works opened on Lucol's site at the southeast corner of the current Richmond Field station property.[31] Later known as the U.S. Briquette Company, the plant appears to have operated at this location until at least 1917.[32] The U.S. Briquette Company buildings were demolished sometime in the 1960s.

The Oliver family aggressively promoted their products both through advertising and publishing. The California Cap Company sponsored or published both articles and book-length treatises on the use of explosives. Safety was a key element of the company image, a topic of company-sponsored technical writing as well as a selling point in advertisements.[33] The Tonite Powder Company's product was known even outside the United States, and by the end of the nineteenth century the powder's explosive properties were considered comparable to the finest English products.[34] Oliver's sons Roland and Edwin Letts Oliver both graduated from UC Berkeley's College of Mining in 1900. Roland Oliver seems to have spent his entire career working in the family enterprises, while Edwin worked at California Cap between mining and other ventures. The Oliver family also became benefactors of the university, and in 1917 the California Cap Company donated substantial amounts of their products to the College of Mining including 500 electric detonators, 500 delayed action exploders, and 500 blasting caps.[35]

Eventually the Tonite factory appears to have been incorporated into the California Cap Company. The Olivers also formed an entity named Pacific Cartridge Company circa 1910. The Pacific Cartridge Company operated from the California Cap plant during World War I.[36] By 1916 there were at least a dozen buildings on the site. When Oliver died in 1918 his son Roland Oliver took over as president of California Cap Company. By 1922 Roland's brother Leslie Oliver was assistant manager of the plant and Edwin Letts Oliver was a director.[37] Roland Oliver substantially expanded the California Cap Company after he took over as president. During this era the plant grew to include 150 buildings and a horse-drawn tram line.[38]

During the late nineteenth and early twentieth century the California Cap Company was one of the most important local employers.[39] As the twentieth century progressed more heavy industry came to Contra Costa County, and by

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[28] Oliver, p. 1.
[29] Max Wilhelm Von Bernewitz, *Cyanide Practice, 1910 – 1913*, Dewey Publishing Company: 1913, p. 327.
[30] Oliver, p. 1.
[31] Oliver, p. 2.
[32] Hulanksi, p. 354.
[33] Halbert Powers Gillette, *Rock Excavation:Methods and Cost,* M.C. Clark, New York: 1904, x.
[34] Manual Eissler, *A Handbook on Modern Explosives,* Crosby, Lockwood & son, London: 1897, p. 117.
[35] University of California, *The University of California Chronicle,* University of California Press, January, 1917, p. 92.
[36] R.L. Polk & Company, *Richmond and Contra Costa County Directory, 1914 – 1915*, Oakland, California: 1915.
[37] Pacific Mining News, p.222.
[38] University of California, Berkeley, *Current Conditions Report,* Prepared by Tetra Tech EM Inc., November 21, 2008, p. 11.
[39] Marguerite Clausen, "On the Waterfront: An Oral History of Richmond, California", Regional Oral History Office, University of California, Berkeley, 1990, p. 21.

1940 the county was second only to Los Angeles in overall industrial production.[40] The nineteenth-century California Cap Company was dwarfed by the scale of some of the newer enterprises, and its physical plant and technology were aging. During World War II California Cap was able to stay open by producing delayed action incendiary bombs that were used against Japan.[41] The California Cap Company could not survive the transition to a peacetime economy, however, and by 1949 the plant was closed and the Oliver family looking for a buyer.

University Research/Richmond Field Station

After World War II UC Berkeley's Engineering Department needed an off-campus location in order to perform experiments that required more space than a laboratory. Department Chair Morrough P. O' Brien and others in the department were performing experiments with sewage, sea water, and other materials unsuited to use on a crowded campus. They also wanted a location that was not too remote. The University purchased the California Cap Company from the Oliver family for the use of the Engineering Department in 1950.[42]

The Richmond Field Station has been the location of a research overseen by numerous UC Berkeley departments over the years. The Sanitary Engineering Research Laboratory (SERL) was one of the first departments to undertake research at the site. SERL focused primarily on sewage treatment technology, and also researched pollution control and disposal of solid and liquid waste.[43] Other early projects at the field station included sea water distillation, heat transfer, and cyclic stress research.[44]

At first the Department of Engineering utilized the buildings left behind by the California Cap Company. The Department established a machine shop, computer shop, receiving facility, mail service, and other facilities in addition to laboratories in the old detonator company buildings.[45] The current Buildings 102, 110, 118, 128, 150, 152 175, and 176 all date to the cap company era and have been repurposed for the Richmond Field Station. They also constructed new buildings as funds became available, and by the mid-1950s five new buildings had been completed at the Richmond Field Station.[46] By the 1970s the department had conducted many experiments at the Richmond Field Station that could not have been performed on the main campus.

Evaluation

The following provides an evaluation of Building 116 under each NRHP/CRHR criteria.

Building 116 does not appear to meet the criteria for listing in NRHP/CRHR because it lacks historical significance. The structure has primarily been used for storage throughout its lifetime and as such lacks the strength of association necessary to be considered historically significant in relation to any particular events or persons (Criteria A/1 and B/2).

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[40] Purcell, p. 649.

[41] Oliver, p. 1.

[42] P.H. McGauhey, "The Sanitary Engineering Research Laboratory: Administration, Research and Consultation, 1950-1975 – An Interview Conducted by Malca Call", Regional Oral History Office, University of California, Berkeley, 1974, p. 70.

[43] University of California, Berkeley, 2008, p. 13.

[44] University of California, Berkeley, Department of Engineering, "Richmond Field Station Open House", May 28, 1952, p. 3 – 4.

[45] McGauhey, p. 71.

[46] University of California, Berkeley, Department of Engineering, "Guide for Engineering Field Station Inspection", undated, p. 3.

The utilitarian prefabricated building lacks any identifiable architectural stylistic design and does not embody distinctive architectural or engineering qualities of type, period, or method of construction (Criterion C/3). In rare instances, buildings themselves can serve as sources of important information, however this building is not a principal source of important information in this regard (Criterion D/4).

State of California – The Resources Agency
DEPARTMENT OF PARKS AND RECREATION

PRIMARY RECORD

Primary # _____
HRI # _____
Trinomial _____
NRHP Status Code _____
Other Listings _____
Review Code _____ Reviewer _____ Date _____

 ***Resource Name or #** (Assigned by recorder) Richmond Field Station Building 117

P1. Other Identifier: Richmond Field Station Building 117

***P2. Location:** ☐ **Not for Publication** ☒ **Unrestricted** ***a. County** Contra Costa
and (P2b and P2c or P2d. Attach a Location Map as necessary.)
***b. USGS 7.5′ Quad** Richmond **Date** 1984 **T**___; **R** ____; __ ¼ **of Sec** ___; Diablo **B.M.**
c. Address _____ City _____ Zip _____
d. UTM: (give more than one for large and/or linear resources) Zone 10 ; 558618 mE/ 4196446 mN
e. Other Locational Data: (e.g., parcel #, directions to resource, elevation, etc., as appropriate)

***P3a. Description:** (Describe resource and its major elements. Include design, materials, condition, alterations, size, setting, and boundaries)
Building 117 is along the southeastern border of the Richmond Field Station. It is a single story and rectangular in plan. The building is topped with a front gabled roof that has exposed wood rafter tails and purlins at the eaves. The walls and roof are corrugated metal. Fenestration is fixed wood sashes. The entrance at the north end of the northwest elevation is double paneled wood doors with windows. Building 117's construction date is unknown. Aerial photographs show it was moved to its present location circa 1990. Its materials indicate that it was constructed prior to 1950 during the California Cap Company era, but research failed to reveal its original use and location. It was used as a maintenance shop in the 1990s and is currently used for storage and support.

***P3b. Resource Attributes:** (List attributes and codes) HP4: Ancillary Building

***P4. Resources Present:** ☒ Building ☐ Structure ☐ Object ☐ Site ☐ District ☐ Element of District ☐ Other (Isolates, etc.)

P5b. Description of Photo: (View, date, accession #) Photograph 1: Northwest and southwest facades of building, camera facing west, January 4, 2013

***P6. Date Constructed/Age and Sources:**
☒ Historic ☐ Prehistoric ☐ Both
Unknown

***P7. Owner and Address:**
U.C. Berkeley
1301 South 46th Street
Richmond, California 94804

***P8. Recorded by:** (Name, affiliation, address)
Kara Brunzell & Julia Mates
Tetra Tech
1999 Harrison Street, Ste 500
Oakland, CA 94612

***P9. Date Recorded:** January 4, 2013

***P10. Survey Type:** (Describe) Intensive

***P11. Report Citation:** (Cite survey report and other sources, or enter "none.") *Historic Properties Survey Report for Portions of the Richmond Field Station* prepared by Tetra Tech, Inc, 2013.

***Attachments:** NONE ☒ Location Map ☐ Sketch Map ☒ Continuation Sheet ☒ Building, Structure, and Object Record ☐ Archaeological Record ☐ District Record ☐ Linear Feature Record ☐ Milling Station Record ☐ Rock Art Record ☐ Artifact Record ☐ Photograph Record ☐ Other (list) _____

***NRHP Status Code** 6Z

***Resource Name or #** (Assigned by recorder) Richmond Field Station Building 117

B1. Historic Name: _____

B2. Common Name: Building 117

B3. Original Use: Unknown B4. Present Use: Storage

***B5. Architectural Style:** Vernacular

***B6. Construction History:** (Construction date, alteration, and date of alterations) Construction date unknown, moved circa 1990

***B7. Moved?** ☐ No ☒ Yes ☐ Unknown **Date:** 1990 **Original Location:** Unknown

***B8. Related Features:** _____

B9. Architect: Unknown b. Builder: Unknown

***B10. Significance: Theme** N/A **Area** N/A

Period of Significance N/A **Property Type** N/A **Applicable Criteria** N/A

(Discuss importance in terms of historical or architectural context as defined by theme, period, and geographic scope. Also address integrity.)

Building 117 at Richmond Field Station does not appear to meet the criteria for listing in the National Register of Historic Places (NRHP). Furthermore, the building has been evaluated in accordance with Section 15064.5(a)(2)-(3) of the CEQA Guidelines, using the criteria outlined in Section 5024.1 of the California Public Resources Code, and does not appear to meet the significance criteria as outlined in these guidelines. Therefore, the building is not eligible for listing in the California Register of Historical Resources (CRHR).

B11. Additional Resource Attributes: (List attributes and codes)

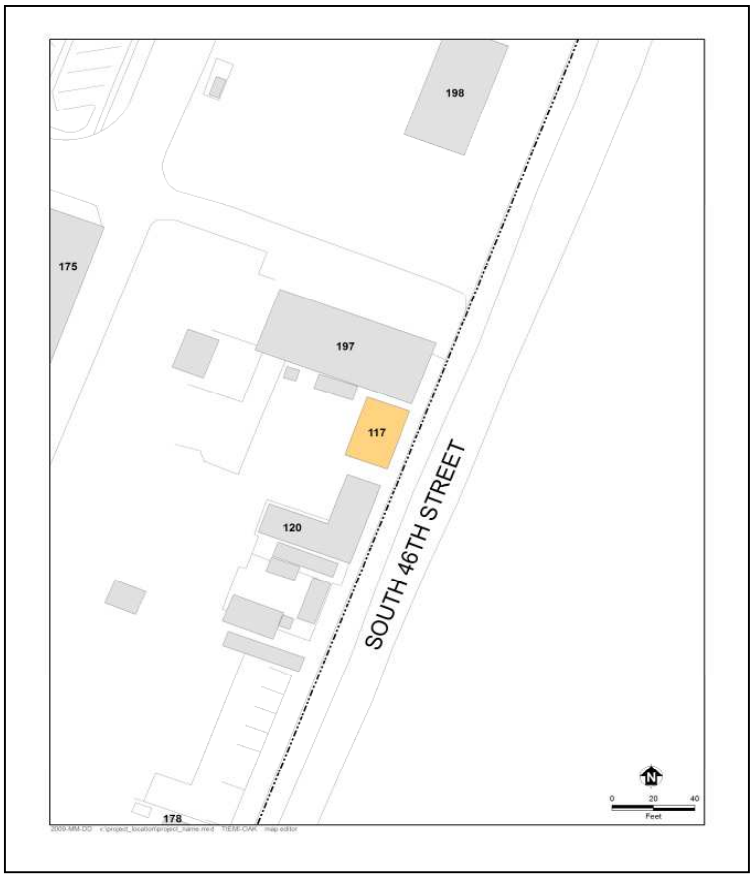
***B12. References:** See Footnotes

B13. Remarks:

***B14. Evaluator:** Kara Brunzell

***Date of Evaluation:** January 2013

(This space reserved for official comments.)



B10. Significance (continued)

Historic Context

Europeans arrived in what would become Contra Costa County in 1772, when a Spanish expedition led by Pedro Fages discovered the San Pablo Bay and the confluence of the Sacramento and San Joaquin rivers.[1] Though subsequent Spanish expeditions passed through the region the Spanish do not appear to have settled in the area during the mission period. In the 1820s and 1830s the Mexican government began granting large tracts of land in the area to its citizens, including Ranchos San Pablo, San Ramon, and Pinole. The first permanent non-native settlers were Francisco Castro and his wife Maria Gabriela Berryessa. The Mexican government granted the 18,000 acre Rancho San Pablo to the Castros in 1823.[2] Americans began farming in Contra Costa County in the late 1830s, and by 1882 2/3 of the cultivated land in the county was devoted to wheat production.[3]

Minna C. C. Quilfelt (or Quilfeldt) purchased 600 acres of Rancho San Pablo in 1852 and 1853.[4] Adjacent to San Francisco Bay in what would eventually become the southern portion of the City of Richmond, a wharf and produce warehouse were constructed on the ranch in the 1860s to ship agricultural produce to the San Francisco markets from Rancho San Pablo as well as the Quilfelt ranch. The warehouse and wharf were used to transport cattle, grain, fruit, and in later years the frogs' legs raised by Richard Stege for the San Francisco restaurant market.[5] German native Richard Stege settled on Rancho San Pablo in the late 1860s after stints in the gold fields and the Siberian fur trade. He married Minna Quilfelt, who was a widow, in 1870.[6] Minna Quilfelt Stege died in 1879, leaving the ranch to Stege and her daughter Edith. Stege began selling off portions of his ranch to raise money while continuing his frog-raising and other ventures. A town named Stege formed on Richard Stege's holdings, and by the late nineteenth century several industries, including the California Cap Works, the United States Briquette Company, the Stauffer Chemical Works and the Stege Lumber Manufacturing Company, were operating from portions of the Stege Ranch.[7] Richmond incorporated in 1905, and by 1917 was already the largest city in Contra Costa County.[8] Stege was eventually absorbed into Richmond as the latter grew.

The Explosives Industry in Contra Costa County

Swedish chemist Alfred Nobel laid the foundation for the high-explosives industry with his innovations beginning in 1860s, inventing first a detonator and then a blasting cap. In 1867 he invented dynamite, which was safer, cheaper, and more powerful than nitroglycerine, which had been the most commonly used explosive. Nobel licensed the Giant Powder Company to produce dynamite in California later that year. Giant was the first American company to produce dynamite, and its plant was initially located in Rock House Canyon, in what is today the City of San Francisco. The California Powder Works began manufacturing dynamite in the same area in 1869.[9]

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[1] Mildred B. Hoover, Hero E. Rensch, Ethel G. Rensch, Douglas E. Kyle, *Historic Spots in California, Fourth Edition*, Stanford University Press, Stanford, California: 1958, p. 129.

[2] Donald Bastin, *Images of America: Richmond*, Arcadia Publishing, Charleston SC: 2003, p. 9.

[3] J.P. Munro-Fraser, *History of Contra Costa County, California*, W.A. Slocum & Co., San Francisco: 1882, p. 55 – 57.

[4] Evan Griffins, "Early History of Richmond", December 1938, El Cerrito Historical Society, website: http://www.elcerritowire.com/history/pages/EarlyRichmond.htm, accessed January 2013.

[5] Roland Oliver, "Recollections of Early Industries in Stege", August 7, 1959, p. 1.

[6] J.P. Munro-Fraser, p. 675.

[7] Frederick J. Hulaniski, *The History of Contra Costa County, California*. Elms Publishing Company, Berkeley, California: 1917, p. 354.

[8] Hulanski p. 288.

[9] Ida Mae Purcell, *History of Contra Costa County*, The Gillick Press, Berkeley, California" 1940, p. 645 – 646.

The nineteenth century explosives industry was extremely dangerous, and as San Francisco's population grew explosives manufacturers needed to relocate. Contra Costa County across the bay was attractive since it was accessible due to its proximity to the harbor yet remote from population centers. In addition, the narrow canyons of Contra Costa County, which terminate in small bays, provided a natural geographical defense against explosions by allowing factory design that placed water between different facets of explosives manufacturing.[10]

During the 1870s chemical and explosives manufacturers began opening in the vicinity of what would eventually become Richmond. The Tonite Powder Company, Western Mineral Company, and California Cap Company were established at 1877 on the Stege ranch. The San Francisco explosives companies soon followed those explosive companies across the bay to Contra Costa County. In 1880, Giant relocated to Point Pinole, changing its name to the Atlas Powder Company. The California Powder Works soon followed, building a new factory in Hercules, which was named for the brand under which the company sold its powder.[11] The Vulcan Powder Works and Judson Powder works also opened in the Stege Ranch area during this era, consolidating Contra Costa County's position as the cradle of the California explosives industry. The East Bay dominated California explosives manufacturing into the twentieth century. In 1902 California had only one powder factory outside Contra Costa and Alameda counties.[12]

William Letts Oliver

William Letts Oliver was born in Chile to English parents in 1844. He attended the University of Edinburgh and became a mining engineer. After returning to Chile, Oliver ran an explosives factory, which was nationalized by the Chilean government in 1864. After the loss of his factory, Oliver left Chile for San Francisco.[13] William Letts Oliver and his wife Carrie lived in Oakland, from about 1880 until Oliver's death in 1918.[14] The couple eventually had six children together: Roland, Edwin, Caroline, Anita, William Harold, and Albert.[15] In addition his various professional activities William Letts Oliver was a yachtsman and an officer of the Bohemian Grove club in the early twentieth century. An avid amateur photographer throughout his lifetime, UC Berkeley's Bancroft Library has a collection of 2700 negatives and prints taken by Oliver and his son.[16]

William Letts Oliver initially gained familiarity with an explosive called guncotton while manufacturing collodion for his photography hobby.[17] As early as 1870, European explosive companies were experimenting with nitrated guncotton in and by 1875 it was manufactured in England under the name "tonite."[18] By 1877 Oliver had left Chile and was mining in the western United States. Engineers working on the Sutro Tunnel in the Comstock

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[10] James E. Vance, *Geography and Urban Evolution in the San Francisco Bay Area,* University of California, Berkeley: 1964, p. 27.

[11] Purcell, p. 646.

[12] Richmond Record, "Contra Costa County: Under the Vitascope", Richmond:1902.

[13] Pacific Mining News, Supplement to Engineering & Mining Journal-Press, "Industrial Notes: Developing of the Blasting Cap Industry", Vol. 1, No. 7, November 1922, p. 222.

[14] United States Census Bureau, Tenth Census of the United States, 1880, National Archives and Records Administration, Washington, D.C., San Francisco, California, Roll: 79, Film: 1254079, Page: 170B.

[15] United States Census Bureau, Twelfth Census of the United States, 1900, National Archives and Records Administration, Washington, D.C., Oakland Ward 3, Alameda, California, Roll: 82, Page: 13A.

[16] Online Archive of California, "Guide to the Oliver Family Photograph Collection", UC Berkeley: 2009, website: http://www.oac.cdlib.org/findaid/ark:/13030/ft0q2n99r1/ accessed February, 2013.

[17] Pacific Mining News, p. 222.

[18] G.A. Price Cuxson, ed., "Society of Engineers: Transactions for 1889", E. & F. N. Spon, London: 1890, p. 95.

needed an explosive that would remain stable at the high temperatures underground to complete the tunnel, and Oliver was able to solve the problem by substituting tonite for more volatile compounds.[19]

The California Cap Company

In 1877 William Letts Oliver was inspired by his success with tonite to leave mining and establish the Tonite Powder Company, on a portion of the former Stege Ranch.[20] In the 1870s all blasting caps in the United States had to be imported from Europe. Not only were they expensive, but the timing of deliveries was uncertain, creating business difficulties for the powder plant. Oliver was determined to create his own caps in order to protect the tonite factory business. He experimented until he came up with a blasting cap that was safer to use and had better detonating qualities than imported detonators. Oliver and his partner Freeborn Fletter founded the California Cap Company. It was located adjacent to the Tonite Powder Company a 160 acre parcel carved out of the southern portion of Stege Ranch.[21] California Cap Company, which went on to operate on the site for nearly seven decades, was the first manufacturer of blasting caps in the United States. Richard Stege, meanwhile, continued to reside on the ranch, and contracted with Tonite Powder and California Cap to transport their products to the railroad.[22] The California Cap Company was located on the parcel that is currently the Richmond Field Station. The Tonite Powder Company appears to have been located to the east on the parcel that became the Stauffer Chemical Company and later the Zeneca site, although its exact location is unclear.

The Tonite and California Cap factories, which were the first of several gunpowder and chemical companies in the region, were separated by the Stege agricultural warehouse for safety.[23] The explosives industry during this era was an extremely dangerous one. A horrific explosion in 1882 at the nearby Vulcan Powder Company caused 11 deaths and destroyed the plant.[24] Between 1882 and 1918 the Hercules and Atlas plants suffered numerous explosions which destroyed plant buildings and killed a total of 64 workers.[25] Despite its focus on safety, the California Cap Company had accidents as well. Two of its Chinese workers were killed in 1917 when one of them dropped a tray of caps. In 1941 an explosion caused a fire and critically injured a worker.[26]

William Letts Oliver continued to innovate throughout his long career in the chemical and explosives industries. In 1888 he formed the American Lucol Company adjacent to the California Cap Company property.[27] The Lucol plant was at what is currently the southeastern corner of the Richmond Field Station, at the approximate location of Building 163. Lucol manufactured a linseed oil substitute.[28] The factory was dismantled and relocated to New Jersey circa 1900.[29] In 1903 the Hotaling Briquette Works opened on Lucol's site at the southeast corner of the current Richmond Field station property.[30] Later known as the U.S. Briquette Company, the plant appears to have

[19] Pacific Mining News, p. 222.
[20] Oliver, p. 1.
[21] Pacific Mining News, p. 222.
[22] Nilda Rego, "Enterprising Stege lost all and died without a penny", Time Out, March 27, 1994, p. 2, column 4.
[23] Oliver, p. 1.
[24] Munro-Fraser, p. 424.
[25] Purcell, p. 648.
[26] Contra Costa County Standard, "Stege Powder Plant Blast; One Near Death", June 6, 1941, p. 1A.
[27] Oliver, p. 1.
[28] Max Wilhelm Von Bernewitz, *Cyanide Practice, 1910 – 1913*, Dewey Publishing Company: 1913, p. 327.
[29] Oliver, p. 1.
[30] Oliver, p. 2.

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[31] Hulanksi, p. 354.
[32] Halbert Powers Gillette, *Rock Excavation:Methods and Cost,* M.C. Clark, New York: 1904, x.
[33] Manual Eissler, *A Handbook on Modern Explosives,* Crosby, Lockwood & son, London: 1897, p. 117.
[34] University of California, *The University of California Chronicle,* University of California Press, January, 1917, p. 92.
[35] R.L. Polk & Company, *Richmond and Contra Costa County Directory, 1914 – 1915*, Oakland, California: 1915.
[36] Pacific Mining News, p.222.
[37] University of California, Berkeley, *Current Conditions Report,* Prepared by Tetra Tech EM Inc., November 21, 2008, p. 11.
[38] Marguerite Clausen, "On the Waterfront: An Oral History of Richmond, California", Regional Oral History Office, University of California, Berkeley, 1990, p. 21.
[39] Purcell, p. 649.
[40] Oliver, p. 1.

department were performing experiments with sewage, sea water, and other materials unsuited to use on a crowded campus. They also wanted a location that was not too remote. The University purchased the California Cap Company from the Oliver family for the use of the Engineering Department in 1950.[41]

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Evaluation

The following provides an evaluation of Building 117 under each NRHP/CRHR criteria.

Building 117 does not appear to meet the criteria for listing in NHRP/CRHR because it lacks historical significance. The structure has served various functions throughout its lifetime and as such lacks the strength of association necessary to be considered historically significant in relation to any particular events or persons (Criteria A/1 and B/2).

The utilitarian building lacks any identifiable architectural stylistic design and does not embody distinctive architectural or engineering qualities of type, period, or method of construction (Criterion C/3). In rare instances, buildings themselves can serve as sources of important information, however this building is not a principal source of important information in this regard (Criterion D/4).

[41] P.H. McGauhey, "The Sanitary Engineering Research Laboratory: Administration, Research and Consultation, 1950-1975 – An Interview Conducted by Malca Call", Regional Oral History Office, University of California, Berkeley, 1974, p. 70.
[42] University of California, Berkeley, 2008, p. 13.
[43] University of California, Berkeley, Department of Engineering, "Richmond Field Station Open House", May 28, 1952, p. 3 – 4.
[44] McGauhey, p. 71.
[45] University of California, Berkeley, Department of Engineering, "Guide for Engineering Field Station Inspection", undated, p. 3.

State of California – The Resources Agency
DEPARTMENT OF PARKS AND RECREATION

PRIMARY RECORD

Primary # _____
HRI # _____
Trinomial _____
NRHP Status Code _____
Other Listings _____
Review Code _____ Reviewer _____ Date _____

*Resource Name or # (Assigned by recorder) Richmond Field Station Building 118

P1. Other Identifier: Richmond Field Station Building 118

*P2. Location: ☐ Not for Publication ☒ Unrestricted *a. County Contra Costa
and (P2b and P2c or P2d. Attach a Location Map as necessary.)
*b. USGS 7.5′ Quad Richmond Date 1984 T___; R ____; __ ¼ of Sec ___; Diablo B.M.
c. Address _____ City _____ Zip _____
d. UTM: (give more than one for large and/or linear resources) Zone 10 ; 558500 mE/ 4196438 mN
e. Other Locational Data: (e.g., parcel #, directions to resource, elevation, etc., as appropriate)

*P3a. Description: (Describe resource and its major elements. Include design, materials, condition, alterations, size, setting, and boundaries)
Building 118 is in the southern portion of the Richmond Field Station. It is west of Egret Way and adjacent to Building 125 with its primary façade facing northeast. The utilitarian building does not express any particular architectural style. It is 1,708 square feet and was constructed prior to 1940. It is a single story building with a rectangular plan. (See Continuation Sheet)

*P3b. Resource Attributes: (List attributes and codes) HP4: Ancillary Building

*P4. Resources Present: ☒ Building ☐ Structure ☐ Object ☐ Site ☐ District ☐ Element of District ☐ Other (Isolates, etc.)

P5b. Description of Photo: (View, date, accession #) Photograph 1: Southeast and northeast facades of building, camera facing west, January 4, 2013.

*P6. Date Constructed/Age and Sources:
☒ Historic ☐ Prehistoric ☐ Both
Circa 1930s/UC Berkeley records

*P7. Owner and Address:
U.C. Berkeley
1301 South 46th Street
Richmond, California 94804

*P8. Recorded by: (Name, affiliation, address)
Kara Brunzell & Julia Mates
Tetra Tech
1999 Harrison Street, Ste 500
Oakland, CA 94612

*P9. Date Recorded: January 4, 2013

*P10. Survey Type: (Describe) Intensive

*P11. Report Citation: (Cite survey report and other sources, or enter "none.") *Historic Properties Survey Report for Portions of the Richmond Field Station* prepared by Tetra Tech, Inc, 2013.

*Attachments: NONE ☒ Location Map ☐ Sketch Map ☒ Continuation Sheet ☒ Building, Structure, and Object Record ☐ Archaeological Record ☐ District Record ☐ Linear Feature Record ☐ Milling Station Record ☐ Rock Art Record ☐ Artifact Record ☐ Photograph Record ☐ Other (list) _____

***NRHP Status Code** 6Z

***Resource Name or #** (Assigned by recorder) Richmond Field Station Building 118

B1. Historic Name: California Cap Company Building 149
B2. Common Name: Building 118
B3. Original Use: Fuel Oil Boiler B4. Present Use: Art practice
***B5. Architectural Style:** Vernacular
***B6. Construction History:** (Construction date, alteration, and date of alterations) Constructed circa 1930s, dates of alterations unknown
***B7. Moved?** ☒ No ☐ Yes ☐ Unknown **Date:** _____ **Original Location:** _____
***B8. Related Features:** _____
B9. Architect: Unknown b. Builder: Unknown
***B10. Significance: Theme** N/A **Area** N/A
Period of Significance N/A **Property Type** N/A **Applicable Criteria** N/A
(Discuss importance in terms of historical or architectural context as defined by theme, period, and geographic scope. Also address integrity.)

Building 118 at Richmond Field Station does not appear to meet the criteria for listing in the National Register of Historic Places (NRHP). Furthermore, the building has been evaluated in accordance with Section 15064.5(a)(2)-(3) of the CEQA Guidelines, using the criteria outlined in Section 5024.1 of the California Public Resources Code, and does not appear to meet the significance criteria as outlined in these guidelines. Therefore, the building is not eligible for listing in the California Register of Historical Resources (CRHR). (See Continuation Sheet.)

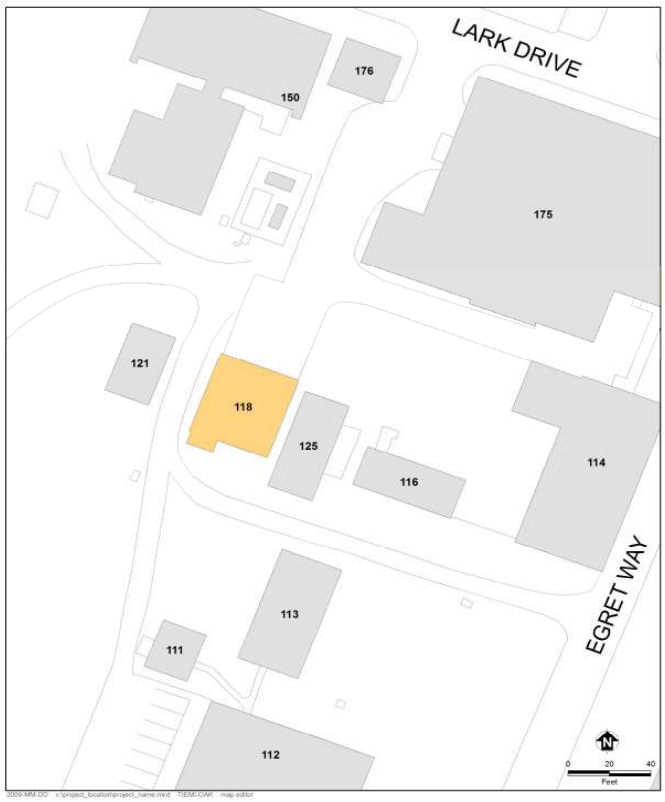
B11. Additional Resource Attributes: (List attributes and codes)

***B12. References:** See Footnotes
B13. Remarks:

***B14. Evaluator:** Kara Brunzell

***Date of Evaluation:** January 2013

(This space reserved for official comments.)



P3a. Description (continued)

The building is topped with a very shallow pitched roof with minimal eave overhang. The walls are clad in roof paper. Fenestration is a single multi-light, fixed wood sash adjacent to the primary entrance, and a single aluminum sliding sash at the rear (southwest) elevation. The primary entrance, at the east end of the northeast elevation, is a wood paneled door with a window. A large metal roll up door is centered in the façade.

The secondary entrance is sliding doors at the south end of the northwest elevation. A low shed roofed addition at the rear corner of the building has another wood paneled door, and a southwest facing window.

Building 118, originally labeled "Building 149" was constructed circa the 1930s by the California Cap Company. The building was constructed to house the fuel oil boiler for the plant. After UC Berkeley purchased the property in 1950, the building was used as a fire test research area and maintenance shop. Fire safety research studies were done at Richmond Field Station to determine the safety of a variety of products including plastics and airplane restrooms.[1] Building 118 also housed the plumbing shop for the Richmond Field Station until 2009. It is currently used as an art facility for graduate students.[2] The wood siding has been covered with roof paper. A small addition at the southwest corner was constructed in the modern period. Dates for these alterations are unknown.

B10. Significance (continued)

Historic Context

Europeans arrived in what would become Contra Costa County in 1772, when a Spanish expedition led by Pedro Fages discovered the San Pablo Bay and the confluence of the Sacramento and San Joaquin rivers.[3] Though subsequent Spanish expeditions passed through the region the Spanish do not appear to have settled in the area during the mission period. In the 1820s and 1830s the Mexican government began granting large tracts of land in the area to its citizens, including Ranchos San Pablo, San Ramon, and Pinole. The first permanent non-native settlers were Francisco Castro and his wife Maria Gabriela Berryessa. The Mexican government granted the 18,000 acre Rancho San Pablo to the Castros in 1823.[4] Americans began farming in Contra Costa County in the late 1830s, and by 1882 2/3 of the cultivated land in the county was devoted to wheat production.[5]

Minna C. C. Quilfelt (or Quilfeldt) purchased 600 acres of Rancho San Pablo in 1852 and 1853.[6] Adjacent to San Francisco Bay in what would eventually become the southern portion of the City of Richmond, a wharf and produce warehouse were constructed on the ranch in the 1860s to ship agricultural produce to the San Francisco markets from Rancho San Pablo as well as the Quilfelt ranch. The warehouse and wharf were used to transport cattle, grain, fruit, and in later years the frogs' legs raised by Richard Stege for the San Francisco restaurant market.[7] German native Richard Stege settled on Rancho San Pablo in the late 1860s after stints in the gold fields

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[1] University of California, Berkeley, 2008, p. 14.

[2] Shackleton, 2013.

[3] Mildred B. Hoover, Hero E. Rensch, Ethel G. Rensch, Douglas E. Kyle, *Historic Spots in California, Fourth Edition*, Stanford University Press, Stanford, California: 1958, p. 129.

[4] Donald Bastin, *Images of America: Richmond*, Arcadia Publishing, Charleston SC: 2003, p. 9.

[5] J.P. Munro-Fraser, *History of Contra Costa County, California*, W.A. Slocum & Co., San Francisco: 1882, p. 55 – 57.

[6] Evan Griffins, "Early History of Richmond", December 1938, El Cerrito Historical Society, website: http://www.elcerritowire.com/history/pages/EarlyRichmond.htm, accessed January 2013.

[7] Roland Oliver, "Recollections of Early Industries in Stege", August 7, 1959, p. 1.

and the Siberian fur trade. He married Minna Quilfelt, who was a widow, in 1870.[8] Minna Quilfelt Stege died in 1879, leaving the ranch to Stege and her daughter Edith. Stege began selling off portions of his ranch to raise money while continuing his frog-raising and other ventures. A town named Stege formed on Richard Stege's holdings, and by the late nineteenth century several industries, including the California Cap Works, the United States Briquette Company, the Stauffer Chemical Works and the Stege Lumber Manufacturing Company, were operating from portions of the Stege Ranch.[9] Richmond incorporated in 1905, and by 1917 was already the largest city in Contra Costa County.[10] Stege was eventually absorbed into Richmond as the latter grew.

The Explosives Industry in Contra Costa County

Swedish chemist Alfred Nobel laid the foundation for the high-explosives industry with his innovations beginning in 1860s, inventing first a detonator and then a blasting cap. In 1867 he invented dynamite, which was safer, cheaper, and more powerful than nitroglycerine, which had been the most commonly used explosive. Nobel licensed the Giant Powder Company to produce dynamite in California later that year. Giant was the first American company to produce dynamite, and its plant was initially located in Rock House Canyon, in what is today the City of San Francisco. The California Powder Works began manufacturing dynamite in the same area in 1869.[11]

The nineteenth century explosives industry was extremely dangerous, and as San Francisco's population grew explosives manufacturers needed to relocate. Contra Costa County across the bay was attractive since it was accessible due to its proximity to the harbor yet remote from population centers. In addition, the narrow canyons of Contra Costa County, which terminate in small bays, provided a natural geographical defense against explosions by allowing factory design that placed water between different facets of explosives manufacturing.[12]

During the 1870s chemical and explosives manufacturers began opening in the vicinity of what would eventually become Richmond. The Tonite Powder Company, Western Mineral Company, and California Cap Company were established at 1877 on the Stege ranch. The San Francisco explosives companies soon followed those explosive companies across the bay to Contra Costa County. In 1880, Giant relocated to Point Pinole, changing its name to the Atlas Powder Company. The California Powder Works soon followed, building a new factory in Hercules, which was named for the brand under which the company sold its powder.[13] The Vulcan Powder Works and Judson Powder works also opened in the Stege Ranch area during this era, consolidating Contra Costa County's position as the cradle of the California explosives industry. The East Bay dominated California explosives manufacturing into the twentieth century. In 1902 California had only one powder factory outside Contra Costa and Alameda counties.[14]

William Letts Oliver

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[8] J.P. Munro-Fraser, p. 675.

[9] Frederick J. Hulaniski, *The History of Contra Costa County, California*. Elms Publishing Company, Berkeley, California: 1917, p. 354.

[10] Hulanski p. 288.

[11] Ida Mae Purcell, *History of Contra Costa County*, The Gillick Press, Berkeley, California" 1940, p. 645 – 646.

[12] James E. Vance, *Geography and Urban Evolution in the San Francisco Bay Area*, University of California, Berkeley: 1964, p. 27.

[13] Purcell, p. 646.

[14] Richmond Record, "Contra Costa County: Under the Vitascope", Richmond:1902.

William Letts Oliver was born in Chile to English parents in 1844. He attended the University of Edinburgh and became a mining engineer. After returning to Chile, Oliver ran an explosives factory, which was nationalized by the Chilean government in 1864. After the loss of his factory, Oliver left Chile for San Francisco.[15] William Letts Oliver and his wife Carrie lived in Oakland, from about 1880 until Oliver's death in 1918.[16] The couple eventually had six children together: Roland, Edwin, Caroline, Anita, William Harold, and Albert.[17] In addition his various professional activities William Letts Oliver was a yachtsman and an officer of the Bohemian Grove club in the early twentieth century. An avid amateur photographer throughout his lifetime, UC Berkeley's Bancroft Library has a collection of 2700 negatives and prints taken by Oliver and his son.[18]

William Letts Oliver initially gained familiarity with an explosive called guncotton while manufacturing collodion for his photography hobby.[19] As early as 1870, European explosive companies were experimenting with nitrated guncotton in and by 1875 it was manufactured in England under the name "tonite."[20] By 1877 Oliver had left Chile and was mining in the western United States. Engineers working on the Sutro Tunnel in the Comstock needed an explosive that would remain stable at the high temperatures underground to complete the tunnel, and Oliver was able to solve the problem by substituting tonite for more volatile compounds.[21]

The California Cap Company

In 1877 William Letts Oliver was inspired by his success with tonite to leave mining and establish the Tonite Powder Company, on a portion of the former Stege Ranch.[22] In the 1870s all blasting caps in the United States had to be imported from Europe. Not only were they expensive, but the timing of deliveries was uncertain, creating business difficulties for the powder plant. Oliver was determined to create his own caps in order to protect the tonite factory business. He experimented until he came up with a blasting cap that was safer to use and had better detonating qualities than imported detonators. Oliver and his partner Freeborn Fletter founded the California Cap Company. It was located adjacent to the Tonite Powder Company a 160 acre parcel carved out of the southern portion of Stege Ranch.[23] California Cap Company, which went on to operate on the site for nearly seven decades, was the first manufacturer of blasting caps in the United States. Richard Stege, meanwhile, continued to reside on the ranch, and contracted with Tonite Powder and California Cap to transport their products to the railroad.[24] The California Cap Company was located on the parcel that is currently the Richmond Field Station. The Tonite Powder Company appears to have been located to the east on the parcel that became the Stauffer Chemical Company and later the Zeneca site, although its exact location is unclear.

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[15] Pacific Mining News, Supplement to Engineering & Mining Journal-Press, "Industrial Notes: Developing of the Blasting Cap Industry", Vol. 1, No. 7, November 1922, p. 222.

[16] United States Census Bureau, Tenth Census of the United States, 1880, National Archives and Records Administration, Washington, D.C., San Francisco, California, Roll: 79, Film: 1254079, Page: 170B.

[17] United States Census Bureau, Twelfth Census of the United States, 1900, National Archives and Records Administration, Washington, D.C., Oakland Ward 3, Alameda, California, Roll: 82, Page: 13A.

[18] Online Archive of California, "Guide to the Oliver Family Photograph Collection", UC Berkeley: 2009, website: http://www.oac.cdlib.org/findaid/ark:/13030/ft0q2n99r1/ accessed February, 2013.

[19] Pacific Mining News, p. 222.

[20] G.A. Price Cuxson, ed., "Society of Engineers: Transactions for 1889", E. & F. N. Spon, London: 1890, p. 95.

[21] Pacific Mining News, p. 222.

[22] Oliver, p. 1.

[23] Pacific Mining News, p. 222.

[24] Nilda Rego, "Enterprising Stege lost all and died without a penny", Time Out, March 27, 1994, p. 2, column 4.

The Tonite and California Cap factories, which were the first of several gunpowder and chemical companies in the region, were separated by the Stege agricultural warehouse for safety.[25] The explosives industry during this era was an extremely dangerous one. A horrific explosion in 1882 at the nearby Vulcan Powder Company caused 11 deaths and destroyed the plant.[26] Between 1882 and 1918 the Hercules and Atlas plants suffered numerous explosions which destroyed plant buildings and killed a total of 64 workers.[27] Despite its focus on safety, the California Cap Company had accidents as well. Two of its Chinese workers were killed in 1917 when one of them dropped a tray of caps. In 1941 an explosion caused a fire and critically injured a worker.[28]

William Letts Oliver continued to innovate throughout his long career in the chemical and explosives industries. In 1888 he formed the American Lucol Company adjacent to the California Cap Company property.[29] The Lucol plant was at what is currently the southeastern corner of the Richmond Field Station, at the approximate location of Building 163. Lucol manufactured a linseed oil substitute.[30] The factory was dismantled and relocated to New Jersey circa 1900.[31] In 1903 the Hotaling Briquette Works opened on Lucol's site at the southeast corner of the current Richmond Field station property.[32] Later known as the U.S. Briquette Company, the plant appears to have operated at this location until at least 1917.[33] The U.S. Briquette Company buildings were demolished sometime in the 1960s.

The Oliver family aggressively promoted their products both through advertising and publishing. The California Cap Company sponsored or published both articles and book-length treatises on the use of explosives. Safety was a key element of the company image, a topic of company-sponsored technical writing as well as a selling point in advertisements.[34] The Tonite Powder Company's product was known even outside the United States, and by the end of the nineteenth century the powder's explosive properties were considered comparable to the finest English products.[35] Oliver's sons Roland and Edwin Letts Oliver both graduated from UC Berkeley's College of Mining in 1900. Roland Oliver seems to have spent his entire career working in the family enterprises, while Edwin worked at California Cap between mining and other ventures. The Oliver family also became benefactors of the university, and in 1917 the California Cap Company donated substantial amounts of their products to the College of Mining including 500 electric detonators, 500 delayed action exploders, and 500 blasting caps.[36]

Eventually the Tonite factory appears to have been incorporated into the California Cap Company. The Olivers also formed an entity named Pacific Cartridge Company circa 1910. The Pacific Cartridge Company operated from the California Cap plant during World War I.[37] By 1916 there were at least a dozen buildings on the site.

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[25] Oliver, p. 1.
[26] Munro-Fraser, p. 424.
[27] Purcell, p. 648.
[28] Contra Costa County Standard, "Stege Powder Plant Blast; One Near Death", June 6, 1941, p. 1A.
[29] Oliver, p. 1.
[30] Max Wilhelm Von Bernewitz, *Cyanide Practice, 1910 – 1913*, Dewey Publishing Company: 1913, p. 327.
[31] Oliver, p. 1.
[32] Oliver, p. 2.
[33] Hulanksi, p. 354.
[34] Halbert Powers Gillette, *Rock Excavation:Methods and Cost*, M.C. Clark, New York: 1904, x.
[35] Manual Eissler, *A Handbook on Modern Explosives*, Crosby, Lockwood & son, London: 1897, p. 117.
[36] University of California, *The University of California Chronicle*, University of California Press, January, 1917, p. 92.
[37] R.L. Polk & Company, *Richmond and Contra Costa County Directory, 1914 – 1915*, Oakland, California: 1915.

When Oliver died in 1918 his son Roland Oliver took over as president of California Cap Company. By 1922 Roland's brother Leslie Oliver was assistant manager of the plant and Edwin Letts Oliver was a director.[38] Roland Oliver substantially expanded the California Cap Company after he took over as president. During this era the plant grew to include 150 buildings and a horse-drawn tram line.[39]

During the late nineteenth and early twentieth century the California Cap Company was one of the most important local employers.[40] As the twentieth century progressed more heavy industry came to Contra Costa County, and by 1940 the county was second only to Los Angeles in overall industrial production.[41] The nineteenth-century California Cap Company was dwarfed by the scale of some of the newer enterprises, and its physical plant and technology were aging. During World War II California Cap was able to stay open by producing delayed action incendiary bombs that were used against Japan.[42] The California Cap Company could not survive the transition to a peacetime economy, however, and by 1949 the plant was closed and the Oliver family looking for a buyer.

University Research/Richmond Field Station

After World War II UC Berkeley's Engineering Department needed an off-campus location in order to perform experiments that required more space than a laboratory. Department Chair Morrough P. O' Brien and others in the department were performing experiments with sewage, sea water, and other materials unsuited to use on a crowded campus. They also wanted a location that was not too remote. The University purchased the California Cap Company from the Oliver family for the use of the Engineering Department in 1950.[43]

The Richmond Field Station has been the location of a research overseen by numerous UC Berkeley departments over the years. The Sanitary Engineering Research Laboratory (SERL) was one of the first departments to undertake research at the site. SERL focused primarily on sewage treatment technology, and also researched pollution control and disposal of solid and liquid waste.[44] Other early projects at the field station included sea water distillation, heat transfer, and cyclic stress research.[45]

At first the Department of Engineering utilized the buildings left behind by the California Cap Company. The Department established a machine shop, computer shop, receiving facility, mail service, and other facilities in addition to laboratories in the old detonator company buildings.[46] The current Buildings 102, 110, 118, 128, 150, 152 175, and 176 all date to the cap company era and have been repurposed for the Richmond Field Station. They also constructed new buildings as funds became available, and by the mid-1950s five new buildings had been

[38] Pacific Mining News, p.222.

[39] University of California, Berkeley, *Current Conditions Report*, Prepared by Tetra Tech EM Inc., November 21, 2008, p. 11.

[40] Marguerite Clausen, "On the Waterfront: An Oral History of Richmond, California", Regional Oral History Office, University of California, Berkeley, 1990, p. 21.

[41] Purcell, p. 649.

[42] Oliver, p. 1.

[43] P.H. McGauhey, "The Sanitary Engineering Research Laboratory: Administration, Research and Consultation, 1950-1975 – An Interview Conducted by Malca Call", Regional Oral History Office, University of California, Berkeley, 1974, p. 70.

[44] University of California, Berkeley, 2008, p. 13.

[45] University of California, Berkeley, Department of Engineering, "Richmond Field Station Open House", May 28, 1952, p. 3 – 4.

[46] McGauhey, p. 71.

completed at the Richmond Field Station.[47] By the 1970s the department had conducted many experiments at the Richmond Field Station that could not have been performed on the main campus.

Evaluation

The following provides an evaluation of Building 118 under each NRHP/CRHR criteria.

Building 118 does not appear to meet the criteria for listing in NRHP/CRHR because it lacks historical significance. The structure has served various functions throughout its lifetime and as such lacks the strength of association necessary to be considered historically significant in relation to any particular events or persons (Criteria A/1 and B/2).

The utilitarian building lacks any identifiable architectural stylistic design and does not embody distinctive architectural or engineering qualities of type, period, or method of construction (Criterion C/3). In rare instances, buildings themselves can serve as sources of important information, however this building is not a principal source of important information in this regard (Criterion D/4).

[47] University of California, Berkeley, Department of Engineering, "Guide for Engineering Field Station Inspection", undated, p. 3.

State of California – The Resources Agency
DEPARTMENT OF PARKS AND RECREATION

PRIMARY RECORD

Primary # _____
HRI # _____
Trinomial _____
NRHP Status Code _____
Other Listings _____
Review Code _____ Reviewer _____ Date _____

 ***Resource Name or #** (Assigned by recorder) Richmond Field Station Building 120

P1. Other Identifier: Richmond Field Station Building 120

***P2. Location:** ☐ **Not for Publication** ☒ **Unrestricted** ***a. County** Contra Costa
and (P2b and P2c or P2d. Attach a Location Map as necessary.)
***b. USGS 7.5′ Quad** Richmond **Date** 1984 **T**___; **R** ____; __ ¼ **of Sec** ___; Diablo **B.M.**
c. Address _____ City _____ Zip _____
d. UTM: (give more than one for large and/or linear resources) Zone 10 ; 558606 mE/ 4196431 mN
e. Other Locational Data: (e.g., parcel #, directions to resource, elevation, etc., as appropriate)

***P3a. Description:** (Describe resource and its major elements. Include design, materials, condition, alterations, size, setting, and boundaries)
Building 120 is along the southeastern border of the Richmond Field Station. It is set back from Egret Way adjacent to building 117. The utilitarian building does not express any architectural style. It is 269 square feet and was constructed in 1967. It is single story and rectangular in plan. The building is topped with a shed roof. The walls and roof are corrugated metal, and the building lacks fenestration. The only entrances to the building are large openings on its northeast elevation that are covered with a metal construction fence.

***P3b. Resource Attributes:** (List attributes and codes) HP4: Ancillary Building

***P4. Resources Present:** ☒ Building ☐ Structure ☐ Object ☐ Site ☐ District ☐ Element of District ☐ Other (Isolates, etc.)

P5b. Description of Photo: (View, date, accession #) Photograph 1: Northeast and northwest facades of building, camera facing east, January 4, 2013.

***P6. Date Constructed/Age and Sources:**
☒ Historic ☐ Prehistoric ☐ Both
1967/UC Berkeley records

***P7. Owner and Address:**
U.C. Berkeley
1301 South 46th Street
Richmond, California 94804

***P8. Recorded by:** (Name, affiliation, address)
Kara Brunzell & Julia Mates
Tetra Tech
1999 Harrison Street, Ste 500
Oakland, CA 94612

***P9. Date Recorded:** January 4, 2013

***P10. Survey Type:** (Describe) Intensive

***P11. Report Citation:** (Cite survey report and other sources, or enter "none.") *Historic Properties Survey Report for Portions of the Richmond Field Station* prepared by Tetra Tech, Inc, 2013.

***Attachments:** NONE ☒ Location Map ☐ Sketch Map ☒ Continuation Sheet ☒ Building, Structure, and Object Record ☐ Archaeological Record ☐ District Record ☐ Linear Feature Record ☐ Milling Station Record ☐ Rock Art Record ☐ Artifact Record ☐ Photograph Record ☐ Other (list) _____

***NRHP Status Code** 6Z

***Resource Name or #** (Assigned by recorder) Richmond Field Station Building 120

B1. Historic Name: _____

B2. Common Name: Building 120

B3. Original Use: Unknown B4. Present Use: Storage

***B5. Architectural Style:** Vernacular

***B6. Construction History:** (Construction date, alteration, and date of alterations) Constructed in 1967

***B7. Moved?** ☐ **No** ☒ **Yes** ☐ **Unknown** **Date:** circa 1990 **Original Location:** Unknown

***B8. Related Features:** _____

B9. Architect: Unknown b. Builder: Unknown

***B10. Significance: Theme** N/A **Area** N/A

Period of Significance N/A **Property Type** N/A **Applicable Criteria** N/A

(Discuss importance in terms of historical or architectural context as defined by theme, period, and geographic scope. Also address integrity.)

Building 120 at Richmond Field Station does not appear to meet the criteria for listing in the National Register of Historic Places (NRHP). Furthermore, the building has been evaluated in accordance with Section 15064.5(a)(2)-(3) of the CEQA Guidelines, using the criteria outlined in Section 5024.1 of the California Public Resources Code, and does not appear to meet the significance criteria as outlined in these guidelines. Therefore, the building is not eligible for listing in the California Register of Historical Resources (CRHR). (See Continuation Sheet.)

B11. Additional Resource Attributes: (List attributes and codes)

***B12. References:** See Footnotes

B13. Remarks:

***B14. Evaluator:** Kara Brunzell

***Date of Evaluation:** January 2013

(This space reserved for official comments.)

P3a. Description (continued)

This building was constructed in 1967. During the 1960s and 1970s an incinerator burned garbage at this location.[1] Aerial photographs show that Building 120 was moved to its present location circa 1990. Research failed to reveal the building's original location. It was used as a solvent storage shed in the 1990s. Currently, drums containing waste petroleum products are stored in the building.[2]

B10. Significance (continued)

Historic Context

Europeans arrived in what would become Contra Costa County in 1772, when a Spanish expedition led by Pedro Fages discovered the San Pablo Bay and the confluence of the Sacramento and San Joaquin rivers.[3] Though subsequent Spanish expeditions passed through the region the Spanish do not appear to have settled in the area during the mission period. In the 1820s and 1830s the Mexican government began granting large tracts of land in the area to its citizens, including Ranchos San Pablo, San Ramon, and Pinole. The first permanent non-native settlers were Francisco Castro and his wife Maria Gabriela Berryessa. The Mexican government granted the 18,000 acre Rancho San Pablo to the Castros in 1823.[4] Americans began farming in Contra Costa County in the late 1830s, and by 1882 2/3 of the cultivated land in the county was devoted to wheat production.[5]

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[3] Mildred B. Hoover, Hero E. Rensch, Ethel G. Rensch, Douglas E. Kyle, *Historic Spots in California, Fourth Edition*, Stanford University Press, Stanford, California: 1958, p. 129.

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[7] Roland Oliver, "Recollections of Early Industries in Stege", August 7, 1959, p. 1.

[8] J.P. Munro-Fraser, p. 675.

[9] Frederick J. Hulaniski, *The History of Contra Costa County, California*. Elms Publishing Company, Berkeley, California: 1917, p. 354.

[10] Hulanski p. 288.

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[11] Ida Mae Purcell, *History of Contra Costa County*, The Gillick Press, Berkeley, California" 1940, p. 645 – 646.

[12] James E. Vance, *Geography and Urban Evolution in the San Francisco Bay Area*, University of California, Berkeley: 1964, p. 27.

[13] Purcell, p. 646.

[14] Richmond Record, "Contra Costa County: Under the Vitascope", Richmond:1902.

[15] Pacific Mining News, Supplement to Engineering & Mining Journal-Press, "Industrial Notes: Developing of the Blasting Cap Industry", Vol. 1, No. 7, November 1922, p. 222.

[16] United States Census Bureau, Tenth Census of the United States, 1880, National Archives and Records Administration, Washington, D.C., San Francisco, California, Roll: 79, Film: 1254079, Page: 170B.

[17] United States Census Bureau, Twelfth Census of the United States, 1900, National Archives and Records Administration, Washington, D.C., Oakland Ward 3, Alameda, California, Roll: 82, Page: 13A.

early twentieth century. An avid amateur photographer throughout his lifetime, UC Berkeley's Bancroft Library has a collection of 2700 negatives and prints taken by Oliver and his son.[18]

William Letts Oliver initially gained familiarity with an explosive called guncotton while manufacturing collodion for his photography hobby.[19] As early as 1870, European explosive companies were experimenting with nitrated guncotton in and by 1875 it was manufactured in England under the name "tonite."[20] By 1877 Oliver had left Chile and was mining in the western United States. Engineers working on the Sutro Tunnel in the Comstock needed an explosive that would remain stable at the high temperatures underground to complete the tunnel, and Oliver was able to solve the problem by substituting tonite for more volatile compounds.[21]

The California Cap Company

In 1877 William Letts Oliver was inspired by his success with tonite to leave mining and establish the Tonite Powder Company, on a portion of the former Stege Ranch.[22] In the 1870s all blasting caps in the United States had to be imported from Europe. Not only were they expensive, but the timing of deliveries was uncertain, creating business difficulties for the powder plant. Oliver was determined to create his own caps in order to protect the tonite factory business. He experimented until he came up with a blasting cap that was safer to use and had better detonating qualities than imported detonators. Oliver and his partner Freeborn Fletter founded the California Cap Company. It was located adjacent to the Tonite Powder Company a 160 acre parcel carved out of the southern portion of Stege Ranch.[23] California Cap Company, which went on to operate on the site for nearly seven decades, was the first manufacturer of blasting caps in the United States. Richard Stege, meanwhile, continued to reside on the ranch, and contracted with Tonite Powder and California Cap to transport their products to the railroad.[24] The California Cap Company was located on the parcel that is currently the Richmond Field Station. The Tonite Powder Company appears to have been located to the east on the parcel that became the Stauffer Chemical Company and later the Zeneca site, although its exact location is unclear.

The Tonite and California Cap factories, which were the first of several gunpowder and chemical companies in the region, were separated by the Stege agricultural warehouse for safety.[25] The explosives industry during this era was an extremely dangerous one. A horrific explosion in 1882 at the nearby Vulcan Powder Company caused 11 deaths and destroyed the plant.[26] Between 1882 and 1918 the Hercules and Atlas plants suffered numerous explosions which destroyed plant buildings and killed a total of 64 workers.[27] Despite its focus on safety, the California Cap Company had accidents as well. Two of its Chinese workers were killed in 1917 when one of them dropped a tray of caps. In 1941 an explosion caused a fire and critically injured a worker.[28]

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[18] Online Archive of California, "Guide to the Oliver Family Photograph Collection", UC Berkeley: 2009, website: http://www.oac.cdlib.org/findaid/ark:/13030/ft0q2n99r1/ accessed February, 2013.
[19] Pacific Mining News, p. 222.
[20] G.A. Price Cuxson, ed., "Society of Engineers: Transactions for 1889", E. & F. N. Spon, London: 1890, p. 95.
[21] Pacific Mining News, p. 222.
[22] Oliver, p. 1.
[23] Pacific Mining News, p. 222.
[24] Nilda Rego, "Enterprising Stege lost all and died without a penny", Time Out, March 27, 1994, p. 2, column 4.
[25] Oliver, p. 1.
[26] Munro-Fraser, p. 424.
[27] Purcell, p. 648.
[28] Contra Costa County Standard, "Stege Powder Plant Blast; One Near Death", June 6, 1941, p. 1A.

William Letts Oliver continued to innovate throughout his long career in the chemical and explosives industries. In 1888 he formed the American Lucol Company adjacent to the California Cap Company property.[29] The Lucol plant was at what is currently the southeastern corner of the Richmond Field Station, at the approximate location of Building 163. Lucol manufactured a linseed oil substitute.[30] The factory was dismantled and relocated to New Jersey circa 1900.[31] In 1903 the Hotaling Briquette Works opened on Lucol's site at the southeast corner of the current Richmond Field station property.[32] Later known as the U.S. Briquette Company, the plant appears to have operated at this location until at least 1917.[33] The U.S. Briquette Company buildings were demolished sometime in the 1960s.

The Oliver family aggressively promoted their products both through advertising and publishing. The California Cap Company sponsored or published both articles and book-length treatises on the use of explosives. Safety was a key element of the company image, a topic of company-sponsored technical writing as well as a selling point in advertisements.[34] The Tonite Powder Company's product was known even outside the United States, and by the end of the nineteenth century the powder's explosive properties were considered comparable to the finest English products.[35] Oliver's sons Roland and Edwin Letts Oliver both graduated from UC Berkeley's College of Mining in 1900. Roland Oliver seems to have spent his entire career working in the family enterprises, while Edwin worked at California Cap between mining and other ventures. The Oliver family also became benefactors of the university, and in 1917 the California Cap Company donated substantial amounts of their products to the College of Mining including 500 electric detonators, 500 delayed action exploders, and 500 blasting caps.[36]

Eventually the Tonite factory appears to have been incorporated into the California Cap Company. The Olivers also formed an entity named Pacific Cartridge Company circa 1910. The Pacific Cartridge Company operated from the California Cap plant during World War I.[37] By 1916 there were at least a dozen buildings on the site. When Oliver died in 1918 his son Roland Oliver took over as president of California Cap Company. By 1922 Roland's brother Leslie Oliver was assistant manager of the plant and Edwin Letts Oliver was a director.[38] Roland Oliver substantially expanded the California Cap Company after he took over as president. During this era the plant grew to include 150 buildings and a horse-drawn tram line.[39]

During the late nineteenth and early twentieth century the California Cap Company was one of the most important local employers.[40] As the twentieth century progressed more heavy industry came to Contra Costa County, and by

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[29] Oliver, p. 1.
[30] Max Wilhelm Von Bernewitz, *Cyanide Practice, 1910 – 1913*, Dewey Publishing Company: 1913, p. 327.
[31] Oliver, p. 1.
[32] Oliver, p. 2.
[33] Hulanksi, p. 354.
[34] Halbert Powers Gillette, *Rock Excavation:Methods and Cost,* M.C. Clark, New York: 1904, x.
[35] Manual Eissler, *A Handbook on Modern Explosives,* Crosby, Lockwood & son, London: 1897, p. 117.
[36] University of California, *The University of California Chronicle,* University of California Press, January, 1917, p. 92.
[37] R.L. Polk & Company, *Richmond and Contra Costa County Directory, 1914 – 1915*, Oakland, California: 1915.
[38] Pacific Mining News, p.222.
[39] University of California, Berkeley, *Current Conditions Report,* Prepared by Tetra Tech EM Inc., November 21, 2008, p. 11.
[40] Marguerite Clausen, "On the Waterfront: An Oral History of Richmond, California", Regional Oral History Office, University of California, Berkeley, 1990, p. 21.

1940 the county was second only to Los Angeles in overall industrial production.[41] The nineteenth-century California Cap Company was dwarfed by the scale of some of the newer enterprises, and its physical plant and technology were aging. During World War II California Cap was able to stay open by producing delayed action incendiary bombs that were used against Japan.[42] The California Cap Company could not survive the transition to a peacetime economy, however, and by 1949 the plant was closed and the Oliver family looking for a buyer.

University Research/Richmond Field Station

After World War II UC Berkeley's Engineering Department needed an off-campus location in order to perform experiments that required more space than a laboratory. Department Chair Morrough P. O' Brien and others in the department were performing experiments with sewage, sea water, and other materials unsuited to use on a crowded campus. They also wanted a location that was not too remote. The University purchased the California Cap Company from the Oliver family for the use of the Engineering Department in 1950.[43]

The Richmond Field Station has been the location of a research overseen by numerous UC Berkeley departments over the years. The Sanitary Engineering Research Laboratory (SERL) was one of the first departments to undertake research at the site. SERL focused primarily on sewage treatment technology, and also researched pollution control and disposal of solid and liquid waste.[44] Other early projects at the field station included sea water distillation, heat transfer, and cyclic stress research.[45]

At first the Department of Engineering utilized the buildings left behind by the California Cap Company. The Department established a machine shop, computer shop, receiving facility, mail service, and other facilities in addition to laboratories in the old detonator company buildings.[46] The current Buildings 102, 110, 118, 128, 150, 152 175, and 176 all date to the cap company era and have been repurposed for the Richmond Field Station. They also constructed new buildings as funds became available, and by the mid-1950s five new buildings had been completed at the Richmond Field Station.[47] By the 1970s the department had conducted many experiments at the Richmond Field Station that could not have been performed on the main campus.

Evaluation

The following provides an evaluation of Building 120 under each NRHP/CRHR criteria.

Building 120 does not appear to meet the criteria for listing in NRHP/CRHR because it lacks historical significance. The structure has been used for storage throughout its lifetime and as such lacks the strength of association necessary to be considered historically significant in relation to any particular events or persons (Criteria A/1 and B/2).

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[41] Purcell, p. 649.

[42] Oliver, p. 1.

[43] P.H. McGauhey, "The Sanitary Engineering Research Laboratory: Administration, Research and Consultation, 1950-1975 – An Interview Conducted by Malca Call", Regional Oral History Office, University of California, Berkeley, 1974, p. 70.

[44] University of California, Berkeley, 2008, p. 13.

[45] University of California, Berkeley, Department of Engineering, "Richmond Field Station Open House", May 28, 1952, p. 3 – 4.

[46] McGauhey, p. 71.

[47] University of California, Berkeley, Department of Engineering, "Guide for Engineering Field Station Inspection", undated, p. 3.

The utilitarian building lacks any identifiable architectural stylistic design and does not embody distinctive architectural or engineering qualities of type, period, or method of construction (Criterion C/3). In rare instances, buildings themselves can serve as sources of important information, however this building is not a principal source of important information in this regard (Criterion D/4).

State of California – The Resources Agency
DEPARTMENT OF PARKS AND RECREATION
PRIMARY RECORD

Primary # _____
HRI # _____
Trinomial _____
NRHP Status Code _____
Other Listings _____
Review Code _____ Reviewer _____ Date _____

 ***Resource Name or #** (Assigned by recorder) Richmond Field Station Building 121

P1. Other Identifier: Richmond Field Station Building 121

***P2. Location:** ☐ **Not for Publication** ☒ **Unrestricted** ***a. County** Contra Costa
and (P2b and P2c or P2d. Attach a Location Map as necessary.)
***b. USGS 7.5′ Quad** Richmond **Date** 1984 **T**___; **R** ___; __ ¼ **of Sec** ___; Diablo **B.M.**
c. Address _____ City _____ Zip _____
d. UTM: (give more than one for large and/or linear resources) Zone 10 ; 558484 mE/ 4196446 mN
e. Other Locational Data: (e.g., parcel #, directions to resource, elevation, etc., as appropriate)

***P3a. Description:** (Describe resource and its major elements. Include design, materials, condition, alterations, size, setting, and boundaries)
Building 121 is in the southern portion of the Richmond Field Station. The utilitarian building does not express any architectural style. It is 728 square feet and was constructed in 1982. It is single story and rectangular in plan. The building is topped with a front gabled roof, with exposed rafter tails at the eaves. The walls and roof are corrugated metal. It lacks fenestration. The only opening is a roll up garage door on the northeast elevation. Building 121 was constructed circa 1970, as shown by aerial photographs. It was constructed as a garage for the storage of lawn equipment. The roll up garage door was added at an unknown date. The UC Berkeley Solar Powered Vehicle Club began using it for storage circa 2009.

***P3b. Resource Attributes:** (List attributes and codes) HP4: Ancillary Building

***P4. Resources Present:** ☒ Building ☐ Structure ☐ Object ☐ Site ☐ District ☐ Element of District ☐ Other (Isolates, etc.)

P5b. Description of Photo: (View, date, accession #) Photograph 1: Northeast and northwest facades of building, camera facing southwest, January 4, 2013.

***P6. Date Constructed/Age and Sources:**
☒ Historic ☐ Prehistoric ☐ Both
Circa 1970/Aerial photographs

***P7. Owner and Address:**
U.C. Berkeley
1301 South 46th Street
Richmond, California 94804

***P8. Recorded by:** (Name, affiliation, address)
Kara Brunzell & Julia Mates
Tetra Tech
1999 Harrison Street, Ste 500
Oakland, CA 94612

***P9. Date Recorded:** January 4, 2013

***P10. Survey Type:** (Describe) Intensive

***P11. Report Citation:** (Cite survey report and other sources, or enter "none.") *Historic Properties Survey Report for Portions of the Richmond Field Station* prepared by Tetra Tech, Inc, 2013.

***Attachments:** NONE ☒ Location Map ☐ Sketch Map ☒ Continuation Sheet ☒ Building, Structure, and Object Record ☐ Archaeological Record ☐ District Record ☐ Linear Feature Record ☐ Milling Station Record ☐ Rock Art Record ☐ Artifact Record ☐ Photograph Record ☐ Other (list) _____

***NRHP Status Code** 6Z

***Resource Name or #** (Assigned by recorder) Richmond Field Station Building 121

B1. Historic Name: _____

B2. Common Name: Building 121

B3. Original Use: Storage B4. Present Use: Storage

***B5. Architectural Style:** Vernacular

***B6. Construction History:** (Construction date, alteration, and date of alterations) Constructed circa 1970

***B7. Moved?** ☒ **No** ☐ **Yes** ☐ **Unknown** **Date:** _____ **Original Location:** _____

***B8. Related Features:** _____

B9. Architect: Unknown b. Builder: Unknown

***B10. Significance: Theme** N/A **Area** N/A

Period of Significance N/A **Property Type** N/A **Applicable Criteria** N/A

(Discuss importance in terms of historical or architectural context as defined by theme, period, and geographic scope. Also address integrity.)

Building 121 at Richmond Field Station does not appear to meet the criteria for listing in the National Register of Historic Places (NRHP). Furthermore, the building has been evaluated in accordance with Section 15064.5(a)(2)-(3) of the CEQA Guidelines, using the criteria outlined in Section 5024.1 of the California Public Resources Code, and does not appear to meet the significance criteria as outlined in these guidelines. Therefore, the building is not eligible for listing in the California Register of Historical Resources (CRHR). (See Continuation Sheet.)

B11. Additional Resource Attributes: (List attributes and codes)

***B12. References:** See Footnotes

B13. Remarks:

***B14. Evaluator:** Kara Brunzell

***Date of Evaluation:** January 2013

(This space reserved for official comments.)

B10. Significance (continued)

Historic Context

Europeans arrived in what would become Contra Costa County in 1772, when a Spanish expedition led by Pedro Fages discovered the San Pablo Bay and the confluence of the Sacramento and San Joaquin rivers.[1] Though subsequent Spanish expeditions passed through the region the Spanish do not appear to have settled in the area during the mission period. In the 1820s and 1830s the Mexican government began granting large tracts of land in the area to its citizens, including Ranchos San Pablo, San Ramon, and Pinole. The first permanent non-native settlers were Francisco Castro and his wife Maria Gabriela Berryessa. The Mexican government granted the 18,000 acre Rancho San Pablo to the Castros in 1823.[2] Americans began farming in Contra Costa County in the late 1830s, and by 1882 2/3 of the cultivated land in the county was devoted to wheat production.[3]

Minna C. C. Quilfelt (or Quilfeldt) purchased 600 acres of Rancho San Pablo in 1852 and 1853.[4] Adjacent to San Francisco Bay in what would eventually become the southern portion of the City of Richmond, a wharf and produce warehouse were constructed on the ranch in the 1860s to ship agricultural produce to the San Francisco markets from Rancho San Pablo as well as the Quilfelt ranch. The warehouse and wharf were used to transport cattle, grain, fruit, and in later years the frogs' legs raised by Richard Stege for the San Francisco restaurant market.[5] German native Richard Stege settled on Rancho San Pablo in the late 1860s after stints in the gold fields and the Siberian fur trade. He married Minna Quilfelt, who was a widow, in 1870.[6] Minna Quilfelt Stege died in 1879, leaving the ranch to Stege and her daughter Edith. Stege began selling off portions of his ranch to raise money while continuing his frog-raising and other ventures. A town named Stege formed on Richard Stege's holdings, and by the late nineteenth century several industries, including the California Cap Works, the United States Briquette Company, the Stauffer Chemical Works and the Stege Lumber Manufacturing Company, were operating from portions of the Stege Ranch.[7] Richmond incorporated in 1905, and by 1917 was already the largest city in Contra Costa County.[8] Stege was eventually absorbed into Richmond as the latter grew.

The Explosives Industry in Contra Costa County

Swedish chemist Alfred Nobel laid the foundation for the high-explosives industry with his innovations beginning in 1860s, inventing first a detonator and then a blasting cap. In 1867 he invented dynamite, which was safer, cheaper, and more powerful than nitroglycerine, which had been the most commonly used explosive. Nobel licensed the Giant Powder Company to produce dynamite in California later that year. Giant was the first American company to produce dynamite, and its plant was initially located in Rock House Canyon, in what is today the City of San Francisco. The California Powder Works began manufacturing dynamite in the same area in 1869.[9]

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[1] Mildred B. Hoover, Hero E. Rensch, Ethel G. Rensch, Douglas E. Kyle, *Historic Spots in California, Fourth Edition*, Stanford University Press, Stanford, California: 1958, p. 129.

[2] Donald Bastin, *Images of America: Richmond*, Arcadia Publishing, Charleston SC: 2003, p. 9.

[3] J.P. Munro-Fraser, *History of Contra Costa County, California*, W.A. Slocum & Co., San Francisco: 1882, p. 55 – 57.

[4] Evan Griffins, "Early History of Richmond", December 1938, El Cerrito Historical Society, website: http://www.elcerritowire.com/history/pages/EarlyRichmond.htm, accessed January 2013.

[5] Roland Oliver, "Recollections of Early Industries in Stege", August 7, 1959, p. 1.

[6] J.P. Munro-Fraser, p. 675.

[7] Frederick J. Hulaniski, *The History of Contra Costa County, California*. Elms Publishing Company, Berkeley, California: 1917, p. 354.

[8] Hulanski p. 288.

[9] Ida Mae Purcell, *History of Contra Costa County*, The Gillick Press, Berkeley, California" 1940, p. 645 – 646.

The nineteenth century explosives industry was extremely dangerous, and as San Francisco's population grew explosives manufacturers needed to relocate. Contra Costa County across the bay was attractive since it was accessible due to its proximity to the harbor yet remote from population centers. In addition, the narrow canyons of Contra Costa County, which terminate in small bays, provided a natural geographical defense against explosions by allowing factory design that placed water between different facets of explosives manufacturing.[10]

During the 1870s chemical and explosives manufacturers began opening in the vicinity of what would eventually become Richmond. The Tonite Powder Company, Western Mineral Company, and California Cap Company were established at 1877 on the Stege ranch. The San Francisco explosives companies soon followed those explosive companies across the bay to Contra Costa County. In 1880, Giant relocated to Point Pinole, changing its name to the Atlas Powder Company. The California Powder Works soon followed, building a new factory in Hercules, which was named for the brand under which the company sold its powder.[11] The Vulcan Powder Works and Judson Powder works also opened in the Stege Ranch area during this era, consolidating Contra Costa County's position as the cradle of the California explosives industry. The East Bay dominated California explosives manufacturing into the twentieth century. In 1902 California had only one powder factory outside Contra Costa and Alameda counties.[12]

William Letts Oliver

William Letts Oliver was born in Chile to English parents in 1844. He attended the University of Edinburgh and became a mining engineer. After returning to Chile, Oliver ran an explosives factory, which was nationalized by the Chilean government in 1864. After the loss of his factory, Oliver left Chile for San Francisco.[13] William Letts Oliver and his wife Carrie lived in Oakland, from about 1880 until Oliver's death in 1918.[14] The couple eventually had six children together: Roland, Edwin, Caroline, Anita, William Harold, and Albert.[15] In addition his various professional activities William Letts Oliver was a yachtsman and an officer of the Bohemian Grove club in the early twentieth century. An avid amateur photographer throughout his lifetime, UC Berkeley's Bancroft Library has a collection of 2700 negatives and prints taken by Oliver and his son.[16]

William Letts Oliver initially gained familiarity with an explosive called guncotton while manufacturing collodion for his photography hobby.[17] As early as 1870, European explosive companies were experimenting with nitrated guncotton in and by 1875 it was manufactured in England under the name "tonite."[18] By 1877 Oliver had left Chile and was mining in the western United States. Engineers working on the Sutro Tunnel in the Comstock

[10] James E. Vance, *Geography and Urban Evolution in the San Francisco Bay Area,* University of California, Berkeley: 1964, p. 27.

[11] Purcell, p. 646.

[12] Richmond Record, "Contra Costa County: Under the Vitascope", Richmond:1902.

[13] Pacific Mining News, Supplement to Engineering & Mining Journal-Press, "Industrial Notes: Developing of the Blasting Cap Industry", Vol. 1, No. 7, November 1922, p. 222.

[14] United States Census Bureau, Tenth Census of the United States, 1880, National Archives and Records Administration, Washington, D.C., San Francisco, California, Roll: 79, Film: 1254079, Page: 170B.

[15] United States Census Bureau, Twelfth Census of the United States, 1900, National Archives and Records Administration, Washington, D.C., Oakland Ward 3, Alameda, California, Roll: 82, Page: 13A.

[16] Online Archive of California, "Guide to the Oliver Family Photograph Collection", UC Berkeley: 2009, website: http://www.oac.cdlib.org/findaid/ark:/13030/ft0q2n99r1/ accessed February, 2013.

[17] Pacific Mining News, p. 222.

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[20] Oliver, p. 1.
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[22] Nilda Rego, "Enterprising Stege lost all and died without a penny", Time Out, March 27, 1994, p. 2, column 4.
[23] Oliver, p. 1.
[24] Munro-Fraser, p. 424.
[25] Purcell, p. 648.
[26] Contra Costa County Standard, "Stege Powder Plant Blast; One Near Death", June 6, 1941, p. 1A.
[27] Oliver, p. 1.
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[31] Hulanksi, p. 354.
[32] Halbert Powers Gillette, *Rock Excavation:Methods and Cost,* M.C. Clark, New York: 1904, x.
[33] Manual Eissler, *A Handbook on Modern Explosives,* Crosby, Lockwood & son, London: 1897, p. 117.
[34] University of California, *The University of California Chronicle,* University of California Press, January, 1917, p. 92.
[35] R.L. Polk & Company, *Richmond and Contra Costa County Directory, 1914 – 1915*, Oakland, California: 1915.
[36] Pacific Mining News, p.222.
[37] University of California, Berkeley, *Current Conditions Report,* Prepared by Tetra Tech EM Inc., November 21, 2008, p. 11.
[38] Marguerite Clausen, "On the Waterfront: An Oral History of Richmond, California", Regional Oral History Office, University of California, Berkeley, 1990, p. 21.
[39] Purcell, p. 649.
[40] Oliver, p. 1.

department were performing experiments with sewage, sea water, and other materials unsuited to use on a crowded campus. They also wanted a location that was not too remote. The University purchased the California Cap Company from the Oliver family for the use of the Engineering Department in 1950.[41]

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Evaluation

The following provides an evaluation of Building 121 under each NRHP/CRHR criteria.

Building 121 does not appear to meet the criteria for listing in NRHP/CRHR because it lacks historical significance. The structure has been used for vehicle storage throughout its lifetime and as such lacks the strength of association necessary to be considered historically significant in relation to any particular events or persons (Criteria A/1 and B/2).

The utilitarian building lacks any identifiable architectural stylistic design and does not embody distinctive architectural or engineering qualities of type, period, or method of construction (Criterion C/3). In rare instances, buildings themselves can serve as sources of important information, however this building is not a principal source of important information in this regard (Criterion D/4).

Criterion G: As a vehicle storage facility, Building 121 does not meet the standard of exceptional importance required for properties less than 50 years old to be eligible to the NHRP.

[41] P.H. McGauhey, "The Sanitary Engineering Research Laboratory: Administration, Research and Consultation, 1950-1975 – An Interview Conducted by Malca Call", Regional Oral History Office, University of California, Berkeley, 1974, p. 70.

[42] University of California, Berkeley, 2008, p. 13.

[43] University of California, Berkeley, Department of Engineering, "Richmond Field Station Open House", May 28, 1952, p. 3 – 4.

[44] McGauhey, p. 71.

[45] University of California, Berkeley, Department of Engineering, "Guide for Engineering Field Station Inspection", undated, p. 3.

State of California – The Resources Agency
DEPARTMENT OF PARKS AND RECREATION

PRIMARY RECORD

Primary # _____
HRI # _____
Trinomial _____
NRHP Status Code _____
Other Listings _____
Review Code _____ Reviewer _____ Date _____

*Resource Name or # (Assigned by recorder) Richmond Field Station Building 125

P1. Other Identifier: Richmond Field Station Building 125

*P2. Location: ☐ Not for Publication ☒ Unrestricted *a. County Contra Costa
and (P2b and P2c or P2d. Attach a Location Map as necessary.)
*b. USGS 7.5′ Quad Richmond Date 1984 T___; R ____; __ ¼ of Sec ___; Diablo B.M.
c. Address _____ City _____ Zip _____
d. UTM: (give more than one for large and/or linear resources) Zone 10 ; 558509 mE/ 4196433 mN
e. Other Locational Data: (e.g., parcel #, directions to resource, elevation, etc., as appropriate)

*P3a. Description: (Describe resource and its major elements. Include design, materials, condition, alterations, size, setting, and boundaries)
Building 125 is in the southern portion of the Richmond Field Station. It is west of Egret Way and between to Building 116 and Building 118 with its primary façade facing northeast. The vernacular building does not express any particular architectural style. It is 1,024 square feet and was constructed prior to 1940. It is single story and rectangular in plan. (See continuation sheet)

*P3b. Resource Attributes: (List attributes and codes) HP4: Ancillary Building

*P4. Resources Present: ☒ Building ☐ Structure ☐ Object ☐ Site ☐ District ☐ Element of District ☐ Other (Isolates, etc.)

P5b. Description of Photo: (View, date, accession #) Photograph 1: Northeast and southeast facades of building, camera facing southwest, January 4, 2013.

*P6. Date Constructed/Age and Sources:
☒ Historic ☐ Prehistoric ☐ Both
Circa 1930s/UC Berkeley records

*P7. Owner and Address:
U.C. Berkeley
1301 South 46th Street
Richmond, California 94804

*P8. Recorded by: (Name, affiliation, address)
Kara Brunzell & Julia Mates
Tetra Tech
1999 Harrison Street, Ste 500
Oakland, CA 94612

*P9. Date Recorded: January 4, 2013

*P10. Survey Type: (Describe) Intensive

*P11. Report Citation: (Cite survey report and other sources, or enter "none.") *Historic Properties Survey Report for Portions of the Richmond Field Station* prepared by Tetra Tech, Inc, 2013.

*Attachments: NONE ☒ Location Map ☐ Sketch Map ☒ Continuation Sheet ☒ Building, Structure, and Object Record ☐ Archaeological Record ☐ District Record ☐ Linear Feature Record ☐ Milling Station Record ☐ Rock Art Record ☐ Artifact Record ☐ Photograph Record ☐ Other (list) _____

***NRHP Status Code** 6Z

***Resource Name or #** (Assigned by recorder) Richmond Field Station Building 125

B1. Historic Name: California Cap Company Building 24
B2. Common Name: Building 125
B3. Original Use: Storage B4. Present Use: Storage
***B5. Architectural Style:** Vernacular
***B6. Construction History:** (Construction date, alteration, and date of alterations) Constructed circa 1930
***B7. Moved?** ☐ **No** ☒ **Yes** ☐ **Unknown** **Date:** 1998 **Original Location:** Building 102 area
***B8. Related Features:** _____
B9. Architect: Unknown b. Builder: Unknown
***B10. Significance: Theme** N/A **Area** N/A
Period of Significance N/A **Property Type** N/A **Applicable Criteria** N/A
(Discuss importance in terms of historical or architectural context as defined by theme, period, and geographic scope. Also address integrity.)

Building 125 at Richmond Field Station does not appear to meet the criteria for listing in the National Register of Historic Places (NRHP). Furthermore, the building has been evaluated in accordance with Section 15064.5(a)(2)-(3) of the CEQA Guidelines, using the criteria outlined in Section 5024.1 of the California Public Resources Code, and does not appear to meet the significance criteria as outlined in these guidelines. Therefore, the building is not eligible for listing in the California Register of Historical Resources (CRHR). (See Continuation Sheet.)

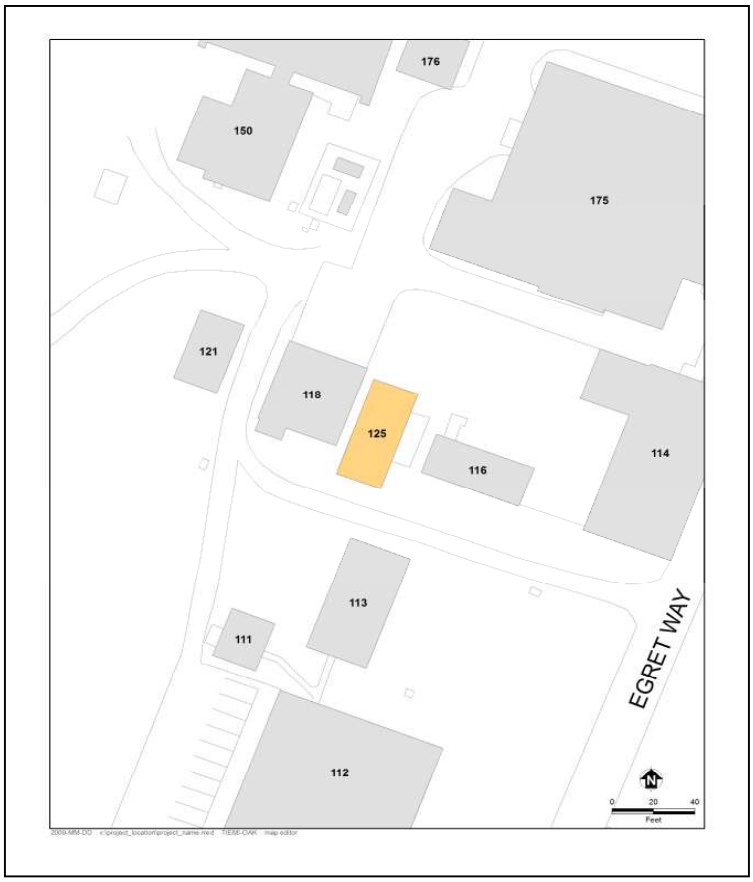
B11. Additional Resource Attributes: (List attributes and codes)

***B12. References:** See Footnotes
B13. Remarks:

***B14. Evaluator:** Kara Brunzell

***Date of Evaluation:** January 2013

(This space reserved for official comments.)



*P3a. Description: (continued)

The building is topped with a front gabled roof, and purlins are exposed at the minimal eaves on the front (northeast) and rear (southwest) elevations. Both gables are adorned with simple, decorative, stickwork trusses. The walls and roof are corrugated metal. Fenestration throughout the building is multi- light, wood sashes. The wide primary entrance is fitted with a flush door and reached by a wooden ramp leading to a small deck at the front of the building. The rear (southwest) door is flush, and accessed by a set of wooden stairs.

Building 125, originally labeled "Building 24," was constructed circa 1930 by the California Cap Company. It was adjacent to the plant's mercury fulminate production facility (near Building 102) and was used as an alcohol warehouse. After UC Berkeley purchased the property in 1950 the building was initially used as a composting facility.[1] During the 1960s SERL used the building for a laboratory and shop. It was moved to its current location as part of an environmental remediation project in 1998. It is currently used as a bioengineering research facility.[2]

B10. Significance (continued)

Historic Context

Europeans arrived in what would become Contra Costa County in 1772, when a Spanish expedition led by Pedro Fages discovered the San Pablo Bay and the confluence of the Sacramento and San Joaquin rivers.[3] Though subsequent Spanish expeditions passed through the region the Spanish do not appear to have settled in the area during the mission period. In the 1820s and 1830s the Mexican government began granting large tracts of land in the area to its citizens, including Ranchos San Pablo, San Ramon, and Pinole. The first permanent non-native settlers were Francisco Castro and his wife Maria Gabriela Berryessa. The Mexican government granted the 18,000 acre Rancho San Pablo to the Castros in 1823.[4] Americans began farming in Contra Costa County in the late 1830s, and by 1882 2/3 of the cultivated land in the county was devoted to wheat production.[5]

Minna C. C. Quilfelt (or Quilfeldt) purchased 600 acres of Rancho San Pablo in 1852 and 1853.[6] Adjacent to San Francisco Bay in what would eventually become the southern portion of the City of Richmond, a wharf and produce warehouse were constructed on the ranch in the 1860s to ship agricultural produce to the San Francisco markets from Rancho San Pablo as well as the Quilfelt ranch. The warehouse and wharf were used to transport cattle, grain, fruit, and in later years the frogs' legs raised by Richard Stege for the San Francisco restaurant market.[7] German native Richard Stege settled on Rancho San Pablo in the late 1860s after stints in the gold fields and the Siberian fur trade. He married Minna Quilfelt, who was a widow, in 1870.[8] Minna Quilfelt Stege died in 1879, leaving the ranch to Stege and her daughter Edith. Stege began selling off portions of his ranch to raise money while continuing his frog-raising and other ventures. A town named Stege formed on Richard Stege's

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[1] University of California, Berkeley, 2008, p. 196.

[2] Shackleton, 2013.

[3] Mildred B. Hoover, Hero E. Rensch, Ethel G. Rensch, Douglas E. Kyle, *Historic Spots in California, Fourth Edition*, Stanford University Press, Stanford, California: 1958, p. 129.

[4] Donald Bastin, *Images of America: Richmond*, Arcadia Publishing, Charleston SC: 2003, p. 9.

[5] J.P. Munro-Fraser, *History of Contra Costa County, California*, W.A. Slocum & Co., San Francisco: 1882, p. 55 – 57.

[6] Evan Griffins, "Early History of Richmond", December 1938, El Cerrito Historical Society, website: http://www.elcerritowire.com/history/pages/EarlyRichmond.htm, accessed January 2013.

[7] Roland Oliver, "Recollections of Early Industries in Stege", August 7, 1959, p. 1.

[8] J.P. Munro-Fraser, p. 675.

holdings, and by the late nineteenth century several industries, including the California Cap Works, the United States Briquette Company, the Stauffer Chemical Works and the Stege Lumber Manufacturing Company, were operating from portions of the Stege Ranch.[9] Richmond incorporated in 1905, and by 1917 was already the largest city in Contra Costa County.[10] Stege was eventually absorbed into Richmond as the latter grew.

The Explosives Industry in Contra Costa County

Swedish chemist Alfred Nobel laid the foundation for the high-explosives industry with his innovations beginning in 1860s, inventing first a detonator and then a blasting cap. In 1867 he invented dynamite, which was safer, cheaper, and more powerful than nitroglycerine, which had been the most commonly used explosive. Nobel licensed the Giant Powder Company to produce dynamite in California later that year. Giant was the first American company to produce dynamite, and its plant was initially located in Rock House Canyon, in what is today the City of San Francisco. The California Powder Works began manufacturing dynamite in the same area in 1869.[11]

The nineteenth century explosives industry was extremely dangerous, and as San Francisco's population grew explosives manufacturers needed to relocate. Contra Costa County across the bay was attractive since it was accessible due to its proximity to the harbor yet remote from population centers. In addition, the narrow canyons of Contra Costa County, which terminate in small bays, provided a natural geographical defense against explosions by allowing factory design that placed water between different facets of explosives manufacturing.[12]

During the 1870s chemical and explosives manufacturers began opening in the vicinity of what would eventually become Richmond. The Tonite Powder Company, Western Mineral Company, and California Cap Company were established at 1877 on the Stege ranch. The San Francisco explosives companies soon followed those explosive companies across the bay to Contra Costa County. In 1880, Giant relocated to Point Pinole, changing its name to the Atlas Powder Company. The California Powder Works soon followed, building a new factory in Hercules, which was named for the brand under which the company sold its powder.[13] The Vulcan Powder Works and Judson Powder works also opened in the Stege Ranch area during this era, consolidating Contra Costa County's position as the cradle of the California explosives industry. The East Bay dominated California explosives manufacturing into the twentieth century. In 1902 California had only one powder factory outside Contra Costa and Alameda counties.[14]

William Letts Oliver

William Letts Oliver was born in Chile to English parents in 1844. He attended the University of Edinburgh and became a mining engineer. After returning to Chile, Oliver ran an explosives factory, which was nationalized by the Chilean government in 1864. After the loss of his factory, Oliver left Chile for San Francisco.[15] William Letts

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[9] Frederick J. Hulaniski, *The History of Contra Costa County, California*. Elms Publishing Company, Berkeley, California: 1917, p. 354.

[10] Hulanski p. 288.

[11] Ida Mae Purcell, *History of Contra Costa County*, The Gillick Press, Berkeley, California" 1940, p. 645 – 646.

[12] James E. Vance, *Geography and Urban Evolution in the San Francisco Bay Area*, University of California, Berkeley: 1964, p. 27.

[13] Purcell, p. 646.

[14] Richmond Record, "Contra Costa County: Under the Vitascope", Richmond:1902.

[15] Pacific Mining News, Supplement to Engineering & Mining Journal-Press, "Industrial Notes: Developing of the Blasting Cap Industry", Vol. 1, No. 7, November 1922, p. 222.

Oliver and his wife Carrie lived in Oakland, from about 1880 until Oliver's death in 1918.[16] The couple eventually had six children together: Roland, Edwin, Caroline, Anita, William Harold, and Albert.[17] In addition his various professional activities William Letts Oliver was a yachtsman and an officer of the Bohemian Grove club in the early twentieth century. An avid amateur photographer throughout his lifetime, UC Berkeley's Bancroft Library has a collection of 2700 negatives and prints taken by Oliver and his son.[18]

William Letts Oliver initially gained familiarity with an explosive called guncotton while manufacturing collodion for his photography hobby.[19] As early as 1870, European explosive companies were experimenting with nitrated guncotton in and by 1875 it was manufactured in England under the name "tonite."[20] By 1877 Oliver had left Chile and was mining in the western United States. Engineers working on the Sutro Tunnel in the Comstock needed an explosive that would remain stable at the high temperatures underground to complete the tunnel, and Oliver was able to solve the problem by substituting tonite for more volatile compounds.[21]

The California Cap Company

In 1877 William Letts Oliver was inspired by his success with tonite to leave mining and establish the Tonite Powder Company, on a portion of the former Stege Ranch.[22] In the 1870s all blasting caps in the United States had to be imported from Europe. Not only were they expensive, but the timing of deliveries was uncertain, creating business difficulties for the powder plant. Oliver was determined to create his own caps in order to protect the tonite factory business. He experimented until he came up with a blasting cap that was safer to use and had better detonating qualities than imported detonators. Oliver and his partner Freeborn Fletter founded the California Cap Company. It was located adjacent to the Tonite Powder Company a 160 acre parcel carved out of the southern portion of Stege Ranch.[23] California Cap Company, which went on to operate on the site for nearly seven decades, was the first manufacturer of blasting caps in the United States. Richard Stege, meanwhile, continued to reside on the ranch, and contracted with Tonite Powder and California Cap to transport their products to the railroad.[24] The California Cap Company was located on the parcel that is currently the Richmond Field Station. The Tonite Powder Company appears to have been located to the east on the parcel that became the Stauffer Chemical Company and later the Zeneca site, although its exact location is unclear.

The Tonite and California Cap factories, which were the first of several gunpowder and chemical companies in the region, were separated by the Stege agricultural warehouse for safety.[25] The explosives industry during this era was an extremely dangerous one. A horrific explosion in 1882 at the nearby Vulcan Powder Company caused 11

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[16] United States Census Bureau, Tenth Census of the United States, 1880, National Archives and Records Administration, Washington, D.C., San Francisco, California, Roll: 79, Film: 1254079, Page: 170B.

[17] United States Census Bureau, Twelfth Census of the United States, 1900, National Archives and Records Administration, Washington, D.C., Oakland Ward 3, Alameda, California, Roll: 82, Page: 13A.

[18] Online Archive of California, "Guide to the Oliver Family Photograph Collection", UC Berkeley: 2009, website: http://www.oac.cdlib.org/findaid/ark:/13030/ft0q2n99r1/ accessed February, 2013.

[19] Pacific Mining News, p. 222.

[20] G.A. Price Cuxson, ed., "Society of Engineers: Transactions for 1889", E. & F. N. Spon, London: 1890, p. 95.

[21] Pacific Mining News, p. 222.

[22] Oliver, p. 1.

[23] Pacific Mining News, p. 222.

[24] Nilda Rego, "Enterprising Stege lost all and died without a penny", Time Out, March 27, 1994, p. 2, column 4.

[25] Oliver, p. 1.

deaths and destroyed the plant.[26] Between 1882 and 1918 the Hercules and Atlas plants suffered numerous explosions which destroyed plant buildings and killed a total of 64 workers.[27] Despite its focus on safety, the California Cap Company had accidents as well. Two of its Chinese workers were killed in 1917 when one of them dropped a tray of caps. In 1941 an explosion caused a fire and critically injured a worker.[28]

William Letts Oliver continued to innovate throughout his long career in the chemical and explosives industries. In 1888 he formed the American Lucol Company adjacent to the California Cap Company property.[29] The Lucol plant was at what is currently the southeastern corner of the Richmond Field Station, at the approximate location of Building 163. Lucol manufactured a linseed oil substitute.[30] The factory was dismantled and relocated to New Jersey circa 1900.[31] In 1903 the Hotaling Briquette Works opened on Lucol's site at the southeast corner of the current Richmond Field station property.[32] Later known as the U.S. Briquette Company, the plant appears to have operated at this location until at least 1917.[33] The U.S. Briquette Company buildings were demolished sometime in the 1960s.

The Oliver family aggressively promoted their products both through advertising and publishing. The California Cap Company sponsored or published both articles and book-length treatises on the use of explosives. Safety was a key element of the company image, a topic of company-sponsored technical writing as well as a selling point in advertisements.[34] The Tonite Powder Company's product was known even outside the United States, and by the end of the nineteenth century the powder's explosive properties were considered comparable to the finest English products.[35] Oliver's sons Roland and Edwin Letts Oliver both graduated from UC Berkeley's College of Mining in 1900. Roland Oliver seems to have spent his entire career working in the family enterprises, while Edwin worked at California Cap between mining and other ventures. The Oliver family also became benefactors of the university, and in 1917 the California Cap Company donated substantial amounts of their products to the College of Mining including 500 electric detonators, 500 delayed action exploders, and 500 blasting caps.[36]

Eventually the Tonite factory appears to have been incorporated into the California Cap Company. The Olivers also formed an entity named Pacific Cartridge Company circa 1910. The Pacific Cartridge Company operated from the California Cap plant during World War I.[37] By 1916 there were at least a dozen buildings on the site. When Oliver died in 1918 his son Roland Oliver took over as president of California Cap Company. By 1922 Roland's brother Leslie Oliver was assistant manager of the plant and Edwin Letts Oliver was a director.[38] Roland

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[26] Munro-Fraser, p. 424.
[27] Purcell, p. 648.
[28] Contra Costa County Standard, "Stege Powder Plant Blast; One Near Death", June 6, 1941, p. 1A.
[29] Oliver, p. 1.
[30] Max Wilhelm Von Bernewitz, *Cyanide Practice, 1910 – 1913*, Dewey Publishing Company: 1913, p. 327.
[31] Oliver, p. 1.
[32] Oliver, p. 2.
[33] Hulanksi, p. 354.
[34] Halbert Powers Gillette, *Rock Excavation:Methods and Cost*, M.C. Clark, New York: 1904, x.
[35] Manual Eissler, *A Handbook on Modern Explosives*, Crosby, Lockwood & son, London: 1897, p. 117.
[36] University of California, *The University of California Chronicle*, University of California Press, January, 1917, p. 92.
[37] R.L. Polk & Company, *Richmond and Contra Costa County Directory, 1914 – 1915*, Oakland, California: 1915.
[38] Pacific Mining News, p.222.

Oliver substantially expanded the California Cap Company after he took over as president. During this era the plant grew to include 150 buildings and a horse-drawn tram line.[39]

During the late nineteenth and early twentieth century the California Cap Company was one of the most important local employers.[40] As the twentieth century progressed more heavy industry came to Contra Costa County, and by 1940 the county was second only to Los Angeles in overall industrial production.[41] The nineteenth-century California Cap Company was dwarfed by the scale of some of the newer enterprises, and its physical plant and technology were aging. During World War II California Cap was able to stay open by producing delayed action incendiary bombs that were used against Japan.[42] The California Cap Company could not survive the transition to a peacetime economy, however, and by 1949 the plant was closed and the Oliver family looking for a buyer.

University Research/Richmond Field Station

After World War II UC Berkeley's Engineering Department needed an off-campus location in order to perform experiments that required more space than a laboratory. Department Chair Morrough P. O' Brien and others in the department were performing experiments with sewage, sea water, and other materials unsuited to use on a crowded campus. They also wanted a location that was not too remote. The University purchased the California Cap Company from the Oliver family for the use of the Engineering Department in 1950.[43]

The Richmond Field Station has been the location of a research overseen by numerous UC Berkeley departments over the years. The Sanitary Engineering Research Laboratory (SERL) was one of the first departments to undertake research at the site. SERL focused primarily on sewage treatment technology, and also researched pollution control and disposal of solid and liquid waste.[44] Other early projects at the field station included sea water distillation, heat transfer, and cyclic stress research.[45]

At first the Department of Engineering utilized the buildings left behind by the California Cap Company. The Department established a machine shop, computer shop, receiving facility, mail service, and other facilities in addition to laboratories in the old detonator company buildings.[46] The current Buildings 102, 110, 118, 128, 150, 152 175, and 176 all date to the cap company era and have been repurposed for the Richmond Field Station. They also constructed new buildings as funds became available, and by the mid-1950s five new buildings had been completed at the Richmond Field Station.[47] By the 1970s the department had conducted many experiments at the Richmond Field Station that could not have been performed on the main campus.

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[39] University of California, Berkeley, *Current Conditions Report,* Prepared by Tetra Tech EM Inc., November 21, 2008, p. 11.

[40] Marguerite Clausen, "On the Waterfront: An Oral History of Richmond, California", Regional Oral History Office, University of California, Berkeley, 1990, p. 21.

[41] Purcell, p. 649.

[42] Oliver, p. 1.

[43] P.H. McGauhey, "The Sanitary Engineering Research Laboratory: Administration, Research and Consultation, 1950-1975 – An Interview Conducted by Malca Call", Regional Oral History Office, University of California, Berkeley, 1974, p. 70.

[44] University of California, Berkeley, 2008, p. 13.

[45] University of California, Berkeley, Department of Engineering, "Richmond Field Station Open House", May 28, 1952, p. 3 – 4.

[46] McGauhey, p. 71.

[47] University of California, Berkeley, Department of Engineering, "Guide for Engineering Field Station Inspection", undated, p. 3.

Evaluation

The following provides an evaluation of Building 125 under each NRHP/CRHR criteria.

No particular association was found between the Building 125 and events significant to national, state, or local history (Criterion A/1) Although the California Cap Company was the first blasting cap manufacturer in the United States there is no indication that Building 125, a warehouse building, was central to the development of the plant or its technical processes. Therefore the building is not eligible for inclusion in the NRHP/CRHR for historical significance.

Although William Letts Oliver and his son Roland Oliver were significant in the history of the explosives industry, no particular association was found between the Oliver family and the building. Therefore it lacks the strength of association necessary to be considered historically significant in relation to any particular persons (Criteria B/2).

The building does not embody the distinctive characteristics of a type, period, region, or method of construction, or represent the work of an important creative individual or possess high artistic values (Criterion C/3). Building 125 is a vernacular building of a type that was commonly constructed from the late nineteenth to the early twentieth century and is not located in its original location. Therefore the building is not eligible to the NHRP for its architecture.

In rare instances, buildings themselves can serve as sources of important information, however this building is not a principal source of important information in this regard (Criterion D/4).

State of California – The Resources Agency
DEPARTMENT OF PARKS AND RECREATION

PRIMARY RECORD

Primary # _____
HRI # _____
Trinomial _____
NRHP Status Code _____
Other Listings _____
Review Code _____ Reviewer _____ Date _____

 ***Resource Name or #** (Assigned by recorder) Richmond Field Station Building 128

P1. Other Identifier: Richmond Field Station Building 128

***P2. Location:** ☐ **Not for Publication** ☒ **Unrestricted** ***a. County** Contra Costa
and (P2b and P2c or P2d. Attach a Location Map as necessary.)
***b. USGS 7.5′ Quad** Richmond **Date** 1984 **T**___; **R** ____; __ ¼ **of Sec** ___; Diablo **B.M.**
c. Address _____ City _____ Zip _____
d. UTM: (give more than one for large and/or linear resources) Zone 10 ; 558356 mE/ 4196398 mN
e. Other Locational Data: (e.g., parcel #, directions to resource, elevation, etc., as appropriate)

***P3a. Description:** (Describe resource and its major elements. Include design, materials, condition, alterations, size, setting, and boundaries)
Building 128 is in the southwestern portion of the Richmond Field Station, along Heron Drive, adjacent to the Environmental Protection Agency building. The vernacular building does not clearly express any particular architectural style. It is 10,287 square feet, constructed circa 1930, single story, and has an irregular plan.

The building is topped with a shallow, pitched, side-gabled roof. The primary façade, that faces southeast, features a partial width entry porch and several projecting bays. The building walls are sided in horizontal wood siding. Fenestration is a combination of original, multi- light wood and replacement aluminum sashes. (See Continuation Sheet)

***P3b. Resource Attributes:** (List attributes and codes) HP8: Industrial building

***P4. Resources Present:** ☒ Building ☐ Structure ☐ Object ☐ Site ☐ District ☐ Element of District ☐ Other (Isolates, etc.)

P5b. Description of Photo: (View, date, accession #) Photograph 1: Northwest and southwest facades of building, camera facing northeast, January 4, 2013.

***P6. Date Constructed/Age and Sources:**
☒ Historic ☐ Prehistoric ☐ Both
Circa the 1930s/Sanborn maps

***P7. Owner and Address:**
U.C. Berkeley
1301 South 46th Street
Richmond, California 94804

***P8. Recorded by:** (Name, affiliation, address)
Kara Brunzell & Julia Mates
Tetra Tech
1999 Harrison Street, Ste 500
Oakland, CA 94612

***P9. Date Recorded:** January 4, 2013

***P10. Survey Type:** (Describe) Intensive

***P11. Report Citation:** (Cite survey report and other sources, or enter "none.") *Historic Properties Survey Report for Portions of the Richmond Field Station* prepared by Tetra Tech, Inc, 2013.

***Attachments:** NONE ☒ Location Map ☐ Sketch Map ☒ Continuation Sheet ☒ Building, Structure, and Object Record ☐ Archaeological Record ☐ District Record ☐ Linear Feature Record ☐ Milling Station Record ☐ Rock Art Record ☐ Artifact Record ☐ Photograph Record ☐ Other (list) _____

***NRHP Status Code** 6Z

***Resource Name or #** (Assigned by recorder) Richmond Field Station Building 128

B1. Historic Name: California Cap Company Building 4b

B2. Common Name: Building 128

B3. Original Use: Manufacturing B4. Present Use: Storage/Research

***B5. Architectural Style:** Vernacular

***B6. Construction History:** (Construction date, alteration, and date of alterations) Constructed circa the 1930s; northwest section added Circa 1960s; west section added Circa 1970s.

***B7. Moved?** ☒ **No** ☐ **Yes** ☐ **Unknown** **Date:** _____ **Original Location:** _____

***B8. Related Features:** _____

B9. Architect: Unknown b. Builder: Unknown

***B10. Significance: Theme** N/A **Area** N/A

Period of Significance N/A **Property Type** N/A **Applicable Criteria** N/A

(Discuss importance in terms of historical or architectural context as defined by theme, period, and geographic scope. Also address integrity.)

Building 128 at Richmond Field Station does not appear to meet the criteria for listing in the National Register of Historic Places (NRHP). Furthermore, the building has been evaluated in accordance with Section 15064.5(a)(2)-(3) of the CEQA Guidelines, using the criteria outlined in Section 5024.1 of the California Public Resources Code, and does not appear to meet the significance criteria as outlined in these guidelines. Therefore, the building is not eligible for listing in the California Register of Historical Resources (CRHR). (See Continuation Sheet.)

B11. Additional Resource Attributes: (List attributes and codes)

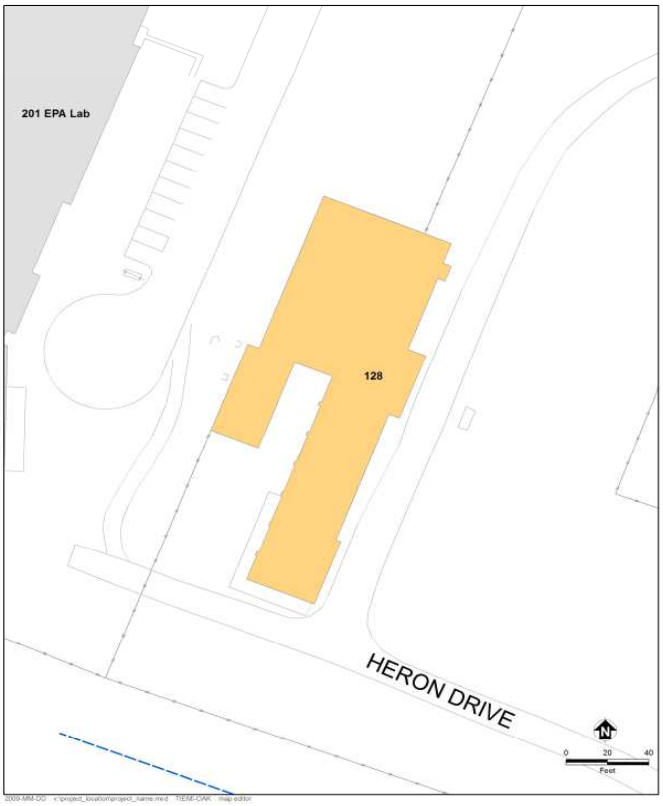
***B12. References:** See Footnotes

B13. Remarks:

***B14. Evaluator:** Kara Brunzell

***Date of Evaluation:** January 2013

(This space reserved for official comments.)



P3a. Description (continued)

A paneled entry door with windows is accessed by wooden stairs that lead to the porch. At the rear of this section of the building, are seven bays separated by poured concrete walls that project past the walls and above the roof. There are two rectangular plan sections at the northwest end of the primary wing. The smaller section, at the west end of the building, is topped with a shed roof. The larger section, to the north, has a very shallow, pitched, gabled roof. Both sections are accessed by large replacement roll up doors at their southwest ends.

Building 128, originally labeled "Building 4b," was constructed circa 1930 by the California Cap Company.[1] The original building consisted of what is today the southeast wing of the building and was used as a press house. The press house was where gunpowder was compressed into cakes using weights. There were several other small buildings in the vicinity that were also press houses. The heavy concrete walls at the rear of the original building are reinforced concrete blast walls, intended to limit damage in case of explosion. After UC Berkeley purchased the property in the 1950s, the University added two warehouse additions to the building. The first was the northwest section of the building, built circa 1950.[2] The smaller west section was added in 1974.[3] The building housed internal combustion laboratories and was used for detonation research. Rocket engine tests using model rockets were among the modes of research conducted in Building 128.[4] By 1980 Building 128 was altered to its current irregular footprint. During the 1980s, large machinery was installed for research into automated recycling.[5] The building is currently used as a research facility.

B10. Significance (continued)

Historic Context

Europeans arrived in what would become Contra Costa County in 1772, when a Spanish expedition led by Pedro Fages discovered the San Pablo Bay and the confluence of the Sacramento and San Joaquin rivers.[6] Though subsequent Spanish expeditions passed through the region the Spanish do not appear to have settled in the area during the mission period. In the 1820s and 1830s the Mexican government began granting large tracts of land in the area to its citizens, including Ranchos San Pablo, San Ramon, and Pinole. The first permanent non-native settlers were Francisco Castro and his wife Maria Gabriela Berryessa. The Mexican government granted the 18,000 acre Rancho San Pablo to the Castros in 1823.[7] Americans began farming in Contra Costa County in the late 1830s, and by 1882 2/3 of the cultivated land in the county was devoted to wheat production.[8]

Minna C. C. Quilfelt (or Quilfeldt) purchased 600 acres of Rancho San Pablo in 1852 and 1853.[9] Adjacent to San Francisco Bay in what would eventually become the southern portion of the City of Richmond, a wharf and produce warehouse were constructed on the ranch in the 1860s to ship agricultural produce to the San Francisco

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[1] University of California, Berkeley, 2008, p. 199.

[2] Shackleton, 2013.

[3] University of California, Berkeley, File "Building 128," located in vertical files in Room 148, Richmond Field Station.

[4] University of California, Berkeley, File "Building 128," located in vertical files in Room 148, Richmond Field Station.

[5] Shackleton, 2013.

[6] Mildred B. Hoover, Hero E. Rensch, Ethel G. Rensch, Douglas E. Kyle, *Historic Spots in California, Fourth Edition*, Stanford University Press, Stanford, California: 1958, p. 129.

[7] Donald Bastin, *Images of America: Richmond*, Arcadia Publishing, Charleston SC: 2003, p. 9.

[8] J.P. Munro-Fraser, *History of Contra Costa County, California*, W.A. Slocum & Co., San Francisco: 1882, p. 55 – 57.

[9] Evan Griffins, "Early History of Richmond", December 1938, El Cerrito Historical Society, website: http://www.elcerritowire.com/history/pages/EarlyRichmond.htm, accessed January 2013.

markets from Rancho San Pablo as well as the Quilfelt ranch. The warehouse and wharf were used to transport cattle, grain, fruit, and in later years the frogs' legs raised by Richard Stege for the San Francisco restaurant market.[10] German native Richard Stege settled on Rancho San Pablo in the late 1860s after stints in the gold fields and the Siberian fur trade. He married Minna Quilfelt, who was a widow, in 1870.[11] Minna Quilfelt Stege died in 1879, leaving the ranch to Stege and her daughter Edith. Stege began selling off portions of his ranch to raise money while continuing his frog-raising and other ventures. A town named Stege formed on Richard Stege's holdings, and by the late nineteenth century several industries, including the California Cap Works, the United States Briquette Company, the Stauffer Chemical Works and the Stege Lumber Manufacturing Company, were operating from portions of the Stege Ranch.[12] Richmond incorporated in 1905, and by 1917 was already the largest city in Contra Costa County.[13] Stege was eventually absorbed into Richmond as the latter grew.

The Explosives Industry in Contra Costa County

Swedish chemist Alfred Nobel laid the foundation for the high-explosives industry with his innovations beginning in 1860s, inventing first a detonator and then a blasting cap. In 1867 he invented dynamite, which was safer, cheaper, and more powerful than nitroglycerine, which had been the most commonly used explosive. Nobel licensed the Giant Powder Company to produce dynamite in California later that year. Giant was the first American company to produce dynamite, and its plant was initially located in Rock House Canyon, in what is today the City of San Francisco. The California Powder Works began manufacturing dynamite in the same area in 1869.[14]

The nineteenth century explosives industry was extremely dangerous, and as San Francisco's population grew explosives manufacturers needed to relocate. Contra Costa County across the bay was attractive since it was accessible due to its proximity to the harbor yet remote from population centers. In addition, the narrow canyons of Contra Costa County, which terminate in small bays, provided a natural geographical defense against explosions by allowing factory design that placed water between different facets of explosives manufacturing.[15]

During the 1870s chemical and explosives manufacturers began opening in the vicinity of what would eventually become Richmond. The Tonite Powder Company, Western Mineral Company, and California Cap Company were established at 1877 on the Stege ranch. The San Francisco explosives companies soon followed those explosive companies across the bay to Contra Costa County. In 1880, Giant relocated to Point Pinole, changing its name to the Atlas Powder Company. The California Powder Works soon followed, building a new factory in Hercules, which was named for the brand under which the company sold its powder.[16] The Vulcan Powder Works and Judson Powder works also opened in the Stege Ranch area during this era, consolidating Contra Costa County's position as the cradle of the California explosives industry. The East Bay dominated California explosives manufacturing into the twentieth century. In 1902 California had only one powder factory outside Contra Costa and Alameda counties.[17]

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[10] Roland Oliver, "Recollections of Early Industries in Stege", August 7, 1959, p. 1.

[11] J.P. Munro-Fraser, p. 675.

[12] Frederick J. Hulaniski, *The History of Contra Costa County, California*. Elms Publishing Company, Berkeley, California: 1917, p. 354.

[13] Hulanski p. 288.

[14] Ida Mae Purcell, *History of Contra Costa County*, The Gillick Press, Berkeley, California" 1940, p. 645 – 646.

[15] James E. Vance, *Geography and Urban Evolution in the San Francisco Bay Area*, University of California, Berkeley: 1964, p. 27.

[16] Purcell, p. 646.

[17] Richmond Record, "Contra Costa County: Under the Vitascope", Richmond:1902.

William Letts Oliver

William Letts Oliver was born in Chile to English parents in 1844. He attended the University of Edinburgh and became a mining engineer. After returning to Chile, Oliver ran an explosives factory, which was nationalized by the Chilean government in 1864. After the loss of his factory, Oliver left Chile for San Francisco.[18] William Letts Oliver and his wife Carrie lived in Oakland, from about 1880 until Oliver's death in 1918.[19] The couple eventually had six children together: Roland, Edwin, Caroline, Anita, William Harold, and Albert.[20] In addition his various professional activities William Letts Oliver was a yachtsman and an officer of the Bohemian Grove club in the early twentieth century. An avid amateur photographer throughout his lifetime, UC Berkeley's Bancroft Library has a collection of 2700 negatives and prints taken by Oliver and his son.[21]

William Letts Oliver initially gained familiarity with an explosive called guncotton while manufacturing collodion for his photography hobby.[22] As early as 1870, European explosive companies were experimenting with nitrated guncotton in and by 1875 it was manufactured in England under the name "tonite."[23] By 1877 Oliver had left Chile and was mining in the western United States. Engineers working on the Sutro Tunnel in the Comstock needed an explosive that would remain stable at the high temperatures underground to complete the tunnel, and Oliver was able to solve the problem by substituting tonite for more volatile compounds.[24]

The California Cap Company

In 1877 William Letts Oliver was inspired by his success with tonite to leave mining and establish the Tonite Powder Company, on a portion of the former Stege Ranch.[25] In the 1870s all blasting caps in the United States had to be imported from Europe. Not only were they expensive, but the timing of deliveries was uncertain, creating business difficulties for the powder plant. Oliver was determined to create his own caps in order to protect the tonite factory business. He experimented until he came up with a blasting cap that was safer to use and had better detonating qualities than imported detonators. Oliver and his partner Freeborn Fletter founded the California Cap Company. It was located adjacent to the Tonite Powder Company a 160 acre parcel carved out of the southern portion of Stege Ranch.[26] California Cap Company, which went on to operate on the site for nearly seven decades, was the first manufacturer of blasting caps in the United States. Richard Stege, meanwhile, continued to reside on the ranch, and contracted with Tonite Powder and California Cap to transport their products to the railroad.[27] The California Cap Company was located on the parcel that is currently the Richmond Field

[18] Pacific Mining News, Supplement to Engineering & Mining Journal-Press, "Industrial Notes: Developing of the Blasting Cap Industry", Vol. 1, No. 7, November 1922, p. 222.

[19] United States Census Bureau, Tenth Census of the United States, 1880, National Archives and Records Administration, Washington, D.C., San Francisco, California, Roll: 79, Film: 1254079, Page: 170B.

[20] United States Census Bureau, Twelfth Census of the United States, 1900, National Archives and Records Administration, Washington, D.C., Oakland Ward 3, Alameda, California, Roll: 82, Page: 13A.

[21] Online Archive of California, "Guide to the Oliver Family Photograph Collection", UC Berkeley: 2009, website: http://www.oac.cdlib.org/findaid/ark:/13030/ft0q2n99r1/ accessed February, 2013.

[22] Pacific Mining News, p. 222.

[23] G.A. Price Cuxson, ed., "Society of Engineers: Transactions for 1889", E. & F. N. Spon, London: 1890, p. 95.

[24] Pacific Mining News, p. 222.

[25] Oliver, p. 1.

[26] Pacific Mining News, p. 222.

[27] Nilda Rego, "Enterprising Stege lost all and died without a penny", Time Out, March 27, 1994, p. 2, column 4.

Station. The Tonite Powder Company appears to have been located to the east on the parcel that became the Stauffer Chemical Company and later the Zeneca site, although its exact location is unclear.

The Tonite and California Cap factories, which were the first of several gunpowder and chemical companies in the region, were separated by the Stege agricultural warehouse for safety.[28] The explosives industry during this era was an extremely dangerous one. A horrific explosion in 1882 at the nearby Vulcan Powder Company caused 11 deaths and destroyed the plant.[29] Between 1882 and 1918 the Hercules and Atlas plants suffered numerous explosions which destroyed plant buildings and killed a total of 64 workers.[30] Despite its focus on safety, the California Cap Company had accidents as well. Two of its Chinese workers were killed in 1917 when one of them dropped a tray of caps. In 1941 an explosion caused a fire and critically injured a worker.[31]

William Letts Oliver continued to innovate throughout his long career in the chemical and explosives industries. In 1888 he formed the American Lucol Company adjacent to the California Cap Company property.[32] The Lucol plant was at what is currently the southeastern corner of the Richmond Field Station, at the approximate location of Building 163. Lucol manufactured a linseed oil substitute.[33] The factory was dismantled and relocated to New Jersey circa 1900.[34] In 1903 the Hotaling Briquette Works opened on Lucol's site at the southeast corner of the current Richmond Field station property.[35] Later known as the U.S. Briquette Company, the plant appears to have operated at this location until at least 1917.[36] The U.S. Briquette Company buildings were demolished sometime in the 1960s.

The Oliver family aggressively promoted their products both through advertising and publishing. The California Cap Company sponsored or published both articles and book-length treatises on the use of explosives. Safety was a key element of the company image, a topic of company-sponsored technical writing as well as a selling point in advertisements.[37] The Tonite Powder Company's product was known even outside the United States, and by the end of the nineteenth century the powder's explosive properties were considered comparable to the finest English products.[38] Oliver's sons Roland and Edwin Letts Oliver both graduated from UC Berkeley's College of Mining in 1900. Roland Oliver seems to have spent his entire career working in the family enterprises, while Edwin worked at California Cap between mining and other ventures. The Oliver family also became benefactors of the university, and in 1917 the California Cap Company donated substantial amounts of their products to the College of Mining including 500 electric detonators, 500 delayed action exploders, and 500 blasting caps.[39]

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[28] Oliver, p. 1.
[29] Munro-Fraser, p. 424.
[30] Purcell, p. 648.
[31] Contra Costa County Standard, "Stege Powder Plant Blast; One Near Death", June 6, 1941, p. 1A.
[32] Oliver, p. 1.
[33] Max Wilhelm Von Bernewitz, *Cyanide Practice, 1910 – 1913,* Dewey Publishing Company: 1913, p. 327.
[34] Oliver, p. 1.
[35] Oliver, p. 2.
[36] Hulanksi, p. 354.
[37] Halbert Powers Gillette, *Rock Excavation:Methods and Cost,* M.C. Clark, New York: 1904, x.
[38] Manual Eissler, *A Handbook on Modern Explosives,* Crosby, Lockwood & son, London: 1897, p. 117.
[39] University of California, *The University of California Chronicle,* University of California Press, January, 1917, p. 92.

Eventually the Tonite factory appears to have been incorporated into the California Cap Company. The Olivers also formed an entity named Pacific Cartridge Company circa 1910. The Pacific Cartridge Company operated from the California Cap plant during World War I.[40] By 1916 there were at least a dozen buildings on the site. When Oliver died in 1918 his son Roland Oliver took over as president of California Cap Company. By 1922 Roland's brother Leslie Oliver was assistant manager of the plant and Edwin Letts Oliver was a director.[41] Roland Oliver substantially expanded the California Cap Company after he took over as president. During this era the plant grew to include 150 buildings and a horse-drawn tram line.[42]

During the late nineteenth and early twentieth century the California Cap Company was one of the most important local employers.[43] As the twentieth century progressed more heavy industry came to Contra Costa County, and by 1940 the county was second only to Los Angeles in overall industrial production.[44] The nineteenth-century California Cap Company was dwarfed by the scale of some of the newer enterprises, and its physical plant and technology were aging. During World War II California Cap was able to stay open by producing delayed action incendiary bombs that were used against Japan.[45] The California Cap Company could not survive the transition to a peacetime economy, however, and by 1949 the plant was closed and the Oliver family looking for a buyer.

University Research/Richmond Field Station

After World War II UC Berkeley's Engineering Department needed an off-campus location in order to perform experiments that required more space than a laboratory. Department Chair Morrough P. O' Brien and others in the department were performing experiments with sewage, sea water, and other materials unsuited to use on a crowded campus. They also wanted a location that was not too remote. The University purchased the California Cap Company from the Oliver family for the use of the Engineering Department in 1950.[46]

The Richmond Field Station has been the location of a research overseen by numerous UC Berkeley departments over the years. The Sanitary Engineering Research Laboratory (SERL) was one of the first departments to undertake research at the site. SERL focused primarily on sewage treatment technology, and also researched pollution control and disposal of solid and liquid waste.[47] Other early projects at the field station included sea water distillation, heat transfer, and cyclic stress research.[48]

At first the Department of Engineering utilized the buildings left behind by the California Cap Company. The Department established a machine shop, computer shop, receiving facility, mail service, and other facilities in addition to laboratories in the old detonator company buildings.[49] The current Buildings 102, 110, 118, 128, 150,

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[40] R.L. Polk & Company, *Richmond and Contra Costa County Directory, 1914 – 1915*, Oakland, California: 1915.

[41] Pacific Mining News, p.222.

[42] University of California, Berkeley, *Current Conditions Report*, Prepared by Tetra Tech EM Inc., November 21, 2008, p. 11.

[43] Marguerite Clausen, "On the Waterfront: An Oral History of Richmond, California", Regional Oral History Office, University of California, Berkeley, 1990, p. 21.

[44] Purcell, p. 649.

[45] Oliver, p. 1.

[46] P.H. McGauhey, "The Sanitary Engineering Research Laboratory: Administration, Research and Consultation, 1950-1975 – An Interview Conducted by Malca Call", Regional Oral History Office, University of California, Berkeley, 1974, p. 70.

[47] University of California, Berkeley, 2008, p. 13.

[48] University of California, Berkeley, Department of Engineering, "Richmond Field Station Open House", May 28, 1952, p. 3 – 4.

[49] McGauhey, p. 71.

152 175, and 176 all date to the cap company era and have been repurposed for the Richmond Field Station. They also constructed new buildings as funds became available, and by the mid-1950s five new buildings had been completed at the Richmond Field Station.[50] By the 1970s the department had conducted many experiments at the Richmond Field Station that could not have been performed on the main campus.

Evaluation

The following provides an evaluation of Building 128 under each NRHP/CRHR criteria.

Building 128 does not appear to meet the criteria for listing in the NHRP/CRHR because it lacks historical significance Although the California Cap Company was the first blasting cap manufacturer in the United States there is no indication that Building 128, as a press house, was central to the development of the plant and its technical processes. In addition, it has been used for a variety of purposes over its lifetime. Therefore it lacks the strength of association to be considered historically significant in relation to any particular events in national, state, or local history to (Criterion A/1).

Although William Letts Oliver and his son Roland Oliver were significant in the history of the explosives industry, no particular association was found between the Oliver family and the building. Therefore it lacks the strength of association necessary to be considered historically significant in relation to any particular persons (Criteria B/2).

Building 128 was constructed in a utilitarian style, with materials commonly used in industrial structures during the early twentieth century. In addition, alterations were performed on the building and additions were constructed over the years in response to changing needs. Therefore it does not embody the distinctive characteristics of a type, period, region, or method of construction, or represent the work of an important creative individual or possess high artistic values (Criterion C/3).

In rare instances, buildings themselves can serve as sources of important information, however this building is not a principal source of important information in this regard (Criterion D/4).

[50] University of California, Berkeley, Department of Engineering, "Guide for Engineering Field Station Inspection", undated, p. 3.

State of California – The Resources Agency
DEPARTMENT OF PARKS AND RECREATION

PRIMARY RECORD

Primary # _____
HRI # _____
Trinomial _____
NRHP Status Code _____
Other Listings _____
Review Code _____ Reviewer _____ Date _____

 ***Resource Name or #** (Assigned by recorder) Richmond Field Station Building 149

P1. Other Identifier: Richmond Field Station Building 149

***P2. Location:** ☐ **Not for Publication** ☒ **Unrestricted** ***a. County** Contra Costa
and (P2b and P2c or P2d. Attach a Location Map as necessary.)
***b. USGS 7.5′ Quad** Richmond **Date** 1984 **T**___; **R** ____; __ ¼ **of Sec** ___; Diablo **B.M.**
c. Address _____ City _____ Zip _____
d. UTM: (give more than one for large and/or linear resources) Zone 10 ; 558448 mE/ 4196467 mN
e. Other Locational Data: (e.g., parcel #, directions to resource, elevation, etc., as appropriate)

***P3a. Description:** (Describe resource and its major elements. Include design, materials, condition, alterations, size, setting, and boundaries)
Building 149 is in the southern portion of the Richmond Field Station. Its primary façade faces southeast; it is 720 square feet and was constructed in 1982. It is single story and rectangular in plan.

The building is topped with a front gabled roof, with shallow eaves and exposed rafters on the southwest and northeast elevations. The building is clad in plain and vertical groove plywood. Fenestration is vinyl sashes. The primary entrance, on the southeast elevation, is a flush, at-grade door. A similar door is near the rear of the southwest elevation. The southeast elevation features a flush double door. (See Continuation Sheet)
***P3b. Resource Attributes:** (List attributes and codes) HP4: Ancillary Building

***P4. Resources Present:** ☒ Building ☐ Structure ☐ Object ☐ Site ☐ District ☐ Element of District ☐ Other (Isolates, etc.)

P5b. Description of Photo: (View, date, accession #) Photograph 1: Southwest and southeast facades of building, camera facing north, January 4, 2013.

***P6. Date Constructed/Age and Sources:**
☒ Historic ☐ Prehistoric ☐ Both
1982/UC Berkeley records
***P7. Owner and Address:**
U.C. Berkeley
1301 South 46th Street
Richmond, California 94804
***P8. Recorded by:** (Name, affiliation, address)
Kara Brunzell & Julia Mates
Tetra Tech
1999 Harrison Street, Ste 500
Oakland, CA 94612

***P9. Date Recorded:** January 4, 2013
***P10. Survey Type:** (Describe) Intensive

***P11. Report Citation:** (Cite survey report and other sources, or enter "none.") *Historic Properties Survey Report for Portions of the Richmond Field Station* prepared by Tetra Tech, Inc, 2013.
***Attachments:** NONE ☒ Location Map ☐ Sketch Map ☒ Continuation Sheet ☒ Building, Structure, and Object Record ☐ Archaeological Record ☐ District Record ☐ Linear Feature Record ☐ Milling Station Record ☐ Rock Art Record ☐ Artifact Record ☐ Photograph Record ☐ Other (list) _____

***NRHP Status Code** 6Z

***Resource Name or #** (Assigned by recorder) Richmond Field Station Building 149

B1. Historic Name: _____

B2. Common Name: Building 149

B3. Original Use: Unknown B4. Present Use: Storage

***B5. Architectural Style:** Vernacular

***B6. Construction History:** (Construction date, alteration, and date of alterations) Constructed in 1982

***B7. Moved?** ☒ **No** ☐ **Yes** ☐ **Unknown** **Date:** _____ **Original Location:** _____

***B8. Related Features:** _____

B9. Architect: Unknown b. Builder: Unknown

***B10. Significance: Theme** N/A **Area** N/A

Period of Significance N/A **Property Type** N/A **Applicable Criteria** N/A

(Discuss importance in terms of historical or architectural context as defined by theme, period, and geographic scope. Also address integrity.)

Building 149 at Richmond Field Station does not appear to meet the criteria for listing in the National Register of Historic Places (NRHP). Furthermore, the building has been evaluated in accordance with Section 15064.5(a)(2)-(3) of the CEQA Guidelines, using the criteria outlined in Section 5024.1 of the California Public Resources Code, and does not appear to meet the significance criteria as outlined in these guidelines. Therefore, the building is not eligible for listing in the California Register of Historical Resources (CRHR). (See Continuation Sheet.)

B11. Additional Resource Attributes: (List attributes and codes)

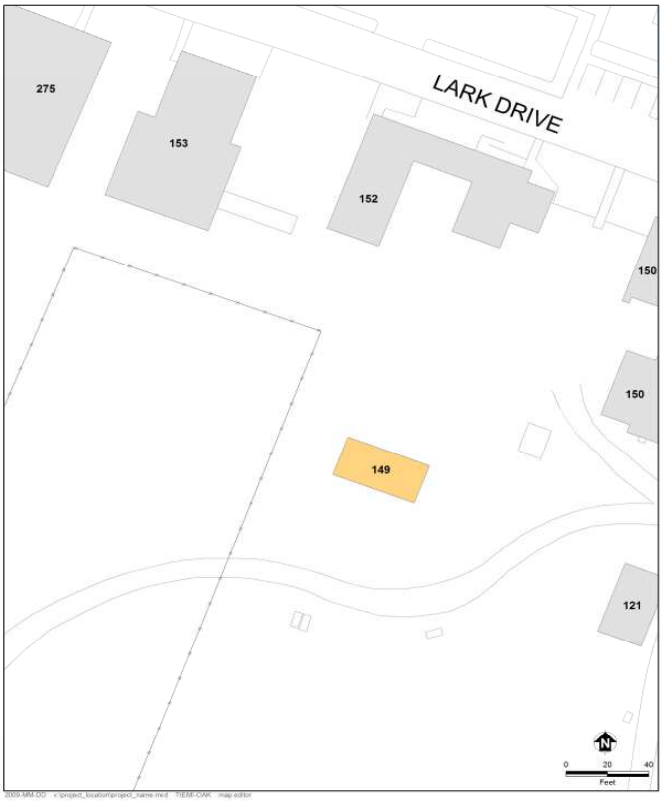
***B12. References:** See Footnotes

B13. Remarks:

***B14. Evaluator:** Kara Brunzell

***Date of Evaluation:** January 2013

(This space reserved for official comments.)



P3a. Description (continued)

Building 149 was constructed by UC Berkeley in 1982. Originally it was used for water technology research. It has also been used for solar research. Between 1992 and 1998 it was used as hang glider storage. It is currently being used by the UC Berkeley Concrete Canoe Club.[1] It is not of historic age, as it was constructed 31 years ago.

B10. Significance (continued)

Historic Context

Europeans arrived in what would become Contra Costa County in 1772, when a Spanish expedition led by Pedro Fages discovered the San Pablo Bay and the confluence of the Sacramento and San Joaquin rivers.[2] Though subsequent Spanish expeditions passed through the region the Spanish do not appear to have settled in the area during the mission period. In the 1820s and 1830s the Mexican government began granting large tracts of land in the area to its citizens, including Ranchos San Pablo, San Ramon, and Pinole. The first permanent non-native settlers were Francisco Castro and his wife Maria Gabriela Berryessa. The Mexican government granted the 18,000 acre Rancho San Pablo to the Castros in 1823.[3] Americans began farming in Contra Costa County in the late 1830s, and by 1882 2/3 of the cultivated land in the county was devoted to wheat production.[4]

Minna C. C. Quilfelt (or Quilfeldt) purchased 600 acres of Rancho San Pablo in 1852 and 1853.[5] Adjacent to San Francisco Bay in what would eventually become the southern portion of the City of Richmond, a wharf and produce warehouse were constructed on the ranch in the 1860s to ship agricultural produce to the San Francisco markets from Rancho San Pablo as well as the Quilfelt ranch. The warehouse and wharf were used to transport cattle, grain, fruit, and in later years the frogs' legs raised by Richard Stege for the San Francisco restaurant market.[6] German native Richard Stege settled on Rancho San Pablo in the late 1860s after stints in the gold fields and the Siberian fur trade. He married Minna Quilfelt, who was a widow, in 1870.[7] Minna Quilfelt Stege died in 1879, leaving the ranch to Stege and her daughter Edith. Stege began selling off portions of his ranch to raise money while continuing his frog-raising and other ventures. A town named Stege formed on Richard Stege's holdings, and by the late nineteenth century several industries, including the California Cap Works, the United States Briquette Company, the Stauffer Chemical Works and the Stege Lumber Manufacturing Company, were operating from portions of the Stege Ranch.[8] Richmond incorporated in 1905, and by 1917 was already the largest city in Contra Costa County.[9] Stege was eventually absorbed into Richmond as the latter grew.

The Explosives Industry in Contra Costa County

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[1] Shackleton, 2013.

[2] Mildred B. Hoover, Hero E. Rensch, Ethel G. Rensch, Douglas E. Kyle, *Historic Spots in California, Fourth Edition*, Stanford University Press, Stanford, California: 1958, p. 129.

[3] Donald Bastin, *Images of America: Richmond*, Arcadia Publishing, Charleston SC: 2003, p. 9.

[4] J.P. Munro-Fraser, *History of Contra Costa County, California*, W.A. Slocum & Co., San Francisco: 1882, p. 55 – 57.

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[27] Contra Costa County Standard, "Stege Powder Plant Blast; One Near Death", June 6, 1941, p. 1A.

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The Oliver family aggressively promoted their products both through advertising and publishing. The California Cap Company sponsored or published both articles and book-length treatises on the use of explosives. Safety was a key element of the company image, a topic of company-sponsored technical writing as well as a selling point in advertisements.[33] The Tonite Powder Company's product was known even outside the United States, and by the end of the nineteenth century the powder's explosive properties were considered comparable to the finest English products.[34] Oliver's sons Roland and Edwin Letts Oliver both graduated from UC Berkeley's College of Mining in 1900. Roland Oliver seems to have spent his entire career working in the family enterprises, while Edwin worked at California Cap between mining and other ventures. The Oliver family also became benefactors of the university, and in 1917 the California Cap Company donated substantial amounts of their products to the College of Mining including 500 electric detonators, 500 delayed action exploders, and 500 blasting caps.[35]

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[28] Oliver, p. 1.
[29] Max Wilhelm Von Bernewitz, *Cyanide Practice, 1910 – 1913*, Dewey Publishing Company: 1913, p. 327.
[30] Oliver, p. 1.
[31] Oliver, p. 2.
[32] Hulanksi, p. 354.
[33] Halbert Powers Gillette, *Rock Excavation:Methods and Cost*, M.C. Clark, New York: 1904, x.
[34] Manual Eissler, *A Handbook on Modern Explosives*, Crosby, Lockwood & son, London: 1897, p. 117.
[35] University of California, *The University of California Chronicle*, University of California Press, January, 1917, p. 92.
[36] R.L. Polk & Company, *Richmond and Contra Costa County Directory, 1914 – 1915*, Oakland, California: 1915.
[37] Pacific Mining News, p.222.
[38] University of California, Berkeley, *Current Conditions Report*, Prepared by Tetra Tech EM Inc., November 21, 2008, p. 11.
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1940 the county was second only to Los Angeles in overall industrial production.[40] The nineteenth-century California Cap Company was dwarfed by the scale of some of the newer enterprises, and its physical plant and technology were aging. During World War II California Cap was able to stay open by producing delayed action incendiary bombs that were used against Japan.[41] The California Cap Company could not survive the transition to a peacetime economy, however, and by 1949 the plant was closed and the Oliver family looking for a buyer.

University Research/Richmond Field Station

After World War II UC Berkeley's Engineering Department needed an off-campus location in order to perform experiments that required more space than a laboratory. Department Chair Morrough P. O' Brien and others in the department were performing experiments with sewage, sea water, and other materials unsuited to use on a crowded campus. They also wanted a location that was not too remote. The University purchased the California Cap Company from the Oliver family for the use of the Engineering Department in 1950.[42]

The Richmond Field Station has been the location of a research overseen by numerous UC Berkeley departments over the years. The Sanitary Engineering Research Laboratory (SERL) was one of the first departments to undertake research at the site. SERL focused primarily on sewage treatment technology, and also researched pollution control and disposal of solid and liquid waste.[43] Other early projects at the field station included sea water distillation, heat transfer, and cyclic stress research.[44]

At first the Department of Engineering utilized the buildings left behind by the California Cap Company. The Department established a machine shop, computer shop, receiving facility, mail service, and other facilities in addition to laboratories in the old detonator company buildings.[45] The current Buildings 102, 110, 118, 128, 150, 152 175, and 176 all date to the cap company era and have been repurposed for the Richmond Field Station. They also constructed new buildings as funds became available, and by the mid-1950s five new buildings had been completed at the Richmond Field Station.[46] By the 1970s the department had conducted many experiments at the Richmond Field Station that could not have been performed on the main campus.

Evaluation

The following provides an evaluation of Building 149 under each NRHP/CRHR criteria.

Building 149 does not appear to meet the criteria for listing in NRHP/CRHR because it lacks historical significance. The structure has been used for a variety of purposes throughout its lifetime and as such lacks the strength of association necessary to be considered historically significant in relation to any particular events or persons (Criteria A/1 and B/2).

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[40] Purcell, p. 649.

[41] Oliver, p. 1.

[42] P.H. McGauhey, "The Sanitary Engineering Research Laboratory: Administration, Research and Consultation, 1950-1975 – An Interview Conducted by Malca Call", Regional Oral History Office, University of California, Berkeley, 1974, p. 70.

[43] University of California, Berkeley, 2008, p. 13.

[44] University of California, Berkeley, Department of Engineering, "Richmond Field Station Open House", May 28, 1952, p. 3 – 4.

[45] McGauhey, p. 71.

[46] University of California, Berkeley, Department of Engineering, "Guide for Engineering Field Station Inspection", undated, p. 3.

The utilitarian building lacks any identifiable architectural stylistic design and does not embody distinctive architectural or engineering qualities of type, period, or method of construction (Criterion C/3). In rare instances, buildings themselves can serve as sources of important information, however this building is not a principal source of important information in this regard (Criterion D/4).

As a storage facility Building 149 does not meet the standard of exceptional importance required for properties under 50 years old to be eligible to the NHRP (Criterion G).

State of California – The Resources Agency
DEPARTMENT OF PARKS AND RECREATION

PRIMARY RECORD

Primary # _____
HRI # _____
Trinomial _____
NRHP Status Code _____
Other Listings _____
Review Code _____ Reviewer _____ Date _____

 ***Resource Name or #** (Assigned by recorder) Richmond Field Station Building 150

P1. Other Identifier: Richmond Field Station Building 150

***P2. Location:** ☐ **Not for Publication** ☒ **Unrestricted** ***a. County** Contra Costa
and (P2b and P2c or P2d. Attach a Location Map as necessary.)
***b. USGS 7.5′ Quad** Richmond **Date** 1984 **T**___; **R** ___; __ ¼ **of Sec** ___; Diablo **B.M.**
c. Address _____ City _____ Zip _____
d. UTM: (give more than one for large and/or linear resources) Zone 10 ; 558497 mE/ 4196497 mN
e. Other Locational Data: (e.g., parcel #, directions to resource, elevation, etc., as appropriate)

***P3a. Description:** (Describe resource and its major elements. Include design, materials, condition, alterations, size, setting, and boundaries)
Building 150 is in the southern portion of the Richmond Field Station. Its primary façade faces northeast along Lark Drive. It is 5,410 square feet and was constructed in approximately 1910. The building is single story and rectangular in plan, with additions to the rear (southwest) side. The building is topped with a shallow-pitched, side gabled roof with shallow eaves and exposed shaped wood rafter tails and purlins. Many of the original features remain and the building continues to convey original use as a shop with its sets of industrial, metal-frame, multi-light sashes, walls sided in board formed concrete, and low, open configuration.(See Continuation Sheet).

***P3b. Resource Attributes:** (List attributes and codes) HP15: Educational building

***P4. Resources Present:** ☒ Building ☐ Structure ☐ Object ☐ Site ☐ District ☐ Element of District ☐ Other (Isolates, etc.)

P5b. Description of Photo: (View, date, accession #) Photograph 1: Northeast and northwest facades of building, camera facing south, January 4, 2013.

***P6. Date Constructed/Age and Sources:**
☒ Historic ☐ Prehistoric ☐ Both
Circa 1910/Sanborn maps

***P7. Owner and Address:**
U.C. Berkeley
1301 South 46th Street
Richmond, California 94804

***P8. Recorded by:** (Name, affiliation, address)
Kara Brunzell & Julia Mates
Tetra Tech
1999 Harrison Street, Ste 500
Oakland, CA 94612

***P9. Date Recorded:** January 4, 2013

***P10. Survey Type:** (Describe) Intensive

***P11. Report Citation:** (Cite survey report and other sources, or enter "none.") *Historic Properties Survey Report for Portions of the Richmond Field Station* prepared by Tetra Tech, Inc, 2013.

***Attachments:** NONE ☒ Location Map ☐ Sketch Map ☒ Continuation Sheet ☒ Building, Structure, and Object Record ☐ Archaeological Record ☐ District Record ☐ Linear Feature Record ☐ Milling Station Record ☐ Rock Art Record ☐ Artifact Record ☐ Photograph Record ☐ Other (list) _____

***NRHP Status Code** 3D

***Resource Name or #** (Assigned by recorder) Richmond Field Station Building 150

B1. Historic Name: California Cap Company Building 66a

B2. Common Name: Building 150

B3. Original Use: Manufacturing B4. Present Use: Research

***B5. Architectural Style:** Vernacular

***B6. Construction History:** (Construction date, alteration, and date of alterations) Constructed circa 1910 for Californa Cap Company; additions constructed circa 1946.

***B7. Moved?** ☒ **No** ☐ **Yes** ☐ **Unknown** **Date:** _____ **Original Location:** _____

***B8. Related Features:** _____

B9. Architect: Unknown b. Builder: Unknown

***B10. Significance: Theme** History **Area** Richmond Field Station

Period of Significance 1910 - 1949 **Property Type** Industrial **Applicable Criteria** A

(Discuss importance in terms of historical or architectural context as defined by theme, period, and geographic scope. Also address integrity.)

Building 150 at Richmond Field Station appears to meet the criteria for listing in the National Register of Historic Places (NRHP). Furthermore, the building has been evaluated in accordance with Section 15064.5(a)(2)-(3) of the CEQA Guidelines, using the criteria outlined in Section 5024.1 of the California Public Resources Code, and appears to meet the significance criteria as outlined in these guidelines. Therefore, the building is eligible for listing in the California Register of Historical Resources (CRHR). (See Continuation Sheet)

B11. Additional Resource Attributes: (List attributes and codes)

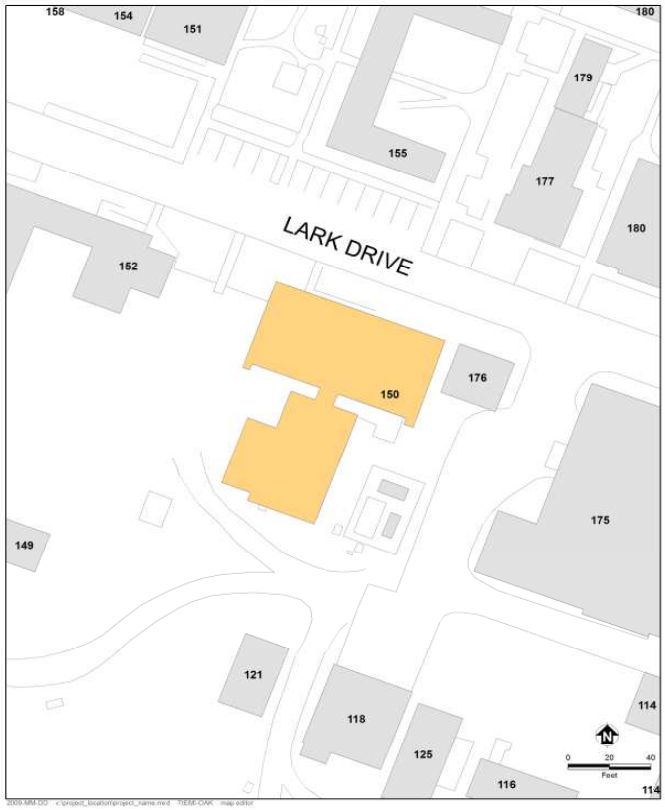
***B12. References:** See footnotes and continuation sheet

B13. Remarks:

***B14. Evaluator:** Kara Brunzell

***Date of Evaluation:** January 2013

(This space reserved for official comments.)



P3a. Description (continued)

The main entrance is centered in the primary elevation and is original flush wood double doors with multi-light windows and transoms (Photograph 2). A concrete loading dock in front of these doors is accessed by a set of wooden stairs at its east end and a ramp at its west end.

The northwest elevation features a large roll up metal door. The rear (southwest) elevation of the building lacks the overhanging eaves with their decorative rafter tails that are found on the front and sides of the building. Fenestration at the rear is original, metal-frame, multi-light, industrial sashes.

Photograph 2: Building 150, January 4, 2013, camera facing south

A separate rectangular-plan addition is perpendicular to the main section of the building, at its rear (Photograph 3). It was added in 1946. This addition is topped with a shallow, pitched, gabled roof lower than the main building's roof with an eave overhang and rafter tail treatment mimicking that of the street-facing façade. Fenestration on this addition is multi-light, hung, wood sashes. A flush-mounted wood door is the entrance on the southwest elevation. It is sheltered by a shed roofed awning and accessed by a wooden staircase. An addition on the northwest side of the rear building has an even lower shed roof. The walls are clad in corrugated metal. Fenestration at this addition is horizontal sliding sashes, and the entrance is a large wood sliding door.

Photograph 3: Building 150, January 4, 2013, camera facing northwest

The California Cap Company constructed Building 150 circa 1910. The building was known as "Building 66a" and used for wire insulating. The addition at the southeast end of the building, known as "Building 66," was also constructed during the California Cap Company era. Aerial photographs show that it had been constructed by 1946. It was used for wire saturating.[1] Insulated wires were an essential element of the fuse-type blasting caps manufactured by the California Cap Company. Wire saturating was one step in the process of manufacturing insulated wire.

After UC Berkeley purchased the property in 1950, the Division of Mechanical Engineering was housed in Building 150. During the 1950s, Associate Dean E. D. Howe supervised Fluid Mechanics Test Facilities in the building.[2] Over the years the building was used as a petroleum studies facility, a machine shop, and a laboratory for UCSF.[3] Building 150 is currently used as an student art facility.

B10. Significance (continued)

Historic Context

Europeans arrived in what would become Contra Costa County in 1772, when a Spanish expedition led by Pedro Fages discovered the San Pablo Bay and the confluence of the Sacramento and San Joaquin rivers.[4] Though subsequent Spanish expeditions passed through the region the Spanish do not appear to have settled in the area during the mission period. In the 1820s and 1830s the Mexican government began granting large tracts of land in the area to its citizens, including Ranchos San Pablo, San Ramon, and Pinole. The first permanent non-native

[1] Sanborn Map, Richmond, 1949.

[2] University of California, Berkeley, Department of Engineering, "Guide for Engineering Field Station Inspection," undated, p.2.

[3] University of California, Berkeley, 2008, p. 196.

[4] Mildred B. Hoover, Hero E. Rensch, Ethel G. Rensch, Douglas E. Kyle, *Historic Spots in California, Fourth Edition*, Stanford University Press, Stanford, California: 1958, p. 129.

settlers were Francisco Castro and his wife Maria Gabriela Berryessa. The Mexican government granted the 18,000 acre Rancho San Pablo to the Castros in 1823.[5] Americans began farming in Contra Costa County in the late 1830s, and by 1882 2/3 of the cultivated land in the county was devoted to wheat production.[6]

Minna C. C. Quilfelt (or Quilfeldt) purchased 600 acres of Rancho San Pablo in 1852 and 1853.[7] Adjacent to San Francisco Bay in what would eventually become the southern portion of the City of Richmond, a wharf and produce warehouse were constructed on the ranch in the 1860s to ship agricultural produce to the San Francisco markets from Rancho San Pablo as well as the Quilfelt ranch. The warehouse and wharf were used to transport cattle, grain, fruit, and in later years the frogs' legs raised by Richard Stege for the San Francisco restaurant market.[8] German native Richard Stege settled on Rancho San Pablo in the late 1860s after stints in the gold fields and the Siberian fur trade. He married Minna Quilfelt, who was a widow, in 1870.[9] Minna Quilfelt Stege died in 1879, leaving the ranch to Stege and her daughter Edith. Stege began selling off portions of his ranch to raise money while continuing his frog-raising and other ventures. A town named Stege formed on Richard Stege's holdings, and by the late nineteenth century several industries, including the California Cap Works, the United States Briquette Company, the Stauffer Chemical Works and the Stege Lumber Manufacturing Company, were operating from portions of the Stege Ranch.[10] Richmond incorporated in 1905, and by 1917 was already the largest city in Contra Costa County.[11] Stege was eventually absorbed into Richmond as the latter grew.

The Explosives Industry in Contra Costa County

Swedish chemist Alfred Nobel laid the foundation for the high-explosives industry with his innovations beginning in 1860s, inventing first a detonator and then a blasting cap. In 1867 he invented dynamite, which was safer, cheaper, and more powerful than nitroglycerine, which had been the most commonly used explosive. Nobel licensed the Giant Powder Company to produce dynamite in California later that year. Giant was the first American company to produce dynamite, and its plant was initially located in Rock House Canyon, in what is today the City of San Francisco. The California Powder Works began manufacturing dynamite in the same area in 1869.[12]

The nineteenth century explosives industry was extremely dangerous, and as San Francisco's population grew explosives manufacturers needed to relocate. Contra Costa County across the bay was attractive since it was accessible due to its proximity to the harbor yet remote from population centers. In addition, the narrow canyons of Contra Costa County, which terminate in small bays, provided a natural geographical defense against explosions by allowing factory design that placed water between different facets of explosives manufacturing.[13]

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[5] Donald Bastin, *Images of America: Richmond*, Arcadia Publishing, Charleston SC: 2003, p. 9.

[6] J.P. Munro-Fraser, *History of Contra Costa County, California*, W.A. Slocum & Co., San Francisco: 1882, p. 55 – 57.

[7] Evan Griffins, "Early History of Richmond", December 1938, El Cerrito Historical Society, website: http://www.elcerritowire.com/history/pages/EarlyRichmond.htm, accessed January 2013.

[8] Roland Oliver, "Recollections of Early Industries in Stege", August 7, 1959, p. 1.

[9] J.P. Munro-Fraser, p. 675.

[10] Frederick J. Hulaniski, *The History of Contra Costa County, California*. Elms Publishing Company, Berkeley, California: 1917, p. 354.

[11] Hulanski p. 288.

[12] Ida Mae Purcell, *History of Contra Costa County*, The Gillick Press, Berkeley, California" 1940, p. 645 – 646.

[13] James E. Vance, *Geography and Urban Evolution in the San Francisco Bay Area*, University of California, Berkeley: 1964, p. 27.

During the 1870s chemical and explosives manufacturers began opening in the vicinity of what would eventually become Richmond. The Tonite Powder Company, Western Mineral Company, and California Cap Company were established at 1877 on the Stege ranch. The San Francisco explosives companies soon followed those explosive companies across the bay to Contra Costa County. In 1880, Giant relocated to Point Pinole, changing its name to the Atlas Powder Company. The California Powder Works soon followed, building a new factory in Hercules, which was named for the brand under which the company sold its powder.[14] The Vulcan Powder Works and Judson Powder works also opened in the Stege Ranch area during this era, consolidating Contra Costa County's position as the cradle of the California explosives industry. The East Bay dominated California explosives manufacturing into the twentieth century. In 1902 California had only one powder factory outside Contra Costa and Alameda counties.[15]

William Letts Oliver

William Letts Oliver was born in Chile to English parents in 1844. He attended the University of Edinburgh and became a mining engineer. After returning to Chile, Oliver ran an explosives factory, which was nationalized by the Chilean government in 1864. After the loss of his factory, Oliver left Chile for San Francisco.[16] William Letts Oliver and his wife Carrie lived in Oakland, from about 1880 until Oliver's death in 1918.[17] The couple eventually had six children together: Roland, Edwin, Caroline, Anita, William Harold, and Albert.[18] In addition his various professional activities William Letts Oliver was a yachtsman and an officer of the Bohemian Grove club in the early twentieth century. An avid amateur photographer throughout his lifetime, UC Berkeley's Bancroft Library has a collection of 2700 negatives and prints taken by Oliver and his son.[19]

William Letts Oliver initially gained familiarity with an explosive called guncotton while manufacturing collodion for his photography hobby.[20] As early as 1870, European explosive companies were experimenting with nitrated guncotton in and by 1875 it was manufactured in England under the name "tonite."[21] By 1877 Oliver had left Chile and was mining in the western United States. Engineers working on the Sutro Tunnel in the Comstock needed an explosive that would remain stable at the high temperatures underground to complete the tunnel, and Oliver was able to solve the problem by substituting tonite for more volatile compounds.[22]

The California Cap Company

In 1877 William Letts Oliver was inspired by his success with tonite to leave mining and establish the Tonite Powder Company, on a portion of the former Stege Ranch.[23] In the 1870s all blasting caps in the United States

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[14] Purcell, p. 646.

[15] Richmond Record, "Contra Costa County: Under the Vitascope", Richmond:1902.

[16] Pacific Mining News, Supplement to Engineering & Mining Journal-Press, "Industrial Notes: Developing of the Blasting Cap Industry", Vol. 1, No. 7, November 1922, p. 222.

[17] United States Census Bureau, Tenth Census of the United States, 1880, National Archives and Records Administration, Washington, D.C., San Francisco, California, Roll: 79, Film: 1254079, Page: 170B.

[18] United States Census Bureau, Twelfth Census of the United States, 1900, National Archives and Records Administration, Washington, D.C., Oakland Ward 3, Alameda, California, Roll: 82, Page: 13A.

[19] Online Archive of California, "Guide to the Oliver Family Photograph Collection", UC Berkeley: 2009, website: http://www.oac.cdlib.org/findaid/ark:/13030/ft0q2n99r1/ accessed February, 2013.

[20] Pacific Mining News, p. 222.

[21] G.A. Price Cuxson, ed., "Society of Engineers: Transactions for 1889", E. & F. N. Spon, London: 1890, p. 95.

[22] Pacific Mining News, p. 222.

[23] Oliver, p. 1.

had to be imported from Europe. Not only were they expensive, but the timing of deliveries was uncertain, creating business difficulties for the powder plant. Oliver was determined to create his own caps in order to protect the tonite factory business. He experimented until he came up with a blasting cap that was safer to use and had better detonating qualities than imported detonators. Oliver and his partner Freeborn Fletter founded the California Cap Company. It was located adjacent to the Tonite Powder Company a 160 acre parcel carved out of the southern portion of Stege Ranch.[24] California Cap Company, which went on to operate on the site for nearly seven decades, was the first manufacturer of blasting caps in the United States. Richard Stege, meanwhile, continued to reside on the ranch, and contracted with Tonite Powder and California Cap to transport their products to the railroad.[25] The California Cap Company was located on the parcel that is currently the Richmond Field Station. The Tonite Powder Company appears to have been located to the east on the parcel that became the Stauffer Chemical Company and later the Zeneca site, although its exact location is unclear.

The Tonite and California Cap factories, which were the first of several gunpowder and chemical companies in the region, were separated by the Stege agricultural warehouse for safety.[26] The explosives industry during this era was an extremely dangerous one. A horrific explosion in 1882 at the nearby Vulcan Powder Company caused 11 deaths and destroyed the plant.[27] Between 1882 and 1918 the Hercules and Atlas plants suffered numerous explosions which destroyed plant buildings and killed a total of 64 workers.[28] Despite its focus on safety, the California Cap Company had accidents as well. Two of its Chinese workers were killed in 1917 when one of them dropped a tray of caps. In 1941 an explosion caused a fire and critically injured a worker.[29]

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[24] Pacific Mining News, p. 222.
[25] Nilda Rego, "Enterprising Stege lost all and died without a penny", Time Out, March 27, 1994, p. 2, column 4.
[26] Oliver, p. 1.
[27] Munro-Fraser, p. 424.
[28] Purcell, p. 648.
[29] Contra Costa County Standard, "Stege Powder Plant Blast; One Near Death", June 6, 1941, p. 1A.
[30] Oliver, p. 1.
[31] Max Wilhelm Von Bernewitz, *Cyanide Practice, 1910 – 1913*, Dewey Publishing Company: 1913, p. 327.
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[35] Halbert Powers Gillette, *Rock Excavation:Methods and Cost*, M.C. Clark, New York: 1904, x.

[36] Manual Eissler, *A Handbook on Modern Explosives*, Crosby, Lockwood & son, London: 1897, p. 117.

[37] University of California, *The University of California Chronicle*, University of California Press, January, 1917, p. 92.

[38] R.L. Polk & Company, *Richmond and Contra Costa County Directory, 1914 – 1915*, Oakland, California: 1915.

[39] Pacific Mining News, p.222.

[40] University of California, Berkeley, *Current Conditions Report*, Prepared by Tetra Tech EM Inc., November 21, 2008, p. 11.

[41] Marguerite Clausen, "On the Waterfront: An Oral History of Richmond, California", Regional Oral History Office, University of California, Berkeley, 1990, p. 21.

[42] Purcell, p. 649.

[43] Oliver, p. 1.

[44] P.H. McGauhey, "The Sanitary Engineering Research Laboratory: Administration, Research and Consultation, 1950-1975 – An Interview Conducted by Malca Call", Regional Oral History Office, University of California, Berkeley, 1974, p. 70.

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Evaluation

Criterion A/1: Building 150 appears to be eligible for listing in the NHRP/CRHR under Criterion A/1 because it is associated with the early explosives industry in the United States. The California Cap company was the oldest blasting manufacturer in the East Bay. Blasting caps, or detonators, were an important safety innovation, invented only a few years before California Cap was opened.[49] Several other explosives factories were opened in Contra Costa County after the Tonite Powder and California Cap companies, and from the 1880s into the twentieth century the East Bay produced most of the explosives products in California. High-explosive powder and blasting caps were essential to mining, road-building, and other economically important activities in California. These factories also produced munitions that were used during wartime. The manufacturing activities in Building 150, specifically wire insulating and wire saturating, were central to the production processes of the California Cap Company, the first blasting cap company in the United States. Insulated wire was required for blasting caps, one of the primary products of the plant. In addition, Building 150 is closely associated with Building 175, the California Cap Company's primary building.

Criterion B/2: Although William Letts Oliver and his son Roland Oliver were significant in the history of the explosives industry, no particular association was found between the Oliver family and the building, so it lacks the strength of association necessary to be considered historically significant in relation to any particular persons.

Criterion C/3: The building does not embody the distinctive characteristics of a type, period, region, or method of construction, or represent the work of an important creative individual or possess high artistic values. Building 150 is a simple industrial building, so it is not eligible to the NHRP/CRHR for its architecture.

Criterion D/4: In rare instances, buildings themselves can serve as sources of important information, but this building is not a principal source of important information in this regard.

Eligibility for listing on either the NRHP rests on significance and integrity. A property must have both factors to be considered eligible. Loss of integrity, if sufficiently great, would overwhelm the historical significance of a resource and render it ineligible. Integrity of a historic resource is measured by applying seven factors: location,

[45] University of California, Berkeley, 2008, p. 13.
[46] University of California, Berkeley, Department of Engineering, "Richmond Field Station Open House", May 28, 1952, p. 3 – 4.
[47] McGauhey, p. 71.
[48] University of California, Berkeley, Department of Engineering, "Guide for Engineering Field Station Inspection", undated, p. 3.
[49] A detonator is a small explosive charge that ignites a larger charge, allowing for the use of a more stable and thus safer type of explosive.

design, setting, workmanship, materials, feeling, and association. Building 150 has retained a sufficient level of integrity in all measures. Although the building has undergone alterations, including the additional square footage constructed at the rear, these alterations have not compromised the historic integrity of the building. It continues to convey its historic significance as a California Cap Company manufacturing facility.

*B12. References (continued):

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--------Stege, California. 1912.
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--------Tenth Census of the United States, 1880. National Archives and Records Administration, Washington, D.C. San Francisco, California, Roll: 79, Film: 1254079, Page: 170B.
--------Twelfth Census of the United States, 1900. National Archives and Records Administration, Washington, D.C. Oakland Ward 3, Alameda, California, Roll: 82, Page: 13A.

University of California, Berkeley.
--------"Current Conditions Report." Prepared by Tetra Tech EM Inc. November 21, 2008.
--------"Draft Environmental Impact Report, Proposed U.S. Environmental Protection Agency, Region IX Laboratory at the University of California's Richmond Field Station". Prepared by University of California, Berkeley Planning, Design and Construction Department. July 1991.
---------Building files. Vertical files, Room 148. Richmond Field Station.

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State of California – The Resources Agency
DEPARTMENT OF PARKS AND RECREATION

PRIMARY RECORD

Primary # _____
HRI # _____
Trinomial _____
NRHP Status Code _____
Other Listings _____
Review Code _____ Reviewer _____ Date _____

 ***Resource Name or #** (Assigned by recorder) Richmond Field Station Building 152

P1. Other Identifier: Richmond Field Station Building 152

***P2. Location:** ☐ **Not for Publication** ☒ **Unrestricted** ***a. County** Contra Costa
and (P2b and P2c or P2d. Attach a Location Map as necessary.)
***b. USGS 7.5′ Quad** Richmond **Date** 1984 **T**___; **R** ___; __ ¼ **of Sec** ___; Diablo **B.M.**
c. Address _____ City _____ Zip _____
d. UTM: (give more than one for large and/or linear resources) Zone 10 ; 558495 mE/ 4196494 mN
e. Other Locational Data: (e.g., parcel #, directions to resource, elevation, etc., as appropriate)

***P3a. Description:** (Describe resource and its major elements. Include design, materials, condition, alterations, size, setting, and boundaries)
Building 152 is in the southern portion of the Richmond Field Station. It is on the south side of Lark Drive adjacent to Building 150, with its primary façade facing northeast. The vernacular building does not strongly express any particular architecture style. It is two stories and has an irregular plan, is 4,201 square feet, and was constructed prior to 1940. (See Continuation Sheet)

***P3b. Resource Attributes:** (List attributes and codes) HP15: Educational building, HP39:Other

***P4. Resources Present:** ☒ Building ☐ Structure ☐ Object ☐ Site ☐ District ☐ Element of District ☐ Other (Isolates, etc.)

P5b. Description of Photo: (View, date, accession #) Photograph 1: Southeast and northeast facades of building, camera facing southwest, January 4, 2013.

***P6. Date Constructed/Age and Sources:**
☒ Historic ☐ Prehistoric ☐ Both
Circa 1930s/UC Berkeley records

***P7. Owner and Address:**
U.C. Berkeley
1301 South 46th Street
Richmond, California 94804

***P8. Recorded by:** (Name, affiliation, address)
Kara Brunzell & Julia Mates
Tetra Tech
1999 Harrison Street, Ste 500
Oakland, CA 94612

***P9. Date Recorded:** January 4, 2013

***P10. Survey Type:** (Describe) Intensive

***P11. Report Citation:** (Cite survey report and other sources, or enter "none.") *Historic Properties Survey Report for Portions of the Richmond Field Station* prepared by Tetra Tech, Inc, 2013.

***Attachments:** NONE ☒ Location Map ☐ Sketch Map ☒ Continuation Sheet ☒ Building, Structure, and Object Record ☐ Archaeological Record ☐ District Record ☐ Linear Feature Record ☐ Milling Station Record ☐ Rock Art Record ☐ Artifact Record ☐ Photograph Record ☐ Other (list) _____

***Resource Name or #** (Assigned by recorder) Richmond Field Station Building 152

B1. Historic Name: California Cap Company Building 59, Building 60, and Building 142
B2. Common Name: Building 152
B3. Original Use: Box assembly/packing B4. Present Use: Art practice/storage
***B5. Architectural Style:** Vernacular
***B6. Construction History:** (Construction date, alteration, and date of alterations) Constructed circa the 1930s
***B7. Moved?** ☒ **No** ☐ **Yes** ☐ **Unknown** **Date:** _____ **Original Location:** _____
***B8. Related Features:** _____
B9. Architect: Unknown b. Builder: Unknown
***B10. Significance: Theme** N/A **Area** N/A
Period of Significance N/A **Property Type** N/A **Applicable Criteria** N/A
(Discuss importance in terms of historical or architectural context as defined by theme, period, and geographic scope. Also address integrity.)

Building 152 at Richmond Field Station does not appear to meet the criteria for listing in the National Register of Historic Places (NRHP). Furthermore, the building has been evaluated in accordance with Section 15064.5(a)(2)-(3) of the CEQA Guidelines, using the criteria outlined in Section 5024.1 of the California Public Resources Code, and does not appear to meet the significance criteria as outlined in these guidelines. Therefore, the building is not eligible for listing in the California Register of Historical Resources (CRHR). (See Continuation Sheet.)

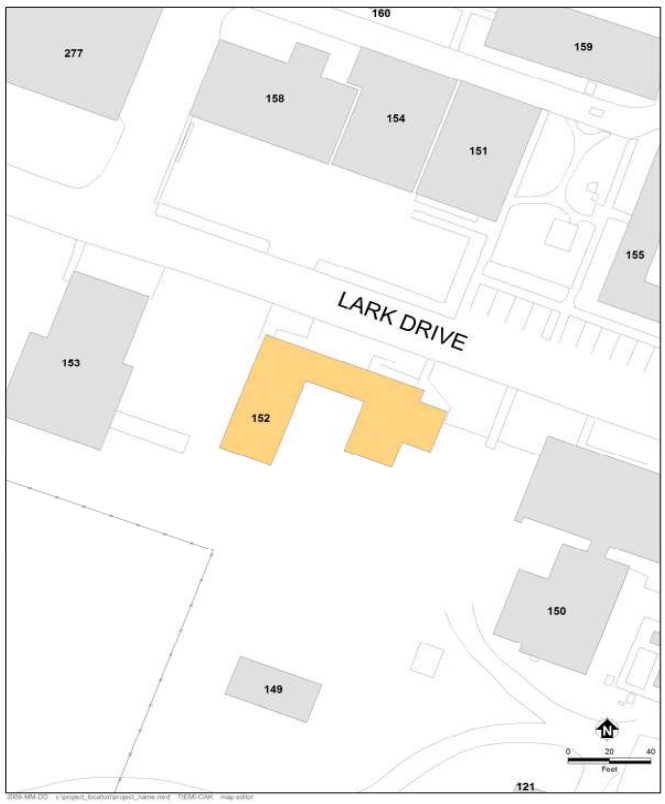
B11. Additional Resource Attributes: (List attributes and codes)

***B12. References:** See Footnotes
B13. Remarks:

***B14. Evaluator:** Kara Brunzell

***Date of Evaluation:** January 2013

(This space reserved for official comments.)



P3a. Description (continued)

The building consists of two front gabled wings facing the street, joined by a wing that runs parallel to the street. The roof is sheathed in composition shingles. The building is clad in a combination of horizontal wood, vertical board-and-batten, and asbestos siding. Fenestration also varies, and includes vinyl replacement windows and multi-light, double hung wood sashes. An entrance at the east gable is fitted with a flush wood door and accessed by a wood deck with stairs at one end and a ramp at the other. A similar entrance at the west gable is accessed by a concrete loading dock and stairs. A single story addition at the northwest end of the building features a hipped roof covered in corrugated metal. Multi- light, fixed, wood sashes have been painted over on its southeast elevation. The entrance at the northeast elevation is a large wood sliding door with a wood paneled door adjacent to it.

A rear entrance is toward the southwest corner of the west gable, facing the inside of the "U" formed by the building's wings. It is a flush mounted wood door that is accessed via a set of wooden stairs. The west gable is several feet longer than the east gable at the rear of the building. A small gable roofed shed is to the rear of the building adjacent to its southeast corner.

Building 152 was constructed by the California Cap Company circa the 1930s. It was originally three connected buildings referred to as "Building 59," Building 60," and "Building 142". Wooden boxes were assembled and other carpentry tasks performed in "Building 59," while "Building 60" was the packing house. "Building 142" was for sawdust storage and a restroom.[1] After UC Berkeley purchased the property in 1950 the building was used for salt water research and storage. A Mineral Dressing laboratory was installed by the Department of Mineral Technology in the late 1950s, but it appears not to have been used.[2] By 1980 the building was being used primarily for storage.[3] In the 1990s Building 152 began to house graduate student Art Practice, the current use of the building.[4]

B10. Significance (continued)

Historic Context

Europeans arrived in what would become Contra Costa County in 1772, when a Spanish expedition led by Pedro Fages discovered the San Pablo Bay and the confluence of the Sacramento and San Joaquin rivers.[5] Though subsequent Spanish expeditions passed through the region the Spanish do not appear to have settled in the area during the mission period. In the 1820s and 1830s the Mexican government began granting large tracts of land in the area to its citizens, including Ranchos San Pablo, San Ramon, and Pinole. The first permanent non-native settlers were Francisco Castro and his wife Maria Gabriela Berryessa. The Mexican government granted the 18,000 acre Rancho San Pablo to the Castros in 1823.[6] Americans began farming in Contra Costa County in the late 1830s, and by 1882 2/3 of the cultivated land in the county was devoted to wheat production.[7]

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[1] University of California, Berkeley, 2008, p. 200, 202.

[2] University of California, Berkeley, File "Building 152," located in vertical files in Room 148, Richmond Field Station.

[3] University of California, Berkeley, File "Building 152," located in vertical files in Room 148, Richmond Field Station.

[4] Shackleton, 2013.

[5] Mildred B. Hoover, Hero E. Rensch, Ethel G. Rensch, Douglas E. Kyle, *Historic Spots in California, Fourth Edition*, Stanford University Press, Stanford, California: 1958, p. 129.

[6] Donald Bastin, *Images of America: Richmond*, Arcadia Publishing, Charleston SC: 2003, p. 9.

[7] J.P. Munro-Fraser, *History of Contra Costa County, California*, W.A. Slocum & Co., San Francisco: 1882, p. 55 – 57.

Minna C. C. Quilfelt (or Quilfeldt) purchased 600 acres of Rancho San Pablo in 1852 and 1853.[8] Adjacent to San Francisco Bay in what would eventually become the southern portion of the City of Richmond, a wharf and produce warehouse were constructed on the ranch in the 1860s to ship agricultural produce to the San Francisco markets from Rancho San Pablo as well as the Quilfelt ranch. The warehouse and wharf were used to transport cattle, grain, fruit, and in later years the frogs' legs raised by Richard Stege for the San Francisco restaurant market.[9] German native Richard Stege settled on Rancho San Pablo in the late 1860s after stints in the gold fields and the Siberian fur trade. He married Minna Quilfelt, who was a widow, in 1870.[10] Minna Quilfelt Stege died in 1879, leaving the ranch to Stege and her daughter Edith. Stege began selling off portions of his ranch to raise money while continuing his frog-raising and other ventures. A town named Stege formed on Richard Stege's holdings, and by the late nineteenth century several industries, including the California Cap Works, the United States Briquette Company, the Stauffer Chemical Works and the Stege Lumber Manufacturing Company, were operating from portions of the Stege Ranch.[11] Richmond incorporated in 1905, and by 1917 was already the largest city in Contra Costa County.[12] Stege was eventually absorbed into Richmond as the latter grew.

The Explosives Industry in Contra Costa County

Swedish chemist Alfred Nobel laid the foundation for the high-explosives industry with his innovations beginning in 1860s, inventing first a detonator and then a blasting cap. In 1867 he invented dynamite, which was safer, cheaper, and more powerful than nitroglycerine, which had been the most commonly used explosive. Nobel licensed the Giant Powder Company to produce dynamite in California later that year. Giant was the first American company to produce dynamite, and its plant was initially located in Rock House Canyon, in what is today the City of San Francisco. The California Powder Works began manufacturing dynamite in the same area in 1869.[13]

The nineteenth century explosives industry was extremely dangerous, and as San Francisco's population grew explosives manufacturers needed to relocate. Contra Costa County across the bay was attractive since it was accessible due to its proximity to the harbor yet remote from population centers. In addition, the narrow canyons of Contra Costa County, which terminate in small bays, provided a natural geographical defense against explosions by allowing factory design that placed water between different facets of explosives manufacturing.[14]

During the 1870s chemical and explosives manufacturers began opening in the vicinity of what would eventually become Richmond. The Tonite Powder Company, Western Mineral Company, and California Cap Company were established at 1877 on the Stege ranch. The San Francisco explosives companies soon followed those explosive companies across the bay to Contra Costa County. In 1880, Giant relocated to Point Pinole, changing its name to the Atlas Powder Company. The California Powder Works soon followed, building a new factory in Hercules, which was named for the brand under which the company sold its powder.[15] The Vulcan Powder Works and

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[8] Evan Griffins, "Early History of Richmond", December 1938, El Cerrito Historical Society, website: http://www.elcerritowire.com/history/pages/EarlyRichmond.htm, accessed January 2013.

[9] Roland Oliver, "Recollections of Early Industries in Stege", August 7, 1959, p. 1.

[10] J.P. Munro-Fraser, p. 675.

[11] Frederick J. Hulaniski, *The History of Contra Costa County, California*. Elms Publishing Company, Berkeley, California: 1917, p. 354.

[12] Hulanski p. 288.

[13] Ida Mae Purcell, *History of Contra Costa County*, The Gillick Press, Berkeley, California" 1940, p. 645 – 646.

[14] James E. Vance, *Geography and Urban Evolution in the San Francisco Bay Area*, University of California, Berkeley: 1964, p. 27.

[15] Purcell, p. 646.

Judson Powder works also opened in the Stege Ranch area during this era, consolidating Contra Costa County's position as the cradle of the California explosives industry. The East Bay dominated California explosives manufacturing into the twentieth century. In 1902 California had only one powder factory outside Contra Costa and Alameda counties.[16]

William Letts Oliver

William Letts Oliver was born in Chile to English parents in 1844. He attended the University of Edinburgh and became a mining engineer. After returning to Chile, Oliver ran an explosives factory, which was nationalized by the Chilean government in 1864. After the loss of his factory, Oliver left Chile for San Francisco.[17] William Letts Oliver and his wife Carrie lived in Oakland, from about 1880 until Oliver's death in 1918.[18] The couple eventually had six children together: Roland, Edwin, Caroline, Anita, William Harold, and Albert.[19] In addition his various professional activities William Letts Oliver was a yachtsman and an officer of the Bohemian Grove club in the early twentieth century. An avid amateur photographer throughout his lifetime, UC Berkeley's Bancroft Library has a collection of 2700 negatives and prints taken by Oliver and his son.[20]

William Letts Oliver initially gained familiarity with an explosive called guncotton while manufacturing collodion for his photography hobby.[21] As early as 1870, European explosive companies were experimenting with nitrated guncotton in and by 1875 it was manufactured in England under the name "tonite."[22] By 1877 Oliver had left Chile and was mining in the western United States. Engineers working on the Sutro Tunnel in the Comstock needed an explosive that would remain stable at the high temperatures underground to complete the tunnel, and Oliver was able to solve the problem by substituting tonite for more volatile compounds.[23]

The California Cap Company

In 1877 William Letts Oliver was inspired by his success with tonite to leave mining and establish the Tonite Powder Company, on a portion of the former Stege Ranch.[24] In the 1870s all blasting caps in the United States had to be imported from Europe. Not only were they expensive, but the timing of deliveries was uncertain, creating business difficulties for the powder plant. Oliver was determined to create his own caps in order to protect the tonite factory business. He experimented until he came up with a blasting cap that was safer to use and had better detonating qualities than imported detonators. Oliver and his partner Freeborn Fletter founded the California Cap Company. It was located adjacent to the Tonite Powder Company a 160 acre parcel carved out of the southern portion of Stege Ranch.[25] California Cap Company, which went on to operate on the site for nearly

[16] Richmond Record, "Contra Costa County: Under the Vitascope", Richmond:1902.

[17] Pacific Mining News, Supplement to Engineering & Mining Journal-Press, "Industrial Notes: Developing of the Blasting Cap Industry", Vol. 1, No. 7, November 1922, p. 222.

[18] United States Census Bureau, Tenth Census of the United States, 1880, National Archives and Records Administration, Washington, D.C., San Francisco, California, Roll: 79, Film: 1254079, Page: 170B.

[19] United States Census Bureau, Twelfth Census of the United States, 1900, National Archives and Records Administration, Washington, D.C., Oakland Ward 3, Alameda, California, Roll: 82, Page: 13A.

[20] Online Archive of California, "Guide to the Oliver Family Photograph Collection", UC Berkeley: 2009, website: http://www.oac.cdlib.org/findaid/ark:/13030/ft0q2n99r1/ accessed February, 2013.

[21] Pacific Mining News, p. 222.

[22] G.A. Price Cuxson, ed., "Society of Engineers: Transactions for 1889", E. & F. N. Spon, London: 1890, p. 95.

[23] Pacific Mining News, p. 222.

[24] Oliver, p. 1.

[25] Pacific Mining News, p. 222.

seven decades, was the first manufacturer of blasting caps in the United States. Richard Stege, meanwhile, continued to reside on the ranch, and contracted with Tonite Powder and California Cap to transport their products to the railroad.[26] The California Cap Company was located on the parcel that is currently the Richmond Field Station. The Tonite Powder Company appears to have been located to the east on the parcel that became the Stauffer Chemical Company and later the Zeneca site, although its exact location is unclear.

The Tonite and California Cap factories, which were the first of several gunpowder and chemical companies in the region, were separated by the Stege agricultural warehouse for safety.[27] The explosives industry during this era was an extremely dangerous one. A horrific explosion in 1882 at the nearby Vulcan Powder Company caused 11 deaths and destroyed the plant.[28] Between 1882 and 1918 the Hercules and Atlas plants suffered numerous explosions which destroyed plant buildings and killed a total of 64 workers.[29] Despite its focus on safety, the California Cap Company had accidents as well. Two of its Chinese workers were killed in 1917 when one of them dropped a tray of caps. In 1941 an explosion caused a fire and critically injured a worker.[30]

William Letts Oliver continued to innovate throughout his long career in the chemical and explosives industries. In 1888 he formed the American Lucol Company adjacent to the California Cap Company property.[31] The Lucol plant was at what is currently the southeastern corner of the Richmond Field Station, at the approximate location of Building 163. Lucol manufactured a linseed oil substitute.[32] The factory was dismantled and relocated to New Jersey circa 1900.[33] In 1903 the Hotaling Briquette Works opened on Lucol's site at the southeast corner of the current Richmond Field station property.[34] Later known as the U.S. Briquette Company, the plant appears to have operated at this location until at least 1917.[35] The U.S. Briquette Company buildings were demolished sometime in the 1960s.

The Oliver family aggressively promoted their products both through advertising and publishing. The California Cap Company sponsored or published both articles and book-length treatises on the use of explosives. Safety was a key element of the company image, a topic of company-sponsored technical writing as well as a selling point in advertisements.[36] The Tonite Powder Company's product was known even outside the United States, and by the end of the nineteenth century the powder's explosive properties were considered comparable to the finest English products.[37] Oliver's sons Roland and Edwin Letts Oliver both graduated from UC Berkeley's College of Mining in 1900. Roland Oliver seems to have spent his entire career working in the family enterprises, while Edwin worked at California Cap between mining and other ventures. The Oliver family also became benefactors of the

[26] Nilda Rego, "Enterprising Stege lost all and died without a penny", Time Out, March 27, 1994, p. 2, column 4.
[27] Oliver, p. 1.
[28] Munro-Fraser, p. 424.
[29] Purcell, p. 648.
[30] Contra Costa County Standard, "Stege Powder Plant Blast; One Near Death", June 6, 1941, p. 1A.
[31] Oliver, p. 1.
[32] Max Wilhelm Von Bernewitz, *Cyanide Practice, 1910 – 1913*, Dewey Publishing Company: 1913, p. 327.
[33] Oliver, p. 1.
[34] Oliver, p. 2.
[35] Hulanksi, p. 354.
[36] Halbert Powers Gillette, *Rock Excavation:Methods and Cost*, M.C. Clark, New York: 1904, x.
[37] Manual Eissler, *A Handbook on Modern Explosives*, Crosby, Lockwood & son, London: 1897, p. 117.

university, and in 1917 the California Cap Company donated substantial amounts of their products to the College of Mining including 500 electric detonators, 500 delayed action exploders, and 500 blasting caps.[38]

Eventually the Tonite factory appears to have been incorporated into the California Cap Company. The Olivers also formed an entity named Pacific Cartridge Company circa 1910. The Pacific Cartridge Company operated from the California Cap plant during World War I.[39] By 1916 there were at least a dozen buildings on the site. When Oliver died in 1918 his son Roland Oliver took over as president of California Cap Company. By 1922 Roland's brother Leslie Oliver was assistant manager of the plant and Edwin Letts Oliver was a director.[40] Roland Oliver substantially expanded the California Cap Company after he took over as president. During this era the plant grew to include 150 buildings and a horse-drawn tram line.[41]

During the late nineteenth and early twentieth century the California Cap Company was one of the most important local employers.[42] As the twentieth century progressed more heavy industry came to Contra Costa County, and by 1940 the county was second only to Los Angeles in overall industrial production.[43] The nineteenth-century California Cap Company was dwarfed by the scale of some of the newer enterprises, and its physical plant and technology were aging. During World War II California Cap was able to stay open by producing delayed action incendiary bombs that were used against Japan.[44] The California Cap Company could not survive the transition to a peacetime economy, however, and by 1949 the plant was closed and the Oliver family looking for a buyer.

University Research/Richmond Field Station

After World War II UC Berkeley's Engineering Department needed an off-campus location in order to perform experiments that required more space than a laboratory. Department Chair Morrough P. O' Brien and others in the department were performing experiments with sewage, sea water, and other materials unsuited to use on a crowded campus. They also wanted a location that was not too remote. The University purchased the California Cap Company from the Oliver family for the use of the Engineering Department in 1950.[45]

The Richmond Field Station has been the location of a research overseen by numerous UC Berkeley departments over the years. The Sanitary Engineering Research Laboratory (SERL) was one of the first departments to undertake research at the site. SERL focused primarily on sewage treatment technology, and also researched pollution control and disposal of solid and liquid waste.[46] Other early projects at the field station included sea water distillation, heat transfer, and cyclic stress research.[47]

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[38] University of California, *The University of California Chronicle*, University of California Press, January, 1917, p. 92.

[39] R.L. Polk & Company, *Richmond and Contra Costa County Directory, 1914 – 1915*, Oakland, California: 1915.

[40] Pacific Mining News, p.222.

[41] University of California, Berkeley, *Current Conditions Report*, Prepared by Tetra Tech EM Inc., November 21, 2008, p. 11.

[42] Marguerite Clausen, "On the Waterfront: An Oral History of Richmond, California", Regional Oral History Office, University of California, Berkeley, 1990, p. 21.

[43] Purcell, p. 649.

[44] Oliver, p. 1.

[45] P.H. McGauhey, "The Sanitary Engineering Research Laboratory: Administration, Research and Consultation, 1950-1975 – An Interview Conducted by Malca Call", Regional Oral History Office, University of California, Berkeley, 1974, p. 70.

[46] University of California, Berkeley, 2008, p. 13.

[47] University of California, Berkeley, Department of Engineering, "Richmond Field Station Open House", May 28, 1952, p. 3 – 4.

At first the Department of Engineering utilized the buildings left behind by the California Cap Company. The Department established a machine shop, computer shop, receiving facility, mail service, and other facilities in addition to laboratories in the old detonator company buildings.[48] The current Buildings 102, 110, 118, 128, 150, 152 175, and 176 all date to the cap company era and have been repurposed for the Richmond Field Station. They also constructed new buildings as funds became available, and by the mid-1950s five new buildings had been completed at the Richmond Field Station.[49] By the 1970s the department had conducted many experiments at the Richmond Field Station that could not have been performed on the main campus.

Evaluation

The following provides an evaluation of Building 152 under each NRHP/CRHR criteria.

No particular association was found between the Building 152 and events significant to national, state, or local history (Criterion A/1). Although the California Cap Company was the first blasting cap manufacturer in the United States there is no indication that the activities that took place in Building 152 were central to the development of the plant or its technical processes. In addition, the building has been used for a variety of purposes throughout its lifetime. Therefore the building is not eligible for inclusion in the NRHP/CRHR for historical significance

Although William Letts Oliver and his son Roland Oliver were significant in the history of the explosives industry, no particular association was found between the Oliver family and the building. Therefore it lacks the strength of association necessary to be considered historically significant in relation to any particular persons (Criterion B/2).

The building does not embody the distinctive characteristics of a type, period, region, or method of construction, or represent the work of an important creative individual or possess high artistic values (Criterion C/3). Building 152 is a vernacular building of a type that was commonly constructed from the late nineteenth to the early twentieth century. Therefore the building is not eligible to the NHRP for its architecture.

In rare instances, buildings themselves can serve as sources of important information, however this building is not a principal source of important information in this regard (Criterion D/4).

[48] McGauhey, p. 71.

[49] University of California, Berkeley, Department of Engineering, "Guide for Engineering Field Station Inspection", undated, p. 3.

State of California – The Resources Agency
DEPARTMENT OF PARKS AND RECREATION

PRIMARY RECORD

Primary # _____
HRI # _____
Trinomial _____
NRHP Status Code _____
Other Listings _____
Review Code _____ Reviewer _____ Date _____

 ***Resource Name or #** (Assigned by recorder) Richmond Field Station Building 153

P1. Other Identifier: Richmond Field Station Building 153

***P2. Location:** ☐ **Not for Publication** ☒ **Unrestricted** ***a. County** Contra Costa
and (P2b and P2c or P2d. Attach a Location Map as necessary.)
***b. USGS 7.5′ Quad** Richmond **Date** 1984 **T**___; **R** ___; __ ¼ **of Sec** ___; Diablo **B.M.**
c. Address _____ City _____ Zip _____
d. UTM: (give more than one for large and/or linear resources) Zone 10 ; 409938 mE/ 4397486 mN
e. Other Locational Data: (e.g., parcel #, directions to resource, elevation, etc., as appropriate)

***P3a. Description:** (Describe resource and its major elements. Include design, materials, condition, alterations, size, setting, and boundaries)
Building 153 is in the southern portion of the Richmond Field Station. It is on the south side of Lark Drive adjacent to Building 152, with its primary façade facing northeast. The vernacular building does not strongly express any particular architecture style. It is single story and rectangular in plan, 2,731 square feet, and was constructed in 1959. (See Continuation Sheet)

***P3b. Resource Attributes:** (List attributes and codes) HP15: Educational building; HP39: Other

***P4. Resources Present:** ☒ Building ☐ Structure ☐ Object ☐ Site ☐ District ☐ Element of District ☐ Other (Isolates, etc.)

P5b. Description of Photo: (View, date, accession #) Photograph 1: Southeast and northeast facades of building, camera facing southwest, January 4, 2013.

***P6. Date Constructed/Age and Sources:**
☒ Historic ☐ Prehistoric ☐ Both
1959/UC Berkeley records

***P7. Owner and Address:**
U.C. Berkeley
1301 South 46th Street
Richmond, California 94804

***P8. Recorded by:** (Name, affiliation, address)
Kara Brunzell & Julia Mates
Tetra Tech
1999 Harrison Street, Ste 500
Oakland, CA 94612

***P9. Date Recorded:** January 4, 2013

***P10. Survey Type:** (Describe) Intensive

***P11. Report Citation:** (Cite survey report and other sources, or enter "none.") *Historic Properties Survey Report for Portions of the Richmond Field Station* prepared by Tetra Tech, Inc, 2013.

***Attachments:** NONE ☒ Location Map ☐ Sketch Map ☒ Continuation Sheet ☒ Building, Structure, and Object Record ☐ Archaeological Record ☐ District Record ☐ Linear Feature Record ☐ Milling Station Record ☐ Rock Art Record ☐ Artifact Record ☐ Photograph Record ☐ Other (list) _____

***NRHP Status Code** 6Z

***Resource Name or #** (Assigned by recorder) Richmond Field Station Building 153

B1. Historic Name: _____

B2. Common Name: Building 153

B3. Original Use: Shop B4. Present Use: Shop

***B5. Architectural Style:** Vernacular

***B6. Construction History:** (Construction date, alteration, and date of alterations) Constructed in 1956

***B7. Moved?** ☒ **No** ☐ **Yes** ☐ **Unknown** **Date:** _____ **Original Location:** _____

***B8. Related Features:** _____

B9. Architect: Unknown b. Builder: Unknown

***B10. Significance: Theme** N/A **Area** N/A

Period of Significance N/A **Property Type** N/A **Applicable Criteria** N/A

(Discuss importance in terms of historical or architectural context as defined by theme, period, and geographic scope. Also address integrity.)

Building 153 at Richmond Field Station does not appear to meet the criteria for listing in the National Register of Historic Places (NRHP). Furthermore, the building has been evaluated in accordance with Section 15064.5(a)(2)-(3) of the CEQA Guidelines, using the criteria outlined in Section 5024.1 of the California Public Resources Code, and does not appear to meet the significance criteria as outlined in these guidelines. Therefore, the building is not eligible for listing in the California Register of Historical Resources (CRHR). (See Continuation Sheet.)

B11. Additional Resource Attributes: (List attributes and codes)

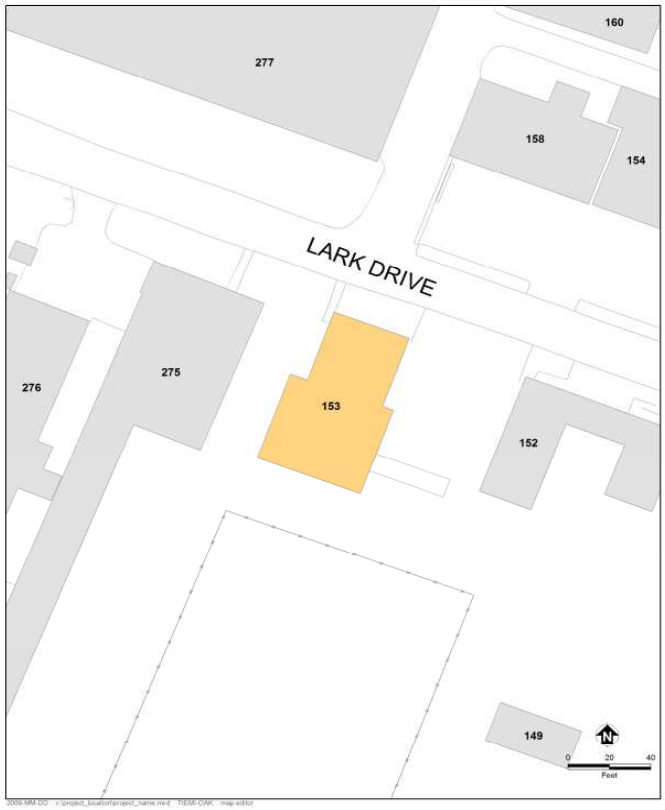
***B12. References:** See Footnotes

B13. Remarks:

***B14. Evaluator:** Kara Brunzell

***Date of Evaluation:** January 2013

(This space reserved for official comments.)



P3a. Description (continued)

The front section of the building is flat roofed. The walls are covered in stucco, and fenestration is multi-light fixed sashes. The northeast elevation lacks fenestration, but has two entry doors and two large swinging double doors. All doors are wood paneled with windows. A rear addition to the building is topped with both a flat roof and a shed roof section. An entrance at the rear of the southeast elevation is a large sliding door.

Building 153 was constructed by UC Berkeley in 1959. It was used as a modeling shop and for salt water research.[1] The Naval Architecture Department used the building for ship design over the years.[2] In 1958 the department of Nuclear Engineering was looking for space for gamma-shielding experiments, and may have moved into Building 153 for a time.[3] Aerial photography indicates that the addition at the rear (southeast) of the building was constructed in approximately 1975. It is currently used as a research facility and a shop.

B10. Significance (continued)

Historic Context

Europeans arrived in what would become Contra Costa County in 1772, when a Spanish expedition led by Pedro Fages discovered the San Pablo Bay and the confluence of the Sacramento and San Joaquin rivers.[4] Though subsequent Spanish expeditions passed through the region the Spanish do not appear to have settled in the area during the mission period. In the 1820s and 1830s the Mexican government began granting large tracts of land in the area to its citizens, including Ranchos San Pablo, San Ramon, and Pinole. The first permanent non-native settlers were Francisco Castro and his wife Maria Gabriela Berryessa. The Mexican government granted the 18,000 acre Rancho San Pablo to the Castros in 1823.[5] Americans began farming in Contra Costa County in the late 1830s, and by 1882 2/3 of the cultivated land in the county was devoted to wheat production.[6]

Minna C. C. Quilfelt (or Quilfeldt) purchased 600 acres of Rancho San Pablo in 1852 and 1853.[7] Adjacent to San Francisco Bay in what would eventually become the southern portion of the City of Richmond, a wharf and produce warehouse were constructed on the ranch in the 1860s to ship agricultural produce to the San Francisco markets from Rancho San Pablo as well as the Quilfelt ranch. The warehouse and wharf were used to transport cattle, grain, fruit, and in later years the frogs' legs raised by Richard Stege for the San Francisco restaurant market.[8] German native Richard Stege settled on Rancho San Pablo in the late 1860s after stints in the gold fields and the Siberian fur trade. He married Minna Quilfelt, who was a widow, in 1870.[9] Minna Quilfelt Stege died in 1879, leaving the ranch to Stege and her daughter Edith. Stege began selling off portions of his ranch to raise money while continuing his frog-raising and other ventures. A town named Stege formed on Richard Stege's holdings, and by the late nineteenth century several industries, including the California Cap Works, the United

[1] University of California, Berkeley, 2008, p. 196.
[2] Shackleton, 2013.
[3] University of California, Berkeley, File "Building 153," located in vertical files in Room 148, Richmond Field Station.
[4] Mildred B. Hoover, Hero E. Rensch, Ethel G. Rensch, Douglas E. Kyle, *Historic Spots in California, Fourth Edition*, Stanford University Press, Stanford, California: 1958, p. 129.
[5] Donald Bastin, *Images of America: Richmond*, Arcadia Publishing, Charleston SC: 2003, p. 9.
[6] J.P. Munro-Fraser, *History of Contra Costa County, California*, W.A. Slocum & Co., San Francisco: 1882, p. 55 – 57.
[7] Evan Griffins, "Early History of Richmond", December 1938, El Cerrito Historical Society, website: http://www.elcerritowire.com/history/pages/EarlyRichmond.htm, accessed January 2013.
[8] Roland Oliver, "Recollections of Early Industries in Stege", August 7, 1959, p. 1.
[9] J.P. Munro-Fraser, p. 675.

States Briquette Company, the Stauffer Chemical Works and the Stege Lumber Manufacturing Company, were operating from portions of the Stege Ranch.[10] Richmond incorporated in 1905, and by 1917 was already the largest city in Contra Costa County.[11] Stege was eventually absorbed into Richmond as the latter grew.

The Explosives Industry in Contra Costa County

Swedish chemist Alfred Nobel laid the foundation for the high-explosives industry with his innovations beginning in 1860s, inventing first a detonator and then a blasting cap. In 1867 he invented dynamite, which was safer, cheaper, and more powerful than nitroglycerine, which had been the most commonly used explosive. Nobel licensed the Giant Powder Company to produce dynamite in California later that year. Giant was the first American company to produce dynamite, and its plant was initially located in Rock House Canyon, in what is today the City of San Francisco. The California Powder Works began manufacturing dynamite in the same area in 1869.[12]

The nineteenth century explosives industry was extremely dangerous, and as San Francisco's population grew explosives manufacturers needed to relocate. Contra Costa County across the bay was attractive since it was accessible due to its proximity to the harbor yet remote from population centers. In addition, the narrow canyons of Contra Costa County, which terminate in small bays, provided a natural geographical defense against explosions by allowing factory design that placed water between different facets of explosives manufacturing.[13]

During the 1870s chemical and explosives manufacturers began opening in the vicinity of what would eventually become Richmond. The Tonite Powder Company, Western Mineral Company, and California Cap Company were established at 1877 on the Stege ranch. The San Francisco explosives companies soon followed those explosive companies across the bay to Contra Costa County. In 1880, Giant relocated to Point Pinole, changing its name to the Atlas Powder Company. The California Powder Works soon followed, building a new factory in Hercules, which was named for the brand under which the company sold its powder.[14] The Vulcan Powder Works and Judson Powder works also opened in the Stege Ranch area during this era, consolidating Contra Costa County's position as the cradle of the California explosives industry. The East Bay dominated California explosives manufacturing into the twentieth century. In 1902 California had only one powder factory outside Contra Costa and Alameda counties.[15]

William Letts Oliver

William Letts Oliver was born in Chile to English parents in 1844. He attended the University of Edinburgh and became a mining engineer. After returning to Chile, Oliver ran an explosives factory, which was nationalized by the Chilean government in 1864. After the loss of his factory, Oliver left Chile for San Francisco.[16] William Letts

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[10] Frederick J. Hulaniski, *The History of Contra Costa County, California*. Elms Publishing Company, Berkeley, California: 1917, p. 354.

[11] Hulanski p. 288.

[12] Ida Mae Purcell, *History of Contra Costa County*, The Gillick Press, Berkeley, California" 1940, p. 645 – 646.

[13] James E. Vance, *Geography and Urban Evolution in the San Francisco Bay Area*, University of California, Berkeley: 1964, p. 27.

[14] Purcell, p. 646.

[15] Richmond Record, "Contra Costa County: Under the Vitascope", Richmond:1902.

[16] Pacific Mining News, Supplement to Engineering & Mining Journal-Press, "Industrial Notes: Developing of the Blasting Cap Industry", Vol. 1, No. 7, November 1922, p. 222.

Oliver and his wife Carrie lived in Oakland, from about 1880 until Oliver's death in 1918.[17] The couple eventually had six children together: Roland, Edwin, Caroline, Anita, William Harold, and Albert.[18] In addition his various professional activities William Letts Oliver was a yachtsman and an officer of the Bohemian Grove club in the early twentieth century. An avid amateur photographer throughout his lifetime, UC Berkeley's Bancroft Library has a collection of 2700 negatives and prints taken by Oliver and his son.[19]

William Letts Oliver initially gained familiarity with an explosive called guncotton while manufacturing collodion for his photography hobby.[20] As early as 1870, European explosive companies were experimenting with nitrated guncotton in and by 1875 it was manufactured in England under the name "tonite."[21] By 1877 Oliver had left Chile and was mining in the western United States. Engineers working on the Sutro Tunnel in the Comstock needed an explosive that would remain stable at the high temperatures underground to complete the tunnel, and Oliver was able to solve the problem by substituting tonite for more volatile compounds.[22]

The California Cap Company

In 1877 William Letts Oliver was inspired by his success with tonite to leave mining and establish the Tonite Powder Company, on a portion of the former Stege Ranch.[23] In the 1870s all blasting caps in the United States had to be imported from Europe. Not only were they expensive, but the timing of deliveries was uncertain, creating business difficulties for the powder plant. Oliver was determined to create his own caps in order to protect the tonite factory business. He experimented until he came up with a blasting cap that was safer to use and had better detonating qualities than imported detonators. Oliver and his partner Freeborn Fletter founded the California Cap Company. It was located adjacent to the Tonite Powder Company a 160 acre parcel carved out of the southern portion of Stege Ranch.[24] California Cap Company, which went on to operate on the site for nearly seven decades, was the first manufacturer of blasting caps in the United States. Richard Stege, meanwhile, continued to reside on the ranch, and contracted with Tonite Powder and California Cap to transport their products to the railroad.[25] The California Cap Company was located on the parcel that is currently the Richmond Field Station. The Tonite Powder Company appears to have been located to the east on the parcel that became the Stauffer Chemical Company and later the Zeneca site, although its exact location is unclear.

The Tonite and California Cap factories, which were the first of several gunpowder and chemical companies in the region, were separated by the Stege agricultural warehouse for safety.[26] The explosives industry during this era was an extremely dangerous one. A horrific explosion in 1882 at the nearby Vulcan Powder Company caused 11

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[17] United States Census Bureau, Tenth Census of the United States, 1880, National Archives and Records Administration, Washington, D.C., San Francisco, California, Roll: 79, Film: 1254079, Page: 170B.

[18] United States Census Bureau, Twelfth Census of the United States, 1900, National Archives and Records Administration, Washington, D.C., Oakland Ward 3, Alameda, California, Roll: 82, Page: 13A.

[19] Online Archive of California, "Guide to the Oliver Family Photograph Collection", UC Berkeley: 2009, website: http://www.oac.cdlib.org/findaid/ark:/13030/ft0q2n99r1/ accessed February, 2013.

[20] Pacific Mining News, p. 222.

[21] G.A. Price Cuxson, ed., "Society of Engineers: Transactions for 1889", E. & F. N. Spon, London: 1890, p. 95.

[22] Pacific Mining News, p. 222.

[23] Oliver, p. 1.

[24] Pacific Mining News, p. 222.

[25] Nilda Rego, "Enterprising Stege lost all and died without a penny", Time Out, March 27, 1994, p. 2, column 4.

[26] Oliver, p. 1.

deaths and destroyed the plant.[27] Between 1882 and 1918 the Hercules and Atlas plants suffered numerous explosions which destroyed plant buildings and killed a total of 64 workers.[28] Despite its focus on safety, the California Cap Company had accidents as well. Two of its Chinese workers were killed in 1917 when one of them dropped a tray of caps. In 1941 an explosion caused a fire and critically injured a worker.[29]

William Letts Oliver continued to innovate throughout his long career in the chemical and explosives industries. In 1888 he formed the American Lucol Company adjacent to the California Cap Company property.[30] The Lucol plant was at what is currently the southeastern corner of the Richmond Field Station, at the approximate location of Building 163. Lucol manufactured a linseed oil substitute.[31] The factory was dismantled and relocated to New Jersey circa 1900.[32] In 1903 the Hotaling Briquette Works opened on Lucol's site at the southeast corner of the current Richmond Field station property.[33] Later known as the U.S. Briquette Company, the plant appears to have operated at this location until at least 1917.[34] The U.S. Briquette Company buildings were demolished sometime in the 1960s.

The Oliver family aggressively promoted their products both through advertising and publishing. The California Cap Company sponsored or published both articles and book-length treatises on the use of explosives. Safety was a key element of the company image, a topic of company-sponsored technical writing as well as a selling point in advertisements.[35] The Tonite Powder Company's product was known even outside the United States, and by the end of the nineteenth century the powder's explosive properties were considered comparable to the finest English products.[36] Oliver's sons Roland and Edwin Letts Oliver both graduated from UC Berkeley's College of Mining in 1900. Roland Oliver seems to have spent his entire career working in the family enterprises, while Edwin worked at California Cap between mining and other ventures. The Oliver family also became benefactors of the university, and in 1917 the California Cap Company donated substantial amounts of their products to the College of Mining including 500 electric detonators, 500 delayed action exploders, and 500 blasting caps.[37]

Eventually the Tonite factory appears to have been incorporated into the California Cap Company. The Olivers also formed an entity named Pacific Cartridge Company circa 1910. The Pacific Cartridge Company operated from the California Cap plant during World War I.[38] By 1916 there were at least a dozen buildings on the site. When Oliver died in 1918 his son Roland Oliver took over as president of California Cap Company. By 1922 Roland's brother Leslie Oliver was assistant manager of the plant and Edwin Letts Oliver was a director.[39] Roland

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[27] Munro-Fraser, p. 424.
[28] Purcell, p. 648.
[29] Contra Costa County Standard, "Stege Powder Plant Blast; One Near Death", June 6, 1941, p. 1A.
[30] Oliver, p. 1.
[31] Max Wilhelm Von Bernewitz, *Cyanide Practice, 1910 – 1913*, Dewey Publishing Company: 1913, p. 327.
[32] Oliver, p. 1.
[33] Oliver, p. 2.
[34] Hulanksi, p. 354.
[35] Halbert Powers Gillette, *Rock Excavation:Methods and Cost*, M.C. Clark, New York: 1904, x.
[36] Manual Eissler, *A Handbook on Modern Explosives*, Crosby, Lockwood & son, London: 1897, p. 117.
[37] University of California, *The University of California Chronicle*, University of California Press, January, 1917, p. 92.
[38] R.L. Polk & Company, *Richmond and Contra Costa County Directory, 1914 – 1915*, Oakland, California: 1915.
[39] Pacific Mining News, p.222.

Oliver substantially expanded the California Cap Company after he took over as president. During this era the plant grew to include 150 buildings and a horse-drawn tram line.[40]

During the late nineteenth and early twentieth century the California Cap Company was one of the most important local employers.[41] As the twentieth century progressed more heavy industry came to Contra Costa County, and by 1940 the county was second only to Los Angeles in overall industrial production.[42] The nineteenth-century California Cap Company was dwarfed by the scale of some of the newer enterprises, and its physical plant and technology were aging. During World War II California Cap was able to stay open by producing delayed action incendiary bombs that were used against Japan.[43] The California Cap Company could not survive the transition to a peacetime economy, however, and by 1949 the plant was closed and the Oliver family looking for a buyer.

University Research/Richmond Field Station

After World War II UC Berkeley's Engineering Department needed an off-campus location in order to perform experiments that required more space than a laboratory. Department Chair Morrough P. O' Brien and others in the department were performing experiments with sewage, sea water, and other materials unsuited to use on a crowded campus. They also wanted a location that was not too remote. The University purchased the California Cap Company from the Oliver family for the use of the Engineering Department in 1950.[44]

The Richmond Field Station has been the location of a research overseen by numerous UC Berkeley departments over the years. The Sanitary Engineering Research Laboratory (SERL) was one of the first departments to undertake research at the site. SERL focused primarily on sewage treatment technology, and also researched pollution control and disposal of solid and liquid waste.[45] Other early projects at the field station included sea water distillation, heat transfer, and cyclic stress research.[46]

At first the Department of Engineering utilized the buildings left behind by the California Cap Company. The Department established a machine shop, computer shop, receiving facility, mail service, and other facilities in addition to laboratories in the old detonator company buildings.[47] The current Buildings 102, 110, 118, 128, 150, 152 175, and 176 all date to the cap company era and have been repurposed for the Richmond Field Station. They also constructed new buildings as funds became available, and by the mid-1950s five new buildings had been completed at the Richmond Field Station.[48] By the 1970s the department had conducted many experiments at the Richmond Field Station that could not have been performed on the main campus.

The following provides an evaluation of Building 153 under each NRHP/CRHR criteria.

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[40] University of California, Berkeley, *Current Conditions Report,* Prepared by Tetra Tech EM Inc., November 21, 2008, p. 11.

[41] Marguerite Clausen, "On the Waterfront: An Oral History of Richmond, California", Regional Oral History Office, University of California, Berkeley, 1990, p. 21.

[42] Purcell, p. 649.

[43] Oliver, p. 1.

[44] P.H. McGauhey, "The Sanitary Engineering Research Laboratory: Administration, Research and Consultation, 1950-1975 – An Interview Conducted by Malca Call", Regional Oral History Office, University of California, Berkeley, 1974, p. 70.

[45] University of California, Berkeley, 2008, p. 13.

[46] University of California, Berkeley, Department of Engineering, "Richmond Field Station Open House", May 28, 1952, p. 3 – 4.

[47] McGauhey, p. 71.

[48] University of California, Berkeley, Department of Engineering, "Guide for Engineering Field Station Inspection", undated, p. 3.

Building 153 does not appear to meet the criteria for listing in NRHP/CRHR because it lacks historical significance. The structure has been used for a variety of purposes throughout its lifetime and as such lacks the strength of association necessary to be considered historically significant in relation to any particular events or persons (Criteria A/1 and B/2).

The utilitarian building lacks any identifiable architectural stylistic design and does not embody distinctive architectural or engineering qualities of type, period, or method of construction (Criterion C/3). In rare instances, buildings themselves can serve as sources of important information, however this building is not a principal source of important information in this regard (Criterion D/4).

State of California – The Resources Agency
DEPARTMENT OF PARKS AND RECREATION
PRIMARY RECORD

Primary # _____
HRI # _____
Trinomial _____
NRHP Status Code _____
Other Listings _____
Review Code _____ Reviewer _____ Date _____

 ***Resource Name or #** (Assigned by recorder) Richmond Field Station Building 163

P1. Other Identifier: Richmond Field Station Building 163

***P2. Location:** ☐ **Not for Publication** ☒ **Unrestricted** ***a. County** Contra Costa
and (P2b and P2c or P2d. Attach a Location Map as necessary.)
***b. USGS 7.5′ Quad** Richmond **Date** 1984 **T**___; **R** ___; __ ¼ **of Sec** ___; Diablo **B.M.**
c. Address _____ City _____ Zip _____
d. UTM: (give more than one for large and/or linear resources) Zone 10 ; 558560 mE/ 4196300 mN
e. Other Locational Data: (e.g., parcel #, directions to resource, elevation, etc., as appropriate)

***P3a. Description:** (Describe resource and its major elements. Include design, materials, condition, alterations, size, setting, and boundaries)
Building 163 is at the southeastern edge of the Richmond Field Station. The primary façades of this L-shaped building face northwest and southwest. The vernacular building does not strongly express any particular architecture style. It is single story and 6,430 square feet. The building was constructed prior to 1940.
Both wings of the building have front gabled roofs covered with composition shingles. The walls are clad in horizontal wood siding; a portion of the walls is covered with stucco. Fenestration is aluminum replacement sashes. The primary entrance is a paneled, southeast-facing, wood door. It is accessed by a concrete ramp. Other entrances are centered in each gable end and are flush wood doors. (See Continuation Sheet)
***P3b. Resource Attributes:** (List attributes and codes) HP15: Educational building; HP39: Other

***P4. Resources Present:** ☒ Building ☐ Structure ☐ Object ☐ Site ☐ District ☐ Element of District ☐ Other (Isolates, etc.)

P5b. Description of Photo: (View, date, accession #) Photograph 1: Northwest and southwest facades of building, camera facing northeast, January 4, 2013.

***P6. Date Constructed/Age and Sources:**
☒ Historic ☐ Prehistoric ☐ Both
1996/UC Berkeley records

***P7. Owner and Address:**
U.C. Berkeley
1301 South 46th Street
Richmond, California 94804

***P8. Recorded by:** (Name, affiliation, address)
Kara Brunzell & Julia Mates
Tetra Tech
1999 Harrison Street, Ste 500
Oakland, CA 94612

***P9. Date Recorded:** January 4, 2013
***P10. Survey Type:** (Describe) Intensive

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***NRHP Status Code** 6Z

***Resource Name or #** (Assigned by recorder) Richmond Field Station Building 163

B1. Historic Name: _____

B2. Common Name: Building 163

B3. Original Use: Research/offices B4. Present Use: Research/offices

***B5. Architectural Style:** Vernacular

***B6. Construction History:** (Construction date, alteration, and date of alterations) Constructed in 1996

***B7. Moved?** ☐ No ☒ Yes ☐ Unknown **Date:** 1996 **Original Location:** A portion of Building 165

***B8. Related Features:** _____

B9. Architect: Unknown b. Builder: Unknown

***B10. Significance: Theme** N/A **Area** N/A

Period of Significance N/A **Property Type** N/A **Applicable Criteria** N/A

(Discuss importance in terms of historical or architectural context as defined by theme, period, and geographic scope. Also address integrity.)

Building 163 at Richmond Field Station does not appear to meet the criteria for listing in the National Register of Historic Places (NRHP). Furthermore, the building has been evaluated in accordance with Section 15064.5(a)(2)-(3) of the CEQA Guidelines, using the criteria outlined in Section 5024.1 of the California Public Resources Code, and does not appear to meet the significance criteria as outlined in these guidelines. Therefore, the building is not eligible for listing in the California Register of Historical Resources (CRHR). (See Continuation Sheet.)

B11. Additional Resource Attributes: (List attributes and codes)

***B12. References:** See Footnotes

B13. Remarks:

***B14. Evaluator:** Kara Brunzell

***Date of Evaluation:** January 2013

(This space reserved for official comments.)

P3a. Description (continued)

The northwest entrance is accessed by concrete steps. The southwest entrance is accessed by a set of wooden steps and sheltered by a shed roof over the entry. There is a similar entrance on the rear (southeast) elevation.

Building 163 was created when Building 165 and another building were moved and another addition added to it to create Building 163 at this location in 1996. The two buildings that were moved to form Building 163 was a California Cap Company building originally constructed circa 1930. They were connected with a new section at the corner of the "L" to create Building 1963. Its site overlaps with the footprint of the U.S. Briquette Company plant and William Letts Oliver's American Lucol Company. Aerial photographs indicate that the U.S. Briquette buildings were demolished circa the 1960s after UC Berkeley took over the site. Ergonomic studies, seeking to prevent chronic disorders of the upper extremities, have been done in the building since the 1990s.[1] Building 163 continues to be used as a research facility, and houses offices.

B10. Significance (continued)

Historic Context

Europeans arrived in what would become Contra Costa County in 1772, when a Spanish expedition led by Pedro Fages discovered the San Pablo Bay and the confluence of the Sacramento and San Joaquin rivers.[2] Though subsequent Spanish expeditions passed through the region the Spanish do not appear to have settled in the area during the mission period. In the 1820s and 1830s the Mexican government began granting large tracts of land in the area to its citizens, including Ranchos San Pablo, San Ramon, and Pinole. The first permanent non-native settlers were Francisco Castro and his wife Maria Gabriela Berryessa. The Mexican government granted the 18,000 acre Rancho San Pablo to the Castros in 1823.[3] Americans began farming in Contra Costa County in the late 1830s, and by 1882 2/3 of the cultivated land in the county was devoted to wheat production.[4]

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[1] Shackleton, 2013.

[2] Mildred B. Hoover, Hero E. Rensch, Ethel G. Rensch, Douglas E. Kyle, *Historic Spots in California, Fourth Edition*, Stanford University Press, Stanford, California: 1958, p. 129.

[3] Donald Bastin, *Images of America: Richmond*, Arcadia Publishing, Charleston SC: 2003, p. 9.

[4] J.P. Munro-Fraser, *History of Contra Costa County, California*, W.A. Slocum & Co., San Francisco: 1882, p. 55 – 57.

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[6] Roland Oliver, "Recollections of Early Industries in Stege", August 7, 1959, p. 1.

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[8] Frederick J. Hulaniski, *The History of Contra Costa County, California*. Elms Publishing Company, Berkeley, California: 1917, p. 354.

[9] Hulanski p. 288.

[10] Ida Mae Purcell, *History of Contra Costa County*, The Gillick Press, Berkeley, California" 1940, p. 645 – 646.

[11] James E. Vance, *Geography and Urban Evolution in the San Francisco Bay Area*, University of California, Berkeley: 1964, p. 27.

[12] Purcell, p. 646.

[13] Richmond Record, "Contra Costa County: Under the Vitascope", Richmond:1902.

[14] Pacific Mining News, Supplement to Engineering & Mining Journal-Press, "Industrial Notes: Developing of the Blasting Cap Industry", Vol. 1, No. 7, November 1922, p. 222.

[15] United States Census Bureau, Tenth Census of the United States, 1880, National Archives and Records Administration, Washington, D.C., San Francisco, California, Roll: 79, Film: 1254079, Page: 170B.

had six children together: Roland, Edwin, Caroline, Anita, William Harold, and Albert.[16] In addition his various professional activities William Letts Oliver was a yachtsman and an officer of the Bohemian Grove club in the early twentieth century. An avid amateur photographer throughout his lifetime, UC Berkeley's Bancroft Library has a collection of 2700 negatives and prints taken by Oliver and his son.[17]

William Letts Oliver initially gained familiarity with an explosive called guncotton while manufacturing collodion for his photography hobby.[18] As early as 1870, European explosive companies were experimenting with nitrated guncotton in and by 1875 it was manufactured in England under the name "tonite."[19] By 1877 Oliver had left Chile and was mining in the western United States. Engineers working on the Sutro Tunnel in the Comstock needed an explosive that would remain stable at the high temperatures underground to complete the tunnel, and Oliver was able to solve the problem by substituting tonite for more volatile compounds.[20]

The California Cap Company

In 1877 William Letts Oliver was inspired by his success with tonite to leave mining and establish the Tonite Powder Company, on a portion of the former Stege Ranch.[21] In the 1870s all blasting caps in the United States had to be imported from Europe. Not only were they expensive, but the timing of deliveries was uncertain, creating business difficulties for the powder plant. Oliver was determined to create his own caps in order to protect the tonite factory business. He experimented until he came up with a blasting cap that was safer to use and had better detonating qualities than imported detonators. Oliver and his partner Freeborn Fletter founded the California Cap Company. It was located adjacent to the Tonite Powder Company a 160 acre parcel carved out of the southern portion of Stege Ranch.[22] California Cap Company, which went on to operate on the site for nearly seven decades, was the first manufacturer of blasting caps in the United States. Richard Stege, meanwhile, continued to reside on the ranch, and contracted with Tonite Powder and California Cap to transport their products to the railroad.[23] The California Cap Company was located on the parcel that is currently the Richmond Field Station. The Tonite Powder Company appears to have been located to the east on the parcel that became the Stauffer Chemical Company and later the Zeneca site, although its exact location is unclear.

The Tonite and California Cap factories, which were the first of several gunpowder and chemical companies in the region, were separated by the Stege agricultural warehouse for safety.[24] The explosives industry during this era was an extremely dangerous one. A horrific explosion in 1882 at the nearby Vulcan Powder Company caused 11 deaths and destroyed the plant.[25] Between 1882 and 1918 the Hercules and Atlas plants suffered numerous

[16] United States Census Bureau, Twelfth Census of the United States, 1900, National Archives and Records Administration, Washington, D.C., Oakland Ward 3, Alameda, California, Roll: 82, Page: 13A.

[17] Online Archive of California, "Guide to the Oliver Family Photograph Collection", UC Berkeley: 2009, website: http://www.oac.cdlib.org/findaid/ark:/13030/ft0q2n99r1/ accessed February, 2013.

[18] Pacific Mining News, p. 222.

[19] G.A. Price Cuxson, ed., "Society of Engineers: Transactions for 1889", E. & F. N. Spon, London: 1890, p. 95.

[20] Pacific Mining News, p. 222.

[21] Oliver, p. 1.

[22] Pacific Mining News, p. 222.

[23] Nilda Rego, "Enterprising Stege lost all and died without a penny", Time Out, March 27, 1994, p. 2, column 4.

[24] Oliver, p. 1.

[25] Munro-Fraser, p. 424.

explosions which destroyed plant buildings and killed a total of 64 workers.[26] Despite its focus on safety, the California Cap Company had accidents as well. Two of its Chinese workers were killed in 1917 when one of them dropped a tray of caps. In 1941 an explosion caused a fire and critically injured a worker.[27]

William Letts Oliver continued to innovate throughout his long career in the chemical and explosives industries. In 1888 he formed the American Lucol Company adjacent to the California Cap Company property.[28] The Lucol plant was at what is currently the southeastern corner of the Richmond Field Station, at the approximate location of Building 163. Lucol manufactured a linseed oil substitute.[29] The factory was dismantled and relocated to New Jersey circa 1900.[30] In 1903 the Hotaling Briquette Works opened on Lucol's site at the southeast corner of the current Richmond Field station property.[31] Later known as the U.S. Briquette Company, the plant appears to have operated at this location until at least 1917.[32] The U.S. Briquette Company buildings were demolished sometime in the 1960s.

The Oliver family aggressively promoted their products both through advertising and publishing. The California Cap Company sponsored or published both articles and book-length treatises on the use of explosives. Safety was a key element of the company image, a topic of company-sponsored technical writing as well as a selling point in advertisements.[33] The Tonite Powder Company's product was known even outside the United States, and by the end of the nineteenth century the powder's explosive properties were considered comparable to the finest English products.[34] Oliver's sons Roland and Edwin Letts Oliver both graduated from UC Berkeley's College of Mining in 1900. Roland Oliver seems to have spent his entire career working in the family enterprises, while Edwin worked at California Cap between mining and other ventures. The Oliver family also became benefactors of the university, and in 1917 the California Cap Company donated substantial amounts of their products to the College of Mining including 500 electric detonators, 500 delayed action exploders, and 500 blasting caps.[35]

Eventually the Tonite factory appears to have been incorporated into the California Cap Company. The Olivers also formed an entity named Pacific Cartridge Company circa 1910. The Pacific Cartridge Company operated from the California Cap plant during World War I.[36] By 1916 there were at least a dozen buildings on the site. When Oliver died in 1918 his son Roland Oliver took over as president of California Cap Company. By 1922 Roland's brother Leslie Oliver was assistant manager of the plant and Edwin Letts Oliver was a director.[37] Roland Oliver substantially expanded the California Cap Company after he took over as president. During this era the plant grew to include 150 buildings and a horse-drawn tram line.[38]

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[26] Purcell, p. 648.
[27] Contra Costa County Standard, "Stege Powder Plant Blast; One Near Death", June 6, 1941, p. 1A.
[28] Oliver, p. 1.
[29] Max Wilhelm Von Bernewitz, *Cyanide Practice, 1910 – 1913*, Dewey Publishing Company: 1913, p. 327.
[30] Oliver, p. 1.
[31] Oliver, p. 2.
[32] Hulanksi, p. 354.
[33] Halbert Powers Gillette, *Rock Excavation:Methods and Cost*, M.C. Clark, New York: 1904, x.
[34] Manual Eissler, *A Handbook on Modern Explosives*, Crosby, Lockwood & son, London: 1897, p. 117.
[35] University of California, *The University of California Chronicle*, University of California Press, January, 1917, p. 92.
[36] R.L. Polk & Company, *Richmond and Contra Costa County Directory, 1914 – 1915*, Oakland, California: 1915.
[37] Pacific Mining News, p.222.
[38] University of California, Berkeley, *Current Conditions Report*, Prepared by Tetra Tech EM Inc., November 21, 2008, p. 11.

During the late nineteenth and early twentieth century the California Cap Company was one of the most important local employers.[39] As the twentieth century progressed more heavy industry came to Contra Costa County, and by 1940 the county was second only to Los Angeles in overall industrial production.[40] The nineteenth-century California Cap Company was dwarfed by the scale of some of the newer enterprises, and its physical plant and technology were aging. During World War II California Cap was able to stay open by producing delayed action incendiary bombs that were used against Japan.[41] The California Cap Company could not survive the transition to a peacetime economy, however, and by 1949 the plant was closed and the Oliver family looking for a buyer.

University Research/Richmond Field Station

After World War II UC Berkeley's Engineering Department needed an off-campus location in order to perform experiments that required more space than a laboratory. Department Chair Morrough P. O' Brien and others in the department were performing experiments with sewage, sea water, and other materials unsuited to use on a crowded campus. They also wanted a location that was not too remote. The University purchased the California Cap Company from the Oliver family for the use of the Engineering Department in 1950.[42]

The Richmond Field Station has been the location of a research overseen by numerous UC Berkeley departments over the years. The Sanitary Engineering Research Laboratory (SERL) was one of the first departments to undertake research at the site. SERL focused primarily on sewage treatment technology, and also researched pollution control and disposal of solid and liquid waste.[43] Other early projects at the field station included sea water distillation, heat transfer, and cyclic stress research.[44]

At first the Department of Engineering utilized the buildings left behind by the California Cap Company. The Department established a machine shop, computer shop, receiving facility, mail service, and other facilities in addition to laboratories in the old detonator company buildings.[45] The current Buildings 102, 110, 118, 128, 150, 152 175, and 176 all date to the cap company era and have been repurposed for the Richmond Field Station. They also constructed new buildings as funds became available, and by the mid-1950s five new buildings had been completed at the Richmond Field Station.[46] By the 1970s the department had conducted many experiments at the Richmond Field Station that could not have been performed on the main campus.

Evaluation

The following provides an evaluation of Building 163 under each NRHP/CRHR criteria.

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[39] Marguerite Clausen, "On the Waterfront: An Oral History of Richmond, California", Regional Oral History Office, University of California, Berkeley, 1990, p. 21.

[40] Purcell, p. 649.

[41] Oliver, p. 1.

[42] P.H. McGauhey, "The Sanitary Engineering Research Laboratory: Administration, Research and Consultation, 1950-1975 – An Interview Conducted by Malca Call", Regional Oral History Office, University of California, Berkeley, 1974, p. 70.

[43] University of California, Berkeley, 2008, p. 13.

[44] University of California, Berkeley, Department of Engineering, "Richmond Field Station Open House", May 28, 1952, p. 3 – 4.

[45] McGauhey, p. 71.

[46] University of California, Berkeley, Department of Engineering, "Guide for Engineering Field Station Inspection", undated, p. 3.

Building 163 does not appear to meet the criteria for listing in National Register of Historic Places because it lacks historical significance. The structure has been used for research throughout its lifetime and as such lacks the strength of association necessary to be considered historically significant in relation to any particular events or persons (Criteria A/1 and B/2).

The utilitarian building lacks any identifiable architectural stylistic design and does not embody distinctive architectural or engineering qualities of type, period, or method of construction (Criterion C/3) The building has been moved from its original location as part of two other buildings. In rare instances, buildings themselves can serve as sources of important information, however this building is not a principal source of important information in this regard (Criterion D/4).

As a research facility Building 163 does not meet the standard of exceptional importance required for properties under 50 years old to be eligible to the NHRP (Criterion G).

State of California – The Resources Agency
DEPARTMENT OF PARKS AND RECREATION
PRIMARY RECORD

Primary # _____
HRI # _____
Trinomial _____
NRHP Status Code _____
Other Listings _____
Review Code _____ Reviewer _____ Date _____

 ***Resource Name or #** (Assigned by recorder) Richmond Field Station Building 175

P1. Other Identifier: Richmond Field Station Building 175

***P2. Location:** ☐ **Not for Publication** ☒ **Unrestricted** ***a. County** Contra Costa
and (P2b and P2c or P2d. Attach a Location Map as necessary.)
***b. USGS 7.5′ Quad** Richmond **Date** 1984 **T**___; **R** ____; __ ¼ **of Sec** ___; Diablo **B.M.**
c. Address _____ City _____ Zip _____
d. UTM: (give more than one for large and/or linear resources) Zone 10 ; 558547 mE/ 4196474 mN
e. Other Locational Data: (e.g., parcel #, directions to resource, elevation, etc., as appropriate)

***P3a. Description:** (Describe resource and its major elements. Include design, materials, condition, alterations, size, setting, and boundaries)
Building 175 is in the southern portion of the Richmond Field Station at the intersection of Lark Drive and Egret Way. Its primary façade faces northeast, along Lark Drive. It is 16,502 square feet and was constructed in approximately 1910. The building is single story and rectangular in plan, with additions to the rear (southwest) side. The building is topped with a shallow, pitched-side, gabled roof with shallow eaves and exposed, shaped-wood rafter tails and purlins. (See Continuation Sheet)

***P3b. Resource Attributes:** (List attributes and codes) HP15: Educational building; HP4: Other

***P4. Resources Present:** ☒ Building ☐ Structure ☐ Object ☐ Site ☐ District ☐ Element of District ☐ Other (Isolates, etc.)

P5b. Description of Photo: (View, date, accession #) Photograph 1: Southeast and northeast facades of building, camera facing southwest, January 4, 2013

***P6. Date Constructed/Age and Sources:**
☒ Historic ☐ Prehistoric ☐ Both
Circa 1910/Sanborn maps

***P7. Owner and Address:**
U.C. Berkeley
1301 South 46th Street
Richmond, California 94804

***P8. Recorded by:** (Name, affiliation, address)
Kara Brunzell & Julia Mates
Tetra Tech
1999 Harrison Street, Ste 500
Oakland, CA 94612

***P9. Date Recorded:** January 4, 2013

***P10. Survey Type:** (Describe) Intensive

***P11. Report Citation:** (Cite survey report and other sources, or enter "none".) *Historic Properties Survey Report for Portions of the Richmond Field Station* prepared by Tetra Tech, Inc, 2013.

***Attachments:** NONE ☒ Location Map ☐ Sketch Map ☒ Continuation Sheet ☒ Building, Structure, and Object Record ☐ Archaeological Record ☐ District Record ☐ Linear Feature Record ☐ Milling Station Record ☐ Rock Art Record ☐ Artifact Record ☐ Photograph Record ☐ Other (list) _____

***NRHP Status Code** B3

***Resource Name or #** (Assigned by recorder) Richmond Field Station Building 175

B1. Historic Name: California Cap Company Building 75 & Building 76

B2. Common Name: Building 175

B3. Original Use: Manufacturing/office B4. Present Use: Shop/office

***B5. Architectural Style:** Vernacular

***B6. Construction History:** (Construction date, alteration, and date of alterations) Constructed circa 1910 for California Cap Company; rear addition constructed circa 1950s; wood sash windows replaced 1969

***B7. Moved?** ☒ **No** ☐ **Yes** ☐ **Unknown** **Date:** _____ **Original Location:** _____

***B8. Related Features:** _____

B9. Architect: Unknown b. Builder: Unknown

***B10. Significance: Theme** History **Area** Richmond Field Station

Period of Significance 1910 - 1949 **Property Type** industrial **Applicable Criteria** A

(Discuss importance in terms of historical or architectural context as defined by theme, period, and geographic scope. Also address integrity.)

Building 175 at Richmond Field Station appears to meet the criteria for listing in the National Register of Historic Places (NRHP). Furthermore, the building has been evaluated in accordance with Section 15064.5(a)(2)-(3) of the CEQA Guidelines, using the criteria outlined in Section 5024.1 of the California Public Resources Code, and appears to meet the significance criteria as outlined in these guidelines. Therefore, the building is eligible for listing in the California Register of Historical Resources (CRHR). (See Continuation Sheet)

B11. Additional Resource Attributes: (List attributes and codes)

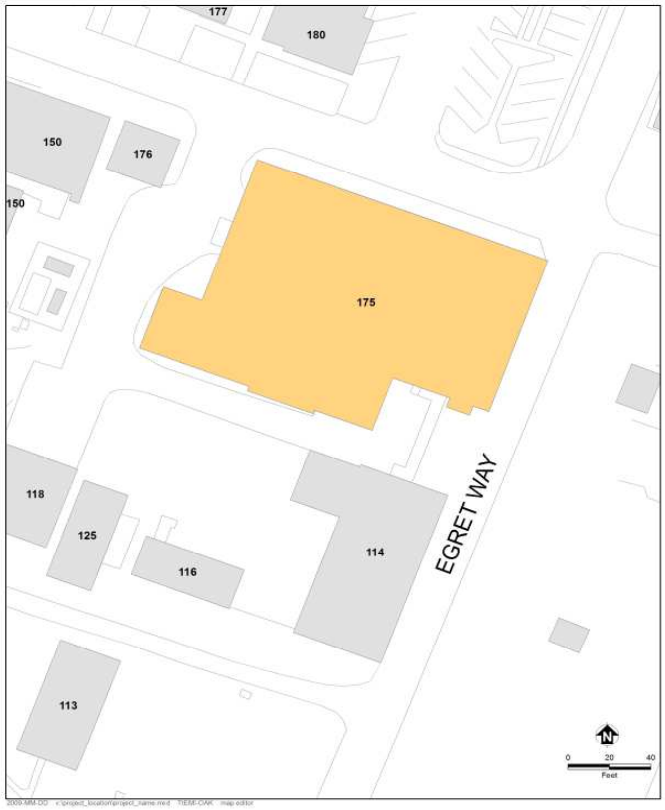
***B12. References:** See Footnotes and Continuation Sheet

B13. Remarks:

***B14. Evaluator:** Kara Brunzell

***Date of Evaluation:** January 2013

(This space reserved for official comments.)



P3a. Description (continued)

Many of the building's original features remain, and the building continues to convey its original use as a shop with its, walls sided in board formed concrete, and low, open configuration. Fenestration is aluminum replacement windows and small aluminum sliding sashes. The east door has been replaced with a modern glass door.

Photograph 2: Building 175, January 4, 2013, camera facing south

A large, projecting, two-story addition at the southwestern end of the building is topped with a shed roof, its walls are clad in corrugated metal. Fenestration is both multiple pane fixed windows and vinyl replacement windows. A shed roof covers an open area at the center of the rear elevation adjacent to the corrugated addition. Double paneled wood doors with windows are at the center of the façade. A raised concrete ramp leads to these doors.
Historic maps and documents show that the building that is now Building 175 was constructed in 1910, when the California Cap Company and Pacific Cartridge Company were operating simultaneously. When in use for the Pacific Cartridge Company, Building 175 was numbered both "Building 75" and "Building 76" and was the primary production facility for Pacific Cartridge. The building appears to have been used as a cartridge loading facility during the early years, where powder was loaded into shells.[1] It also housed a small office, a vault, and cleaning and annealing rooms.[2] (Metal cartridges were strengthened through heat treating, or annealing.) Both the Pacific Cartridge Company and the California Cap Company were administered from the office in Building 175 (Photograph 3 and 4). By 1916 the company was producing cartridge shells in the building, but no longer loading

[1] Sanborn Map, Stege, 1912.
[2] Sanborn Map, Stege, 1912.

powder there.[3] Pacific Cartridge Company was absorbed by the California Cap Company circa 1920. The 1949 Sanborn map shows the same uses for the Building 175 but lists only California Cap on the property.[4]

Photograph 3: Building 175, circa 1910, from Bancroft Library's Oliver Family Photograph Collection, labeled "Exterior California Cap Company office, California"

[3] Sanborn Map, Richmond, 1916.
[4] Sanborn Map, Richmond, 1949.

Photograph 4: Building 175, circa 1910, from Bancroft Library's Oliver Family Photograph Collection, labeled "Pacific Cartridge Co. Exterior – Stege, Calif."

After UC Berkeley purchased the property in 1950, this building continued to house an office and hazardous chemical storage area.[5] Building 175 was the Richmond Field Station's primary facility for maintenance and administration.[6] During the early 1950s the Department of Engineering's machine shop was also in Building 175, fabricating experimental equipment for research. By 1952 a new high-speed wind tunnel for research was being assembled in the building.[7] The University made piecemeal additions to the rear (southwest) of the building beginning in the 1950s. By 1966 Building 175 reached its current footprint and housed machine, carpenter, and welding shops, and an office.[8] The University removed the original wood frame windows and replaced them with aluminum sashes in 1969.[9] The building continued to be considered important, as indicated by a 1977 letter arguing for "one of the most important buildings at the Station and if it were lost the program impact could be catastrophic, inasmuch that the Station operations would most likely come to a halt."[10] It continued to house maintenance operations until approximately 2008 when, in spite of the building's former importance, it was left vacant. It remained vacant until 2012 when the UC Bindery moved into the building.[11]

[5] University of California, Berkeley, 2008, p. 197
[6] University of California, Berkeley, 2008, p. 20.
[7] University of California, Berkeley, Department of Engineering, "Richmond Field Station Open House," May 28, 1952, p. 3.
[8] Sanborn Map, Richmond, 1966.
[9] University of California, Berkeley, File "Building 175," located in vertical files in Room 148, Richmond Field Station.
[10] University of California, Berkeley, File "Building 175," located in vertical files in Room 148, Richmond Field Station.
[11] Shackleton, 2013.

B10. Significance (continued)

Historic Contexts

Europeans arrived in what would become Contra Costa County in 1772, when a Spanish expedition led by Pedro Fages discovered the San Pablo Bay and the confluence of the Sacramento and San Joaquin rivers.[12] Though subsequent Spanish expeditions passed through the region the Spanish do not appear to have settled in the area during the mission period. In the 1820s and 1830s the Mexican government began granting large tracts of land in the area to its citizens, including Ranchos San Pablo, San Ramon, and Pinole. The first permanent non-native settlers were Francisco Castro and his wife Maria Gabriela Berryessa. The Mexican government granted the 18,000 acre Rancho San Pablo to the Castros in 1823.[13] Americans began farming in Contra Costa County in the late 1830s, and by 1882 2/3 of the cultivated land in the county was devoted to wheat production.[14]

Minna C. C. Quilfelt (or Quilfeldt) purchased 600 acres of Rancho San Pablo in 1852 and 1853.[15] Adjacent to San Francisco Bay in what would eventually become the southern portion of the City of Richmond, a wharf and produce warehouse were constructed on the ranch in the 1860s to ship agricultural produce to the San Francisco markets from Rancho San Pablo as well as the Quilfelt ranch. The warehouse and wharf were used to transport cattle, grain, fruit, and in later years the frogs' legs raised by Richard Stege for the San Francisco restaurant market.[16] German native Richard Stege settled on Rancho San Pablo in the late 1860s after stints in the gold fields and the Siberian fur trade. He married Minna Quilfelt, who was a widow, in 1870.[17] Minna Quilfelt Stege died in 1879, leaving the ranch to Stege and her daughter Edith. Stege began selling off portions of his ranch to raise money while continuing his frog-raising and other ventures. A town named Stege formed on Richard Stege's holdings, and by the late nineteenth century several industries, including the California Cap Works, the United States Briquette Company, the Stauffer Chemical Works and the Stege Lumber Manufacturing Company, were operating from portions of the Stege Ranch.[18] Richmond incorporated in 1905, and by 1917 was already the largest city in Contra Costa County.[19] Stege was eventually absorbed into Richmond as the latter grew.

The Explosives Industry in Contra Costa County

Swedish chemist Alfred Nobel laid the foundation for the high-explosives industry with his innovations beginning in 1860s, inventing first a detonator and then a blasting cap. In 1867 he invented dynamite, which was safer, cheaper, and more powerful than nitroglycerine, which had been the most commonly used explosive. Nobel licensed the Giant Powder Company to produce dynamite in California later that year. Giant was the first American company to produce dynamite, and its plant was initially located in Rock House Canyon, in what is today the City of San Francisco. The California Powder Works began manufacturing dynamite in the same area in 1869.[20]

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[12] Mildred B. Hoover, Hero E. Rensch, Ethel G. Rensch, Douglas E. Kyle, *Historic Spots in California, Fourth Edition*, Stanford University Press, Stanford, California: 1958, p. 129.

[13] Donald Bastin, *Images of America: Richmond*, Arcadia Publishing, Charleston SC: 2003, p. 9.

[14] J.P. Munro-Fraser, *History of Contra Costa County, California*, W.A. Slocum & Co., San Francisco: 1882, p. 55 – 57.

[15] Evan Griffins, "Early History of Richmond", December 1938, El Cerrito Historical Society, website: http://www.elcerritowire.com/history/pages/EarlyRichmond.htm, accessed January 2013.

[16] Roland Oliver, "Recollections of Early Industries in Stege", August 7, 1959, p. 1.

[17] J.P. Munro-Fraser, p. 675.

[18] Frederick J. Hulaniski, *The History of Contra Costa County, California*. Elms Publishing Company, Berkeley, California: 1917, p. 354.

[19] Hulanski p. 288.

[20] Ida Mae Purcell, *History of Contra Costa County*, The Gillick Press, Berkeley, California" 1940, p. 645 – 646.

The nineteenth century explosives industry was extremely dangerous, and as San Francisco's population grew explosives manufacturers needed to relocate. Contra Costa County across the bay was attractive since it was accessible due to its proximity to the harbor yet remote from population centers. In addition, the narrow canyons of Contra Costa County, which terminate in small bays, provided a natural geographical defense against explosions by allowing factory design that placed water between different facets of explosives manufacturing.[21]

During the 1870s chemical and explosives manufacturers began opening in the vicinity of what would eventually become Richmond. The Tonite Powder Company, Western Mineral Company, and California Cap Company were established at 1877 on the Stege ranch. The San Francisco explosives companies soon followed those explosive companies across the bay to Contra Costa County. In 1880, Giant relocated to Point Pinole, changing its name to the Atlas Powder Company. The California Powder Works soon followed, building a new factory in Hercules, which was named for the brand under which the company sold its powder.[22] The Vulcan Powder Works and Judson Powder works also opened in the Stege Ranch area during this era, consolidating Contra Costa County's position as the cradle of the California explosives industry. The East Bay dominated California explosives manufacturing into the twentieth century. In 1902 California had only one powder factory outside Contra Costa and Alameda counties.[23]

William Letts Oliver

William Letts Oliver was born in Chile to English parents in 1844. He attended the University of Edinburgh and became a mining engineer. After returning to Chile, Oliver ran an explosives factory, which was nationalized by the Chilean government in 1864. After the loss of his factory, Oliver left Chile for San Francisco.[24] William Letts Oliver and his wife Carrie lived in Oakland, from about 1880 until Oliver's death in 1918.[25] The couple eventually had six children together: Roland, Edwin, Caroline, Anita, William Harold, and Albert.[26] In addition his various professional activities William Letts Oliver was a yachtsman and an officer of the Bohemian Grove club in the early twentieth century. An avid amateur photographer throughout his lifetime, UC Berkeley's Bancroft Library has a collection of 2700 negatives and prints taken by Oliver and his son.[27]

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[21] James E. Vance, *Geography and Urban Evolution in the San Francisco Bay Area,* University of California, Berkeley: 1964, p. 27.

[22] Purcell, p. 646.

[23] Richmond Record, "Contra Costa County: Under the Vitascope", Richmond:1902.

[24] Pacific Mining News, Supplement to Engineering & Mining Journal-Press, "Industrial Notes: Developing of the Blasting Cap Industry", Vol. 1, No. 7, November 1922, p. 222.

[25] United States Census Bureau, Tenth Census of the United States, 1880, National Archives and Records Administration, Washington, D.C., San Francisco, California, Roll: 79, Film: 1254079, Page: 170B.

[26] United States Census Bureau, Twelfth Census of the United States, 1900, National Archives and Records Administration, Washington, D.C., Oakland Ward 3, Alameda, California, Roll: 82, Page: 13A.

[27] Online Archive of California, "Guide to the Oliver Family Photograph Collection", UC Berkeley: 2009, website: http://www.oac.cdlib.org/findaid/ark:/13030/ft0q2n99r1/ accessed February, 2013.

[28] Pacific Mining News, p. 222.

[29] G.A. Price Cuxson, ed., "Society of Engineers: Transactions for 1889", E. & F. N. Spon, London: 1890, p. 95.

needed an explosive that would remain stable at the high temperatures underground to complete the tunnel, and Oliver was able to solve the problem by substituting tonite for more volatile compounds.[30]

The California Cap Company

In 1877 William Letts Oliver was inspired by his success with tonite to leave mining and establish the Tonite Powder Company, on a portion of the former Stege Ranch.[31] In the 1870s all blasting caps in the United States had to be imported from Europe. Not only were they expensive, but the timing of deliveries was uncertain, creating business difficulties for the powder plant. Oliver was determined to create his own caps in order to protect the tonite factory business. He experimented until he came up with a blasting cap that was safer to use and had better detonating qualities than imported detonators. Oliver and his partner Freeborn Fletter founded the California Cap Company. It was located adjacent to the Tonite Powder Company a 160 acre parcel carved out of the southern portion of Stege Ranch.[32] California Cap Company, which went on to operate on the site for nearly seven decades, was the first manufacturer of blasting caps in the United States. Richard Stege, meanwhile, continued to reside on the ranch, and contracted with Tonite Powder and California Cap to transport their products to the railroad.[33] The California Cap Company was located on the parcel that is currently the Richmond Field Station. The Tonite Powder Company appears to have been located to the east on the parcel that became the Stauffer Chemical Company and later the Zeneca site, although its exact location is unclear.

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[30] Pacific Mining News, p. 222.
[31] Oliver, p. 1.
[32] Pacific Mining News, p. 222.
[33] Nilda Rego, "Enterprising Stege lost all and died without a penny", Time Out, March 27, 1994, p. 2, column 4.
[34] Oliver, p. 1.
[35] Munro-Fraser, p. 424.
[36] Purcell, p. 648.
[37] Contra Costa County Standard, "Stege Powder Plant Blast; One Near Death", June 6, 1941, p. 1A.
[38] Oliver, p. 1.
[39] Max Wilhelm Von Bernewitz, *Cyanide Practice, 1910 – 1913*, Dewey Publishing Company: 1913, p. 327.
[40] Oliver, p. 1.
[41] Oliver, p. 2.

operated at this location until at least 1917.[42] The U.S. Briquette Company buildings were demolished sometime in the 1960s.

The Oliver family aggressively promoted their products both through advertising and publishing. The California Cap Company sponsored or published both articles and book-length treatises on the use of explosives. Safety was a key element of the company image, a topic of company-sponsored technical writing as well as a selling point in advertisements.[43] The Tonite Powder Company's product was known even outside the United States, and by the end of the nineteenth century the powder's explosive properties were considered comparable to the finest English products.[44] Oliver's sons Roland and Edwin Letts Oliver both graduated from UC Berkeley's College of Mining in 1900. Roland Oliver seems to have spent his entire career working in the family enterprises, while Edwin worked at California Cap between mining and other ventures. The Oliver family also became benefactors of the university, and in 1917 the California Cap Company donated substantial amounts of their products to the College of Mining including 500 electric detonators, 500 delayed action exploders, and 500 blasting caps.[45]

Eventually the Tonite factory appears to have been incorporated into the California Cap Company. The Olivers also formed an entity named Pacific Cartridge Company circa 1910. The Pacific Cartridge Company operated from the California Cap plant during World War I.[46] By 1916 there were at least a dozen buildings on the site. When Oliver died in 1918 his son Roland Oliver took over as president of California Cap Company. By 1922 Roland's brother Leslie Oliver was assistant manager of the plant and Edwin Letts Oliver was a director.[47] Roland Oliver substantially expanded the California Cap Company after he took over as president. During this era the plant grew to include 150 buildings and a horse-drawn tram line.[48]

During the late nineteenth and early twentieth century the California Cap Company was one of the most important local employers.[49] As the twentieth century progressed more heavy industry came to Contra Costa County, and by 1940 the county was second only to Los Angeles in overall industrial production.[50] The nineteenth-century California Cap Company was dwarfed by the scale of some of the newer enterprises, and its physical plant and technology were aging. During World War II California Cap was able to stay open by producing delayed action incendiary bombs that were used against Japan.[51] The California Cap Company could not survive the transition to a peacetime economy, however, and by 1949 the plant was closed and the Oliver family looking for a buyer.

University Research/Richmond Field Station

After World War II UC Berkeley's Engineering Department needed an off-campus location in order to perform experiments that required more space than a laboratory. Department Chair Morrough P. O' Brien and others in the

[42] Hulanksi, p. 354.
[43] Halbert Powers Gillette, *Rock Excavation:Methods and Cost,* M.C. Clark, New York: 1904, x.
[44] Manual Eissler, *A Handbook on Modern Explosives,* Crosby, Lockwood & son, London: 1897, p. 117.
[45] University of California, *The University of California Chronicle,* University of California Press, January, 1917, p. 92.
[46] R.L. Polk & Company, *Richmond and Contra Costa County Directory, 1914 – 1915*, Oakland, California: 1915.
[47] Pacific Mining News, p.222.
[48] University of California, Berkeley, *Current Conditions Report,* Prepared by Tetra Tech EM Inc., November 21, 2008, p. 11.
[49] Marguerite Clausen, "On the Waterfront: An Oral History of Richmond, California", Regional Oral History Office, University of California, Berkeley, 1990, p. 21.
[50] Purcell, p. 649.
[51] Oliver, p. 1.

department were performing experiments with sewage, sea water, and other materials unsuited to use on a crowded campus. They also wanted a location that was not too remote. The University purchased the California Cap Company from the Oliver family for the use of the Engineering Department in 1950.[52]

The Richmond Field Station has been the location of a research overseen by numerous UC Berkeley departments over the years. The Sanitary Engineering Research Laboratory (SERL) was one of the first departments to undertake research at the site. SERL focused primarily on sewage treatment technology, and also researched pollution control and disposal of solid and liquid waste.[53] Other early projects at the field station included sea water distillation, heat transfer, and cyclic stress research.[54]

At first the Department of Engineering utilized the buildings left behind by the California Cap Company. The Department established a machine shop, computer shop, receiving facility, mail service, and other facilities in addition to laboratories in the old detonator company buildings.[55] The current Buildings 102, 110, 118, 128, 150, 152 175, and 176 all date to the cap company era and have been repurposed for the Richmond Field Station. They also constructed new buildings as funds became available, and by the mid-1950s five new buildings had been completed at the Richmond Field Station.[56] By the 1970s the department had conducted many experiments at the Richmond Field Station that could not have been performed on the main campus.

Evaluation

The following provides an evaluation of Building 175 under each NRHP and CRHR criteria. The property's period of significance is from 1910, when it was constructed, until it ceased to be used for the California Cap Company, in 1949.

Criterion A/1: Building 175 appears to be eligible for listing in the NHRP/CRHR under Criterion A/1 because it is associated with the early explosives industry in the United States, as it was part of the first blasting cap company in the United States. The California Cap company was also the oldest blasting manufacturer in the East Bay area. Blasting caps, or detonators, were an important safety innovation, invented only a few years before California Cap was opened.[57] Several other explosives factories were opened in Contra Costa County after the Tonite Powder and California Cap companies, and from the 1880s into the twentieth century the East Bay produced most of the explosives products in California. High-explosive powder and blasting caps were essential to mining, road-building, and other economically important activities in California. These factories also produced munitions that were used during wartime.

The manufacturing activities in Building 175, specifically cartridge loading and cartridge production, were central to the production processes of the Pacific Cartridge Company and the California Cap Company. Building 175 was one of the plant's primary manufacturing buildings in the 1910s. In addition, the company was administered from

[52] P.H. McGauhey, "The Sanitary Engineering Research Laboratory: Administration, Research and Consultation, 1950-1975 – An Interview Conducted by Malca Call", Regional Oral History Office, University of California, Berkeley, 1974, p. 70.

[53] University of California, Berkeley, 2008, p. 13.

[54] University of California, Berkeley, Department of Engineering, "Richmond Field Station Open House", May 28, 1952, p. 3 – 4.

[55] McGauhey, p. 71.

[56] University of California, Berkeley, Department of Engineering, "Guide for Engineering Field Station Inspection", undated, p. 3.

[57] A detonator is a small explosive charge that ignites a larger charge, allowing for the use of a more stable and thus safer type of explosive.

the office in the building. The building is at what was the geographical center of the plant between circa 1900 and 1940s, and is featured in historic photographs as the Pacific Cartridge and the California Cap Companies' primary building.

Criterion B/2: Although William Letts Oliver and his son Roland Oliver were significant in the history of the explosives industry, no particular association was found between the Oliver family, the architect or builder, or any person associated with the building, so it lacks the strength of association necessary to be considered historically significant in relation to any particular persons under Criterion B/2.

Criterion C/3: The building does not embody the distinctive characteristics of a type, period, region, or method of construction, or represent the work of an important creative individual or possess high artistic values (Criterion C). Building 175 is an industrial building with little ornamentation, so it is not eligible to the NHRP/CRHR under this criterion.

Criterion D/4: In rare instances, buildings themselves can serve as sources of important information, but this building is not a principal source of important information in this regard.

Eligibility for listing on either the NRHP rests on significance and integrity. A property must have both factors to be considered eligible. Loss of integrity, if sufficiently great, would overwhelm the historical significance of a resource and render it ineligible. Integrity of a historic resource is measured by applying seven factors: location, design, setting, workmanship, materials, feeling, and association. Building 175 retains a sufficient level of integrity in all measures. Although the building has undergone alterations, including the additional square footage constructed at the rear of the building and the replacement of the original wood frame sashes, these alterations have not compromised the historic integrity of the building and Building 175, which continues to convey the its significance as a California Cap Company administration building.

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University of California, Berkeley.
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--------"Draft Environmental Impact Report, Proposed U.S. Environmental Protection Agency, Region IX Laboratory at the University of California's Richmond Field Station". Prepared by University of California, Berkeley Planning, Design and Construction Department. July 1991.
---------Building files. Vertical files, Room 148. Richmond Field Station.

University of California, Berkeley, Department of Engineering.
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Von Bernewitz, Max Wilhelm. *Cyanide Practice, 1910 – 1913.* Dewey Publishing Company: 1913. through 2002.

Photographs:

Photograph 2: Building 175, January 4, 2013, looking south

Photograph 3: Building 175, circa 1910, from Bancroft Library's Oliver Family Photograph Collection, labeled "Exterior California Cap Company office, California"

Photograph 4: Building 175, circa 1910, from Bancroft Library's Oliver Family Photograph Collection, labeled "Pacific Cartridge Co. Exterior – Stege, Calif."

Photograph 5: Workers outside Building 175 circa 1914,
Contra Costa County Historical Society collection

Photograph 6: Workers inside Building 175 circa 1914,
Contra Costa County Historical Society collection

State of California – The Resources Agency
DEPARTMENT OF PARKS AND RECREATION

PRIMARY RECORD

Primary # _____
HRI # _____
Trinomial _____
NRHP Status Code _____
Other Listings _____
Review Code _____ Reviewer _____ Date _____

*Resource Name or # (Assigned by recorder) Richmond Field Station Building 176

P1. Other Identifier: Richmond Field Station Building 176

*P2. Location: ☐ Not for Publication ☒ Unrestricted *a. County Contra Costa
and (P2b and P2c or P2d. Attach a Location Map as necessary.)
*b. USGS 7.5′ Quad Richmond Date 1984 T___; R ____; __ ¼ of Sec ___; _Diablo____ B.M.
c. Address _____ City _____ Zip_____
d. UTM: (give more than one for large and/or linear resources) Zone 10 ; 558516 mE/ 4196491 mN
e. Other Locational Data: (e.g., parcel #, directions to resource, elevation, etc., as appropriate)

*P3a. Description: (Describe resource and its major elements. Include design, materials, condition, alterations, size, setting, and boundaries)
Building 176 is in the southern portion of the Richmond Field Station between Building 175 and Building 150. Its primary façade faces northeast, along Lark Drive. The vernacular building does not strongly express any particular architecture style. It is single story and square in plan, 672 square feet, and was constructed prior to 1940.

*P3b. Resource Attributes: (List attributes and codes) HP4: Ancillary Building

*P4. Resources Present: ☒ Building ☐ Structure ☐ Object ☐ Site ☐ District ☐ Element of District ☐ Other (Isolates, etc.)

P5b. Description of Photo: (View, date, accession #) Photograph 1: Northwest and northeast facades of building, camera facing south, January 4, 2013.

*P6. Date Constructed/Age and Sources:
☒ Historic ☐ Prehistoric ☐ Both
Circa 1930/UC Berkeley records

*P7. Owner and Address:
U.C. Berkeley
1301 South 46th Street
Richmond, California 94804

*P8. Recorded by: (Name, affiliation, address)
Kara Brunzell & Julia Mates
Tetra Tech
1999 Harrison Street, Ste 500
Oakland, CA 94612

*P9. Date Recorded: January 4, 2013

*P10. Survey Type: (Describe) Intensive

*P11. Report Citation: (Cite survey report and other sources, or enter "none.") *Historic Properties Survey Report for Portions of the Richmond Field Station* prepared by Tetra Tech, Inc, 2013.

*Attachments: NONE ☒ Location Map ☐ Sketch Map ☒ Continuation Sheet ☒ Building, Structure, and Object Record ☐ Archaeological Record ☐ District Record ☐ Linear Feature Record ☐ Milling Station Record ☐ Rock Art Record ☐ Artifact Record ☐ Photograph Record ☐ Other (list) _____

***NRHP Status Code** 6Z

***Resource Name or #** (Assigned by recorder) Richmond Field Station Building 176

B1. Historic Name: California Cap Company Building 73
B2. Common Name: Building 176
B3. Original Use: Unknown B4. Present Use: Research
***B5. Architectural Style:** Vernacular
***B6. Construction History:** (Construction date, alteration, and date of alterations) Constructed circa 1930s
***B7. Moved?** ☒ **No** ☐ **Yes** ☐ **Unknown** **Date:** _____ **Original Location:** _____
***B8. Related Features:** _____
B9. Architect: Unknown b. Builder: Unknown
***B10. Significance: Theme** N/A **Area** N/A
Period of Significance N/A **Property Type** N/A **Applicable Criteria** N/A
(Discuss importance in terms of historical or architectural context as defined by theme, period, and geographic scope. Also address integrity.)

Building 176 at Richmond Field Station does not appear to meet the criteria for listing in the National Register of Historic Places (NRHP). Furthermore, the building has been evaluated in accordance with Section 15064.5(a)(2)-(3) of the CEQA Guidelines, using the criteria outlined in Section 5024.1 of the California Public Resources Code, and does not appear to meet the significance criteria as outlined in these guidelines. Therefore, the building is not eligible for listing in the California Register of Historical Resources (CRHR). (See Continuation Sheet.)

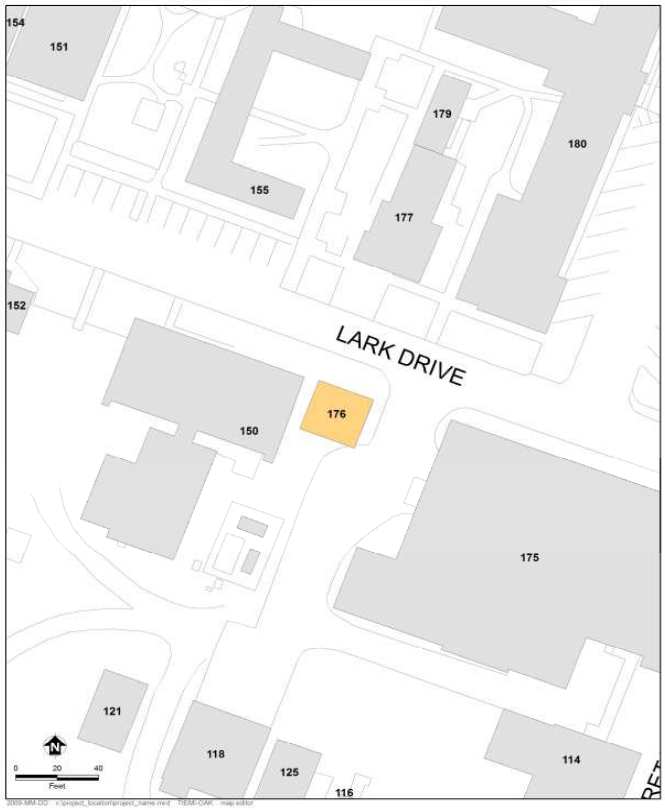
B11. Additional Resource Attributes: (List attributes and codes)

***B12. References:** See Footnotes
B13. Remarks:

***B14. Evaluator:** Kara Brunzell

***Date of Evaluation:** January 2013

(This space reserved for official comments.)



P3a. Description (continued)

The building is topped with a front gabled roof, with a large vent on the gable ridge. The building's walls are reinforced concrete covered in stucco. The building lacks fenestration. Its only opening is a flush metal door with a small window on the primary (northeast) elevation, accessed by a sloping concrete walkway that leads from the street.

The California Cap Company constructed Building 176 circa the 1930s. It was originally referred to as "Building 73," and was used by the plant as a warehouse. After UC Berkeley purchased the property in 1950 it continued to use the building for storage. Although the building was retrofitted as an animal lab, it was never used for that purpose. In 1998 it was renovated for the use of a private company named Stratacor that works on topical anti-insect solutions.[1]

B10. Significance (continued)

Historic Context

Europeans arrived in what would become Contra Costa County in 1772, when a Spanish expedition led by Pedro Fages discovered the San Pablo Bay and the confluence of the Sacramento and San Joaquin rivers.[2] Though subsequent Spanish expeditions passed through the region the Spanish do not appear to have settled in the area during the mission period. In the 1820s and 1830s the Mexican government began granting large tracts of land in the area to its citizens, including Ranchos San Pablo, San Ramon, and Pinole. The first permanent non-native settlers were Francisco Castro and his wife Maria Gabriela Berryessa. The Mexican government granted the 18,000 acre Rancho San Pablo to the Castros in 1823.[3] Americans began farming in Contra Costa County in the late 1830s, and by 1882 2/3 of the cultivated land in the county was devoted to wheat production.[4]

Minna C. C. Quilfelt (or Quilfeldt) purchased 600 acres of Rancho San Pablo in 1852 and 1853.[5] Adjacent to San Francisco Bay in what would eventually become the southern portion of the City of Richmond, a wharf and produce warehouse were constructed on the ranch in the 1860s to ship agricultural produce to the San Francisco markets from Rancho San Pablo as well as the Quilfelt ranch. The warehouse and wharf were used to transport cattle, grain, fruit, and in later years the frogs' legs raised by Richard Stege for the San Francisco restaurant market.[6] German native Richard Stege settled on Rancho San Pablo in the late 1860s after stints in the gold fields and the Siberian fur trade. He married Minna Quilfelt, who was a widow, in 1870.[7] Minna Quilfelt Stege died in 1879, leaving the ranch to Stege and her daughter Edith. Stege began selling off portions of his ranch to raise money while continuing his frog-raising and other ventures. A town named Stege formed on Richard Stege's holdings, and by the late nineteenth century several industries, including the California Cap Works, the United States Briquette Company, the Stauffer Chemical Works and the Stege Lumber Manufacturing Company, were

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[1] Shackleton, 2013.

[2] Mildred B. Hoover, Hero E. Rensch, Ethel G. Rensch, Douglas E. Kyle, *Historic Spots in California, Fourth Edition*, Stanford University Press, Stanford, California: 1958, p. 129.

[3] Donald Bastin, *Images of America: Richmond*, Arcadia Publishing, Charleston SC: 2003, p. 9.

[4] J.P. Munro-Fraser, *History of Contra Costa County, California*, W.A. Slocum & Co., San Francisco: 1882, p. 55 – 57.

[5] Evan Griffins, "Early History of Richmond", December 1938, El Cerrito Historical Society, website: http://www.elcerritowire.com/history/pages/EarlyRichmond.htm, accessed January 2013.

[6] Roland Oliver, "Recollections of Early Industries in Stege", August 7, 1959, p. 1.

[7] J.P. Munro-Fraser, p. 675.

operating from portions of the Stege Ranch.[8] Richmond incorporated in 1905, and by 1917 was already the largest city in Contra Costa County.[9] Stege was eventually absorbed into Richmond as the latter grew.

The Explosives Industry in Contra Costa County

Swedish chemist Alfred Nobel laid the foundation for the high-explosives industry with his innovations beginning in 1860s, inventing first a detonator and then a blasting cap. In 1867 he invented dynamite, which was safer, cheaper, and more powerful than nitroglycerine, which had been the most commonly used explosive. Nobel licensed the Giant Powder Company to produce dynamite in California later that year. Giant was the first American company to produce dynamite, and its plant was initially located in Rock House Canyon, in what is today the City of San Francisco. The California Powder Works began manufacturing dynamite in the same area in 1869.[10]

The nineteenth century explosives industry was extremely dangerous, and as San Francisco's population grew explosives manufacturers needed to relocate. Contra Costa County across the bay was attractive since it was accessible due to its proximity to the harbor yet remote from population centers. In addition, the narrow canyons of Contra Costa County, which terminate in small bays, provided a natural geographical defense against explosions by allowing factory design that placed water between different facets of explosives manufacturing.[11]

During the 1870s chemical and explosives manufacturers began opening in the vicinity of what would eventually become Richmond. The Tonite Powder Company, Western Mineral Company, and California Cap Company were established at 1877 on the Stege ranch. The San Francisco explosives companies soon followed those explosive companies across the bay to Contra Costa County. In 1880, Giant relocated to Point Pinole, changing its name to the Atlas Powder Company. The California Powder Works soon followed, building a new factory in Hercules, which was named for the brand under which the company sold its powder.[12] The Vulcan Powder Works and Judson Powder works also opened in the Stege Ranch area during this era, consolidating Contra Costa County's position as the cradle of the California explosives industry. The East Bay dominated California explosives manufacturing into the twentieth century. In 1902 California had only one powder factory outside Contra Costa and Alameda counties.[13]

William Letts Oliver

William Letts Oliver was born in Chile to English parents in 1844. He attended the University of Edinburgh and became a mining engineer. After returning to Chile, Oliver ran an explosives factory, which was nationalized by the Chilean government in 1864. After the loss of his factory, Oliver left Chile for San Francisco.[14] William Letts Oliver and his wife Carrie lived in Oakland, from about 1880 until Oliver's death in 1918.[15] The couple eventually

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[8] Frederick J. Hulaniski, *The History of Contra Costa County, California*. Elms Publishing Company, Berkeley, California: 1917, p. 354.

[9] Hulanski p. 288.

[10] Ida Mae Purcell, *History of Contra Costa County*, The Gillick Press, Berkeley, California" 1940, p. 645 – 646.

[11] James E. Vance, *Geography and Urban Evolution in the San Francisco Bay Area*, University of California, Berkeley: 1964, p. 27.

[12] Purcell, p. 646.

[13] Richmond Record, "Contra Costa County: Under the Vitascope", Richmond:1902.

[14] Pacific Mining News, Supplement to Engineering & Mining Journal-Press, "Industrial Notes: Developing of the Blasting Cap Industry", Vol. 1, No. 7, November 1922, p. 222.

[15] United States Census Bureau, Tenth Census of the United States, 1880, National Archives and Records Administration, Washington, D.C., San Francisco, California, Roll: 79, Film: 1254079, Page: 170B.

had six children together: Roland, Edwin, Caroline, Anita, William Harold, and Albert.[16] In addition his various professional activities William Letts Oliver was a yachtsman and an officer of the Bohemian Grove club in the early twentieth century. An avid amateur photographer throughout his lifetime, UC Berkeley's Bancroft Library has a collection of 2700 negatives and prints taken by Oliver and his son.[17]

William Letts Oliver initially gained familiarity with an explosive called guncotton while manufacturing collodion for his photography hobby.[18] As early as 1870, European explosive companies were experimenting with nitrated guncotton in and by 1875 it was manufactured in England under the name "tonite."[19] By 1877 Oliver had left Chile and was mining in the western United States. Engineers working on the Sutro Tunnel in the Comstock needed an explosive that would remain stable at the high temperatures underground to complete the tunnel, and Oliver was able to solve the problem by substituting tonite for more volatile compounds.[20]

The California Cap Company

In 1877 William Letts Oliver was inspired by his success with tonite to leave mining and establish the Tonite Powder Company, on a portion of the former Stege Ranch.[21] In the 1870s all blasting caps in the United States had to be imported from Europe. Not only were they expensive, but the timing of deliveries was uncertain, creating business difficulties for the powder plant. Oliver was determined to create his own caps in order to protect the tonite factory business. He experimented until he came up with a blasting cap that was safer to use and had better detonating qualities than imported detonators. Oliver and his partner Freeborn Fletter founded the California Cap Company. It was located adjacent to the Tonite Powder Company a 160 acre parcel carved out of the southern portion of Stege Ranch.[22] California Cap Company, which went on to operate on the site for nearly seven decades, was the first manufacturer of blasting caps in the United States. Richard Stege, meanwhile, continued to reside on the ranch, and contracted with Tonite Powder and California Cap to transport their products to the railroad.[23] The California Cap Company was located on the parcel that is currently the Richmond Field Station. The Tonite Powder Company appears to have been located to the east on the parcel that became the Stauffer Chemical Company and later the Zeneca site, although its exact location is unclear.

The Tonite and California Cap factories, which were the first of several gunpowder and chemical companies in the region, were separated by the Stege agricultural warehouse for safety.[24] The explosives industry during this era was an extremely dangerous one. A horrific explosion in 1882 at the nearby Vulcan Powder Company caused 11 deaths and destroyed the plant.[25] Between 1882 and 1918 the Hercules and Atlas plants suffered numerous

[16] United States Census Bureau, Twelfth Census of the United States, 1900, National Archives and Records Administration, Washington, D.C., Oakland Ward 3, Alameda, California, Roll: 82, Page: 13A.

[17] Online Archive of California, "Guide to the Oliver Family Photograph Collection", UC Berkeley: 2009, website: http://www.oac.cdlib.org/findaid/ark:/13030/ft0q2n99r1/ accessed February, 2013.

[18] Pacific Mining News, p. 222.

[19] G.A. Price Cuxson, ed., "Society of Engineers: Transactions for 1889", E. & F. N. Spon, London: 1890, p. 95.

[20] Pacific Mining News, p. 222.

[21] Oliver, p. 1.

[22] Pacific Mining News, p. 222.

[23] Nilda Rego, "Enterprising Stege lost all and died without a penny", Time Out, March 27, 1994, p. 2, column 4.

[24] Oliver, p. 1.

[25] Munro-Fraser, p. 424.

explosions which destroyed plant buildings and killed a total of 64 workers.[26] Despite its focus on safety, the California Cap Company had accidents as well. Two of its Chinese workers were killed in 1917 when one of them dropped a tray of caps. In 1941 an explosion caused a fire and critically injured a worker.[27]

William Letts Oliver continued to innovate throughout his long career in the chemical and explosives industries. In 1888 he formed the American Lucol Company adjacent to the California Cap Company property.[28] The Lucol plant was at what is currently the southeastern corner of the Richmond Field Station, at the approximate location of Building 163. Lucol manufactured a linseed oil substitute.[29] The factory was dismantled and relocated to New Jersey circa 1900.[30] In 1903 the Hotaling Briquette Works opened on Lucol's site at the southeast corner of the current Richmond Field station property.[31] Later known as the U.S. Briquette Company, the plant appears to have operated at this location until at least 1917.[32] The U.S. Briquette Company buildings were demolished sometime in the 1960s.

The Oliver family aggressively promoted their products both through advertising and publishing. The California Cap Company sponsored or published both articles and book-length treatises on the use of explosives. Safety was a key element of the company image, a topic of company-sponsored technical writing as well as a selling point in advertisements.[33] The Tonite Powder Company's product was known even outside the United States, and by the end of the nineteenth century the powder's explosive properties were considered comparable to the finest English products.[34] Oliver's sons Roland and Edwin Letts Oliver both graduated from UC Berkeley's College of Mining in 1900. Roland Oliver seems to have spent his entire career working in the family enterprises, while Edwin worked at California Cap between mining and other ventures. The Oliver family also became benefactors of the university, and in 1917 the California Cap Company donated substantial amounts of their products to the College of Mining including 500 electric detonators, 500 delayed action exploders, and 500 blasting caps.[35]

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[26] Purcell, p. 648.
[27] Contra Costa County Standard, "Stege Powder Plant Blast; One Near Death", June 6, 1941, p. 1A.
[28] Oliver, p. 1.
[29] Max Wilhelm Von Bernewitz, *Cyanide Practice, 1910 – 1913*, Dewey Publishing Company: 1913, p. 327.
[30] Oliver, p. 1.
[31] Oliver, p. 2.
[32] Hulanksi, p. 354.
[33] Halbert Powers Gillette, *Rock Excavation:Methods and Cost*, M.C. Clark, New York: 1904, x.
[34] Manual Eissler, *A Handbook on Modern Explosives*, Crosby, Lockwood & son, London: 1897, p. 117.
[35] University of California, *The University of California Chronicle*, University of California Press, January, 1917, p. 92.
[36] R.L. Polk & Company, *Richmond and Contra Costa County Directory, 1914 – 1915*, Oakland, California: 1915.
[37] Pacific Mining News, p.222.
[38] University of California, Berkeley, *Current Conditions Report*, Prepared by Tetra Tech EM Inc., November 21, 2008, p. 11.

During the late nineteenth and early twentieth century the California Cap Company was one of the most important local employers.[39] As the twentieth century progressed more heavy industry came to Contra Costa County, and by 1940 the county was second only to Los Angeles in overall industrial production.[40] The nineteenth-century California Cap Company was dwarfed by the scale of some of the newer enterprises, and its physical plant and technology were aging. During World War II California Cap was able to stay open by producing delayed action incendiary bombs that were used against Japan.[41] The California Cap Company could not survive the transition to a peacetime economy, however, and by 1949 the plant was closed and the Oliver family looking for a buyer.

University Research/Richmond Field Station

After World War II UC Berkeley's Engineering Department needed an off-campus location in order to perform experiments that required more space than a laboratory. Department Chair Morrough P. O' Brien and others in the department were performing experiments with sewage, sea water, and other materials unsuited to use on a crowded campus. They also wanted a location that was not too remote. The University purchased the California Cap Company from the Oliver family for the use of the Engineering Department in 1950.[42]

The Richmond Field Station has been the location of a research overseen by numerous UC Berkeley departments over the years. The Sanitary Engineering Research Laboratory (SERL) was one of the first departments to undertake research at the site. SERL focused primarily on sewage treatment technology, and also researched pollution control and disposal of solid and liquid waste.[43] Other early projects at the field station included sea water distillation, heat transfer, and cyclic stress research.[44]

At first the Department of Engineering utilized the buildings left behind by the California Cap Company. The Department established a machine shop, computer shop, receiving facility, mail service, and other facilities in addition to laboratories in the old detonator company buildings.[45] The current Buildings 102, 110, 118, 128, 150, 152 175, and 176 all date to the cap company era and have been repurposed for the Richmond Field Station. They also constructed new buildings as funds became available, and by the mid-1950s five new buildings had been completed at the Richmond Field Station.[46] By the 1970s the department had conducted many experiments at the Richmond Field Station that could not have been performed on the main campus.

[39] Marguerite Clausen, "On the Waterfront: An Oral History of Richmond, California", Regional Oral History Office, University of California, Berkeley, 1990, p. 21.

[40] Purcell, p. 649.

[41] Oliver, p. 1.

[42] P.H. McGauhey, "The Sanitary Engineering Research Laboratory: Administration, Research and Consultation, 1950-1975 – An Interview Conducted by Malca Call", Regional Oral History Office, University of California, Berkeley, 1974, p. 70.

[43] University of California, Berkeley, 2008, p. 13.

[44] University of California, Berkeley, Department of Engineering, "Richmond Field Station Open House", May 28, 1952, p. 3 – 4.

[45] McGauhey, p. 71.

[46] University of California, Berkeley, Department of Engineering, "Guide for Engineering Field Station Inspection", undated, p. 3.

Evaluation

The following provides an evaluation of Building 176 under each NRHP/CRHR criteria.

Building 176 does not appear to meet the criteria for listing in NRHP/CRHR because it lacks historical significance. The structure has been used for storage throughout its lifetime and as such lacks the strength of association necessary to be considered historically significant in relation to any particular events or persons (Criteria A/1 or B/2).

The utilitarian building lacks any identifiable architectural stylistic design and does not embody distinctive architectural or engineering qualities of type, period, or method of construction (Criterion C/3). In rare instances, buildings themselves can serve as sources of important information, however this building is not a principal source of important information in this regard (Criterion D/4).

State of California – The Resources Agency
DEPARTMENT OF PARKS AND RECREATION
PRIMARY RECORD

Primary # _____
HRI # _____
Trinomial _____
NRHP Status Code _____
Other Listings _____
Review Code _____ Reviewer _____ Date _____

 ***Resource Name or #** (Assigned by recorder) Richmond Field Station Building 178

P1. Other Identifier: Richmond Field Station Building 178

***P2. Location:** ☐ **Not for Publication** ☒ **Unrestricted** ***a. County** Contra Costa
and (P2b and P2c or P2d. Attach a Location Map as necessary.)
***b. USGS 7.5′ Quad** Richmond **Date** 1984 **T**___; **R** ___; __ ¼ **of Sec** ___; Diablo **B.M.**
c. Address _____ City _____ Zip _____
d. UTM: (give more than one for large and/or linear resources) Zone 10 ; 558587 mE/ 4196368 mN
e. Other Locational Data: (e.g., parcel #, directions to resource, elevation, etc., as appropriate)

***P3a. Description:** (Describe resource and its major elements. Include design, materials, condition, alterations, size, setting, and boundaries)
Building 178 is along the southeastern border of the Richmond Field Station. It is set back from Egret Way to the east adjacent to building 185. Its primary façade faces northwest. The utilitarian building does not strongly express any particular architecture style. It is single story, rectangular in plan, 3,950 square feet, and was constructed prior to 1940. The building is topped with a side gabled roof. Its roof and walls are clad in corrugated metal. Fenestration is both aluminum sliding sashes and multiple light wood sashes. There are three entryways on the primary (northwest) elevation. Entrances at the north end and the center of the elevation are metal double doors with windows. The south entrance is a single metal door with a window. At either end of the building the entrances are accessed by sets of wooden stairs. A similar door is at the north end of the rear (southeast) elevation. (See Continuation Sheet)

***P3b. Resource Attributes:** (List attributes and codes) HP4: Ancillary Building

***P4. Resources Present:** ☒ Building ☐ Structure ☐ Object ☐ Site ☐ District ☐ Element of District ☐ Other (Isolates, etc.)

P5b. Description of Photo: (View, date, accession #) Photograph 1: Northwest and southwest facades of building, camera facing east, January 4, 2013.

***P6. Date Constructed/Age and Sources:**
☒ Historic ☐ Prehistoric ☐ Both
Unknown

***P7. Owner and Address:**
U.C. Berkeley
1301 South 46th Street
Richmond, California 94804

***P8. Recorded by:** (Name, affiliation, address)
Kara Brunzell & Julia Mates
Tetra Tech
1999 Harrison Street, Ste 500
Oakland, CA 94612

***P9. Date Recorded:** January 4, 2013

***P10. Survey Type:** (Describe) Intensive

***P11. Report Citation:** (Cite survey report and other sources, or enter "none.") *Historic Properties Survey Report for Portions of the Richmond Field Station* prepared by Tetra Tech, Inc, 2013.

***Attachments:** NONE ☒ Location Map ☐ Sketch Map ☒ Continuation Sheet ☒ Building, Structure, and Object Record ☐ Archaeological Record ☐ District Record ☐ Linear Feature Record ☐ Milling Station Record ☐ Rock Art Record ☐ Artifact Record ☐ Photograph Record ☐ Other (list) _____

***NRHP Status Code** 6Z

***Resource Name or #** (Assigned by recorder) Richmond Field Station Building 178

B1. Historic Name: _____

B2. Common Name: Building 178

B3. Original Use: Unknown B4. Present Use: Art practice

***B5. Architectural Style:** Vernacular

***B6. Construction History:** (Construction date, alteration, and date of alterations) Unknown

***B7. Moved?** ☐ No ☒ Yes ☐ Unknown **Date:** circa 1990 **Original Location:** Unknown

***B8. Related Features:** _____

B9. Architect: Unknown b. Builder: Unknown

***B10. Significance: Theme** N/A **Area** N/A

Period of Significance N/A **Property Type** N/A **Applicable Criteria** N/A

(Discuss importance in terms of historical or architectural context as defined by theme, period, and geographic scope. Also address integrity.)

Building 178 at Richmond Field Station does not appear to meet the criteria for listing in the National Register of Historic Places (NRHP). Furthermore, the building has been evaluated in accordance with Section 15064.5(a)(2)-(3) of the CEQA Guidelines, using the criteria outlined in Section 5024.1 of the California Public Resources Code, and does not appear to meet the significance criteria as outlined in these guidelines. Therefore, the building is not eligible for listing in the California Register of Historical Resources. (See Continuation Sheet.)

B11. Additional Resource Attributes: (List attributes and codes)

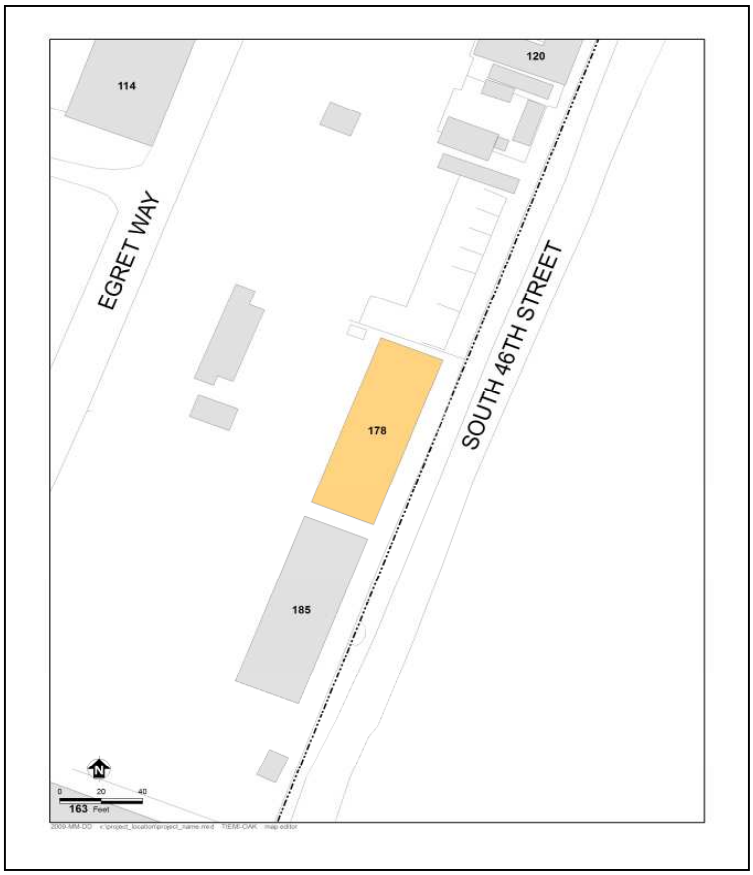
***B12. References:** See Footnotes

B13. Remarks:

***B14. Evaluator:** Kara Brunzell

***Date of Evaluation:** January 2013

(This space reserved for official comments.)



P3a. Description (continued)

Building 178 appears to have been moved to this location circa 1990. Although UC Berkeley property records and building materials suggest a build date prior to 1950, Building 178 does not appear on aerial photographs of this location until the 1990s. Research has not uncovered its original use or location. Building 178 housed the California Conservation Corps until circa 1999, after which it served as an electrical shop and a warehouse. It is currently used for Art Practice Studies.[1]

B10. Significance (continued)

Historic Context

Europeans arrived in what would become Contra Costa County in 1772, when a Spanish expedition led by Pedro Fages discovered the San Pablo Bay and the confluence of the Sacramento and San Joaquin rivers.[2] Though subsequent Spanish expeditions passed through the region the Spanish do not appear to have settled in the area during the mission period. In the 1820s and 1830s the Mexican government began granting large tracts of land in the area to its citizens, including Ranchos San Pablo, San Ramon, and Pinole. The first permanent non-native settlers were Francisco Castro and his wife Maria Gabriela Berryessa. The Mexican government granted the 18,000 acre Rancho San Pablo to the Castros in 1823.[3] Americans began farming in Contra Costa County in the late 1830s, and by 1882 2/3 of the cultivated land in the county was devoted to wheat production.[4]

Minna C. C. Quilfelt (or Quilfeldt) purchased 600 acres of Rancho San Pablo in 1852 and 1853.[5] Adjacent to San Francisco Bay in what would eventually become the southern portion of the City of Richmond, a wharf and produce warehouse were constructed on the ranch in the 1860s to ship agricultural produce to the San Francisco markets from Rancho San Pablo as well as the Quilfelt ranch. The warehouse and wharf were used to transport cattle, grain, fruit, and in later years the frogs' legs raised by Richard Stege for the San Francisco restaurant market.[6] German native Richard Stege settled on Rancho San Pablo in the late 1860s after stints in the gold fields and the Siberian fur trade. He married Minna Quilfelt, who was a widow, in 1870.[7] Minna Quilfelt Stege died in 1879, leaving the ranch to Stege and her daughter Edith. Stege began selling off portions of his ranch to raise money while continuing his frog-raising and other ventures. A town named Stege formed on Richard Stege's holdings, and by the late nineteenth century several industries, including the California Cap Works, the United States Briquette Company, the Stauffer Chemical Works and the Stege Lumber Manufacturing Company, were operating from portions of the Stege Ranch.[8] Richmond incorporated in 1905, and by 1917 was already the largest city in Contra Costa County.[9] Stege was eventually absorbed into Richmond as the latter grew.

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[1] Shackleton, 2013.

[2] Mildred B. Hoover, Hero E. Rensch, Ethel G. Rensch, Douglas E. Kyle, *Historic Spots in California, Fourth Edition*, Stanford University Press, Stanford, California: 1958, p. 129.

[3] Donald Bastin, *Images of America: Richmond*, Arcadia Publishing, Charleston SC: 2003, p. 9.

[4] J.P. Munro-Fraser, *History of Contra Costa County, California*, W.A. Slocum & Co., San Francisco: 1882, p. 55 – 57.

[5] Evan Griffins, "Early History of Richmond", December 1938, El Cerrito Historical Society, website: http://www.elcerritowire.com/history/pages/EarlyRichmond.htm, accessed January 2013.

[6] Roland Oliver, "Recollections of Early Industries in Stege", August 7, 1959, p. 1.

[7] J.P. Munro-Fraser, p. 675.

[8] Frederick J. Hulaniski, *The History of Contra Costa County, California*. Elms Publishing Company, Berkeley, California: 1917, p. 354.

[9] Hulanski p. 288.

The Explosives Industry in Contra Costa County

Swedish chemist Alfred Nobel laid the foundation for the high-explosives industry with his innovations beginning in 1860s, inventing first a detonator and then a blasting cap. In 1867 he invented dynamite, which was safer, cheaper, and more powerful than nitroglycerine, which had been the most commonly used explosive. Nobel licensed the Giant Powder Company to produce dynamite in California later that year. Giant was the first American company to produce dynamite, and its plant was initially located in Rock House Canyon, in what is today the City of San Francisco. The California Powder Works began manufacturing dynamite in the same area in 1869.[10]

The nineteenth century explosives industry was extremely dangerous, and as San Francisco's population grew explosives manufacturers needed to relocate. Contra Costa County across the bay was attractive since it was accessible due to its proximity to the harbor yet remote from population centers. In addition, the narrow canyons of Contra Costa County, which terminate in small bays, provided a natural geographical defense against explosions by allowing factory design that placed water between different facets of explosives manufacturing.[11]

During the 1870s chemical and explosives manufacturers began opening in the vicinity of what would eventually become Richmond. The Tonite Powder Company, Western Mineral Company, and California Cap Company were established at 1877 on the Stege ranch. The San Francisco explosives companies soon followed those explosive companies across the bay to Contra Costa County. In 1880, Giant relocated to Point Pinole, changing its name to the Atlas Powder Company. The California Powder Works soon followed, building a new factory in Hercules, which was named for the brand under which the company sold its powder.[12] The Vulcan Powder Works and Judson Powder works also opened in the Stege Ranch area during this era, consolidating Contra Costa County's position as the cradle of the California explosives industry. The East Bay dominated California explosives manufacturing into the twentieth century. In 1902 California had only one powder factory outside Contra Costa and Alameda counties.[13]

William Letts Oliver

William Letts Oliver was born in Chile to English parents in 1844. He attended the University of Edinburgh and became a mining engineer. After returning to Chile, Oliver ran an explosives factory, which was nationalized by the Chilean government in 1864. After the loss of his factory, Oliver left Chile for San Francisco.[14] William Letts Oliver and his wife Carrie lived in Oakland, from about 1880 until Oliver's death in 1918.[15] The couple eventually had six children together: Roland, Edwin, Caroline, Anita, William Harold, and Albert.[16] In addition his various professional activities William Letts Oliver was a yachtsman and an officer of the Bohemian Grove club in the

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[10] Ida Mae Purcell, *History of Contra Costa County*, The Gillick Press, Berkeley, California" 1940, p. 645 – 646.

[11] James E. Vance, *Geography and Urban Evolution in the San Francisco Bay Area*, University of California, Berkeley: 1964, p. 27.

[12] Purcell, p. 646.

[13] Richmond Record, "Contra Costa County: Under the Vitascope", Richmond:1902.

[14] Pacific Mining News, Supplement to Engineering & Mining Journal-Press, "Industrial Notes: Developing of the Blasting Cap Industry", Vol. 1, No. 7, November 1922, p. 222.

[15] United States Census Bureau, Tenth Census of the United States, 1880, National Archives and Records Administration, Washington, D.C., San Francisco, California, Roll: 79, Film: 1254079, Page: 170B.

[16] United States Census Bureau, Twelfth Census of the United States, 1900, National Archives and Records Administration, Washington, D.C., Oakland Ward 3, Alameda, California, Roll: 82, Page: 13A.

early twentieth century. An avid amateur photographer throughout his lifetime, UC Berkeley's Bancroft Library has a collection of 2700 negatives and prints taken by Oliver and his son.[17]

William Letts Oliver initially gained familiarity with an explosive called guncotton while manufacturing collodion for his photography hobby.[18] As early as 1870, European explosive companies were experimenting with nitrated guncotton in and by 1875 it was manufactured in England under the name "tonite."[19] By 1877 Oliver had left Chile and was mining in the western United States. Engineers working on the Sutro Tunnel in the Comstock needed an explosive that would remain stable at the high temperatures underground to complete the tunnel, and Oliver was able to solve the problem by substituting tonite for more volatile compounds.[20]

The California Cap Company

In 1877 William Letts Oliver was inspired by his success with tonite to leave mining and establish the Tonite Powder Company, on a portion of the former Stege Ranch.[21] In the 1870s all blasting caps in the United States had to be imported from Europe. Not only were they expensive, but the timing of deliveries was uncertain, creating business difficulties for the powder plant. Oliver was determined to create his own caps in order to protect the tonite factory business. He experimented until he came up with a blasting cap that was safer to use and had better detonating qualities than imported detonators. Oliver and his partner Freeborn Fletter founded the California Cap Company. It was located adjacent to the Tonite Powder Company a 160 acre parcel carved out of the southern portion of Stege Ranch.[22] California Cap Company, which went on to operate on the site for nearly seven decades, was the first manufacturer of blasting caps in the United States. Richard Stege, meanwhile, continued to reside on the ranch, and contracted with Tonite Powder and California Cap to transport their products to the railroad.[23] The California Cap Company was located on the parcel that is currently the Richmond Field Station. The Tonite Powder Company appears to have been located to the east on the parcel that became the Stauffer Chemical Company and later the Zeneca site, although its exact location is unclear.

The Tonite and California Cap factories, which were the first of several gunpowder and chemical companies in the region, were separated by the Stege agricultural warehouse for safety.[24] The explosives industry during this era was an extremely dangerous one. A horrific explosion in 1882 at the nearby Vulcan Powder Company caused 11 deaths and destroyed the plant.[25] Between 1882 and 1918 the Hercules and Atlas plants suffered numerous explosions which destroyed plant buildings and killed a total of 64 workers.[26] Despite its focus on safety, the California Cap Company had accidents as well. Two of its Chinese workers were killed in 1917 when one of them dropped a tray of caps. In 1941 an explosion caused a fire and critically injured a worker.[27]

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[17] Online Archive of California, "Guide to the Oliver Family Photograph Collection", UC Berkeley: 2009, website: http://www.oac.cdlib.org/findaid/ark:/13030/ft0q2n99r1/ accessed February, 2013.
[18] Pacific Mining News, p. 222.
[19] G.A. Price Cuxson, ed., "Society of Engineers: Transactions for 1889", E. & F. N. Spon, London: 1890, p. 95.
[20] Pacific Mining News, p. 222.
[21] Oliver, p. 1.
[22] Pacific Mining News, p. 222.
[23] Nilda Rego, "Enterprising Stege lost all and died without a penny", Time Out, March 27, 1994, p. 2, column 4.
[24] Oliver, p. 1.
[25] Munro-Fraser, p. 424.
[26] Purcell, p. 648.
[27] Contra Costa County Standard, "Stege Powder Plant Blast; One Near Death", June 6, 1941, p. 1A.

William Letts Oliver continued to innovate throughout his long career in the chemical and explosives industries. In 1888 he formed the American Lucol Company adjacent to the California Cap Company property.[28] The Lucol plant was at what is currently the southeastern corner of the Richmond Field Station, at the approximate location of Building 163. Lucol manufactured a linseed oil substitute.[29] The factory was dismantled and relocated to New Jersey circa 1900.[30] In 1903 the Hotaling Briquette Works opened on Lucol's site at the southeast corner of the current Richmond Field station property.[31] Later known as the U.S. Briquette Company, the plant appears to have operated at this location until at least 1917.[32] The U.S. Briquette Company buildings were demolished sometime in the 1960s.

The Oliver family aggressively promoted their products both through advertising and publishing. The California Cap Company sponsored or published both articles and book-length treatises on the use of explosives. Safety was a key element of the company image, a topic of company-sponsored technical writing as well as a selling point in advertisements.[33] The Tonite Powder Company's product was known even outside the United States, and by the end of the nineteenth century the powder's explosive properties were considered comparable to the finest English products.[34] Oliver's sons Roland and Edwin Letts Oliver both graduated from UC Berkeley's College of Mining in 1900. Roland Oliver seems to have spent his entire career working in the family enterprises, while Edwin worked at California Cap between mining and other ventures. The Oliver family also became benefactors of the university, and in 1917 the California Cap Company donated substantial amounts of their products to the College of Mining including 500 electric detonators, 500 delayed action exploders, and 500 blasting caps.[35]

Eventually the Tonite factory appears to have been incorporated into the California Cap Company. The Olivers also formed an entity named Pacific Cartridge Company circa 1910. The Pacific Cartridge Company operated from the California Cap plant during World War I.[36] By 1916 there were at least a dozen buildings on the site. When Oliver died in 1918 his son Roland Oliver took over as president of California Cap Company. By 1922 Roland's brother Leslie Oliver was assistant manager of the plant and Edwin Letts Oliver was a director.[37] Roland Oliver substantially expanded the California Cap Company after he took over as president. During this era the plant grew to include 150 buildings and a horse-drawn tram line.[38]

During the late nineteenth and early twentieth century the California Cap Company was one of the most important local employers.[39] As the twentieth century progressed more heavy industry came to Contra Costa County, and by

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[28] Oliver, p. 1.
[29] Max Wilhelm Von Bernewitz, *Cyanide Practice, 1910 – 1913*, Dewey Publishing Company: 1913, p. 327.
[30] Oliver, p. 1.
[31] Oliver, p. 2.
[32] Hulanksi, p. 354.
[33] Halbert Powers Gillette, *Rock Excavation:Methods and Cost*, M.C. Clark, New York: 1904, x.
[34] Manual Eissler, *A Handbook on Modern Explosives*, Crosby, Lockwood & son, London: 1897, p. 117.
[35] University of California, *The University of California Chronicle*, University of California Press, January, 1917, p. 92.
[36] R.L. Polk & Company, *Richmond and Contra Costa County Directory, 1914 – 1915*, Oakland, California: 1915.
[37] Pacific Mining News, p.222.
[38] University of California, Berkeley, *Current Conditions Report*, Prepared by Tetra Tech EM Inc., November 21, 2008, p. 11.
[39] Marguerite Clausen, "On the Waterfront: An Oral History of Richmond, California", Regional Oral History Office, University of California, Berkeley, 1990, p. 21.

1940 the county was second only to Los Angeles in overall industrial production.[40] The nineteenth-century California Cap Company was dwarfed by the scale of some of the newer enterprises, and its physical plant and technology were aging. During World War II California Cap was able to stay open by producing delayed action incendiary bombs that were used against Japan.[41] The California Cap Company could not survive the transition to a peacetime economy, however, and by 1949 the plant was closed and the Oliver family looking for a buyer.

University Research/Richmond Field Station

After World War II UC Berkeley's Engineering Department needed an off-campus location in order to perform experiments that required more space than a laboratory. Department Chair Morrough P. O' Brien and others in the department were performing experiments with sewage, sea water, and other materials unsuited to use on a crowded campus. They also wanted a location that was not too remote. The University purchased the California Cap Company from the Oliver family for the use of the Engineering Department in 1950.[42]

The Richmond Field Station has been the location of a research overseen by numerous UC Berkeley departments over the years. The Sanitary Engineering Research Laboratory (SERL) was one of the first departments to undertake research at the site. SERL focused primarily on sewage treatment technology, and also researched pollution control and disposal of solid and liquid waste.[43] Other early projects at the field station included sea water distillation, heat transfer, and cyclic stress research.[44]

At first the Department of Engineering utilized the buildings left behind by the California Cap Company. The Department established a machine shop, computer shop, receiving facility, mail service, and other facilities in addition to laboratories in the old detonator company buildings.[45] The current Buildings 102, 110, 118, 128, 150, 152 175, and 176 all date to the cap company era and have been repurposed for the Richmond Field Station. They also constructed new buildings as funds became available, and by the mid-1950s five new buildings had been completed at the Richmond Field Station.[46] By the 1970s the department had conducted many experiments at the Richmond Field Station that could not have been performed on the main campus.

Evaluation

The following provides an evaluation of Building 178 under each NRHP/CRHR criteria.

Building 178 does not appear to meet the criteria for listing in NRHP/CRHR because it lacks historical significance. The structure has been used for a variety of purposes throughout its lifetime and as such lacks the strength of association necessary to be considered historically significant in relation to any particular events or persons (Criteria A/1 and B/2).

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[40] Purcell, p. 649.

[41] Oliver, p. 1.

[42] P.H. McGauhey, "The Sanitary Engineering Research Laboratory: Administration, Research and Consultation, 1950-1975 – An Interview Conducted by Malca Call", Regional Oral History Office, University of California, Berkeley, 1974, p. 70.

[43] University of California, Berkeley, 2008, p. 13.

[44] University of California, Berkeley, Department of Engineering, "Richmond Field Station Open House", May 28, 1952, p. 3 – 4.

[45] McGauhey, p. 71.

[46] University of California, Berkeley, Department of Engineering, "Guide for Engineering Field Station Inspection", undated, p. 3.

The utilitarian building lacks any identifiable architectural stylistic design and does not embody distinctive architectural or engineering qualities of type, period, or method of construction (Criterion C/3). In rare instances, buildings themselves can serve as sources of important information, however this building is not a principal source of important information in this regard (Criterion D/4).

As a multiple use building, Building 178 does not meet the standard of exceptional importance required for properties under 50 years old to be eligible to the NHRP (Criterion G).

State of California – The Resources Agency
DEPARTMENT OF PARKS AND RECREATION
PRIMARY RECORD

Primary # _____
HRI # _____
Trinomial _____
NRHP Status Code _____
Other Listings _____
Review Code _____ Reviewer _____ Date _____

 ***Resource Name or #** (Assigned by recorder) Richmond Field Station Building 185

P1. Other Identifier: Richmond Field Station Building 185

***P2. Location:** ☐ **Not for Publication** ☒ **Unrestricted** ***a. County** Contra Costa
and (P2b and P2c or P2d. Attach a Location Map as necessary.)
***b. USGS 7.5′ Quad** Richmond **Date** 1984 **T**___; **R** ___; __ ¼ **of Sec** ___; Diablo **B.M.**
c. Address _____ City _____ Zip _____
d. UTM: (give more than one for large and/or linear resources) Zone 10 ; 558577 mE/ 4196342 mN
e. Other Locational Data: (e.g., parcel #, directions to resource, elevation, etc., as appropriate)

***P3a. Description:** (Describe resource and its major elements. Include design, materials, condition, alterations, size, setting, and boundaries)
Building 185 is along the southeastern border of the Richmond Field Station. It is set back from Egret Way to the east adjacent to building 178. Its primary façade faces northwest. The utilitarian building does not strongly express any particular architecture style. It is single story, rectangular in plan, 3,165 square feet, and constructed prior to 1940. The building is topped with a side gabled roof. Its roof and walls are clad in corrugated metal and it lacks fenestration. Entryways, at either end of the primary (northeast) elevation, are flush wood doors. The south door is accessed by a set of wooden stairs. Another entryway is at the north end of the rear (southwest) elevation. Building 185 appears to have been moved to this location circa 1990. Although UC Berkeley property records and building materials suggest a build date prior to 1950, Building 185 does not appear on aerial photographs of this location until the 1990s. Research has not uncovered its original use or location. The building has been a support facility since the 1990s.

***P3b. Resource Attributes:** (List attributes and codes) HP4: Ancillary Building

***P4. Resources Present:** ☒ Building ☐ Structure ☐ Object ☐ Site ☐ District ☐ Element of District ☐ Other (Isolates, etc.)

P5b. Description of Photo: (View, date, accession #) Photograph 1: Northwest and southwest facades of building, camera facing east, January 4, 2013.

***P6. Date Constructed/Age and Sources:**
☒ Historic ☐ Prehistoric ☐ Both
Unknown

***P7. Owner and Address:**
U.C. Berkeley
1301 South 46th Street
Richmond, California 94804

***P8. Recorded by:** (Name, affiliation, address)
Kara Brunzell & Julia Mates
Tetra Tech
1999 Harrison Street, Ste 500
Oakland, CA 94612

***P9. Date Recorded:** January 4, 2013

***P10. Survey Type:** (Describe) Intensive

***P11. Report Citation:** (Cite survey report and other sources, or enter "none.") *Historic Properties Survey Report for Portions of the Richmond Field Station* prepared by Tetra Tech, Inc, 2013.

***Attachments:** NONE ☒ Location Map ☐ Sketch Map ☒ Continuation Sheet ☒ Building, Structure, and Object Record ☐ Archaeological Record ☐ District Record ☐ Linear Feature Record ☐ Milling Station Record ☐ Rock Art Record ☐ Artifact Record ☐ Photograph Record ☐ Other (list) _____

***NRHP Status Code** 6Z

***Resource Name or #** (Assigned by recorder) Richmond Field Station Building 185

B1. Historic Name: _____

B2. Common Name: Building 185

B3. Original Use: Unknown B4. Present Use: Admistrative/Support

***B5. Architectural Style:** Vernacular

***B6. Construction History:** (Construction date, alteration, and date of alterations) Unknown

***B7. Moved?** ☐ **No** ☒ **Yes** ☐ **Unknown** **Date:** circa 1990 **Original Location:** Unknown

***B8. Related Features:** _____

B9. Architect: Unknown b. Builder: Unknown

***B10. Significance: Theme** N/A **Area** N/A

Period of Significance N/A **Property Type** N/A **Applicable Criteria** N/A

(Discuss importance in terms of historical or architectural context as defined by theme, period, and geographic scope. Also address integrity.)

Building 185 at Richmond Field Station does not appear to meet the criteria for listing in the National Register of Historic Places (NRHP). Furthermore, the building has been evaluated in accordance with Section 15064.5(a)(2)-(3) of the CEQA Guidelines, using the criteria outlined in Section 5024.1 of the California Public Resources Code, and does not appear to meet the significance criteria as outlined in these guidelines. Therefore, the building is not eligible for listing in the California Register of Historical Resources (CRHR). (See Continuation Sheet.)

B11. Additional Resource Attributes: (List attributes and codes)

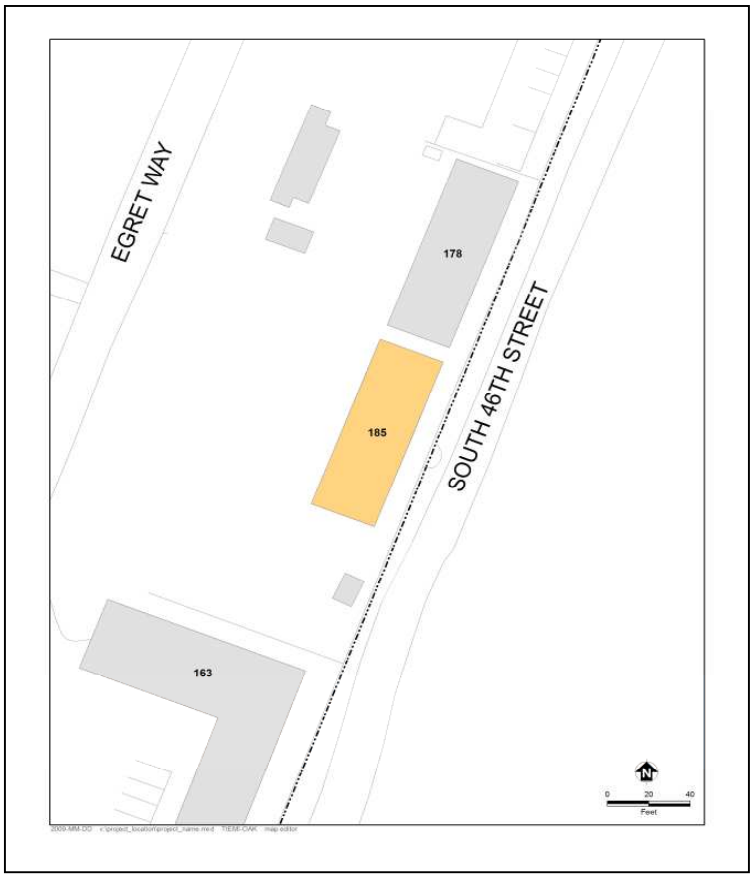
***B12. References:** See Footnotes

B13. Remarks:

***B14. Evaluator:** Kara Brunzell

***Date of Evaluation:** January 2013

(This space reserved for official comments.)



B10. Significance (continued)

Historic Context

Europeans arrived in what would become Contra Costa County in 1772, when a Spanish expedition led by Pedro Fages discovered the San Pablo Bay and the confluence of the Sacramento and San Joaquin rivers.[1] Though subsequent Spanish expeditions passed through the region the Spanish do not appear to have settled in the area during the mission period. In the 1820s and 1830s the Mexican government began granting large tracts of land in the area to its citizens, including Ranchos San Pablo, San Ramon, and Pinole. The first permanent non-native settlers were Francisco Castro and his wife Maria Gabriela Berryessa. The Mexican government granted the 18,000 acre Rancho San Pablo to the Castros in 1823.[2] Americans began farming in Contra Costa County in the late 1830s, and by 1882 2/3 of the cultivated land in the county was devoted to wheat production.[3]

Minna C. C. Quilfelt (or Quilfeldt) purchased 600 acres of Rancho San Pablo in 1852 and 1853.[4] Adjacent to San Francisco Bay in what would eventually become the southern portion of the City of Richmond, a wharf and produce warehouse were constructed on the ranch in the 1860s to ship agricultural produce to the San Francisco markets from Rancho San Pablo as well as the Quilfelt ranch. The warehouse and wharf were used to transport cattle, grain, fruit, and in later years the frogs' legs raised by Richard Stege for the San Francisco restaurant market.[5] German native Richard Stege settled on Rancho San Pablo in the late 1860s after stints in the gold fields and the Siberian fur trade. He married Minna Quilfelt, who was a widow, in 1870.[6] Minna Quilfelt Stege died in 1879, leaving the ranch to Stege and her daughter Edith. Stege began selling off portions of his ranch to raise money while continuing his frog-raising and other ventures. A town named Stege formed on Richard Stege's holdings, and by the late nineteenth century several industries, including the California Cap Works, the United States Briquette Company, the Stauffer Chemical Works and the Stege Lumber Manufacturing Company, were operating from portions of the Stege Ranch.[7] Richmond incorporated in 1905, and by 1917 was already the largest city in Contra Costa County.[8] Stege was eventually absorbed into Richmond as the latter grew.

The Explosives Industry in Contra Costa County

Swedish chemist Alfred Nobel laid the foundation for the high-explosives industry with his innovations beginning in 1860s, inventing first a detonator and then a blasting cap. In 1867 he invented dynamite, which was safer, cheaper, and more powerful than nitroglycerine, which had been the most commonly used explosive. Nobel licensed the Giant Powder Company to produce dynamite in California later that year. Giant was the first American company to produce dynamite, and its plant was initially located in Rock House Canyon, in what is today the City of San Francisco. The California Powder Works began manufacturing dynamite in the same area in 1869.[9]

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[1] Mildred B. Hoover, Hero E. Rensch, Ethel G. Rensch, Douglas E. Kyle, *Historic Spots in California, Fourth Edition*, Stanford University Press, Stanford, California: 1958, p. 129.

[2] Donald Bastin, *Images of America: Richmond*, Arcadia Publishing, Charleston SC: 2003, p. 9.

[3] J.P. Munro-Fraser, *History of Contra Costa County, California*, W.A. Slocum & Co., San Francisco: 1882, p. 55 – 57.

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[5] Roland Oliver, "Recollections of Early Industries in Stege", August 7, 1959, p. 1.

[6] J.P. Munro-Fraser, p. 675.

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[8] Hulanski p. 288.

[9] Ida Mae Purcell, *History of Contra Costa County*, The Gillick Press, Berkeley, California" 1940, p. 645 – 646.

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During the 1870s chemical and explosives manufacturers began opening in the vicinity of what would eventually become Richmond. The Tonite Powder Company, Western Mineral Company, and California Cap Company were established at 1877 on the Stege ranch. The San Francisco explosives companies soon followed those explosive companies across the bay to Contra Costa County. In 1880, Giant relocated to Point Pinole, changing its name to the Atlas Powder Company. The California Powder Works soon followed, building a new factory in Hercules, which was named for the brand under which the company sold its powder.[11] The Vulcan Powder Works and Judson Powder works also opened in the Stege Ranch area during this era, consolidating Contra Costa County's position as the cradle of the California explosives industry. The East Bay dominated California explosives manufacturing into the twentieth century. In 1902 California had only one powder factory outside Contra Costa and Alameda counties.[12]

William Letts Oliver

William Letts Oliver was born in Chile to English parents in 1844. He attended the University of Edinburgh and became a mining engineer. After returning to Chile, Oliver ran an explosives factory, which was nationalized by the Chilean government in 1864. After the loss of his factory, Oliver left Chile for San Francisco.[13] William Letts Oliver and his wife Carrie lived in Oakland, from about 1880 until Oliver's death in 1918.[14] The couple eventually had six children together: Roland, Edwin, Caroline, Anita, William Harold, and Albert.[15] In addition his various professional activities William Letts Oliver was a yachtsman and an officer of the Bohemian Grove club in the early twentieth century. An avid amateur photographer throughout his lifetime, UC Berkeley's Bancroft Library has a collection of 2700 negatives and prints taken by Oliver and his son.[16]

William Letts Oliver initially gained familiarity with an explosive called guncotton while manufacturing collodion for his photography hobby.[17] As early as 1870, European explosive companies were experimenting with nitrated guncotton in and by 1875 it was manufactured in England under the name "tonite."[18] By 1877 Oliver had left Chile and was mining in the western United States. Engineers working on the Sutro Tunnel in the Comstock

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[10] James E. Vance, *Geography and Urban Evolution in the San Francisco Bay Area,* University of California, Berkeley: 1964, p. 27.

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[13] Pacific Mining News, Supplement to Engineering & Mining Journal-Press, "Industrial Notes: Developing of the Blasting Cap Industry", Vol. 1, No. 7, November 1922, p. 222.

[14] United States Census Bureau, Tenth Census of the United States, 1880, National Archives and Records Administration, Washington, D.C., San Francisco, California, Roll: 79, Film: 1254079, Page: 170B.

[15] United States Census Bureau, Twelfth Census of the United States, 1900, National Archives and Records Administration, Washington, D.C., Oakland Ward 3, Alameda, California, Roll: 82, Page: 13A.

[16] Online Archive of California, "Guide to the Oliver Family Photograph Collection", UC Berkeley: 2009, website: http://www.oac.cdlib.org/findaid/ark:/13030/ft0q2n99r1/ accessed February, 2013.

[17] Pacific Mining News, p. 222.

[18] G.A. Price Cuxson, ed., "Society of Engineers: Transactions for 1889", E. & F. N. Spon, London: 1890, p. 95.

needed an explosive that would remain stable at the high temperatures underground to complete the tunnel, and Oliver was able to solve the problem by substituting tonite for more volatile compounds.[19]

The California Cap Company

In 1877 William Letts Oliver was inspired by his success with tonite to leave mining and establish the Tonite Powder Company, on a portion of the former Stege Ranch.[20] In the 1870s all blasting caps in the United States had to be imported from Europe. Not only were they expensive, but the timing of deliveries was uncertain, creating business difficulties for the powder plant. Oliver was determined to create his own caps in order to protect the tonite factory business. He experimented until he came up with a blasting cap that was safer to use and had better detonating qualities than imported detonators. Oliver and his partner Freeborn Fletter founded the California Cap Company. It was located adjacent to the Tonite Powder Company a 160 acre parcel carved out of the southern portion of Stege Ranch.[21] California Cap Company, which went on to operate on the site for nearly seven decades, was the first manufacturer of blasting caps in the United States. Richard Stege, meanwhile, continued to reside on the ranch, and contracted with Tonite Powder and California Cap to transport their products to the railroad.[22] The California Cap Company was located on the parcel that is currently the Richmond Field Station. The Tonite Powder Company appears to have been located to the east on the parcel that became the Stauffer Chemical Company and later the Zeneca site, although its exact location is unclear.

The Tonite and California Cap factories, which were the first of several gunpowder and chemical companies in the region, were separated by the Stege agricultural warehouse for safety.[23] The explosives industry during this era was an extremely dangerous one. A horrific explosion in 1882 at the nearby Vulcan Powder Company caused 11 deaths and destroyed the plant.[24] Between 1882 and 1918 the Hercules and Atlas plants suffered numerous explosions which destroyed plant buildings and killed a total of 64 workers.[25] Despite its focus on safety, the California Cap Company had accidents as well. Two of its Chinese workers were killed in 1917 when one of them dropped a tray of caps. In 1941 an explosion caused a fire and critically injured a worker.[26]

William Letts Oliver continued to innovate throughout his long career in the chemical and explosives industries. In 1888 he formed the American Lucol Company adjacent to the California Cap Company property.[27] The Lucol plant was at what is currently the southeastern corner of the Richmond Field Station, at the approximate location of Building 163. Lucol manufactured a linseed oil substitute.[28] The factory was dismantled and relocated to New Jersey circa 1900.[29] In 1903 the Hotaling Briquette Works opened on Lucol's site at the southeast corner of the current Richmond Field station property.[30] Later known as the U.S. Briquette Company, the plant appears to have

[19] Pacific Mining News, p. 222.
[20] Oliver, p. 1.
[21] Pacific Mining News, p. 222.
[22] Nilda Rego, "Enterprising Stege lost all and died without a penny", Time Out, March 27, 1994, p. 2, column 4.
[23] Oliver, p. 1.
[24] Munro-Fraser, p. 424.
[25] Purcell, p. 648.
[26] Contra Costa County Standard, "Stege Powder Plant Blast; One Near Death", June 6, 1941, p. 1A.
[27] Oliver, p. 1.
[28] Max Wilhelm Von Bernewitz, *Cyanide Practice, 1910 – 1913*, Dewey Publishing Company: 1913, p. 327.
[29] Oliver, p. 1.
[30] Oliver, p. 2.

operated at this location until at least 1917.[31] The U.S. Briquette Company buildings were demolished sometime in the 1960s.

The Oliver family aggressively promoted their products both through advertising and publishing. The California Cap Company sponsored or published both articles and book-length treatises on the use of explosives. Safety was a key element of the company image, a topic of company-sponsored technical writing as well as a selling point in advertisements.[32] The Tonite Powder Company's product was known even outside the United States, and by the end of the nineteenth century the powder's explosive properties were considered comparable to the finest English products.[33] Oliver's sons Roland and Edwin Letts Oliver both graduated from UC Berkeley's College of Mining in 1900. Roland Oliver seems to have spent his entire career working in the family enterprises, while Edwin worked at California Cap between mining and other ventures. The Oliver family also became benefactors of the university, and in 1917 the California Cap Company donated substantial amounts of their products to the College of Mining including 500 electric detonators, 500 delayed action exploders, and 500 blasting caps.[34]

Eventually the Tonite factory appears to have been incorporated into the California Cap Company. The Olivers also formed an entity named Pacific Cartridge Company circa 1910. The Pacific Cartridge Company operated from the California Cap plant during World War I.[35] By 1916 there were at least a dozen buildings on the site. When Oliver died in 1918 his son Roland Oliver took over as president of California Cap Company. By 1922 Roland's brother Leslie Oliver was assistant manager of the plant and Edwin Letts Oliver was a director.[36] Roland Oliver substantially expanded the California Cap Company after he took over as president. During this era the plant grew to include 150 buildings and a horse-drawn tram line.[37]

During the late nineteenth and early twentieth century the California Cap Company was one of the most important local employers.[38] As the twentieth century progressed more heavy industry came to Contra Costa County, and by 1940 the county was second only to Los Angeles in overall industrial production.[39] The nineteenth-century California Cap Company was dwarfed by the scale of some of the newer enterprises, and its physical plant and technology were aging. During World War II California Cap was able to stay open by producing delayed action incendiary bombs that were used against Japan.[40] The California Cap Company could not survive the transition to a peacetime economy, however, and by 1949 the plant was closed and the Oliver family looking for a buyer.

University Research/Richmond Field Station

After World War II UC Berkeley's Engineering Department needed an off-campus location in order to perform experiments that required more space than a laboratory. Department Chair Morrough P. O' Brien and others in the

[31] Hulanksi, p. 354.
[32] Halbert Powers Gillette, *Rock Excavation:Methods and Cost,* M.C. Clark, New York: 1904, x.
[33] Manual Eissler, *A Handbook on Modern Explosives,* Crosby, Lockwood & son, London: 1897, p. 117.
[34] University of California, *The University of California Chronicle,* University of California Press, January, 1917, p. 92.
[35] R.L. Polk & Company, *Richmond and Contra Costa County Directory, 1914 – 1915*, Oakland, California: 1915.
[36] Pacific Mining News, p.222.
[37] University of California, Berkeley, *Current Conditions Report,* Prepared by Tetra Tech EM Inc., November 21, 2008, p. 11.
[38] Marguerite Clausen, "On the Waterfront: An Oral History of Richmond, California", Regional Oral History Office, University of California, Berkeley, 1990, p. 21.
[39] Purcell, p. 649.
[40] Oliver, p. 1.

department were performing experiments with sewage, sea water, and other materials unsuited to use on a crowded campus. They also wanted a location that was not too remote. The University purchased the California Cap Company from the Oliver family for the use of the Engineering Department in 1950.[41]

The Richmond Field Station has been the location of a research overseen by numerous UC Berkeley departments over the years. The Sanitary Engineering Research Laboratory (SERL) was one of the first departments to undertake research at the site. SERL focused primarily on sewage treatment technology, and also researched pollution control and disposal of solid and liquid waste.[42] Other early projects at the field station included sea water distillation, heat transfer, and cyclic stress research.[43]

At first the Department of Engineering utilized the buildings left behind by the California Cap Company. The Department established a machine shop, computer shop, receiving facility, mail service, and other facilities in addition to laboratories in the old detonator company buildings.[44] The current Buildings 102, 110, 118, 128, 150, 152 175, and 176 all date to the cap company era and have been repurposed for the Richmond Field Station. They also constructed new buildings as funds became available, and by the mid-1950s five new buildings had been completed at the Richmond Field Station.[45] By the 1970s the department had conducted many experiments at the Richmond Field Station that could not have been performed on the main campus.

Evaluation

The following provides an evaluation of Building 185 under each NRHP/CRHR criteria.

Building 185 does not appear to meet the criteria for listing in NRHP/CRHR because it lacks historical significance. The structure has been used for a variety of purposes throughout its lifetime and as such lacks the strength of association necessary to be considered historically significant in relation to any particular events or persons (Criteria A/1 and B/2).

The utilitarian building lacks any identifiable architectural stylistic design and does not embody distinctive architectural or engineering qualities of type, period, or method of construction (Criterion C/3). In rare instances, buildings themselves can serve as sources of important information, however this building is not a principal source of important information in this regard (Criterion D/4).

As a multiple use building, Building 185 does not meet the standard of exceptional importance required for properties under 50 years old to be eligible to the NHRP (Criterion G).

[41] P.H. McGauhey, "The Sanitary Engineering Research Laboratory: Administration, Research and Consultation, 1950-1975 – An Interview Conducted by Malca Call", Regional Oral History Office, University of California, Berkeley, 1974, p. 70.

[42] University of California, Berkeley, 2008, p. 13.

[43] University of California, Berkeley, Department of Engineering, "Richmond Field Station Open House", May 28, 1952, p. 3 – 4.

[44] McGauhey, p. 71.

[45] University of California, Berkeley, Department of Engineering, "Guide for Engineering Field Station Inspection", undated, p. 3.

State of California – The Resources Agency
DEPARTMENT OF PARKS AND RECREATION
PRIMARY RECORD

Primary # _____
HRI # _____
Trinomial _____
NRHP Status Code _____
Other Listings _____
Review Code _____ Reviewer _____ Date _____

 ***Resource Name or #** (Assigned by recorder) Richmond Field Station Building 197

P1. Other Identifier: Richmond Field Station Building 197

***P2. Location:** ☐ **Not for Publication** ☒ **Unrestricted** ***a. County** Contra Costa
and (P2b and P2c or P2d. Attach a Location Map as necessary.)
***b. USGS 7.5′ Quad** Richmond **Date** 1984 **T**___; **R** ____; __ ¼ **of Sec** ___; Diablo **B.M.**
c. Address _____ City _____ Zip _____
d. UTM: (give more than one for large and/or linear resources) Zone 10 ; 558614 mE/ 4196460 mN
e. Other Locational Data: (e.g., parcel #, directions to resource, elevation, etc., as appropriate)

***P3a. Description:** (Describe resource and its major elements. Include design, materials, condition, alterations, size, setting, and boundaries)
Building 197 is along the southeastern border of the Richmond Field Station. It is set back from Egret Way to the east adjacent to building 117. Its primary façade faces northeast. The utilitarian building does not strongly express any particular architecture style. It is single story, rectangular in plan, 2,419 square feet, and constructed in 1975. The building is topped with a very shallow-pitched, side-gabled roof. Its roof and walls are clad in corrugated metal. Fenestration is an aluminum sliding sash. Three large open bays provide access to the northern end of the primary (northeast) elevation. A large metal roll up door is at its southern end. The entrance at the south end of the northwest elevation is a flush metal door. UC Berkeley constructed Building 197 in 1975. It has been used for support and heavy vehicle storage since its construction. In addition, drums containing waste petroleum products are stored in the building. The building is not of historic age as it is 38 years old.

***P3b. Resource Attributes:** (List attributes and codes) HP4: Ancillary Building

***P4. Resources Present:** ☒ Building ☐ Structure ☐ Object ☐ Site ☐ District ☐ Element of District ☐ Other (Isolates, etc.)

P5b. Description of Photo: (View, date, accession #) Photograph 1: Northwest and southwest facades of building, camera facing east, January 4, 2013.

***P6. Date Constructed/Age and Sources:**
☒ Historic ☐ Prehistoric ☐ Both
1975/UC Berkeley records

***P7. Owner and Address:**
U.C. Berkeley
1301 South 46th Street
Richmond, California 94804

***P8. Recorded by:** (Name, affiliation, address)
Kara Brunzell & Julia Mates
Tetra Tech
1999 Harrison Street, Ste 500
Oakland, CA 94612

***P9. Date Recorded:** January 4, 2013

***P10. Survey Type:** (Describe) Intensive

***P11. Report Citation:** (Cite survey report and other sources, or enter "none.") *Historic Properties Survey Report for Portions of the Richmond Field Station* prepared by Tetra Tech, Inc, 2013.

***Attachments:** NONE ☒ Location Map ☐ Sketch Map ☒ Continuation Sheet ☒ Building, Structure, and Object Record ☐ Archaeological Record ☐ District Record ☐ Linear Feature Record ☐ Milling Station Record ☐ Rock Art Record ☐ Artifact Record ☐ Photograph Record ☐ Other (list) _____

***NRHP Status Code** 6Z

***Resource Name or #** (Assigned by recorder) Richmond Field Station Building 197

B1. Historic Name: _____

B2. Common Name: Building 197

B3. Original Use: Vehicle Storage B4. Present Use: Vehicle Storage

***B5. Architectural Style:** Vernacular

***B6. Construction History:** (Construction date, alteration, and date of alterations) Constructed in 1975

***B7. Moved?** ☒ **No** ☐ **Yes** ☐ **Unknown** **Date:** _____ **Original Location:** _____

***B8. Related Features:** _____

B9. Architect: Unknown b. Builder: Unknown

***B10. Significance: Theme** N/A **Area** N/A

Period of Significance N/A **Property Type** N/A **Applicable Criteria** N/A

(Discuss importance in terms of historical or architectural context as defined by theme, period, and geographic scope. Also address integrity.)

Building 197 at Richmond Field Station does not appear to meet the criteria for listing in the National Register of Historic Places (NRHP). Furthermore, the building has been evaluated in accordance with Section 15064.5(a)(2)-(3) of the CEQA Guidelines, using the criteria outlined in Section 5024.1 of the California Public Resources Code, and does not appear to meet the significance criteria as outlined in these guidelines. Therefore, the building is not eligible for listing in the California Register of Historical Resources (CRHR). (See Continuation Sheet)

B11. Additional Resource Attributes: (List attributes and codes)

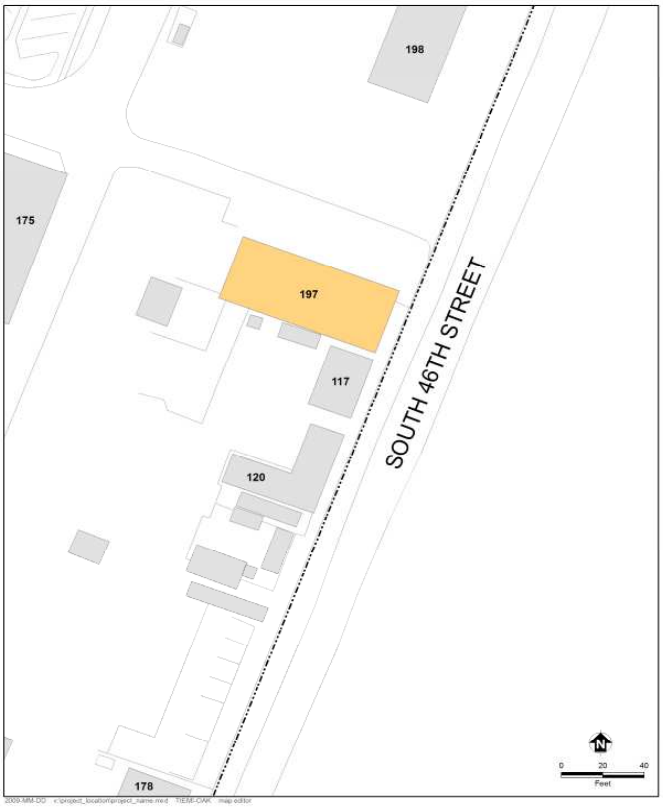
***B12. References:** See footnotes

B13. Remarks:

***B14. Evaluator:** Kara Brunzell

***Date of Evaluation:** January 2013

(This space reserved for official comments.)



B10. Significance (continued)

Historic Context

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William Letts Oliver continued to innovate throughout his long career in the chemical and explosives industries. In 1888 he formed the American Lucol Company adjacent to the California Cap Company property.[27] The Lucol plant was at what is currently the southeastern corner of the Richmond Field Station, at the approximate location of Building 163. Lucol manufactured a linseed oil substitute.[28] The factory was dismantled and relocated to New Jersey circa 1900.[29] In 1903 the Hotaling Briquette Works opened on Lucol's site at the southeast corner of the current Richmond Field station property.[30] Later known as the U.S. Briquette Company, the plant appears to have

[19] Pacific Mining News, p. 222.
[20] Oliver, p. 1.
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[22] Nilda Rego, "Enterprising Stege lost all and died without a penny", Time Out, March 27, 1994, p. 2, column 4.
[23] Oliver, p. 1.
[24] Munro-Fraser, p. 424.
[25] Purcell, p. 648.
[26] Contra Costa County Standard, "Stege Powder Plant Blast; One Near Death", June 6, 1941, p. 1A.
[27] Oliver, p. 1.
[28] Max Wilhelm Von Bernewitz, *Cyanide Practice, 1910 – 1913*, Dewey Publishing Company: 1913, p. 327.
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operated at this location until at least 1917.[31] The U.S. Briquette Company buildings were demolished sometime in the 1960s.

The Oliver family aggressively promoted their products both through advertising and publishing. The California Cap Company sponsored or published both articles and book-length treatises on the use of explosives. Safety was a key element of the company image, a topic of company-sponsored technical writing as well as a selling point in advertisements.[32] The Tonite Powder Company's product was known even outside the United States, and by the end of the nineteenth century the powder's explosive properties were considered comparable to the finest English products.[33] Oliver's sons Roland and Edwin Letts Oliver both graduated from UC Berkeley's College of Mining in 1900. Roland Oliver seems to have spent his entire career working in the family enterprises, while Edwin worked at California Cap between mining and other ventures. The Oliver family also became benefactors of the university, and in 1917 the California Cap Company donated substantial amounts of their products to the College of Mining including 500 electric detonators, 500 delayed action exploders, and 500 blasting caps.[34]

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During the late nineteenth and early twentieth century the California Cap Company was one of the most important local employers.[38] As the twentieth century progressed more heavy industry came to Contra Costa County, and by 1940 the county was second only to Los Angeles in overall industrial production.[39] The nineteenth-century California Cap Company was dwarfed by the scale of some of the newer enterprises, and its physical plant and technology were aging. During World War II California Cap was able to stay open by producing delayed action incendiary bombs that were used against Japan.[40] The California Cap Company could not survive the transition to a peacetime economy, however, and by 1949 the plant was closed and the Oliver family looking for a buyer.

University Research/Richmond Field Station

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[30] Oliver, p. 2.
[31] Hulanksi, p. 354.
[32] Halbert Powers Gillette, *Rock Excavation:Methods and Cost,* M.C. Clark, New York: 1904, x.
[33] Manual Eissler, *A Handbook on Modern Explosives,* Crosby, Lockwood & son, London: 1897, p. 117.
[34] University of California, *The University of California Chronicle,* University of California Press, January, 1917, p. 92.
[35] R.L. Polk & Company, *Richmond and Contra Costa County Directory, 1914 – 1915*, Oakland, California: 1915.
[36] Pacific Mining News, p.222.
[37] University of California, Berkeley, *Current Conditions Report,* Prepared by Tetra Tech EM Inc., November 21, 2008, p. 11.
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[40] Oliver, p. 1.

After World War II UC Berkeley's Engineering Department needed an off-campus location in order to perform experiments that required more space than a laboratory. Department Chair Morrough P. O' Brien and others in the department were performing experiments with sewage, sea water, and other materials unsuited to use on a crowded campus. They also wanted a location that was not too remote. The University purchased the California Cap Company from the Oliver family for the use of the Engineering Department in 1950.[41]

The Richmond Field Station has been the location of a research overseen by numerous UC Berkeley departments over the years. The Sanitary Engineering Research Laboratory (SERL) was one of the first departments to undertake research at the site. SERL focused primarily on sewage treatment technology, and also researched pollution control and disposal of solid and liquid waste.[42] Other early projects at the field station included sea water distillation, heat transfer, and cyclic stress research.[43]

At first the Department of Engineering utilized the buildings left behind by the California Cap Company. The Department established a machine shop, computer shop, receiving facility, mail service, and other facilities in addition to laboratories in the old detonator company buildings.[44] The current Buildings 102, 110, 118, 128, 150, 152 175, and 176 all date to the cap company era and have been repurposed for the Richmond Field Station. They also constructed new buildings as funds became available, and by the mid-1950s five new buildings had been completed at the Richmond Field Station.[45] By the 1970s the department had conducted many experiments at the Richmond Field Station that could not have been performed on the main campus.

Evaluation

The following provides an evaluation of Building 197 under each NRHP and CRHR criteria.

Building 197 does not appear to meet the criteria for listing in National Register of Historic Places because it lacks historical significance. The structure has been used for a variety of purposes throughout its lifetime and as such lacks the strength of association necessary to be considered historically significant in relation to any particular events or persons (Criteria A/1 and B/2).

The utilitarian building lacks any identifiable architectural stylistic design and does not embody distinctive architectural or engineering qualities of type, period, or method of construction (Criterion C/3). In rare instances, buildings themselves can serve as sources of important information, however this building is not a principal source of important information in this regard (Criterion D/4).

As a storage facility Building 197 does not meet the standard of exceptional importance required for properties under 50 years old to be eligible to the NHRP (Criterion G).

[41] P.H. McGauhey, "The Sanitary Engineering Research Laboratory: Administration, Research and Consultation, 1950-1975 – An Interview Conducted by Malca Call", Regional Oral History Office, University of California, Berkeley, 1974, p. 70.
[42] University of California, Berkeley, 2008, p. 13.
[43] University of California, Berkeley, Department of Engineering, "Richmond Field Station Open House", May 28, 1952, p. 3 – 4.
[44] McGauhey, p. 71.
[45] University of California, Berkeley, Department of Engineering, "Guide for Engineering Field Station Inspection", undated, p. 3.

State of California – The Resources Agency
DEPARTMENT OF PARKS AND RECREATION

PRIMARY RECORD

Primary # _____
HRI # _____
Trinomial _____
NRHP Status Code _____
Other Listings _____
Review Code _____ Reviewer _____ Date _____

 ***Resource Name or #** (Assigned by recorder) Richmond Field Station Building 275

P1. Other Identifier: Richmond Field Station Building 275

***P2. Location:** ☐ **Not for Publication** ☒ **Unrestricted** ***a. County** Contra Costa
and (P2b and P2c or P2d. Attach a Location Map as necessary.)
***b. USGS 7.5′ Quad** Richmond **Date** 1984 **T**___; **R** ____; __ ¼ **of Sec** ___; Diablo **B.M.**
c. Address _____ City _____ Zip _____
d. UTM: (give more than one for large and/or linear resources) Zone 10 ; 558393 mE/ 4196523 mN
e. Other Locational Data: (e.g., parcel #, directions to resource, elevation, etc., as appropriate)

***P3a. Description:** (Describe resource and its major elements. Include design, materials, condition, alterations, size, setting, and boundaries)
Building 275 is in the southern portion of the Richmond Field Station. It is on the south side of Lark Drive between Building 153 and Building 276, with its primary façade facing northeast. The vernacular building does not strongly express any particular architecture style. It is single story, irregular in plan, 7,914 square feet, constructed in 1956. (See Continuation Sheet)

***P3b. Resource Attributes:** (List attributes and codes) HP15: Educational building; HP39: Other

***P4. Resources Present:** ☒ Building ☐ Structure ☐ Object ☐ Site ☐ District ☐ Element of District ☐ Other (Isolates, etc.)

P5b. Description of Photo: (View, date, accession #) Photograph 1: Northeast and southeast facades of building, camera facing southwest, January 4, 2013.

***P6. Date Constructed/Age and Sources:**
☒ Historic ☐ Prehistoric ☐ Both
1956/UC Berkeley records

***P7. Owner and Address:**
U.C. Berkeley
1301 South 46th Street
Richmond, California 94804

***P8. Recorded by:** (Name, affiliation, address)
Kara Brunzell & Julia Mates
Tetra Tech
1999 Harrison Street, Ste 500
Oakland, CA 94612

***P9. Date Recorded:** January 4, 2013

***P10. Survey Type:** (Describe) Intensive

***P11. Report Citation:** (Cite survey report and other sources, or enter "none.") *Historic Properties Survey Report for Portions of the Richmond Field Station* prepared by Tetra Tech, Inc, 2013.

***Attachments:** NONE ☒ Location Map ☐ Sketch Map ☒ Continuation Sheet ☒ Building, Structure, and Object Record ☐ Archaeological Record ☐ District Record ☐ Linear Feature Record ☐ Milling Station Record ☐ Rock Art Record ☐ Artifact Record ☐ Photograph Record ☐ Other (list) _____

***NRHP Status Code** 6Z

***Resource Name or #** (Assigned by recorder) Richmond Field Station Building 275

B1. Historic Name: _____

B2. Common Name: Building 275

B3. Original Use: Research B4. Present Use: Research/offices

***B5. Architectural Style:** Vernacular

***B6. Construction History:** (Construction date, alteration, and date of alterations) Constructed in 1956
1966: Addition constructed

***B7. Moved?** ☒ **No** ☐ **Yes** ☐ **Unknown** **Date:** _____ **Original Location:** _____

***B8. Related Features:** _____

B9. Architect: Unknown b. Builder: Unknown

***B10. Significance: Theme** N/A **Area** N/A

Period of Significance N/A **Property Type** N/A **Applicable Criteria** N/A

(Discuss importance in terms of historical or architectural context as defined by theme, period, and geographic scope. Also address integrity.)

Building 275 at Richmond Field Station does not appear to meet the criteria for listing in the National Register of Historic Places (NRHP). Furthermore, the building has been evaluated in accordance with Section 15064.5(a)(2)-(3) of the CEQA Guidelines, using the criteria outlined in Section 5024.1 of the California Public Resources Code, and does not appear to meet the significance criteria as outlined in these guidelines. Therefore, the building is not eligible for listing in the California Register of Historical Resources (CRHR). (See Continuation Sheet.)

B11. Additional Resource Attributes: (List attributes and codes)

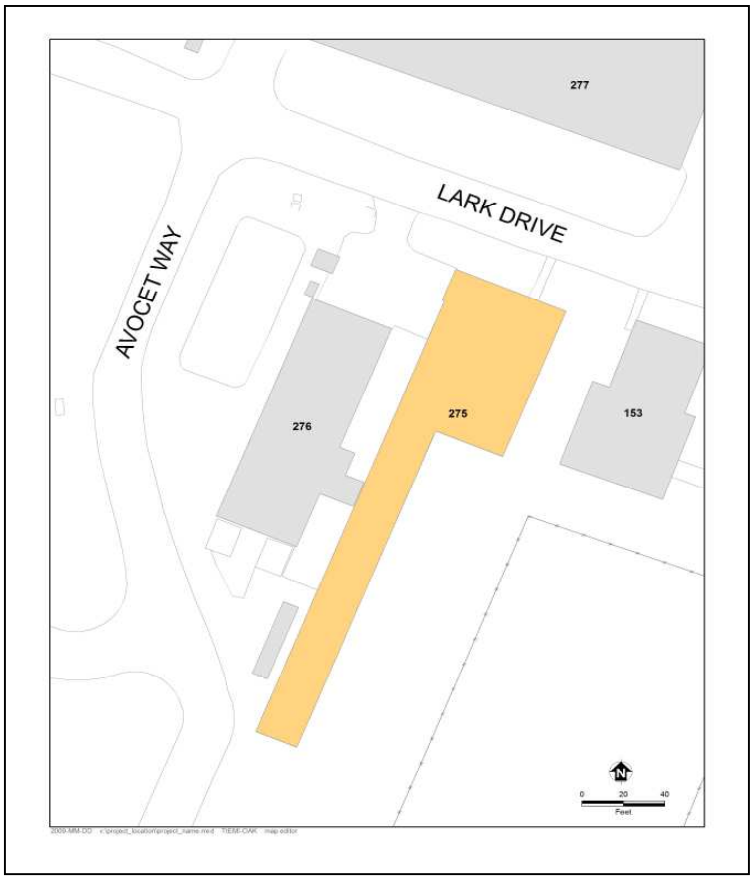
***B12. References:** See Footnotes

B13. Remarks:

***B14. Evaluator:** Kara Brunzell

***Date of Evaluation:** January 2013

(This space reserved for official comments.)



P3a. Description (continued)

The front portion of the building, adjacent to Lark Drive, is topped with a flat roof featuring a broad eave overhang with large exposed roof members. The walls are sided in smooth stucco with vertical wood trim. Fenestration is fixed and awning metal sashes. The entrance is a flush door with a window at the east end of the primary (northeast) elevation.

An older, front-gabled building, with its front gable visible behind the flat roof, is joined to the rear of the main section of the building. Its roof and walls are clad in corrugated metal. Fenestration is multiple light fixed metal sashes. This older section of the building has no entryways.

UC Berkeley constructed building 275 in 1956. Originally it consisted of the long narrow section currently the southwest wing of the building. It was used as a laboratory for hydraulic and coastal engineering, and to test ship hull designs.[1] The facility included a towing tank for experiments. Historic aerial photographs indicate that the front (northeast) portion of the building along Lark Drive was constructed in 1966. The building currently houses offices.

B10. Significance (continued)

Historic Context

Europeans arrived in what would become Contra Costa County in 1772, when a Spanish expedition led by Pedro Fages discovered the San Pablo Bay and the confluence of the Sacramento and San Joaquin rivers.[2] Though subsequent Spanish expeditions passed through the region the Spanish do not appear to have settled in the area during the mission period. In the 1820s and 1830s the Mexican government began granting large tracts of land in the area to its citizens, including Ranchos San Pablo, San Ramon, and Pinole. The first permanent non-native settlers were Francisco Castro and his wife Maria Gabriela Berryessa. The Mexican government granted the 18,000 acre Rancho San Pablo to the Castros in 1823.[3] Americans began farming in Contra Costa County in the late 1830s, and by 1882 2/3 of the cultivated land in the county was devoted to wheat production.[4]

Minna C. C. Quilfelt (or Quilfeldt) purchased 600 acres of Rancho San Pablo in 1852 and 1853.[5] Adjacent to San Francisco Bay in what would eventually become the southern portion of the City of Richmond, a wharf and produce warehouse were constructed on the ranch in the 1860s to ship agricultural produce to the San Francisco markets from Rancho San Pablo as well as the Quilfelt ranch. The warehouse and wharf were used to transport cattle, grain, fruit, and in later years the frogs' legs raised by Richard Stege for the San Francisco restaurant market.[6] German native Richard Stege settled on Rancho San Pablo in the late 1860s after stints in the gold fields and the Siberian fur trade. He married Minna Quilfelt, who was a widow, in 1870.[7] Minna Quilfelt Stege died in 1879, leaving the ranch to Stege and her daughter Edith. Stege began selling off portions of his ranch to raise

[1] University of California, Berkeley, 2008, p. 14.

[2] Mildred B. Hoover, Hero E. Rensch, Ethel G. Rensch, Douglas E. Kyle, *Historic Spots in California, Fourth Edition*, Stanford University Press, Stanford, California: 1958, p. 129.

[3] Donald Bastin, *Images of America: Richmond*, Arcadia Publishing, Charleston SC: 2003, p. 9.

[4] J.P. Munro-Fraser, *History of Contra Costa County, California*, W.A. Slocum & Co., San Francisco: 1882, p. 55 – 57.

[5] Evan Griffins, "Early History of Richmond", December 1938, El Cerrito Historical Society, website: http://www.elcerritowire.com/history/pages/EarlyRichmond.htm, accessed January 2013.

[6] Roland Oliver, "Recollections of Early Industries in Stege", August 7, 1959, p. 1.

[7] J.P. Munro-Fraser, *History of Contra Costa County, California*, W.A. Slocum & Co., San Francisco: 1882, p. 675.

money while continuing his frog-raising and other ventures. A town named Stege formed on Richard Stege's holdings, and by the late nineteenth century several industries, including the California Cap Works, the United States Briquette Company, the Stauffer Chemical Works and the Stege Lumber Manufacturing Company, were operating from portions of the Stege Ranch.[8] Richmond incorporated in 1905, and by 1917 was already the largest city in Contra Costa County.[9] Stege was eventually absorbed into Richmond as the latter grew.

The Explosives Industry in Contra Costa County

Swedish chemist Alfred Nobel laid the foundation for the high-explosives industry with his innovations beginning in 1860s, inventing first a detonator and then a blasting cap. In 1867 he invented dynamite, which was safer, cheaper, and more powerful than nitroglycerine, which had been the most commonly used explosive. Nobel licensed the Giant Powder Company to produce dynamite in California later that year. Giant was the first American company to produce dynamite, and its plant was initially located in Rock House Canyon, in what is today the City of San Francisco. The California Powder Works began manufacturing dynamite in the same area in 1869.[10]

The nineteenth century explosives industry was extremely dangerous, and as San Francisco's population grew explosives manufacturers needed to relocate. Contra Costa County across the bay was attractive since it was accessible due to its proximity to the harbor yet remote from population centers. In addition, the narrow canyons of Contra Costa County, which terminate in small bays, provided a natural geographical defense against explosions by allowing factory design that placed water between different facets of explosives manufacturing.[11]

During the 1870s chemical and explosives manufacturers began opening in the vicinity of what would eventually become Richmond. The Tonite Powder Company, Western Mineral Company, and California Cap Company were established at 1877 on the Stege ranch. The San Francisco explosives companies soon followed those explosive companies across the bay to Contra Costa County. In 1880, Giant relocated to Point Pinole, changing its name to the Atlas Powder Company. The California Powder Works soon followed, building a new factory in Hercules, which was named for the brand under which the company sold its powder.[12] The Vulcan Powder Works and Judson Powder works also opened in the Stege Ranch area during this era, consolidating Contra Costa County's position as the cradle of the California explosives industry. The East Bay dominated California explosives manufacturing into the twentieth century. In 1902 California had only one powder factory outside Contra Costa and Alameda counties.[13]

William Letts Oliver

William Letts Oliver was born in Chile to English parents in 1844. He attended the University of Edinburgh and became a mining engineer. After returning to Chile, Oliver ran an explosives factory, which was nationalized by the Chilean government in 1864. After the loss of his factory, Oliver left Chile for San Francisco.[14] William Letts

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[8] Frederick J. Hulaniski, *The History of Contra Costa County, California*. Elms Publishing Company, Berkeley, California: 1917, p. 354.

[9] Hulanski p. 288.

[10] Ida Mae Purcell, *History of Contra Costa County*, The Gillick Press, Berkeley, California" 1940, p. 645 – 646.

[11] James E. Vance, *Geography and Urban Evolution in the San Francisco Bay Area*, University of California, Berkeley: 1964, p. 27.

[12] Purcell, p. 646.

[13] Richmond Record, "Contra Costa County: Under the Vitascope", Richmond:1902.

[14] Pacific Mining News, Supplement to Engineering & Mining Journal-Press, "Industrial Notes: Developing of the Blasting Cap Industry", Vol. 1, No. 7, November 1922, p. 222.

Oliver and his wife Carrie lived in Oakland, from about 1880 until Oliver's death in 1918.[15] The couple eventually had six children together: Roland, Edwin, Caroline, Anita, William Harold, and Albert.[16] In addition his various professional activities William Letts Oliver was a yachtsman and an officer of the Bohemian Grove club in the early twentieth century. An avid amateur photographer throughout his lifetime, UC Berkeley's Bancroft Library has a collection of 2700 negatives and prints taken by Oliver and his son.[17]

William Letts Oliver initially gained familiarity with an explosive called guncotton while manufacturing collodion for his photography hobby.[18] As early as 1870, European explosive companies were experimenting with nitrated guncotton in and by 1875 it was manufactured in England under the name "tonite."[19] By 1877 Oliver had left Chile and was mining in the western United States. Engineers working on the Sutro Tunnel in the Comstock needed an explosive that would remain stable at the high temperatures underground to complete the tunnel, and Oliver was able to solve the problem by substituting tonite for more volatile compounds.[20]

The California Cap Company

In 1877 William Letts Oliver was inspired by his success with tonite to leave mining and establish the Tonite Powder Company, on a portion of the former Stege Ranch.[21] In the 1870s all blasting caps in the United States had to be imported from Europe. Not only were they expensive, but the timing of deliveries was uncertain, creating business difficulties for the powder plant. Oliver was determined to create his own caps in order to protect the tonite factory business. He experimented until he came up with a blasting cap that was safer to use and had better detonating qualities than imported detonators. Oliver and his partner Freeborn Fletter founded the California Cap Company. It was located adjacent to the Tonite Powder Company a 160 acre parcel carved out of the southern portion of Stege Ranch.[22] California Cap Company, which went on to operate on the site for nearly seven decades, was the first manufacturer of blasting caps in the United States. Richard Stege, meanwhile, continued to reside on the ranch, and contracted with Tonite Powder and California Cap to transport their products to the railroad.[23] The California Cap Company was located on the parcel that is currently the Richmond Field Station. The Tonite Powder Company appears to have been located to the east on the parcel that became the Stauffer Chemical Company and later the Zeneca site, although its exact location is unclear.

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[15] United States Census Bureau, Tenth Census of the United States, 1880, National Archives and Records Administration, Washington, D.C., San Francisco, California, Roll: 79, Film: 1254079, Page: 170B.

[16] United States Census Bureau, Twelfth Census of the United States, 1900, National Archives and Records Administration, Washington, D.C., Oakland Ward 3, Alameda, California, Roll: 82, Page: 13A.

[17] Online Archive of California, "Guide to the Oliver Family Photograph Collection", UC Berkeley:2009, website: http://www.oac.cdlib.org/findaid/ark:/13030/ft0q2n99r1/ accessed February, 2013.

[18] Pacific Mining News, p. 222.

[19] G.A. Price Cuxson, ed., "Society of Engineers: Transactions for 1889", E. & F. N. Spon, London: 1890, p. 95.

[20] Pacific Mining News, p. 222.

[21] Oliver, p. 1.

[22] Pacific Mining News, p. 222.

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[25] Munro-Fraser, p. 424.
[26] Purcell, p. 648.
[27] Contra Costa County Standard, "Stege Powder Plant Blast; One Near Death", June 6, 1941, p. 1A.
[28] Oliver, p. 1.
[29] Max Wilhelm Von Bernewitz, *Cyanide Practice, 1910 – 1913*, Dewey Publishing Company: 1913, p. 327.
[30] Oliver, p. 1.
[31] Oliver, p. 2.
[32] Hulanksi, p. 354.
[33] Halbert Powers Gillette, *Rock Excavation:Methods and Cost*, M.C. Clark, New York: 1904, x.
[34] Manual Eissler, *A Handbook on Modern Explosives*, Crosby, Lockwood & son, London: 1897, p. 117.
[35] University of California, *The University of California Chronicle*, University of California Press, January, 1917, p. 92.
[36] R.L. Polk & Company, *Richmond and Contra Costa County Directory, 1914 – 1915*, Oakland, California: 1915.
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Evaluation

[38] University of California, Berkeley, *Current Conditions Report,* Prepared by Tetra Tech EM Inc., November 21, 2008, p. 11.

[39] Marguerite Clausen, "On the Waterfront: An Oral History of Richmond, California", Regional Oral History Office, University of California, Berkeley, 1990, p. 21.

[40] Purcell, p. 649.

[41] Oliver, p. 1.

[42] P.H. McGauhey, "The Sanitary Engineering Research Laboratory: Administration, Research and Consultation, 1950-1975 – An Interview Conducted by Malca Call", Regional Oral History Office, University of California, Berkeley, 1974, p. 70.

[43] University of California, Berkeley, 2008, p. 13.

[44] University of California, Berkeley, Department of Engineering, "Richmond Field Station Open House", May 28, 1952, p. 3 – 4.

[45] McGauhey, p. 71.

[46] University of California, Berkeley, Department of Engineering, "Guide for Engineering Field Station Inspection", undated, p. 3.

The following provides an evaluation of Building 275 under each NRHP/CRHR criteria.

Building 275 does not appear to meet the criteria for listing in NRHP/CRHR because it lacks historical significance. The structure has been used for research throughout its lifetime and as such lacks the strength of association necessary to be considered historically significant in relation to any particular events or persons (Criteria A/1 and B/2).

The utilitarian building lacks any identifiable architectural stylistic design and does not embody distinctive architectural or engineering qualities of type, period, or method of construction (Criterion C/3). In rare instances, buildings themselves can serve as sources of important information, however this building is not a principal source of important information in this regard (Criterion D/4).

State of California – The Resources Agency
DEPARTMENT OF PARKS AND RECREATION

PRIMARY RECORD

Primary # _____
HRI # _____
Trinomial _____
NRHP Status Code _____
Other Listings _____
Review Code _____ Reviewer _____ Date _____

 ***Resource Name or #** (Assigned by recorder) Richmond Field Station Building 276

P1. Other Identifier: Richmond Field Station Building 276

***P2. Location:** ☐ **Not for Publication** ☒ **Unrestricted** ***a. County** Contra Costa
and (P2b and P2c or P2d. Attach a Location Map as necessary.)
***b. USGS 7.5′ Quad** Richmond **Date** 1984 **T**___; **R** ____; __ ¼ **of Sec** ___; Diablo **B.M.**
c. Address _____ City _____ Zip_____
d. UTM: (give more than one for large and/or linear resources) Zone 10 ; 396633 mE/ 4396112 mN
e. Other Locational Data: (e.g., parcel #, directions to resource, elevation, etc., as appropriate)

***P3a. Description:** (Describe resource and its major elements. Include design, materials, condition, alterations, size, setting, and boundaries)
Building 276 is in the southern portion of the Richmond Field Station. It is on the south side of Lark Drive adjacent to Building 276, with its primary façade facing northeast. The utilitarian building does not strongly express any particular architecture style. It is single story and rectangular in plan.

The building is topped with a front-gabled roof. Its walls are corrugated metal. Fenestration is multi-light metal sashes. The main entrance is through a flush metal industrial door. A shed roofed addition projects from the rear elevation of the building.

***P3b. Resource Attributes:** (List attributes and codes) HP4: Ancillary Building

***P4. Resources Present:** ☒ Building ☐ Structure ☐ Object ☐ Site ☐ District ☐ Element of District ☐ Other (Isolates, etc.)

P5b. Description of Photo: (View, date, accession #) Photograph 1: Northeast façade of building, camera facing south, January 4, 2013.

***P6. Date Constructed/Age and Sources:**
☒ Historic ☐ Prehistoric ☐ Both
1958

***P7. Owner and Address:**
U.C. Berkeley
1301 South 46th Street
Richmond, California 94804

***P8. Recorded by:** (Name, affiliation, address)
Kara Brunzell & Julia Mates
Tetra Tech
1999 Harrison Street, Ste 500
Oakland, CA 94612

***P9. Date Recorded:** January 4, 2013
***P10. Survey Type:** (Describe) Intensive

***P11. Report Citation:** (Cite survey report and other sources, or enter "none.") *Historic Properties Survey Report for Portions of the Richmond Field Station* prepared by Tetra Tech, Inc, 2013.
***Attachments:** NONE ☒ Location Map ☐ Sketch Map ☒ Continuation Sheet ☒ Building, Structure, and Object Record ☐ Archaeological Record ☐ District Record ☐ Linear Feature Record ☐ Milling Station Record ☐ Rock Art Record ☐ Artifact Record ☐ Photograph Record ☐ Other (list) _____

***NRHP Status Code** 6Z

***Resource Name or #** (Assigned by recorder) Richmond Field Station Building 276

B1. Historic Name: _____

B2. Common Name: Building 276

B3. Original Use: Research B4. Present Use: Research

***B5. Architectural Style:** Vernacular

***B6. Construction History:** (Construction date, alteration, and date of alterations) Constructed in 1958

***B7. Moved?** ☒ **No** ☐ **Yes** ☐ **Unknown** **Date:** _____ **Original Location:** _____

***B8. Related Features:** _____

B9. Architect: Unknown b. Builder: Unknown

***B10. Significance: Theme** N/A **Area** N/A

Period of Significance N/A **Property Type** N/A **Applicable Criteria** N/A

(Discuss importance in terms of historical or architectural context as defined by theme, period, and geographic scope. Also address integrity.)

Building 276 at Richmond Field Station does not appear to meet the criteria for listing in the National Register of Historic Places (NRHP). Furthermore, the building has been evaluated in accordance with Section 15064.5(a)(2)-(3) of the CEQA Guidelines, using the criteria outlined in Section 5024.1 of the California Public Resources Code, and does not appear to meet the significance criteria as outlined in these guidelines. Therefore, the building is not eligible for listing in the California Register of Historical Resources (CRHR). (See Continuation Sheet)

B11. Additional Resource Attributes: (List attributes and codes)

***B12. References:**

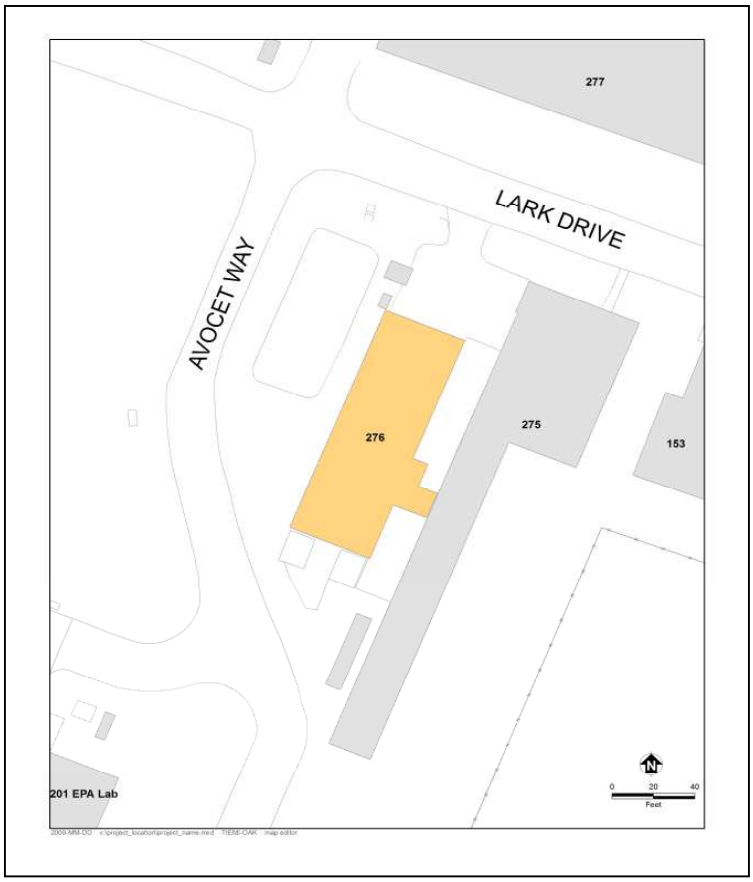
See Footnotes

B13. Remarks:

***B14. Evaluator:** Kara Brunzell

***Date of Evaluation:** January 2013

(This space reserved for official comments.)



B10. Significance (continued)

Historic Context

Europeans arrived in what would become Contra Costa County in 1772, when a Spanish expedition led by Pedro Fages discovered the San Pablo Bay and the confluence of the Sacramento and San Joaquin rivers.[1] Though subsequent Spanish expeditions passed through the region the Spanish do not appear to have settled in the area during the mission period. In the 1820s and 1830s the Mexican government began granting large tracts of land in the area to its citizens, including Ranchos San Pablo, San Ramon, and Pinole. The first permanent non-native settlers were Francisco Castro and his wife Maria Gabriela Berryessa. The Mexican government granted the 18,000 acre Rancho San Pablo to the Castros in 1823.[2] Americans began farming in Contra Costa County in the late 1830s, and by 1882 2/3 of the cultivated land in the county was devoted to wheat production.[3]

Minna C. C. Quilfelt (or Quilfeldt) purchased 600 acres of Rancho San Pablo in 1852 and 1853.[4] Adjacent to San Francisco Bay in what would eventually become the southern portion of the City of Richmond, a wharf and produce warehouse were constructed on the ranch in the 1860s to ship agricultural produce to the San Francisco markets from Rancho San Pablo as well as the Quilfelt ranch. The warehouse and wharf were used to transport cattle, grain, fruit, and in later years the frogs' legs raised by Richard Stege for the San Francisco restaurant market.[5] German native Richard Stege settled on Rancho San Pablo in the late 1860s after stints in the gold fields and the Siberian fur trade. He married Minna Quilfelt, who was a widow, in 1870.[6] Minna Quilfelt Stege died in 1879, leaving the ranch to Stege and her daughter Edith. Stege began selling off portions of his ranch to raise money while continuing his frog-raising and other ventures. A town named Stege formed on Richard Stege's holdings, and by the late nineteenth century several industries, including the California Cap Works, the United States Briquette Company, the Stauffer Chemical Works and the Stege Lumber Manufacturing Company, were operating from portions of the Stege Ranch.[7] Richmond incorporated in 1905, and by 1917 was already the largest city in Contra Costa County.[8] Stege was eventually absorbed into Richmond as the latter grew.

The Explosives Industry in Contra Costa County

Swedish chemist Alfred Nobel laid the foundation for the high-explosives industry with his innovations beginning in 1860s, inventing first a detonator and then a blasting cap. In 1867 he invented dynamite, which was safer, cheaper, and more powerful than nitroglycerine, which had been the most commonly used explosive. Nobel licensed the Giant Powder Company to produce dynamite in California later that year. Giant was the first American company to produce dynamite, and its plant was initially located in Rock House Canyon, in what is today the City of San Francisco. The California Powder Works began manufacturing dynamite in the same area in 1869.[9]

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[1] Mildred B. Hoover, Hero E. Rensch, Ethel G. Rensch, Douglas E. Kyle, *Historic Spots in California, Fourth Edition*, Stanford University Press, Stanford, California: 1958, p. 129.

[2] Donald Bastin, *Images of America: Richmond*, Arcadia Publishing, Charleston SC: 2003, p. 9.

[3] J.P. Munro-Fraser, *History of Contra Costa County, California*, W.A. Slocum & Co., San Francisco: 1882, p. 55 – 57.

[4] Evan Griffins, "Early History of Richmond", December 1938, El Cerrito Historical Society, website: http://www.elcerritowire.com/history/pages/EarlyRichmond.htm, accessed January 2013.

[5] Roland Oliver, "Recollections of Early Industries in Stege", August 7, 1959, p. 1.

[6] J.P. Munro-Fraser, *History of Contra Costa County, California*, W.A. Slocum & Co., San Francisco: 1882, p. 675.

[7] Frederick J. Hulaniski, *The History of Contra Costa County, California*. Elms Publishing Company, Berkeley, California: 1917, p. 354.

[8] Hulanski p. 288.

[9] Ida Mae Purcell, *History of Contra Costa County*, The Gillick Press, Berkeley, California" 1940, p. 645 – 646.

The nineteenth century explosives industry was extremely dangerous, and as San Francisco's population grew explosives manufacturers needed to relocate. Contra Costa County across the bay was attractive since it was accessible due to its proximity to the harbor yet remote from population centers. In addition, the narrow canyons of Contra Costa County, which terminate in small bays, provided a natural geographical defense against explosions by allowing factory design that placed water between different facets of explosives manufacturing.[10]

During the 1870s chemical and explosives manufacturers began opening in the vicinity of what would eventually become Richmond. The Tonite Powder Company, Western Mineral Company, and California Cap Company were established at 1877 on the Stege ranch. The San Francisco explosives companies soon followed those explosive companies across the bay to Contra Costa County. In 1880, Giant relocated to Point Pinole, changing its name to the Atlas Powder Company. The California Powder Works soon followed, building a new factory in Hercules, which was named for the brand under which the company sold its powder.[11] The Vulcan Powder Works and Judson Powder works also opened in the Stege Ranch area during this era, consolidating Contra Costa County's position as the cradle of the California explosives industry. The East Bay dominated California explosives manufacturing into the twentieth century. In 1902 California had only one powder factory outside Contra Costa and Alameda counties.[12]

William Letts Oliver

William Letts Oliver was born in Chile to English parents in 1844. He attended the University of Edinburgh and became a mining engineer. After returning to Chile, Oliver ran an explosives factory, which was nationalized by the Chilean government in 1864. After the loss of his factory, Oliver left Chile for San Francisco.[13] William Letts Oliver and his wife Carrie lived in Oakland, from about 1880 until Oliver's death in 1918.[14] The couple eventually had six children together: Roland, Edwin, Caroline, Anita, William Harold, and Albert.[15] In addition his various professional activities William Letts Oliver was a yachtsman and an officer of the Bohemian Grove club in the early twentieth century. An avid amateur photographer throughout his lifetime, UC Berkeley's Bancroft Library has a collection of 2700 negatives and prints taken by Oliver and his son.[16]

William Letts Oliver initially gained familiarity with an explosive called guncotton while manufacturing collodion for his photography hobby.[17] As early as 1870, European explosive companies were experimenting with nitrated guncotton in and by 1875 it was manufactured in England under the name "tonite."[18] By 1877 Oliver had left Chile and was mining in the western United States. Engineers working on the Sutro Tunnel in the Comstock

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[10] James E. Vance, *Geography and Urban Evolution in the San Francisco Bay Area,* University of California, Berkeley: 1964, p. 27.

[11] Purcell, p. 646.

[12] Richmond Record, "Contra Costa County: Under the Vitascope", Richmond:1902.

[13] Pacific Mining News, Supplement to Engineering & Mining Journal-Press, "Industrial Notes: Developing of the Blasting Cap Industry", Vol. 1, No. 7, November 1922, p. 222.

[14] United States Census Bureau, Tenth Census of the United States, 1880, National Archives and Records Administration, Washington, D.C., San Francisco, California, Roll: 79, Film: 1254079, Page: 170B.

[15] United States Census Bureau, Twelfth Census of the United States, 1900, National Archives and Records Administration, Washington, D.C., Oakland Ward 3, Alameda, California, Roll: 82, Page: 13A.

[16] Online Archive of California, "Guide to the Oliver Family Photograph Collection", UC Berkeley:2009, website: http://www.oac.cdlib.org/findaid/ark:/13030/ft0q2n99r1/ accessed February, 2013.

[17] Pacific Mining News, p. 222.

[18] G.A. Price Cuxson, ed., "Society of Engineers: Transactions for 1889", E. & F. N. Spon, London: 1890, p. 95.

needed an explosive that would remain stable at the high temperatures underground to complete the tunnel, and Oliver was able to solve the problem by substituting tonite for more volatile compounds.[19]

The California Cap Company

In 1877 William Letts Oliver was inspired by his success with tonite to leave mining and establish the Tonite Powder Company, on a portion of the former Stege Ranch.[20] In the 1870s all blasting caps in the United States had to be imported from Europe. Not only were they expensive, but the timing of deliveries was uncertain, creating business difficulties for the powder plant. Oliver was determined to create his own caps in order to protect the tonite factory business. He experimented until he came up with a blasting cap that was safer to use and had better detonating qualities than imported detonators. Oliver and his partner Freeborn Fletter founded the California Cap Company. It was located adjacent to the Tonite Powder Company a 160 acre parcel carved out of the southern portion of Stege Ranch.[21] California Cap Company, which went on to operate on the site for nearly seven decades, was the first manufacturer of blasting caps in the United States. Richard Stege, meanwhile, continued to reside on the ranch, and contracted with Tonite Powder and California Cap to transport their products to the railroad.[22] The California Cap Company was located on the parcel that is currently the Richmond Field Station. The Tonite Powder Company appears to have been located to the east on the parcel that became the Stauffer Chemical Company and later the Zeneca site, although its exact location is unclear.

The Tonite and California Cap factories, which were the first of several gunpowder and chemical companies in the region, were separated by the Stege agricultural warehouse for safety.[23] The explosives industry during this era was an extremely dangerous one. A horrific explosion in 1882 at the nearby Vulcan Powder Company caused 11 deaths and destroyed the plant.[24] Between 1882 and 1918 the Hercules and Atlas plants suffered numerous explosions which destroyed plant buildings and killed a total of 64 workers.[25] Despite its focus on safety, the California Cap Company had accidents as well. Two of its Chinese workers were killed in 1917 when one of them dropped a tray of caps. In 1941 an explosion caused a fire and critically injured a worker.[26]

William Letts Oliver continued to innovate throughout his long career in the chemical and explosives industries. In 1888 he formed the American Lucol Company adjacent to the California Cap Company property.[27] The Lucol plant was at what is currently the southeastern corner of the Richmond Field Station, at the approximate location of Building 163. Lucol manufactured a linseed oil substitute.[28] The factory was dismantled and relocated to New Jersey circa 1900.[29] In 1903 the Hotaling Briquette Works opened on Lucol's site at the southeast corner of the current Richmond Field station property.[30] Later known as the U.S. Briquette Company, the plant appears to have

[19] Pacific Mining News, p. 222.
[20] Oliver, p. 1.
[21] Pacific Mining News, p. 222.
[22] Nilda Rego, "Enterprising Stege lost all and died without a penny", Time Out, March 27, 1994, p. 2, column 4.
[23] Oliver, p. 1.
[24] Munro-Fraser, p. 424.
[25] Purcell, p. 648.
[26] Contra Costa County Standard, "Stege Powder Plant Blast; One Near Death", June 6, 1941, p. 1A.
[27] Oliver, p. 1.
[28] Max Wilhelm Von Bernewitz, *Cyanide Practice, 1910 – 1913*, Dewey Publishing Company: 1913, p. 327.
[29] Oliver, p. 1.
[30] Oliver, p. 2.

operated at this location until at least 1917.[31] The U.S. Briquette Company buildings were demolished sometime in the 1960s.

The Oliver family aggressively promoted their products both through advertising and publishing. The California Cap Company sponsored or published both articles and book-length treatises on the use of explosives. Safety was a key element of the company image, a topic of company-sponsored technical writing as well as a selling point in advertisements.[32] The Tonite Powder Company's product was known even outside the United States, and by the end of the nineteenth century the powder's explosive properties were considered comparable to the finest English products.[33] Oliver's sons Roland and Edwin Letts Oliver both graduated from UC Berkeley's College of Mining in 1900. Roland Oliver seems to have spent his entire career working in the family enterprises, while Edwin worked at California Cap between mining and other ventures. The Oliver family also became benefactors of the university, and in 1917 the California Cap Company donated substantial amounts of their products to the College of Mining including 500 electric detonators, 500 delayed action exploders, and 500 blasting caps.[34]

Eventually the Tonite factory appears to have been incorporated into the California Cap Company. The Olivers also formed an entity named Pacific Cartridge Company circa 1910. The Pacific Cartridge Company operated from the California Cap plant during World War I.[35] By 1916 there were at least a dozen buildings on the site. When Oliver died in 1918 his son Roland Oliver took over as president of California Cap Company. By 1922 Roland's brother Leslie Oliver was assistant manager of the plant and Edwin Letts Oliver was a director.[36] Roland Oliver substantially expanded the California Cap Company after he took over as president. During this era the plant grew to include 150 buildings and a horse-drawn tram line.[37]

During the late nineteenth and early twentieth century the California Cap Company was one of the most important local employers.[38] As the twentieth century progressed more heavy industry came to Contra Costa County, and by 1940 the county was second only to Los Angeles in overall industrial production.[39] The nineteenth-century California Cap Company was dwarfed by the scale of some of the newer enterprises, and its physical plant and technology were aging. During World War II California Cap was able to stay open by producing delayed action incendiary bombs that were used against Japan.[40] The California Cap Company could not survive the transition to a peacetime economy, however, and by 1949 the plant was closed and the Oliver family looking for a buyer.

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[31] Hulanksi, p. 354.
[32] Halbert Powers Gillette, *Rock Excavation:Methods and Cost,* M.C. Clark, New York: 1904, x.
[33] Manual Eissler, *A Handbook on Modern Explosives,* Crosby, Lockwood & son, London: 1897, p. 117.
[34] University of California, *The University of California Chronicle,* University of California Press, January, 1917, p. 92.
[35] R.L. Polk & Company, *Richmond and Contra Costa County Directory, 1914 – 1915*, Oakland, California: 1915.
[36] Pacific Mining News, p.222.
[37] University of California, Berkeley, *Current Conditions Report,* Prepared by Tetra Tech EM Inc., November 21, 2008, p. 11.
[38] Marguerite Clausen, "On the Waterfront: An Oral History of Richmond, California", Regional Oral History Office, University of California, Berkeley, 1990, p. 21.
[39] Purcell, p. 649.
[40] Oliver, p. 1.

University Research/Richmond Field Station

After World War II UC Berkeley's Engineering Department needed an off-campus location in order to perform experiments that required more space than a laboratory. Department Chair Morrough P. O' Brien and others in the department were performing experiments with sewage, sea water, and other materials unsuited to use on a crowded campus. They also wanted a location that was not too remote. The University purchased the California Cap Company from the Oliver family for the use of the Engineering Department in 1950.[41]

The Richmond Field Station has been the location of a research overseen by numerous UC Berkeley departments over the years. The Sanitary Engineering Research Laboratory (SERL) was one of the first departments to undertake research at the site. SERL focused primarily on sewage treatment technology, and also researched pollution control and disposal of solid and liquid waste.[42] Other early projects at the field station included sea water distillation, heat transfer, and cyclic stress research.[43]

At first the Department of Engineering utilized the buildings left behind by the California Cap Company. The Department established a machine shop, computer shop, receiving facility, mail service, and other facilities in addition to laboratories in the old detonator company buildings.[44] The current Buildings 102, 110, 118, 128, 150, 152 175, and 176 all date to the cap company era and have been repurposed for the Richmond Field Station. They also constructed new buildings as funds became available, and by the mid-1950s five new buildings had been completed at the Richmond Field Station.[45] By the 1970s the department had conducted many experiments at the Richmond Field Station that could not have been performed on the main campus.

Evaluation

Building 276 does not appear to meet the criteria for listing in NRHP/CRHR because it lacks historical significance. The structure has been used for research throughout its lifetime and lacks the strength of association necessary to be considered historically significant in relation to any particular events or persons (Criteria A/1 and B/2).

The utilitarian building lacks any identifiable architectural stylistic design and does not embody distinctive architectural or engineering qualities of type, period, or method of construction (Criterion C/3) Instead, it is a simple utilitarian building. In rare instances, buildings themselves can serve as sources of important information, however this building is not a principal source of important information in this regard (Criterion D/4).

*B12. References (continued):

Bastin, Donald. *Images of America: Richmond.* Arcadia Publishing, Charleston SC: 2003.

Clausen, Marguerite. "On the Waterfront: An Oral History of Richmond, California". Regional Oral History

[41] P.H. McGauhey, "The Sanitary Engineering Research Laboratory: Administration, Research and Consultation, 1950-1975 – An Interview Conducted by Malca Call", Regional Oral History Office, University of California, Berkeley, 1974, p. 70.
[42] University of California, Berkeley, 2008, p. 13.
[43] University of California, Berkeley, Department of Engineering, "Richmond Field Station Open House", May 28, 1952, p. 3 – 4.
[44] McGauhey, p. 71.
[45] University of California, Berkeley, Department of Engineering, "Guide for Engineering Field Station Inspection", undated, p. 3.

Office, University of California, Berkeley: 1990.

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--------Stege, California. 1912.
--------Richmond, California. 1916.
--------Richmond, California. 1949.

San Francisco Chronicle. "EPA Signs Lab Lease in Richmond". June 19, 1991.

Shackleton, Scott. University of California, Berkeley. Personal communication with Julia Mates, Tetra Tech 2013.

United States Census Bureau.
--------Tenth Census of the United States, 1880. National Archives and Records Administration, Washington, D.C. San Francisco, California, Roll: 79, Film: 1254079, Page: 170B.
--------Twelfth Census of the United States, 1900. National Archives and Records Administration, Washington, D.C. Oakland Ward 3, Alameda, California, Roll: 82, Page: 13A.

University of California, Berkeley.
--------"Current Conditions Report." Prepared by Tetra Tech EM Inc. November 21, 2008.
--------"Draft Environmental Impact Report, Proposed U.S. Environmental Protection Agency, Region IX Laboratory at the University of California's Richmond Field Station". Prepared by University of California, Berkeley Planning, Design and Construction Department. July 1991.
---------Building files. Vertical files, Room 148. Richmond Field Station.

University of California, Berkeley, Department of Engineering.
--------- "Richmond Field Station Open House." May 28, 1952.
--------- "Guide for Engineering Field Station Inspection", undated.

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BUILDINGS IN THE INDIRECT APE

State of California – The Resources Agency
DEPARTMENT OF PARKS AND RECREATION
PRIMARY RECORD

Primary # _____
HRI # _____
Trinomial _____
NRHP Status Code _____
Other Listings _____
Review Code _____ Reviewer _____ Date _____

 ***Resource Name or #** (Assigned by recorder) Richmond Field Station Building 151

P1. Other Identifier: Richmond Field Station Building 151

***P2. Location:** ☐ **Not for Publication** ☒ **Unrestricted** ***a. County** Contra Costa
and (P2b and P2c or P2d. Attach a Location Map as necessary.)
***b. USGS 7.5′ Quad** Richmond **Date** 2013 **T** 1N **; R** 4W; ___ **¼ of Sec** 20 ; Mt. Diablo **B.M.**
c. Address _____ City _____ Zip _____
d. UTM: (give more than one for large and/or linear resources) Zone 10 ; 558475 mE/ 4196552 mN
e. Other Locational Data: (e.g., parcel #, directions to resource, elevation, etc., as appropriate)

***P3a. Description:** (Describe resource and its major elements. Include design, materials, condition, alterations, size, setting, and boundaries)
Building 151 is in the southern portion of the Richmond Field Station. It is on the north side of Lark Drive, with its primary façade facing southwest. This 2,629 square-foot building is rectangular in plan and is a Soule Steel Company prefabricated building, topped with a front gabled roof. Vents are located at each gable end. The walls and roof are corrugated metal. Fenestration consists of multi-light, metal sashes. There is also a small aluminum frame window in the center of the primary façade. The main entrance consists of a metal industrial door with a glass insert located at the east end. This entrance is sheltered by a metal awning and accessed by a very gradual concrete ramp that runs across the main façade of the building. The rear of the building, at the northeast, contains an overhead mounted sliding door (Photograph 2). In 1965, a 1,600 square-foot addition was constructed on the north end of the building.

***P3b. Resource Attributes:** (List attributes and codes) P39: Other

***P4. Resources Present:** ☒ Building ☐ Structure ☐ Object ☐ Site ☐ District ☐ Element of District ☐ Other (Isolates, etc.)

P5b. Description of Photo: (View, date, accession #) Photograph 1, camera facing northeast, April 30, 2013.

***P6. Date Constructed/Age and Sources:**
☒ Historic ☐ Prehistoric ☐ Both
1961/Richmond Field Station Building Files

***P7. Owner and Address:**
University of California, Berkeley
1301 South 46th Street
Richmond, California 94804

***P8. Recorded by:** (Name, affiliation, address)
Kara Brunzell & Julia Mates
Tetra Tech
1999 Harrison Street, Ste 500
Oakland, CA 94612

***P9. Date Recorded:** April 30, 2013

***P10. Survey Type:** (Describe) Intensive

***P11. Report Citation:** (Cite survey report and other sources, or enter "none.")
Historic Properties Survey Report for Portions of the Richmond Field Station, prepared by Tetra Tech, Inc., 2013.

***Attachments:** NONE ☒ Location Map ☐ Sketch Map ☒ Continuation Sheet ☒ Building, Structure, and Object Record ☐ Archaeological Record ☐ District Record ☐ Linear Feature Record ☐ Milling Station Record ☐ Rock Art Record ☐ Artifact Record ☐ Photograph Record ☐ Other (list) _____

***NRHP Status Code** 6Z

***Resource Name or #** (Assigned by recorder) Richmond Field Station Building 151

B1. Historic Name: _____

B2. Common Name: Building 151

B3. Original Use: Research B4. Present Use: Research

***B5. Architectural Style:** Vernacular

***B6. Construction History:** (Construction date, alteration, and date of alterations) Constructed in 1961; additional 20 feet by 40 feet at each end of building, constructed 1965

***B7. Moved?** ☒ **No** ☐ **Yes** ☐ **Unknown** **Date:** _____ **Original Location:** _____

***B8. Related Features:** _____

B9. Architect: Unknown b. Builder: Unknown

***B10. Significance: Theme** N/A **Area** N/A

Period of Significance N/A **Property Type** N/A **Applicable Criteria** N/A

(Discuss importance in terms of historical or architectural context as defined by theme, period, and geographic scope. Also address integrity.)

Building 151 at the Richmond Field Station does not appear to meet the criteria for listing in the National Register of Historic Places (NRHP). Furthermore, the building has been evaluated in accordance with Section 15064.5(a)(2)-(3) of the CEQA Guidelines, using the criteria outlined in Section 5024.1 of the California Public Resources Code and does not appear to meet the significance criteria as outlined in these guidelines. Therefore, the building is not eligible for listing in the California Register of Historical Resources (CRHR). (See Continuation Sheet)

B11. Additional Resource Attributes: (List attributes and codes)

***B12. References:**

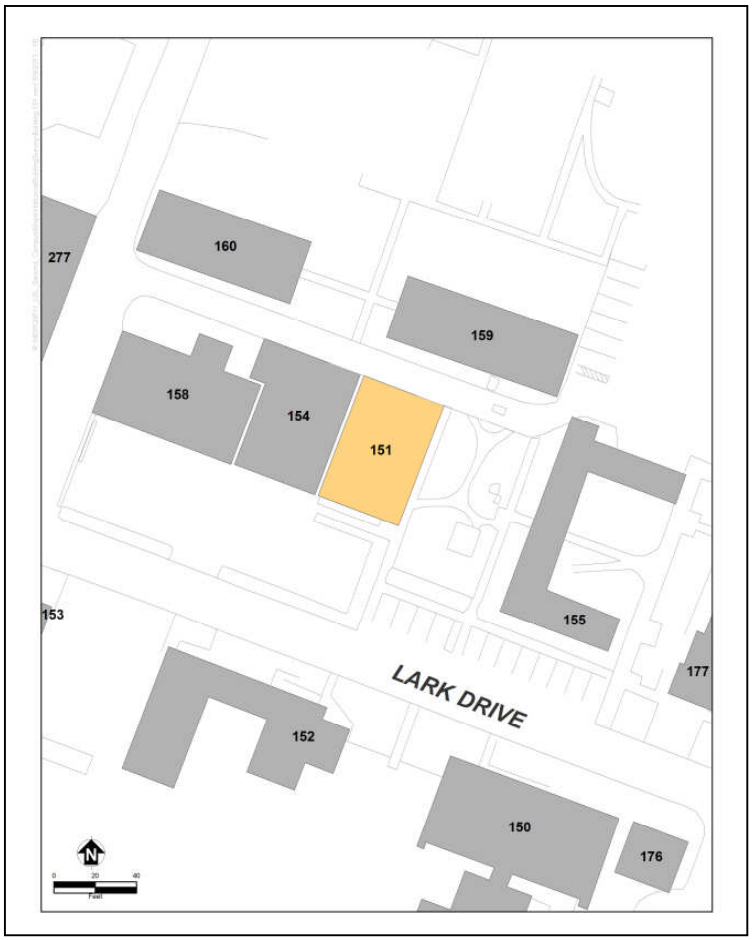
(See Footnotes)

B13. Remarks:

***B14. Evaluator:** Kara Brunzell

***Date of Evaluation:** April 2013

(This space reserved for official comments.)



B10. Significance (continued)

Historic Context

Europeans arrived in what would become Contra Costa County in 1772, when a Spanish expedition led by Pedro Fages came upon the San Pablo Bay and the confluence of the Sacramento and San Joaquin rivers.[1] Though subsequent Spanish expeditions passed through the region, the Spanish do not appear to have settled in the area during the mission period. In the 1820s and 1830s, the Mexican government began granting large tracts of land in the area to its citizens, including Ranchos San Pablo, San Ramon, and Pinole. The first permanent non-native settlers were Francisco Castro and his wife Maria Gabriela Berryessa. The Mexican government granted the 18,000-acre Rancho San Pablo to the Castros in 1823.[2] Americans began farming in Contra Costa County in the late 1830s, and by 1882, two-thirds of the cultivated land in the county was devoted to wheat production.[3]

Minna C. C. Quilfelt (or Quilfeldt) purchased 600 acres of Rancho San Pablo in 1852 and 1853.[4] German native Richard Stege settled on Rancho San Pablo in the late 1860s after stints in the gold fields and the Siberian fur trade, marrying Quilfelt and gaining title to her ranch. A town named Stege formed on Richard Stege's holdings, and by the late nineteenth century, several industries, including the California Cap Company, the United States Briquette Company, the Stauffer Chemical Works and the Stege Lumber Manufacturing Company, were operating from portions of the Stege Ranch.[5] Richmond incorporated in 1905, and by 1917 was already the largest city in Contra Costa County. Stege was eventually absorbed into Richmond as the latter grew.

William Letts Oliver established the Tonite Powder Company and California Cap Company on land purchased from the Stege Ranch in 1877. The California Cap Company, which went on to operate on the site for nearly seven decades, was the first manufacturer of blasting caps in the United States. The company was operated by Oliver's sons after his death and survived through the end of World War II. By 1949, however, the plant was closed and for sale.

University Research/Richmond Field Station

After World War II, the University of California (UC) Berkeley Engineering Department needed an off-campus location in order to perform experiments that required more space than a laboratory. Department Chair Morrough P. O'Brien and others in the department were performing experiments with sewage, sea water, and other materials unsuited for use on a crowded campus. They also wanted a location that was not too remote. UC Berkeley

[1] Mildred B. Hoover, Hero E. Rensch, Ethel G. Rensch, Douglas E. Kyle, *Historic Spots in California, Fourth Edition*, Stanford University Press, Stanford, California: 1958, p. 129.

[2] Donald Bastin, *Images of America: Richmond*, Arcadia Publishing, Charleston SC: 2003, p. 9.

[3] J.P. Munro-Fraser, *History of Contra Costa County, California*, W.A. Slocum & Co., San Francisco: 1882, p. 55 – 57.

[4] Evan Griffins, "Early History of Richmond", December 1938, El Cerrito Historical Society, website: http://www.elcerritowire.com/history/pages/EarlyRichmond.htm, accessed January 2013.

[5] Frederick J. Hulaniski, *The History of Contra Costa County, California*. Elms Publishing Company, Berkeley, California: 1917, p. 354: Hulanski p. 288.

B10. Significance (continued)

purchased the California Cap Company from the Oliver family for the use of the Engineering Department in 1950.[6]

At first, the Department of Engineering utilized the buildings left behind by the California Cap Company. The Department established a machine shop, computer shop, receiving facility, mail service, and other facilities in addition to laboratories in the old detonator company buildings.[7] The buildings currently numbered 102, 110, 118, 128, 150, 152, 155, 175, 177, 176, and 180 all date to the California Cap Company era, and were repurposed for the Richmond Field Station. UC Berkeley constructed new buildings as funds became available, and by the mid-1950s, five new buildings had been completed at the Richmond Field Station.[8] By the 1970s, the Department of Engineering had conducted many experiments at the Richmond Field Station that could not have been performed on the main campus.

The Richmond Field Station has been the location of research overseen by numerous UC Berkeley departments over the years. The Sanitary Engineering Research Laboratory (SERL) was one of the first departments to undertake research at the site. SERL focused primarily on sewage treatment technology and also researched pollution control and disposal of solid and liquid waste.[9] Other early projects at the field station included heat transfer and cyclic stress research.[10]

Another laboratory that utilized Richmond Field Station was the Sea Water Conversion Laboratory (SWCL). In 1952, congress had created and funded the Office of Saline Water in order to encourage desalination studies as a solution to water shortages.[11] In response, UC Berkeley Mechanical Engineering professor Everett D. Howe formed the SWCL at the Richmond Field Station in 1958.[12]

Building 154 was constructed circa 1957, for SWCL research, and the program continued to expand under Howe's direction for the next decade. SWCL eventually encompassed most of the buildings on the north side of Lark Drive, including Buildings 151, 155, 158, 177, and 180.[13] Howe became the coordinator for Saline Water Conversion Projects throughout the UC system and authored several books on desalination before his retirement in 1968.[14] Although Howe has been referred to as a pioneer in the solar distillation of seawater, research has not

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[6] P.H. McGauhey, "The Sanitary Engineering Research Laboratory: Administration, Research and Consultation, 1950-1975 – An Interview Conducted by Malca Call", Regional Oral History Office, University of California, Berkeley, 1974, p. 70.

[7] McGauhey, p. 71.

[8] University of California, Berkeley, Department of Engineering, "Guide for Engineering Field Station Inspection", undated, p. 3.

[9] University of California, Berkeley, 2008, p. 13.

[10] University of California, Berkeley, Department of Engineering, "Richmond Field Station Open House", May 28, 1952, p. 3 – 4.

[11] Heather Cooley, Peter H. Gleick, and Gary Wolff, "Desalination, With a Grain of Salt: A California Perspective," Pacific Institute, Oakland, California: 2006, p.11.

[12] University of California (System) Academic Senate, "1991, University of California: In Memoriam," 1991, Internet website: http://texts.cdlib.org/view?docId=hb4t1nb2bd&doc.view=frames&chunk.id=div00031&toc.depth=1&toc.id=.

[13] University of California, Berkeley, Files "Building 151", "Building 154", "Building 158", "Building 177", and "Building 180," located in vertical files in Room 148, Richmond Field Station.

[14] University of California (System) Academic Senate, "1991, University of California: In Memoriam," 1991, Internet website: http://texts.cdlib.org/view?docId=hb4t1nb2bd&doc.view=frames&chunk.id=div00031&toc.depth=1&toc.id=.

B10. Significance (continued)

revealed a significant lasting impact on desalination science resulting from his work.[15] Howe's primary contributions appear to have been administering and promoting desalination research. Breakthroughs such as reverse osmosis were developed by scientists at the University of California Los Angeles (UCLA) and the University of Florida. UCLA researchers also designed the pilot desalination plant in Coalinga, California, that went online in 1965, while Howe's role in that effort seems to have been limited to coordination.[16]

Professor Alan D.K. Laird became SWCL Director when Howe retired, a position he held until the laboratory was closed in 1987.[17] By 1978, SWCL encompassed twelve separate research projects. During this era, the cluster of buildings devoted to SWCL had grown to include Building 150 on the south side of Lark Drive, as well as the six buildings on the north side of the street. In 1978, Laird proposed a major capital improvement project involving 10,000 square feet of new construction.[18] In 1982, the Office of Saline Water was closed when the Reagan administration made broad cuts to funding for scientific research.[19] Professor Laird's proposed capital improvements were never constructed. Alan D.K. Laird does not seem to have been responsible for groundbreaking contributions to desalination science.

Building 151

Building 151 was constructed in 1961, in order to house expanded activities of the SWCL, which was operated next door in Building 154 by Professor Everett D. Howe. In 1965, a 1,600 square-foot addition was constructed on the north end of the building.[20] This building has also housed a solar materials laboratory in later years.[21] Building 151 is currently used for research.

Evaluation

Building 151 does not meet the criteria for listing in the NRHP or CRHR under Criterion A/1 because it lacks historical significance. The historical record does not indicate that Building 151 was important within local, state, or national events or trends. While academic research is important to anyone directly involved in the field, the historical record must show that the research or studies conducted had a significant impact on historical events and trends. The SWCL and Building 151 are not significant in this regard (Criterion A/1).

Although the structure was used for university research by Professor Howe and others throughout its lifetime, none of the available evidence suggests that the building has association with persons important to the

[15] Soteris A. Kalogirou, *Solar Engineering: Processes and Systems*, Academic Press, Burlington, MA: 2009, p. 31.

[16] Yorem Cohen and Julius Glater, "A Tribute to Sidney Loeb, the Pioneer of Reverse Osmosis Desalination Research," Water Technology Research Center, Chemical and Biomolecular Engineering Research, University of California, Los Angeles, December, 2009, p. 13.

[17] University of California (System) Academic Senate, "1996, University of California: In Memoriam," 1996, Internet website: http://texts.cdlib.org/view?docId=hb0z09n6nn&doc.view=frames&chunk.id=div00041&toc.depth=1&toc.id=.

[18] University of California, Berkeley, Files "Building 180," located in vertical files in Room 148, Richmond Field Station.

[19] Heather Cooley, Peter H. Gleick, and Gary Wolff, "Desalination, With a Grain of Salt: A California Perspective," Pacific Institute, Oakland, California: 2006, p.12.

[20] University of California, Berkeley, File "Building 151", located in vertical files in Room 148, Richmond Field Station.

[21] University of California, Berkeley, 2008, p. 196.

B10. Significance (continued)

development of the desalination field. Academic research is important to those working directly in that specific field; however, none of the persons associated with Building 151 had a significant impact on local, state, or national history. Therefore, the building lacks the strength of association necessary to be considered historically significant in relation to any particular persons (Criterion B/2).

Building 151 lacks any identifiable architectural stylistic design and does not embody distinctive architectural or engineering qualities of type, period, or method of construction and is a simple, prefabricated building (Criterion C/3).

In rare instances, buildings themselves can serve as sources of important information; however, this building is not a principal source of important information in this regard (Criterion D/4).

Building 151 does not meet the significance criteria for listing in the NRHP or CRHR.

Photograph 2: Building 151, April 30, 2013, camera facing southwest

State of California – The Resources Agency
DEPARTMENT OF PARKS AND RECREATION
PRIMARY RECORD

Primary # _____
HRI # _____
Trinomial _____
NRHP Status Code _____
Other Listings _____
Review Code _____ Reviewer _____ Date _____

 ***Resource Name or #** (Assigned by recorder) Richmond Field Station Building 154

P1. Other Identifier: Richmond Field Station Building 154

***P2. Location:** ☐ **Not for Publication** ☒ **Unrestricted** ***a. County** Contra Costa
and (P2b and P2c or P2d. Attach a Location Map as necessary.)
***b. USGS 7.5′ Quad** Richmond **Date** 2013 **T** 1N **; R** 4W; ___ **¼ of Sec** 20 ; Mt. Diablo **B.M.**
c. Address _____ City _____ Zip _____
d. UTM: (give more than one for large and/or linear resources) Zone 10 ; 558463 mE/ 4196555 mN
e. Other Locational Data: (e.g., parcel #, directions to resource, elevation, etc., as appropriate) Assessor Parcel Number

***P3a. Description:** (Describe resource and its major elements. Include design, materials, condition, alterations, size, setting, and boundaries)

Building 154 is in the southern portion of the Richmond Field Station. It is on the north side of Lark Drive between Buildings 158 and 151, with its primary façade facing southwest. The 2,731 square-foot building has a rectangular footprint and is a prefabricated Dudley Steel Building topped with a front gabled roof. The walls and roof are corrugated metal. Primary fenestration consists of multi-light metal sashes. A metal industrial door with a glass insert is centered in its southwest elevation and serves as the main entrance. This entrance is sheltered by a metal awning and accessed by both concrete stairs and a ramp. The rear of the building contains an overhead-mounted, sliding door (Photograph 2). In 1965, a 1,600 square-foot addition was constructed on the north end of the building.

***P3b. Resource Attributes:** (List attributes and codes) HP39: Other

***P4. Resources Present:** ☒ Building ☐ Structure ☐ Object ☐ Site ☐ District ☐ Element of District ☐ Other (Isolates, etc.)

P5b. Description of Photo: (View, date, accession #) Photograph 1, camera facing northeast, April 30, 2013.

***P6. Date Constructed/Age and Sources:**
☒ Historic ☐ Prehistoric ☐ Both
1958/Richmond Field Station building files

***P7. Owner and Address:**
U.C. Berkeley
1301 South 46th Street
Richmond, California 94804

***P8. Recorded by:** (Name, affiliation, address)
Kara Brunzell & Julia Mates
Tetra Tech
1999 Harrison Street, Ste 500
Oakland, CA 94612

***P9. Date Recorded:** April 30, 2013

***P10. Survey Type:** (Describe) Intensive

***P11. Report Citation:** (Cite survey report and other sources, or enter "none.") *Historic Properties Survey Report for Portions of the Richmond Field Station, prepared by Tetra Tech, Inc., 2013.*

***Attachments:** NONE ☒ Location Map ☐ Sketch Map ☒ Continuation Sheet ☒ Building, Structure, and Object Record ☐ Archaeological Record ☐ District Record ☐ Linear Feature Record ☐ Milling Station Record ☐ Rock Art Record ☐ Artifact Record ☐ Photograph Record ☐ Other (list) _____

***Resource Name or #** (Assigned by recorder) Richmond Field Station Building 154

B1. Historic Name: _____
B2. Common Name: Building 154
B3. Original Use: Research B4. Present Use: Research
***B5. Architectural Style:** Vernacular
***B6. Construction History:** (Construction date, alteration, and date of alterations) Constructed 1958; Addition constructed 1965
***B7. Moved?** ☒ **No** ☐ **Yes** ☐ **Unknown** **Date:** _____ **Original Location:** _____
***B8. Related Features:** _____
B9. Architect: Unknown b. Builder: Unknown
***B10. Significance: Theme** N/A **Area** N/A
Period of Significance N/A **Property Type** N/A **Applicable Criteria** N/A
(Discuss importance in terms of historical or architectural context as defined by theme, period, and geographic scope. Also address integrity.)

Building 154 at the Richmond Field Station does not appear to meet the criteria for listing in the National Register of Historic Places (NRHP). Furthermore, the building has been evaluated in accordance with Section 15064.5(a)(2)-(3) of the CEQA Guidelines, using the criteria outlined in Section 5024.1 of the California Public Resources Code and does not appear to meet the significance criteria as outlined in these guidelines. Therefore, the building is not eligible for listing in the California Register of Historical Resources (CRHR). (See Continuation Sheet)

B11. Additional Resource Attributes: (List attributes and codes)

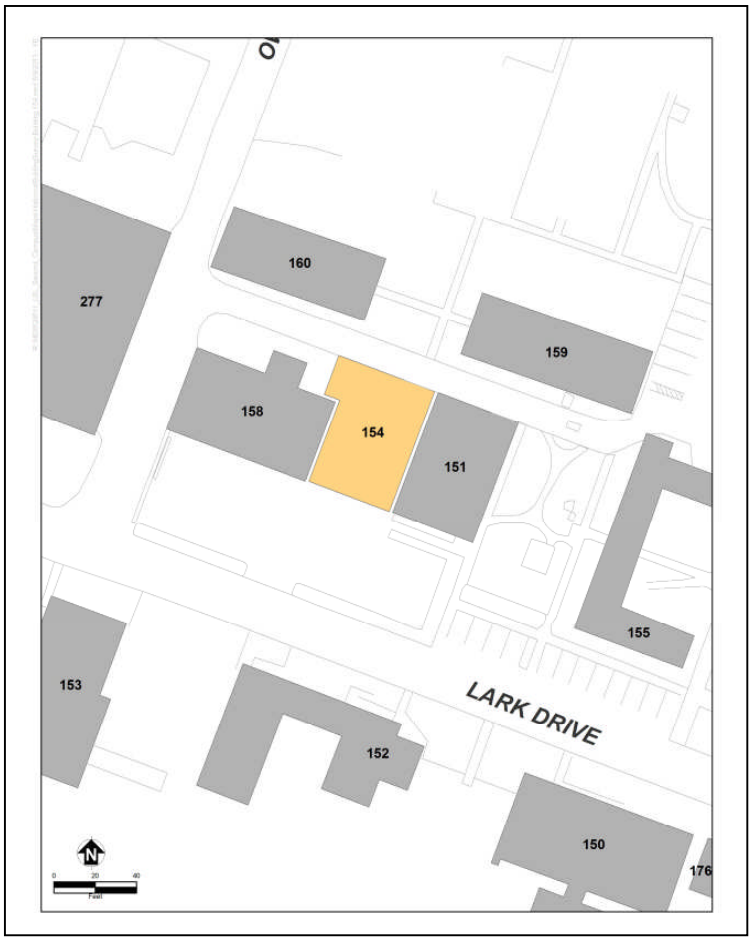
***B12. References:**
(See Footnotes)

B13. Remarks:

***B14. Evaluator:** Kara Brunzell

***Date of Evaluation:** April 2013

(This space reserved for official comments.)



B10. Significance (continued)

Historic Context

Europeans arrived in what would become Contra Costa County in 1772, when a Spanish expedition led by Pedro Fages came upon the San Pablo Bay and the confluence of the Sacramento and San Joaquin rivers.[1] Though subsequent Spanish expeditions passed through the region, the Spanish do not appear to have settled in the area during the mission period. In the 1820s and 1830s, the Mexican government began granting large tracts of land in the area to its citizens, including Ranchos San Pablo, San Ramon, and Pinole. The first permanent non-native settlers were Francisco Castro and his wife Maria Gabriela Berryessa. The Mexican government granted the 18,000-acre Rancho San Pablo to the Castros in 1823.[2] Americans began farming in Contra Costa County in the late 1830s, and by 1882, two-thirds of the cultivated land in the county was devoted to wheat production.[3]

Minna C. C. Quilfelt (or Quilfeldt) purchased 600 acres of Rancho San Pablo in 1852 and 1853.[4] German native Richard Stege settled on Rancho San Pablo in the late 1860s after stints in the gold fields and the Siberian fur trade, marrying Quilfelt and gaining title to her ranch. A town named Stege formed on Richard Stege's holdings, and by the late nineteenth century, several industries, including the California Cap Company, the United States Briquette Company, the Stauffer Chemical Works and the Stege Lumber Manufacturing Company, were operating from portions of the Stege Ranch.[5] Richmond incorporated in 1905, and by 1917 was already the largest city in Contra Costa County. Stege was eventually absorbed into Richmond as the latter grew.

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[1] Mildred B. Hoover, Hero E. Rensch, Ethel G. Rensch, Douglas E. Kyle, *Historic Spots in California, Fourth Edition*, Stanford University Press, Stanford, California: 1958, p. 129.

[2] Donald Bastin, *Images of America: Richmond*, Arcadia Publishing, Charleston SC: 2003, p. 9.

[3] J.P. Munro-Fraser, *History of Contra Costa County, California*, W.A. Slocum & Co., San Francisco: 1882, p. 55 – 57.

[4] Evan Griffins, "Early History of Richmond", December 1938, El Cerrito Historical Society, website: http://www.elcerritowire.com/history/pages/EarlyRichmond.htm, accessed January 2013.

[5] Frederick J. Hulaniski, *The History of Contra Costa County, California*. Elms Publishing Company, Berkeley, California: 1917, p. 354: Hulanski p. 288.

B10. Significance (continued)

purchased the California Cap Company from the Oliver family for the use of the Engineering Department in 1950.[6]

At first, the Department of Engineering utilized the buildings left behind by the California Cap Company. The Department established a machine shop, computer shop, receiving facility, mail service, and other facilities in addition to laboratories in the old detonator company buildings.[7] The buildings currently numbered 102, 110, 118, 128, 150, 152, 155, 175, 177, 176, and 180 all date to the California Cap Company era, and were repurposed for the Richmond Field Station. UC Berkeley also constructed new buildings as funds became available, and by the mid-1950s, five new buildings had been completed at the Richmond Field Station.[8] By the 1970s, the Department of Engineering had conducted many experiments at the Richmond Field Station that could not have been performed on the main campus.

The Richmond Field Station has been the location of research overseen by numerous UC Berkeley departments over the years. The Sanitary Engineering Research Laboratory (SERL) was one of the first departments to undertake research at the site. SERL focused primarily on sewage treatment technology and also researched pollution control and disposal of solid and liquid waste.[9] Other early projects at the field station included heat transfer and cyclic stress research.[10]

Another laboratory that utilized Richmond Field Station was the Sea Water Conversion Laboratory (SWCL). In 1952, congress had created and funded the Office of Saline Water in order to encourage desalination studies as a solution to water shortages.[11] In response, UC Berkeley Mechanical Engineering professor Everett D. Howe formed the SWCL at the Richmond Field Station in 1958.[12]

Building 154 was constructed circa 1958, for SWCL research, and the program continued to expand under Howe's direction for the next decade. SWCL eventually encompassed most of the buildings on the north side of Lark Drive, including Buildings 151, 155, 158, 177, and 180.[13] Howe became the coordinator for Saline Water Conversion Projects throughout the UC system and authored several books on desalination before his retirement in 1968.[14] Although Howe has been referred to as a pioneer in the solar distillation of seawater, research has not

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[6] P.H. McGauhey, "The Sanitary Engineering Research Laboratory: Administration, Research and Consultation, 1950-1975 – An Interview Conducted by Malca Call", Regional Oral History Office, University of California, Berkeley, 1974, p. 70.

[7] McGauhey, p. 71.

[8] University of California, Berkeley, Department of Engineering, "Guide for Engineering Field Station Inspection", undated, p. 3.

[9] University of California, Berkeley, 2008, p. 13.

[10] University of California, Berkeley, Department of Engineering, "Richmond Field Station Open House", May 28, 1952, p. 3 – 4.

[11] Heather Cooley, Peter H. Gleick, and Gary Wolff, "Desalination, With a Grain of Salt: A California Perspective," Pacific Institute, Oakland, California: 2006, p.11.

[12] University of California (System) Academic Senate, "1991, University of California: In Memoriam," 1991, Internet website: http://texts.cdlib.org/view?docId=hb4t1nb2bd&doc.view=frames&chunk.id=div00031&toc.depth=1&toc.id=.

[13] University of California, Berkeley, Files "Building 151", "Building 154", "Building 158", "Building 177", and "Building 180," located in vertical files in Room 148, Richmond Field Station.

[14] University of California (System) Academic Senate, "1991, University of California: In Memoriam," 1991, Internet website: http://texts.cdlib.org/view?docId=hb4t1nb2bd&doc.view=frames&chunk.id=div00031&toc.depth=1&toc.id=.

B10. Significance (continued)

revealed a significant lasting impact on desalination science resulting from his work.[15] Howe's primary contributions appear to have been administering and promoting desalination research. Breakthroughs such as reverse osmosis were developed by scientists at the University of California Los Angeles (UCLA) and the University of Florida. UCLA researchers also designed the pilot desalination plant in Coalinga, California, that went online in 1965, while Howe's role in that effort seems to have been limited to coordination.[16]

Professor Alan D.K. Laird became SWCL Director when Howe retired, a position he held until the laboratory was closed in 1987.[17] By 1978, SWCL encompassed twelve separate research projects. During this era, the cluster of buildings devoted to SWCL had grown to include Building 150 on the south side of Lark Drive, as well as the six buildings on the north side of the street. In 1978, Laird proposed a major capital improvement project involving 10,000 square feet of new construction.[18] In 1982, the Office of Saline Water was closed when the Reagan administration made broad cuts to funding for scientific research.[19] Professor Laird's proposed capital improvements were never constructed. Alan D.K. Laird does not seem to have been responsible for groundbreaking contributions to desalination science.

Building 154

Building 154 was constructed circa 1958 as a Seawater Conversion Laboratory, which was operated by Professor Everett D. Howe (Photograph 3). In 1965, a 1,600 square-foot addition was constructed on the north end of the building.[20] Initially labeled Building 158A, by 1970, it was being referred to as Building 154.[21] Space station research, sewage system evaluation, robotics evaluation, and insect research also took place in the building.[22] Building 154 is currently used for research.

Evaluation

Building 154 does not meet the criteria for listing in the NRHP or CRHR under Criterion A/1 because it lacks historical significance. The historical record does not indicate that Building 154 was important within local, state, or national events or trends. While academic research is important to anyone directly involved in that field, in order to be eligible for the NRHP or CRHR, the historical record must show that the research or studies conducted had a significant impact on historical events and trends. The SWCL and Building 151 are not significant in this regard.

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[15] Soteris A. Kalogirou, *Solar Engineering: Processes and Systems*, Academic Press, Burlington, MA: 2009, p. 31.

[16] Yorem Cohen and Julius Glater, "A Tribute to Sidney Loeb, the Pioneer of Reverse Osmosis Desalination Research," Water Technology Research Center, Chemical and Biomolecular Engineering Research, University of California, Los Angeles, December, 2009, p. 13.

[17] University of California (System) Academic Senate, "1996, University of California: In Memoriam," 1996, Internet website: http://texts.cdlib.org/view?docId=hb0z09n6nn&doc.view=frames&chunk.id=div00041&toc.depth=1&toc.id=.

[18] University of California, Berkeley, Files "Building 180," located in vertical files in Room 148, Richmond Field Station.

[19] Heather Cooley, Peter H. Gleick, and Gary Wolff, "Desalination, With a Grain of Salt: A California Perspective," Pacific Institute, Oakland, California: 2006, p.12.

[20] University of California, Berkeley, File "Building 154," located in vertical files in Room 148, Richmond Field Station.

[21] Sanborn Maps, 1966, 1970.

[22] University of California, Berkeley, 2008, p. 196.

B10. Significance (continued)

Although the structure was used for university research by Professor Howe and others throughout its lifetime, none of the available evidence suggests that the building has association with persons important to the development of the desalination field. Academic research is important to those working directly in that specific field; however, none of the persons associated with Building 154 had a significant impact on local, state, or national history. Therefore, the building lacks the strength of association necessary to be considered historically significant in relation to any particular persons (Criterion B/2).

Building 154 lacks any identifiable architectural stylistic design and is a simple prefabricated building. It does not embody distinctive architectural or engineering qualities of type, period, or method of construction (Criterion C/3).

In rare instances, buildings themselves can serve as sources of important information; however, this building is not a principal source of important information in this regard (Criterion D/4).

Building 154 does not meet the significance criteria for listing in the NRHP or CRHR.

Photographs (continued):

Photograph 2: Rear of building 154, April 30, 2013, camera facing southeast

Photographs (continued):

Photograph 3, Building 154 at center between Buildings 158 and 151, circa 1965, camera facing northwest

State of California – The Resources Agency
DEPARTMENT OF PARKS AND RECREATION
PRIMARY RECORD

Primary # _____
HRI # _____
Trinomial _____
NRHP Status Code _____
Other Listings _____
Review Code _____ Reviewer _____ Date _____

 ***Resource Name or #** (Assigned by recorder) Richmond Field Station Building 155

P1. Other Identifier: Richmond Field Station Building 155

***P2. Location:** ☐ **Not for Publication** ☒ **Unrestricted** ***a. County** Contra Costa
and (P2b and P2c or P2d. Attach a Location Map as necessary.)
***b. USGS 7.5′ Quad** Richmond **Date** 2013 **T** 1N **; R** 4W; ___ **¼ of Sec** 20 ; Mt. Diablo **B.M.**
c. Address _____ City _____ Zip _____
d. UTM: (give more than one for large and/or linear resources) Zone 10 ; 558463 mE/ 4196555 mN
e. Other Locational Data: (e.g., parcel #, directions to resource, elevation, etc., as appropriate)

***P3a. Description:** (Describe resource and its major elements. Include design, materials, condition, alterations, size, setting, and boundaries)
Building 155 is in the southern portion of the Richmond Field Station. It is on the north side of Lark Drive between Buildings 151 and 177. The vernacular building does not strongly express a particular architecture style. It has 1,896 square feet and one story, with an irregular "U" plan. It was constructed in 1953 by combining three building dating from the 1920s.

The building consists of two side gabled wings joined by a wing that runs perpendicular to the street, forming a "U" shape. The roof is sheathed in replacement composition shingles, its walls clad in horizontal wood siding. Fenestration throughout the building consists of fixed, square, wood frame windows. (See Continuation Sheet)

***P3b. Resource Attributes:** (List attributes and codes) P39: Other

***P4. Resources Present:** ☒ Building ☐ Structure ☐ Object ☐ Site ☐ District ☐ Element of District ☐ Other (Isolates, etc.)

P5b. Description of Photo: (View, date, accession #) Photograph 1, Camera facing north, April 30, 2013.

***P6. Date Constructed/Age and Sources:**
☒ Historic ☐ Prehistoric ☐ Both
1953/Richmond Field Station Building Files

***P7. Owner and Address:**
U.C. Berkeley
1301 South 46th Street
Richmond, California 94804

***P8. Recorded by:** (Name, affiliation, address)
Kara Brunzell & Julia Mates
Tetra Tech
1999 Harrison Street, Ste 500
Oakland, CA 94612

***P9. Date Recorded:** April 30, 2013

***P10. Survey Type:** (Describe) Intensive

***P11. Report Citation:** (Cite survey report and other sources, or enter "none.") *Historic Properties Survey Report for Portions of the Richmond Field Station, prepared by Tetra Tech, Inc., 2013.*

***Attachments:** NONE ☒ Location Map ☐ Sketch Map ☒ Continuation Sheet ☒ Building, Structure, and Object Record ☐ Archaeological Record ☐ District Record ☐ Linear Feature Record ☐ Milling Station Record ☐ Rock Art Record ☐ Artifact Record ☐ Photograph Record ☐ Other (list) _____

***NRHP Status Code** 6Z

***Resource Name or #** (Assigned by recorder) Richmond Field Station Building 155

B1. Historic Name: "Building 64", "Building 67", and "Building 92"

B2. Common Name: Building 155

B3. Original Use: Manufacturing B4. Present Use: Research, offices

***B5. Architectural Style:** Vernacular

***B6. Construction History:** (Construction date, alteration, and date of alterations) Three original buildings constructed circa 1920; moved, connected, and remodeled into one building 1953; replacement windows were likely installed in the 1950s; concrete foundation added 1977.

***B7. Moved?** ☐ No ☒Yes ☐ Unknown **Date:** 1953 **Original Location:** Richmond Field Station

***B8. Related Features:** _____

B9. Architect: Unknown b. Builder: Unknown

***B10. Significance: Theme** N/A **Area** N/A

Period of Significance N/A **Property Type** N/A **Applicable Criteria** N/A

(Discuss importance in terms of historical or architectural context as defined by theme, period, and geographic scope. Also address integrity.)

Building 155 at the Richmond Field Station does not appear to meet the criteria for listing in the National Register of Historic Places (NRHP). The building was evaluated in accordance with Section 15064.5(a)(2)-(3) of the CEQA Guidelines, using the criteria outlined in Section 5024.1 of the California Public Resources Code and does not appear to meet the significance criteria in these guidelines. Therefore, the building is not eligible for listing in the California Register of Historical Resources (CRHR). (See Continuation Sheet)

B11. Additional Resource Attributes: (List attributes and codes)

***B12. References:**

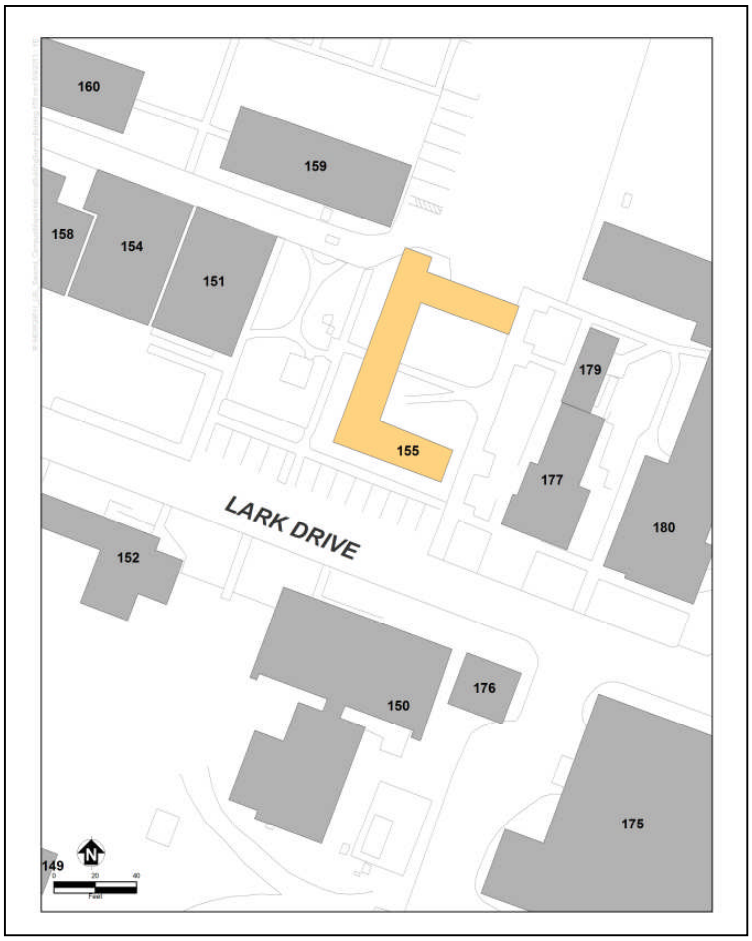
(See Footnotes)

B13. Remarks:

***B14. Evaluator:** Kara Brunzell

***Date of Evaluation:** April 2013

(This space reserved for official comments.)



P3a. Description (continued)

The windows are not original and were likely replaced during the 1950s. A paneled wood door reached by a set of wooden stairs is centered in the gable end of the southwest wing, which is the closest to Lark Drive. The southwest elevation of the northeast wing features a similar entrance. A third entrance, centered in the connecting wing and faces southeast, is fitted with a modern door and accessed by a concrete ramp.

Construction of Building 155 was pieced together from former California Cap Company buildings, "Building 64", "Building 67", and "Building 92". The California Cap Company constructed these three buildings circa 1920.[1] The buildings were originally used for waterproofing and assembling by the California Cap Company.[2] In 1953, the University of California (UC) appears to have turned "Building 67" perpendicular to its original position to form a connecting wing in a single "U" shaped building. In addition to joining the three buildings, UC replaced original siding and original windows on all three buildings. At first, the southwest wing adjacent to Lark Drive was labeled Building 155, and the northeast (rear) wing was labeled Building 157. At some point, all three wings became known as Building 155.[3] In 1977, a concrete foundation was installed under the building.[4]

B10. Significance (continued)

Historic Context

Europeans arrived in what would become Contra Costa County in 1772, when a Spanish expedition led by Pedro Fages came upon the San Pablo Bay and the confluence of the Sacramento and San Joaquin rivers.[5] Though subsequent Spanish expeditions passed through the region, the Spanish do not appear to have settled in the area during the mission period. In the 1820s and 1830s, the Mexican government began granting large tracts of land in the area to its citizens, including Ranchos San Pablo, San Ramon, and Pinole. The first permanent non-native settlers were Francisco Castro and his wife Maria Gabriela Berryessa. The Mexican government granted the 18,000-acre Rancho San Pablo to the Castros in 1823.[6] Americans began farming in Contra Costa County in the late 1830s, and by 1882, two-thirds of the cultivated land in the county was devoted to wheat production.[7]

Minna C. C. Quilfelt (or Quilfeldt) purchased 600 acres of Rancho San Pablo in 1852 and 1853.[8] Adjacent to San Francisco Bay in what would eventually become the southern portion of the City of Richmond, a wharf and produce warehouse were constructed on the ranch in the 1860s to ship agricultural produce to the San Francisco markets from Rancho San Pablo, as well as from the Quilfelt ranch. The warehouse and wharf were used to transport cattle, grain, fruit, and in later years, the frogs' legs raised by Richard Stege for the San Francisco

[1] University of California, Berkeley, File "Building 155," located in vertical files in Room 148, Richmond Field Station.
[2] University of California, Berkeley, 2008, p. 200 – 204.
[3] Sanborn Map, 1966.
[4] Scott Shackleton, University of California, Berkeley, Personal communication with Julia Mates, Tetra Tech 2013.
[5] Mildred B. Hoover, Hero E. Rensch, Ethel G. Rensch, Douglas E. Kyle, *Historic Spots in California, Fourth Edition*, Stanford University Press, Stanford, California: 1958, p. 129.
[6] Donald Bastin, *Images of America: Richmond*, Arcadia Publishing, Charleston SC: 2003, p. 9.
[7] J.P. Munro-Fraser, *History of Contra Costa County, California*, W.A. Slocum & Co., San Francisco: 1882, p. 55 – 57.
[8] Evan Griffins, "Early History of Richmond", December 1938, El Cerrito Historical Society, website: http://www.elcerritowire.com/history/pages/EarlyRichmond.htm, accessed January 2013.

B10. Significance (continued)

restaurant market.[9] German native Richard Stege settled on Rancho San Pablo in the late 1860s after stints in the gold fields and the Siberian fur trade, marrying Quilfelt and gaining title to her ranch. Stege began selling off portions of his ranch to raise money while continuing his frog-raising and other ventures. A town named Stege formed on Richard Stege's holdings, and by the late nineteenth century several industries, including the California Cap Company, the United States Briquette Company, the Stauffer Chemical Works and the Stege Lumber Manufacturing Company, were operating from portions of the Stege Ranch.[10] Richmond incorporated in 1905, and by 1917 was already the largest city in Contra Costa County.[11] Stege was eventually absorbed into Richmond as the latter grew.

The Explosives Industry in Contra Costa County

Swedish chemist Alfred Nobel laid the foundation for the high-explosives industry with his innovations beginning in 1860s, inventing first a detonator and then a blasting cap. In 1867, he invented dynamite, which was safer, cheaper, and more powerful than nitroglycerine, which had been the most commonly used explosive.

During the 1870s, chemical and explosives manufacturers began opening in the vicinity of what would eventually become Richmond. The Tonite Powder Company, Western Mineral Company, and California Cap Company were established at 1877 on the Stege ranch.

William Letts Oliver

William Letts Oliver was born in Chile to English parents in 1844. He initially gained familiarity with an explosive called guncotton while manufacturing collodion for his photography hobby.[12] As early as 1870, European explosive companies were experimenting with nitrated guncotton. By 1875, it was being manufactured in England under the name "Tonite."[13] In 1877, Oliver was mining in the western United States. Engineers working on the Sutro Tunnel in the Comstock needed an explosive to complete the tunnel that would remain stable at the high temperatures underground, and Oliver was able to solve the problem by substituting Tonite for more volatile compounds.[14]

The California Cap Company

In 1877, William Letts Oliver established the Tonite Powder Company on a portion of the former Stege Ranch.[15] Oliver eventually invented a blasting cap that was safer to use and had better detonating qualities than imported detonators. Oliver and his partner Freeborn Fletter then founded the California Cap Company. It was located

[9] Roland Oliver, "Recollections of Early Industries in Stege", August 7, 1959, p. 1.
[10] Frederick J. Hulaniski, *The History of Contra Costa County, California*. Elms Publishing Company, Berkeley, California: 1917, p. 354.
[11] Hulanski p. 288.
[12] Pacific Mining News, p. 222.
[13] G.A. Price Cuxson, ed., "Society of Engineers: Transactions for 1889", E. & F. N. Spon, London: 1890, p. 95.
[14] Pacific Mining News, p. 222.
[15] Oliver, p. 1.

B10. Significance (continued)

adjacent to the Tonite Powder Company on a 160-acre parcel carved out of the southern portion of Stege Ranch.[16] The California Cap Company, which went on to operate on the site for nearly seven decades, was the first manufacturer of blasting caps in the United States. Richard Stege, meanwhile, continued to reside on the ranch, and contracted with Tonite Powder and California Cap to transport their products to the railroad.[17] The California Cap Company was located on the parcel that is currently the Richmond Field Station. The Tonite Powder Company appears to have been located to the east on the parcel that became the Stauffer Chemical Company and later the Zeneca site, although its exact location is unclear.

William Letts Oliver continued to innovate throughout his long career in the chemical and explosives industries. In 1888, he formed the American Lucol Company adjacent to the California Cap Company property.[18] The Lucol plant was at what is currently the southeastern corner of the Richmond Field Station. Lucol manufactured a linseed oil substitute.[19] The factory was dismantled and relocated to New Jersey circa 1900.[20] In 1903, the Hotaling Briquette Works opened on Lucol's site at the southeast corner of the current Richmond Field Station property.[21] Later known as the U.S. Briquette Company, the plant appears to have operated at this location until at least 1917.[22] The U.S. Briquette Company buildings were demolished during the 1960s.

Eventually, the Tonite factory appears to have been incorporated into the California Cap Company. The Olivers also formed an entity named Pacific Cartridge Company circa 1910. The Pacific Cartridge Company operated from the California Cap plant during World War I.[23] By 1916, there were at least a dozen buildings on the site. By 1922, the California Cap Company was substantially expanded and the plant grew to include 150 buildings and a horse-drawn tram line.[24]

During the late nineteenth and early twentieth century, the California Cap Company was one of the most important local employers.[25] As the twentieth century progressed more heavy industry came to Contra Costa County, and by 1940, the county was second only to Los Angeles in overall industrial production.[26] The nineteenth-century California Cap Company was dwarfed by the scale of some of the newer enterprises, and its physical plant and technology were aging. During World War II, California Cap Company was able to stay open by producing delayed action incendiary bombs that were used against Japan.[27] The California Cap Company could not survive the transition to a peacetime economy, however, and by 1949 the plant was closed.

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[16] Pacific Mining News, p. 222.
[17] Nilda Rego, "Enterprising Stege lost all and died without a penny", Time Out, March 27, 1994, p. 2, column 4.
[18] Oliver, p. 1.
[19] Max Wilhelm Von Bernewitz, *Cyanide Practice, 1910 – 1913*, Dewey Publishing Company: 1913, p. 327.
[20] Oliver, p. 1.
[21] Oliver, p. 2.
[22] Hulaniski, p. 354.
[23] R.L. Polk & Company, *Richmond and Contra Costa County Directory, 1914 – 1915*, Oakland, California: 1915.
[24] University of California, Berkeley, *Current Conditions Report*, Prepared by Tetra Tech EM Inc., November 21, 2008, p. 11.
[25] Marguerite Clausen, "On the Waterfront: An Oral History of Richmond, California", Regional Oral History Office, University of California, Berkeley, 1990, p. 21.
[26] Purcell, p. 649.
[27] Oliver, p. 1.

B10. Significance (continued)

University Research/Richmond Field Station

After World War II, the UC Berkeley Engineering Department needed an off-campus location in order to perform experiments that required more space than a laboratory. Department Chair Morrough P. O'Brien and others in the department were performing experiments with sewage, sea water, and other materials unsuited to use on a crowded campus. They also wanted a location that was not too remote. UC Berkeley purchased the California Cap Company from the Oliver family for the use of the Engineering Department in 1950.[28]

At first, the Department of Engineering utilized the buildings left behind by the California Cap Company. The department established a machine shop, computer shop, receiving facility, mail service, and other facilities in addition to laboratories in the old detonator company buildings.[29] The current Buildings 102, 110, 118, 128, 150, 152, 155, 175, 177, 176, and 180 all date to the California Cap Company era and were repurposed for the Richmond Field Station. UC Berkeley also constructed new buildings as funds became available, and by the mid-1950s, five new buildings had been completed at the Richmond Field Station.[30] By the 1970s, the Department of Engineering had conducted many experiments at the Richmond Field Station that could not have been performed on the main campus.

The Richmond Field Station has been the location of research overseen by numerous UC Berkeley departments over the years. The Sanitary Engineering Research Laboratory (SERL) was one of the first departments to undertake research at the site. The focus of SERL was primarily on sewage treatment technology, and also researched pollution control and disposal of solid and liquid waste.[31] Other early research projects at the field station included heat transfer and cyclic stress research.[32]

Another laboratory that utilized the Richmond Field Station was the Sea Water Conversion Laboratory (SWCL). In 1952, Congress had created and funded the Office of Saline Water in order to encourage desalination studies as a solution to water shortages.[33] In response, UC Berkeley Mechanical Engineering professor Everett D. Howe formed the SWCL at the Richmond Field Station in 1958.[34]

Building 154 was constructed circa 1957 for SWCL research, and the program continued to expand under Howe's direction for the next decade. SWCL eventually encompassed most of the buildings on the north side of Lark

[28] P.H. McGauhey, "The Sanitary Engineering Research Laboratory: Administration, Research and Consultation, 1950-1975 – An Interview Conducted by Malca Call", Regional Oral History Office, University of California, Berkeley, 1974, p. 70.

[29] McGauhey, p. 71.

[30] University of California, Berkeley, Department of Engineering, "Guide for Engineering Field Station Inspection", undated, p. 3.

[31] University of California, Berkeley, 2008, p. 13.

[32] University of California, Berkeley, Department of Engineering, "Richmond Field Station Open House", May 28, 1952, p. 3 – 4.

[33] Heather Cooley, Peter H. Gleick, and Gary Wolff, "Desalination, With a Grain of Salt: A California Perspective," Pacific Institute, Oakland, California: 2006, p.11.

[34] University of California (System) Academic Senate, "1991, University of California: In Memoriam," 1991, Internet website: http://texts.cdlib.org/view?docId=hb4t1nb2bd&doc.view=frames&chunk.id=div00031&toc.depth=1&toc.id=.

B10. Significance (continued)

Drive, including Buildings 151, 155, 158, 177, and 180.[35] Howe became the coordinator for Saline Water Conversion Projects throughout the UC system and authored several books on desalination before his retirement in 1968.[36] Although Howe has been referred to as a pioneer in the solar distillation of seawater, research has not revealed a significant lasting impact on desalination science resulting from his work.[37]

Howe's primary contributions appear to have been administering and promoting desalination research. Breakthroughs such as reverse osmosis were developed by scientists at the University of California Los Angeles (UCLA) and the University of Florida. UCLA researchers also designed the pilot desalination plant in Coalinga, California, that went online in 1965, while Howe's role in that effort seems to have been limited to coordination.[38]

Professor Alan D.K. Laird became SWCL Director when Howe retired, a position he held until the laboratory was closed in 1987.[39] By 1978, SWCL encompassed twelve separate research projects. During this era, the cluster of buildings devoted to SWCL had grown to include Building 150 on the south side of Lark Drive as well as the six buildings on the north side of the street. In 1978, Laird proposed a major capital improvement project involving 10,000 square feet of new construction.[40] In 1982, the Office of Saline Water was closed when the Reagan administration made broad cuts to funding for scientific research.[41] Professor Laird's proposed capital improvements were never constructed. Alan D.K. Laird does not seem to have been responsible for groundbreaking contributions to desalination science.

Building 155

Activities in the building in the early years included Low Pressure Research and Sea Water Conversion program administration. The Catalytic Liquefaction of Biomass Project, also known as the Biocrude project, moved into Building 155 in the late 1970s.[42] Building 155 was later used as a solar research facility.[43] It is currently used for research and houses non-profit offices.

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[35] University of California, Berkeley, Files "Building 151", "Building 154", "Building 158", "Building 177", and "Building 180," located in vertical files in Room 148, Richmond Field Station.

[36] University of California (System) Academic Senate, "1991, University of California: In Memoriam," 1991, Internet website: http://texts.cdlib.org/view?docId=hb4t1nb2bd&doc.view=frames&chunk.id=div00031&toc.depth=1&toc.id=.

[37] Soteris A. Kalogirou, *Solar Engineering: Processes and Systems*, Academic Press, Burlington, MA: 2009, p. 31.

[38] Yorem Cohen and Julius Glater, "A Tribute to Sidney Loeb, the Pioneer of Reverse Osmosis Desalination Research," Water Technology Research Center, Chemical and Biomolecular Engineering Research, University of California, Los Angeles, December, 2009, p. 13.

[39] University of California (System) Academic Senate, "1996, University of California: In Memoriam," 1996, Internet website: http://texts.cdlib.org/view?docId=hb0z09n6nn&doc.view=frames&chunk.id=div00041&toc.depth=1&toc.id=.

[40] University of California, Berkeley, Files "Building 180," located in vertical files in Room 148, Richmond Field Station.

[41] Heather Cooley, Peter H. Gleick, and Gary Wolff, "Desalination, With a Grain of Salt: A California Perspective," Pacific Institute, Oakland, California: 2006, p.12.

[42] University of California, Berkeley, File "Building 155," located in vertical files in Room 148, Richmond Field Station.

[43] University of California, Berkeley, 2008, p. 196.

B10. Significance (continued)

Evaluation

No association was found between Building 155 and events significant to national, state, or local history. Although the California Cap Company was the first blasting cap manufacturer in the United States, there is no indication that the activities in Building 155 were central to the development of the plant or its technical processes. Academic research took place in the building after UC Berkeley took over the property, and while academic research is important to anyone directly involved in the field, the historical record must show that the research or studies had a significant impact on events and trends for a building to be eligible for the NRHP or CRHR. The historical record does not indicate such significance, and Building 155 is not eligible for inclusion in the NRHP or CRHR under Criterion A/1.

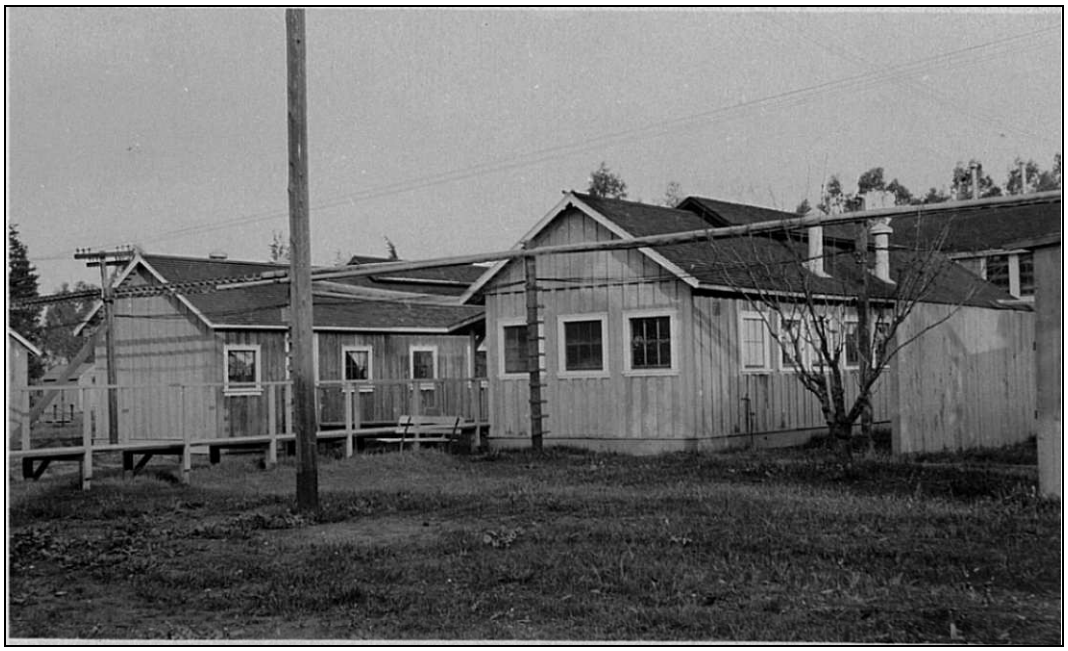
Although the Olivers were significant in the history of the explosives industry, no particular association was found between the Oliver family and Building 155. Although the structure was used for university research by Professor Howe and others throughout its lifetime, none of the available historical evidence suggests that the building has association with persons important to the development of the desalination field. Academic research is important to those working directly in that specific field; however, none of the persons associated with Building 155 had a significant impact on local, state, or national history. The building lacks the strength of association necessary to be considered historically significant in relation to any particular persons (Criterion B/2).

The building does not embody the distinctive characteristics of a type, period, region, or method of construction, or represent the work of an important creative individual or possess high artistic values. Building 155 is a vernacular building of a type that was commonly constructed in the early twentieth century. It has been heavily altered over the years since UC Berkeley took possession in 1950, so the building is not eligible for the NRHP or CRHR for its architecture (Criterion C/3).

In rare instances, buildings themselves can serve as sources of important information; however, this building is not a principal source of important information (Criterion D/4).

Building 155 does not meet the significance criteria for listing in the NRHP or CRHR.

Photographs (continued):



Photograph 2, California Cap Company "Building 64" and "Building 67," 1921, camera facing northeast

Photographs (continued):

Photograph 3, Buildings 155 and 157, 1953, camera facing west

Photograph 4, Buildings 155 and 157, circa 1953, camera facing northwest

Photographs (continued):

Photograph 5, gable end, southwest wing, April 20, 2013, camera facing west

Photograph 6, Building 155, April 30, 2013, northeast wing, camera facing southwest

Photographs (continued):

Photograph 7, Building 155, connecting wing, April 30, 2013, camera facing west

State of California – The Resources Agency
DEPARTMENT OF PARKS AND RECREATION
PRIMARY RECORD

Primary # _____
HRI # _____
Trinomial _____
NRHP Status Code _____
Other Listings _____
Review Code _____ Reviewer _____ Date _____

 ***Resource Name or #** (Assigned by recorder) Richmond Field Station Building 158

P1. Other Identifier: Richmond Field Station Building 158

***P2. Location:** ☐ **Not for Publication** ☒ **Unrestricted** ***a. County** Contra Costa
and (P2b and P2c or P2d. Attach a Location Map as necessary.)
***b. USGS 7.5′ Quad** Richmond **Date** 2013 **T** 1N **; R** 4W; ___ **¼ of Sec** 20 ; Mt. Diablo **B.M.**
c. Address _____ City _____ Zip _____
d. UTM: (give more than one for large and/or linear resources) Zone 10 ; 558442 mE/ 4196541 mN
e. Other Locational Data: (e.g., parcel #, directions to resource, elevation, etc., as appropriate) Assessor Parcel Number

***P3a. Description:** (Describe resource and its major elements. Include design, materials, condition, alterations, size, setting, and boundaries)
Building 158 is in the southern portion of the Richmond Field Station. It is on the north side of Lark Drive, with its primary façade facing southwest. The 3,343 square-foot building is a rectangular, prefabricated building topped with a front gabled roof. It features shallow eaves with exposed rafters and exposed steel purlins. The walls and roof are corrugated metal. Fenestration consists of multi-light metal sashes and replacement sliding sashes. An overhead-mounted, sliding, metal door is centered in its southwest elevation. An entrance fitted with a single metal industrial door with a glass insert is located adjacent to the large door to the east. This entrance is sheltered by a metal awning and accessed at grade.

***P3b. Resource Attributes:** (List attributes and codes) P39: Other

***P4. Resources Present:** ☒ Building ☐ Structure ☐ Object ☐ Site ☐ District ☐ Element of District ☐ Other (Isolates, etc.)

P5b. Description of Photo: (View, date, accession #) Photograph 1, camera facing northeast, April 30, 2013.

***P6. Date Constructed/Age and Sources:**
☒ Historic ☐ Prehistoric ☐ Both
Circa 1957

***P7. Owner and Address:**
U.C. Berkeley
1301 South 46th Street
Richmond, California 94804

***P8. Recorded by:** (Name, affiliation, address)
Kara Brunzell & Julia Mates
Tetra Tech
1999 Harrison Street, Ste 500
Oakland, CA 94612

***P9. Date Recorded:** April 30, 2013

***P10. Survey Type:** (Describe) Intensive

***P11. Report Citation:** (Cite survey report and other sources, or enter "none.") *Historic Properties Survey Report for Portions of the Richmond Field Station, prepared by Tetra Tech, Inc., 2013.*

***Attachments:** NONE ☒ Location Map ☐ Sketch Map ☒ Continuation Sheet ☒ Building, Structure, and Object Record ☐ Archaeological Record ☐ District Record ☐ Linear Feature Record ☐ Milling Station Record ☐ Rock Art Record ☐ Artifact Record ☐ Photograph Record ☐ Other (list) _____

***NRHP Status Code** 6Z

***Resource Name or #** (Assigned by recorder) Richmond Field Station Building 158

B1. Historic Name: _____

B2. Common Name: Building 158

B3. Original Use: Research B4. Present Use: Research

***B5. Architectural Style:** Vernacular

***B6. Construction History:** (Construction date, alteration, and date of alterations) Constructed 1957; replacement windows no date

***B7. Moved?** ☒ **No** ☐ **Yes** ☐ **Unknown** **Date:** _____ **Original Location:** _____

***B8. Related Features:** _____

B9. Architect: Unknown b. Builder: Unknown

***B10. Significance: Theme** N/A **Area** N/A

Period of Significance N/A **Property Type** N/A **Applicable Criteria** N/A

(Discuss importance in terms of historical or architectural context as defined by theme, period, and geographic scope. Also address integrity.)

Building 158 at the Richmond Field Station does not appear to meet the criteria for listing in the National Register of Historic Places (NRHP). Furthermore, the building has been evaluated in accordance with Section 15064.5(a)(2)-(3) of the CEQA Guidelines, using the criteria outlined in Section 5024.1 of the California Public Resources Code and does not appear to meet the significance criteria as outlined in these guidelines. Therefore, the building is not eligible for listing in the California Register of Historical Resources (CRHR). (See Continuation Sheet)

B11. Additional Resource Attributes: (List attributes and codes)

***B12. References:**

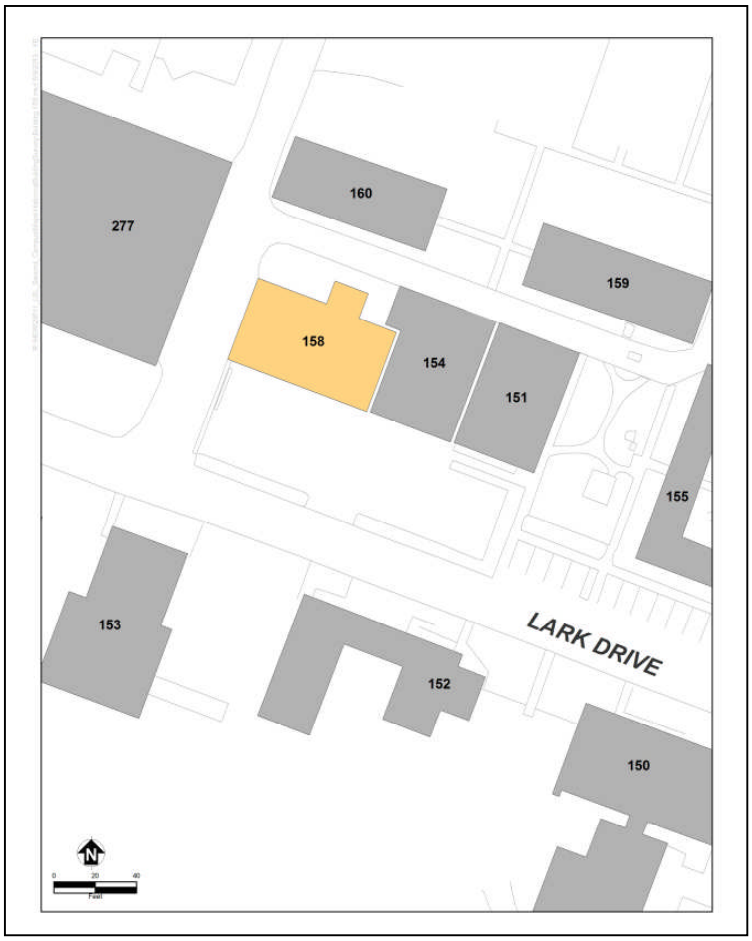
(See Footnotes)

B13. Remarks:

***B14. Evaluator:** Kara Brunzell

***Date of Evaluation:** April 2013

(This space reserved for official comments.)



B10. Significance (continued)

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William Letts Oliver established the Tonite Powder Company and California Cap Company on land purchased from the Stege Ranch in 1877. The California Cap Company, which went on to operate on the site for nearly seven decades, was the first manufacturer of blasting caps in the United States. The company was operated by Oliver's sons after his death and managed to survive through the end of World War II. By 1949, however, the plant was closed and for sale.

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[2] Donald Bastin, *Images of America: Richmond*, Arcadia Publishing, Charleston SC: 2003, p. 9.

[3] J.P. Munro-Fraser, *History of Contra Costa County, California*, W.A. Slocum & Co., San Francisco: 1882, p. 55 – 57.

[4] Evan Griffins, "Early History of Richmond", December 1938, El Cerrito Historical Society, website: http://www.elcerritowire.com/history/pages/EarlyRichmond.htm, accessed January 2013.

[5] Frederick J. Hulaniski, *The History of Contra Costa County, California*. Elms Publishing Company, Berkeley, California: 1917, p. 354: Hulanski p. 288.

B10. Significance (continued)

purchased the California Cap Company from the Oliver family for the use of the Engineering Department in 1950.[6]

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Another laboratory that utilized Richmond Field Station was the Sea Water Conversion Laboratory (SWCL). In 1952, congress had created and funded the Office of Saline Water in order to encourage desalination studies as a solution to water shortages.[11] In response, UC Berkeley Mechanical Engineering professor Everett D. Howe formed the SWCL at the Richmond Field Station in 1958.[12]

Building 154 was constructed circa 1957, for SWCL research, and the program continued to expand under Howe's direction for the next decade. SWCL eventually encompassed most of the buildings on the north side of Lark Drive, including Buildings 151, 155, 158, 177, and 180.[13] Howe became the coordinator for Saline Water Conversion Projects throughout the UC system and authored several books on desalination before his retirement in 1968.[14] Although Howe has been referred to as a pioneer in the solar distillation of seawater, research has not

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[6] P.H. McGauhey, "The Sanitary Engineering Research Laboratory: Administration, Research and Consultation, 1950-1975 – An Interview Conducted by Malca Call", Regional Oral History Office, University of California, Berkeley, 1974, p. 70.

[7] McGauhey, p. 71.

[8] University of California, Berkeley, Department of Engineering, "Guide for Engineering Field Station Inspection", undated, p. 3.

[9] University of California, Berkeley, 2008, p. 13.

[10] University of California, Berkeley, Department of Engineering, "Richmond Field Station Open House", May 28, 1952, p. 3 – 4.

[11] Heather Cooley, Peter H. Gleick, and Gary Wolff, "Desalination, With a Grain of Salt: A California Perspective," Pacifc Institue, Oakland, California: 2006, p.11.

[12] University of California (System) Academic Senate, "1991, University of California: In Memoriam," 1991, Internet website: http://texts.cdlib.org/view?docId=hb4t1nb2bd&doc.view=frames&chunk.id=div00031&toc.depth=1&toc.id=.

[13] University of California, Berkeley, Files "Building 151", "Building 154", "Building 158", "Building 177", and "Building 180," located in vertical files in Room 148, Richmond Field Station.

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B10. Significance (continued)

revealed a significant lasting impact on desalination science resulting from his work.[15] Howe's primary contributions appear to have been administering and promoting desalination research. Breakthroughs such as reverse osmosis were developed by scientists at the University of California Los Angeles (UCLA) and the University of Florida. UCLA researchers also designed the pilot desalination plant in Coalinga, California, that went online in 1965, while Howe's role in that effort seems to have been limited to coordination.[16]

Professor Alan D.K. Laird became SWCL Director when Howe retired, a position he held until the laboratory was closed in 1987.[17] By 1978, SWCL encompassed twelve separate research projects. During this era, the cluster of buildings devoted to SWCL had grown to include Building 150 on the south side of Lark Drive, as well as the six buildings on the north side of the street. In 1978, Laird proposed a major capital improvement project involving 10,000 square feet of new construction.[18] In 1982, the Office of Saline Water was closed when the Reagan administration made broad cuts to funding for scientific research.[19] Professor Laird's proposed capital improvements were never constructed.

Building 158

Building 158 was constructed circa 1957 for use as a research facility. It appears to have been the first building constructed for use by Professor Everett D. Howe's Seawater Conversion Laboratory.[20] The building is currently used for research.

Evaluation

Building 158 does not meet the criteria for listing in the NRHP or CRHR under Criterion A/1 because it lacks historical significance. The historical record does not indicate that Building 158 was important within local, state, or national events or trends. While academic research is important to anyone directly involved in the field, the historical record must show that the research or studies conducted had a significant impact on historical events and trends in order to be eligible for the NRHP or CRHR. Building 158 is not significant in this regard (Criterion A/1).

Although the structure was used for university research by Professor Howe and others throughout its lifetime, none of the available evidence suggests that the building has association with persons important to the development of the desalination field. Academic research is important to those working directly in that specific field; however, none of the persons associated with Building 158 have had a significant impact on local, state, or

[15] Soteris A. Kalogirou, *Solar Engineering: Processes and Systems*, Academic Press, Burlington, MA: 2009, p. 31.

[16] Yorem Cohen and Julius Glater, "A Tribute to Sidney Loeb, the Pioneer of Reverse Osmosis Desalination Research," Water Technology Research Center, Chemical and Biomolecular Engineering Research,University of California, Los Angeles, December, 2009, p. 13.

[17] University of California (System) Academic Senate, "1996, University of California: In Memoriam," 1996, Internet website: http://texts.cdlib.org/view?docId=hb0z09n6nn&doc.view=frames&chunk.id=div00041&toc.depth=1&toc.id=.

[18] University of California, Berkeley, Files "Building 180," located in vertical files in Room 148, Richmond Field Station.

[19] Heather Cooley, Peter H. Gleick, and Gary Wolff, "Desalination, With a Grain of Salt: A California Perspective," Pacifc Institue, Oakland, California: 2006, p.12.

[20] University of California, Berkeley, File "Building 158", located in vertical files in Room 148, Richmond Field Station.

B10. Significance (continued)

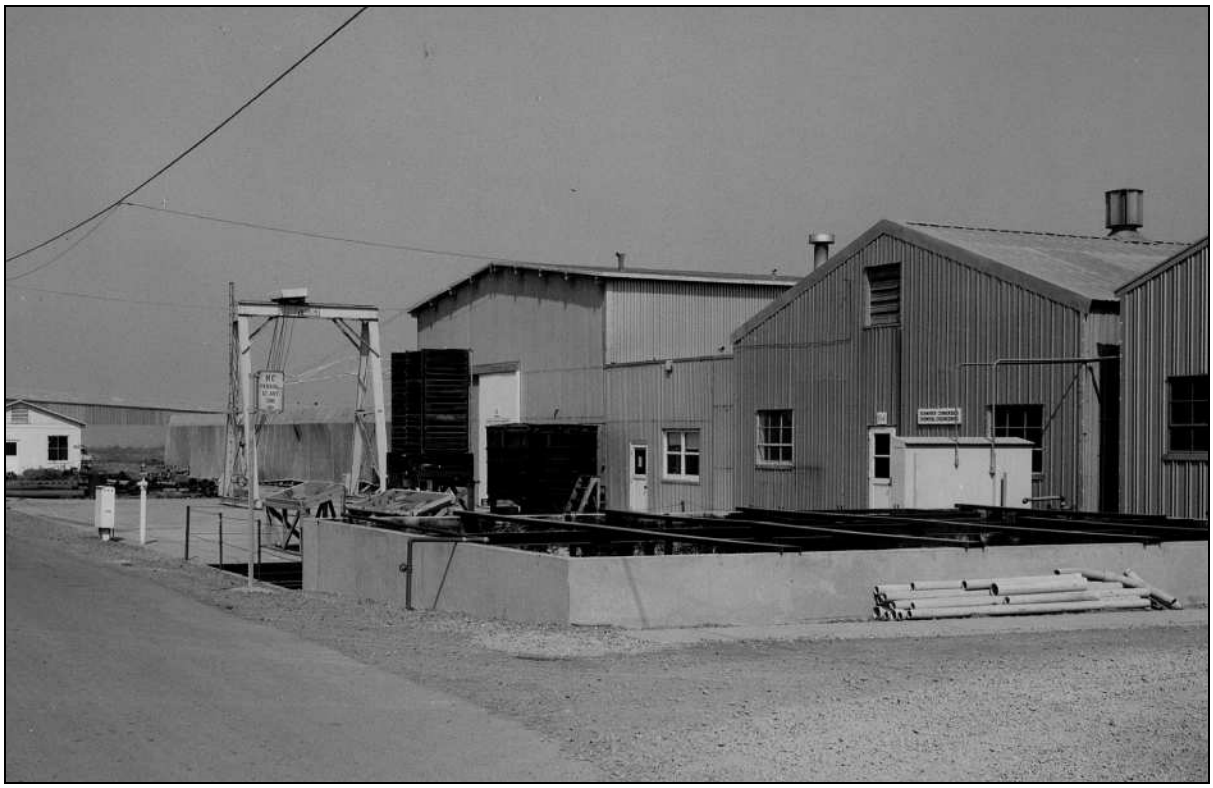
national history. Therefore, the building lacks the strength of association necessary to be considered historically significant in relation to any particular persons (Criterion B/2).

Building 158 lacks any identifiable architectural stylistic design and does not embody distinctive architectural or engineering qualities of type, period, or method of construction (Criterion C/3).

In rare instances, buildings themselves can serve as sources of important information; however, this building is not a principal source of important information in this regard (Criterion D/4).

Building 158 does not meet the significance criteria for listing in the NRHP or CRHR.

Photographs (continued):



Photograph 2, Building 158 at left with Buildings 154 and 151 to the right, circa 1965, camera facing northwest

State of California – The Resources Agency
DEPARTMENT OF PARKS AND RECREATION

PRIMARY RECORD

Primary # _____
HRI # _____
Trinomial _____
NRHP Status Code _____
Other Listings _____
Review Code _____ Reviewer _____ Date _____

 *Resource Name or # (Assigned by recorder) Richmond Field Station Building 177

P1. Other Identifier: Richmond Field Station Building 177

*P2. Location: ☐ Not for Publication ☒ Unrestricted *a. County Contra Costa
and (P2b and P2c or P2d. Attach a Location Map as necessary.)
*b. USGS 7.5′ Quad Richmond Date 2013 T 1N ; R 4W; ___ ¼ of Sec 20 ; Mt. Diablo B.M.
c. Address _____ City _____ Zip _____
d. UTM: (give more than one for large and/or linear resources) Zone 10 ; 558528 mE/ 4196527 mN
e. Other Locational Data: (e.g., parcel #, directions to resource, elevation, etc., as appropriate)

*P3a. Description: (Describe resource and its major elements. Include design, materials, condition, alterations, size, setting, and boundaries)
Building 177 is in the southern portion of the Richmond Field Station. It is on the north side of Lark Drive, with its primary façade facing southwest. The vernacular building does not strongly express any particular architectural style. It is a 2,969 square-foot, two-story building with a modified rectangular plan. It is topped by a front gabled roof; its walls are clad in horizontal wood siding. A decorative octagonal vent is centered in the front gable. Fenestration consists of replacement vinyl sashes. The building's main façade is centered in the southwest elevation and features a full width, hipped roof porch. (See Continuation Sheet.)

*P3b. Resource Attributes: (List attributes and codes) P39: Other

*P4. Resources Present: ☒ Building ☐ Structure ☐ Object ☐ Site ☐ District ☐ Element of District ☐ Other (Isolates, etc.)

P5b. Description of Photo: (View, date, accession #) Photograph 1, camera facing north, January 4, 2013.

*P6. Date Constructed/Age and Sources:
☒ Historic ☐ Prehistoric ☐ Both
Circa 1920

*P7. Owner and Address:
U.C. Berkeley
1301 South 46th Street
Richmond, California 94804

*P8. Recorded by: (Name, affiliation, address)
Kara Brunzell & Julia Mates
Tetra Tech
1999 Harrison Street, Ste 500
Oakland, CA 94612

*P9. Date Recorded: April 30, 2013

*P10. Survey Type: (Describe) Intensive

*P11. Report Citation: (Cite survey report and other sources, or enter "none.") *Historic Properties Survey Report for Portions of the Richmond Field Station, prepared by Tetra Tech, Inc., 2013.*

*Attachments: NONE ☒ Location Map ☐ Sketch Map ☒ Continuation Sheet ☒ Building, Structure, and Object Record ☐ Archaeological Record ☐ District Record ☐ Linear Feature Record ☐ Milling Station Record ☐ Rock Art Record ☐ Artifact Record ☐ Photograph Record ☐ Other (list) _____

***NRHP Status Code** 6Z

***Resource Name or #** (Assigned by recorder) Richmond Field Station Building 177

B1. Historic Name: "Building 72", "Building 131"

B2. Common Name: Building 177

B3. Original Use: Maintenance Shop/Rest Rooms B4. Present Use: Offices

***B5. Architectural Style:** Vernacular

***B6. Construction History:** (Construction date, alteration, and date of alterations) Two original buildings constructed circa 1920; renovated and renumbered 1953; buildings joined, porch remodeled, windows replaced circa 1990s

***B7. Moved?** ☒ **No** ☐ **Yes** ☐ **Unknown** **Date:** _____ **Original Location:** _____

***B8. Related Features:** _____

B9. Architect: Unknown b. Builder: Unknown

***B10. Significance: Theme** N/A **Area** N/A

Period of Significance N/A **Property Type** N/A **Applicable Criteria** N/A

(Discuss importance in terms of historical or architectural context as defined by theme, period, and geographic scope. Also address integrity.)

Building 177 at the Richmond Field Station does not appear to meet the criteria for listing in the National Register of Historic Places (NRHP). Furthermore, the building has been evaluated in accordance with Section 15064.5(a)(2)-(3) of the CEQA Guidelines, using the criteria outlined in Section 5024.1 of the California Public Resources Code, and does not appear to meet the significance criteria as outlined in these guidelines. Therefore, the building is not eligible for listing in the California Register of Historical Resources (CRHR). (See Continuation Sheet)

B11. Additional Resource Attributes: (List attributes and codes)

***B12. References:**

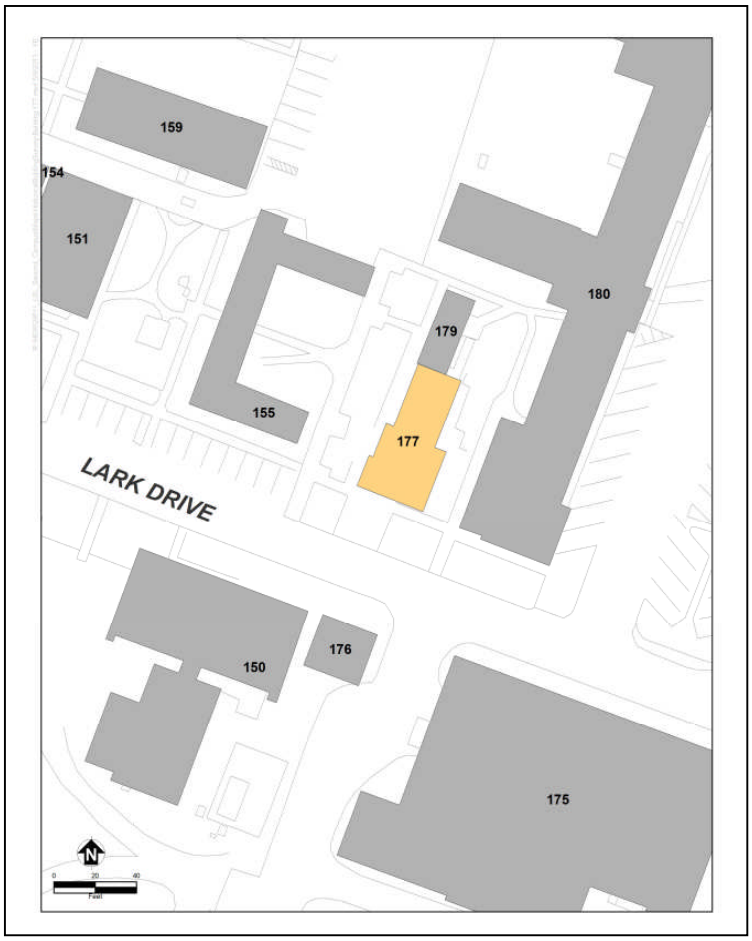
(See Footnotes)

B13. Remarks:

***B14. Evaluator:** Kara Brunzell

***Date of Evaluation:** April 2013

(This space reserved for official comments.)



P3a. Description (continued)

The two-story main wing of Building 177 is connected to a small, single-story building at the rear, the former Building 179 (Photograph 2). The single story gable at the rear (northeast) of the building features decorative stickwork at the eaves (Photograph 3). An exterior industrial-style staircase leads to the rear portion of the main wing's second floor (Photograph 4).

Originally constructed circa 1920, Building 177 was known as "Building 72" during the California Cap Company era. "Building 72" consisted of the two story main wing of what is today Building 177, and is depicted on Sanborn Maps as a "Rest Room." A separate one story building to the rear, "Building 131," was also labeled as "Women's Rest Room" and a "Water Closet" on historic maps.

By the time the University of California (UC) took over the property in 1950, Building 177 had small additions added onto its facade and had become somewhat dilapidated (Photographs 5 and 6). The University renovated the building in 1953, removing some of the additions and changing the shed roofed entry porch to a small gable roof (Photograph 7). By 1966, Building 177 was being utilized as a maintenance shop. California Cap Company's "Building 131" at the rear was renumbered Building 179 and continued to be used as a restroom until it was joined to Building 177. Although Building 179 is still shown on maps of the Richmond Field Station, the rear portion of the building is currently labeled Building 177.

B10. Significance (continued)

Historic Context

Europeans arrived in what would become Contra Costa County in 1772, when a Spanish expedition led by Pedro Fages came upon the San Pablo Bay and the confluence of the Sacramento and San Joaquin rivers.[1] Though subsequent Spanish expeditions passed through the region, the Spanish do not appear to have settled in the area during the mission period. In the 1820s and 1830s, the Mexican government began granting large tracts of land in the area to its citizens, including Ranchos San Pablo, San Ramon, and Pinole. The first permanent non-native settlers were Francisco Castro and his wife Maria Gabriela Berryessa. The Mexican government granted the 18,000-acre Rancho San Pablo to the Castros in 1823.[2] Americans began farming in Contra Costa County in the late 1830s, and by 1882, two-thirds of the cultivated land in the county was devoted to wheat production.[3]

Minna C. C. Quilfelt (or Quilfeldt) purchased 600 acres of Rancho San Pablo in 1852 and 1853.[4] Adjacent to San Francisco Bay in what would eventually become the southern portion of the City of Richmond, a wharf and produce warehouse were constructed on the ranch in the 1860s to ship agricultural produce to the San Francisco markets from Rancho San Pablo, as well as from the Quilfelt ranch. The warehouse and wharf were used to transport cattle, grain, fruit, and in later years, the frogs' legs raised by Richard Stege for the San Francisco

[1] Mildred B. Hoover, Hero E. Rensch, Ethel G. Rensch, Douglas E. Kyle, *Historic Spots in California, Fourth Edition*, Stanford University Press, Stanford, California: 1958, p. 129.

[2] Donald Bastin, *Images of America: Richmond*, Arcadia Publishing, Charleston SC: 2003, p. 9.

[3] J.P. Munro-Fraser, *History of Contra Costa County, California*, W.A. Slocum & Co., San Francisco: 1882, p. 55 – 57.

[4] Evan Griffins, "Early History of Richmond", December 1938, El Cerrito Historical Society, website: http://www.elcerritowire.com/history/pages/EarlyRichmond.htm, accessed January 2013.

B10. Significance (continued)

restaurant market.[5] German native Richard Stege settled on Rancho San Pablo in the late 1860s after stints in the gold fields and the Siberian fur trade, marrying Quilfelt and gaining title to her ranch. Stege began selling off portions of his ranch to raise money while continuing his frog-raising and other ventures. A town named Stege formed on Richard Stege's holdings, and by the late nineteenth century several industries, including the California Cap Company, the United States Briquette Company, the Stauffer Chemical Works and the Stege Lumber Manufacturing Company, were operating from portions of the Stege Ranch.[6] Richmond incorporated in 1905, and by 1917 was already the largest city in Contra Costa County.[7] Stege was eventually absorbed into Richmond as the latter grew.

The Explosives Industry in Contra Costa County

Swedish chemist Alfred Nobel laid the foundation for the high-explosives industry with his innovations beginning in 1860s, inventing first a detonator and then a blasting cap. In 1867, he invented dynamite, which was safer, cheaper, and more powerful than nitroglycerine, which had been the most commonly used explosive.

During the 1870s, chemical and explosives manufacturers began opening in the vicinity of what would eventually become Richmond. The Tonite Powder Company, Western Mineral Company, and California Cap Company were established at 1877 on the Stege ranch.

William Letts Oliver

William Letts Oliver was born in Chile to English parents in 1844. He initially gained familiarity with an explosive called guncotton while manufacturing collodion for his photography hobby.[8] As early as 1870, European explosive companies were experimenting with nitrated guncotton. By 1875, it was being manufactured in England under the name "Tonite."[9] In 1877, Oliver was mining in the western United States. Engineers working on the Sutro Tunnel in the Comstock needed an explosive to complete the tunnel that would remain stable at the high temperatures underground, and Oliver was able to solve the problem by substituting Tonite for more volatile compounds.[10]

The California Cap Company

In 1877, William Letts Oliver established the Tonite Powder Company on a portion of the former Stege Ranch.[11] Oliver eventually invented a blasting cap that was safer to use and had better detonating qualities than imported detonators. Oliver and his partner Freeborn Fletter then founded the California Cap Company. It was located

[5] Roland Oliver, "Recollections of Early Industries in Stege", August 7, 1959, p. 1.
[6] Frederick J. Hulaniski, *The History of Contra Costa County, California*. Elms Publishing Company, Berkeley, California: 1917, p. 354.
[7] Hulanski p. 288.
[8] Pacific Mining News, p. 222.
[9] G.A. Price Cuxson, ed., "Society of Engineers: Transactions for 1889", E. & F. N. Spon, London: 1890, p. 95.
[10] Pacific Mining News, p. 222.
[11] Oliver, p. 1.

B10. Significance (continued)

adjacent to the Tonite Powder Company on a 160-acre parcel carved out of the southern portion of Stege Ranch.[12] The California Cap Company, which went on to operate on the site for nearly seven decades, was the first manufacturer of blasting caps in the United States. Richard Stege, meanwhile, continued to reside on the ranch, and contracted with Tonite Powder and California Cap to transport their products to the railroad.[13] The California Cap Company was located on the parcel that is currently the Richmond Field Station. The Tonite Powder Company appears to have been located to the east on the parcel that became the Stauffer Chemical Company and later the Zeneca site, although its exact location is unclear.

William Letts Oliver continued to innovate throughout his long career in the chemical and explosives industries. In 1888, he formed the American Lucol Company adjacent to the California Cap Company property.[14] The Lucol plant was at what is currently the southeastern corner of the Richmond Field Station. Lucol manufactured a linseed oil substitute.[15] The factory was dismantled and relocated to New Jersey circa 1900.[16] In 1903, the Hotaling Briquette Works opened on Lucol's site at the southeast corner of the current Richmond Field Station property.[17] Later known as the U.S. Briquette Company, the plant appears to have operated at this location until at least 1917.[18] The U.S. Briquette Company buildings were demolished during the 1960s.

Eventually, the Tonite factory appears to have been incorporated into the California Cap Company. The Olivers also formed an entity named Pacific Cartridge Company circa 1910. The Pacific Cartridge Company operated from the California Cap plant during World War I.[19] By 1916, there were at least a dozen buildings on the site. By 1922, the California Cap Company was substantially expanded and the plant grew to include 150 buildings and a horse-drawn tram line.[20]

During the late nineteenth and early twentieth century, the California Cap Company was one of the most important local employers.[21] As the twentieth century progressed more heavy industry came to Contra Costa County, and by 1940, the county was second only to Los Angeles in overall industrial production.[22] The nineteenth-century California Cap Company was dwarfed by the scale of some of the newer enterprises, and its physical plant and technology were aging. During World War II, California Cap Company was able to stay open by producing delayed action incendiary bombs that were used against Japan.[23] The California Cap Company could not survive the transition to a peacetime economy, however, and by 1949 the plant was closed.

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[12] Pacific Mining News, p. 222.
[13] Nilda Rego, "Enterprising Stege lost all and died without a penny", Time Out, March 27, 1994, p. 2, column 4.
[14] Oliver, p. 1.
[15] Max Wilhelm Von Bernewitz, *Cyanide Practice, 1910 – 1913*, Dewey Publishing Company: 1913, p. 327.
[16] Oliver, p. 1.
[17] Oliver, p. 2.
[18] Hulaniski, p. 354.
[19] R.L. Polk & Company, *Richmond and Contra Costa County Directory, 1914 – 1915*, Oakland, California: 1915.
[20] University of California, Berkeley, *Current Conditions Report*, Prepared by Tetra Tech EM Inc., November 21, 2008, p. 11.
[21] Marguerite Clausen, "On the Waterfront: An Oral History of Richmond, California", Regional Oral History Office, University of California, Berkeley, 1990, p. 21.
[22] Purcell, p. 649.
[23] Oliver, p. 1.

B10. Significance (continued)

University Research/Richmond Field Station

After World War II, the UC Berkeley Engineering Department needed an off-campus location in order to perform experiments that required more space than a laboratory. Department Chair Morrough P. O'Brien and others in the department were performing experiments with sewage, sea water, and other materials unsuited to use on a crowded campus. They also wanted a location that was not too remote. UC Berkeley purchased the California Cap Company from the Oliver family for the use of the Engineering Department in 1950.[24]

At first, the Department of Engineering utilized the buildings left behind by the California Cap Company. The department established a machine shop, computer shop, receiving facility, mail service, and other facilities in addition to laboratories in the old detonator company buildings.[25] The current Buildings 102, 110, 118, 128, 150, 152, 155, 175, 177, 176, and 180 all date to the California Cap Company era and were repurposed for the Richmond Field Station. UC Berkeley also constructed new buildings as funds became available, and by the mid-1950s, five new buildings had been completed at the Richmond Field Station.[26] By the 1970s, the Department of Engineering had conducted many experiments at the Richmond Field Station that could not have been performed on the main campus.

The Richmond Field Station has been the location of research overseen by numerous UC Berkeley departments over the years. The Sanitary Engineering Research Laboratory (SERL) was one of the first departments to undertake research at the site. The focus of SERL was primarily on sewage treatment technology, and also researched pollution control and disposal of solid and liquid waste.[27] Other early research projects at the field station included heat transfer and cyclic stress research.[28]

Another laboratory that utilized the Richmond Field Station was the Sea Water Conversion Laboratory (SWCL). In 1952, Congress had created and funded the Office of Saline Water in order to encourage desalination studies as a solution to water shortages.[29] In response, UC Berkeley Mechanical Engineering professor Everett D. Howe formed the SWCL at the Richmond Field Station in 1958.[30]

Building 154 was constructed circa 1957 for SWCL research, and the program continued to expand under Howe's direction for the next decade. SWCL eventually encompassed most of the buildings on the north side of Lark

[24] P.H. McGauhey, "The Sanitary Engineering Research Laboratory: Administration, Research and Consultation, 1950-1975 – An Interview Conducted by Malca Call", Regional Oral History Office, University of California, Berkeley, 1974, p. 70.

[25] McGauhey, p. 71.

[26] University of California, Berkeley, Department of Engineering, "Guide for Engineering Field Station Inspection", undated, p. 3.

[27] University of California, Berkeley, 2008, p. 13.

[28] University of California, Berkeley, Department of Engineering, "Richmond Field Station Open House", May 28, 1952, p. 3 – 4.

[29] Heather Cooley, Peter H. Gleick, and Gary Wolff, "Desalination, With a Grain of Salt: A California Perspective," Pacific Institute, Oakland, California: 2006, p.11.

[30] University of California (System) Academic Senate, "1991, University of California: In Memoriam," 1991, Internet website: http://texts.cdlib.org/view?docId=hb4t1nb2bd&doc.view=frames&chunk.id=div00031&toc.depth=1&toc.id=.

B10. Significance (continued)

Drive, including Buildings 151, 155, 158, 177, and 180.[31] Howe became the coordinator for Saline Water Conversion Projects throughout the UC system and authored several books on desalination before his retirement in 1968.[32] Although Howe has been referred to as a pioneer in the solar distillation of seawater, research has not revealed a significant lasting impact on desalination science resulting from his work.[33]

Howe's primary contributions appear to have been administering and promoting desalination research. Breakthroughs such as reverse osmosis were developed by scientists at the University of California Los Angeles (UCLA) and the University of Florida. UCLA researchers also designed the pilot desalination plant in Coalinga, California, that went online in 1965, while Howe's role in that effort seems to have been limited to coordination.[34]

Professor Alan D.K. Laird became SWCL Director when Howe retired, a position he held until the laboratory was closed in 1987.[35] By 1978, SWCL encompassed twelve separate research projects. During this era, the cluster of buildings devoted to SWCL had grown to include Building 150 on the south side of Lark Drive as well as the six buildings on the north side of the street. In 1978, Laird proposed a major capital improvement project involving 10,000 square feet of new construction.[36] In 1982, the Office of Saline Water was closed when the Reagan administration made broad cuts to funding for scientific research.[37] Professor Laird's proposed capital improvements were never constructed. Alan D.K. Laird does not seem to have been responsible for groundbreaking contributions to desalination science.

Building 177

Like the other buildings on the north side of Lark Drive, Building 177 was utilized by the SWCL. By 1978, the building had been abandoned, and its demolition was proposed. Eventually, however, the Richmond Field Station used the building for offices. The full width porch was added and the original windows replaced circa the 1990s.

Evaluation

No association was found between Building 177 and events significant to national, state, or local history (Criterion A/1). Although the California Cap Company was the first blasting cap manufacturer in the United States, there is no indication that the activities that took place in Building 177 were central to the development of the plant or its technical processes. Academic research took place in the building after UC Berkeley took over the

[31] University of California, Berkeley, Files "Building 151", "Building 154", "Building 158", "Building 177", and "Building 180," located in vertical files in Room 148, Richmond Field Station.

[32] University of California (System) Academic Senate, "1991, University of California: In Memoriam," 1991, Internet website: http://texts.cdlib.org/view?docId=hb4t1nb2bd&doc.view=frames&chunk.id=div00031&toc.depth=1&toc.id=.

[33] Soteris A. Kalogirou, *Solar Engineering: Processes and Systems*, Academic Press, Burlington, MA: 2009, p. 31.

[34] Yorem Cohen and Julius Glater, "A Tribute to Sidney Loeb, the Pioneer of Reverse Osmosis Desalination Research," Water Technology Research Center, Chemical and Biomolecular Engineering Research, University of California, Los Angeles, December, 2009, p. 13.

[35] University of California (System) Academic Senate, "1996, University of California: In Memoriam," 1996, Internet website: http://texts.cdlib.org/view?docId=hb0z09n6nn&doc.view=frames&chunk.id=div00041&toc.depth=1&toc.id=.

[36] University of California, Berkeley, Files "Building 180," located in vertical files in Room 148, Richmond Field Station.

[37] Heather Cooley, Peter H. Gleick, and Gary Wolff, "Desalination, With a Grain of Salt: A California Perspective," Pacific Institute, Oakland, California: 2006, p.12.

B10. Significance (continued)

property, and while academic research is important to anyone directly involved in the field, the historical record must show that the research or studies conducted had a significant impact on historical events and trends in order to merit eligibility for listing in the NRHP or CRHR. The historical record does not indicate that Building 177 is eligible in this regard under Criterion A/1.

Although the Olivers were significant in the history of the explosives industry, no particular association was found between the Oliver family and the building. Although Building 177 was used for university research by Professor Howe and others throughout its lifetime, none of the available evidence suggests that the building has association with persons important to the development of the desalination field. Academic research is important to those working directly in that specific field; however, none of the persons associated with Building 177 had a significant impact on local, state, or national history. Therefore, the building lacks the strength of association necessary to be considered historically significant in relation to any particular persons (Criterion B/2).

The building does not embody the distinctive characteristics of a type, period, region, or method of construction, or represent the work of an important creative individual or possess high artistic values. Building 177 is a vernacular building of a type that was commonly constructed in the early twentieth century. In addition, it has been heavily altered over the years since UC Berkeley took possession in 1950, and the building is not eligible for listing in the NRHP or CRHR for its architecture (Criterion C/3).

In rare instances, buildings themselves can serve as sources of important information; however, this building is not a principal source of important information in this regard (Criterion D/4).

Building 177 does not meet the significance criteria for listing in the NRHP or CRHR.

Photographs (continued):

Photograph 2, rear of Building 177, April 30, 2013, camera facing southeast

Photographs (continued):

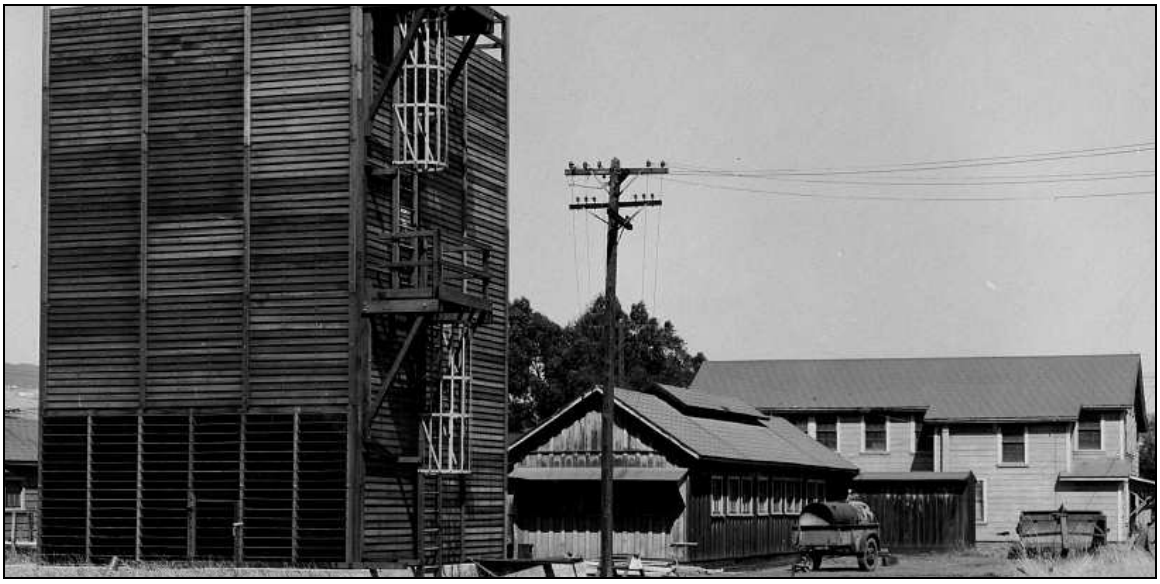
Photograph 3, rear of single-story portion of Building 177 showing decorative stickwork, April 30, 2013, camera facing south

Photographs (continued):

Photograph 4, rear of two-story portion of Building 177 showing exterior stairs, January 4, 2013, camera facing southwest

Photographs (continued):

Photograph 5, Building 177 (background), 1952, camera facing east



Photograph 6, Building 177 (Cooling Tower and "Building 64" in foreground), 1952, camera facing east

Photographs (continued):

Photograph 7, Building 177 with former Building 179 at left of frame, 1953, camera facing east

State of California – The Resources Agency
DEPARTMENT OF PARKS AND RECREATION
PRIMARY RECORD

Primary # _____
HRI # _____
Trinomial _____
NRHP Status Code _____
Other Listings _____
Review Code _____ Reviewer _____ Date _____

 ***Resource Name or #** (Assigned by recorder) Richmond Field Station Building 180

P1. Other Identifier: Richmond Field Station Building 180

***P2. Location:** ☐ **Not for Publication** ☒ **Unrestricted** ***a. County** Contra Costa
and (P2b and P2c or P2d. Attach a Location Map as necessary.)
***b. USGS 7.5′ Quad** Richmond **Date** 2013 **T** 1N **; R** 4W; ___ **¼ of Sec** 20 **;** Mt. Diablo **B.M.**
c. Address _____ City _____ Zip _____
d. UTM: (give more than one for large and/or linear resources) Zone 10 ; 558555 mE/ 4196547 mN
e. Other Locational Data: (e.g., parcel #, directions to resource, elevation, etc., as appropriate)

***P3a. Description:** (Describe resource and its major elements. Include design, materials, condition, alterations, size, setting, and boundaries)

Building 180 is in the southern portion of the Richmond Field Station. It is on the north side of Lark Drive, and its primary façade faces southwest. The vernacular building does not strongly express any particular architectural style. It is 11,008 square feet, single-story, and has an irregular plan. It is topped with a cross gabled roof. The primary fenestration consists of aluminum replacement sliding and awning sashes. The main entrance is centered in the southeast elevation. Its aluminum framed glass door is sheltered by a flat roofed entry porch and accessed via concrete steps. (See Continuation sheet)

***P3b. Resource Attributes:** (List attributes and codes) 39: Other

***P4. Resources Present:** ☒ Building ☐ Structure ☐ Object ☐ Site ☐ District ☐ Element of District ☐ Other (Isolates, etc.)

P5b. Description of Photo: (View, date, accession #) Photograph 1, camera facing northeast, April 30, 2013

***P6. Date Constructed/Age and Sources:**
☒ Historic ☐ Prehistoric ☐ Both
Circa 1920/Sanborn maps

***P7. Owner and Address:**
U.C. Berkeley
1301 South 46th Street
Richmond, California 94804

***P8. Recorded by:** (Name, affiliation, address)
Kara Brunzell & Julia Mates
Tetra Tech
1999 Harrison Street, Ste 500
Oakland, CA 94612

***P9. Date Recorded:** April 30, 2013

***P10. Survey Type:** (Describe) Intensive

***P11. Report Citation:** (Cite survey report and other sources, or enter "none.") *Historic Properties Survey Report for Portions of the Richmond Field Station, prepared by Tetra Tech, Inc., 2013.*

***Attachments:** NONE ☒ Location Map ☐ Sketch Map ☒ Continuation Sheet ☒ Building, Structure, and Object Record ☐ Archaeological Record ☐ District Record ☐ Linear Feature Record ☐ Milling Station Record ☐ Rock Art Record ☐ Artifact Record ☐ Photograph Record ☐ Other (list) _____

***NRHP Status Code** 6Z

***Resource Name or #** (Assigned by recorder) Richmond Field Station Building 180

B1. Historic Name: "Building 44", "Building 170", "Building 171", "Building 172", "Building 185"

B2. Common Name: Building 180

B3. Original Use: Manufacturing B4. Present Use: Offices

***B5. Architectural Style:** Vernacular

***B6. Construction History:** (Construction date, alteration, and date of alterations) Five original buildings constructed circa 1920; joined circa 1940; renumbered 1953; windows replaced circa 1980s

***B7. Moved?** ☒ **No** ☐ **Yes** ☐ **Unknown** **Date:** _____ **Original Location:** _____

***B8. Related Features:** _____

B9. Architect: Unknown b. Builder: Unknown

***B10. Significance: Theme** N/A **Area** N/A

Period of Significance N/A **Property Type** N/A **Applicable Criteria** N/A

(Discuss importance in terms of historical or architectural context as defined by theme, period, and geographic scope. Also address integrity.)

Building 180 at the Richmond Field Station does not appear to meet the criteria for listing in the National Register of Historic Places (NRHP). Furthermore, the building has been evaluated in accordance with Section 15064.5(a)(2)-(3) of the CEQA Guidelines, using the criteria outlined in Section 5024.1 of the California Public Resources Code and does not appear to meet the significance criteria as outlined in these guidelines. Therefore, the building is not eligible for listing in the California Register of Historical Resources (CRHR). (See Continuation Sheet)

B11. Additional Resource Attributes: (List attributes and codes)

***B12. References:**

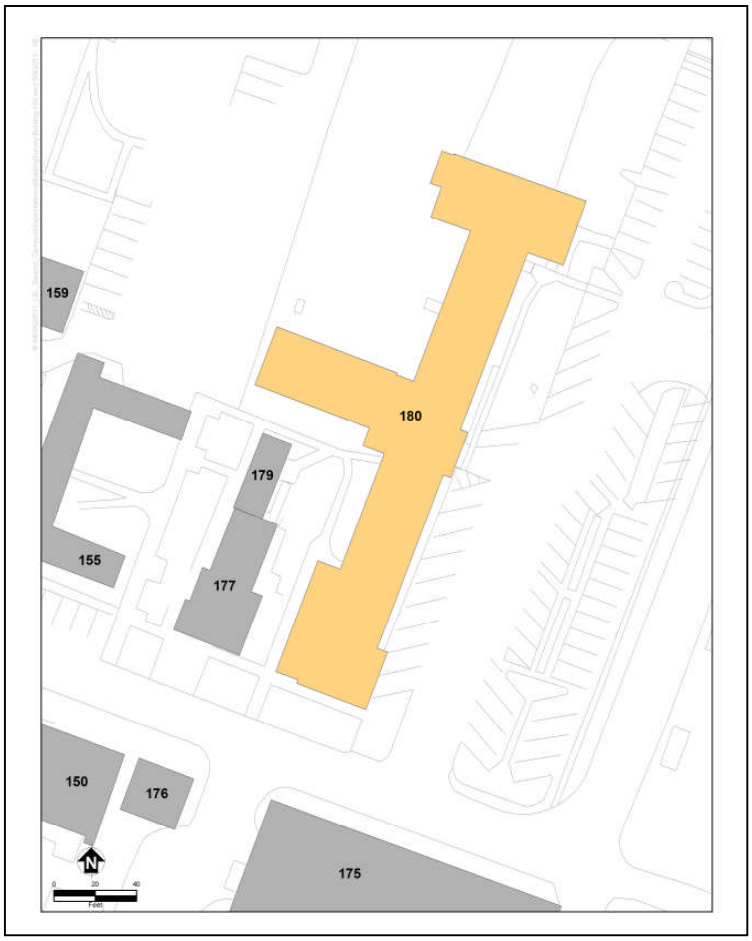
(See Footnotes)

B13. Remarks:

***B14. Evaluator:** Kara Brunzell

***Date of Evaluation:** April 2013

(This space reserved for official comments.)



P3a. Description (continued)

Building 180 was constructed piecemeal, combining several buildings, over a period of decades from about the 1920s through the 1930s. This is why the building has multiple types of wall cladding, including two sizes of brick, horizontal wood siding, and vertical groove plywood (Photographs 1-5). A small two-story wing at the northeast corner of the building contains multi-light wood sash windows that have been painted over (Photograph 4).

During the California Cap Company era, the five connected buildings that comprise what is now Building 180 were devoted to manufacturing. "Building 44," which became the south half of Building 180's main wing, was devoted to plugging, soldering, and concaving (Photograph 5) when originally used by the California Cap Company. Wire cutting was performed in "Building 185," which became the small two-story wing at the north end of the building (Photograph 4). The north half of the building's main wing was "Building 170," where plugging was conducted for the company (Photograph 3). "Building 171," currently the west wing of Building 180, was a match head manufacturing area (Photograph 1). "Building 172" is at the center of Building 180's main wing and was originally an office (Photograph 2). Concrete blast walls on either side of the office protected the space from the explosives handled in Buildings 44 and 170.[1]

After the University of California (UC) took over and renumbered the five buildings, the space on which Building 180 now stands was used for photography work and offices. Most of the building's windows were replaced with aluminum sashes sometime during the 1980s (Photographs 1, 2, and 3). In 1982, restrooms and a conference room were installed in Building 180 (Photograph 5). The new restroom facility served the Sea Water Conversion complex which, prior to 1982, did not have plumbed indoor toilets.[2] It is currently used as offices.

B10. Significance (continued)

Historic Context

Europeans arrived in what would become Contra Costa County in 1772, when a Spanish expedition led by Pedro Fages came upon the San Pablo Bay and the confluence of the Sacramento and San Joaquin rivers.[3] Though subsequent Spanish expeditions passed through the region, the Spanish do not appear to have settled in the area during the mission period. In the 1820s and 1830s, the Mexican government began granting large tracts of land in the area to its citizens, including Ranchos San Pablo, San Ramon, and Pinole. The first permanent non-native settlers were Francisco Castro and his wife Maria Gabriela Berryessa. The Mexican government granted the 18,000-acre Rancho San Pablo to the Castros in 1823.[4] Americans began farming in Contra Costa County in the late 1830s, and by 1882, two-thirds of the cultivated land in the county was devoted to wheat production.[5]

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[1] Sanborn Maps, 1949.

[2] University of California, Berkeley, File "Building 180," located in vertical files in Room 148, Richmond Field Station.

[3] Mildred B. Hoover, Hero E. Rensch, Ethel G. Rensch, Douglas E. Kyle, *Historic Spots in California, Fourth Edition*, Stanford University Press, Stanford, California: 1958, p. 129.

[4] Donald Bastin, *Images of America: Richmond*, Arcadia Publishing, Charleston SC: 2003, p. 9.

[5] J.P. Munro-Fraser, *History of Contra Costa County, California*, W.A. Slocum & Co., San Francisco: 1882, p. 55 – 57.

B10. Significance (continued)

Minna C. C. Quilfelt (or Quilfeldt) purchased 600 acres of Rancho San Pablo in 1852 and 1853.[6] Adjacent to San Francisco Bay in what would eventually become the southern portion of the City of Richmond, a wharf and produce warehouse were constructed on the ranch in the 1860s to ship agricultural produce to the San Francisco markets from Rancho San Pablo, as well as from the Quilfelt ranch. The warehouse and wharf were used to transport cattle, grain, fruit, and in later years, the frogs' legs raised by Richard Stege for the San Francisco restaurant market.[7] German native Richard Stege settled on Rancho San Pablo in the late 1860s after stints in the gold fields and the Siberian fur trade, marrying Quilfelt and gaining title to her ranch. Stege began selling off portions of his ranch to raise money while continuing his frog-raising and other ventures. A town named Stege formed on Richard Stege's holdings, and by the late nineteenth century several industries, including the California Cap Company, the United States Briquette Company, the Stauffer Chemical Works and the Stege Lumber Manufacturing Company, were operating from portions of the Stege Ranch.[8] Richmond incorporated in 1905, and by 1917 was already the largest city in Contra Costa County.[9] Stege was eventually absorbed into Richmond as the latter grew.

The Explosives Industry in Contra Costa County

Swedish chemist Alfred Nobel laid the foundation for the high-explosives industry with his innovations beginning in 1860s, inventing first a detonator and then a blasting cap. In 1867, he invented dynamite, which was safer, cheaper, and more powerful than nitroglycerine, which had been the most commonly used explosive.

During the 1870s, chemical and explosives manufacturers began opening in the vicinity of what would eventually become Richmond. The Tonite Powder Company, Western Mineral Company, and California Cap Company were established at 1877 on the Stege ranch.

William Letts Oliver

William Letts Oliver was born in Chile to English parents in 1844. He initially gained familiarity with an explosive called guncotton while manufacturing collodion for his photography hobby.[10] As early as 1870, European explosive companies were experimenting with nitrated guncotton. By 1875, it was being manufactured in England under the name "Tonite."[11] In 1877, Oliver was mining in the western United States. Engineers working on the Sutro Tunnel in the Comstock needed an explosive to complete the tunnel that would remain stable at the high temperatures underground, and Oliver was able to solve the problem by substituting Tonite for more volatile compounds.[12]

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[6] Evan Griffins, "Early History of Richmond", December 1938, El Cerrito Historical Society, website: http://www.elcerritowire.com/history/pages/EarlyRichmond.htm, accessed January 2013.

[7] Roland Oliver, "Recollections of Early Industries in Stege", August 7, 1959, p. 1.

[8] Frederick J. Hulaniski, *The History of Contra Costa County, California*. Elms Publishing Company, Berkeley, California: 1917, p. 354.

[9] Hulanski p. 288.

[10] Pacific Mining News, p. 222.

[11] G.A. Price Cuxson, ed., "Society of Engineers: Transactions for 1889", E. & F. N. Spon, London: 1890, p. 95.

[12] Pacific Mining News, p. 222.

B10. Significance (continued)

The California Cap Company

In 1877, William Letts Oliver established the Tonite Powder Company on a portion of the former Stege Ranch.[13] Oliver eventually invented a blasting cap that was safer to use and had better detonating qualities than imported detonators. Oliver and his partner Freeborn Fletter then founded the California Cap Company. It was located adjacent to the Tonite Powder Company on a 160-acre parcel carved out of the southern portion of Stege Ranch.[14] The California Cap Company, which went on to operate on the site for nearly seven decades, was the first manufacturer of blasting caps in the United States. Richard Stege, meanwhile, continued to reside on the ranch, and contracted with Tonite Powder and California Cap to transport their products to the railroad.[15] The California Cap Company was located on the parcel that is currently the Richmond Field Station. The Tonite Powder Company appears to have been located to the east on the parcel that became the Stauffer Chemical Company and later the Zeneca site, although its exact location is unclear.

William Letts Oliver continued to innovate throughout his long career in the chemical and explosives industries. In 1888, he formed the American Lucol Company adjacent to the California Cap Company property.[16] The Lucol plant was at what is currently the southeastern corner of the Richmond Field Station. Lucol manufactured a linseed oil substitute.[17] The factory was dismantled and relocated to New Jersey circa 1900.[18] In 1903, the Hotaling Briquette Works opened on Lucol's site at the southeast corner of the current Richmond Field Station property.[19] Later known as the U.S. Briquette Company, the plant appears to have operated at this location until at least 1917.[20] The U.S. Briquette Company buildings were demolished during the 1960s.

Eventually, the Tonite factory appears to have been incorporated into the California Cap Company. The Olivers also formed an entity named Pacific Cartridge Company circa 1910. The Pacific Cartridge Company operated from the California Cap plant during World War I.[21] By 1916, there were at least a dozen buildings on the site. By 1922, the California Cap Company was substantially expanded and the plant grew to include 150 buildings and a horse-drawn tram line.[22]

During the late nineteenth and early twentieth century, the California Cap Company was one of the most important local employers.[23] As the twentieth century progressed more heavy industry came to Contra Costa

[13] Oliver, p. 1.
[14] Pacific Mining News, p. 222.
[15] Nilda Rego, "Enterprising Stege lost all and died without a penny", Time Out, March 27, 1994, p. 2, column 4.
[16] Oliver, p. 1.
[17] Max Wilhelm Von Bernewitz, *Cyanide Practice, 1910 – 1913*, Dewey Publishing Company: 1913, p. 327.
[18] Oliver, p. 1.
[19] Oliver, p. 2.
[20] Hulaniski, p. 354.
[21] R.L. Polk & Company, *Richmond and Contra Costa County Directory, 1914 – 1915*, Oakland, California: 1915.
[22] University of California, Berkeley, *Current Conditions Report*, Prepared by Tetra Tech EM Inc., November 21, 2008, p. 11.
[23] Marguerite Clausen, "On the Waterfront: An Oral History of Richmond, California", Regional Oral History Office, University of California, Berkeley, 1990, p. 21.

B10. Significance (continued)

County, and by 1940, the county was second only to Los Angeles in overall industrial production.[24] The nineteenth-century California Cap Company was dwarfed by the scale of some of the newer enterprises, and its physical plant and technology were aging. During World War II, California Cap Company was able to stay open by producing delayed action incendiary bombs that were used against Japan.[25] The California Cap Company could not survive the transition to a peacetime economy, however, and by 1949 the plant was closed.

University Research/Richmond Field Station

After World War II, the UC Berkeley Engineering Department needed an off-campus location in order to perform experiments that required more space than a laboratory. Department Chair Morrough P. O'Brien and others in the department were performing experiments with sewage, sea water, and other materials unsuited to use on a crowded campus. They also wanted a location that was not too remote. UC Berkeley purchased the California Cap Company from the Oliver family for the use of the Engineering Department in 1950.[26]

At first, the Department of Engineering utilized the buildings left behind by the California Cap Company. The department established a machine shop, computer shop, receiving facility, mail service, and other facilities in addition to laboratories in the old detonator company buildings.[27] The current Buildings 102, 110, 118, 128, 150, 152, 155, 175, 177, 176, and 180 all date to the California Cap Company era and were repurposed for the Richmond Field Station. UC Berkeley also constructed new buildings as funds became available, and by the mid-1950s, five new buildings had been completed at the Richmond Field Station.[28] By the 1970s, the Department of Engineering had conducted many experiments at the Richmond Field Station that could not have been performed on the main campus.

The Richmond Field Station has been the location of research overseen by numerous UC Berkeley departments over the years. The Sanitary Engineering Research Laboratory (SERL) was one of the first departments to undertake research at the site. The focus of SERL was primarily on sewage treatment technology, and also researched pollution control and disposal of solid and liquid waste.[29] Other early research projects at the field station included heat transfer and cyclic stress research.[30]

Another laboratory that utilized the Richmond Field Station was the Sea Water Conversion Laboratory (SWCL). In 1952, Congress had created and funded the Office of Saline Water in order to encourage desalination studies as

[24] Purcell, p. 649.
[25] Oliver, p. 1.
[26] P.H. McGauhey, "The Sanitary Engineering Research Laboratory: Administration, Research and Consultation, 1950-1975 – An Interview Conducted by Malca Call", Regional Oral History Office, University of California, Berkeley, 1974, p. 70.
[27] McGauhey, p. 71.
[28] University of California, Berkeley, Department of Engineering, "Guide for Engineering Field Station Inspection", undated, p. 3.
[29] University of California, Berkeley, 2008, p. 13.
[30] University of California, Berkeley, Department of Engineering, "Richmond Field Station Open House", May 28, 1952, p. 3 – 4.

B10. Significance (continued)

a solution to water shortages.[31] In response, UC Berkeley Mechanical Engineering professor Everett D. Howe formed the SWCL at the Richmond Field Station in 1958.[32]

Building 154 was constructed circa 1957 for SWCL research, and the program continued to expand under Howe's direction for the next decade. SWCL eventually encompassed most of the buildings on the north side of Lark Drive, including Buildings 151, 155, 158, 177, and 180.[33] Howe became the coordinator for Saline Water Conversion Projects throughout the UC system and authored several books on desalination before his retirement in 1968.[34] Although Howe has been referred to as a pioneer in the solar distillation of seawater, research has not revealed a significant lasting impact on desalination science resulting from his work.[35]

Howe's primary contributions appear to have been administering and promoting desalination research. Breakthroughs such as reverse osmosis were developed by scientists at the University of California Los Angeles (UCLA) and the University of Florida. UCLA researchers also designed the pilot desalination plant in Coalinga, California, that went online in 1965, while Howe's role in that effort seems to have been limited to coordination.[36]

Professor Alan D.K. Laird became SWCL Director when Howe retired, a position he held until the laboratory was closed in 1987.[37] By 1978, SWCL encompassed twelve separate research projects. During this era, the cluster of buildings devoted to SWCL had grown to include Building 150 on the south side of Lark Drive as well as the six buildings on the north side of the street. In 1978, Laird proposed a major capital improvement project involving 10,000 square feet of new construction.[38] In 1982, the Office of Saline Water was closed when the Reagan administration made broad cuts to funding for scientific research.[39] Professor Laird's proposed capital improvements were never constructed. Alan D.K. Laird does not seem to have been responsible for groundbreaking contributions to desalination science.

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[31] Heather Cooley, Peter H. Gleick, and Gary Wolff, "Desalination, With a Grain of Salt: A California Perspective," Pacific Institute, Oakland, California: 2006, p.11.

[32] University of California (System) Academic Senate, "1991, University of California: In Memoriam," 1991, Internet website: http://texts.cdlib.org/view?docId=hb4t1nb2bd&doc.view=frames&chunk.id=div00031&toc.depth=1&toc.id=.

[33] University of California, Berkeley, Files "Building 151", "Building 154", "Building 158", "Building 177", and "Building 180," located in vertical files in Room 148, Richmond Field Station.

[34] University of California (System) Academic Senate, "1991, University of California: In Memoriam," 1991, Internet website: http://texts.cdlib.org/view?docId=hb4t1nb2bd&doc.view=frames&chunk.id=div00031&toc.depth=1&toc.id=.

[35] Soteris A. Kalogirou, *Solar Engineering: Processes and Systems*, Academic Press, Burlington, MA: 2009, p. 31.

[36] Yorem Cohen and Julius Glater, "A Tribute to Sidney Loeb, the Pioneer of Reverse Osmosis Desalination Research," Water Technology Research Center, Chemical and Biomolecular Engineering Research, University of California, Los Angeles, December, 2009, p. 13.

[37] University of California (System) Academic Senate, "1996, University of California: In Memoriam," 1996, Internet website: http://texts.cdlib.org/view?docId=hb0z09n6nn&doc.view=frames&chunk.id=div00041&toc.depth=1&toc.id=.

[38] University of California, Berkeley, Files "Building 180," located in vertical files in Room 148, Richmond Field Station.

[39] Heather Cooley, Peter H. Gleick, and Gary Wolff, "Desalination, With a Grain of Salt: A California Perspective," Pacific Institute, Oakland, California: 2006, p.12.

B10. Significance (continued)

Evaluation

No association was found between Building 180 and events significant to national, state, or local history (Criterion A/1). Although the California Cap Company was the first blasting cap manufacturer in the United States, there is no indication that the activities that took place in Building 180 were central to the development of the plant or its technical processes. Academic research took place in the building after UC Berkeley took over the property, and while academic research is important to anyone directly involved in the field, the historical record must show that the research or studies conducted had a significant impact on events and trends in order to merit listing in the NRHP or CRHR. The historical record does not indicate such significance, so the building is not eligible for inclusion in the NRHP or CRHR for historical significance (Criterion A/1).

Although the Olivers were significant in the history of the explosives industry, no particular association was found between the Oliver family and the building. The building was used for university research by Professor Howe and others throughout its lifetime; however, none of the available historical evidence suggests that the building has association with persons important to local, state, or national history. Academic research is important to those working directly in that specific field; however, none of the persons associated with Building 180 have the strength of association necessary to be considered eligible under Criterion B/2.

The building does not embody the distinctive characteristics of a type, period, region, or method of construction, or represent the work of an important creative individual or possess high artistic values. Building 180 is a combination of five buildings that were joined to make one building complex and has alteration dates from 1930 through 1950. The building is not eligible for the NRHP or CRHR for its architecture (Criterion C/3).

In rare instances, buildings themselves can serve as sources of important information; however, this building is not a principal source of important information in this regard (Criterion D/4).

Building 180 does not meet the significance criteria for listing in the NRHP or CRHR.

Photographs (continued):

Photograph 2, Building 180, primary entrance in main wing, April 30, 2013, camera facing west

Photograph 3, Building 180, rear of main wing, April 30, 2013, camera facing east

Photographs (continued):

Photograph 4, Building 180, northeast wing,
April 30, 2013, camera facing south

Photograph 5, Building 180, south end of main wing,
April 30, 2013, camera facing west

State of California – The Resources Agency
DEPARTMENT OF PARKS AND RECREATION

PRIMARY RECORD

Primary # _____
HRI # _____
Trinomial _____
NRHP Status Code _____
Other Listings _____
Review Code _____ Reviewer _____ Date _____

Page 1 **of** 1 ***Resource Name or #** (Assigned by recorder) Richmond Field Station Building 198

P1. Other Identifier: Richmond Field Station Building 198

***P2. Location:** ☐ **Not for Publication** ☒ **Unrestricted** ***a. County** Contra Costa
and (P2b and P2c or P2d. Attach a Location Map as necessary.)
***b. USGS 7.5′ Quad** Richmond **Date** 1984 **T**___; **R** ____; __ ¼ **of Sec** ___; Diablo **B.M.**
c. Address _____ City _____ Zip_____
d. UTM: (give more than one for large and/or linear resources) Zone 10 ; 558629 mE/ 4196501 mN
e. Other Locational Data: (e.g., parcel #, directions to resource, elevation, etc., as appropriate)

***P3a. Description:** (Describe resource and its major elements. Include design, materials, condition, alterations, size, setting, and boundaries)

Building 198 is in the southern portion of the Richmond Field Station across Lark Drive from Building 197. It is a 1,800 square-foot, rectangular plan, prefabricated building, topped with a very shallow pitched, gable roof with vents in the gables. Its walls and roof are corrugated steel and the building lacks fenestration. A large metal roll-up door is centered in its northwest elevation, while its southwest elevation features a metal industrial entrance door at grade.

***P3b. Resource Attributes:** (List attributes and codes) HP39: Other

***P4. Resources Present:** ☒ Building ☐ Structure ☐ Object ☐ Site ☐ District ☐ Element of District ☐ Other (Isolates, etc.)

P5b. Description of Photo: (View, date, accession #) Photograph 1, camera facing northeast, April 30, 2013.

***P6. Date Constructed/Age and Sources:**
☒ Historic ☐ Prehistoric ☐ Both
1981

***P7. Owner and Address:**
U.C. Berkeley
1301 South 46th Street
Richmond, California 94804

***P8. Recorded by:** (Name, affiliation, address)
Kara Brunzell & Julia Mates
Tetra Tech
1999 Harrison Street, Ste 500
Oakland, CA 94612

***P9. Date Recorded:** April 30, 2013

***P10. Survey Type:** (Describe) Intensive

***P11. Report Citation:** (Cite survey report and other sources, or enter "none.") *Historic Properties Survey Report for Portions of the Richmond Field Station, prepared by Tetra Tech, Inc., 2013.*

***Attachments:** NONE ☐ Location Map ☐ Sketch Map ☐ Continuation Sheet ☐ Building, Structure, and Object Record ☐ Archaeological Record ☐ District Record ☐ Linear Feature Record ☐ Milling Station Record ☐ Rock Art Record ☐ Artifact Record ☐ Photograph Record ☐ Other (list) _____

State of California – The Resources Agency
DEPARTMENT OF PARKS AND RECREATION

PRIMARY RECORD

Primary # _____
HRI # _____
Trinomial _____
NRHP Status Code _____

Other Listings _____
Review Code _____ **Reviewer** _____ **Date** _____

Page 1 **of** 1 ***Resource Name or #** (Assigned by recorder) Richmond Field Station Building 201

P1. Other Identifier: Richmond Field Station Building 201

***P2. Location:** ☐ **Not for Publication** ☒ **Unrestricted** ***a. County** Contra Costa
and (P2b and P2c or P2d. Attach a Location Map as necessary.)
***b. USGS 7.5′ Quad** Richmond **Date** 1984 **T**___; **R** _____; ¼ **of Sec** ___; Diablo **B.M.**
c. Address _____ City _____ Zip_____
d. UTM: (give more than one for large and/or linear resources) Zone 10 ; 558629 mE/ 4196501 mN
e. Other Locational Data: (e.g., parcel #, directions to resource, elevation, etc., as appropriate)

***P3a. Description:** (Describe resource and its major elements. Include design, materials, condition, alterations, size, setting, and boundaries)

Building 201 is in the southwestern portion of the Richmond Field Station, along Avocet Way, on a 3.5-acre parcel. It is a single-story structure and houses the U.S. Environmental Protection Agency's Region IX laboratory and office building. It is a 46,000 square-foot tilt-up building that is ornamented through with reveals and indentations in the tilt-up panels, with sculpting. Covered trellises surround the building's walkways, and the main entrance features a modern glass enclosure. It was constructed in 1992.

***P3b. Resource Attributes:** (List attributes and codes) HP14: Government Building

***P4. Resources Present:** ☒ Building ☐ Structure ☐ Object ☐ Site ☐ District ☐ Element of District ☐ Other (Isolates, etc.)

P5b. Description of Photo: (View, date, accession #) Photograph 1, camera facing northwest, April 30, 2013.

***P6. Date Constructed/Age and Sources:**
☒ Historic ☐ Prehistoric ☐ Both
1992/Richmond Field Station Building Records

***P7. Owner and Address:**
U.C. Berkeley
1301 South 46th Street
Richmond, California 94804

***P8. Recorded by:** (Name, affiliation, address)
Kara Brunzell & Julia Mates
Tetra Tech
1999 Harrison Street, Ste 500
Oakland, CA 94612

***P9. Date Recorded:** April 30, 2013

***P10. Survey Type:** (Describe) Intensive

***P11. Report Citation:** (Cite survey report and other sources, or enter "none.") *Historic Properties Survey Report for Portions of the Richmond Field Station, prepared by Tetra Tech, Inc., 2013.*

***Attachments:** NONE ☐ Location Map ☐ Sketch Map ☐ Continuation Sheet ☐ Building, Structure, and Object Record ☐ Archaeological Record ☐ District Record ☐ Linear Feature Record ☐ Milling Station Record ☐ Rock Art Record ☐ Artifact Record ☐ Photograph Record ☐ Other (list) _____

State of California – The Resources Agency
DEPARTMENT OF PARKS AND RECREATION
PRIMARY RECORD

Primary # _____
HRI # _____
Trinomial _____
NRHP Status Code _____
Other Listings _____
Review Code _____ Reviewer _____ Date _____

 ***Resource Name or #** (Assigned by recorder) Richmond Field Station Building 277

P1. Other Identifier: Richmond Field Station Building 277

***P2. Location:** ☐ **Not for Publication** ☒ **Unrestricted** ***a. County** Contra Costa
and (P2b and P2c or P2d. Attach a Location Map as necessary.)
***b. USGS 7.5′ Quad** Richmond **Date** 2013 **T** 1N **; R** 4W; ___ **¼ of Sec** 20 **;** Mt. Diablo **B.M.**
c. Address _____ City _____ Zip _____
d. UTM: (give more than one for large and/or linear resources) Zone 10 ; 558397 mE/ 4196579 mN
e. Other Locational Data: (e.g., parcel #, directions to resource, elevation, etc., as appropriate) Assessor Parcel Number

***P3a. Description:** (Describe resource and its major elements. Include design, materials, condition, alterations, size, setting, and boundaries)
Building 277 is in the southern portion of the Richmond Field Station. It is on the north side of Lark Drive, with its primary façade facing northwest. It is 21,426 square feet and was constructed circa 1966. The single-story building is a rectangular plan, prefabricated building topped with a front gabled roof. The walls and roof are corrugated metal. Fenestration consists of metal sash windows that appear to have been repurposed from a vehicle. Its primary entrance is in the northwest elevation, which faces Avocet Way. A metal industrial entry door is set inside a large sliding door. Building 277 was constructed as a model basin building for salinity intrusion study. It has been used throughout its life for storage.

***P3b. Resource Attributes:** (List attributes and codes) HP39: Other

***P4. Resources Present:** ☒ Building ☐ Structure ☐ Object ☐ Site ☐ District ☐ Element of District ☐ Other (Isolates, etc.)

P5b. Description of Photo: (View, date, accession #) Photograph 1, camera facing east, April 30, 2013.

***P6. Date Constructed/Age and Sources:**
☒ Historic ☐ Prehistoric ☐ Both
1966/Richmond Field Station Building Files

***P7. Owner and Address:**
U.C. Berkeley
1301 South 46th Street
Richmond, California 94804

***P8. Recorded by:** (Name, affiliation, address)
Kara Brunzell & Julia Mates
Tetra Tech
1999 Harrison Street, Ste 500
Oakland, CA 94612

***P9. Date Recorded:** April 30, 2013

***P10. Survey Type:** (Describe) Intensive

***P11. Report Citation:** (Cite survey report and other sources, or enter "none.") *Historic Properties Survey Report for Portions of the Richmond Field Station, prepared by Tetra Tech, Inc., 2013.*

***Attachments:** NONE ☒ Location Map ☐ Sketch Map ☒ Continuation Sheet ☒ Building, Structure, and Object Record ☐ Archaeological Record ☐ District Record ☐ Linear Feature Record ☐ Milling Station Record ☐ Rock Art Record ☐ Artifact Record ☐ Photograph Record ☐ Other (list) _____

***NRHP Status Code** 6Z

***Resource Name or #** (Assigned by recorder) Richmond Field Station Building 277

B1. Historic Name: _____

B2. Common Name: Building 277

B3. Original Use: Storage B4. Present Use: Storage

***B5. Architectural Style:** Vernacular

***B6. Construction History:** (Construction date, alteration, and date of alterations) Constructed in 1966

***B7. Moved?** ☒ **No** ☐ **Yes** ☐ **Unknown** **Date:** _____ **Original Location:** _____

***B8. Related Features:** _____

B9. Architect: Unknown b. Builder: Unknown

***B10. Significance: Theme** N/A **Area** N/A

Period of Significance N/A **Property Type** N/A **Applicable Criteria** N/A

(Discuss importance in terms of historical or architectural context as defined by theme, period, and geographic scope. Also address integrity.)

Building 277 at the Richmond Field Station does not appear to meet the criteria for listing in the National Register of Historic Places (NRHP). The building was evaluated in accordance with Section 15064.5(a)(2)-(3) of the CEQA Guidelines, using the criteria outlined in Section 5024.1 of the California Public Resources Code, and does not appear to meet the significance criteria in these guidelines. Therefore, the building is not eligible for listing in the California Register of Historical Resources (CRHR). (See Continuation Sheet)

B11. Additional Resource Attributes: (List attributes and codes)

***B12. References:**

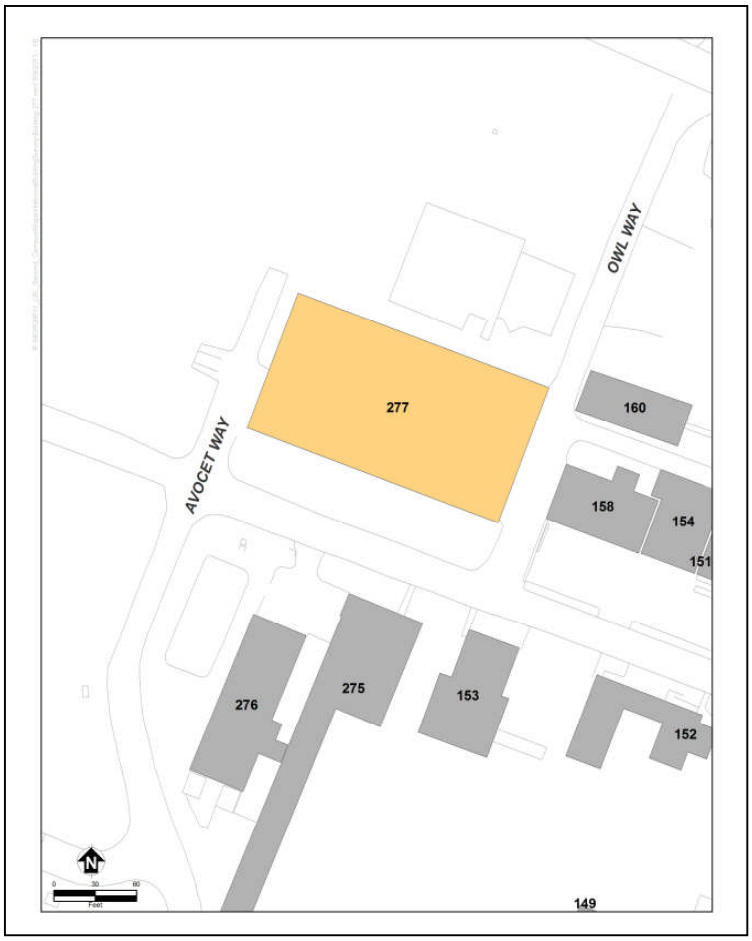
(See Footnotes)

B13. Remarks:

***B14. Evaluator:** Kara Brunzell

***Date of Evaluation:** April 2013

(This space reserved for official comments.)



B10. Significance (continued)

Historic Context

Europeans arrived in what would become Contra Costa County in 1772, when a Spanish expedition led by Pedro Fages discovered the San Pablo Bay and the confluence of the Sacramento and San Joaquin rivers.[1] Though subsequent Spanish expeditions passed through the region, the Spanish do not appear to have settled in the area during the mission period. In the 1820s and 1830s, the Mexican government began granting large tracts of land in the area to its citizens, including Ranchos San Pablo, San Ramon, and Pinole. The first permanent non-native settlers were Francisco Castro and his wife Maria Gabriela Berryessa. The Mexican government granted the 18,000-acre Rancho San Pablo to the Castros in 1823.[2] Americans began farming in Contra Costa County in the late 1830s, and by 1882, two-thirds of the cultivated land in the county was devoted to wheat production.[3]

Minna C. C. Quilfelt (or Quilfeldt) purchased 600 acres of Rancho San Pablo in 1852 and 1853.[4] German native Richard Stege settled on Rancho San Pablo in the late 1860s after stints in the gold fields and the Siberian fur trade, marrying Quilfelt and gaining title to her ranch. A town named Stege formed on Richard Stege's holdings, and by the late nineteenth century, several industries, including the California Cap Company, the United States Briquette Company, the Stauffer Chemical Works and the Stege Lumber Manufacturing Company, were operating from portions of the Stege Ranch.[5] Richmond incorporated in 1905, and by 1917 was already the largest city in Contra Costa County. Stege was eventually absorbed into Richmond as the latter grew.

William Letts Oliver established the Tonite Powder Company and California Cap Company on land purchased from the Stege Ranch in 1877. The California Cap Company, which went on to operate on the site for nearly seven decades, was the first manufacturer of blasting caps in the United States. The company was operated by Oliver's sons after his death and managed to survive through the end of World War II. By 1949, the plant was closed and for sale.

University Research/Richmond Field Station

After World War II, the University of California (UC) Berkeley Engineering Department needed an off-campus location to do experiments requiring more space than a laboratory. Department Chair Morrough P. O'Brien and others in the department were experimenting with sewage, sea water, and other materials unsuited for use on a crowded campus, and they wanted a location that was not too remote. UC Berkeley purchased the California Cap Company from the Oliver family for the use of the Engineering Department in 1950.[6]

---

[1] Mildred B. Hoover, Hero E. Rensch, Ethel G. Rensch, Douglas E. Kyle, *Historic Spots in California, Fourth Edition*, Stanford University Press, Stanford, California: 1958, p. 129.

[2] Donald Bastin, *Images of America: Richmond*, Arcadia Publishing, Charleston SC: 2003, p. 9.

[3] J.P. Munro-Fraser, *History of Contra Costa County, California*, W.A. Slocum & Co., San Francisco: 1882, p. 55 – 57.

[4] Evan Griffins, "Early History of Richmond", December 1938, El Cerrito Historical Society, website: http://www.elcerritowire.com/history/pages/EarlyRichmond.htm, accessed January 2013.

[5] Frederick J. Hulaniski, *The History of Contra Costa County, California*. Elms Publishing Company, Berkeley, California: 1917, p. 354: Hulaniski p. 288.

[6] P.H. McGauhey, "The Sanitary Engineering Research Laboratory: Administration, Research and Consultation, 1950-1975 – An Interview Conducted by Malca Call", Regional Oral History Office, University of California, Berkeley, 1974, p. 70.

B10. Significance (continued)

At first, the Department of Engineering used the buildings left behind by the California Cap Company. The department established a machine shop, computer shop, receiving facility, mail service, and other facilities in addition to laboratories in the old detonator company buildings.[7] The current buildings numbered 102, 110, 118, 128, 150, 152, 155, 175, 177, 176, and 180 all date to the California Cap Company era, and were repurposed for the Richmond Field Station. UC Berkeley constructed new buildings as funds became available, and by the mid-1950s, five new buildings had been completed at the Richmond Field Station.[8] By the 1970s, the Department of Engineering had conducted many experiments at the Richmond Field Station that could not have been done on the main campus.

The Richmond Field Station has been the location of research overseen by numerous UC Berkeley departments over the years. The Sanitary Engineering Research Laboratory (SERL) was one of the first departments to do research at the site. SERL focused primarily on sewage treatment technology and also researched pollution control and disposal of solid and liquid waste.[9] Other early projects at the field station included heat transfer and cyclic stress research.[10]

Another laboratory that used Richmond Field Station was the Sea Water Conversion Laboratory (SWCL). In 1952, Congress created and funded the Office of Saline Water to encourage desalination studies as a solution to water shortages.[11] In response, UC Berkeley Mechanical Engineering professor Everett D. Howe formed the SWCL at the Richmond Field Station in 1958.[12] Professor Alan D.K. Laird became SWCL Director when Howe retired, a position he held until the laboratory was closed in 1987.[13]

Building 277

Building 277 was constructed in 1966. The building has been used for rock storage since its construction.

Evaluation

Building 277 does not meet the criteria for listing in the NRHP or CRHR because it lacks historical significance. The structure has primarily been used for storage throughout its lifetime and lacks the strength of association necessary to be considered historically significant in relation to any particular events or persons (Criteria A/1 and B/2).

---

[7] McGauhey, p. 71.

[8] University of California, Berkeley, Department of Engineering, "Guide for Engineering Field Station Inspection", undated, p. 3.

[9] University of California, Berkeley, 2008, p. 13.

[10] University of California, Berkeley, Department of Engineering, "Richmond Field Station Open House", May 28, 1952, p. 3 – 4.

[11] Heather Cooley, Peter H. Gleick, and Gary Wolff, "Desalination, With a Grain of Salt: A California Perspective," Pacific Institute, Oakland, California: 2006, p.11.

[12] University of California (System) Academic Senate, "1991, University of California: In Memoriam," 1991, Internet website: http://texts.cdlib.org/view?docId=hb4t1nb2bd&doc.view=frames&chunk.id=div00031&toc.depth=1&toc.id=.

[13] University of California (System) Academic Senate, "1996, University of California: In Memoriam," 1996, Internet website: http://texts.cdlib.org/view?docId=hb0z09n6nn&doc.view=frames&chunk.id=div00041&toc.depth=1&toc.id=.

B10. Significance (continued)

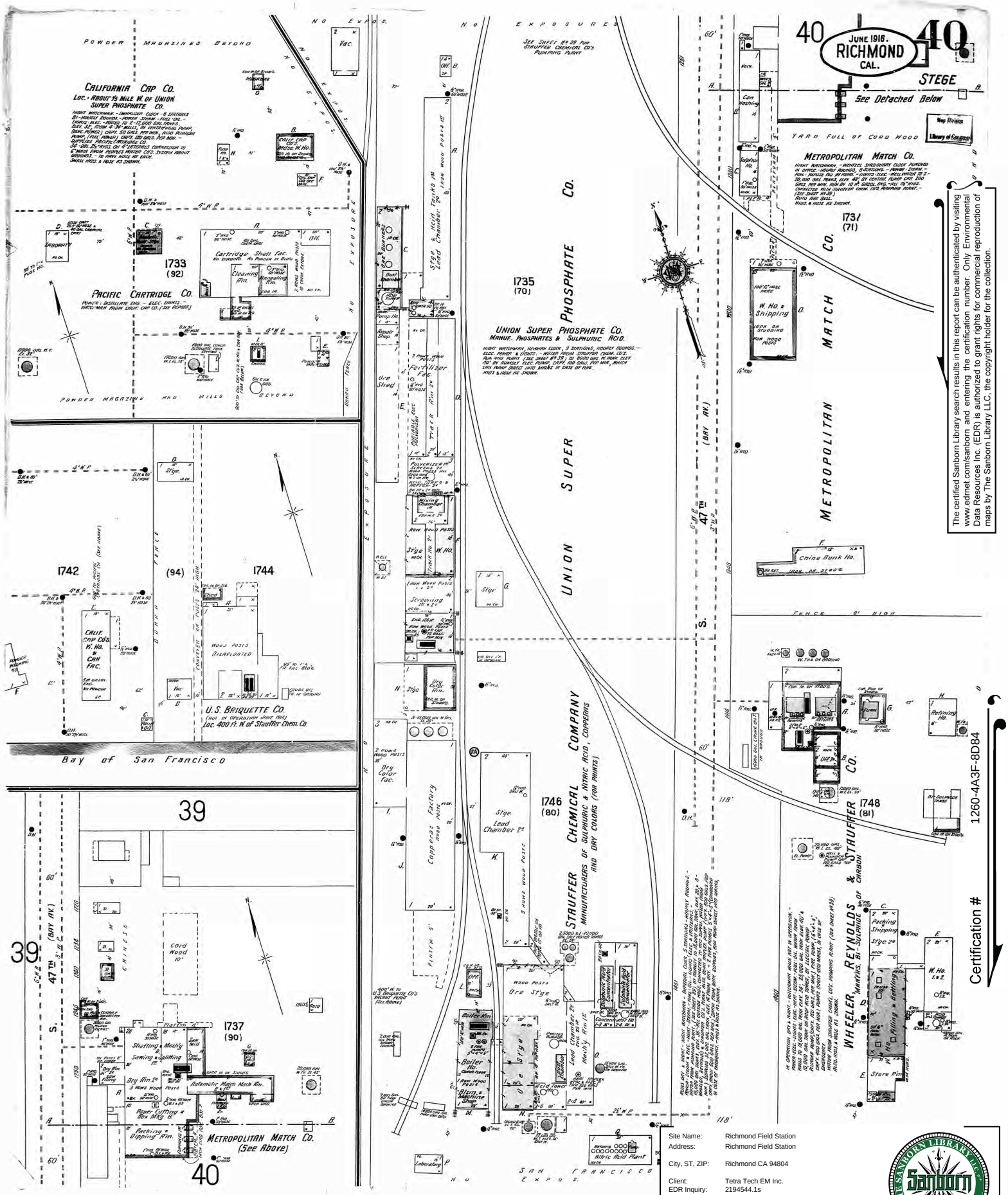
The utilitarian building lacks any identifiable architectural stylistic design and does not embody distinctive architectural or engineering qualities of type, period, or method of construction (Criterion C/3).

In rare instances, buildings themselves can serve as sources of important information, but this building is not a principal source of important information (Criterion D/4).

Building 277 does not meet the significance criteria for listing in the NRHP or CRHR.

APPENDIX B

HISTORIC SANBORN MAPS



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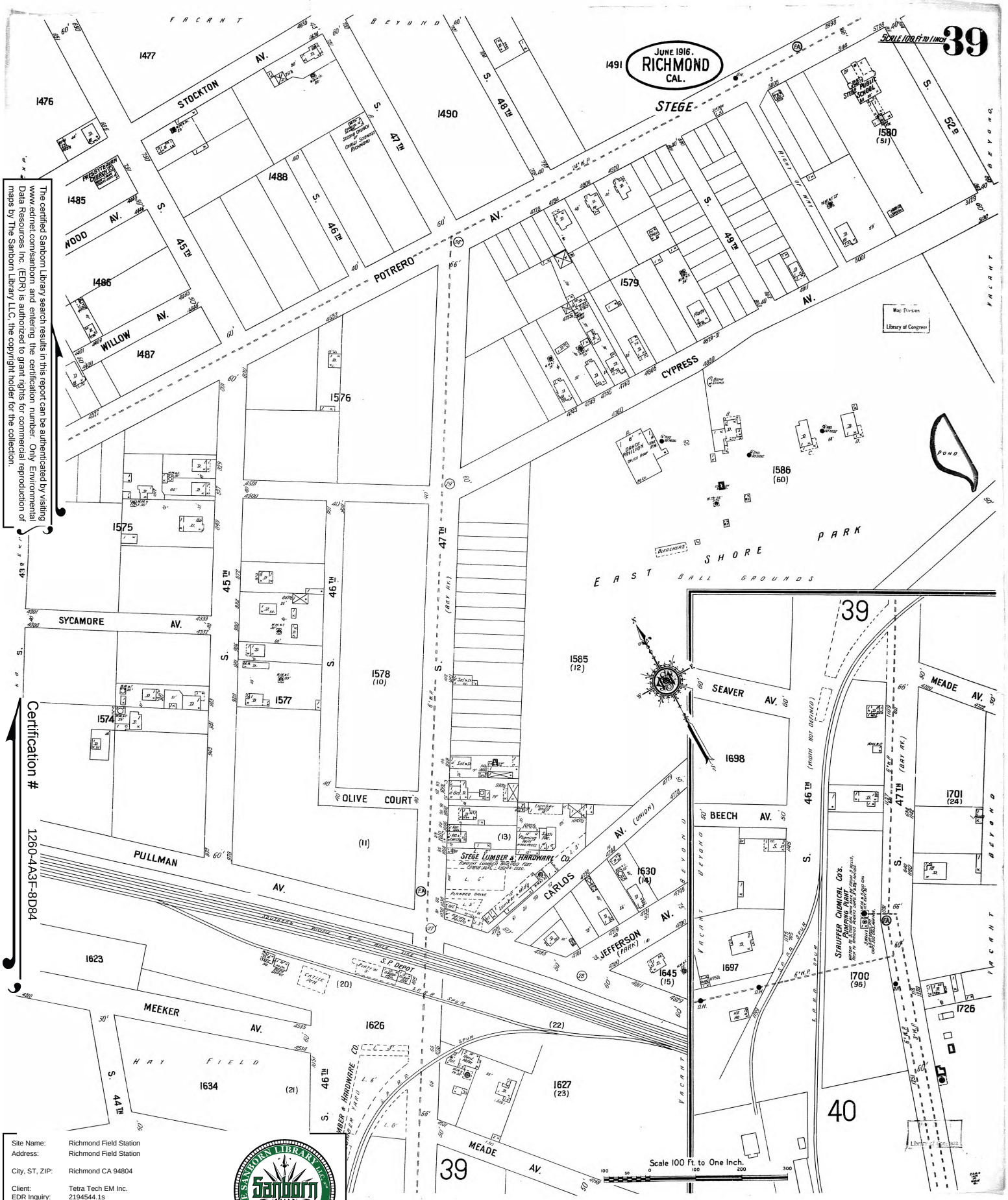

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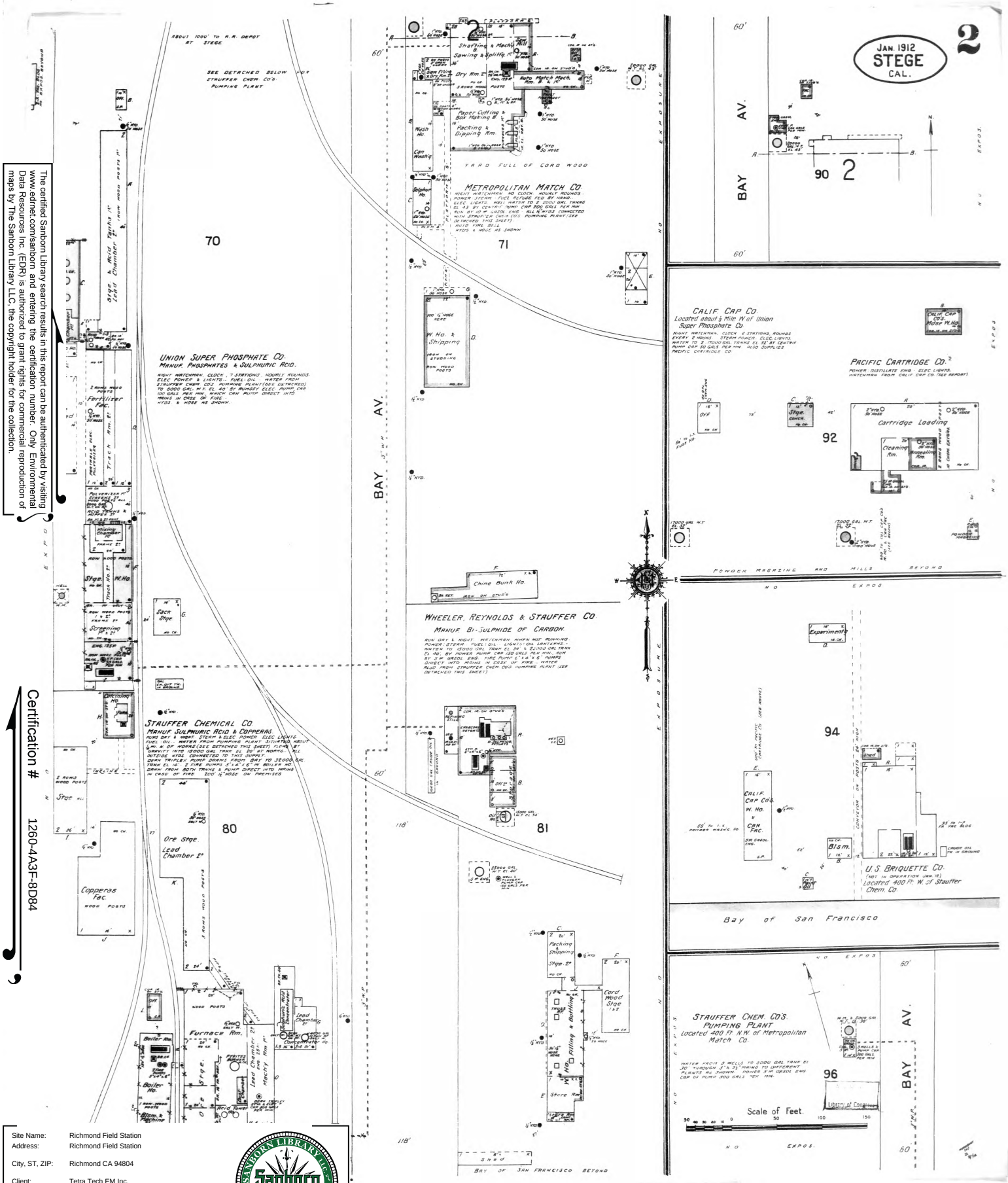

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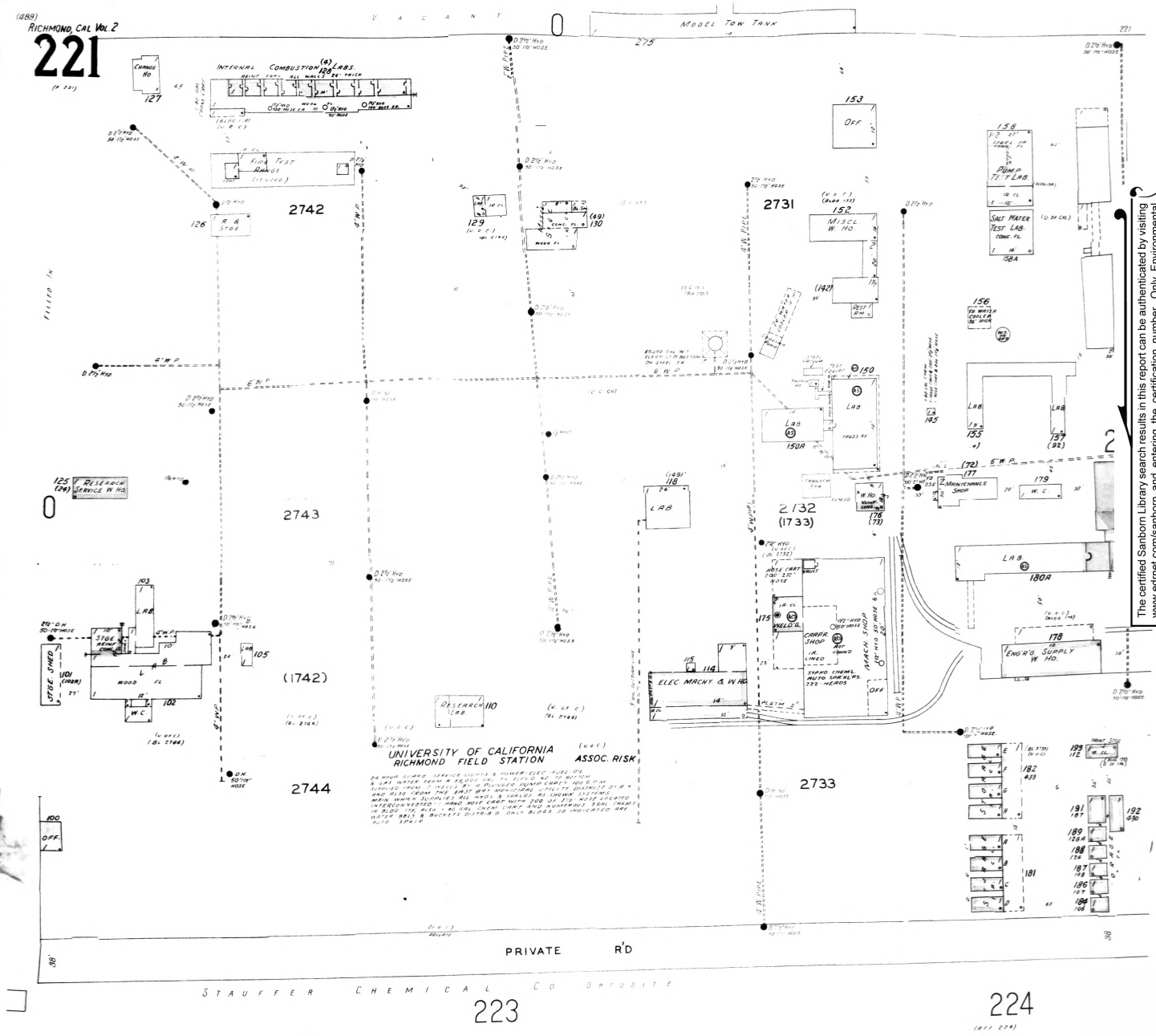

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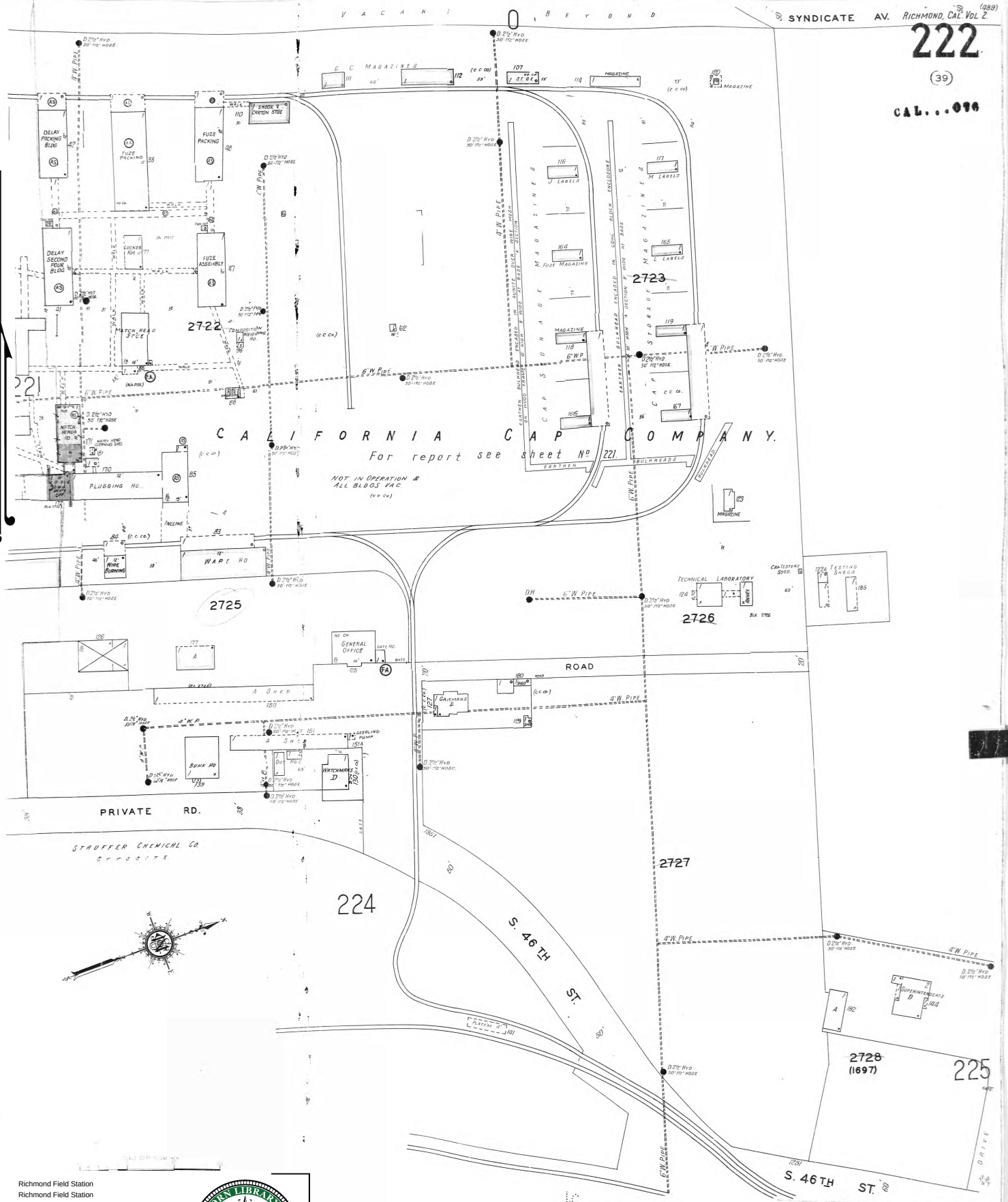

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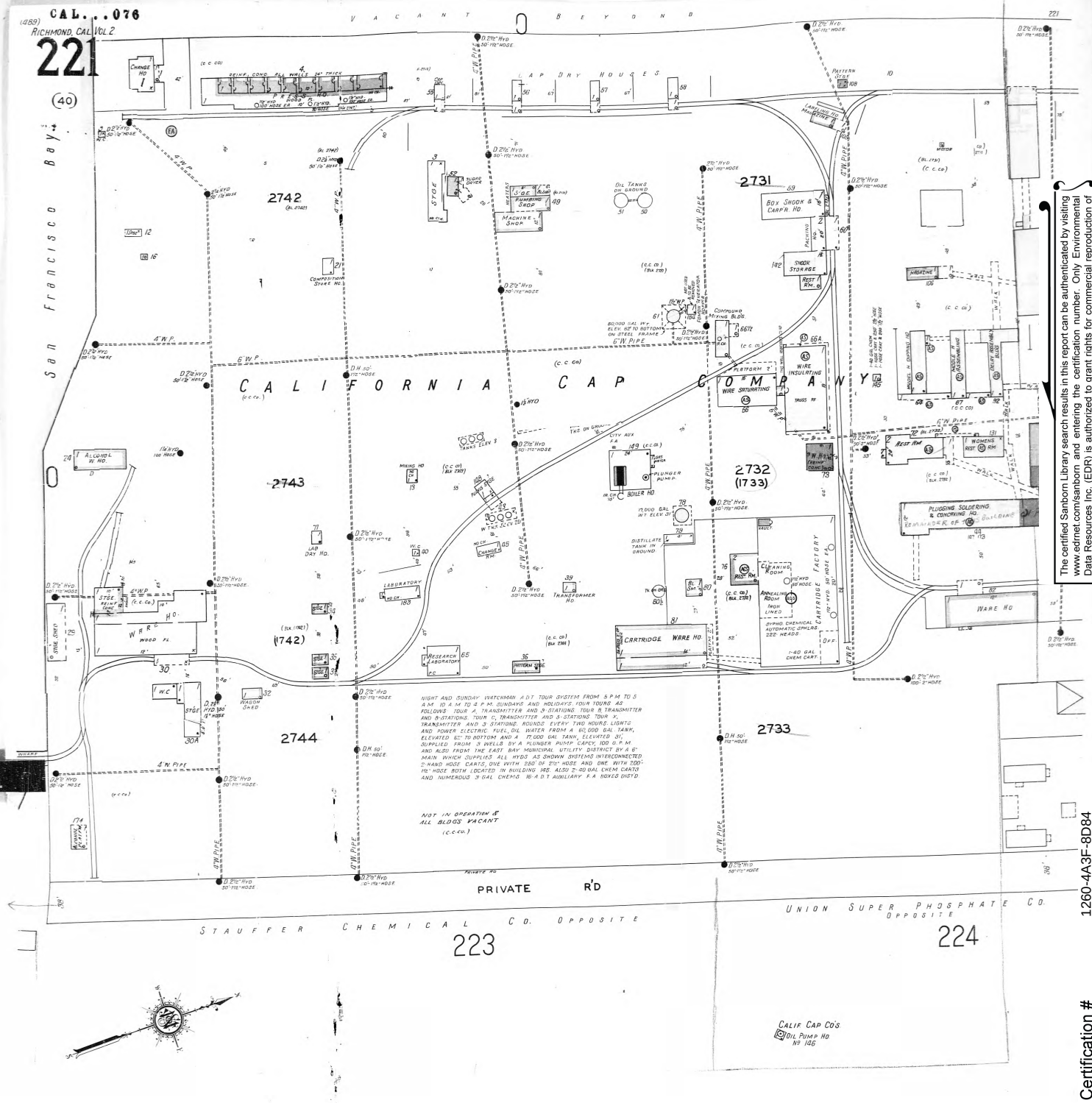

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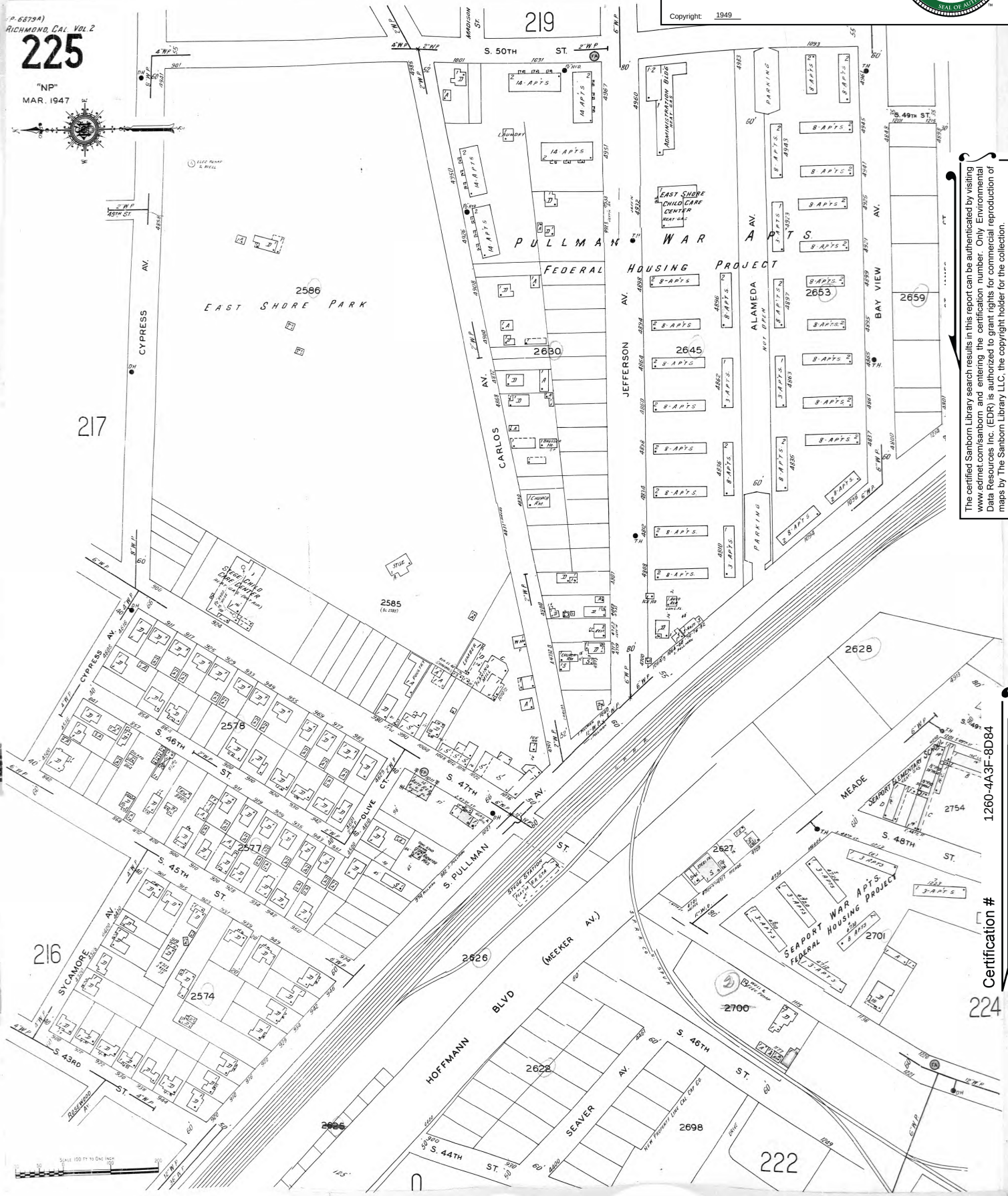

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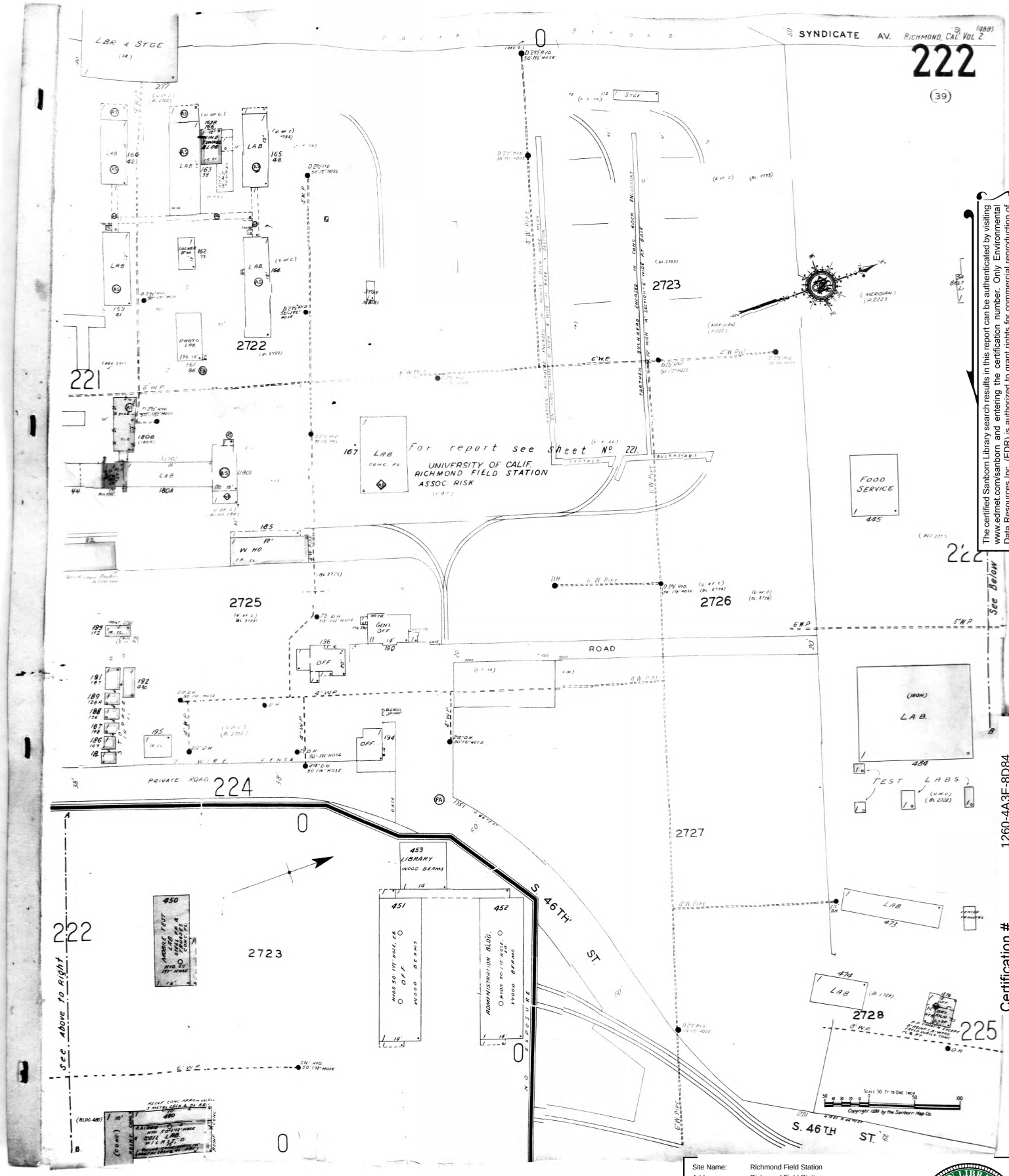

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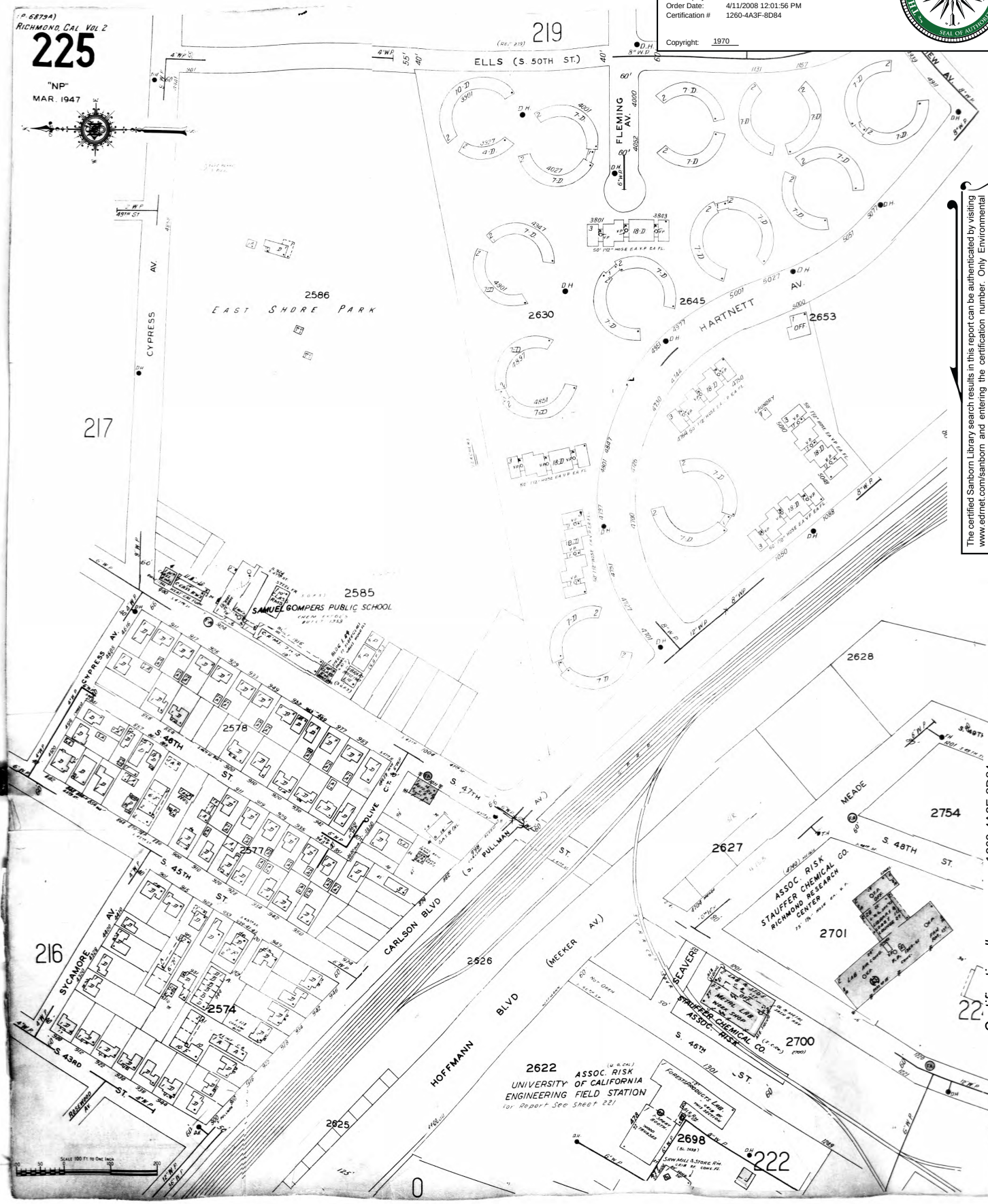

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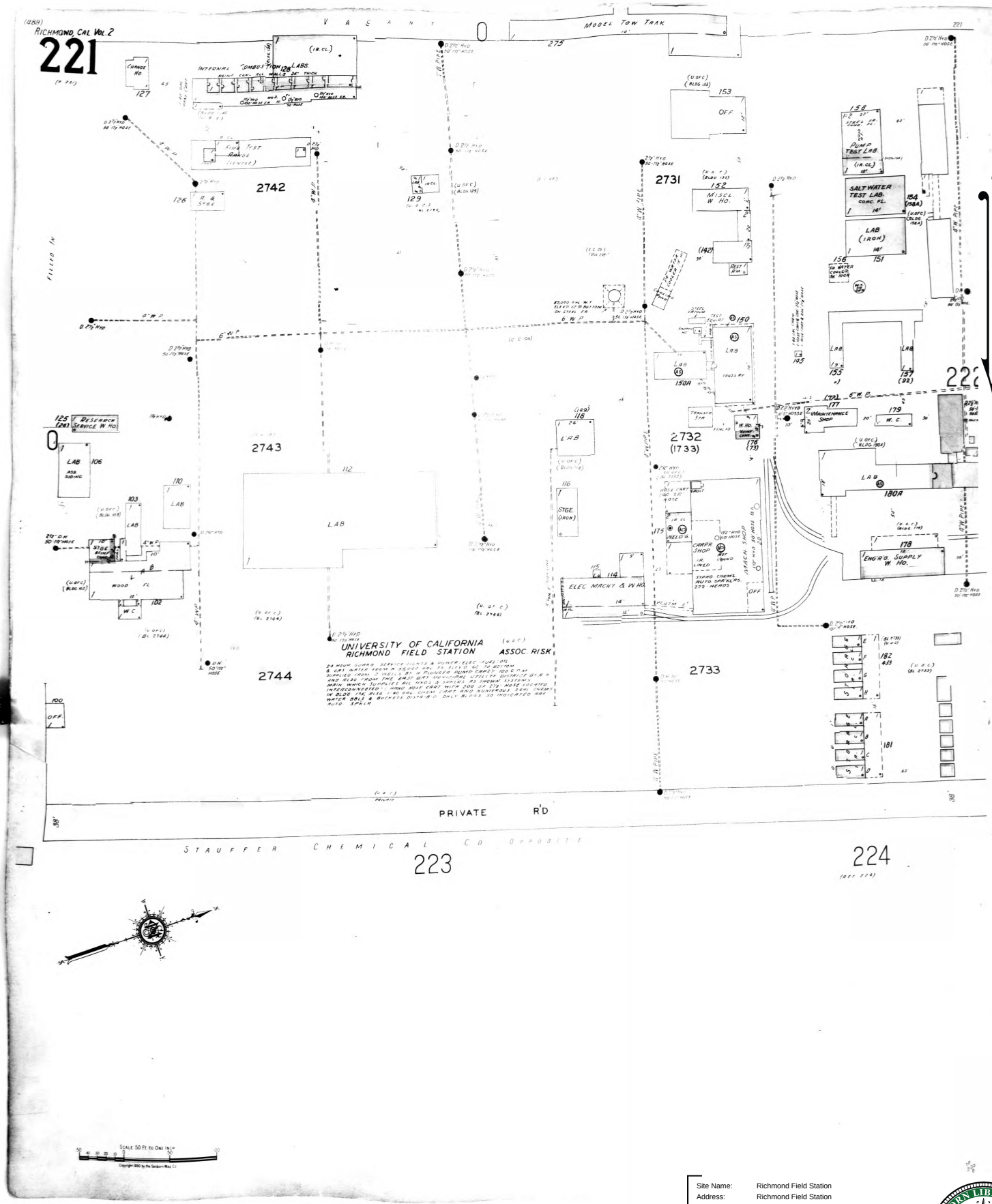

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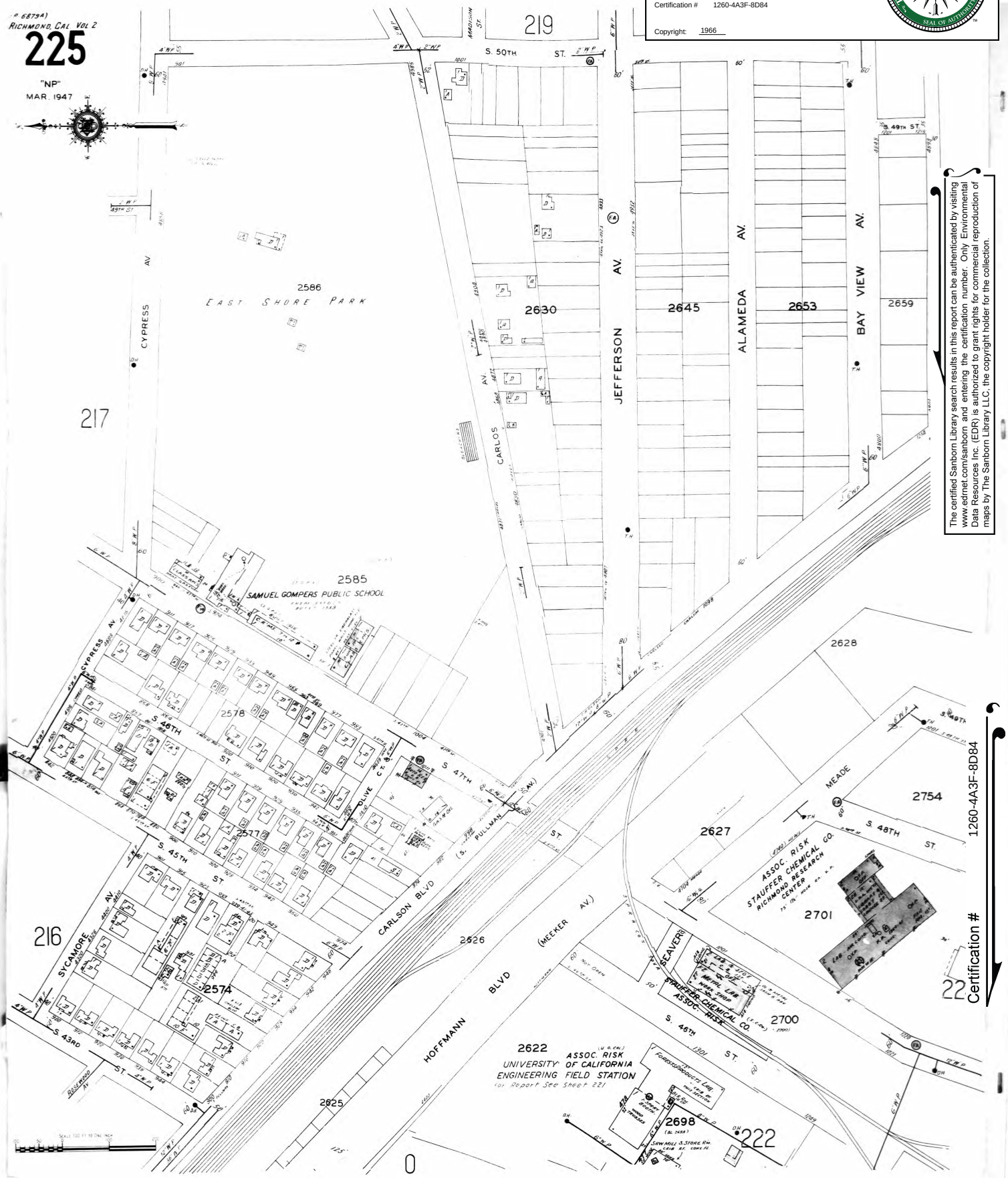

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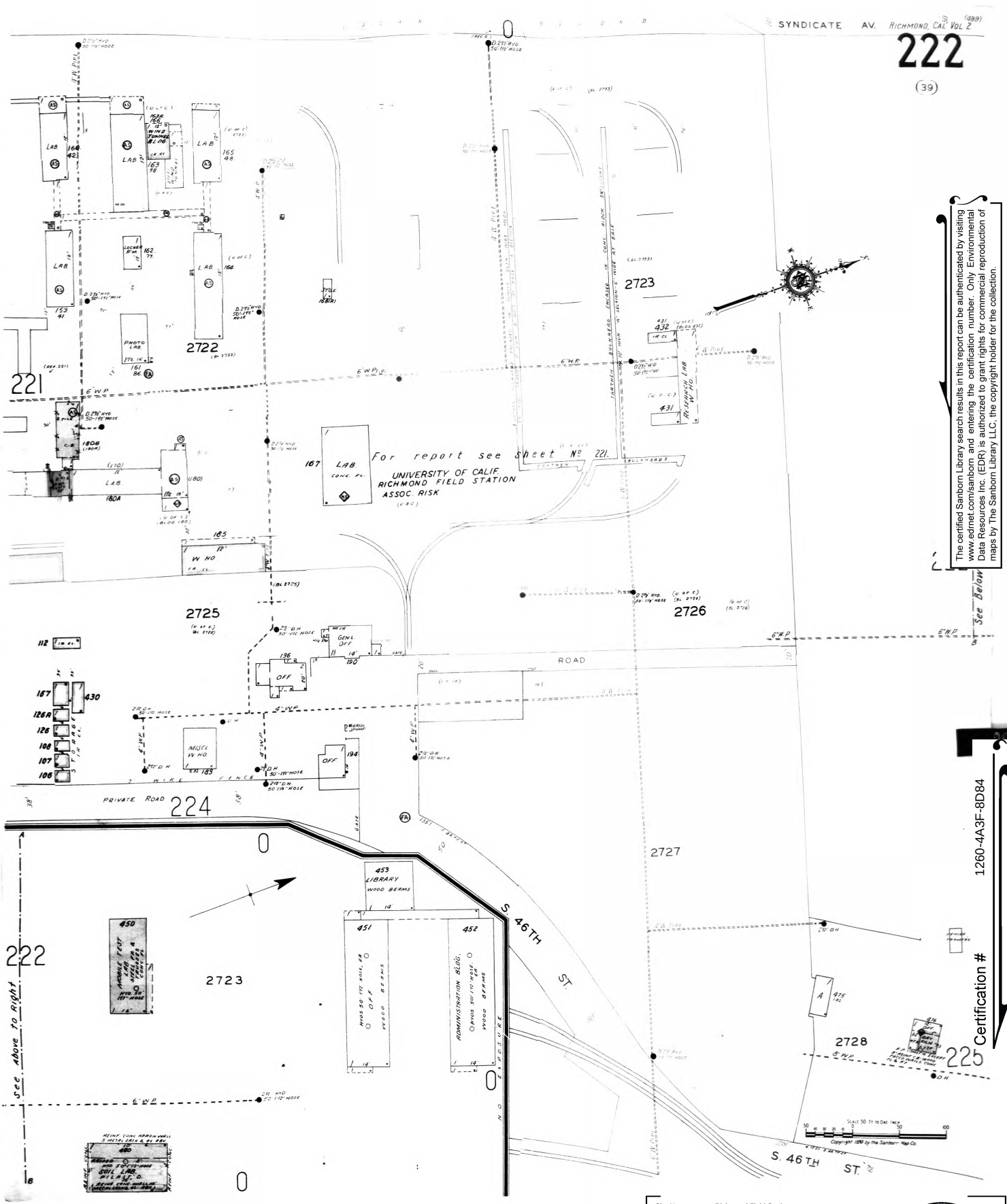

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Appendix E

Noise

BASELINE SOUND STUDY

FOR THE
UNIVERSITY OF CALIFORNIA AND LAWRENCE BERKELEY NATIONAL LABORATORY RICHMOND BAY CAMPUS PROJECT

RICHMOND, CALIFORNIA

July 2013

PREPARED FOR:
Lawrence Berkeley National Laboratory
One Cyclotron Road
Berkeley, CA 94720

PREPARED BY:
Tetra Tech, Inc.

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Appendix

A NIST Laboratory Calibration Sheets

LIST OF ACRONYMS

Acronym or Abbreviation	Full Phrase
ANSI	American National Standards Institute
Caltrans	California Department of Transportation
CCR	California Code of Regulations
CEC	California Energy Commission
CEQA	California Environmental Quality Act
CNEL	Community Noise Equivalent Level
dB	decibels
dBA	A-weighted decibels
DOE	United States Department of Energy
gps	global positioning system
gsf	gross square foot
Hall	Lawrence Berkeley Hall of Science
HVAC	heating, ventilation, and air conditioning
Hz	Hertz
in	inches
in/sec	inches per second
INCE	Institute of Noise Control Engineers
kHz	kilohertz
LBNL	Lawrence Berkeley National Laboratory
L_{10}	intrusive noise level
L_{50}	median sound level
L_{90}	residual sound levlel
L_{eq}	equivalent Sound Level
L_{max}	maximum sound level
Ln	Statistical noise levels (i.e., L_{10}, L_{50}, L_{90})
MP	Monitoring Position
NAD	North American Datum
NIST	National Institute of Standards and Technology
OSHA	Occupational Safety and Health
RBC	Richmond Bay Campus
sec	seconds
UC	University of California
µPa	microPascal
UTM	Universal Transverse Mercator

Section 1 Introduction

1.1 PROJECT OVERVIEW AND PURPOSE

The University of California (UC) is proposing to establish new major research facilities at UC properties in Richmond, California. The new campus consolidates the biosciences programs of the Lawrence Berkeley National Laboratory (LBNL) and will also provide for development of additional facilities to be used by both LBNL and UC Berkeley. The campus is referred to as the Richmond Bay Campus (RBC), or the "Project" herein.

Background sound levels were monitored at several sensitive receptors such as nearby residences. Sound pressure levels reported are routinely used in the assessment of compliance with regulatory limits and in the determination of potential adverse impacts when used in conjunction with modeling results. Baseline sound measurements were collected to document the existing conditions for use in determining the expected net increase as a result of RBC construction and operation. Resultant data would be used for comparative purposes, for impact analysis under the California Environmental Quality Act (CEQA) and the National Environmental Policy Act (NEPA), and for other applicable federal, state, and local ordinances or regulations. This baseline sound report describes the RBC study area, applicable regulations, measurement methodologies, and results.

1.2 RBC STUDY AREA

The RBC project site is in the city of Richmond, California, on approximately 133 acres owned by the UC. The area is located just off Interstate 580 (I-580) and situated between the San Francisco Bay, the Richmond Annex and the Point Isabel neighborhood. The RBC site is surrounded by institutional, residential and neighborhood commercial land uses.

1.3 SOUND SURVEY DESCRIPTION

Baseline measurements were completed during daytime and nighttime periods on January 24th through the 25th to document the existing acoustic environment. Monitoring was conducted at sensitive land uses such as residences, public use areas, and a National Historical Park property (Rosie the Riveter WWII Home Front). Short-term sound level measurements were completed during daytime (i.e. 10:00 a.m. to 4:00 p.m.) and nighttime (10:00 p.m. to 4:00 a.m.) periods. To avoid high vehicular traffic time periods short-term monitoring was completed outside of peak hour traffic periods. Measurements were completed during meteorological conditions conducive to the collection of measurement data (i.e., no rain or high wind). In accordance with CEQA requirements, noise monitoring at one unattended long-term (24-hour) location on the RBC project site was included to determine diurnal variation. These sound survey locations are shown on Figure 1-1.

Figure 1-1 Proposed Project area for RBC

Section 2 Regulatory Context

The regulatory environment for the Project includes federal, state and local noise control regulations and/or guidance. LBNL, as part of a federal agency (i.e., the Department of Energy or DOE), is subject to state and/or local regulation only if there has been a waiver of federal sovereign immunity through federal law, consistent with the U.S. Constitution's supremacy clause. Federal agencies, by way of the Federal Land Policy Management Act (FLPMA), 43 USC §1701 et seq. which provides a limited waiver of federal sovereign immunity, are required to comply with state or local provisions for environmental protection for portions of the federal agency's activities that would be located on federal lands. The authors understanding is that the properties on which RBC would be constructed are owned by the UC and therefore not federal lands per say, but if these are federal lands compliance with state and/or local regulations may be required. Regardless, LBNL is committed to planning its projects to be consistent with state and local laws or regulations.

2.1 FEDERAL REGULATIONS

Federal laws, regulation and guidance establish the national framework for noise regulations. If NEPA documentation is required, LBNL, part of the U.S. Department of Energy, implements NEPA via 10 Code of Federal Regulations (CFR) Part 1021. Noise considerations are typically addressed in NEPA documentation, which incorporate U.S. Environmental Protection Agency (EPA), state and other local regulations into the analysis.

2.1.1 Occupational Safety and Health Administration, Occupational Noise Exposure; Hearing Conservation Amendment (29 CFR 1910.95)

This standard establishes mandates to protect employees from excessive noise exposure and requires a Hearing Conservation Program when employee noise exposures equal or exceed an 8-hour time-weighted average sound level (TWA) of 85 A-weighted decibels (dBA).

2.1.2 Noise Control Act of 1972, as amended (42 USC 4901 et seq.)

The Noise Control Act of 1972, as amended, requires that all Federal agencies "to the fullest extent within their authority" implement programs within their jurisdictions that promote an environment free from noise that jeopardizes health and welfare. Federal, state and local agencies enforce the requirements and standards of the Noise Control Act to regulate noise from facilities, such as those at the RBC.

2.1.3 U.S. Environmental Protection Agency in "Information of Levels on Environmental Noise Requisite to Protect Public Health and Welfare with an Adequate Margin of Safety." (EPA 550/9-74-004)

Published in 1974, this document identifies safe levels of environmental noise exposure and is intended to "provide State and Local governments as well as the Federal Government and the private sector with an informational point of departure for the purpose of decision making." While the EPA has no regulation governing environmental noise, the agency has conducted several extensive studies to identify the effects of sound level on public health and welfare. For outdoor residential areas, the recommended EPA guideline is a day-night average noise level (L_{dn}) of 55 dBA and an indoor L_{dn} limit of 45 dBA. These levels are identified as desirable to protect against speech interference and sleep disturbance for residential, educational, and healthcare areas. Noise-level criteria to protect against hearing damage in are identified as 24-hour L_{eq} values of 70 dBA (both outdoors and indoors), with the value of 70 dBA Leq measured at the human ear, whereas

community/environmental noise is not measured at the ear. This publication remains the authoritative study based on a large sampling of community reaction to noise. The EPA sound level guidelines do not provide an absolute measure of noise impact, but rather a consensus on potential activity interference, human health and welfare effects, and annoyance. Because these protective levels were derived without concern for technical or economic feasibility, and contain a margin of safety to ensure their protective value, they should not be viewed as standards, criteria, regulations, or goals. Rather, they should be viewed as levels below which there is no reason to suspect that the general population will be at risk from any of the identified effects of noise. The following quote from the EPA guidance provides clarification on the use of the cause and effect noise levels:

> *"Perhaps the most fundamental misuse of the Levels Document is treatment of the identified levels as regulatory goals. They are not regulatory goals; they are levels defined by a negotiated scientific consensus. These levels were developed without concern for economic and technological feasibility, are intentionally conservative to protect the most sensitive portion of the American population, and include an additional margin of safety. In short, the levels in Table VIII are neither more nor less than what Congress required."*

The EPA guideline limits are summarized in Table 2-1.

Table 2-1 Summary of EPA Cause and Effect Noise Levels

Location	Level	Effect
All public accessible areas with prolonged exposure	70 dBA $L_{eq(24)}$	Safety
Outdoor at residential structure and other noise sensitive receptors where a large amount of time is spent	55 dBA L_{dn}	Protection against annoyance and activity interference
Outdoor areas where limited amounts of time are spent, e.g., park areas, school yards, golf courses, etc.	55 dBA $L_{eq(24)}$	
Indoor residential	45 dBA L_{dn}	
Indoor non-residential	55 dBA $L_{eq(24)}$	

U.S. Environmental Protection Agency. 1974

$L_{eq(24)}$ – Equivalent sound level for a given 24-hour period.

2.2 STATE REGULATIONS

The California Environmental Quality Act (CEQA) requires that significant environmental impacts be identified and that such impacts be eliminated or mitigated to the extent feasible. The CEQA guidelines (AEP 2012) set forth characteristics that signal a potentially significant impact. Under CEQA the proposed Project would be considered to have significant noise impacts if it results in the following:

- Exposure of persons to or generation of noise levels in excess of standards established in the local general plan (see Section 2.3) or noise ordinance, or applicable standards of other agencies?
- A substantial permanent increase in ambient noise levels in the project vicinity above levels existing without the project?
- A substantial temporary or periodic increase in ambient noise levels in the project vicinity above levels existing without the project?
- For a project located within an airport land use plan or, where such a plan has not been adopted, within two miles of a public airport or public use airport, would the project expose people residing or working in the project area to excessive noise levels?
- For a project within the vicinity of a private airstrip, would the project expose people residing or working in the project area to excessive noise levels?

For the proposed Project, the following criteria were determined to be inapplicable or to result in no impact:

- Exposure of on-site workers to noise levels that exceed occupational safety standards (90 dBA as a time-weighted 8-hour average or peak noise levels above 115 dBA).
- Exposure of residents to airport or private airstrip-related noise levels above a CNEL of 65 dBA.

Occupational noise exposure is governed by federal and state regulations. The California Division of Occupational Safety and Health (Cal/OSHA) administers industrial safety regulations in California. Cal/OSHA regulations establish a time-weighted noise exposure limit of 90 dBA averaged over 8 hours (California Code of Regulations, Title 8, Article 105). Noise source controls, administrative procedures, or worker hearing protection must be provided if worker noise exposure would exceed the 90 dBA limit. These limits are not expected to be a concern for the Project as LBNL complies with the exposure limits outlined in the American Conference of Industrial Hygienists (ACGIH) recommended Threshold Limit Values, 85 dBA with a 3 dB doubling, which is more stringent than the Cal/OSHA regulations (i.e., Cal/OSHA and OSHA are 90 dBA with a 5 dB doubling).

According to the California Energy Commission (CEC), increases in noise less than 5 dBA above background at a sensitive receptor are clearly not significant, and increases in noise greater than 10 dBA above background at a sensitive receptor are clearly significant (CEC 2002). Increases in background noise between 5 and 10 dBA may be significant, depending on the circumstances. It would be reasonable to assume that similar thresholds may be applied to the Project.

The State of California provides regulation by adopted laws and guidance regarding noise emissions through the jurisdiction of state commissions requiring local jurisdictions (California Government Code Section 65302[f]) to prepare general plans, which include Noise Elements. The purpose of the noise element is to identify goals, policies, and implementation measures that can be used to guide future land use development with regard to noise. The State of California identifies the following land uses as noise sensitive: residential areas, schools, convalescent and acute care hospitals, parks and recreational areas, and churches. The recommended noise guideline for exterior living areas (yards and patios) for new residential land uses is a 55 dBA CNEL, and must not exceed 65 dBA CNEL. In addition, for multi-family residential projects, the California Noise Insulation Standard (California Administrative Code, Title 25, Chapter 1, Subchapter 1, Article 4) requires that the indoor noise levels in multi-family residential developments do not exceed a CNEL of 45 dBA to be consistent with State of California standards.

2.3 LOCAL REGULATIONS

The City of Richmond regulates noise via its *"Code of Ordinances, Chapter 9.52 - Community Noise Ordinance"*. Maximum exterior noise levels by zoning district are listed in Table 2-2. Richmond's noise ordinance also provides noise limits applicable to stationary construction equipment.

Table 2-2 Maximum Noise Levels by Zoning District

Zoning District	Maximum Noise Level in dBA (levels not to be exceeded more than 30 minutes in any hour)		Maximum Noise Level in dBA (level not to be exceeded more than 5 minutes in any hour)
	Measured at Property Line or District Boundary	Measured at Any Boundary of a Residential Zone	Between 10 PM and 7 AM***, Measured at Any Boundary of a Residential Zone
Single-Family Residential	60	N/A	N/A
Multifamily Residential	65	N/A	N/A
Commercial	70	60	50 or ambient noise level
Lt. Industrial and Office Flex*	70	60	50 or ambient noise level
Heavy and Marine Industrial	75	65	50 or ambient noise level
Public Facilities and Community Use	65	60	50 or ambient noise level
Open Space and Recreation Districts	65	60	50 or ambient noise level

* For M-1 and M-2 the measurement will be at property line

** For M-3 and M-4 the measurement will be at the boundary of the district

*** Restricted hours may be modified through condition of an approved conditional use permit. Section subsections of Chapter 9.52 also provide for additional restricted hours and the most restrictive hours shall be controlling.

N/A Not applicable

Source: City of Richmond, May 17, 2011

Section 3 Field Methods and Results

This section includes a description of the sound terminology, survey methodologies, a description of areas surveyed, and measurement equipment used. Sound measurements were completed by a full member of the Institute of Noise Control Engineers (INCE) or under their direct supervision. The location of monitoring positions were determined by using a global positioning system (GPS) unit, and photographs were taken from the measurement points in the directions of receptors of interest and the Project site.

3.1 MONITORING LOCATIONS

Ten monitoring locations were identified for baseline sound. Figure 1-1 presents a map of these monitoring locations. Table 3-1 lists the corresponding map identifier to Figure 1-1, the Universal Transverse Mercator (UTM) coordinates, existing land uses, and a description of each location surveyed.

Table Error! No text of specified style in document.**-1 Monitoring Locations**

Map ID	Noise Sensitive Use	UTM Zone 10N X-Coordinate	UTM Zone 10N Y-Coordinate	Description
MP-1	Residential	558230	4196146	Residential Neighborhood at Point Isabel Shoreline
MP-2	Residential	558133	4196302	Eastern Residences at Bayside Court
MP-3	Residential	557948	4196398	Residences at Bayside Court
MP-4	Residential	557626	4196433	Trade Winds Sailing School
MP-5	Civic/Public	557415	4196518	Rosie the Riveter WWII Home Front
MP-6	Residential	557591	4196799	The Anchorage at Marina Bay
MP-7	Residential	557951	4197377	Neighborhood at 30th St. & Hoffman Blvd
MP-8	Residential	558899	4197114	Neighborhood at 43rd St. & Carlson Blvd
MP-9	Civic/Public	559098	4196917	Booker T. Anderson Jr. Park
LT-1	RBC	557415	4196518	Richmond Bay Campus

3.2 TERMINOLOGY AND METRICS

Airborne sound is described as the rapid fluctuation or oscillation of air pressure above and below atmospheric pressure, creating a sound wave. Sound is characterized by properties of the sound waves, which are frequency, wavelength, period, amplitude, and velocity. Sound energy travels in the form of a wave, a rapid fluctuation or oscillation of air pressure above and below atmospheric pressure. Sound levels are presented on a logarithmic scale to account for the large range of acoustic pressures that the human ear is exposed to and is expressed in decibel units or dB. A dB is defined as the ratio between a measured value and a reference value usually corresponding to the lower threshold of human hearing defined as 20 micropascals (μPa). Since the human ear does not perceive every frequency with equal loudness, spectrally varying sounds are often adjusted with a weighting filter. The A-weighted filter is applied to compensate for the frequency response of the human auditory system and sound exposure in acoustic assessments is designated in dBA. Unweighted sound levels are referred to as linear. Linear dBss are used to determine a sound's tonality and to engineer solutions to reduce or control noise as techniques are different for low and high frequency noise.

Several metrics describing the ambient conditions were measured including the time-averaged equivalent sound pressure levels, or the L_{eq}, as well as several statistical parameters including the L_{10}, L_{50}, and L_{90} which

can be used to distinguish long-term baseline sound levels from transitory events. The unit of frequency is hertz (Hz), which corresponds to the rate in cycles per second that sound pressure waves are generated., Typically, a sound frequency analysis examines 11 octave (or 33 1/3 octave) bands ranging from 16 Hz (low) to 16,000 Hz (high). This range encompasses the entire human audible frequency range. Because the human ear does not perceive every frequency with equal loudness, spectrally varying sounds are often adjusted with a weighting filter. The A-weighted filter is applied to compensate for the frequency response of the human auditory system.

Sound levels can be measured and presented in various formats. The sound metrics that were employed in the survey have the following definitions:

- **L_{eq}:** Conventionally expressed in dBA, the L_{eq} is the energy-averaged, A-weighted sound level for the complete time period. It is defined as the steady, continuous sound level over a specified time, which has the same acoustic energy as the actual varying sound levels over the specified period.
- **L_{max}:** The maximum A-weighted sound level as determined during a specified measurement period. It can also be described as the maximum instantaneous sound pressure level generated by a piece of equipment.
- **L_n:** This descriptor identifies the sound level that is exceeded "n" percent of the time over a measurement period (e.g., L_{90} = sound level exceeded 90 percent of the time). The sound level exceeded for a small percent of the time, L_{10}, closely corresponds to short-term, higher-level, intrusive noises (such as vehicle pass-by noise near a roadway). The sound level exceeded for a large percent of the time, L_{90}, closely corresponds to continuous, lower-level background noise (such as continuous noise from a distant industrial facility). L_{50} is the level exceeded 50 percent of the time and is typically referred to the median sound level over a given period.
- **CNEL:** This descriptor is another average A-weighted L_{eq} sound level measured over a 24-hour period; however, this noise scale is adjusted to account for some individuals' increased sensitivity to noise levels during the evening and nighttime hours. A CNEL noise measurement is obtained after adding 5 dB to sound levels occurring during evening hours (7:00 p.m. to 10:00 p.m.) and 10 dB to sound levels occurring during nighttime hours (10:00 p.m. to 7:00 a.m.).

An inherent property of the logarithmic decibel scale is that the sound pressure levels of two separate sources are not directly additive. For example, if a sound of 50 dBA is added to another sound of 50 dBA, the result is a 3-decibel increase (or 53 dBA), not an arithmetic doubling to 100 dBA. With respect to how the human ear perceives changes in sound pressure level relative to changes in "loudness," scientific research demonstrates that the following general relationships hold between sound level and human perception for two sound levels with the same or very similar frequency characteristics:

- **1 dBA** is the practical limit of accuracy for sound measurement systems and corresponds to an approximate 10 percent variation in the sound pressure level. A 1 dBA increase or decrease is a non-perceptible change in sound.
- **3 dBA** increase or decrease is a doubling (or halving) of acoustic energy and it corresponds to the threshold of change in loudness perceptible in a laboratory environment. The average person is generally not able to distinguish a 3 dBA difference in environmental sound outdoors.
- **5 dBA** increase or decrease is described as a perceptible change in sound level and is a readily discernible change in an outdoor environment.
- **10 dBA** increase or decrease is a tenfold increase or decrease in acoustic energy but is perceived as a doubling or halving in loudness (i.e., the average person will judge a 10 dBA change in sound level to be twice or half as loud).

3.3 SURVEY METHODS

Sound measurements were completed with Larson Davis 831 sound level meter equipped with a PCB model 377B02 ½-inch precision condenser microphone. This instrument has an operating range of 5 dB to 140 dB, and an overall frequency range of 8 to 20,000 Hz and meets or exceeds all requirements set forth in the American National Standards Institute (ANSI) standards for Type 1 sound level meters for quality and accuracy (precision). All sound analyzers were programmed to measure full-octave and 1/3-octave band frequency (Hz) levels to document and further describe the quality and character of the existing ambient soundscape. Data was collected for 1/1 and 1/3 octave band data spanning 6.3 Hz to 20 kilohertz. Short-term baseline sound monitoring data were measured and logged at 1-minute intervals for a minimum total duration of 30 minutes. The 24-hour sound monitoring station continuously monitored and logged data in one-hour intervals, consisting of ten-minute time histories.

The microphone and windscreen were tripod-mounted at an approximate height of 1.2 to 1.7 meters (4 to 5.6 feet) above grade. The 24-hour sound monitoring station was self-supporting and weather-proof and was deployed near the Project area centroid. All sound level analyzer microphones were protected from wind-induced self-noise effects by windscreen made of specially prepared open-pored polyurethane. Each sound analyzer was programmed to measure and log broadband A-weighted sound pressure levels, including a number of statistical parameters such as the L_{eq} L_{max}, and statistical L_n sound levels.

Table 3-2 provides an inventory of the measurement equipment that was used. All instrumentation components, including microphones, accelerometer(s), preamplifiers and field calibrators, had current laboratory certified calibrations traceable to the National Institute of Standards Technology (NIST). The NIST laboratory calibration certifications for the measurement instrumentation used on the Project are included in Appendix A.

Table Error! No text of specified style in document.**-2 Measurement Equipment**

Description	Manufacturer	Type
Signal Analyzer	Larson Davis	824/831
Preamplifier	Larson Davis	PRM902
Signal Conditioner	PCB	480E09
Weather Transmitter	Vaisala	WXT520
Microphone	PCB	377B02
Windscreen	ACO Pacific	7-inch
Calibrator	Larson Davis	CAL200

3.4 SURVEY RESULTS, MONITORING POSITION DESCRIPTIONS AND FIELD OBSERVATIONS

Noise measurements were completed to establish baseline conditions. The goal was to identify the regularly occurring baseline sound at monitoring positions near the RBC project site so that a comparison can be made to assess the potential for adverse impacts as a result of the Project. The following survey results and measurement data are intended to support the technical analysis required as part of the permitting process for the Project. Upon completion of the baseline sound survey, the results were tabulated into relevant time periods. The monitoring completed includes the collection and reporting of the following data:

- Sound pressure level data present during daytime and nighttime test periods.
- For each time period, the following sound measurement descriptors were compiled:
    - Spectral octave-band analysis (31.5, 63, 125, 250, 500, 1K, 2K, 4K, and 8K Hz);
    - One hour statistical values including L_{eq}, L_{10}, L_{50}, and L_{90}, in dBA;

- A narrative description of sounds audible during testing as well as a discussion of any anomalous or regularly occurring sound events identified over the course of the monitoring program; and
- Existing land uses in the vicinity of the measurement location.

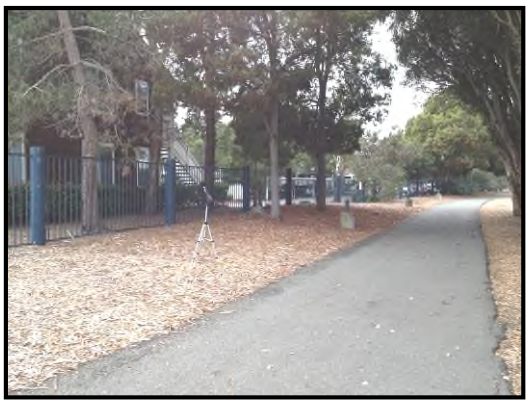
The degree of audibility of a new or modified sound source is dependent in a large part upon the relative level of the ambient noise. A wide range of noise settings occurs in and around the Project area. Variations in acoustic environment are due in part to surrounding land uses, population density, and proximity to transportation corridors. I-580 is generally audible throughout the Project site and throughout all hours of the day. The following subsection provides further details for this data analysis at each of the monitoring locations. A description of the monitoring locations with photographs, acoustic engineer's field observations and pertinent results of the sound survey are summarized in the following charts, tables and graphs. Amplitudes were found to be largely dependent on proximity of the receptor to major roadways and railway lines.

MP-1 – Meeker Slough

Monitoring position (MP) 1 is representative of multi-family residences (i.e., apartments, duplexes, etc.) along the Point Isabel shoreline neighborhood located to the south of the Project. Daytime and nighttime sound monitoring was conducted. Sound monitoring results are included in Table 3-3 and Table 3-4. Field observations included sounds from local roadway traffic, distant highway traffic, multiple aircraft flyovers, distant railroad operations (locomotives, train horns, etc.), pedestrians, bicyclists, birds and frogs.

MP-2 – Multi-Family Residences

MP-2 is representative of multi-family residences located along Bayside Court, southwest of the Project near 32nd street. Daytime and nighttime sound monitoring was conducted, and results are included in Table 3-3 and Table 3-4. Field observations included sounds from distant highway traffic, railroad operations, distant HVAC (heating, ventilation, and air conditioning) unit or units, pedestrians, bicyclists, birds, and sounds from vehicles in the nearby parking lot.



MP-3 – Multi-Family Residences

MP-3 is representative of multi-family residences located along Bayside Court, southwest of the Project but closer to Marina Bay Parkway than MP-2. Daytime and nighttime sound monitoring was conducted, and results are included in Table 3-3 and Table 3-4. Field observations included sounds from local roadway traffic, distant highway traffic, distant railroad operations, distant HVAC unit or units, walkers, bicyclists, birds, and sounds from vehicles in the nearby parking lot.

MP-4 – Trade Winds Sailing School

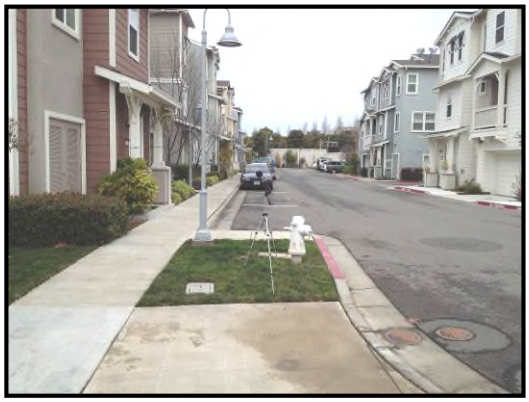
MP-4 is representative of multi-family residences located along Spinnaker Way west of the Project and adjacent to the Trade Winds Sailing School. Daytime and nighttime sound monitoring was conducted, and the results are included in Table 3-3 and Table 3-4. Field observations included sounds from local roadway traffic, distant highway traffic, aircraft overflights, and distant railroad operations.

MP-5 – Rosie the Riveter National Historic Park

MP-5 is representative of the Rosie the Riveter National Historic Park located approximately 1,500 feet west of the Project. The park is only open during the daytime, so only daytime sound monitoring was conducted. Field observations included sounds of roadway traffic, railroad operations including train horns, birds, bicyclists and pedestrians.

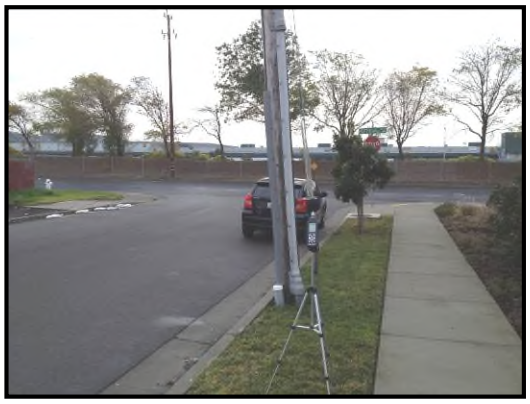
MP-6 – Anchorage Housing

MP-6 represents the Anchorage Residential area near the Marina Bay Highway. Daytime and nighttime sound monitoring was conducted, and sound monitoring results are included in Table 3-3 and Table 3-4. Field observations included sounds from highway traffic, local roadway traffic, aircraft and railroad operations



MP-7 – 30th & Hoffman

MP-7 represents a mix of single-family and multi-family residences located near the intersection of 30th Street and Hoffman Boulevard north of the Project. Only daytime monitoring was conducted at the MP-7 location due to safety concerns with equipment and staff in the area. Nevertheless, nighttime observations were made near MP-7, and sounds from the nearby I-580 dominate the acoustic environment. Daytime observations were similar to nighttime observations with the sounds from highway traffic dominating the acoustic environment mixed in with periodic sounds of local roadway traffic and railroad operations.



MP-8 – Carlson & 43rd

MP-8 represents a single-family residential neighborhood at Carlson Boulevard and 43rd Street northeast of the Project. Daytime monitoring was conducted at MP-8, and the results are included in Table 3-3 and Table 3-4. Only daytime monitoring was conducted due to safety concerns with equipment and staff in the area. Daytime observations included sounds from railroad traffic, traffic noise from I-580, local roadway traffic, periodic aircraft over flights and pedestrians. During the daytime measurement three freight trains accessing the Port of Richmond and one Caltrain passed by the MP. Observations of railroad traffic noted that rail operations reduced after the morning time period; therefore, sound levels associated with low volumes of freight rail traffic at the MP would be similar to those monitored in the afternoon at MP-9.

MP-9 – Booker T. Anderson Jr. Park

MP-9 represents Booker T. Anderson Jr. Park and multi-family residences located northeast of the Project. Daytime sound monitoring was conducted at the MP, and the results are included in Table 3-3 and Table 3-4. The park is closed to the public at night, so only daytime monitoring was conducted. Daytime observations of sound sources included I-580, local roadway traffic including transit buses with a stop near the par, periodic aircraft over flights, and pedestrians.

LT-1 Richmond Bay Campus

LT-1 represents the long term sound station set up in the middle of the Project area at the existing Richmond Field Station. The monitoring equipment was located at a central location to obtain the sound level at a location close to the acoustic centroid of the proposed campus. The acoustic centroid could be considered representative of the average sound level at the RBC project site, meaning that sound levels on the north side of the RBC site near the existing railroad tracks and I-580 are influenced by sounds from the railroad and highway more than locations south of the RBC site near the waterfront. Results of the 24-hour monitoring effort are included in Table 3-3, Table 3-4 and Table 3-5. Figure 3-1 is a chart of the time history for the monitoring period.

Table 3-3 Sound Monitoring Results (L_{eq}, L_{10}, L_{50}, L_{90} and CNEL)

Monitoring Location							Sound Level Metrics (dBA)				
Map ID	Land Use	UTM Coordinates (NAD83 Zone 10 m)		Date	Time	Time Period	L_{eq}	L_{10}	L_{50}	L_{90}	CNEL*
		Easting	Northing								
MP-1	Residential	558243	4566835	1/24/2013	12:57:20 PM	Day	53	54	51	50	58
				1/24/2013	11:25:40 PM	Night	51	53	47	46	
MP-2	Residential	558163	4567111	1/24/2013	1:34:33 PM	Day	53	53	52	51	58
				1/24/2013	10:50:59 PM	Night	51	52	49	48	
MP-3	Residential	557952	4567207	1/24/2013	1:00:59 PM	Day	53	55	51	50	56
				1/24/2013	10:15:22 PM	Night	48	50	46	45	
MP-4	Residential	557633	4567210	1/24/2013	1:41:20 PM	Day	57	61	53	50	59
				1/24/2013	10:48:48 PM	Night	50	53	48	44	
MP-5	Civic/Public	557429	4567387	1/24/2013	11:30:52 AM	Day	50	52	48	46	NA
MP-6	Residential	557591	4567695	1/24/2013	11:26:19 AM	Day	54	58	52	49	61
				1/24/2013	10:15:09 PM	Night	54	58	47	44	
MP-7	Residential	557955	4568452	1/24/2013	9:02:51 AM	Day	62	64	62	60	NA
MP-8	Residential	558866	4568091	1/24/2013	9:34:08 PM	Day	70	71	60	56	NA
MP-9	Civic/Public	559090	4567811	1/24/2013	2:28:15 PM	Day	66	67	65	63	NA
LT-1	Commercial	558561	4567503	1/24/2012 to 1/25/2012		Day	54	54	50	48	57
						Night	51	51	47	45	

*CNEL calculated for only those measurement locations with both day and nighttime monitoring results.

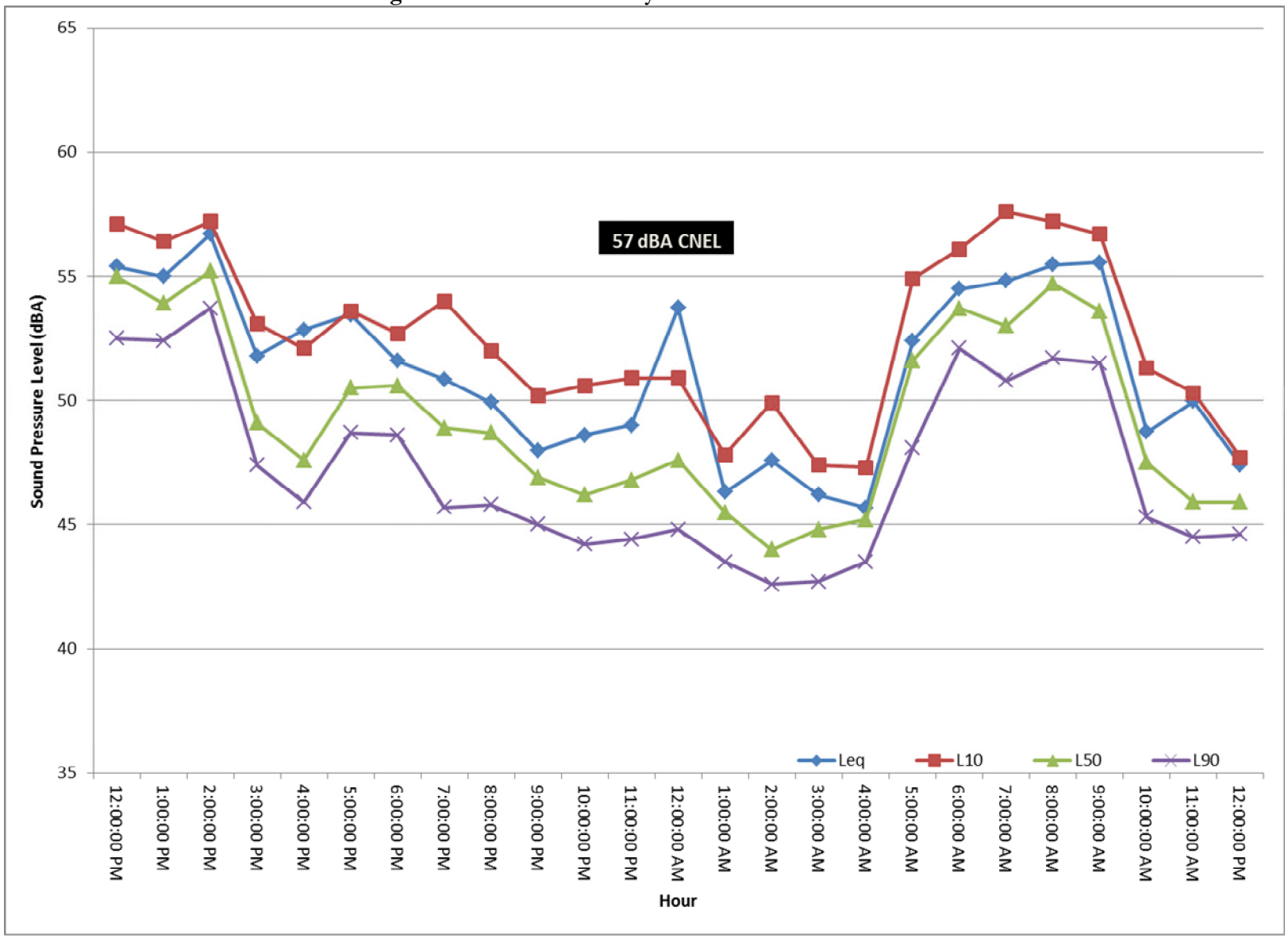
Table 3-4 Sound Monitoring Results (1/1 Octave Band Center Frequencies)

Monitoring Location			Time Period	Octave Band Sound Pressure Levels (dB)											
Map ID	UTM Coordinates (NAD83 Zone 10 m)			8 Hz	16 Hz	31.5 Hz	63 Hz	125 Hz	250 Hz	500 Hz	1 kHz	2 kHz	4 kHz	8 kHz	16 kHz
	Easting	Northing													
MP-1	558243	4566835	Day	61	60	60	60	56	52	51	49	40	30	24	14
			Night	52	58	60	60	55	49	49	47	37	28	24	16
MP-2	558163	4567111	Day	59	60	61	60	52	50	50	50	44	35	29	14
			Night	53	59	61	60	55	52	49	46	38	25	16	10
MP-3	557952	4567207	Day	65	62	59	59	55	52	50	48	42	36	30	25
			Night	51	55	58	57	53	49	47	44	36	26	16	11
MP-4	557633	4567210	Day	59	58	61	63	60	53	52	54	49	41	33	21
			Night	52	56	57	57	56	51	47	45	39	29	19	10
MP-5	557429	4567387	Day	61	58	58	61	56	49	47	46	39	31	23	15
MP-6	557591	4567695	Day	58	59	60	60	58	53	51	51	45	36	26	14
			Night	50	53	57	59	57	52	49	51	46	38	30	22
MP-7	557955	4568452	Day	62	69	70	72	67	59	57	59	54	47	37	27
MP-8	558866	4568091	Day	65	74	73	74	72	66	63	61	59	55	48	38
MP-9	559090	4567811	Day	63	67	69	72	70	62	60	63	57	49	43	39
LT-1	558561	4567503	Day	58	61	61	61	57	51	51	50	39	26	17	9
			Night	54	59	59	60	55	47	49	47	36	21	11	8

Table 3-5 Long-Term (24-Hour) Sound Monitoring Results (dBA)

Date	Time	L_{eq}	L_{10}	L_{50}	L_{90}
1/24/2013	12:00 PM	55	57	55	53
	1:00 PM	55	56	54	52
	2:00 PM	57	57	55	54
	3:00 PM	52	53	49	47
	4:00 PM	53	52	48	46
	5:00 PM	53	54	51	49
	6:00 PM	52	53	51	49
	7:00 PM	51	54	49	46
	8:00 PM	50	52	49	46
	9:00 PM	48	50	47	45
	10:00 PM	49	51	46	44
	11:00 PM	49	51	47	44
1/25/2013	12:00 AM	54	51	48	45
	1:00 AM	46	48	46	44
	2:00 AM	48	50	44	43
	3:00 AM	46	47	45	43
	4:00 AM	46	47	45	44
	5:00 AM	52	55	52	48
	6:00 AM	54	56	54	52
	7:00 AM	55	58	53	51
	8:00 AM	55	57	55	52
	9:00 AM	56	57	54	52
	10:00 AM	49	51	48	45
	11:00 AM	50	50	46	45
	12:00 PM	47	48	46	45
Day Average		54	54	50	48
Night Average		51	51	47	45
CNEL		57			

Figure 3-1 Time History for 24-Hour Measurement



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APPENDIX A

MEASUREMENT EQUIPMENT & NIST LABORATORY CALIBRATION CERTIFICATIONS

Certificate of Calibration and Conformance

This document certifies that the instrument referenced below meets published specifications per Procedure PRD-P263; ANSI S1.4-1983 (R 2006) Type 1; S1.4A-1985; S1.43-1997 Type 1; S1.11-2004 Octave Band Class 0; S1.25-1991; IEC 61672-2002 Class 1; 60651-2001 Type 1; 60804-2000 Type 1; 61260-2001 Class 0; 61252-2002.

Manufacturer:	Larson Davis	Temperature:	75.2	°F
Model Number:	831		25	°C
Serial Number:	1009	Rel. Humidity:	33	%
Customer:		Pressure:	987	mbars
Description:	Sound Level Meter			hPa

Note: As Found / As Left: In Tolerance

Upon receipt for testing, this instrument was found to be:

Within the Stated tolerance of the manufacturer's specification

Calibration Date: 10-Oct-12 Calibration Due:

Calibration Standards Used:

Manufacturer	Model	Serial Number	Cal Due	Traceability No.
Larson Davis	LDSigGen/2239	0760/0109	4/16/2013	2012-157887

This Certificate attests that this instrument has been calibrated under the stated conditions with Measurement and Test Equipment (M&TE) Standards traceable to the National Institute of Standards and Technology (NIST). All of the Measurement Standards have been calibrated to their manufacturers' specified accuracy / uncertainty. Evidence of traceability and accuracy is on file at The Modal Shop and/or Larson Davis Corporate Headquarters. An acceptable accuracy ratio between the Standard(s) and the item calibrated has been maintained. This instrument meets or exceeds the manufacturer's published specification unless noted.

This calibration complies with ISO 17025 and ANSI Z540. The collective uncertainty of the Measurement Standard used does not exceed 25% of the applicable tolerance for each characteristic calibrated unless otherwise noted.

The results documented in this certificate relate only to the item(s) calibrated or tested. Calibration interval assignment and adjustment are the responsibility of the end user. This certificate may not be reproduced, except in full, without the written approval of The Modal Shop.

Technician: THR Signature:

THE MODAL SHOP INC.
A PCB GROUP CO.

The Modal Shop, Inc.
3149 East Kemper Road
Cincinnati, OH 45241
Phone: (513) 351-9919
(800) 860-4867
www.modalshop.com

Certificate of Calibration and Conformance

This document certifies that the instrument referenced below meets published specifications per Procedure PRD-P263; ANSI S1.4-1983 (R 2006) Type 1; S1.4A-1985; S1.43-1997 Type 1; S1.11-2004 Octave Band Class 0; S1.25-1991; IEC 61672-2002 Class 1; 60651-2001 Type 1; 60804-2000 Type 1; 61260-2001 Class 0; 61252-2002.

Manufacturer:	Larson Davis	Temperature:	75.2	°F
Model Number:	831		25	°C
Serial Number:	2546	Rel. Humidity:	33	%
Customer:		Pressure:	987	mbars
Description:	Sound Level Meter			hPa

Note: As Found / As Left: In Tolerance

Upon receipt for testing, this instrument was found to be:

Within the Stated tolerance of the manufacturer's specification

Calibration Date: 9-Oct-12 Calibration Due:

Calibration Standards Used:

Manufacturer	Model	Serial Number	Cal Due	Traceability No.
Larson Davis	LDSigGen/2239	0760/0109	4/16/2013	2012-157887

This Certificate attests that this instrument has been calibrated under the stated conditions with Measurement and Test Equipment (M&TE) Standards traceable to the National Institute of Standards and Technology (NIST). All of the Measurement Standards have been calibrated to their manufacturers' specified accuracy / uncertainty. Evidence of traceability and accuracy is on file at The Modal Shop and/or Larson Davis Corporate Headquarters. An acceptable accuracy ratio between the Standard(s) and the item calibrated has been maintained. This instrument meets or exceeds the manufacturer's published specification unless noted.

This calibration complies with ISO 17025 and ANSI Z540. The collective uncertainty of the Measurement Standard used does not exceed 25% of the applicable tolerance for each characteristic calibrated unless otherwise noted.

The results documented in this certificate relate only to the item(s) calibrated or tested. Calibration interval assignment and adjustment are the responsibility of the end user. This certificate may not be reproduced, except in full, without the written approval of The Modal Shop.

Technician: THR Signature:

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A PCB GROUP CO.

The Modal Shop, Inc.
3149 East Kemper Road
Cincinnati, OH 45241
Phone: (513) 351-9919
(800) 860-4867
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PCB PIEZOTRONICS
A PCB GROUP COMPANY

Certificate of Calibration and Conformance

Certificate Number 2012-163960

Instrument Model 831, Serial Number 0002985, was calibrated on 19SEP2012. The instrument meets factory specifications per Procedure D0001.8310, ANSI S1.4-1983 (R 2006) Type 1; S1.4A-1985 ; S1.43-1997 Type 1; S1.11-2004 Octave Band Class 0; S1.25-1991; IEC 61672-2002 Class 1; 60651-2001 Type 1; 60804-2000 Type 1; 61260-2001 Class 0; 61252-2002.

New Instrument
Date Calibrated: 19SEP2012
Calibration due:

Calibration Standards Used

MANUFACTURER	MODEL	SERIAL NUMBER	INTERVAL	CAL. DUE	TRACEABILITY NO.
Stanford Research Systems	DS360	61889	12 Months	27JAN2013	61889-012712

Reference Standards are traceable to the National Institute of Standards and Technology (NIST)

Calibration Environmental Conditions

Temperature: 24 ° Centigrade

Relative Humidity: 28 %

Affirmations

This Certificate attests that this instrument has been calibrated under the stated conditions with Measurement and Test Equipment (M&TE) Standards traceable to the U.S. National Institute of Standards and Technology (NIST). All of the Measurement Standards have been calibrated to their manufacturers' specified accuracy / uncertainty. Evidence of traceability and accuracy is on file at Provo Engineering & Manufacturing Center. An acceptable accuracy ratio between the Standard(s) and the item calibrated has been maintained. This instrument meets or exceeds the manufacturer's published specification unless noted.

This calibration complies with the requirements of ISO 17025 and ANSI Z540. The collective uncertainty of the Measurement Standard used does not exceed 25% of the applicable tolerance for each characteristic calibrated unless otherwise noted.

The results documented in this certificate relate only to the item(s) calibrated or tested. A one year calibration is recommended, however calibration interval assignment and adjustment are the responsibility of the end user. This certificate may not be reproduced, except in full, without the written approval of the issuer.

Tested with PRM831-023767

Signed: Ron Harris
Technician: Ron Harris

Provo Engineering and Manufacturing Center, 1681 West 820 North, Provo, Utah 84601
Toll Free: 888.258.3222 Telephone: 716.926.8243 Fax: 716.926.8215
ISO 9001-2008 Certified

Appendix F

Transportation and Traffic

Transportation Impact Analysis

RICHMOND BAY CAMPUS LONG RANGE DEVELOPMENT PLAN

Prepared for:

Tetra Tech
LBNL

November 2013

FEHR PEERS

WC12-2953

Richmond Bay Campus
Long Range Development Plan
Transportation Impact Analysis

Prepared for:
Tetra Tech
LBNL

November 2013

WC12-2953

FEHR PEERS

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Appendix D Intersection Count Data Sheets – Alameda Point

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Appendix G Intersection Count Data Sheets – LBNL

Appendix H Intersection LOS Calculation – LBNL

0.0 EXECUTIVE SUMMARY

This report evaluates the impacts of the proposed Richmond Bay Campus (RBC) Long Range Development Plan (LRDP) Project on the transportation network. The analysis identifies impacts and mitigation measures of the Phase 1 Project (consisting of about 1,000 employees) and Campus Buildout (consisting of about 10,000 employees) on traffic operations at intersections and freeway segments in the vicinity of the Project site, as well as on the pedestrian, bicycle, and transit networks. This analysis also assesses the impacts of the Phase 1 Project at Alameda Point and the existing Lawrence Berkeley National Laboratory (LBNL) site and an Additional Employment Alternative (consisting of the 1,000 Phase 1 employees plus an additional 700 employees) at the three sites.

A brief description of each site followed by the impacts and mitigation for each site is provided below.

0.1 RICHMOND BAY CAMPUS

The RBC site is located in the South Shoreline area of Richmond. Phase 1 of the project would provide about 600,000 square feet of space and accommodate up to 1,000 employees. It would also provide about 600 parking spaces in surface parking lots.

At buildout, RBC would provide 5.4 million square feet of space and accommodate up to 10,000 employees. The buildout plan would also consist of a new internal street network providing automobile, bicycle, and pedestrian connections to adjacent streets and trails, emphasizing non-motorized travel within the RBC site. At buildout, RBC is estimated to provide about 6,000 parking spaces mostly in parking structures. The LRDP would also implement a robust Transportation Demand Management (TDM) program, including frequent shuttle service to BART and UC Berkeley/LBNL, to reduce the automobile trips generated by the RBC.

It is estimated that the Phase 1 project would generate about 2,080 daily, 210 AM peak hour, and 200 PM peak hour automobile trips. The buildout project is estimated to generate about 20,230 daily trips, 2,050 AM peak hour, and 1,940 PM peak hour automobile trips.

The Phase 1 project at the RBC site would not result in significant traffic impacts on traffic operations at intersections or freeway segments.

The Additional Employment Alternative would consist of an additional 200,000 square feet of space and accommodate an additional 700 employees at the RBC site. It is estimated that the Additional

Employment Alternative would generate about 3,500 daily, 360 AM peak hour, and 340 PM peak hour automobile trips. The Additional Employment Alternative at the RBC site would not result in significant traffic impacts on traffic operations at intersections or freeway segments.

The Buildout Project at the RBC site would result in the following impacts:

IMPACT 2-1: EXISTING PLUS PROJECT BUILDOUT CONDITIONS INTERSECTION OPERATIONS

The buildout of the RBC would cause significant impacts at the following seven intersections under Existing Plus Buildout conditions:

A. The Project would cause a significant impact at the signalized **Meeker Avenue/23rd Street/Marina Bay Parkway** (Intersection 4) because it would increase v/c ratio by more than 0.01 during the PM peak hour at an intersection operating at LOS F regardless of the Project.

B. The Project would cause a significant impact at the signalized **Regatta Boulevard/ Marina Bay Parkway** (Intersection 5) because it would deteriorate intersection operations from LOS C to LOS F during the AM peak hour and from LOS D to LOS E during the PM peak hour.

C. The Project would cause a significant impact at the signalized **I-580 Eastbound Ramps/ Regatta Boulevard/Meade Street** (Intersection 7) because it would deteriorate intersection operations from LOS A to LOS F during the AM peak hour.

D. The Project would cause a significant impact at the side-street stop-controlled **Meade Street/Seaver Avenue** (Intersection 9) because it would deteriorate operations for the side-street stop-controlled approach from LOS A to LOS F during both AM and PM peak hours and the intersection would satisfy the Caltrans peak hour traffic volume signal warrant.

E. The Project would cause a significant impact at the all-way stop-controlled **Seaport Avenue/I-580 Eastbound Ramps/South 51st Street/Bayview Avenue** (Intersection 10) because it would deteriorate intersection operations from LOS D to LOS F during the AM peak hour and from LOS C to LOS E during the PM peak hour. In addition, the intersection would satisfy the Caltrans peak hour traffic volume signal warrant.

F. The Project would cause a significant impact at the signalized **I-580 Westbound Ramps/ Bayview Avenue** (Intersection 11) because it would deteriorate intersection operations from LOS A to LOS F during both AM and PM peak hours.

G. The Project would cause a significant impact at the signalized **Carlson Boulevard/I-80 Westbound Ramps** (Intersection 13) because it would deteriorate intersection operations from LOS B to LOS E during the AM peak hour.

Mitigation Measure 2-1: Implement the following:

A. **Meeker Avenue/23rd Street/Marina Bay Parkway** (Intersection 4): Implement the following which requires coordination with City of Richmond:

- Convert the eastbound approach to provide one left-turn lane and one through-right lane
- Convert signal operations for the eastbound and westbound approaches from split phasing to protected left-turn phasing.
- Optimize traffic signal timing parameters (i.e., the amount of green signal time allocated to each intersection approach).

The intersection would improve to LOS C during both AM and PM peak hours after implementation of these improvements. Therefore, the mitigation measure would reduce the impact to less than significant if implemented.

B. **Regatta Boulevard/Marina Bay Parkway** (Intersection 5): Implement the following which requires coordination with City of Richmond:

- Optimize traffic signal timing parameters (i.e., the amount of green signal time allocated to each intersection approach).

The intersection would improve to LOS D during the AM peak hour after implementation of this improvement. Therefore, the mitigation measure would reduce the impact to less than significant if implemented.

C. **I-580 Eastbound Ramps/Regatta Boulevard/Meade Street** (Intersection 7): Implement the following which requires coordination with City of Richmond and Caltrans:

- Optimize traffic signal timing parameters (i.e., the amount of green signal time allocated to each intersection approach).

The intersection would improve to LOS D during the AM peak hour after implementation of this improvement. Therefore, the mitigation measure would reduce the impact to less than significant if implemented.

D. **Meade Street/Seaver Avenue** (Intersection 9): Implement the following which requires coordination with City of Richmond:

- Install an actuated signal at the intersection with protected/permitted phasing for the westbound left-turn movement.
- Convert the northbound approach to provide one left-turn lane and one right-turn lane.

The intersection would improve to LOS C during the AM peak hour and LOS B during the PM peak hour after implementation of this improvement. Therefore, the mitigation measure would reduce the impact to less than significant if implemented.

E. **Seaport Avenue/I-580 Eastbound Ramps/Bayview Avenue** (Intersection 10): Implement the following which requires coordination with City of Richmond and Caltrans:

- Install an actuated signal at the intersection with protected phasing for the northbound and southbound left-turn movements.

- Convert the southbound approach to provide two left-turn lanes and one shared right-turn/through lane.

The intersection would improve to LOS C during both AM and PM peak hours after implementation of this improvement. Therefore, the mitigation measure would reduce the impact to less than significant if implemented.

F. **I-580 Westbound Ramps/Bayview Avenue** (Intersection 11): Implement the following which requires coordination with City of Richmond and Caltrans:

- Optimize traffic signal timing parameters (i.e., the amount of green signal time allocated to each intersection approach).

The intersection would improve to LOS C during the AM peak hour and LOS B during the PM peak hour after implementation of this improvement. Therefore, the mitigation measure would reduce the impact to less than significant if implemented.

G. **Carlson Boulevard/I-80 Westbound Ramps** (Intersection 13): Implement the following which requires coordination with City of Richmond and Caltrans:

- Optimize traffic signal timing parameters (i.e., the amount of green signal time allocated to each intersection approach).

The intersection would improve to LOS D during the AM peak hour after implementation of this improvement. Therefore, the mitigation measure would reduce the impact to less than significant if implemented.

IMPACT 2-2: CUMULATIVE (2035) PLUS PROJECT BUILDOUT CONDITIONS INTERSECTION OPERATIONS

The buildout of the RBC would cause significant impacts at the following six intersections under Cumulative (2035) Plus Buildout conditions:

A. The Project would cause a significant impact at the signalized **Meeker Avenue/23rd Street/Marina Bay Parkway** (Intersection 4) because it would increase v/c ratio by more than 0.01 during the PM peak hour at an intersection operating at LOS F regardless of the Project.

B. The Project would cause a significant impact at the side-street stop-controlled **I-580 Westbound Ramps/Juliga Woods Street** (Intersection 6) because it would deteriorate operations for the side-street stop-controlled approach from LOS C to LOS F during the PM peak hour and the intersection would satisfy the Caltrans peak hour traffic volume signal warrant.

C. The Project would cause a significant impact at the side-street stop-controlled **Meade Street/Regatta Boulevard** (Intersection 8) because it would deteriorate operations for the side-street stop-controlled approach from LOS B to LOS F during both AM and PM peak hours and the intersection would satisfy the Caltrans peak hour traffic volume signal warrant.

D. The Project would cause a significant impact at the side-street stop-controlled **Meade Street/Seaver Avenue** (Intersection 9) because it would deteriorate operations for the side-street stop-controlled approach from LOS B to LOS F during both AM and PM peak hours and the intersection would satisfy the Caltrans peak hour traffic volume signal warrant.

E. The Project would cause a significant impact at the all-way stop-controlled **Seaport Avenue/I-580 Eastbound Ramps/South 51st Street/Bayview Avenue** (Intersection 10) because it would deteriorate intersection operations from LOS D during the AM peak hour and LOS E during the PM peak hour to LOS F during both AM and PM peak hours. In addition, the intersection would satisfy the Caltrans peak hour traffic volume signal warrant.

F. The Project would cause a significant impact at the signalized **Carlson Boulevard/I-80 Westbound Ramps** (Intersection 13) because it would deteriorate intersection operations from LOS D to LOS F during the AM peak hour and LOS E to LOS F during the PM peak hour.

Mitigation Measure 2-2: Implement the following:

A. **Meeker Avenue/23rd Street/Marina Bay Parkway** (Intersection 4): Implement the following which requires coordination with City of Richmond (Same as Mitigation Measure 2-1A):

- Convert the eastbound approach to provide one left-turn lane and one through-right lane
- Convert signal operations for the eastbound and westbound approaches from split phasing to protected left-turn phasing. Optimize traffic signal timing parameters (i.e., the amount of green signal time allocated to each intersection approach).

The intersection would improve to LOS C during the AM peak hour and LOS D during the PM peak hour after implementation of these improvements. Therefore, the mitigation measure would reduce the impact to less than significant if implemented.

B. **I-580 Westbound Ramps/Juliga Woods Street** (Intersection 6): Implement the following which requires coordination with City of Richmond and Caltrans:

- Install an actuated signal at the intersection.

The intersection would improve to LOS A during both AM and PM peak hours after implementation of this improvement. Therefore, the mitigation measure would reduce the impact to less than significant if implemented.

C. **Meade Street/Regatta Boulevard** (Intersection 8): Implement the following which requires coordination with City of Richmond:

- Install an actuated signal at the intersection. The new signal shall be connected and coordinated with the existing controls at the at-grade railroad crossing on Meade Street and the existing signal at the I-580 Eastbound Ramps/Regatta

Boulevard/Meade Street (Intersection 7) just west of the intersection to minimize potential queues spilling onto the railroad tracks.

The intersection would improve to LOS B during both AM and PM peak hours after implementation of this improvement. Therefore, the mitigation measure would reduce the impact to less than significant if implemented.

D. **Meade Street/Seaver Avenue** (Intersection 9): Implement the following which requires coordination with City of Richmond (Same as Mitigation Measure 2-1D):

- Install an actuated signal at the intersection with protected/permitted phasing for the westbound left-turn movement.
- Convert the northbound approach to provide one left-turn lane and one right-turn lane.

The intersection would improve to LOS D during the AM peak hour and LOS B during the PM peak hour after implementation of this improvement. Therefore, the mitigation measure would reduce the impact to less than significant if implemented.

E. **Seaport Avenue/I-580 Eastbound Ramps/Bayview Avenue** (Intersection 10): Implement the following which requires coordination with City of Richmond and Caltrans (Same as Mitigation Measure 2-1E):

- Install an actuated signal at the intersection with protected phasing for the northbound and southbound left-turn movements.
- Convert the southbound approach to provide two left-turn lanes and one shared right-turn/through lane.

The intersection would improve to LOS C during both AM and PM peak hours after implementation of this improvement. Therefore, the mitigation measure would reduce the impact to less than significant if implemented.

F. **Carlson Boulevard/I-80 Westbound Ramps** (Intersection 13): Implement the following which requires coordination with City of Richmond and Caltrans:

- Convert the southbound approach to provide one left-turn lane and one right-turn lane.

The intersection would improve to LOS C during both AM and PM peak hours after implementation of this improvement. Therefore, the mitigation measure would reduce the impact to less than significant if implemented.

IMPACT 2-3: CUMULATIVE (2035) PLUS PROJECT BUILDOUT CONDITIONS FREEWAY OPERATIONS

The buildout of the RBC would cause a significant impact under Cumulative (2035) Plus Buildout conditions on **I-580 between Central Avenue and I-80** in westbound direction during the AM peak hour and in the eastbound direction during the PM peak hour because the Project would cause the westbound segment to deteriorate from LOS E to LOS F during the AM peak hour and it increase the PM peak hour

volume on the eastbound freeway segment by more than five percent on a freeway segment that would operate at LOS F regardless of the Project.

Mitigation Measure 2-3: This impact can be mitigated by increasing the freeway capacity through adding one more travel lane in each direction of I-580 in this section. No freeway capacity projects are currently planned by Caltrans for this section of I-580. In addition, the feasibility of implementing this mitigation measure is not known at this time. Therefore, this impact is conservatively considered to be *significant and unavoidable*.

IMPACT 2-4: TRANSIT DEMAND

The Project would generate demand for bus transit service that may not be adequately served by the proposed RBC shuttles serving UC Berkeley, LBNL, and El Cerrito Plaza BART station. Although this is not considered a significant impact, the following improvement is recommended.

Environmental Protection Measure 2-4: The University of California shall implement the following:

- Regularly monitor the use of the proposed shuttle services and if necessary, adjust service frequency, stop location, and routes to better serve the RBC population.
- Coordinate with AC Transit and the City of Richmond to modify and/or extend current bus routes to serve demand generated by the RBC, as employment grows at the campus.

IMPACT 2-5: CONSTRUCTION TRAFFIC IMPACTS

The Project construction would temporarily and intermittently impact traffic operations due to truck movements and construction worker commute trips. This is a *significant* impact.

Mitigation Measure 2-5: Prepare a Construction Traffic Management Plan (CTMP) for each construction project at the RBC site to reduce the impacts of construction on traffic and parking. The University of California shall work with City of Richmond in preparing the CTMP which may consist of the following:

- Proposed truck routes
- Hours of construction and limits on number of truck trips during peak commute periods (7:00 to 9:00 AM and 4:00 to 6:00 PM) if traffic conditions demonstrate the need reduce construction traffic to avoid causing significant delays.
- Parking management plan for construction workers.
- Identification of alternative routes for temporary closure of streets and/or paths during construction in order to provide safe access and circulation for automobiles, bicycles, pedestrians, and emergency access vehicles.

Implementation of this mitigation measure will reduce the impact to a *less than significant* level.

0.2 ALAMEDA POINT ALTERNATIVE

The Alameda Point site is located in northwest part of City of Alameda. Phase 1 of the project would provide about 600,000 square feet of space and accommodate up to 1,000 employees at the site. It is estimated that the Phase 1 project at the Alameda Point site would generate about 2,080 daily, 210 AM peak hour, and 200 PM peak hour automobile trips.

The Phase 1 project at the Alameda Point site would result in the following impacts:

IMPACT 3-1: NEAR-TERM (2018) PLUS PROJECT CONDITIONS INTERSECTION OPERATIONS

The proposed Project at Alameda Point would cause a significant impact at the following intersection under Near-Term (2018) Plus Project conditions:

A. The Project would cause a significant impact at the signalized **Harrison Street/7th Street** (Intersection 12) because it would increase the overall intersection v/c ratio by 0.01 or more and increase critical movement v/c ratio by 0.02 or more during both AM and PM peak hours at an intersection in downtown Oakland operating at LOS F regardless of the Project.

Mitigation Measure 3-1: Implement the following:

A. **Harrison Street/7th Street** (Intersection 12): Implement the following which requires coordination with City of Oakland:

- Increase traffic signal cycle length to 75 seconds and optimize traffic signal timing parameters (i.e., the amount of green signal time allocated to each intersection approach).

The intersection would continue to operate at LOS F during both AM and PM peak hours after the implementation of this mitigation measure. However, this mitigation measure would reduce the overall intersection v/c ratio and the critical movement v/c ratio to the same level or less than under Near-Term (2018) No Project conditions. Therefore, the mitigation measure would reduce the impact to less than significant if implemented.

IMPACT 3-2: CUMULATIVE (2035) PLUS PROJECT CONDITIONS INTERSECTION OPERATIONS

The proposed Project at Alameda Point would cause a significant impact at the following intersections under Cumulative (2035) Plus Project conditions:

A. The Project would cause a significant impact at the signalized **Harrison Street/7th Street** (Intersection 12) because it would increase the overall intersection v/c ratio by .0.01 or more and increase critical movement v/c ratio by 0.02 or more during the PM peak hour at an intersection in downtown Oakland operating at LOS F regardless of the Project.

B. The Project would cause a significant impact at the signalized **Jackson Street/7th Street** (Intersection 13) because it would increase the overall intersection v/c ratio by .0.01 or more and increase critical movement v/c ratio by 0.02 or more during the PM peak hour at an intersection in downtown Oakland operating at LOS F regardless of the Project.

Mitigation Measure 3-2: Implement the following:

A. **Harrison Street/7th Street** (Intersection 12): Implement the following which requires coordination with City of Oakland (Same as Mitigation Measure 3-1A):

- Increase traffic signal cycle length to 80 seconds and optimize traffic signal timing parameters (i.e., the amount of green signal time allocated to each intersection approach).

The intersection would continue to operate at LOS F during the PM peak hour. However, this mitigation measure would reduce the overall intersection v/c ratio and the critical movement v/c ratio to the same level or less than under Cumulative (2035) No Project conditions. Therefore, the mitigation measure would reduce the impact to less than significant if implemented.

B. **Jackson Street/7th Street** (Intersection 13): Implement the following which requires coordination with City of Oakland:

- Increase traffic signal cycle length to 80 seconds and optimize traffic signal timing parameters (i.e., the amount of green signal time allocated to each intersection approach).

The intersection would continue to operate at LOS F during the PM peak hour. However, this mitigation measure would reduce the overall intersection v/c ratio and the critical movement v/c ratio to the same level or less than under Cumulative (2035) No Project conditions. Therefore, the mitigation measure would reduce the impact to less than significant if implemented.

The Additional Employment Alternative would consist of an additional 200,000 square feet of space and accommodate an additional 700 employees at the Alameda Point site. It is estimated that the Additional Employment Alternative would generate about 3,500 daily, 360 AM peak hour, and 340 PM peak hour automobile trips. The Additional Employment Alternative at the Alameda Point site would result in the following significant traffic impact, which is the same as the Project Impact 3-1.

IMPACT 3-3: NEAR-TERM (2018) PLUS ADDITIONAL EMPLOYMENT ALTERNATIVE CONDITIONS INTERSECTION OPERATIONS

The Additional Employment Alternative at Alameda Point would cause a significant impact at the following intersection under Near-Term (2018) Plus Additional Employment Alternative conditions:

A. The Additional Employment Alternative would cause a significant impact at the signalized **Harrison Street/7th Street** (Intersection 12) because it would increase the overall intersection v/c ratio by 0.01 or more and increase critical movement v/c ratio by 0.02 or more during both AM and PM peak hours at an intersection in downtown Oakland operating at LOS F regardless of the Alternative.

Mitigation Measure 3-3: Implement the following:

A. **Harrison Street/7th Street** (Intersection 12): Implement the following which requires coordination with City of Oakland (same as Mitigation Measure 3-1A):

- Increase traffic signal cycle length to 75 seconds and optimize traffic signal timing parameters (i.e., the amount of green signal time allocated to each intersection approach).

The intersection would continue to operate at LOS F during both AM and PM peak hours after the implementation of this mitigation measure. However, this mitigation measure would reduce the overall intersection v/c ratio and the critical movement v/c ratio to the same level or less than under Near-Term (2018) No Project conditions. Therefore, the mitigation measure would reduce the impact to less than significant if implemented.

0.3 LBNL SITE ALTERNATIVE

The LBNL site is located in the hills of Berkeley and Oakland just east of the UC Berkeley campus. Phase 1 of the project would provide about 600,000 square feet of space and accommodate up to 1,000 employees within the existing LBNL campus. It is estimated that the Phase 1 project at the existing LBNL site would generate about 1,590 daily, 160 AM peak hour, and 150 PM peak hour automobile trips.

The Phase 1 project at the existing LBNL site would result in the following impacts:

IMPACT 4-1: NEAR-TERM (2018) PLUS PROJECT CONDITIONS INTERSECTION OPERATIONS

The proposed Project at LBNL site would cause a significant impact at the following intersection under Near-Term (2035) Plus Project conditions:

A. The Project would cause a significant impact at the all-way stop-controlled **Stadium Rim Way/Gayley Road** (Intersection 4) because the Project would contribute to LOS F

operations for a critical movement during the PM peak hour and the intersection would satisfy the Caltrans peak hour traffic volume signal warrant.

Mitigation Measure 4-1: Implement the following:

A. **Stadium Rim Way/Gayley Road** (Intersection 4): Implement the following which requires coordination with City of Berkeley and UC Berkeley:

- Install a traffic signal at the intersection.

The intersection would improve to LOS C or better during both AM and PM peak hours after implementation of this improvement. If found to be feasible and implemented, this mitigation measure would reduce the impact to less than significant.

IMPACT 4-2: CUMULATIVE (2035) PLUS PROJECT CONDITIONS INTERSECTION OPERATIONS

The proposed Project at LBNL site would cause a significant impact at the following intersections under Cumulative (2035) Plus Project conditions:

A. The Project would cause a significant impact at the all-way stop-controlled **Stadium Rim Way/Gayley Road** (Intersection 4) because the Project would contribute to LOS F operations during both AM and PM peak hours and the intersection would satisfy the Caltrans peak hour traffic volume signal warrant.

B. The Project would cause a significant impact at the all-way stop-controlled **Durant Avenue/Piedmont Avenue** (Intersection 9) because the Project would contribute to LOS F operations during both AM and PM peak hours and the intersection would satisfy the Caltrans peak hour traffic volume signal warrant.

Mitigation Measure 4-2: Implement the following:

A. **Stadium Rim Way/Gayley Road** (Intersection 4): Implement the following which requires coordination with City of Berkeley and UC Berkeley (Same as Mitigation Measure 4-1A):

- Install a traffic signal at the intersection.

The intersection would improve to LOS C or better during both AM and PM peak hours after implementation of this improvement. If found to be feasible and implemented, this mitigation measure would reduce the impact to less than significant.

B. **Durant Avenue/Piedmont Avenue** (Intersection 9): Implement the following which requires coordination with City of Berkeley:

- Install a traffic signal at the intersection.

The intersection would improve to LOS B or better during both AM and PM peak hours after implementation of this improvement. If found to be feasible and implemented, this mitigation measure would reduce the impact to less than significant.

The Additional Employment Alternative would consist of an additional 200,000 square feet of space and accommodate an additional 700 employees at the existing LBNL site. It is estimated that the Additional Employment Alternative would generate about 2,700 daily, 270 AM peak hour, and 260 PM peak hour automobile trips. The Additional Employment Alternative at the existing LBNL site would result in the following significant traffic impact, which is the same as the Project Impact 4-1:

IMPACT 4-3: NEAR-TERM (2018) PLUS ADDITIONAL EMPLOYMENT ALTERNATIVE CONDITIONS INTERSECTION OPERATIONS

The Additional Employment Alternative at LBNL site would cause a significant impact at the following intersection under Near-Term (2035) Plus Additional Employment Alternative conditions:

A. The Additional Employment Alternative would cause a significant impact at the all-way stop-controlled **Stadium Rim Way/Gayley Road** (Intersection 4) because it would contribute to LOS F operations for a critical movement during the PM peak hour and the intersection would satisfy the Caltrans peak hour traffic volume signal warrant.

Mitigation Measure 4-3: Implement the following:

A. **Stadium Rim Way/Gayley Road** (Intersection 4): Implement the following which requires coordination with City of Berkeley and UC Berkeley (Same as Mitigation Measure 4-1A):

- Install a traffic signal at the intersection.

The intersection would improve to LOS C or better during both AM and PM peak hours after implementation of this improvement. If found to be feasible and implemented, this mitigation measure would reduce the impact to less than significant.

1.0 INTRODUCTION

This report presents an analysis of the impacts of the proposed Richmond Bay Campus (RBC) Long Range Development Plan (LRDP) Project on the transportation network. The University of California (University) is preparing the LRDP to guide campus development across a projected 40-year planning horizon. This analysis assesses impacts of the Phase 1 Project (consisting of about 1,000 employees) and Campus Buildout (consisting of about 10,000 employees) on traffic operations at intersections and freeway segments in the vicinity of the Project site, as well as on the pedestrian, bicycle, and transit networks. This analysis also assesses the impacts of implementing the Phase 1 Project at Alameda Point and at the Lawrence Berkeley National Laboratory (LBNL) site, and an Additional Employment Alternative (consisting of the 1,000 Phase 1 employees plus an additional 700 employees) at the three sites. Details on the proposed Project and the alternatives are provided in Chapters 2, 3, and 4. **Figure 1-1** shows the location of the RBC, Alameda Point, and LBNL sites.

1.1 REPORT ORGANIZATION

This report is divided into the following four chapters:

- ***Chapter 1 – Introduction*** describes the analysis methods used for the transportation impact assessment for all three project alternatives (RBC, Alameda Point, and LBNL Sites). This chapter also includes the significance criteria for each alternative. The criteria vary to reflect the standards and practices for each jurisdiction

- ***Chapter 2 – Richmond Bay Campus Project*** describes the existing conditions in the vicinity of the RBC site and assesses the impacts of the Phase 1 Project and Project Buildout at this site.

- ***Chapter 3 – Alameda Point Alternative*** describes the existing conditions in the vicinity of the Alameda Point site and assesses the impacts of the Phase 1 development at this site.

- ***Chapter 4 – LBNL Site Alternative*** describes the existing conditions in the vicinity of the existing LBNL site and assesses the impacts of the Phase 1 development at this site.

- ***Chapter 5 – References*** lists reference material used in preparing this report.

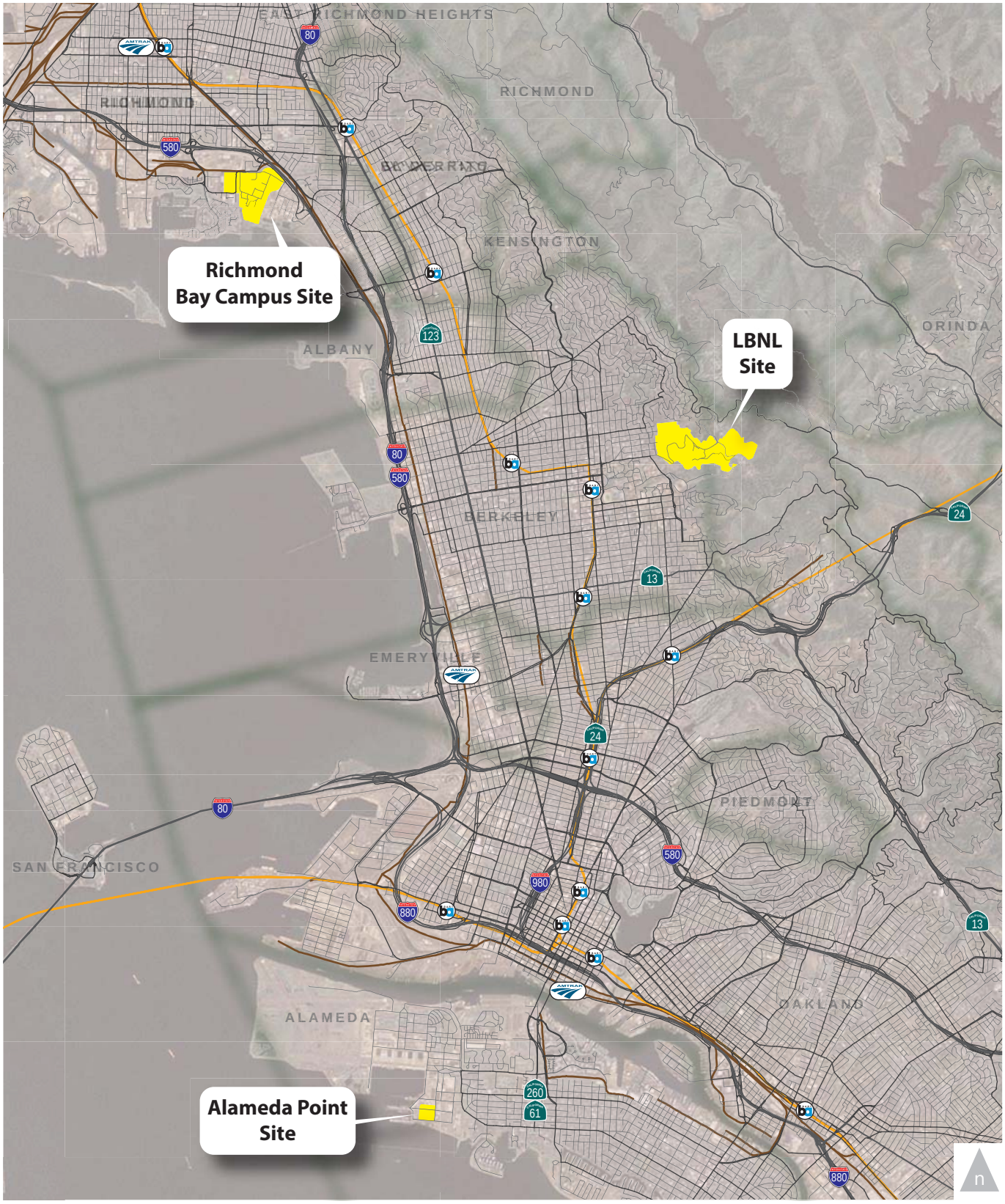

Figure 1-1.

Site Locations

WC12-2953_1-1_SiteLocs

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1.2 INTERSECTION OPERATION ANALYSIS METHOD

Intersection operations are described using the term "Level of Service" (LOS). LOS is a qualitative description of traffic operations from the vehicle driver perspective and consists of the delay experienced by the driver at the intersection. It ranges from LOS A, with no congestion and little delay, to LOS F, with excessive congestion and delays. Different methods are used to assess signalized and unsignalized (stop-controlled) intersections.

1.2.1 SIGNALIZED INTERSECTIONS

Signalized intersection operations are evaluated using methods provided in the 2000 Highway Capacity Manual (HCM). This method uses intersection characteristics to estimate average control delay and then assign an LOS. Control delay is defined as the delay associated with deceleration, stopping, moving up in the queue, and acceleration experienced by drivers at an intersection. **Table 1-1** provides descriptions of various LOS and the corresponding ranges of delays for signalized intersections.

1.2.2 UNSIGNALIZED INTERSECTIONS

Unsignalized intersection (four-way stop-controlled, side-street stop-controlled, and roundabouts) LOS are also analyzed using the 2000 HCM. Delay is calculated for movements that are controlled by a stop sign or that must yield the right-of-way. This method defines operations by average control delay per vehicle (measured in seconds) for each stop-controlled movement. This incorporates delay associated with deceleration, acceleration stopping, and moving up in the queue. For side-street stop-controlled intersections, the movement or approach with the highest delay is reported. **Table 1-1** summarizes the LOS ranges for unsignalized intersections. They are lower than the delay ranges for signalized intersections because drivers will generally tolerate more delay at signals.

1.2.3 ANALYSIS TOOLS

The Synchro Software was used to estimate delay and LOS for all signalized and most of the unsignalized study intersections. Synchro uses the equations provided in 2000 HCM to calculate control delay. These equations use intersection characteristics, such as vehicle and pedestrian volumes, lane geometry, and signal phasings, as inputs in estimating control delay.

TABLE 1-1
INTERSECTION LEVEL OF SERVICE DEFINITIONS

Unsignalized Intersections		Level of Service Grade	Signalized Intersections	
Description	**Average Total Vehicle Delay (Seconds)**		**Average Control Vehicle Delay (Seconds)**	**Description**
No delay for stop-controlled approaches.	≤10.0	A	≤10.0	Free Flow or Insignificant Delays: Operations with very low delay, when signal progression is extremely favorable and most vehicles arrive during the green light phase. Most vehicles do not stop at all.
Operations with minor delay.	>10.0 and ≤15.0	B	>10.0 and ≤20.0	Stable Operation or Minimal Delays: Generally occurs with good signal progression and/or short cycle lengths. More vehicles stop than with LOS A, causing higher levels of average delay. An occasional approach phase is fully utilized.
Operations with moderate delays.	>15.0 and ≤25.0	C	>20.0 and ≤35.0	Stable Operation or Acceptable Delays: Higher delays resulting from fair signal progression and/or longer cycle lengths. Drivers begin having to wait through more than one red light. Most drivers feel somewhat restricted.
Operations with increasingly unacceptable delays.	>25.0 and ≤35.0	D	>35.0 and ≤55.0	Approaching Unstable or Tolerable Delays: Influence of congestion becomes more noticeable. Longer delays result from unfavorable signal progression, long cycle lengths, or high volume to capacity ratios. Many vehicles stop. Drivers may have to wait through more than one red light. Queues may develop, but dissipate rapidly, without excessive delays.
Operations with high delays, and long queues.	>35.0 and ≤50.0	E	>55.0 and ≤80.0	Unstable Operation or Significant Delays: Considered to be the limit of acceptable delay. High delays indicate poor signal progression, long cycle lengths and high volume to capacity ratios. Individual cycle failures are frequent occurrences. Vehicles may wait through several signal cycles. Long queues form upstream from intersection.
Operations with extreme congestion, and with very high delays and long queues unacceptable to most drivers.	>50.0	F	>80.0	Forced Flow or Excessive Delays: Occurs with oversaturation when flows exceed the intersection capacity. Represents jammed conditions. Many cycle failures. Queues may block upstream intersections.

Source: Highway Capacity Manual, Transportation Research Board, 2000.

Delay at some unsignalized intersections (Bancroft Way/Piedmont Avenue and Durant Avenue/Piedmont Avenue intersections in Berkeley) was calculated using SimTraffic because of the unique conditions at these intersections. The heavy pedestrian crossing volumes and the close distance of the intersections to each other cannot be accurately measured by Synchro. SimTraffic is used for modeling and simulating traffic operations based on the behavior of individual drivers in a network. The software accounts for the physical features of the transportation system, traffic flow conditions, and driver behavior characteristics to estimate travel delays and other performance measures that describe traffic operations.

Microsimulation programs, such as SimTraffic, incorporate the element of randomness inherent in traffic flow. Therefore, in order to average out the random fluctuations and obtain a statistically more significant result, a microsimulation model should be run a number of times and the average of the runs should be reported. For this study, the SimTraffic files were each run ten times.

1.3 FREEWAY OPERATIONS ANALYSIS METHOD

1.3.1 FREEWAY MAINLINE SECTIONS

The LOS for a freeway section is based on measures of density (passenger cars/ lane/ mile). Freeway LOS is a qualitative description of traffic flow based on speed, travel time, delay, and freedom to maneuver. There are six levels, ranging from LOS A (i.e., the best operating conditions) to LOS F (i.e., the worst). LOS E represents "at-capacity" operation. When volumes exceed capacity, stop-and-go conditions result and operations are designated as LOS F. **Table 1-2** presents a summary of the relationship between LOS and density for freeway mainline sections.

1.3.2 FREEWAY WEAVE SECTION

The freeway weave sections were analyzed using the Leisch methodology as described in *Highway Design Manual* (California Department of Transportation, 2009). A weave section is defined as a length of freeway where vehicles are crossing paths, changing lanes, or merging/weaving with through traffic as they enter or exit the freeway. This methodology assigns the LOS for the weave section based on volumes, traffic service flow, and capacity using nomographs.

TABLE 1-2
FREEWAY SEGMENT LEVEL OF SERVICE CRITERIA

Level of Service	Freeway Maximum Density (Passenger cars / mile / lane)
A	11
B	18
C	26
D	35
E	45
F	> 45

Notes:
Freeway mainline LOS based on a 65 miles per hour free-flow speed.
Source: Transportation Research Board, 2000.

1.4 SIGNIFICANCE CRITERIA

This section describes the thresholds of significance used to determine if a project would cause a significant impact.

1.4.1 GENERAL

The following thresholds of significance are based on the CEQA Guidelines Appendix G Checklist:

A. Would the Project conflict with an applicable plan, ordinance or policy establishing measures of effectiveness for the performance of the circulation system, taking into account all modes of transportation including mass transit and non-motorized travel and relevant components of the circulation system, including but not limited to intersections, streets, highways and freeways, pedestrian and bicycle paths, and mass transit?

B. Would the Project conflict with an applicable congestion management program, including but not limited to level of service standards and travel demand measures, or other standards established by the county congestion management agency for designated roads and highways?

C. Would the Project result in a change in air traffic patterns, including either an increase in traffic levels or a change in location that result in substantial safety risks;

D. Would the Project substantially increase traffic hazards due to a design feature (e.g. sharp curves or dangerous intersections) or incompatible uses (e.g. farm equipment)?

E. Would the project result in inadequate emergency access?

F. Would the Project conflict with adopted policies, plans, or programs regarding public transit, bicycle or pedestrian facilities, or otherwise decrease the performance or safety of such facilities?

The local jurisdictions and congestion management programs have established specific thresholds of significance for intersections and freeways which are discussed in the next two subsections and used in this analysis. The local jurisdictions do not have specific thresholds for assessing impacts on other aspects of the transportation network; therefore, the thresholds from the CEQA Guidelines Appendix G Checklist, as listed above, are used to determine significant impacts.

1.4.2 INTERSECTION OPERATIONS

For the purposes of this analysis, the following intersection LOS thresholds of significance are used based on the local jurisdictions' standards and practices.

City of Richmond:

An impact is significant if the Project would cause:

- A signalized intersection to deteriorate from LOS D or better to LOS E or LOS F.
- A signalized intersection where the level of service is LOS E, the project would cause the average control delay to increase by more than five seconds or deteriorate to LOS F.
- A signalized intersection where the level of service is LOS F, the project would cause the overall volume-to-capacity ("V/C") ratio to increase 0.01 or more.
- At an unsignalized intersection the project would cause the intersection to operate at LOS F and after project completion satisfy the Caltrans peak hour traffic volume signal warrant.

City of Alameda:

An impact is significant if the Project would cause:

- An intersection to fall from the minimum acceptable LOS (LOS D) to LOS E or F.
- An intersection is already operating at LOS E or F, the impact is significant if the project causes a three percent increase in peak hour traffic volumes.

City of Oakland:

An impact is significant if:

- At a signalized intersection which is located within the Downtown area, the Project would cause the LOS to degrade to worse than LOS E (i.e., LOS F)

- At a signalized intersection for all areas where the level of service is LOS E, the Project would cause an increase in the average delay for any of the critical movements of six (6) seconds or more or degrade to worse than LOS E (i.e., LOS F)
- At a signalized intersection for all areas where the level of service is LOS F, the Project would cause (a) the overall volume-to-capacity ("V/C") ratio to increase 0.01 or more or (b) the critical movement V/C ratio to increase 0.02 or more

City of Berkeley:

An impact is significant if the Project would cause:

- At a signalized intersection operations degrade from LOS D to LOS E or worse and more than a two-second increase in delay; or
- At a signalized intersection, more than a three-second increase in delay at intersections operating at LOS E without and with the project; or
- At a signalized intersection, operations degrade from LOS E to LOS F and more than a three-second increase in delay; or
- At a signalized intersection operating at LOS F without the project, a change in the volume-to-capacity (v/c) ratio of more than 0.01.
- At an unsignalized intersection, the addition of Project-related traffic causes:
    - the critical approach to operate at LOS F; and
    - the intersection meets peak hour traffic volume signal warrants; and
    - no alternative routes are available.

All Jurisdictions:

A project's contribution to cumulative impacts is considered "considerable" (i.e., significant) when the project exceeds at least one of the thresholds listed above under a future year scenario.

1.4.3 FREEWAY SEGMENTS

The 2011 *Contra Costa Congestion Management Program* is the applicable CMP document for the RBC. Based on the CMP requirements, the following standards are used to determine if the Project impacts on a freeway segment are considered significant:

- I-580: Cause a segment to degrade from LOS E or better to LOS F or increase peak hour volume by five percent or more for a segment already operating at LOS F.
- I-80: Increase peak hour volume by five percent or more for a segment already operating at LOS F.

The 2009 Alameda County Congestion Management Program is the applicable CMP document for the Alameda Point Alternative. Based on the CMP requirements, the following standards are used to determine if the Project impacts on a freeway segment are considered significant:

- All freeway segments in Alameda County: Increase peak hour volume by five percent or more for a segment already operating at LOS F.

2.0 RICHMOND BAY CAMPUS PROJECT

This chapter describes existing transportation conditions for the RBC site and identifies impacts and mitigation measures of developing both the Phase 1 and buildout of the proposed LRDP at RBC site.

2.1 EXISTING CONDITIONS

Existing transportation conditions at the RBC site and vicinity are described below.

2.1.1 EXISTING ROADWAY NETWORK

Figure 2-1 shows the existing RBC site, the surrounding roadway system, and study intersections and freeway segments analyzed as part of this assessment. The regional and local roadways serving the project site are described below.

2.1.1.1 Regional Roadways

Interstate 580 (I-580) is a generally east-west six-lane freeway connecting I-80 and points east to US 101 in Marin County, via the Richmond-San Rafael Bridge. Auxiliary lanes (lanes connecting adjacent on-ramps and off-ramps) provide a fourth travel lane in each direction, in the project vicinity. Access between the RBC site and I-580 is provided via interchanges at Bayview Avenue/51st Street, Regatta Boulevard/Juliga Woods Street, and Marina Bay Parkway/South 23rd Street. I-580 has an average annual daily traffic volume (AADT) of 91,000 vehicles (Caltrans, 2011) between the Regatta Boulevard/Juliga Woods Street and Marina Bay Parkway/South 23rd Street interchanges.

Interstate 80 (I-80) freeway connects the San Francisco Bay Area with the Sacramento region and continues east. Near the RBC site, I-80 is oriented in a north-south direction about one mile east, and provides four lanes of travel in each direction. Access between I-80 and the RBC site is provided via I-580 to and from the south and via the Carlson Boulevard interchange to and from the north. I-80 has an AADT of 171,000 vehicles (Caltrans, 2011) north of I-580.

Figure 2-1.

Richmond Bay Campus Study Locations

WC12-2953_2-1_BayCampusStudy

FEHR PEERS

Regatta Boulevard is an east-west arterial that connects Marina Way South to Meade Street, forming the primary east-west connection in the South Shoreline area of Richmond. Regatta Boulevard provides two travel lanes in each direction with a median, turn lanes at intersections, and a continuous sidewalk/path along the north and an intermittent sidewalk/path along the south side of the roadway between Marina Way South and Marina Bay Parkway. East of Marina Bay Parkway, the roadway narrows to three lanes with one travel lane in each direction, a center two-way left-turn lane and a continuous sidewalk along the north side and intermittent sidewalk along the south side of the roadway; further east, the roadway narrows further to a two-lane cross section with shoulders on both sides of the roadway, terminating at Meade Street. The recently completed extension of Regatta Boulevard provides a direct connection to Meade Street, allowing for another access/egress route for the South Shoreline area when trains at the at-grade railroad crossing block the Marina Bay Parkway just north of Regatta Boulevard. The posted speed limit on Regatta Boulevard is 25 miles per hour (mph).

Marina Bay Parkway/South 23rd Street is a north-south arterial connecting downtown Richmond to the South Shoreline area. South of I-580, the roadway is called Marina Bay Parkway and north of I-580, the roadway is called South 23rd Street. In the study area the roadway generally provides two travel lanes in each direction, with turn lanes at intersections. The roadway provides sidewalks on both sides of the roadway north of Meeker Avenue and only on the west side of the street south of Meeker Avenue. The posted speed limit is 30 mph. Marina Bay Parkway/South 23rd Street is currently designated as a Class 3 Bicycle Route.

Cutting Boulevard is an east-west arterial roadway connecting San Pablo Avenue and I-580 in the east with South Garrard Boulevard in the west. In the study area, Cutting Boulevard generally provides two travel lanes in each direction, with turn lanes at intersections and sidewalks on both sides of the street. The posted speed limit is 35 mph.

Carlson Boulevard is a generally four-lane northwest-southeast arterial through the study area, connecting 23rd Street to I-80 via an interchange, and terminating at San Pablo Avenue in El Cerrito. The roadway generally provides two travel lanes in each direction with turn lanes at major intersections and sidewalks on both sides of the street south of Bay View Avenue. Carlson Boulevard does not provide a continuous sidewalk on the west side of the street north of Bay View Avenue. The posted speed limit is 35 mph. Carlson Boulevard between Potrero Drive and Cutting Boulevard is currently designated as a Class 3 bicycle route.

2.1.1.2 Local Roadways

Meade Street is a two-lane roadway that runs northwest from the I-580/Bayview Avenue interchange to the I-580/Regatta Boulevard interchange and would continue to provide access to the RBC site during both the Phase 1 and buildout scenarios. Meade Street provides a continuous sidewalk along the north side and intermittent sidewalk along the south side of the roadway. The posted speed limit is 30 mph.

2.1.2 INTERSECTION OPERATIONS ANALYSIS

This study analyzes existing traffic operations during typical weekday AM and PM peak hours at the following 14 intersections in the City of Richmond:

1. Cutting Boulevard/23rd Street
2. I-580 Westbound Ramps/23rd Street
3. I-580 Eastbound Ramps/23rd Street
4. Meeker Avenue/23rd Street/Marina Bay Pkwy
5. Regatta Boulevard/Marina Bay Parkway
6. I-580 Westbound Ramps/Juliga Woods Street
7. I-580 Eastbound Ramps/Regatta Boulevard/ Meade Street
8. Meade Street/Regatta Boulevard
9. Meade Street/Seaver Avenue
10. Seaport Avenue/I-580 Eastbound Ramps/South 51st Street/Bayview Avenue
11. I-580 Westbound Ramps/Bayview Avenue
12. Carlson Boulevard/Bayview Avenue
13. Carlson Boulevard/I-80 Eastbound Ramps
14. Carlson Boulevard/I-80 Westbound Ramps

These intersections were selected for analysis because they are most likely to be affected by the proposed Project. **Figure 2-1** shows the location of the study intersections.

2.1.2.1 Existing Intersection Volumes

The intersection operations analysis presented in this study are based on AM and PM peak period (7:00 to 9:00 AM and 4:00 to 6:00 PM) intersection turning movement, pedestrian, and bicycle volumes collected on December 12 and 13, 2012. These time periods were selected because trips generated by the proposed Project, in combination with background traffic, are expected to represent typical worst traffic conditions. Within the peak periods, the peak hours (i.e., the hour with the highest traffic volumes observed in the study area) are from 7:30 AM to 8:30 AM (AM peak hour) and 5:00 PM to 6:00 PM (PM peak hour).

Because the traffic counts were collected in December when traffic patterns may be atypical due to irregular school schedules, holidays, and more frequent shopping trips[1], "check counts" were collected during the week of January 28, 2013, at three locations (Meeker Avenue/23rd Street/Marina Bay Parkway, Meade Street/Regatta Boulevard, and Carlson Boulevard/Bayview Avenue). These check counts were compared to the December 2012 counts, in terms of total intersection volumes and also critical

[1] Since the RBC site is not located near schools or major shopping destinations, it is not expected to have different traffic patterns in December, which was confirmed with the counts collected in February.

movements. In comparison, some movements were higher in December 2012 while others were higher in January/February 2013. Overall, the January/February 2013 intersections volumes were between 12 percent lower and 15 percent higher than the December 2012 volumes, which is within the typical daily fluctuation expected in traffic volumes. Thus, the December 2012 traffic volumes represent typical conditions in the vicinity of the RBC site.

Although the December 2012 traffic volumes represent typical conditions in the study area, they were adjusted to reflect the higher traffic volumes observed in January/February 2013 in order to present a more conservative analysis, resulting in a slight overestimation of the anticipated traffic impacts. The adjustments included increasing the northbound through movement at Marina Bay Parkway/Meeker Street intersection and corresponding upstream movements, and increasing the truck percentages at all the intersections based on observed higher truck volumes in the January/February 2013 counts.

Figures 2-2A and 2-2B present the existing AM and PM peak hour intersection vehicle turn movement volumes at the study intersections. **Figures 2-3A and 2-3B** present the existing AM and PM peak hour pedestrian and bicycle volumes at the study intersections. **Appendix A** presents the detailed count sheets at the study intersections.

2.1.2.2 Existing Intersection Operations

Table 2-1 summarizes existing weekday peak hour intersection LOS analysis results. **Appendix B** provides the detailed calculation work sheets. As shown in the table, all study intersections during the AM peak hour, and all but one intersection during the PM peak hour operate at LOS D or better. The one sub-standard intersection is Meeker Avenue/23rd Street/Marina Bay Parkway, which operates at LOS F during the PM peak hour.

2.1.3 FREEWAY OPERATIONS

This study analyzes existing traffic operations during typical weekday AM and PM peak hours at the following seven freeway segments:

1. I-580 between Harbor Way and Marina Bay Parkway
2. I-580 between Marina Bay Parkway and Regatta Boulevard
3. I-580 between Regatta Boulevard and Bayview Avenue
4. I-580 between Bayview Avenue and Central Avenue
5. I-580 between Central Avenue and I-80
6. I-80 between Carlson Boulevard and Potrero Avenue
7. I-80 at the Gilman Street Overpass

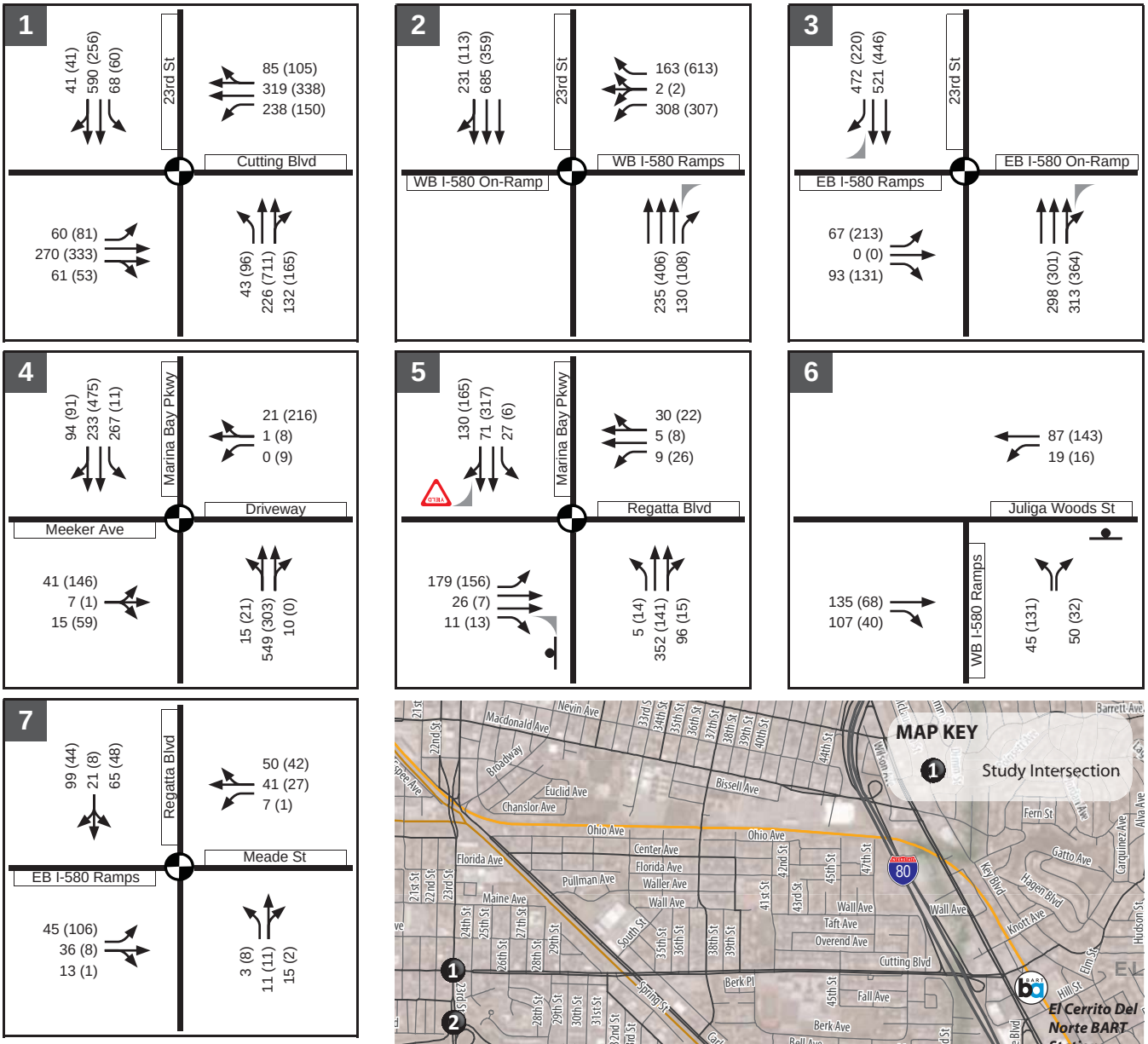

Figure 2-2A.

Richmond Bay Campus Existing
Peak Hour Traffic Volumes, Lane Configurations and Traffic Control

WC12-2953_2-2A_ExVol

FEHR PEERS

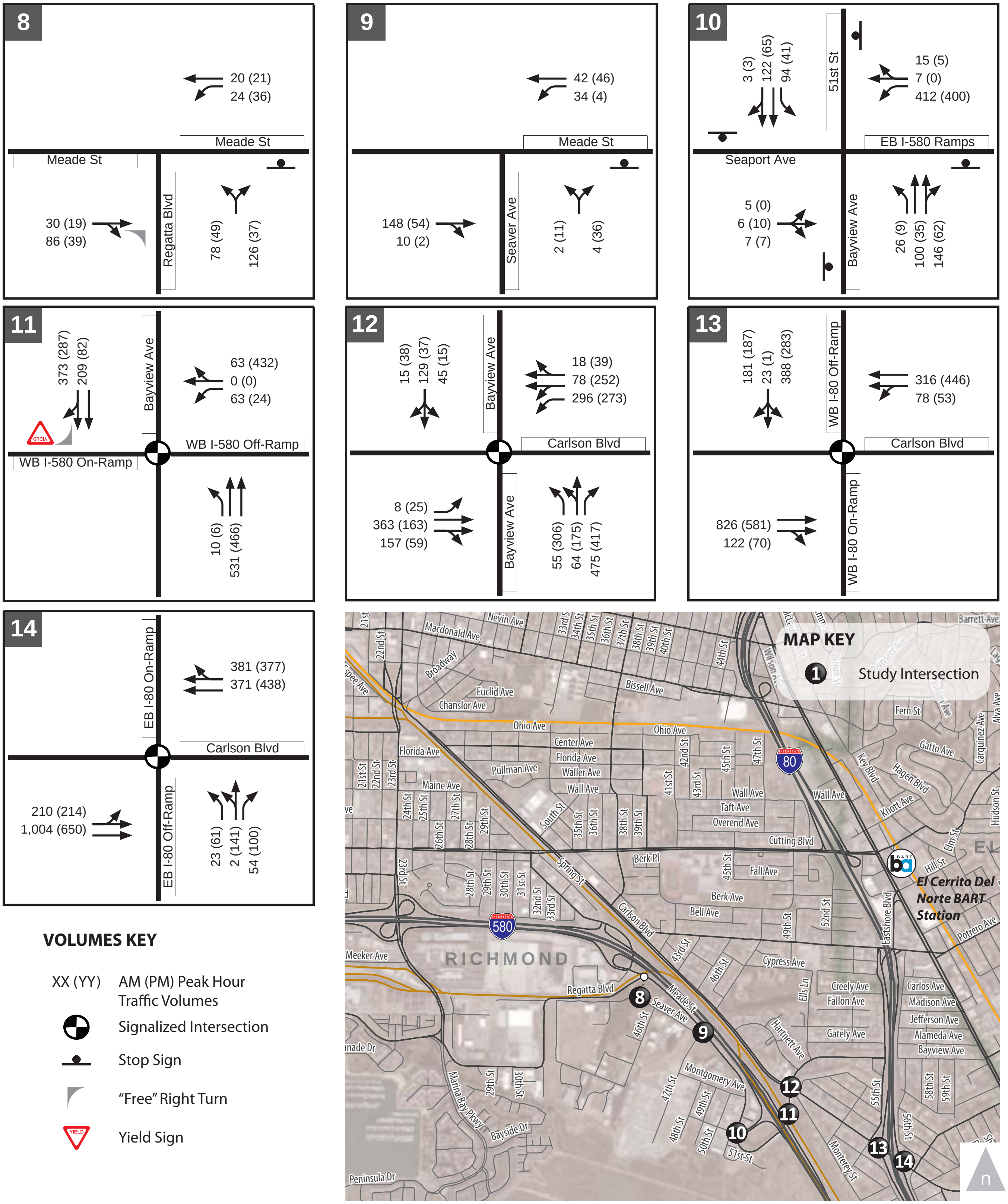

Figure 2-2B.

Richmond Bay Campus Existing
Peak Hour Traffic Volumes, Lane Configurations and Traffic Control

WC12-2953_2-2B_ExVol

FEHR & PEERS

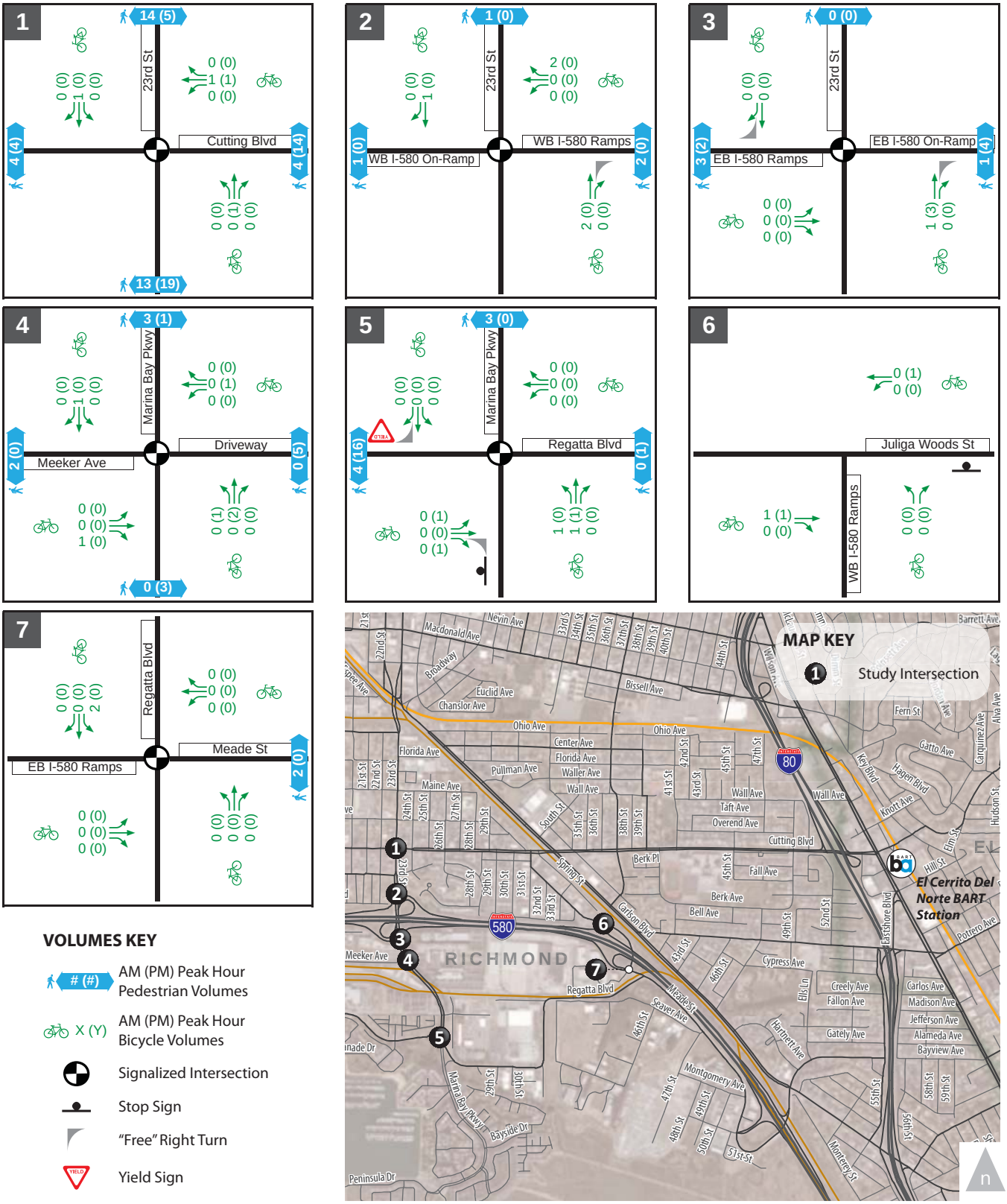

Figure 2-3A.

Richmond Bay Campus Existing Pedestrian and Bicycle Volumes

WC12-2953_2-3A_ExPedBikeVol

FEHR PEERS

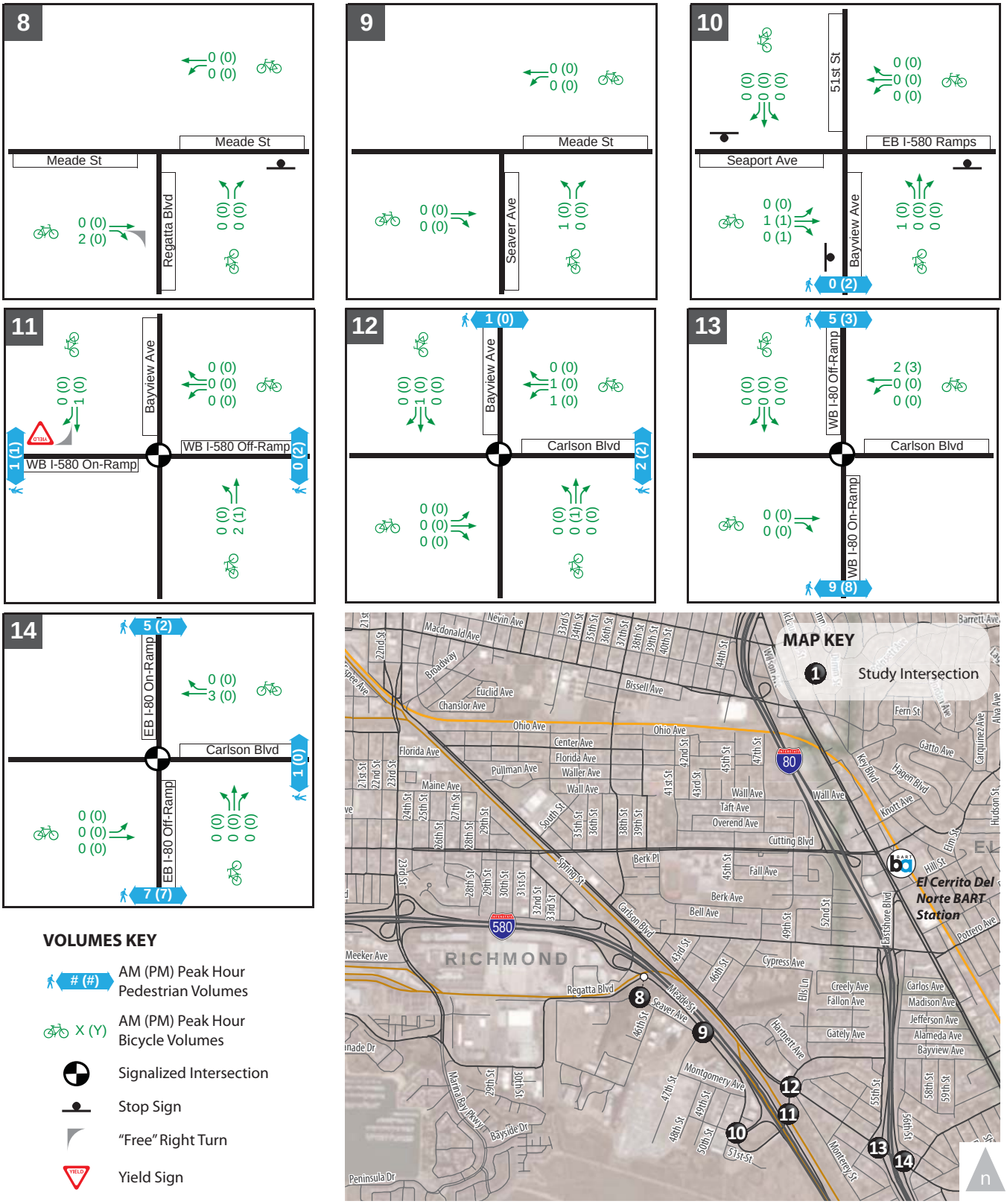

Figure 2-3B.

Richmond Bay Campus Existing Pedestrian and Bicycle Volumes

WC12-2953_2-3B_ExPedBikeVol

FEHR PEERS

TABLE 2-1
RICHMOND BAY CAMPUS
EXISTING CONDITIONS – STUDY INTERSECTION LOS SUMMARY

Intersection	Control	AM Peak Hour		PM Peak Hour	
		Delay (Seconds)[1]	LOS [1]	Delay (Seconds) [1]	LOS [1]
1. Cutting Boulevard/ 23rd Street	Signal	22.9	C	23.0	C
2. I-580 Westbound Ramps/ 23rd Street	Signal	6.9	A	6.8	A
3. I-580 Eastbound Ramps/ 23rd Street	Signal	3.6	A	6.3	A
4. Meeker Avenue/23rd Street/ Marina Bay Pkwy	Signal	37.1	D	**115.8**	**F**
5. Regatta Boulevard/ Marina Bay Parkway	Signal	30.0	C	43.6	D
6. I-580 Westbound Ramps/ Juliga Woods Street	Side Street Stop	2.5 (10.0)	A (B)	4.4 (10.9)	A (B)
7. I-580 Eastbound Ramps/ Regatta Boulevard/ Meade Street	Signal	9.7	A	9.1	A
8. Meade Street/ Regatta Boulevard	Side Street Stop	6.4 (10.6)	A (B)	5.6 (10.0)	A (B)
9. Meade Street/ Seaver Avenue	Side Street Stop	1.3 (9.7)	A (A)	3.0 (9.0)	A (A)
10. Seaport Avenue/I-580 Eastbound Ramps/South 51st Street/Bayview Avenue	All-way Stop	27.6	D	20.0	C
11. I-580 Westbound Ramps/ Bayview Avenue	Signal	5.4	A	6.7	A
12. Carlson Boulevard/ Bayview Avenue	Signal	27.0	C	21.6	C
13. Carlson Boulevard/ I-80 Westbound Ramps	Signal	19.3	B	20.0	B
14. Carlson Boulevard/ I-80 Eastbound Ramps	Signal	10.7	B	9.8	A

Notes: **Bold** indicates an intersection operating at unacceptable LOS E or LOS F.
1. Signalized and all-way stop-controlled intersection delay and LOS based on average control delay per vehicle, according to the Highway Capacity Manual, Special Report 209, Transportation Research Board, 2000.

Source: Fehr & Peers.

These freeway segments were selected for analysis because they are most likely to be affected by the proposed Project.

2.1.3.1 Existing Freeway Volumes

Existing freeway volumes are primarily derived from two sources of data: (1) October 2012 freeway volumes published by Caltrans through the California Freeway Performance Measurement System (PeMS), and (2) ramp terminal intersection turning movement counts collected in December 2012, and described in Section 2.1.2.1.

2.1.3.2 Existing Freeway Operations

Table 2-2 summarizes existing weekday AM and PM peak hour freeway segment LOS analysis results for both mainline and weave sections. **Appendix C** provides the detailed calculation work sheets. As shown in the table, all freeway segments currently operate at LOS D or better during both AM and PM peak hour.

TABLE 2-2
RICHMOND BAY CAMPUS
EXISTING CONDITIONS – FREEWAY SEGMENT LOS SUMMARY

Freeway Segment	Type[1]	Dir[2]	AM Peak Hour		PM Peak Hour	
			Density[2]	LOS	Density[2]	LOS
1. I-580 between Harbor Way and Marina Bay Pkwy	Weave	EB	N/A	A	N/A	A
	Weave	WB	N/A	A	N/A	A
2. I-580 between Marina Bay Pkwy and Regatta Blvd	Weave	EB	N/A	A	N/A	A
	Weave	WB	N/A	A	N/A	A
3. I-580 between Regatta Blvd and Bayview Ave	Weave	EB	N/A	A	N/A	A
	Weave	WB	N/A	A	N/A	A
4. I-580 between Bayview Ave and Central Ave	Basic	EB	15.4	B	14.0	B
	Basic	WB	14.3	B	16.9	B
5. I-580 between Central Ave and I-80	Basic	EB	23.5	C	28.7	D
	Basic	WB	25.0	C	22.6	C
6. I-80 between Carlson Blvd and Potrero Ave	Basic	EB	21.3	C	27.3	D
	Basic	WB	29.5	D	24.0	C
7. I-80 at Gilman St Overpass	Basic	EB	21.7	C	27.3	D
	Basic	WB	30.9	D	25.6	C

1. Segments with auxiliary lanes are classified as weave segments, and were analyzed based on the Leisch Method. Basic segments are analyzed as basic segments using the 2000 HCM methodologies.
2. EB = Eastbound; WB = Westbound
3. Density is presented in passenger cars per lane per mile (pc/ln/mi).

Source: Fehr & Peers.

2.1.4 EXISTING TRANSIT AND SHUTTLE SERVICES

The RBC site is served indirectly by Bay Area Rapid Transit (BART), Alameda-Contra Costa Transit (AC Transit), Amtrak, and directly by the Richmond Field Station (RFS) shuttle. **Figure 2-4** shows the transit routes in the vicinity of the site. Each transit service is described below.

2.1.4.1 BART

BART provides regional commuter rail transit in Alameda, Contra Costa, San Francisco, and San Mateo counties. Currently, BART trains operate on weekdays from 4:00 AM to midnight, on Saturdays from 6:00 AM to midnight, and on Sundays from 8:00 AM to midnight. The nearest BART stations to the RBC site are the Richmond Station (about two miles northwest of the RBC site and at the end of the Richmond-Fremont line), the El Cerrito del Norte Stations (about two miles northeast of the RBC site), and the El Cerrito Plaza Station (about three miles east of the RBC site). These three stations are served by the Richmond-Fremont and Richmond-Daly City/Millbrae lines. Other destinations in the BART system can be reached by transferring at stations in Oakland. Typically, these three stations are served by a train every seven (peak weekday commute periods) to 20 minutes (Sundays). The average weekday daily ridership for the Richmond, El Cerrito del Norte, and El Cerrito Plaza Stations were about 7,500, 15,800 and 9,000 riders in January 2013, respectively.

2.1.4.2 AC Transit

Local bus service in Richmond is provided by AC Transit. **Figure 2-4** illustrates the existing AC Transit routes in the vicinity of the RBC site. **Table 2-3** describes the service provided on these routes and the nearest stops to the RBC site.

2.1.4.3 Amtrak

The Richmond Transit Station, located adjacent to the Richmond BART station, provides Amtrak service on three routes – the Capital Corridor (15 trains per day in each direction between San Jose and Sacramento); the San Joaquin Intercity (four trains per day in each direction to Bakersfield via Modesto and Fresno) and the California Zephyr (one train per day in each direction between Chicago and Emeryville).

2.1.4.4 Richmond Field Station Shuttle

UC Berkeley currently operates a shuttle connecting the main University campus with El Cerrito Plaza BART Station and the Richmond Field Station (RFS) with other stops on Buchanan Street at Jackson Street, Martin Luther King Jr. Way at Hopkins Street, and Downtown Berkeley BART Station. The shuttle operates approximately hourly between 7:00 AM and 6:00 PM on weekdays. Current LBNL staff can use the LBNL (See Section 4.1.1.4 for details for LBNL shuttles) and RFS shuttles to travel between LBNL and RFS.

Figure 2-4.

Richmond Bay Campus Existing Transit Service

WC12-2953_2-4_ExTransit

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TABLE 2-3
RICHMOND BAY CAMPUS
AC TRANSIT SERVICE SUMMARY

Line	Route	Nearest Stop[1]	Weekday		Weekend	
			Hours	Frequency	Hours	Frequency
Local Routes						
71	Richmond Parkway Transit Center – El Cerrito BART	Carlson Blvd./ Cutting Blvd. (About 1.0 miles)	5:00 AM – 8:00 PM	30 minutes	6:30 AM – 9:30 PM	60 minutes
74	Castro Ranch – Richmond BART – Harbor Way South/Ford Point	Marina Bay Pkwy/Regatta Blvd. (About 1.3 miles)	7:00 AM – 10:00 PM	30-40 minutes	7:00 AM – 8:00 PM	30-40 minutes
76	El Cerrito Del Norte BART – Hilltop Mall	Carlson Blvd./ Cutting Blvd. (About 1.0 miles)	6:00 AM – 7:40 PM	30-40 minutes	6:30 AM – 8:20 PM	30 minutes
376	El Cerrito Del Norte BART – Pinole Vista Center	Carlson Blvd./ Cutting Blvd. (About 1.0 miles)	8:00 PM – 3:45 AM	30 minutes	8:00 PM – 3:45 AM	30 minutes

1. Distance shown is current walking distance between bus stop and south 46th Street at Seaver Avenue.
Source: AC Transit, 2013

2.1.5 EXISTING PEDESTRIAN AND BICYCLE CIRCULATION

2.1.5.1 Pedestrian and Bicycle Facilities

Pedestrian facilities in the study area include sidewalks, crosswalks, and multi-use trails. Most roadways in the study area provide sidewalks on both sides of the street; except Regatta Boulevard east of Marina Bay Parkway, where sidewalks are generally only provided where there are fronting uses; Meade Street, which has sidewalks only on the north side of the street; and Marina Bay Parkway south of Meeker Avenue, which has sidewalks only on the west side of the street. The Richmond Bay Trail is located along the bay shoreline to the south of the RBC site, connecting via Marina Bay Parkway to Regatta Boulevard and continuing west.

Based on the *City of Richmond Bicycle Master Plan* (October 2011), bicycle facilities in the study area can be classified into three types, including:

- ***Bicycle Paths (Class 1)*** – These facilities are located off-street and can serve both bicyclists and pedestrians.

- ***Bicycle Lanes (Class 2)*** – These facilities provide a dedicated area for bicyclists within the paved street width through the use of striping and appropriate signage.

- ***Bicycle Routes (Class 3)*** – These facilities are found along streets that do not provide sufficient width for dedicated bicycle lanes. The street is designated as a bicycle route through the use of signage informing drivers to expect bicyclists.

Figure 2-5 identifies existing and proposed bicycle facilities in the study area. Existing bicycle facilities near the project site include the Class 1 Bay Trail along the bay shoreline, and Class 3 routes on Marina Bay Parkway and on Regatta Boulevard west of Marina Bay Parkway.

As previously shown on Figures 2-3A and 2-3B, study intersections in the vicinity of the RBC site have minimal pedestrian and bicycle activity.

2.1.5.2 Proposed Pedestrian and Bicycle Improvements

The *Richmond Bicycle Master Plan* and *City of Richmond Pedestrian Plan* propose the following bicycle and pedestrian improvements in the study area:

- Class 1 path connecting Regatta Boulevard west of Marina Bay Parkway and Bayview Avenue just south of the I-580 Interchange.

- Class 1 path adjacent to the east-west railroad tracks connecting Meade Street at Seaver Street to Regatta Boulevard.

- Class 1 path along south 46th connecting the Bay Trail and Meade Street.

- Class 2 lanes on Regatta Boulevard between Marina Way and Meade Street.

- Class 2 lanes on South 23rd Street/Marina Bay Parkway including potential improvements at the I-580 Overpass such as widening sidewalks, and realigning the freeway ramps to square the intersection and shorten pedestrian crossings.

- Class 2 lanes on Meade Street/South 51st Street between Regatta Boulevard and Seaport Avenue.

- Class 2 lanes on Bay View Avenue between Seaport Avenue and Carlson Boulevard.

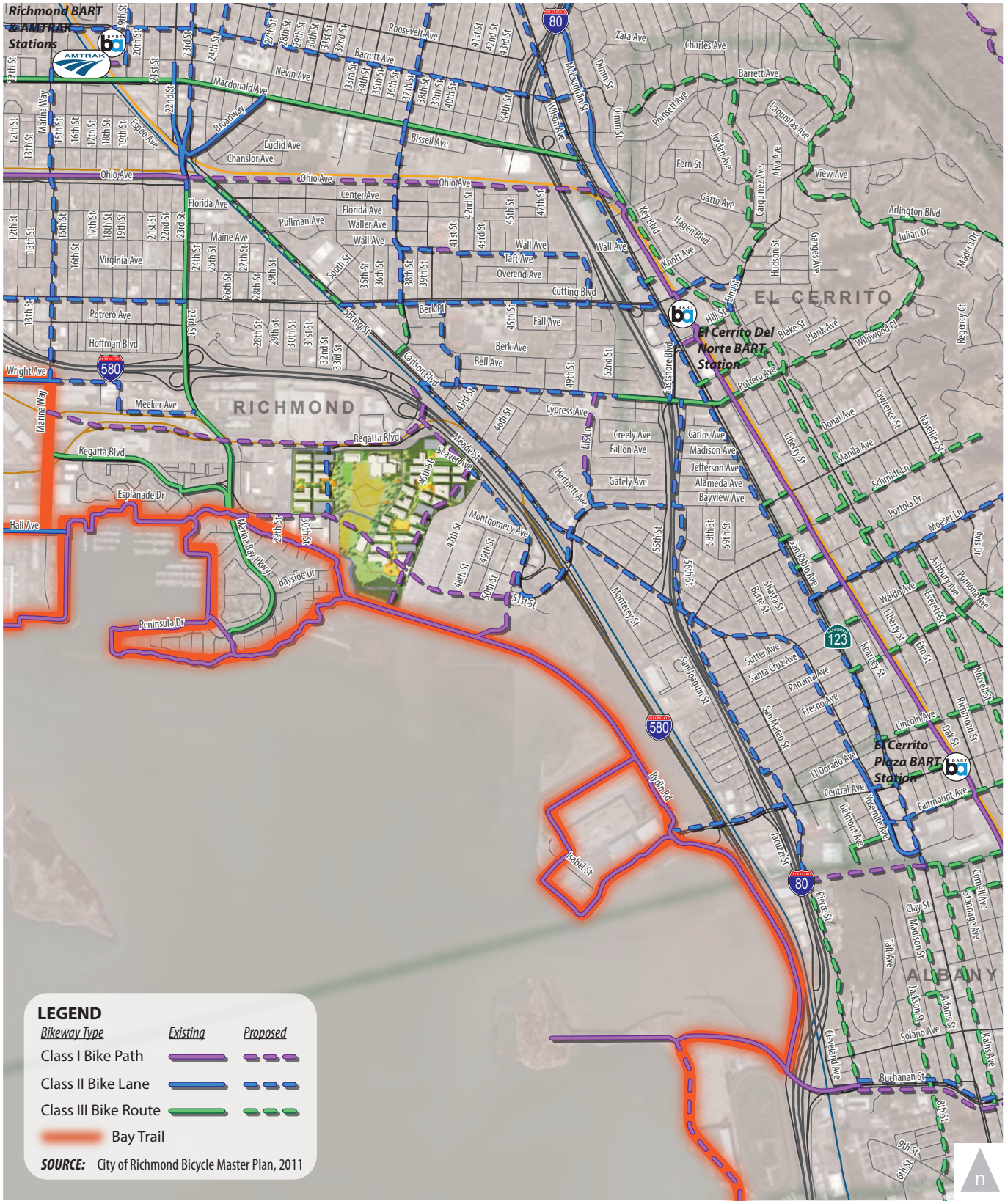


Figure 2-5.

Richmond Bay Campus Existing and Future Bicycle Network

WC12-2953_2-5_ExBikeNet

FEHR PEERS

- Class 2 lanes on Carlson Boulevard between El Cerrito City Limit and Broadway.

The potential improvements listed above are not fully funded, designed, or approved. It is not known if and when they would be implemented. Therefore, this assessment does not assume them in the analysis of future conditions.

2.1.6 EXISTING AT-GRADE RAILROAD CROSSINGS

There are two at-grade railroad crossings in the study area, on Marina Bay Parkway between Meeker Avenue and Regatta Boulevard, and on Meade Street between Regatta Boulevard and the recently completed Regatta Boulevard extension as shown on Figure 2-1. The at-grade crossings are operated by Richmond Pacific and Union Pacific Railroad Corporations.

Based on data provided by Federal Railroad Administration (FRA), about nine trains use the at-grade crossing on Marina Bay Parkway on a typical day with speeds from about one to ten mph, and about four trains use the at-grade crossing on Meade Street with speeds from five to ten mph. The vehicular approaches at both crossings provide gate controls with bells, pavement markings, and advanced warning signs. The crossing on Marina Bay Parkway also includes a sidewalk on the west side of the roadway and the crossing on Meade Street provides a sidewalk on the north side of the roadway.

Based on six years (2007-2012) of collision data summarized by the FRA, one collision was reported at the at-grade crossing on Marina Bay Parkway in 2007 and no collisions were reports at the crossing on Meade Street. The reported collision involved an automobile that drove around or through the safety gates and struck rail equipment. No injuries were reported.

The Marina Bay Parkway at-grade crossing is currently scheduled to be replaced with a grade-separated crossing. The undercrossing will also include separated pedestrian/bicycle path on both sides of the roadway. This project is fully funded and construction is expected to start in 2013.[2]

[2] Source: City of Richmond, www.ci.richmond.ca.us/index.aspx?NID=951

2.2 REGULATORY CONSIDERATIONS

2.2.1 RICHMOND GENERAL PLAN 2030

The Richmond General Plan 2030 Circulation Element contains the following goals, policies and actions that are relevant to the Project. The General Plan document contains more detailed descriptions of these goals, policies and actions; brief statements are provided below.

Goal CR1 An Expanded Multimodal Circulation System. Make conditions safer and more attractive for all modes of transportation including travel by foot and bicycle, public transit and automobiles. Evaluate streets and potential enhancements based on surrounding land use, street function and desired character and by relying on the place-based approach to circulation planning articulated in the General Plan. Take potential improvement measures ranging from physical design treatment of the street environment to social and programmatic responses appropriate to the particular street context.

Policy CR1.1 Balanced Modes of Travel and Equitable Access. Encourage multiple circulation options in the City and work with transit operators to ensure equitable access for all members of the community.

Policy CR1.2 An Interconnected Street System. Promote an interconnected system of streets that adequately serves current and future travel needs.

Policy CR1.3 Local and Regional Transportation Linkages. Enhance circulation linkages within the City and region.

Policy CR1.4 Expanded and Affordable Public Transit. Coordinate with regional transportation agencies and support enhanced and expanded public transit to improve mobility options for residents and visitors.

Policy CR1.5 Safe and Convenient Walking and Bicycling. Promote walking and bicycling as a safe and convenient mode of transportation.

Policy CR1.6 Comprehensive Network of Multi-Use Trails. Develop a comprehensive network of multi-use trails including to enhance bicycle and pedestrian connectivity throughout the City and the region.

Policy CR1.8 Place-Based Circulation Approach. Promote the place-based planning approach and classification system.

Policy CR1.9 Place-Based Circulation Classification System and Multi-Modal Level of Service Standards. Classify all streets in the City to conform to the Place-Based Circulation Classification System discussed in

the Circulation Element of the General Plan and adopt multi-modal level of service (MMLOS) standards that are consistent with each street type's intended function and character.

Policy CR1.10 Vehicular Level of Service Standards for West County Routes of Regional Significance. Maintain vehicular level of service (LOS) standards for signalized intersections consistent with the Contra Costa Transportation Authority's (CCTA) West County Action Plan for Routes of Regional Significance.

Relevant Actions under Goal CR1: Actions CR1.A, B, C, D, E, J, L, and M.

Goal CR2 Walkable Neighborhoods and Complete Streets. Activate the public right-of-way and improve the experience of moving people between key destinations at the pedestrian level. In order to make walking and bicycling a more attractive options, enhance connectivity between neighborhoods, schools, the workplace, and daily goods and services so that reaching key destinations is safer and more convenient. Contribute to walkability and livability by promoting mixed-use and complete streets, high-quality pedestrian environments, context-based street design, and efficient public transit.

Policy CR2.2 Complete Streets. Promote mixed-use urban streets that balance public transit, walking and bicycling with other modes of travel.

Policy CR2.3 Integrated Bicycle and Pedestrian System. Plan, construct and maintain a safe, comprehensive and integrated bicycle and pedestrian system.

Relevant Actions under Goal CR2: Actions CR2.A, D, E and G.

Goal CR3 A safe and well-maintained Circulation System. In order to create a safe and efficient circulation system, emphasize on-going street maintenance and safety improvements that consider all modes of transportation including walking, bicycling, and public transit. Require new facilities and infrastructure as development occurs in order to meet the needs of all users while enhancing mobility and connectivity.

Policy CR3.1 Safety and Accessibility. Enhance safety and accessibility for pedestrians, bicyclists and transit riders.

Policy CR3.3 Concurrent Infrastructure Development. Require concurrent infrastructure development for new and redevelopment projects that may have a significant impact on the existing circulation system including streets, trails, sidewalks, bicycle paths and public transit.

Relevant Actions Under Goal CR3: Actions CR3.A, B, and C.

Goal CR5 Sustainable and Green Practices. In order to create sustainable and clean circulation options, encourage the use of low-impact alternative fuels and new technologies and implement transportation demand management programs. Encourage measures to treat and retain storm water in the design of pedestrian and parking amenities.

Policy CR5.1 Transportation Demand Management. Promote transportation demand management (TDM) strategies among residents and businesses to reduce reliance on automobiles.

Policy CR5.2 Renewable Energy and Clean Technology. Promote the use of renewable energy, including non-fossil fuels, and clean technology for transportation including public transit and goods movement.

Policy CR5.3 Green Streets. Promote the development of street design elements that incorporate natural storm water drainage and landscaping in new and retrofitted streets.

Relevant Actions Under Goal CR5: Actions CR5.A, B, C, E, and F.

2.2.2 RICHMOND BICYCLE MASTER PLAN

Consistent with the vision presented in the General Plan, the City of Richmond *Bicycle Master Plan* provides detailed action items to complete a bikeway system and supporting facilities in the City of Richmond. The Richmond *Bicycle Master Plan* contains the following four goals and objectives:

Goal 1: Expand the city's bicycle routes and parking facilities into an extensive, well-connected and well-designed network, and improve and maintain these facilities over time.

> **Objective:** Increase the number of bikeway miles by 75 percent, complete all gaps in the Bay Trail and double the number of bicycle parking spaces.

Goal 2: Increase the number of people of all ages and backgrounds who bicycle for transportation, recreation and health.

> **Objective:** Double the number of trips made by bicycle.

Goal 3: Make the streets safer for bicyclists, not only during the day but also at night.

> **Objective:** Reduce the number of bicycle fatalities and injuries by 25 percent (even as the number of bicyclists increases).

Goal 4: Incorporate the needs and concerns of cyclists in all transportation and development projects.

Objective: Adopt, institutionalize and have relevant City departments implement a "Complete Streets" policy and bicycle-friendly design standards and guidelines for streets and developments.

2.2.3 RICHMOND PEDESTRIAN PLAN

Consistent with the vision presented in the General Plan, the City of Richmond *Pedestrian Plan* aims to improve the safety, convenience, and appeal of waking throughout the City of Richmond. The Richmond Pedestrian Plan contains the following goals:

Increased Safety. Streets will be developed and retrofitted to accommodate all types of users. Designs and devices will produce speed moderation, visibility, awareness and communication for motorists and non-motorists alike.

Improved Security. Streets, trails and other public spaces will be designed and improved to create active places that are watched over, maintained and that project a sense of control and community ownership.

Improved Connectivity. A range of strategies and solutions will address physical barriers to walking, such as dead-end streets, railroad right of ways, wide roadways, and wide, complex intersections.

Increased Equity. Walking, the cheapest form of transportation, will be a safe, viable and convenient choice for those who cannot afford, are unable, or choose not to drive a car.

Improved Health. Walking and bicycling, the healthiest forms of transportation, will become desirable alternatives for trips to daily destinations.

Increased Sustainability. Walking and bicycling in the city will reduce the number of vehicle miles Richmond residents and visitors travel, and will reduce associated climate change, air and water quality impacts from vehicle emissions. Opportunities will be identified to convert excess paved rights of way to lower impact spaces with trees and landscaping.

Neighborhood and Downtown Revitalization. Improvements to the streets and pedestrian realm will beautify the public realm and set the stage for new investment in private property that can help fund improvements and attract development that supports walking, bicycling and the use of transit.

2.3 PROJECT TRANSPORTATION CHARACTERISTICS

Phase 1 of the project, expected to be completed by 2018, would include up to six new buildings providing 600,000 total square feet of space. The Phase 1 buildings are expected to accommodate 1,000

new employees at the RBC. Phase 1 of the project would provide about 600 parking spaces in surface parking lots. Access to the site would continue to be provided at the current location on Meade Street at Seaver Avenue.

Campus buildout would include a total of 5.4 million square feet of space accommodating up to 10,000 employees. The buildout plan would also reroute Regatta Boulevard to the west and provide multiple access points on Meade Street, Regatta Boulevard, and South 46th Street. At buildout, the RBC is estimated to provide about 6,000 parking spaces mostly in parking structures.

Based on information provided in the Preliminary Project Description, various aspects of site and circulation are described in more detail below.

2.3.1 VEHICLE ACCESS AND CIRCULATION

Regional access to and from the RBC would continue to be provided through the existing interchanges on I-580. In the near-term, direct access to and from the RBC site would continue to be provided through the existing entry on Meade Street at Seaver Street. As the RBC is developed, additional entries on Meade Street to the north, Regatta Boulevard to the west, and South 46th Street to the east would also be provided. Currently, the LRDP envisions up to seven access points from Regatta Boulevard and Meade Street at buildout. These access points would either provide direct access to parking facilities for employees and visitors or provide service access for buildings throughout the campus.

The RBC site would also provide new internal roadways to provide direct access to each facility. Internal streets in the RBC would be generally designed to accommodate multiple travel modes with priority for pedestrians and bicycles with the intent that the majority of internal trips would be walk or bike trips. Internal streets accommodating automobiles would be designed for vehicles with low traveling speeds. The proposed RBC street network is further described below:

- Regatta Boulevard - As part of RBC buildout, Regatta Boulevard would be rerouted to the north and west to continue to provide east-west access through the South Shoreline area of Richmond, and internally connect eastern and western portions of the site and reduce automobile traffic within the RBC.

- Lark Drive – Lark Drive would form the main east-west roadway through the RBC and would connect Regatta Boulevard in the west to South 46th Street in the east. Although it would traverse the RBC site and provides through access, it would be designed to reduce automobile speeds and discourage through traffic. Lark Drive is expected to provide one automobile lane and a bicycle lane in each

direction, with sidewalks on both sides of the street, and parking and/or automobile drop-off area at select locations.

- Peripheral Streets – Streets, such as 46th Street, connecting to Regatta Boulevard and Meade Street, would provide access to parking structures and other facilities throughout the RBC. These streets would provide bicycle lanes and sidewalks and may accommodate transit vehicles.

- Service Access Streets – These streets would allow service vehicles to access each individual building; however, they would restrict general automobile access. These streets would be designed to encourage pedestrian and bicycle use.

2.3.2 AUTOMOBILE PARKING

It is expected over time that the proposed Project would eliminate about 690 of the existing 760 automobile parking spaces in the RBC site's current surface parking lots. In the short term (including Phase 1), automobile parking would continue to be provided in surface parking lots. It is expected that about 600 parking spaces would be provided as part of Phase 1 development. As the RBC site develops, parking structures would be constructed to provide most of the 6,000 vehicle parking spaces estimated for the buildout of the RBC. The LRDP proposes to locate most of parking spaces in parking structures located on the periphery of the site, in order to provide a pedestrian-friendly vehicle-free central campus. Although parking is expected to be free in the early phases of development, a parking charge may be established as parking structures are developed.

2.3.3 BICYCLE CIRCULATION AND PARKING

The RBC site would accommodate bicycles internal to the site by providing on-site paths and on-street facilities that connect to existing and proposed bicycle network in City of Richmond and beyond, including the Bay Trail, located just south of the site. As previously discussed in section 2.1.5.1 and shown on Figure 2-5, the Richmond Bicycle Plan proposes bicycle facilities through the RBC site; the proposed LRDP is consistent with the Richmond Bicycle Plan by providing various facilities internal to the site that connect to existing and proposed bicycle facilities external to the site.

In addition, the RBC may provide a bike sharing system to allow for internal site circulation and travel to and from other nearby destinations.

RBC proposes to provide bicycle parking at a rate of at least one space per every five daily occupants, which corresponds to about 200 bicycle parking spaces at completion of Phase 1 and 2,000 spaces at

buildout. New buildings would provide indoor secure bicycle parking, and amenities such as showers and lockers, in addition to outdoor bicycle racks.

2.3.4 PEDESTRIAN ACCESS AND CIRCULATION

The RBC would be designed so that walking is the primary travel mode for trips within the campus. All internal roadways would provide sidewalks; paths and walkways would connect buildings to parking structures, other roadways providing access to and from the site, and the Bay Trail. A central pedestrian "main street" corridor would provide pedestrian connection to most buildings in the eastern portion of the campus.

2.3.5 TRANSIT

The following two shuttle lines are proposed for the RBC:

- The LBNL-UC Berkeley-RBC Shuttle would provide a no-transfer 20-minute ride between LBNL and the RBC with a single stop at the main UC Berkeley campus.
- The BART-RBC Shuttle would operate continuously between the El Cerrito Plaza BART Station and the RBC, providing a nonstop nine-minute ride between BART and the RBC. This shuttle can also be used to access AC Transit buses at the El Cerrito Plaza BART Station.

As the RBC develops, these routes may be modified or additional routes may be added to serve other destinations. The RBC would provide shuttle stops throughout the campus to ensure minimal walking distance to and from each building. Shuttle stops would provide amenities such as shelters and benches.

2.3.6 TRANSPORTATION DEMAND MANAGEMENT

In addition to providing shuttle services and a potential bike sharing system, the University would also implement a Transportation Demand Management (TDM) program to encourage RBC employees to use transit, bicycling, walking, and carpooling for traveling to and from the site and reduce the number of automobile trips. Although the specific components of the TDM program are not known at this time, it would be similar to the program currently implemented at the LBNL site in Berkeley, and may include strategies such as subsidized or discounted transit passes, Guaranteed Ride Home, carpool matching, and flexible car share programs.

2.3.7 TRIP GENERATION

Table 2-4 shows the estimated vehicle trip generation for RBC at Phase 1 and buildout. The trip generation estimates are derived from trip generation rates per average daily population observed at the existing LBNL site in Berkeley. The LBNL rates were developed based on vehicle counts at the LBNL gates in 2011 and the corresponding on-site population. For the RBC site, these trip rates were adjusted to reflect the differences between the two sites, most notably differences in transit availability, pedestrian and bicycle facilities, and proximity to residential and non-residential uses. The Contra Costa Transportation Authority (CCTA) and Alameda County Transportation Commission (ACTC) Travel Demand Models were used to estimate these effects, by comparing employment zone trip generation for the LBNL zone with employment trip generation in the RBC zone.

TABLE 2-4
RICHMOND BAY CAMPUS
PROJECT VEHICLE TRIP GENERATION SUMMARY

	Average Daily Population	Daily	AM Peak Hour			PM Peak Hour		
			In	Out	Total	In	Out	Total
Project Phase 1 [1]	1,000	2,079	182	29	211	27	172	199
Project Buildout [2]	10,000	20,226	1,770	283	2,053	259	1,678	1,937

1. Based on following trip generation rates:
   Daily = 2.08 trips per Average Daily Population (ADP); AM Peak Hour = 0.21 trips per ADP (86% in, 14% out); PM Peak Hour = 0.20 trips per ADP (13% in, 87% out)
2. Based on following trip generation rates:
   Daily = 2.02 trips per ADP; AM Peak Hour = 0.20 trips per ADP (86% in, 14% out); PM Peak Hour = 0.19 trips per ADP (13% in, 87% out)

Source: Fehr & Peers, based on trip generation rate per average daily population at the existing LBNL site in Berkeley adjusted to reflect the different characteristics of the RBC.

The RBC LRDP Project would include a robust TDM program intended to reduce the vehicular trips generated by the Project. Since the specific components of the TDM program are not known and their effectiveness cannot be accurately measured, the trip generation used for this analysis assumes that the TDM program would be similar to the existing LBNL site. In addition, the trip generation estimate conservatively assumes that parking for both employees and site visitors would be free, similar to the existing LBNL site in Berkeley. If parking at RBC is not free, then fewer employees and visitors would drive to and from the site and reduce the project vehicle trip generation.

The buildout trip generation is estimated at a slightly lower rate than Phase 1, based on a projected economy of scale and more amenities provided on-site. It is estimated that the Project Buildout would generate about 20,230 daily automobile trips, 2,050 AM peak hour trips, and 1,940 PM peak hour trips.

2.3.8 TRIP DISTRIBUTION AND ASSIGNMENT

Trip distribution is defined as the directions of approach and departure that vehicles would use to arrive at and depart from the Project site. This assessment estimated the distribution of project trips based on existing travel patterns, location of complementary land uses, and results from the CCTA Travel Demand Model. **Figure 2-6** shows the resulting trip distribution. **Figures 2-7A and 2-7B** show the Project Phase 1 trip assignment at the study intersections, based on the distribution, and **Figures 2-8A and 2-8B** show the Project Buildout trip assignment.

2.3.9 EXISTING PLUS PHASE 1 PROJECT CONDITIONS

Figures 2-9A and 2-9B show the Existing Plus Phase 1 traffic volumes, which consist of traffic volumes under Existing conditions (Figures 2-2A and 2-2B) plus Phase 1 traffic assignment (Figures 2-7A and 2-7B). This analysis assumes no roadway modifications under this scenario.

2.3.9.1 Intersection Operations

Table 2-5 summarizes intersection operations at the study intersections under the Existing Plus Phase 1 Project conditions. **Appendix B** provides the detailed calculation work sheets.

The addition of the Phase 1 Project traffic would not cause any of the intersections that currently operate at an acceptable LOS to degrade to an unacceptable LOS. At the one intersection currently operating below the LOS standard, Meeker Avenue/23rd Street/Marina Bay Parkway, the addition of project generated traffic would not change the overall v/c ratio. This is because the Project would add traffic to the north-south through movements at the intersection, which are not critical movements for purposes of overall intersection control delay calculation. Therefore, the Phase 1 Project would not cause a significant impact at this or other study intersections under Existing Plus Phase 1 Project conditions.

2.3.9.2 Freeway Operations

Table 2-6 shows the freeway segment LOS results for the Existing Plus Phase 1 Project conditions. **Appendix C** provides the detailed calculation work sheets.

Figure 2-6.

Richmond Bay Campus Project Trip Distribution

WC12-2953_2-6_TripDistro

FEHR PEERS

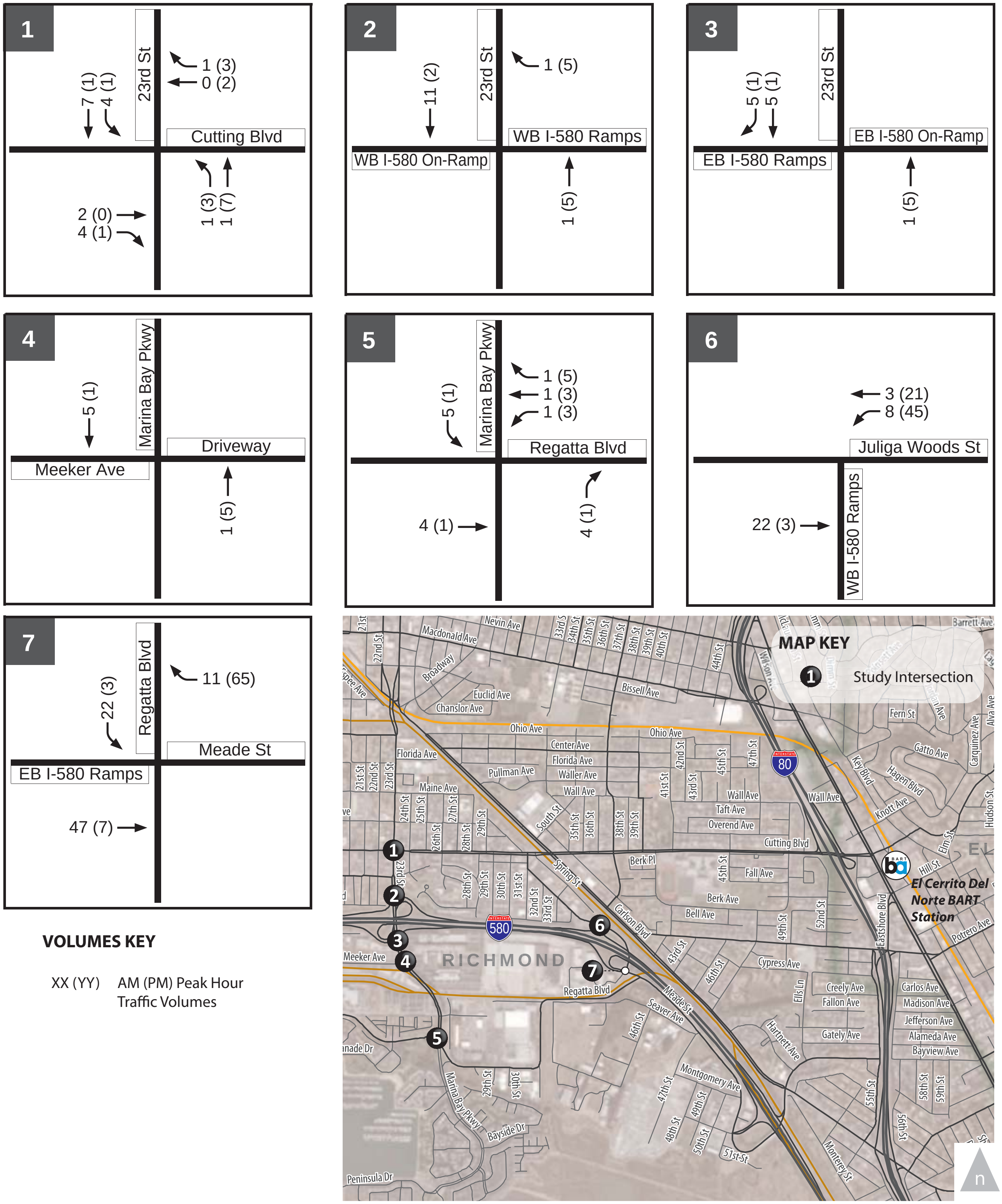
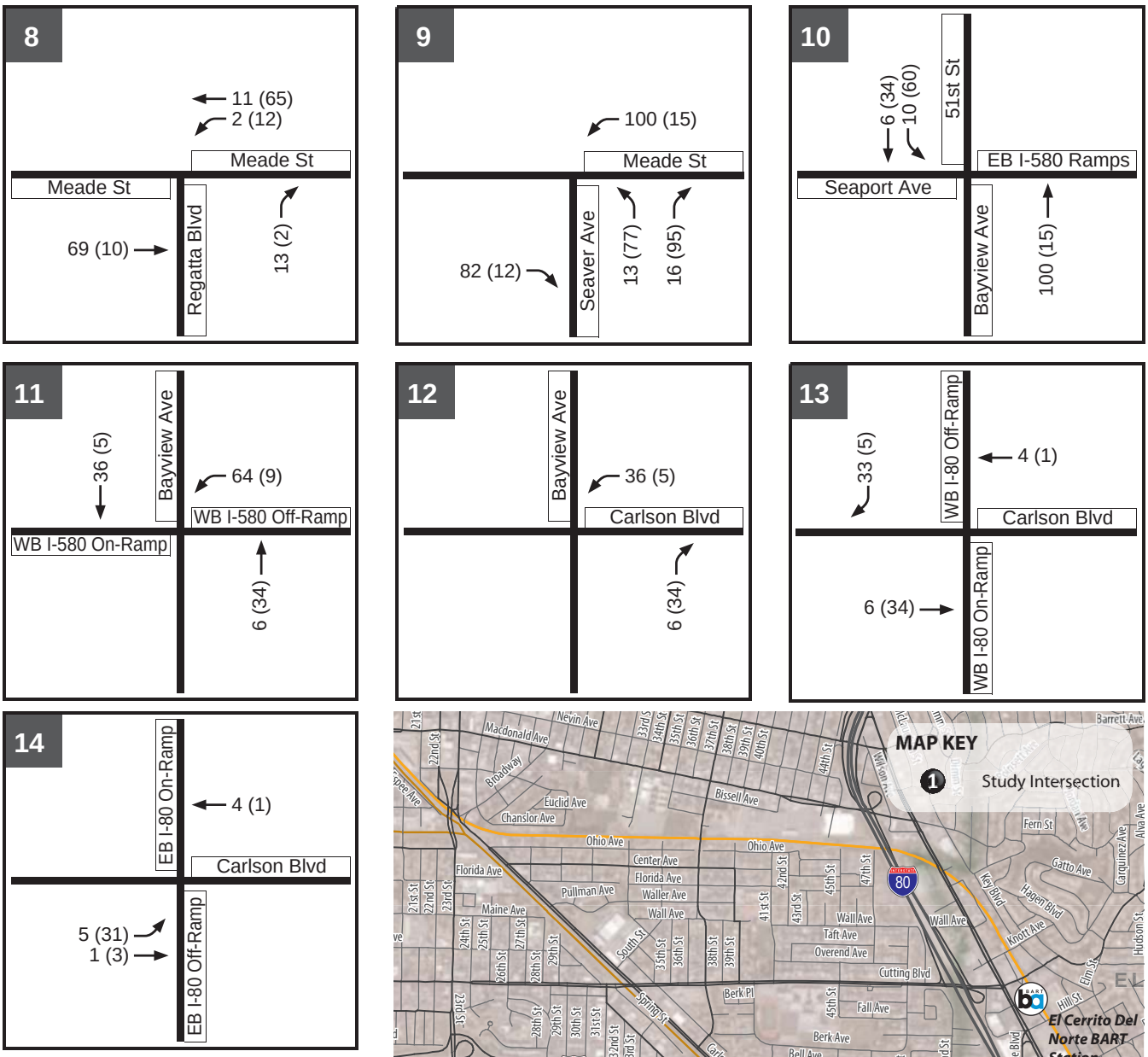


Figure 2-7A.

Richmond Bay Campus
Project Trip Assignment (Phase 1)

WC12-2953_2-7A_PTAPhase1

FEHR & PEERS



VOLUMES KEY

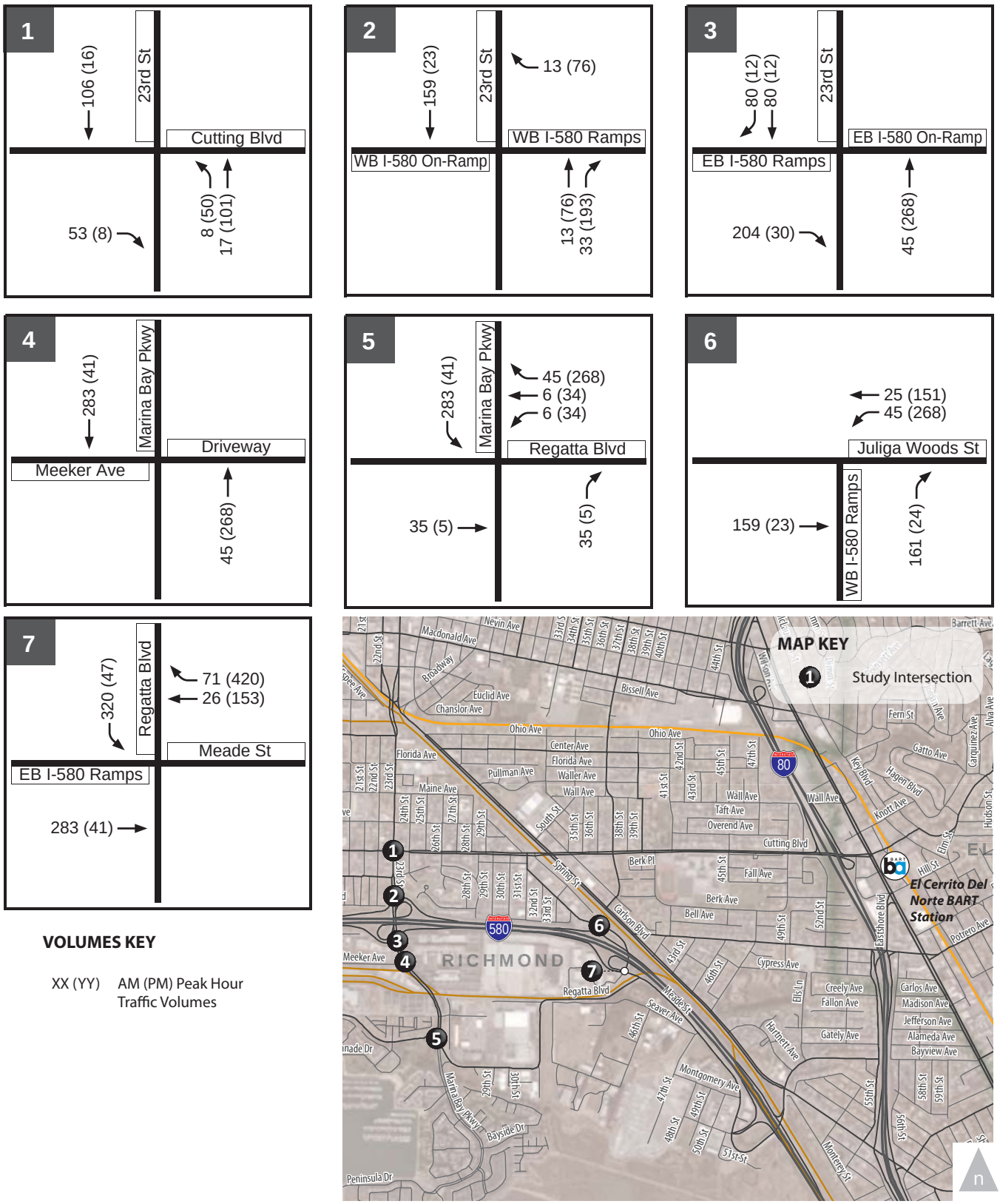
XX (YY) AM (PM) Peak Hour Traffic Volumes

Figure 2-7B.

Richmond Bay Campus
Project Trip Assignment (Phase 1)

WC12-2953_2-7B_PTAPhase1

FEHR PEERS



VOLUMES KEY

XX (YY) AM (PM) Peak Hour Traffic Volumes

Figure 2-8A.

Richmond Bay Campus
Project Trip Assignment (Buildout)

WC12-2953_2-8A_PTABuildout

FEHR PEERS

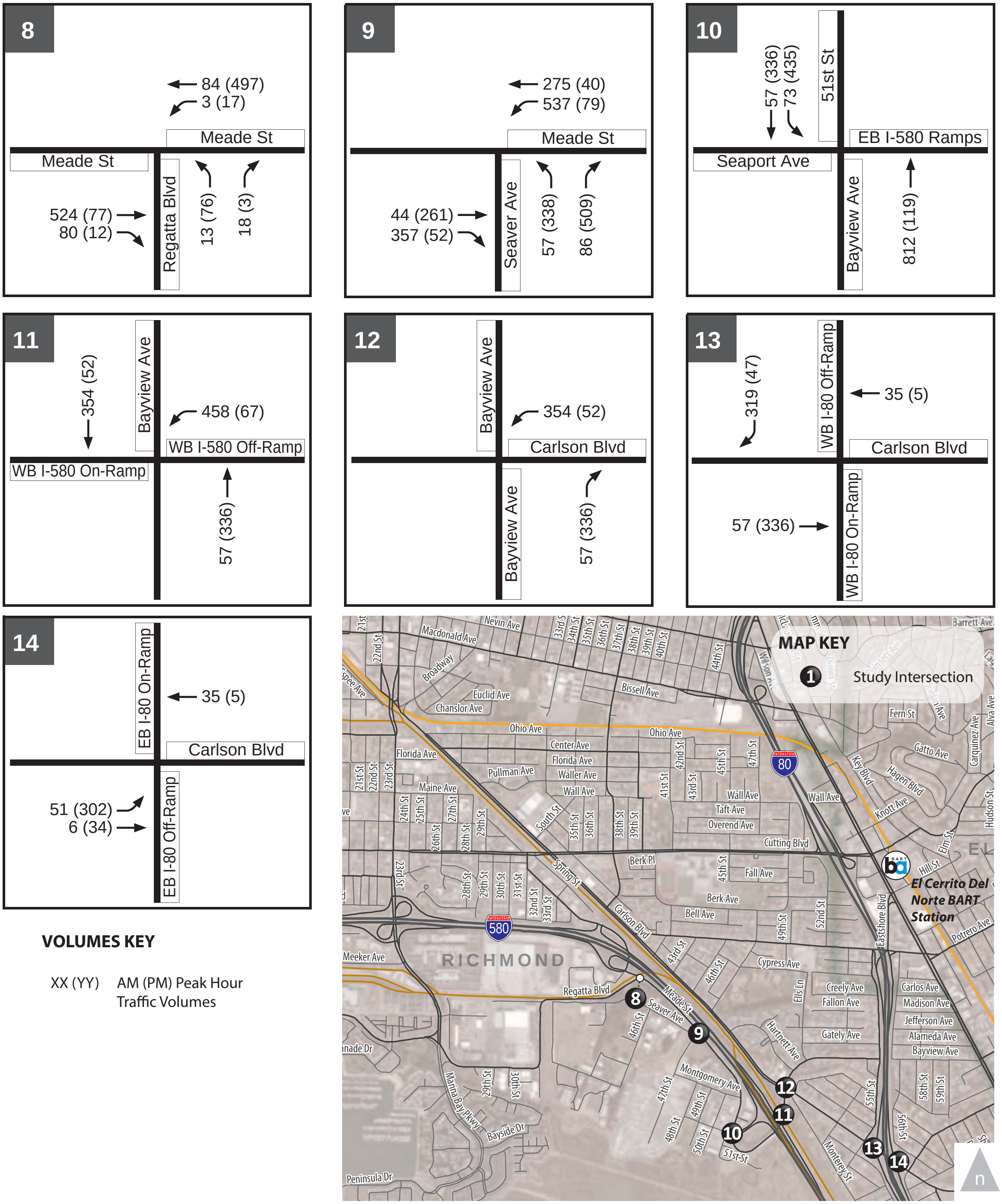


Figure 2-8B.

Richmond Bay Campus
Project Trip Assignment (Buildout)

WC12-2953_2-8B_PTABuildout

FEHR & PEERS

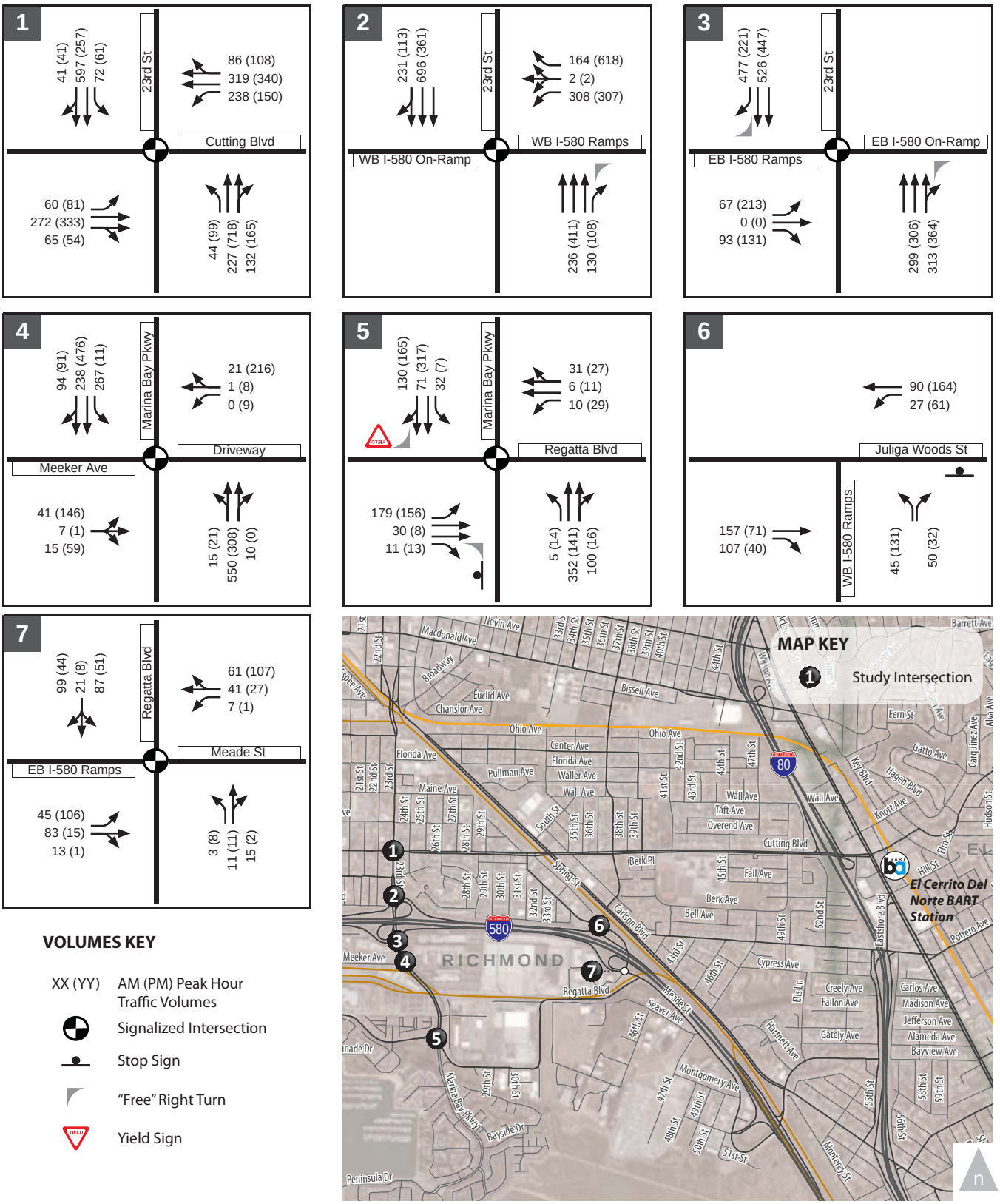


Figure 2-9A.

Richmond Bay Campus
Existing Plus Phase 1 Peak Hour Traffic Volumes

WC12-2953_2-9A_Ex+Ph1Vols

FEHR PEERS

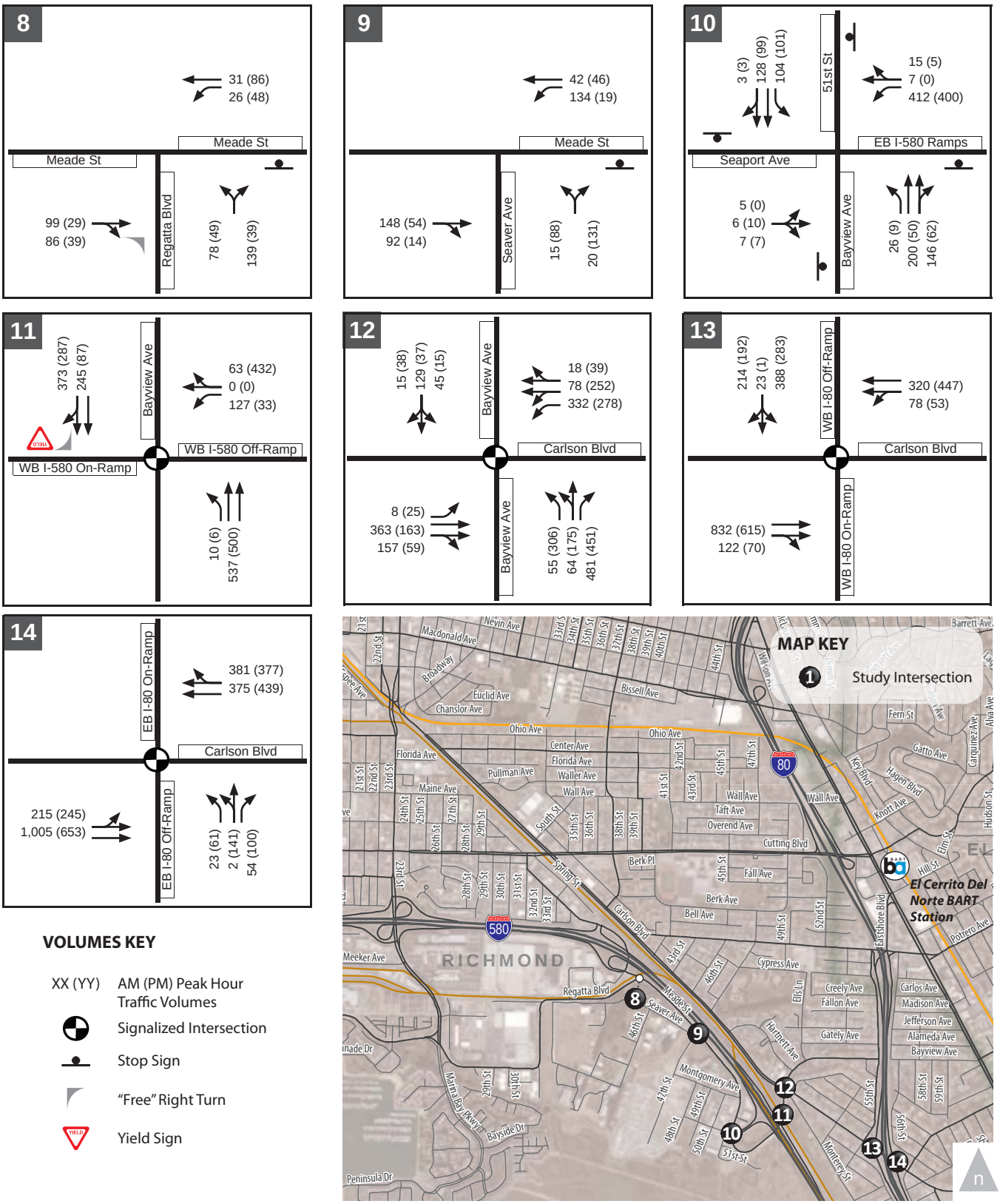


Figure 2-9B.

Richmond Bay Campus
Existing Plus Phase 1 Peak Hour Traffic Volumes

WC12-2953_2-9B_Ex+Ph1Vols

FEHR PEERS

1

TABLE 2-5
RICHMOND BAY CAMPUS
EXISTING PLUS PHASE 1 CONDITIONS – STUDY INTERSECTION LOS SUMMARY

Intersection	Traffic Control	Peak Hour	Existing		Existing Plus Phase 1 Project		Significant Impact?
			Delay[1] (seconds)	LOS[1]	Delay[1] (seconds)	LOS[1]	
1. Cutting Boulevard/ 23rd Street	Signal	AM	22.9	C	23.0	C	No
		PM	23.0	C	23.1	C	No
2. I-580 Westbound Ramps/ 23rd Street	Signal	AM	6.9	A	6.9	A	No
		PM	6.8	A	6.9	A	No
3. I-580 Eastbound Ramps/ 23rd Street	Signal	AM	3.6	A	3.6	A	No
		PM	6.3	A	6.4	A	No
4. Meeker Avenue/23rd Street/ Marina Bay Pkwy	Signal	AM	37.1	D	37.1	D	No
		PM	**115.8 (v/c=0.50)**	**F**	**115.8 (v/c=0.50)**	**F**	No
5. Regatta Boulevard/ Marina Bay Parkway	Signal	AM	30.0	C	39.8	D	No
		PM	43.6	D	51.2	D	No
6. I-580 Westbound Ramps/ Juliga Woods Street	Side Street Stop	AM	2.5 (10.0)	A (B)	2.5 (10.3)	A (B)	No
		PM	4.4 (10.9)	A (B)	5.0 (12.4)	A (B)	No
7. I-580 Eastbound Ramps/ Regatta Blvd/Meade Street	Signal	AM	9.7	A	10.8	B	No
		PM	9.1	A	10.4	B	No
8. Meade Street/ Regatta Boulevard	Side Street Stop	AM	6.4 (10.6)	A (B)	6.4 (12.3)	A (B)	No
		PM	5.6 (10.0)	A (B)	5.6 (10.0)	A (B)	No
9. Meade Street/ Seaver Avenue	Side Street Stop	AM	1.3 (9.7)	A (A)	3.4 (11.9)	A (B)	No
		PM	3.0 (9.0)	A (A)	7.2 (10.8)	A (B)	No
10. Seaport Avenue/I-580 Eastbound Ramps/South 51st Street/Bayview Avenue	All-way Stop	AM	27.6	D	33.3	D	No
		PM	20.0	C	22.9	C	No
11. I-580 Westbound Ramps/ Bayview Avenue	Signal	AM	5.4	A	11.3	B	No
		PM	6.7	A	7.0	A	No
12. Carlson Boulevard/ Bayview Avenue	Signal	AM	27.0	C	27.5	C	No
		PM	21.6	C	21.6	C	No
13. Carlson Boulevard/ I-80 Westbound Ramps	Signal	AM	19.3	B	20.5	C	No
		PM	20.0	B	19.4	B	No
14. Carlson Boulevard/ I-80 Eastbound Ramps	Signal	AM	10.7	B	11.0	B	No
		PM	9.8	A	9.8	A	No

Notes: **Bold** indicates an intersection operating at unacceptable LOS E or LOS F.
1. For signalized and all-way stop-controlled intersections, average intersection delay and LOS based on the 2000 HCM method is shown. For side-street stop-controlled intersections, delays for worst movement and average intersection delay are shown: intersection average (worst movement).

Source: Fehr & Peers.

1

TABLE 2-6
RICHMOND BAY CAMPUS
EXISTING PLUS PHASE 1 CONDITIONS
FREEWAY SEGMENT LOS SUMMARY

Freeway Segment	Type[1]	Dir[2]	Existing No Project				Existing Plus Phase 1 Project				Significant Impact?
			AM Peak Hour		PM Peak Hour		AM Peak Hour		PM Peak Hour		
			Density[3]	LOS	Density[3]	LOS	Density[3]	LOS	Density[3]	LOS	
1. I-580 between Harbor Way and Marina Bay Pkwy	Weave	EB	N/A	A	N/A	A	N/A	A	N/A	A	No
	Weave	WB	N/A	A	N/A	A	N/A	A	N/A	A	No
2. I-580 between Marina Bay Pkwy and Regatta Blvd	Weave	EB	N/A	A	N/A	A	N/A	A	N/A	A	No
	Weave	WB	N/A	A	N/A	A	N/A	A	N/A	A	No
3. I-580 between Regatta Blvd and Bayview Ave	Weave	EB	N/A	A	N/A	A	N/A	A	N/A	A	No
	Weave	WB	N/A	A	N/A	A	N/A	A	N/A	A	No
4. I-580 between Bayview Ave and Central Ave	Basic	EB	15.4	B	14.0	B	15.4	B	14.4	B	No
	Basic	WB	14.3	B	16.9	B	14.7	B	16.9	B	No
5. I-580 between Central Ave and I-80	Basic	EB	23.5	C	28.7	D	23.6	C	29.3	D	No
	Basic	WB	25.0	C	22.6	C	25.5	C	22.6	C	No
6. I-80 between Carlson Blvd and Potrero Ave	Basic	EB	21.3	C	27.3	D	21.3	C	27.5	D	No
	Basic	WB	29.5	D	24.0	C	29.7	D	24.0	C	No
7. I-80 at Gilman St Overpass	Basic	EB	21.7	C	27.3	D	22.0	C	27.3	D	No
	Basic	WB	30.9	D	25.6	C	31.0	D	25.9	C	No

1. Segments with auxiliary lanes are classified as weave segments, and were analyzed based on the Leisch Method. Basic segments are analyzed as basic segments using the 2000 HCM methodologies.
2. EB = Eastbound; WB = Westbound
3. Density is presented in passenger cars per lane per mile (pc/ln/mi).

Source: Fehr & Peers.

2

3

The addition of the Phase 1 Project traffic would not cause any of the study freeway segments to operate at an unacceptable LOS. Therefore, the Phase 1 Project would not cause a significant impact at the study freeway segments under Existing Plus Phase 1 Project conditions.

2.3.10 EXISTING PLUS PROJECT BUILDOUT CONDITIONS

Figures 2-10A and 2-10B show the Existing Plus Project Buildout traffic volumes, which consist of traffic volumes under Existing conditions (Figures 2-2A and 2-2B) plus Project Buildout traffic assignment (Figures 2-8A and 2-8B). This analysis assumes no roadway modifications under this scenario.

2.3.10.1 Intersection Operations

Table 2-7 summarizes intersection operations at the study intersections under the Existing Plus Project Buildout conditions. **Appendix B** provides the detailed calculation work sheets.

The addition of Project Buildout traffic would cause eight intersections to deteriorate from acceptable (LOS D or better) to unacceptable (LOS E or LOS F) conditions during one or both peak hours and would contribute to one intersection that currently operates at LOS F.

The addition of Project Buildout traffic would cause the side-street stop-controlled approach at the I-580 Westbound Ramps/Juliga Woods Street (Intersection 6) to degrade from LOS B to LOS F during the PM peak hour, and the side-street stop-controlled approach at the Meade Street/Regatta Boulevard (intersection 8) to degrade from LOS C to LOS F during the AM peak hour. However, these are not considered significant impacts because neither intersection would satisfy the Caltrans peak hour traffic volume signal warrant.

The Project would cause a significant impact at seven intersections which are summarized under Impact 2-1 discussion.

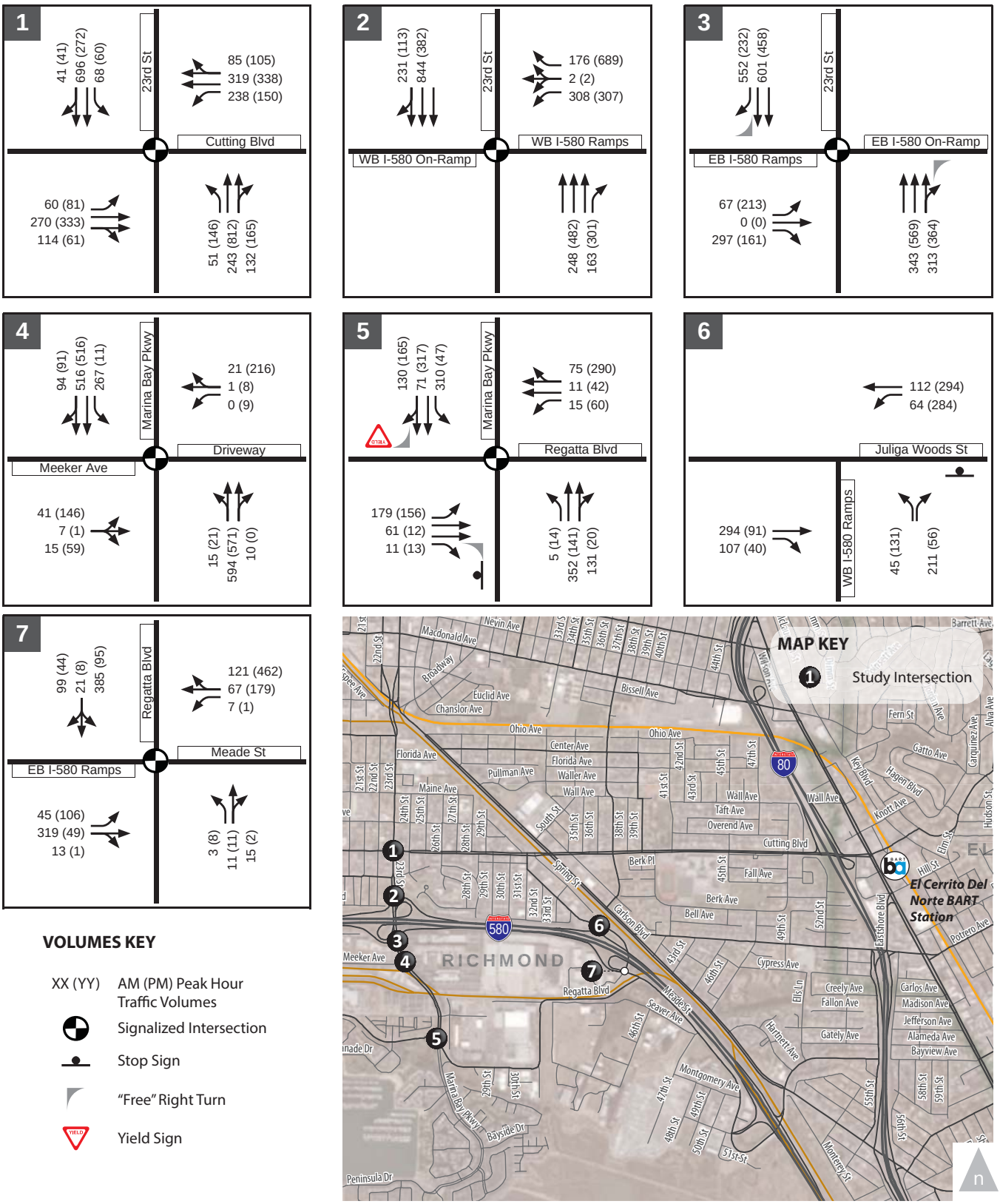


Figure 2-10A.

Richmond Bay Campus
Existing Plus Buildout Peak Hour Traffic Volumes

WC12-2953_2-10A_Ex+BuildoutVols

FEHR PEERS

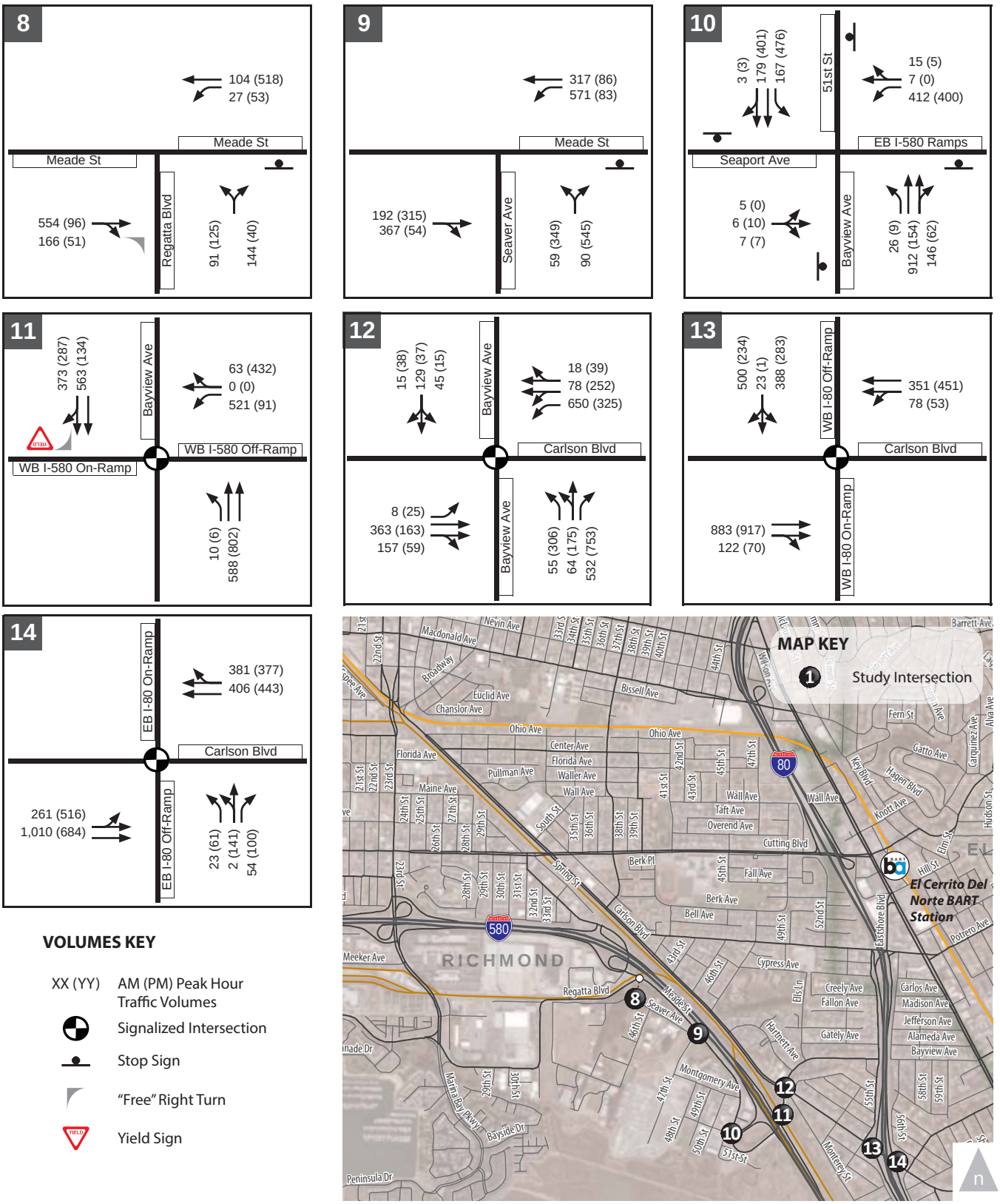


Figure 2-10B.

Richmond Bay Campus
Existing Plus Buildout Peak Hour Traffic Volumes

WC12-2953_2-10B_Ex+BuildoutVols

FEHR PEERS

1

TABLE 2-7
RICHMOND BAY CAMPUS
EXISTING PLUS BUILDOUT PROJECT CONDITIONS – STUDY INTERSECTION LOS SUMMARY

Intersection	Traffic Control	Peak Hour	Existing		Existing Plus Buildout Project		Significant Impact?
			Delay[1] (seconds)	LOS[1]	Delay[1] (seconds)	LOS[1]	
1. Cutting Boulevard/ 23rd Street	Signal	AM	22.9	C	25.3	C	No
		PM	23.0	C	24.4	C	No
2. I-580 Westbound Ramps/ 23rd Street	Signal	AM	6.9	A	7.1	A	No
		PM	6.8	A	6.8	A	No
3. I-580 Eastbound Ramps/ 23rd Street	Signal	AM	3.6	A	5.6	A	No
		PM	6.3	A	6.7	A	No
4. Meeker Avenue/23rd Street/ Marina Bay Pkwy	Signal	AM	37.1	D	37.1	D	No
		PM	**115.8 (v/c=0.50)**	**F**	**>120 (v/c=0.59)**	**F**	**Yes**
5. Regatta Boulevard/ Marina Bay Parkway	Signal	AM	30.0	C	**>120 (v/c=0.64)**	**F**	**Yes**
		PM	43.6	D	**69.3**	**E**	**Yes**
6. I-580 Westbound Ramps/ Juliga Woods Street	Side Street Stop	AM	2.5 (10.0)	A (A)	4.7 (13.1)	A (B)	No
		PM	4.4 (10.9)	A (B)	12.3 (**46.2**)	B (**E**)	No
7. I-580 Eastbound Ramps/ Regatta Boulevard/ Meade Street	Signal	AM	9.7	A	**>120 (v/c=1.03)**	**F**	**Yes**
		PM	9.1	A	19.5	B	No
8. Meade Street/ Regatta Boulevard	Side Street Stop	AM	6.4 (10.6)	A (B)	18.2 (82.9)	C (**F**)	No
		PM	5.6 (10.0)	A (B)	4.4 (21.4)	A (C)	No
9. Meade Street/ Seaver Avenue	Side Street Stop	AM	1.3 (9.7)	A (A)	**>120 (>120)**	**F (F)**	**Yes**
		PM	3.0 (9.0)	A (A)	**>120 (>120)**	**F (F)**	**Yes**
10. Seaport Avenue/I-580 Eastbound Ramps/South 51st Street/Bayview Avenue	All-way Stop	AM	27.6	D	**60.2**	**F**	**Yes**
		PM	20.0	C	**49.4**	**E**	**Yes**
11. I-580 Westbound Ramps/ Bayview Avenue	Signal	AM	5.4	A	**>120 (v/c=1.02)**	**F**	**Yes**
		PM	6.7	A	**109.1 (v/c=0.52)**	**F**	**Yes**
12. Carlson Boulevard/ Bayview Avenue	Signal	AM	27.0	C	34.7	C	No
		PM	21.6	C	22.5	C	No

TABLE 2-7
RICHMOND BAY CAMPUS
EXISTING PLUS BUILDOUT PROJECT CONDITIONS – STUDY INTERSECTION LOS SUMMARY

Intersection	Traffic Control	Peak Hour	Existing		Existing Plus Buildout Project		Significant Impact?
			Delay[1] (seconds)	LOS[1]	Delay[1] (seconds)	LOS[1]	
13. Carlson Boulevard/ I-80 Westbound Ramps	Signal	AM	19.3	B	**77.7**	**E**	**Yes**
		PM	20.0	B	20.0	B	No
14. Carlson Boulevard/ I-80 Eastbound Ramps	Signal	AM	10.7	B	14.6	B	No
		PM	9.8	A	14.1	B	No

Notes: **Bold** indicates an intersection operating at unacceptable LOS E or LOS F.
1. For signalized and all-way stop-controlled intersections, average intersection delay and LOS based on the 2000 HCM method is shown. For side-street stop-controlled intersections, delays for worst movement and average intersection delay are shown: intersection average (worst movement).
Source: Fehr & Peers.

IMPACT 2-1: EXISTING PLUS PROJECT BUILDOUT CONDITIONS INTERSECTION OPERATIONS

The buildout of the RBC would cause significant impacts at the following seven intersections under Existing Plus Buildout conditions:

A. The Project would cause a significant impact at the signalized **Meeker Avenue/23rd Street/Marina Bay Parkway** (Intersection 4) because it would increase v/c ratio by more than 0.01 during the PM peak hour at an intersection operating at LOS F regardless of the Project.

B. The Project would cause a significant impact at the signalized **Regatta Boulevard/ Marina Bay Parkway** (Intersection 5) because it would deteriorate intersection operations from LOS C to LOS F during the AM peak hour and from LOS D to LOS E during the PM peak hour.

C. The Project would cause a significant impact at the signalized **I-580 Eastbound Ramps/ Regatta Boulevard/Meade Street** (Intersection 7) because it would deteriorate intersection operations from LOS A to LOS F during the AM peak hour.

D. The Project would cause a significant impact at the side-street stop-controlled **Meade Street/Seaver Avenue** (Intersection 9) because it would deteriorate operations for the side-street stop-controlled approach from LOS A to LOS F during both AM and PM peak hours and the intersection would satisfy the Caltrans peak hour traffic volume signal warrant.

E. The Project would cause a significant impact at the all-way stop-controlled **Seaport Avenue/I-580 Eastbound Ramps/South 51st Street/Bayview Avenue** (Intersection 10) because it would deteriorate intersection operations from LOS D to LOS F during the AM

peak hour and from LOS C to LOS E during the PM peak hour. In addition, the intersection would satisfy the Caltrans peak hour traffic volume signal warrant.

F. The Project would cause a significant impact at the signalized **I-580 Westbound Ramps/ Bayview Avenue** (Intersection 11) because it would deteriorate intersection operations from LOS A to LOS F during both AM and PM peak hours.

G. The Project would cause a significant impact at the signalized **Carlson Boulevard/I-80 Westbound Ramps** (Intersection 13) because it would deteriorate intersection operations from LOS B to LOS E during the AM peak hour.

Mitigation Measure 2-1: Implement the following:

A. **Meeker Avenue/23rd Street/Marina Bay Parkway** (Intersection 4): Implement the following which requires coordination with City of Richmond:

- Convert the eastbound approach to provide one left-turn lane and one through-right lane
- Convert signal operations for the eastbound and westbound approaches from split phasing to protected left-turn phasing.
- Optimize traffic signal timing parameters (i.e., the amount of green signal time allocated to each intersection approach).

The intersection would improve to LOS C during both AM and PM peak hours after implementation of these improvements. Therefore, the mitigation measure would reduce the impact to less than significant if implemented.

B. **Regatta Boulevard/Marina Bay Parkway** (Intersection 5): Implement the following which requires coordination with City of Richmond:

- Optimize traffic signal timing parameters (i.e., the amount of green signal time allocated to each intersection approach).

The intersection would improve to LOS D during the AM peak hour after implementation of this improvement. Therefore, the mitigation measure would reduce the impact to less than significant if implemented.

C. **I-580 Eastbound Ramps/Regatta Boulevard/Meade Street** (Intersection 7): Implement the following which requires coordination with City of Richmond and Caltrans:

- Optimize traffic signal timing parameters (i.e., the amount of green signal time allocated to each intersection approach).

The intersection would improve to LOS D during the AM peak hour after implementation of this improvement. Therefore, the mitigation measure would reduce the impact to less than significant if implemented.

D. **Meade Street/Seaver Avenue** (Intersection 9): Implement the following which requires coordination with City of Richmond:

- Install an actuated signal at the intersection with protected/permitted phasing for the westbound left-turn movement.
- Convert the northbound approach to provide one left-turn lane and one right-turn lane.

The intersection would improve to LOS C during the AM peak hour and LOS B during the PM peak hour after implementation of this improvement. Therefore, the mitigation measure would reduce the impact to less than significant if implemented.

E. **Seaport Avenue/I-580 Eastbound Ramps/Bayview Avenue** (Intersection 10): Implement the following which requires coordination with City of Richmond and Caltrans:

- Install an actuated signal at the intersection with protected phasing for the northbound and southbound left-turn movements.
- Convert the southbound approach to provide two left-turn lanes and one shared right-turn/through lane.

The intersection would improve to LOS C during both AM and PM peak hours after implementation of this improvement. Therefore, the mitigation measure would reduce the impact to less than significant if implemented.

F. **I-580 Westbound Ramps/Bayview Avenue** (Intersection 11): Implement the following which requires coordination with City of Richmond and Caltrans:

- Optimize traffic signal timing parameters (i.e., the amount of green signal time allocated to each intersection approach).

The intersection would improve to LOS C during the AM peak hour and LOS B during the PM peak hour after implementation of this improvement. Therefore, the mitigation measure would reduce the impact to less than significant if implemented.

G. **Carlson Boulevard/I-80 Westbound Ramps** (Intersection 13): Implement the following which requires coordination with City of Richmond and Caltrans:

- Optimize traffic signal timing parameters (i.e., the amount of green signal time allocated to each intersection approach).

The intersection would improve to LOS D during the AM peak hour after implementation of this improvement. Therefore, the mitigation measure would reduce the impact to less than significant if implemented.

2.3.10.2 Freeway Operations

Table 2-8 shows the freeway segment LOS results for the Existing Plus Project Buildout conditions. **Appendix C** provides the detailed calculation work sheets.

TABLE 2-8
RICHMOND BAY CAMPUS
EXISTING PLUS BUILDOUT PROJECT CONDITIONS
FREEWAY SEGMENT LOS SUMMARY

Freeway Segment	Type[1]	Dir[2]	Existing No Project				Existing Plus Buildout Project				Significant Impact?
			AM Peak Hour		PM Peak Hour		AM Peak Hour		PM Peak Hour		
			Density[3]	LOS	Density[3]	LOS	Density[3]	LOS	Density[3]	LOS	
1. I-580 between Harbor Way and Marina Bay Pkwy	Weave	EB	N/A	A	N/A	A	N/A	A	N/A	A	No
	Weave	WB	N/A	A	N/A	A	N/A	A	N/A	A	No
2. I-580 between Marina Bay Pkwy and Regatta Blvd	Weave	EB	N/A	A	N/A	A	N/A	B	N/A	A	No
	Weave	WB	N/A	A	N/A	A	N/A	A	N/A	B	No
3. I-580 between Regatta Blvd and Bayview Ave	Weave	EB	N/A	A	N/A	A	N/A	A	N/A	A	No
	Weave	WB	N/A	A	N/A	A	N/A	A	N/A	A	No
4. I-580 between Bayview Ave and Central Ave	Basic	EB	15.4	B	14.0	B	16.0	B	17.4	B	No
	Basic	WB	14.3	B	16.9	B	17.9	B	17.4	B	No
5. I-580 between Central Ave and I-80	Basic	EB	23.5	C	28.7	D	24.4	C	37.0	E	No
	Basic	WB	25.0	C	22.6	C	31.7	D	23.4	C	No
6. I-80 between Carlson Blvd and Potrero Ave	Basic	EB	21.3	C	27.3	D	21.6	C	29.4	D	No
	Basic	WB	29.5	D	24.0	C	32.2	D	24.3	C	No
7. I-80 at Gilman St Overpass	Basic	EB	21.7	C	27.3	D	24.4	C	27.7	D	No
	Basic	WB	30.9	D	25.6	C	31.6	D	28.6	D	No

1. Segments with auxiliary lanes are classified as weave segments, and were analyzed based on the Leisch Method. Basic segments are analyzed as basic segments using the 2000 HCM methodologies.
2. EB = Eastbound; WB = Westbound
3. Density is presented in passenger cars per lane per mile (pc/ln/mi).

Source: Fehr & Peers.

The addition of Project Buildout traffic would not cause any study freeway segment to operate at an unacceptable LOS F. Therefore, Project Buildout would not cause a significant impact at the study freeway segments under Existing Plus Project Buildout conditions.

2.4 NEAR-TERM (2018) ANALYSIS

This section summarizes traffic operations under Near-Term (2018) No Project and Near-Term (2018) Plus Phase 1 Project conditions. Project Buildout conditions were not analyzed because no RBC development beyond Phase 1 would occur in 2018.

2.4.1 NEAR-TERM (2018) NO PROJECT CONDITIONS

The Near-Term (2018) No Project traffic volumes were developed by interpolating between the existing volumes (Figure 2-2) and the projected 2035 volumes (Figure 2-13), which were prepared using the CCTA Countywide Travel Demand Model and described in Section 2.5. **Figures 2-11A and 2-11B** show the Near-Term (2018) No Project traffic volumes.

The Near-Term (2018) No Project scenario assumes that signal timing parameters at the signalized study intersections would be optimized to reflect typical signal timing updates due to changing traffic flow over time. No other roadway modifications are assumed in the study area under the Near-Term (2018) No Project scenario.

2.4.1.1 Intersection Operations

Table 2-9 summarizes the Near-Term (2018) No Project intersection LOS analysis results. **Appendix B** provides the detailed calculation work sheets.

All study intersections would continue to operate at LOS D or better, except Meeker Avenue/23rd Street/Marina Bay Parkway intersection, which would continue to operate at LOS F with additional delay during the PM peak hour.

2.4.1.2 Freeway Operations

Table 2-10 summarizes the AM and PM peak hour freeway LOS analysis results under Near-Term (2018) No Project conditions. **Appendix C** provides the detailed calculation work sheets. All freeway segments are projected to continue to operate at LOS D or better during both AM and PM peak hours.

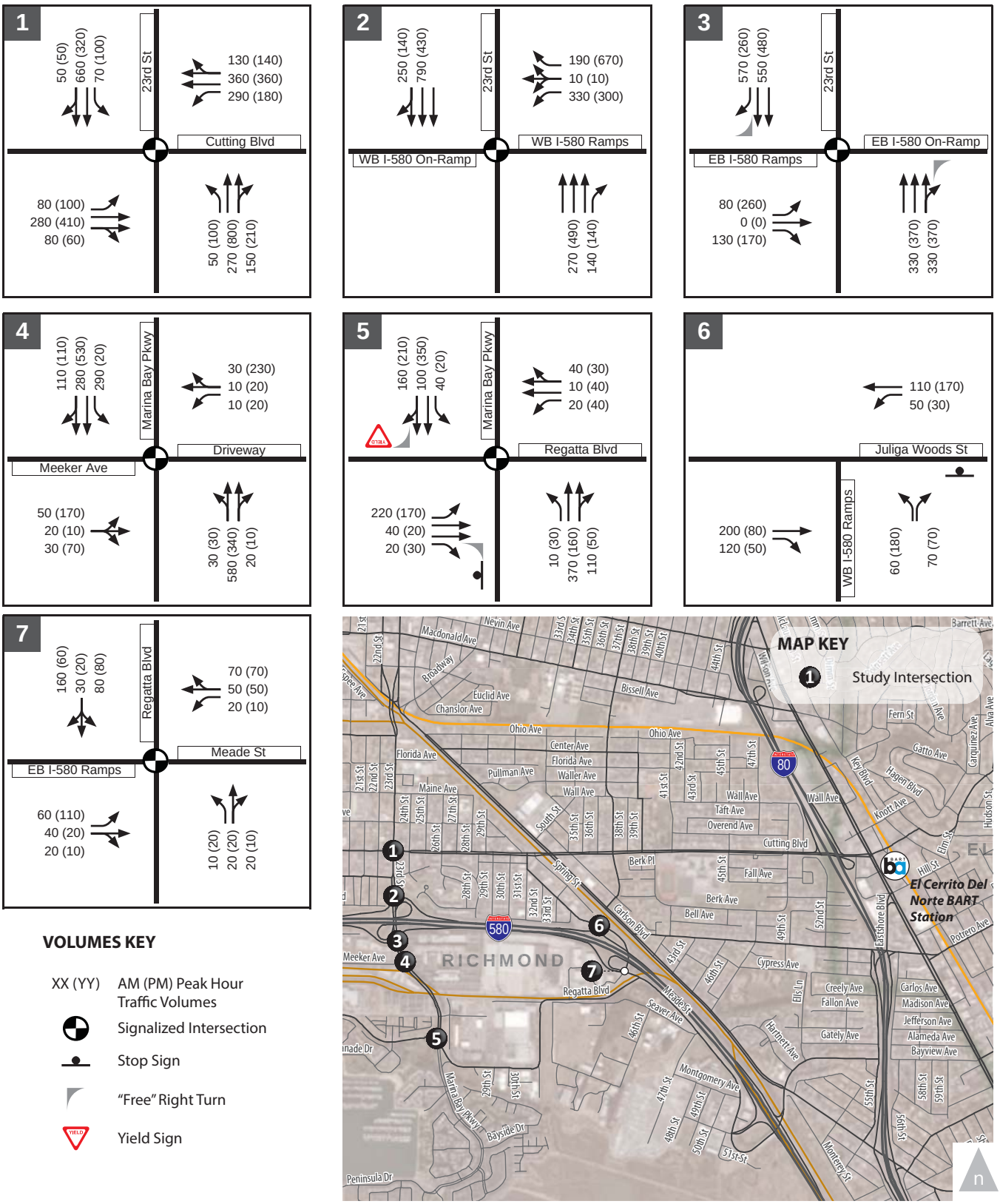


Figure 2-11A.

Richmond Bay Campus
Near-Term (2018) No Project Peak Hour Traffic Volumes

WC12-2953_2-11A_NT2018NPVols

FEHR PEERS

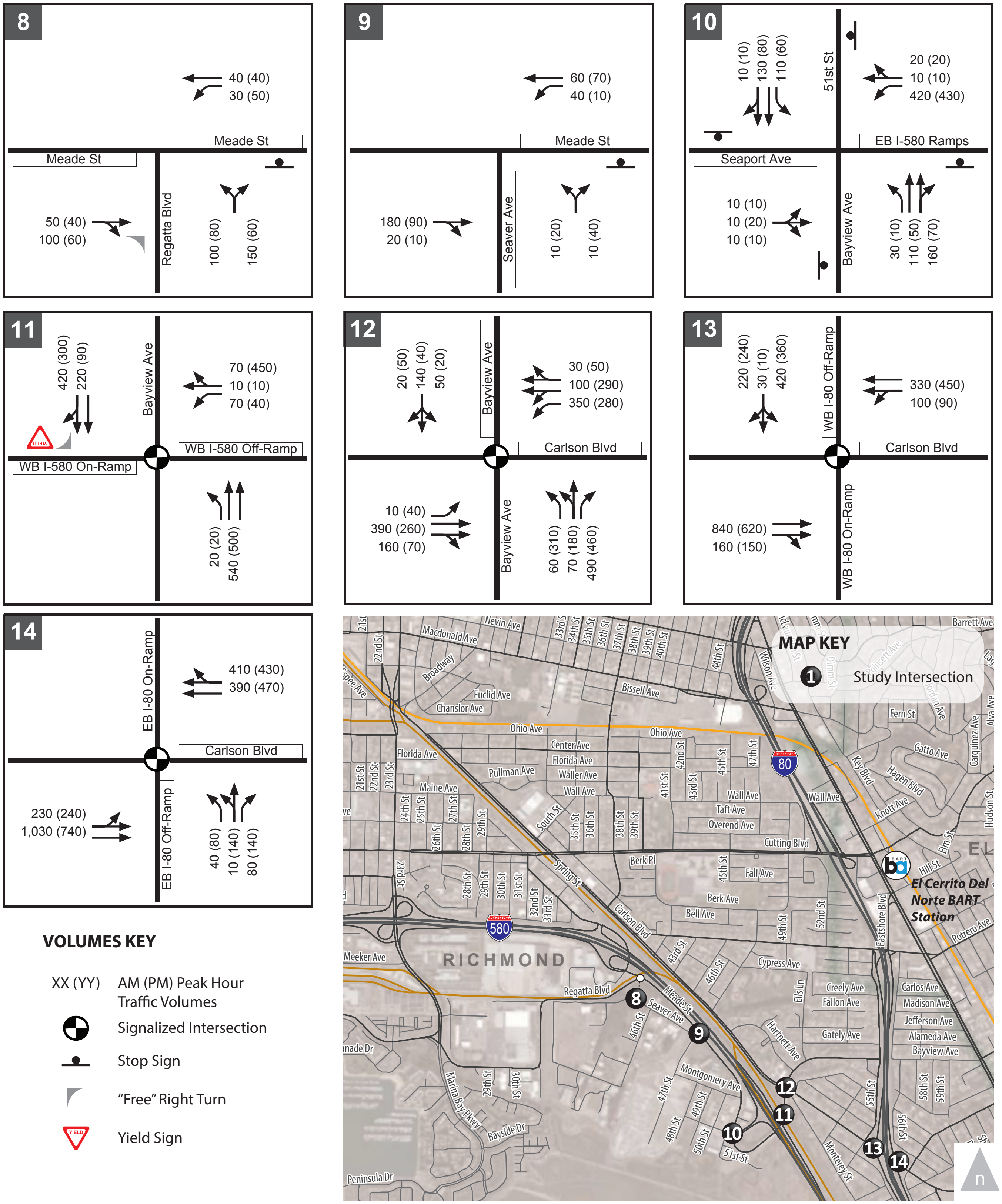


Figure 2-11B.

Richmond Bay Campus
Near-Term (2018) No Project Peak Hour Traffic Volumes

WC12-2953_2-11B_NT2018NPVols

FEHR & PEERS

TABLE 2-9
RICHMOND BAY CAMPUS
NEAR-TERM (2018) CONDITIONS – STUDY INTERSECTION LOS SUMMARY

Intersection	Traffic Control	Peak Hour	Near-Term (2018) No Project		Near-Term (2018) Plus Phase 1 Project		Significant Impact?
			Delay[1] (seconds)	LOS[1]	Delay[1] (seconds)	LOS[1]	
1. Cutting Boulevard/ 23rd Street	Signal	AM	24.4	C	24.9	C	No
		PM	24.5	C	24.6	C	No
2. I-580 Westbound Ramps/ 23rd Street	Signal	AM	7.3	A	7.3	A	No
		PM	7.5	A	7.5	A	No
3. I-580 Eastbound Ramps/ 23rd Street	Signal	AM	4.2	A	4.2	A	No
		PM	6.5	A	6.5	A	No
4. Meeker Avenue/23rd Street/ Marina Bay Pkwy	Signal	AM	40.0	D	40.0	D	No
		PM	**148.5 (v/c=0.54)**	**F**	**148.5 (v/c=0.54)**	**F**	No
5. Regatta Boulevard/ Marina Bay Parkway	Signal	AM	22.0	C	22.0	C	No
		PM	15.1	B	15.5	B	No
6. I-580 Westbound Ramps/ Juliga Woods Street	Side Street Stop	AM	3.1 (11.2)	A (B)	3.1 (11.6)	A (B)	No
		PM	5.5 (12.0)	A (B)	6.3 (14.0)	A (B)	No
7. I-580 Eastbound Ramps/ Regatta Blvd/Meade Street	Signal	AM	11.1	B	12.1	B	No
		PM	11.1	B	11.1	B	No
8. Meade Street/ Regatta Boulevard	Side Street Stop	AM	6.6 (11.5)	A (B)	6.6 (12.9)	A (B)	No
		PM	5.5 (10.4)	A (B)	5.5 (11.1)	A (B)	No
9. Meade Street/ Seaver Avenue	Side Street Stop	AM	1.6 (10.3)	A (B)	3.3 (12.5)	A (B)	No
		PM	2.7 (9.4)	A (A)	6.3 (11.1)	A (B)	No
10. Seaport Avenue/I-580 Eastbound Ramps/South 51st Street/Bayview Avenue	All-way Stop	AM	27.2	D	32.6	D	No
		PM	20.8	C	23.8	C	No
11. I-580 Westbound Ramps/ Bayview Avenue	Signal	AM	5.6	A	7.0	A	No
		PM	8.6	A	8.9	A	No
12. Carlson Boulevard/ Bayview Avenue	Signal	AM	28.6	C	29.2	C	No
		PM	24.5	C	24.6	C	No
13. Carlson Boulevard/ I-80 Westbound Ramps	Signal	AM	20.4	C	21.9	C	No
		PM	15.9	B	16.0	B	No
14. Carlson Boulevard/ I-80 Eastbound Ramps	Signal	AM	12.9	B	13.3	B	No
		PM	12.2	B	12.2	B	No

Notes: **Bold** indicates an intersection operating at unacceptable LOS E or LOS F.
1. For signalized and all-way stop-controlled intersections, average intersection delay and LOS based on the 2000 HCM method is shown. For side-street stop-controlled intersections, delays for worst movement and average intersection delay are shown: intersection average (worst movement).

Source: Fehr & Peers.

1

TABLE 2-10
RICHMOND BAY CAMPUS
NEAR-TERM (2018) CONDITIONS – FREEWAY SEGMENT LOS SUMMARY

Freeway Segment	Type[1]	Dir[2]	Near-Term (2018) No Project				Near-Term (2018) Plus Phase 1 Project				Significant Impact?
			AM Peak Hour		PM Peak Hour		AM Peak Hour		PM Peak Hour		
			Density[3]	LOS	Density[3]	LOS	Density[3]	LOS	Density[3]	LOS	
1. I-580 between Harbor Way and Marina Bay Pkwy	Weave	EB	N/A	A	N/A	B	N/A	A	N/A	B	No
	Weave	WB	N/A	A	N/A	A	N/A	A	N/A	A	No
2. I-580 between Marina Bay Pkwy and Regatta Blvd	Weave	EB	N/A	A	N/A	B	N/A	B	N/A	B	No
	Weave	WB	N/A	B	N/A	A	N/A	B	N/A	A	No
3. I-580 between Regatta Blvd and Bayview Ave	Weave	EB	N/A	B	N/A	B	N/A	B	N/A	B	No
	Weave	WB	N/A	B	N/A	A	N/A	B	N/A	A	No
4. I-580 between Bayview Ave and Central Ave	Basic	EB	17.8	B	17.1	B	17.9	B	17.4	B	No
	Basic	WB	17.3	B	18.6	C	17.6	B	18.7	C	No
5. I-580 between Central Ave and I-80	Basic	EB	26.1	D	32.8	D	26.2	D	33.7	D	No
	Basic	WB	29.1	D	24.0	C	29.8	D	24.1	C	No
6. I-80 between Carlson Blvd and Potrero Ave	Basic	EB	22.9	C	28.2	D	22.9	C	28.5	D	No
	Basic	WB	31.4	D	25.3	C	31.7	D	25.4	C	No
7. I-80 at Gilman St Overpass	Basic	EB	23.0	C	28.4	D	23.2	C	28.4	D	No
	Basic	WB	32.1	D	26.3	D	32.2	D	26.6	D	No

1. Segments with auxiliary lanes are classified as weave segments, and were analyzed based on the Leisch Method. Basic segments are analyzed as basic segments using the 2000 HCM methodologies.
2. EB = Eastbound; WB = Westbound
3. Density is presented in passenger cars per lane per mile (pc/ln/mi).

Source: Fehr & Peers.

2

3

2.4.2 NEAR-TERM (2018) PLUS PHASE 1 PROJECT CONDITIONS

Figures 2-12A and 2-12B show the Near-Term (2018) Plus Phase 1 Project traffic volumes which consist of traffic volumes under Near-Term (2018) No Project conditions (Figures 2-11A and 2-11B) plus Phase 1 traffic assignment (Figures 2-7A and 2-7B).

2.4.2.1 Intersection Operations

Table 2-9 summarizes intersection operations at the study intersections under the Near-Term (2018) Plus Phase 1 Project conditions. **Appendix B** provides the detailed calculation work sheets.

The addition of the Phase 1 Project traffic would not cause any of the study intersections that currently operate at an acceptable LOS to degrade to an unacceptable LOS under Near-Term (2018) conditions. At the one intersection that would operate below the LOS standard regardless of the Project, Meeker Avenue/23rd Street/Marina Bay Parkway, the addition of project generated traffic would not change the overall v/c ratio. Therefore, the Phase 1 Project would not cause a significant impact at this or other study intersections under Near-Term (2018) Plus Phase 1 Project conditions.

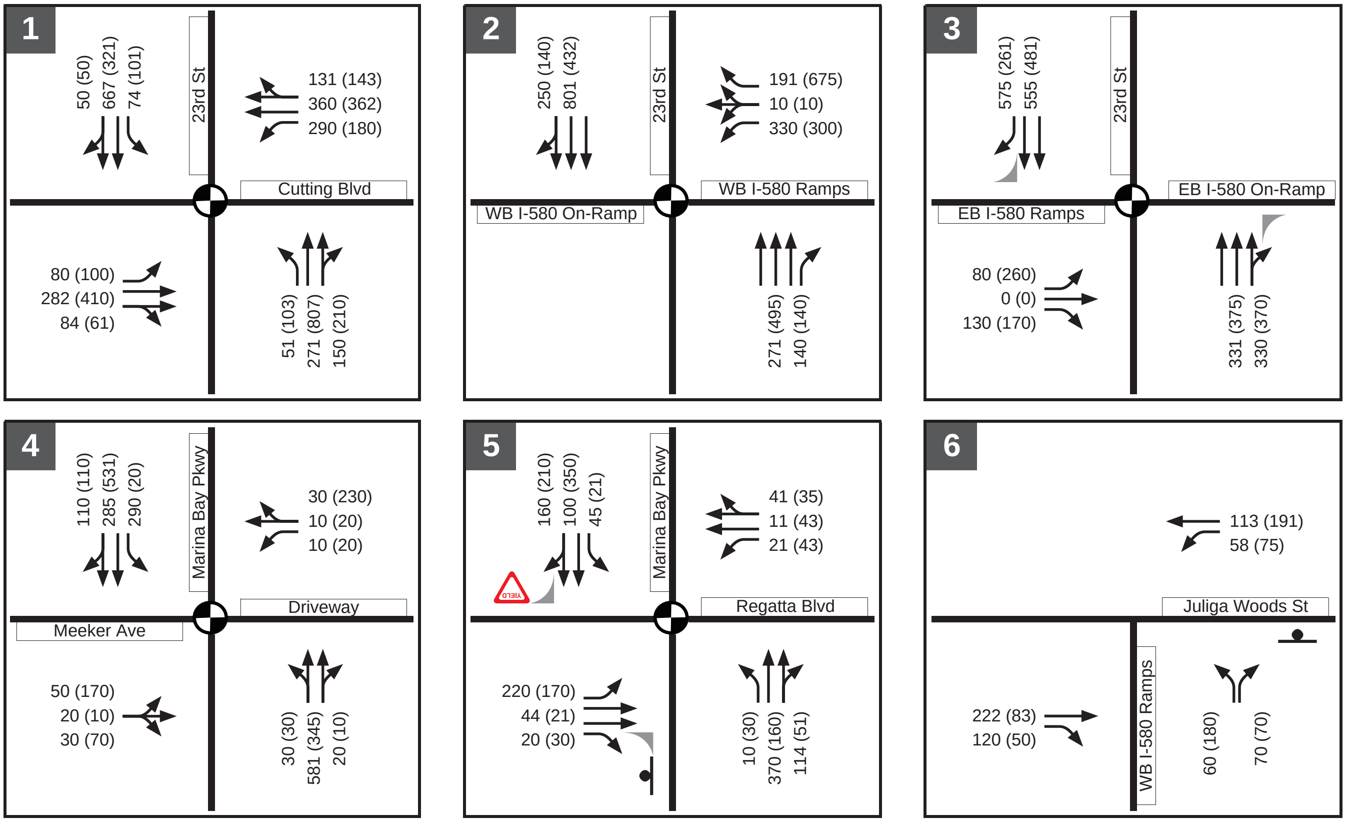
2.4.2.2 Freeway Operations

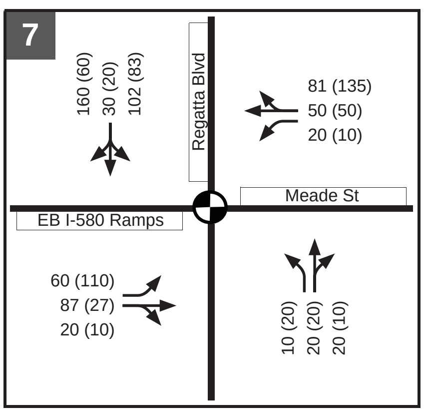
Table 2-10 shows the freeway segment LOS results for the Near-Term (2018) Plus Phase 1 Project conditions. **Appendix C** provides the detailed calculation work sheets.

The addition of the Phase 1 Project traffic would not cause any of the study freeway segments to operate at an unacceptable LOS. Therefore, the Phase 1 Project would not cause a significant impact at the study freeway segments under Near-Term (2018) Plus Phase 1 Project conditions.

2.5 CUMULATIVE (2035) ANALYSIS

This section summarizes traffic operations under Cumulative (2035) No Project and Cumulative (2035) Plus Project Buildout conditions.





VOLUMES KEY

XX (YY) AM (PM) Peak Hour Traffic Volumes

Signalized Intersection

Stop Sign

"Free" Right Turn

Yield Sign

Figure 2-12A.

Richmond Bay Campus
Near-Term (2018) Plus Phase 1 Peak Hour Traffic Volumes

WC12-2953_2-12A_NT2018+Ph1Vols

FEHR & PEERS

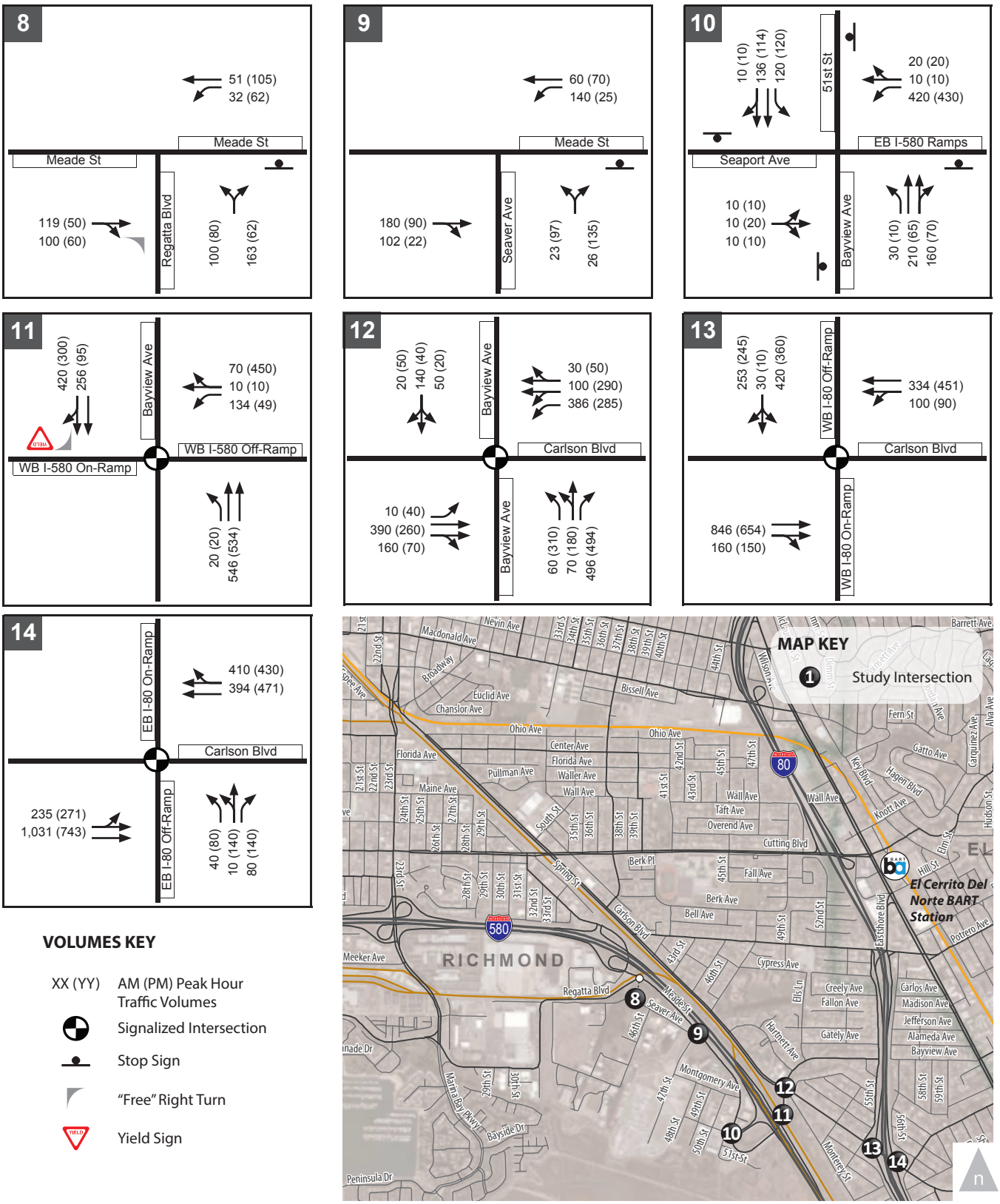


Figure 2-12B.

Richmond Bay Campus
Near-Term (2018) Plus Phase 1 Peak Hour Traffic Volumes

WC12-2953_2-12B_NT2018+Ph1Vols

FEHR PEERS

2.5.1 CUMULATIVE (2035) NO PROJECT CONDITIONS

Traffic forecasts to the year 2035 were developed based on the results of the CCTA Countywide Travel Demand Model. The most recent version of the CCTA Model, which reflects assumptions in residential and non-residential land use growth consistent with the Association of Bay Area Governments (ABAG) *Projections 2007*, served as the basis for developing AM and PM peak hour intersection turning movement forecasts for the year 2035. The Model land use database was checked to ensure the land use growth in Richmond is consistent with the recently adopted *General Plan 2030*. Consistent with CCTA's *Technical Procedures* (2006), the forecasting process involved running the 2010 and 2035 models and using the model produced volumes and existing turning movement count data, to estimate year 2035 intersection turn movements using the Furness[3] method. The 2035 model run did not assume any growth at the RBC site. **Figures 2-13A and 2-13B** shows the Cumulative (2035) No Project traffic volumes.

The Cumulative (2035) No Project scenario assumes that signal timing parameters at the signalized study intersections would be optimized to reflect typical signal timing updates due to changing traffic flow over several years. No other roadway modifications are assumed in the study area under the Cumulative (2035) No Project scenario.

2.5.1.1 Intersection Operations

Table 2-11 summarizes the Cumulative (2035) No Project intersection LOS analysis results. **Appendix B** provides the detailed calculation work sheets.

The delay at all study intersections would increase in comparison to Existing and Near-Term (2018) conditions. All study intersections would continue to operate at LOS D or better, except Meeker Avenue/ 23rd Street/Marina Bay Parkway intersection, which would continue to operate at LOS F during the PM peak hour.

2.5.1.2 Freeway Operations

Table 2-12 summarizes the AM and PM peak hour freeway LOS analysis results under Cumulative (2035) No Project conditions. **Appendix C** provides the detailed calculation work sheets.

All freeway segments are projected to continue to operate at LOS E or better during both AM and PM peak hours, except I-580 between Central Avenue and I-80 which would operate at LOS F in the eastbound direction during the PM peak hour.

[3] Furnessing is an iterative process that develops future turning movements by applying the difference between the base model volumes and the existing counts to future model approach and departure volumes.

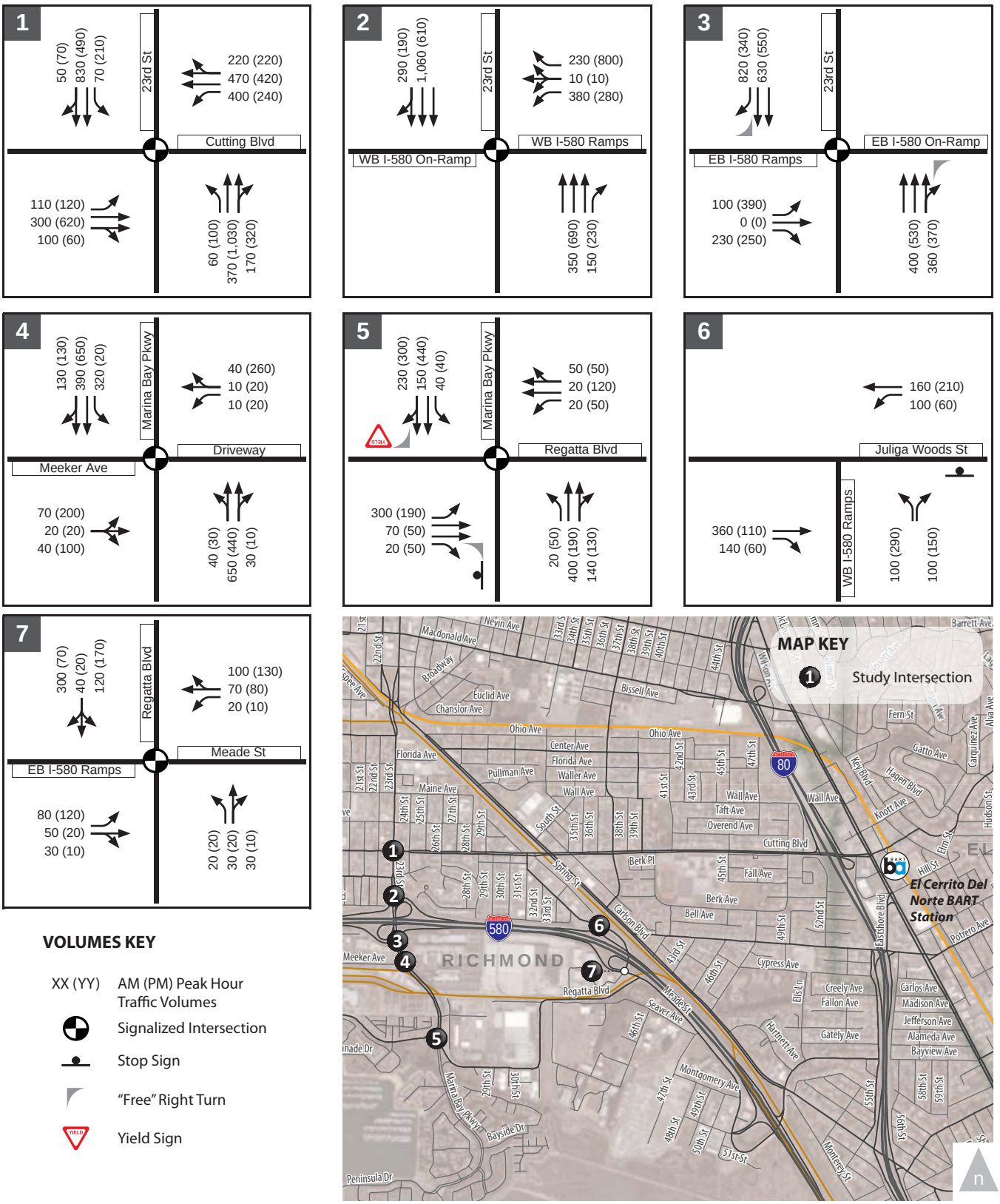


Figure 2-13A.

Richmond Bay Campus
Cumulative (2035) No Project Peak Hour Traffic Volumes

WC12-2953_2-13A_Cumu2035NPVols

FEHR PEERS

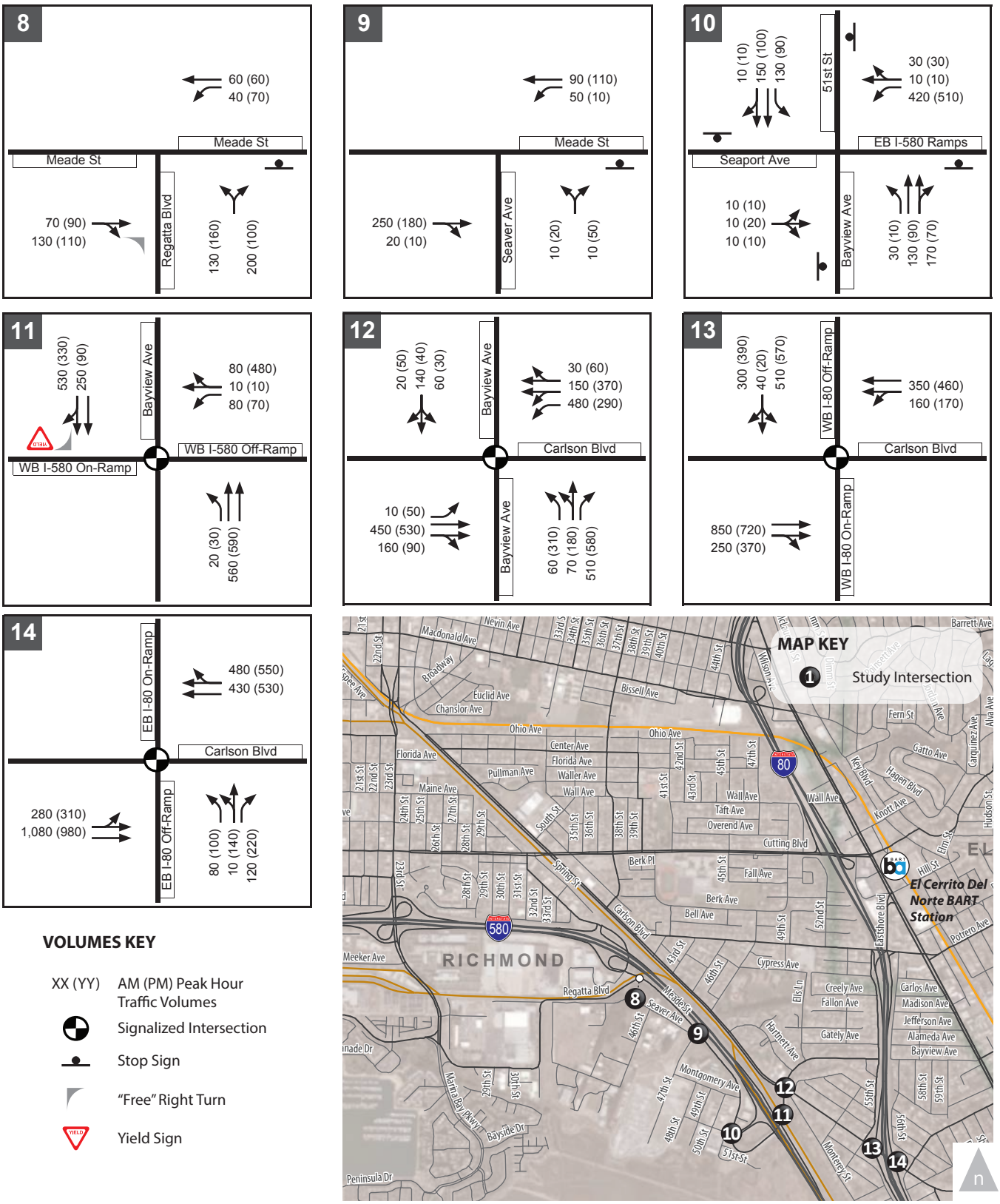


Figure 2-13B.

Richmond Bay Campus
Cumulative (2035) No Project Peak Hour Traffic Volumes

WC12-2953_2-13B_Cumu2035NPVols

FEHR PEERS

TABLE 2-11
RICHMOND BAY CAMPUS
CUMULATIVE (2035) CONDITIONS – STUDY INTERSECTION LOS SUMMARY

Intersection	Traffic Control	Peak Hour	Cumulative (2035) No Project		Cumulative (2035) Plus Buildout Project		Significant Impact?
			Delay[1] (seconds)	LOS[1]	Delay[1] (seconds)	LOS[1]	
1. Cutting Boulevard/ 23rd Street	Signal	AM	32.8	C	36.6	D	No
		PM	43.3	D	46.1	D	No
2. I-580 Westbound Ramps/ 23rd Street	Signal	AM	8.4	A	8.6	A	No
		PM	9.4	A	9.8	A	No
3. I-580 Eastbound Ramps/ 23rd Street	Signal	AM	4.8	A	7.7	A	No
		PM	7.8	A	8.8	A	No
4. Meeker Avenue/23rd Street/ Marina Bay Pkwy	Signal	AM	**61.4**	**E**	**61.4**	**E**	No
		PM	**>120 (v/c=0.65)**	**F**	**>120 (v/c=0.75)**	**F**	**Yes**
5. Regatta Boulevard/ Marina Bay Parkway	Signal	AM	28.2	C	35.0	C	No
		PM	17.4	B	20.9	C	No
6. I-580 Westbound Ramps/ Juliga Woods Street	Side Street Stop	AM	4.5 (17.0)	A (C)	8.3 (27.1)	A (D)	No
		PM	9.5 (18.0)	A (C)	**>120 (>120)**	**F (F)**	**Yes**
7. I-580 Eastbound Ramps/ Regatta Boulevard/ Meade Street	Signal	AM	17.8	B	54.9	D	No
		PM	13.8	B	41.9	D	No
8. Meade Street/ Regatta Boulevard	Side Street Stop	AM	7.5 (13.5)	A (B)	**46.3 (>120)**	**E (F)**	**Yes**
		PM	7.2 (14.3)	A (B)	47.6 **(>120)**	E **(F)**	**Yes**
9. Meade Street/ Seaver Avenue	Side Street Stop	AM	1.5 (11.2)	A (B)	**>120 (>120)**	**F (F)**	**Yes**
		PM	2.1 (10.2)	A (B)	**>120 (>120)**	**F (F)**	**Yes**
10. Seaport Avenue/I-580 Eastbound Ramps/South 51st Street/Bayview Avenue	All-way Stop	AM	30.9	D	**59.8**	**F**	**Yes**
		PM	**39.3**	**E**	**50.2**	**F**	**Yes**
11. I-580 Westbound Ramps/ Bayview Avenue	Signal	AM	6.6	A	25.7	C	No
		PM	10.7	B	13.6	B	No
12. Carlson Boulevard/ Bayview Avenue	Signal	AM	33.6	C	43.2	D	No
		PM	30.6	C	49.1	D	No
13. Carlson Boulevard/ I-80 Westbound Ramps	Signal	AM	43.6	D	**97.9 (v/c=1.21)**	**F**	**Yes**
		PM	**58.1**	**E**	**79.4**	**E**	**Yes**

TABLE 2-11
RICHMOND BAY CAMPUS
CUMULATIVE (2035) CONDITIONS – STUDY INTERSECTION LOS SUMMARY

Intersection	Traffic Control	Peak Hour	Cumulative (2035) No Project		Cumulative (2035) Plus Buildout Project		Significant Impact?
			Delay[1] (seconds)	LOS[1]	Delay[1] (seconds)	LOS[1]	
14. Carlson Boulevard/ I-80 Eastbound Ramps	Signal	AM	13.3	B	23.7	C	No
		PM	14.6	B	49.0	D	No

Notes: **Bold** indicates an intersection operating at unacceptable LOS E or LOS F.
1. For signalized and all-way stop-controlled intersections, average intersection delay and LOS based on the 2000 HCM method is shown. For side-street stop-controlled intersections, delays for worst movement and average intersection delay are shown: intersection average (worst movement).
Source: Fehr & Peers.

2.5.2 CUMULATIVE (2035) PLUS PROJECT BUILDOUT CONDITIONS

Figures 2-14A and 2-14B shows the Cumulative (2035) Plus Project Buildout volumes, which consist of traffic volumes under Cumulative (2035) No Project conditions (Figures 2-13A and 2-13B) plus Project Buildout traffic assignment (Figures 2-8A and 2-8B). This analysis assumes no roadway modifications under this scenario compared to the Cumulative (2035) No Project conditions.

2.5.2.1 Intersection Operations

Table 2-11 summarizes intersection operations at the study intersections under the Cumulative (2035) Plus Project Buildout conditions. **Appendix B** provides the detailed calculation work sheets.

The addition of Project Buildout traffic would cause six intersections to either deteriorate from acceptable (LOS D or better) to unacceptable (LOS E or LOS F) conditions or contribute to already unacceptable conditions during one or both peak hours.

The Project would cause a significant impact at six intersections which are summarized under Impact 2-2 discussion.

TABLE 2-12
RICHMOND BAY CAMPUS
CUMULATIVE (2035) CONDITIONS – FREEWAY SEGMENT LOS SUMMARY

Freeway Segment	Type[1]	Dir[2]	Cumulative (2035) No Project				Cumulative (2035) Plus Project Buildout				Significant Impact?
			AM Peak Hour		PM Peak Hour		AM Peak Hour		PM Peak Hour		
			Density[3]	LOS	Density[3]	LOS	Density[3]	LOS	Density[3]	LOS	
1. I-580 between Harbor Way and Marina Bay Pkwy	Weave	EB	N/A	A	N/A	C	N/A	B	N/A	C	No
	Weave	WB	N/A	C	N/A	A	N/A	C	N/A	A	No
2. I-580 between Marina Bay Pkwy and Regatta Blvd	Weave	EB	N/A	B	N/A	C	N/A	B	N/A	C	No
	Weave	WB	N/A	C	N/A	B	N/A	C	N/A	C	No
3. I-580 between Regatta Blvd and Bayview Ave	Weave	EB	N/A	C	N/A	C	N/A	C	N/A	C	No
	Weave	WB	N/A	C	N/A	B	N/A	C	N/A	B	No
4. I-580 between Bayview Ave and Central Ave	Basic	EB	24.5	C	25.8	C	25.1	C	29.9	D	No
	Basic	WB	25.9	C	23.5	C	30.3	D	24.0	C	No
5. I-580 between Central Ave and I-80	Basic	EB	36.1	E	**--**	**F**	37.9	E	**--**	**F**	Yes
	Basic	WB	40.5	E	26.5	D	**--**	**F**	27.4	D	Yes
6. I-80 between Carlson Blvd and Potrero Ave	Basic	EB	27.2	D	31.5	D	27.5	D	34.3	D	No
	Basic	WB	37.6	E	28.8	D	42.2	E	29.2	D	No
7. I-80 at Gilman St Overpass	Basic	EB	26.2	D	32.2	D	29.5	D	32.8	D	No
	Basic	WB	35.1	E	28.3	D	36.0	E	31.8	D	No

Bold indicates freeway segment operating at unacceptable LOS.
1. Segments with auxiliary lanes are classified as weave segments, and were analyzed based on the Leisch Method. Basic segments are analyzed as basic segments using the 2000 HCM methodologies.
2. EB = Eastbound; WB = Westbound
3. Density is presented in passenger cars per lane per mile (pc/ln/mi).

Source: Fehr & Peers.

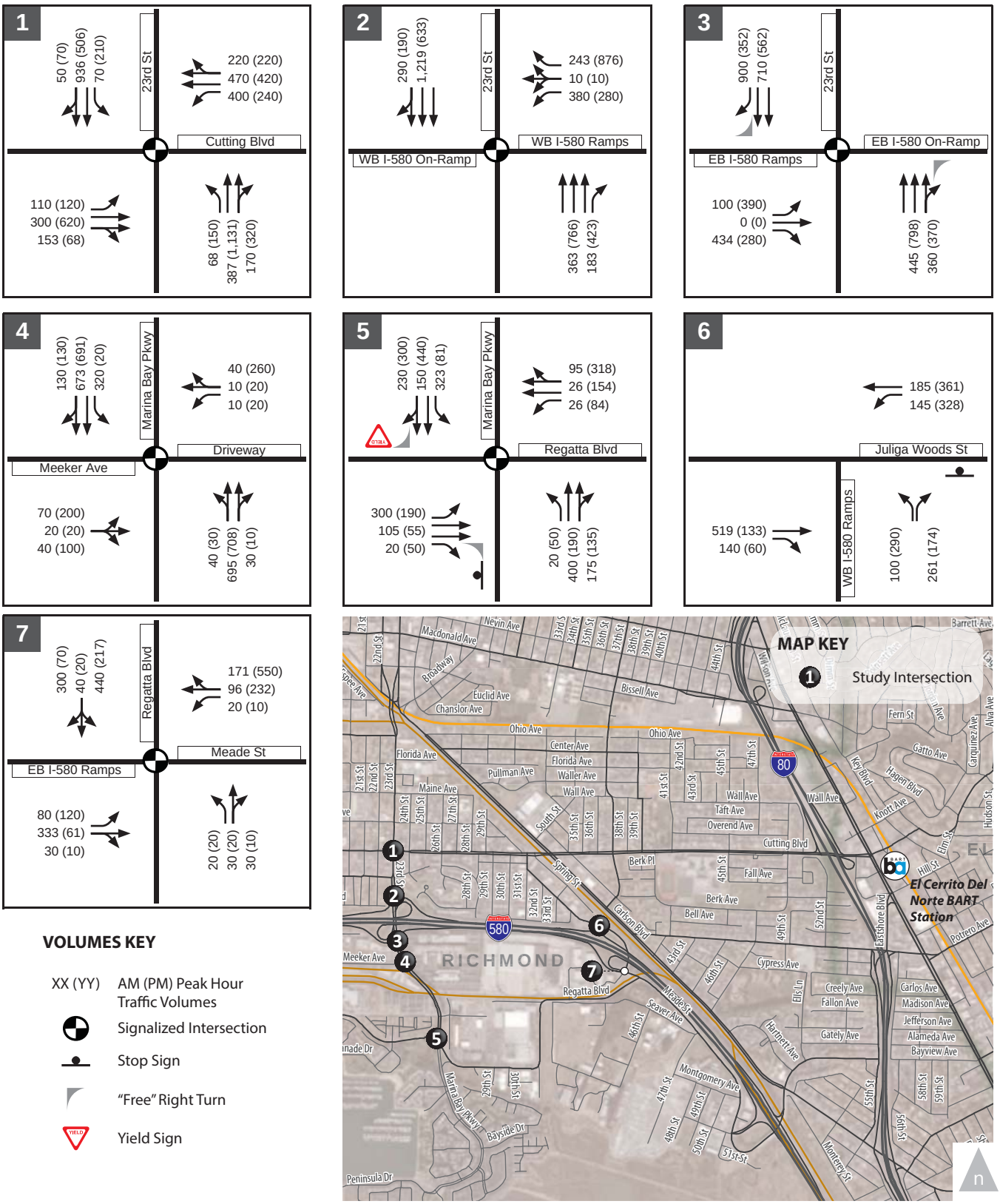


Figure 2-14A.

Richmond Bay Campus
Cumulative (2035) Plus Buildout Peak Hour Traffic Volumes

WC12-2953_2-14A_Cumu2035+BuildoutVols

FEHR PEERS

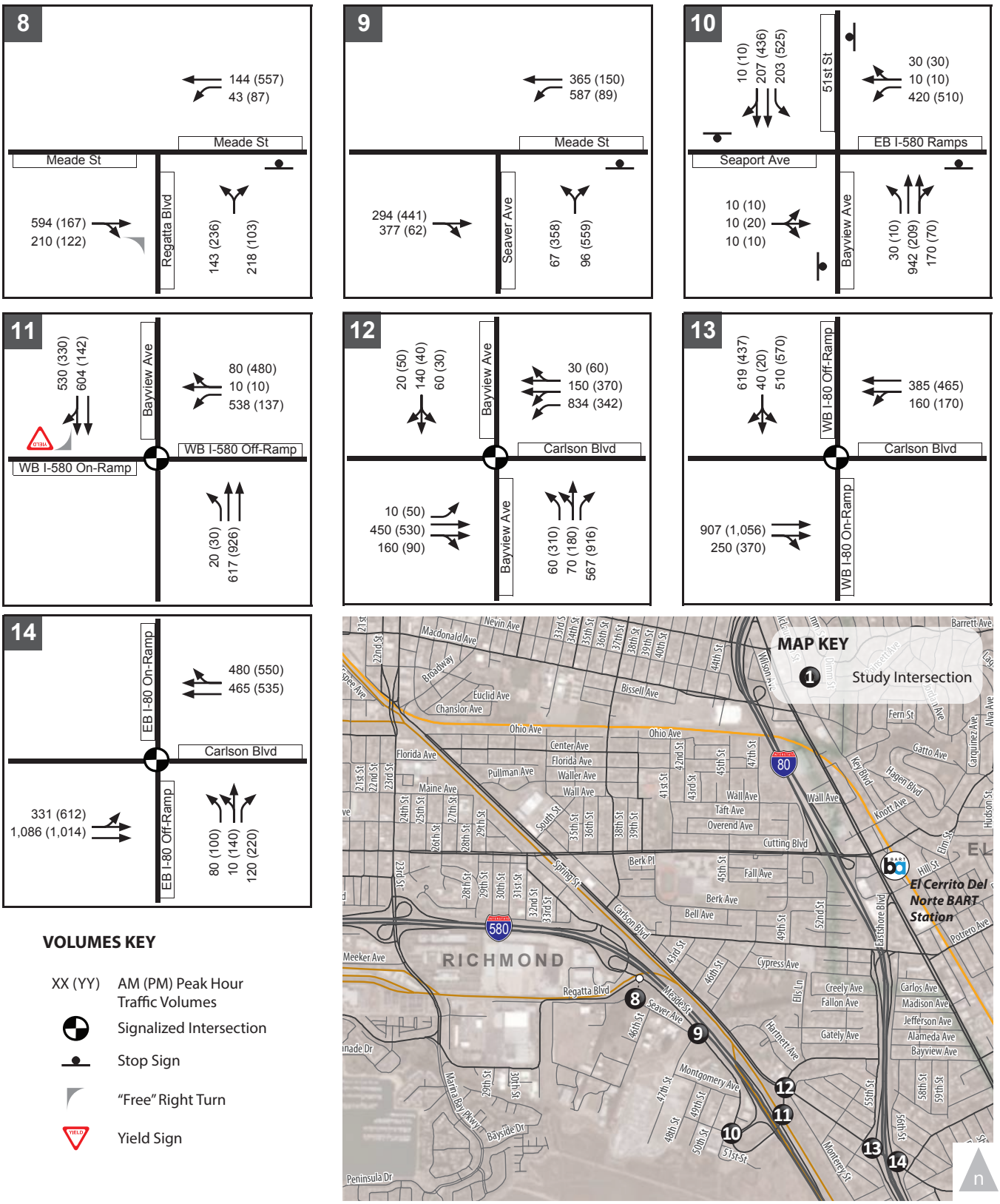


Figure 2-14B.

Richmond Bay Campus
Cumulative (2035) Plus Buildout Peak Hour Traffic Volumes

WC12-2953_2-14B_Cumu2035+BuildoutVols

FEHR PEERS

IMPACT 2-2: CUMULATIVE (2035) PLUS PROJECT BUILDOUT CONDITIONS INTERSECTION OPERATIONS

The buildout of the RBC would cause significant impacts at the following six intersections under Cumulative (2035) Plus Buildout conditions:

A. The Project would cause a significant impact at the signalized **Meeker Avenue/23rd Street/Marina Bay Parkway** (Intersection 4) because it would increase v/c ratio by more than 0.01 during the PM peak hour at an intersection operating at LOS F regardless of the Project.

B. The Project would cause a significant impact at the side-street stop-controlled **I-580 Westbound Ramps/Juliga Woods Street** (Intersection 6) because it would deteriorate operations for the side-street stop-controlled approach from LOS C to LOS F during the PM peak hour and the intersection would satisfy the Caltrans peak hour traffic volume signal warrant.

C. The Project would cause a significant impact at the side-street stop-controlled **Meade Street/Regatta Boulevard** (Intersection 8) because it would deteriorate operations for the side-street stop-controlled approach from LOS B to LOS F during both AM and PM peak hours and the intersection would satisfy the Caltrans peak hour traffic volume signal warrant.

D. The Project would cause a significant impact at the side-street stop-controlled **Meade Street/Seaver Avenue** (Intersection 9) because it would deteriorate operations for the side-street stop-controlled approach from LOS B to LOS F during both AM and PM peak hours and the intersection would satisfy the Caltrans peak hour traffic volume signal warrant.

E. The Project would cause a significant impact at the all-way stop-controlled **Seaport Avenue/I-580 Eastbound Ramps/South 51st Street/Bayview Avenue** (Intersection 10) because it would deteriorate intersection operations from LOS D during the AM peak hour and LOS E during the PM peak hour to LOS F during both AM and PM peak hours. In addition, the intersection would satisfy the Caltrans peak hour traffic volume signal warrant.

F. The Project would cause a significant impact at the signalized **Carlson Boulevard/I-80 Westbound Ramps** (Intersection 13) because it would deteriorate intersection operations from LOS D to LOS F during the AM peak hour and LOS E to LOS F during the PM peak hour.

Mitigation Measure 2-2: Implement the following:

A. **Meeker Avenue/23rd Street/Marina Bay Parkway** (Intersection 4): Implement the following which requires coordination with City of Richmond (Same as Mitigation Measure 2-1A):

- Convert the eastbound approach to provide one left-turn lane and one through-right lane

- Convert signal operations for the eastbound and westbound approaches from split phasing to protected left-turn phasing. Optimize traffic signal timing parameters (i.e., the amount of green signal time allocated to each intersection approach).

The intersection would improve to LOS C during the AM peak hour and LOS D during the PM peak hour after implementation of these improvements. Therefore, the mitigation measure would reduce the impact to less than significant if implemented.

B. **I-580 Westbound Ramps/Juliga Woods Street** (Intersection 6): Implement the following which requires coordination with City of Richmond and Caltrans:

- Install an actuated signal at the intersection.

The intersection would improve to LOS A during both AM and PM peak hours after implementation of this improvement. Therefore, the mitigation measure would reduce the impact to less than significant if implemented.

C. **Meade Street/Regatta Boulevard** (Intersection 8): Implement the following which requires coordination with City of Richmond:

- Install an actuated signal at the intersection. The new signal shall be connected and coordinated with the existing controls at the at-grade railroad crossing on Meade Street and the existing signal at the I-580 Eastbound Ramps/Regatta Boulevard/Meade Street (Intersection 7) just west of the intersection to minimize potential queues spilling onto the railroad tracks.

The intersection would improve to LOS B during both AM and PM peak hours after implementation of this improvement. Therefore, the mitigation measure would reduce the impact to less than significant if implemented.

D. **Meade Street/Seaver Avenue** (Intersection 9): Implement the following which requires coordination with City of Richmond (Same as Mitigation Measure 2-1D):

- Install an actuated signal at the intersection with protected/permitted phasing for the westbound left-turn movement.
- Convert the northbound approach to provide one left-turn lane and one right-turn lane.

The intersection would improve to LOS D during the AM peak hour and LOS B during the PM peak hour after implementation of this improvement. Therefore, the mitigation measure would reduce the impact to less than significant if implemented.

E. **Seaport Avenue/I-580 Eastbound Ramps/Bayview Avenue** (Intersection 10): Implement the following which requires coordination with City of Richmond and Caltrans (Same as Mitigation Measure 2-1E):

- Install an actuated signal at the intersection with protected phasing for the northbound and southbound left-turn movements.

- Convert the southbound approach to provide two left-turn lanes and one shared right-turn/through lane.

The intersection would improve to LOS C during both AM and PM peak hours after implementation of this improvement. Therefore, the mitigation measure would reduce the impact to less than significant if implemented.

F. **Carlson Boulevard/I-80 Westbound Ramps** (Intersection 13): Implement the following which requires coordination with City of Richmond and Caltrans:

- Convert the southbound approach to provide one left-turn lane and one right-turn lane.

The intersection would improve to LOS C during both AM and PM peak hours after implementation of this improvement. Therefore, the mitigation measure would reduce the impact to less than significant if implemented.

2.5.2.2 Freeway Operations

Table 2-12 shows the freeway segment LOS results for the Cumulative (2035) Plus Project Buildout conditions. **Appendix C** provides the detailed calculation work sheets. The addition of Project Buildout traffic would cause one study freeway segment to operate at LOS F and contribute to one study freeway segment that would operate at LOS F regardless of the Project.

The Project would cause a significant impact at one freeway segment which is summarized under Impact 2-3 discussion.

IMPACT 2-3: CUMULATIVE (2035) PLUS PROJECT BUILDOUT CONDITIONS FREEWAY OPERATIONS

The buildout of the RBC would cause a significant impact under Cumulative (2035) Plus Buildout conditions on **I-580 between Central Avenue and I-80** in westbound direction during the AM peak hour and in the eastbound direction during the PM peak hour because the Project would cause the westbound segment to deteriorate from LOS E to LOS F during the AM peak hour and it increase the PM peak hour volume on the eastbound freeway segment by more than five percent on a freeway segment that would operate at LOS F regardless of the Project.

Mitigation Measure 2-3: This impact can be mitigated by increasing the freeway capacity through adding one more travel lane in each direction of I-580 in this section. No freeway capacity projects are currently planned by Caltrans for this section of I-580. In addition, the feasibility of implementing this mitigation measure is not known at this time. Therefore, this impact is conservatively considered to be *significant and unavoidable*.

2.6 ADDITIONAL EMPLOYMENT ALTERNATIVE ANALYSIS

This section presents trip generation for the Additional Employment Alternative scenario and summarizes traffic operations under the Near-Term (2018) Plus Additional Employment Alternative conditions. The Additional Employment Alternative would consist of an additional 200,000 square feet of space and accommodate an additional 700 employees at the RBC site.

2.6.1 TRIP GENERATION

Table 2-13 shows the estimated vehicle trip generation for the Additional Employment Alternative at the RBC site. The trip generation estimates is based on the same methodology used to estimate trip generation for the Phase 1 project as documented in section 2.3.7. The 700 additional employees under the Additional Employment Alternative at the RBC site are expected to increase trip generation to about 3,500 daily, 360 AM peak hour, and 340 PM peak hour automobile trips.

TABLE 2-13
RICHMOND BAY CAMPUS
ADDITIONAL EMPLOYMENT ALTERNATIVE VEHICLE TRIP GENERATION SUMMARY

	Average Daily Population	Daily	AM Peak Hour			PM Peak Hour		
			In	Out	Total	In	Out	Total
Project Phase 1 [1]	1,000	2,079	182	29	211	27	172	199
Additional Employees [1]	700	1,455	127	20	147	18	121	139
Additional Employment Alternative Total	1,700	3,534	309	49	358	45	293	338

1. Based on following trip generation rates:
Daily = 2.08 trips per Average Daily Population (ADP); AM Peak Hour = 0.21 trips per ADP (86% in, 14% out); PM Peak Hour = 0.20 trips per ADP (13% in, 87% out)

Source: Fehr & Peers, based on trip generation rate per average daily population at the existing LBNL site in Berkeley adjusted to reflect the different characteristics of the RBC.

2.6.2 NEAR-TERM (2018) PLUS ADDITIONAL EMPLOYMENT ALTERNATIVE CONDITIONS

Figures 2-15A and 2-15B show the traffic volumes under the Near-Term (2018) Plus Additional Employment Alternative conditions, which consists of traffic volumes under Near-Term (2018) No Project conditions plus traffic generated by the 1,000 Phase 1 employees and the 700 additional employees under the Additional Employment Alternative.

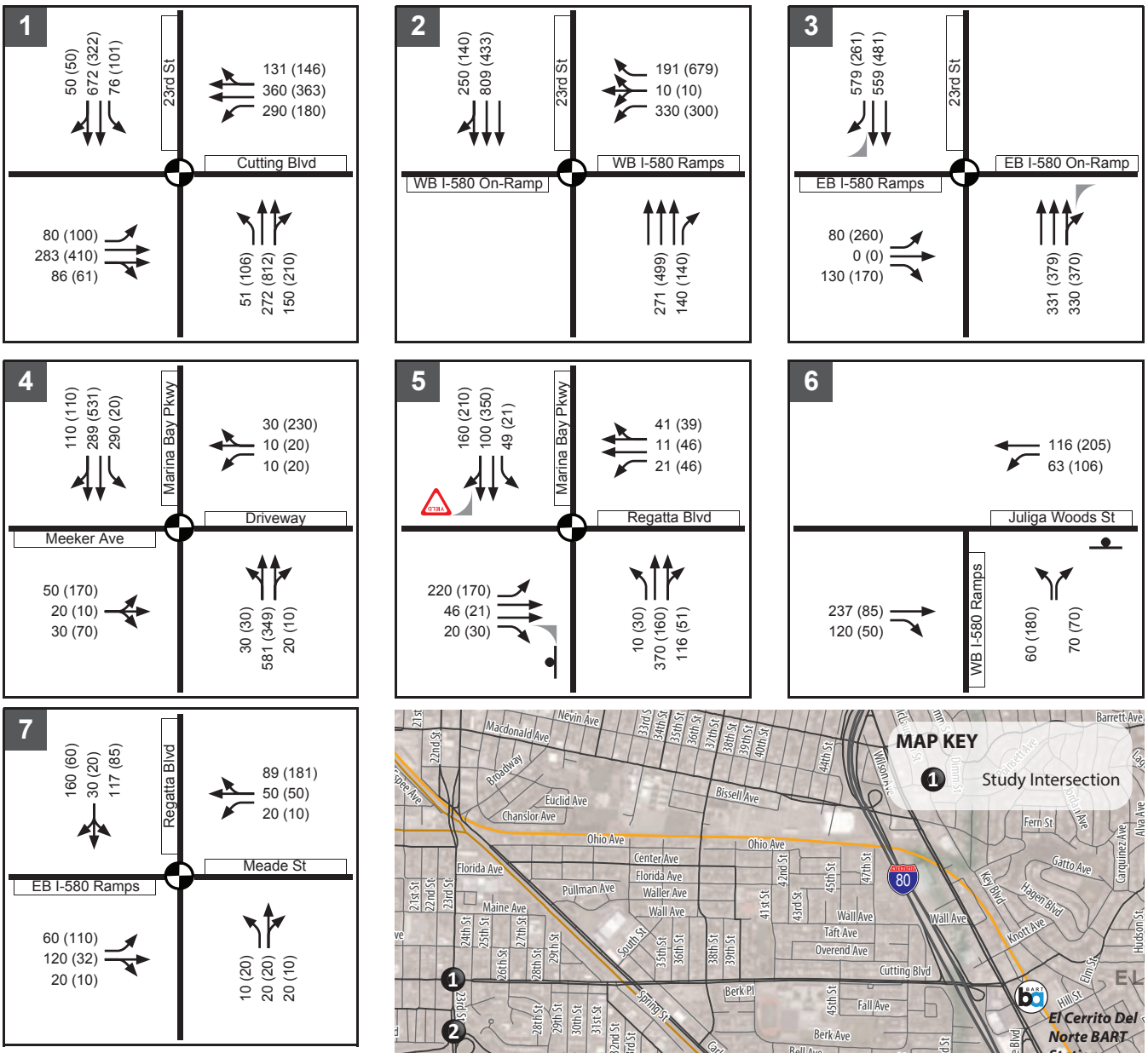


Figure 2-15A.

Richmond Bay Campus Near-Term (2018)
Plus Additional Employment Alternative Peak Hour Traffic Volumes

WC12-2953_2-15A_NT2018+AEAVols

FEHR PEERS

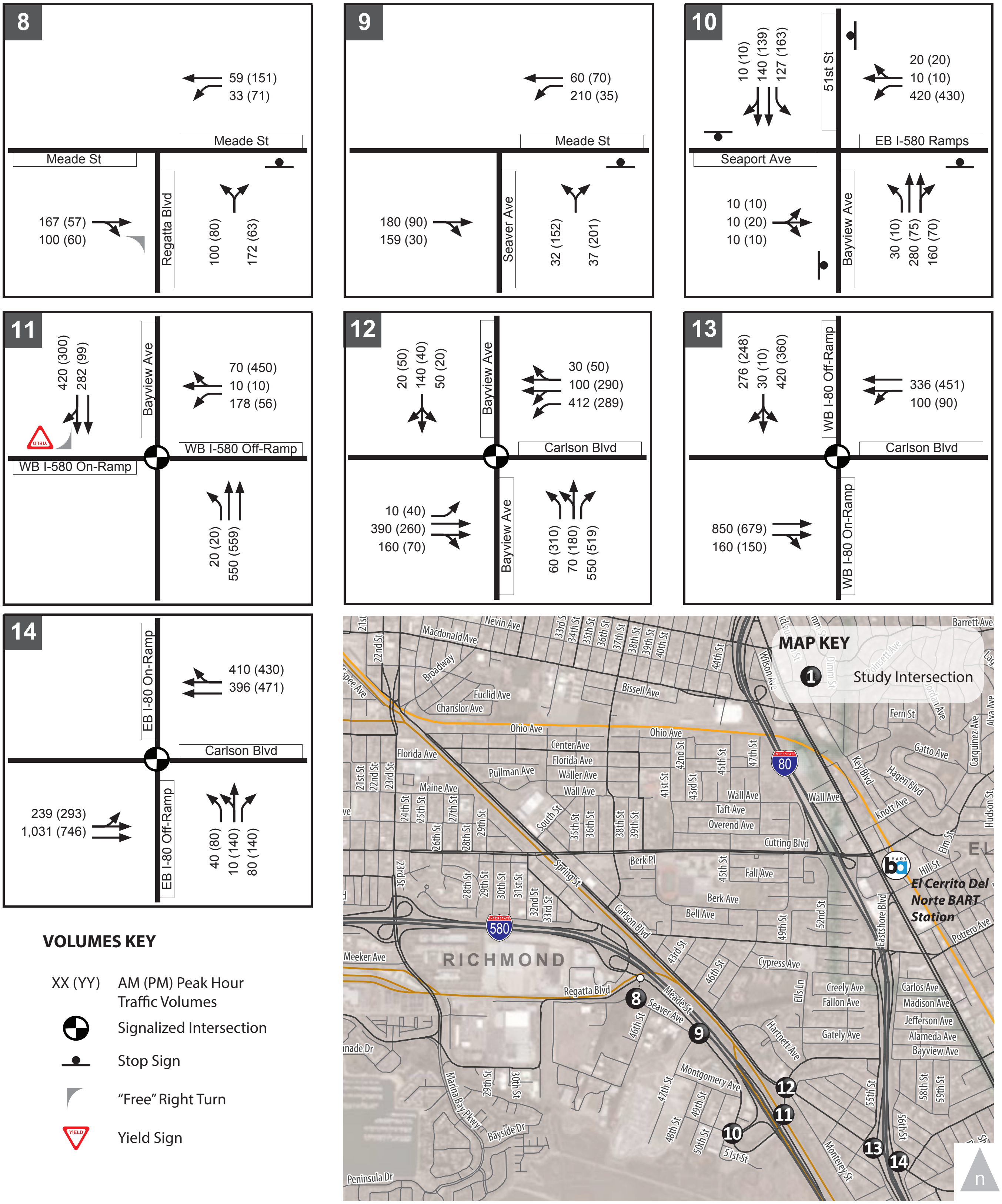


Figure 2-15B.

Richmond Bay Campus Near-Term (2018) Plus Additional Employment Alternative Peak Hour Traffic Volumes

WC12-2953_2-12B_NT2018+AEAVols

FEHR & PEERS

2.6.2.1 Intersection Operations

Table 2-14 summarizes intersection operations at the study intersections under the Near-Term (2018) Plus Additional Employment Alternative conditions. **Appendix B** provides the detailed calculation work sheets.

The traffic generated by the Additional Employment Alternative would not cause any of the study intersections that currently operate at an acceptable LOS to degrade to an unacceptable LOS under Near-Term (2018) conditions. At the one intersection that would operate below the LOS standard regardless of the Alternative, Meeker Avenue/23rd Street/Marina Bay Parkway, the addition of traffic generated by the Additional Employment Alternative would not change the overall v/c ratio. Therefore, the Alternative, combined with the Phase 1 Project would not cause a significant impact at this or other study intersections under Near-Term (2018) Plus Cumulative Alternative conditions.

2.6.2.2 Freeway Operations

Table 2-15 shows the freeway segment LOS results for the Near-Term (2018) Plus Additional Employment Alternative conditions. **Appendix C** provides the detailed calculation work sheets.

The addition of the Alternative traffic would not cause any of the study freeway segments to operate at an unacceptable LOS. Therefore, it would not cause a significant impact at the study freeway segments under Near-Term (2018) Plus Additional Employment Alternative conditions.

2.7 SITE ACCESS AND CIRCULATION IMPACTS

Various aspects of site access and circulation are discussed below.

2.7.1 VEHICULAR ACCESS AND CIRCULATION

Under Phase 1, the RBC site will have vehicle access only at the current location on Meade Street/Seaver Avenue intersection. The Conceptual Layout shows that at buildout, vehicle access to parking lots and structures would be provided at several locations along Regatta Boulevard, Meade Street, and South 46th Street. In addition, cross-campus vehicle circulation will be served via Lark Drive, extending east from Regatta Boulevard, and connecting to a north-south axis roadway that connects to Regatta Boulevard between South 34th Street and Meade Street. Cross-campus access via Lark Drive to South 46th Street may also be provided. These connections would allow campus employees and visitors to travel to/from the site without excessive circulation around the site periphery. The multiple access points from the

TABLE 2-14
RICHMOND BAY CAMPUS
ADDITIONAL EMPLOYMENT ALTERNATIVE (2018) CONDITIONS –
STUDY INTERSECTION LOS SUMMARY

Intersection	Traffic Control	Peak Hour	Near-Term (2018) No Project		Near-Term (2018) Plus Additional Employment Alternative		Significant Impact?
			Delay[1] (seconds)	LOS[1]	Delay[1] (seconds)	LOS[1]	
1. Cutting Boulevard/ 23rd Street	Signal	AM	24.4	C	25.1	C	No
		PM	24.5	C	24.8	C	No
2. I-580 Westbound Ramps/ 23rd Street	Signal	AM	7.3	A	7.3	A	No
		PM	7.5	A	7.5	A	No
3. I-580 Eastbound Ramps/ 23rd Street	Signal	AM	4.2	A	4.2	A	No
		PM	6.5	A	6.5	A	No
4. Meeker Avenue/23rd Street/ Marina Bay Pkwy	Signal	AM	40.0	D	40.0	D	No
		PM	**148.5 (v/c=0.54)**	**F**	**148.5 (v/c=0.54)**	**F**	No
5. Regatta Boulevard/ Marina Bay Parkway	Signal	AM	22.0	C	22.1	C	No
		PM	15.1	B	15.9	B	No
6. I-580 Westbound Ramps/ Juliga Woods Street	Side Street Stop	AM	3.1 (11.2)	A (B)	3.1 (11.9)	A (B)	No
		PM	5.5 (12.0)	A (B)	6.9 (16.0)	A (C)	No
7. I-580 Eastbound Ramps/ Regatta Blvd/Meade Street	Signal	AM	11.1	B	13.2	B	No
		PM	11.1	B	11.2	B	No
8. Meade Street/ Regatta Boulevard	Side Street Stop	AM	6.6 (11.5)	A (B)	6.5 (14.1)	A (B)	No
		PM	5.5 (10.4)	A (B)	4.6 (11.7)	A (B)	No
9. Meade Street/ Seaver Avenue	Side Street Stop	AM	1.6 (10.3)	A (B)	4.3 (15.4)	A (C)	No
		PM	2.7 (9.4)	A (A)	8.5 (13.2)	A (B)	No
10. Seaport Avenue/I-580 Eastbound Ramps/South 51st Street/Bayview Avenue	All-way Stop	AM	27.2	D	34.6	D	No
		PM	20.8	C	26.5	D	No
11. I-580 Westbound Ramps/ Bayview Avenue	Signal	AM	5.6	A	7.6	A	No
		PM	8.6	A	9.2	A	No
12. Carlson Boulevard/ Bayview Avenue	Signal	AM	28.6	C	29.7	C	No
		PM	24.5	C	24.6	C	No
13. Carlson Boulevard/ I-80 Westbound Ramps	Signal	AM	20.4	C	23.3	C	No
		PM	15.9	B	16.1	B	No
14. Carlson Boulevard/ I-80 Eastbound Ramps	Signal	AM	12.9	B	13.6	B	No
		PM	12.2	B	12.8	B	No

Notes: **Bold** indicates an intersection operating at unacceptable LOS E or LOS F.
1. For signalized and all-way stop-controlled intersections, average intersection delay and LOS based on the 2000

TABLE 2-14
RICHMOND BAY CAMPUS
ADDITIONAL EMPLOYMENT ALTERNATIVE (2018) CONDITIONS –
STUDY INTERSECTION LOS SUMMARY

HCM method is shown. For side-street stop-controlled intersections, delays for worst movement and average intersection delay are shown: intersection average (worst movement).
Source: Fehr & Peers.

TABLE 2-15
RICHMOND BAY CAMPUS
ADDITIONAL EMPLOYMENT ALTERNATIVE (2018) CONDITIONS –
FREEWAY SEGMENT LOS SUMMARY

Freeway Segment	Type[1]	Dir[2]	Near-Term (2018) No Project				Near-Term (2018) Plus Additional Employment Alternative				Significant Impact?
			AM Peak Hour		PM Peak Hour		AM Peak Hour		PM Peak Hour		
			Density[3]	LOS	Density[3]	LOS	Density[3]	LOS	Density[3]	LOS	
1. I-580 between Harbor Way and Marina Bay Pkwy	Weave	EB	N/A	A	N/A	B	N/A	A	N/A	B	No
	Weave	WB	N/A	A	N/A	A	N/A	A	N/A	A	No
2. I-580 between Marina Bay Pkwy and Regatta Blvd	Weave	EB	N/A	A	N/A	B	N/A	B	N/A	B	No
	Weave	WB	N/A	B	N/A	A	N/A	B	N/A	B	No
3. I-580 between Regatta Blvd and Bayview Ave	Weave	EB	N/A	B	N/A	B	N/A	B	N/A	B	No
	Weave	WB	N/A	B	N/A	A	N/A	B	N/A	A	No
4. I-580 between Bayview Ave and Central Ave	Basic	EB	17.8	B	17.1	B	17.9	B	17.6	B	No
	Basic	WB	17.3	B	18.6	C	17.9	B	18.7	C	No
5. I-580 between Central Ave and I-80	Basic	EB	26.1	D	32.8	D	26.2	D	34.3	D	No
	Basic	WB	29.1	D	24.0	C	30.4	D	24.2	C	No
6. I-80 between Carlson Blvd and Potrero Ave	Basic	EB	22.9	C	28.2	D	23.0	C	28.6	D	No
	Basic	WB	31.4	D	25.3	C	31.9	D	25.4	C	No
7. I-80 at Gilman St Overpass	Basic	EB	23.0	C	28.4	D	23.4	C	28.5	D	No
	Basic	WB	32.1	D	26.3	D	32.2	D	26.8	D	No

1. Segments with auxiliary lanes are classified as weave segments, and were analyzed based on the Leisch Method. Basic segments are analyzed as basic segments using the 2000 HCM methodologies.
2. EB = Eastbound; WB = Westbound
3. Density is presented in passenger cars per lane per mile (pc/ln/mi).

Source: Fehr & Peers.

campus periphery, combined with the internal circulation roadways, would distribute peak hour traffic volumes and reduce the project traffic volume at any one driveway or intersection.

Regatta Boulevard would be relocated to west and north of its current alignment so that through traffic using Regatta Boulevard would not travel through the RBC site and provide more connectivity between the eastern and western portions of the RBC. Although other internal RBC roadways may allow through traffic to traverse the RBC site, these streets would be designed to minimize automobile speeds to discourage through automobile traffic and prioritize pedestrian and bicycle travel in the RBC.

Traffic generated by the RBC would travel to and from the parking facilities in the RBC. Currently, the exact size, location, and access points of the parking facilities are not known. It is expected that as the size, location, and access points of each future parking facility is established, a more detailed analysis will be conducted to determine the infrastructure (i.e., number of lanes, signal, etc.) needed to serve each parking facility. Therefore, the impacts on vehicular access and circulation are expected to be less than significant.

2.7.2 PEDESTRIAN AND BICYCLE CIRCULATION

The City of Richmond's *Bicycle Master Plan* and *Pedestrian Plan* outline goals and policy objectives to guide and promote the development of bicycle and pedestrian facilities throughout the city and link these facilities, where possible, to other local and regional bicycle and pedestrian networks. Several of these goals and polices are applicable to development of the RBC. Goal 1 of the *Bicycle Master Plan* expands the city's bicycle routes and parking facilities into an extensive, well-connected and well-designed network, and would improve and maintain these facilities over time. Goal 4 incorporates the needs and concerns of cyclists in all transportation and development projects. Similarly, the Increased Connectivity and Increased Sustainability goals of the *Pedestrian Plan* seek to reduce physical barriers to walking and promote walking as a long-term transportation alternative to reduce vehicle miles travelled and climate change and air quality impacts.

The proposed bicycle and pedestrian networks of both plans show pathways through the area encompassing the RBC site connecting to the Bay Trail and to other existing and proposed facilities in the vicinity of the site. The primary pathway outlined in these plans would consist of a bicycle and pedestrian spine through the site connecting Seaver Avenue with the Bay Trail. While minimal detail is provided on the design of internal roadways or paths, the Conceptual Layout for the LRDP shows a pedestrian-friendly workplace, with buildings clustered together connected by tree-lined paths, and internal roadways that minimize walking distance between the two building clusters. Consistent with the goals in the bicycle and pedestrian plans, pathways would provide pedestrian and bicycle connections between the RBC, Meeker

Tidal Slough and the San Francisco Bay Trail. These pathways would also promote walking as an alternative to vehicular transportation within the site, consistent with the Increased Sustainability goal.

2.7.3 TRANSIT DEMAND

As previously described, two shuttle lines, serving UC Berkeley and LBNL campuses and El Cerrito Plaza BART Station, are proposed for the RBC. It is expected that hours of operations and frequency of service will be increased as the RBC expands and the number of employees increases.

As previously described, currently, AC Transit does not serve the RBC directly. However, it is expected that AC Transit would initiate direct service to the RBC as the number of employees and associated transit demand increases. This service may involve modifications of existing routes or a new route.

IMPACT 2-4: TRANSIT DEMAND

The Project would generate demand for bus transit service that may not be adequately served by the proposed RBC shuttles serving UC Berkeley, LBNL, and El Cerrito Plaza BART station. Although this is not considered a significant impact, the following improvement is recommended.

Environmental Protection Measure 2-4: The University of California shall implement the following:

- Regularly monitor the use of the proposed shuttle services and if necessary, adjust service frequency, stop location, and routes to better serve the RBC population.
- Coordinate with AC Transit and the City of Richmond to modify and/or extend current bus routes to serve demand generated by the RBC, as employment grows at the campus.

2.7.4 TRAFFIC HAZARDS

The proposed RBC LRDP would result in increased vehicular traffic and pedestrian and bicycle activity in and around the Project site. The LRDP proposes gateway elements to orient the visitor that they are arriving at the RBC, and vehicular access would be limited primarily to the perimeter of the campus to promote pedestrian and bicycle activity and safety. The exception is Lark Drive, which would provide an important link to adjoining research and industrial districts to the east as they are developed with the LRDP. Lark Drive would also provide public access into the campus, including access to public amenities, including the San Francisco Bay Trail. The LRDP proposes to design this street to discourage cut-through traffic or speeding, and proposes design elements, such as narrow roadway width, stop signs or other traffic controls, street alignment (e.g., curve radii), and special paving to denote pedestrian crossing zones. This design, combined with the design of other internal and access streets, would minimize potential

conflicts between different modes of travel and provide safe and efficient pedestrian, bicycle, and vehicular access and circulation throughout the RBC. Although, detailed design for various buildings, parking facilities, and internal roadways and pathways has not been completed, the final design for each project element will be reviewed to ensure consistency with applicable design standards. In addition, the proposed uses at the RBC are similar to and consistent with the existing uses at the site. Thus, the proposed Project would not cause a significant impact by substantially increasing traffic hazards to motor vehicles, bicycles, or pedestrians due to a design feature or incompatible uses.

2.7.5 RAILROAD CROSSINGS

The existing at-grade railroad crossing on Marina Bay Parkway is expected to be replaced by a grade separated crossing, which will also provide grade separated facilities for bicycles and pedestrians. Construction is scheduled to begin in 2013. Thus, neither the Phase 1 Project, nor the buildout project would cause an impact at this location.

The other at-grade railroad crossing is on Meade Street between the RBC and I-580 Interchange at Regatta Boulevard/Juliga Woods Street. The recently completed Meade Street bypass allows traffic on Regatta Boulevard to access I-580 further east via Meade Street and the Bayview Avenue Interchange without crossing the at-grade railroad tracks. At both Phase 1 and buildout of the RBC, drivers who may typically use the Regatta Boulevard/Juliga Woods Street to travel to and from the site have a choice of using different streets to access the site. Thus, if trains are using the at-grade crossing and blocking through vehicular traffic, drivers can divert to other streets. Mitigation Measure 2-2C would also signalize the recently constructed Meade Street/Regatta Boulevard (Intersection 8) and interconnect the signal operations with the controls at the at-grade railroad crossing and the existing signal at the I-580 Eastbound Ramps/Regatta Boulevard/Meade Street (intersection 7). This improvement would minimize the potential for vehicular queues at either intersection to spill back onto the railroad tracks.

The at-grade railroad crossing on Meade Street provides a center median and directional safety gates that prevent automobiles and bicycles from crossing the tracks when trains are passing. The crossing currently provides a sidewalk on the north side of the roadway which also provides a safety gate to prevent pedestrians from crossing the tracks when trains are passing. The crossing currently provides a sidewalk on the north side of the roadway which provides a safety gate. In addition, considering the infrequent use of the at-grade crossing by trains, and that the at-grade crossing currently provides safety features such as gates and bells, the Project would not cause a significant impact at this at-grade railroad crossing.

2.7.6 CONSISTENCY WITH ADOPTED POLICIES, PLANS OR PROGRAMS SUPPORTING ALTERNATIVE TRANSPORTATION

The proposed RBC LRDP is consistent with adopted policies, plans, and programs that support alternative transportation and would not cause a significant impact by conflicting with adopted policies, plans, or programs supporting public transit, bicycle, or pedestrian through the following:

- The Conceptual Layout locates parking facilities in the parameter of the RBC site and provides paths connecting the various buildings. Thus, walking would be the primary mode of transportation for internal trips within the RBC. This is consistent with the Increased Connectivity, Improved Health, and Increased Sustainability goals of the *Pedestrian Plan*.
- The LRDP would provide connections to Bay Trail and other planned bicycle facilities in City of Richmond, consistent with Goals 1 and 4 of the Bicycle Master Plan.
- The Project would provide adequate bicycle parking and amenities such as showers and lockers. The Project may also provide bike sharing. This is consistent with the objective of doubling the number of bicycle parking spaces per Goal 1 of the *Bicycle Master Plan*.
- The LRDP would not prevent the installation of planned and proposed pedestrian and bicycle facilities in the City of Richmond as previously described in Section 2.1.5, consistent with Goal 1 of the *Bicycle Master Plan* and the Increased Connectivity goal of the *Pedestrian Plan*.
- The Project would include a robust Transportation Demand Management Program (TDM) program that provides incentives that encourage the use of transit, walking, biking, and carpooling. This is consistent with Policy CR5.1 of the Circulation Element of the City of Richmond General Plan 2030.
- The Project would provide on-site amenities, such as food service and temporary housing, that would reduce the need for off-site travel. This would be consistent with the Increased Sustainability goal of the *Pedestrian Plan*.
- The Project would provide frequent shuttle service to BART, UC Berkeley, and LBNL, consistent with Goal 4 of the Bicycle Master Plan and Goal CR3 of the Circulation Element.
- The high number of employees expected at buildout of the RBC would make extending transit service in the project area more viable, consistent with Goal CR3 of the Circulation Element.

Thus, the proposed RBC Project would not cause a significant impact on consistency with adopted policies, plans, and programs that support alternative transportation.

2.7.7 EMERGENCY ACCESS

The nearest fire station to the RBC site is Richmond Fire Department Station 64, which is located at 4801 Bayview Avenue, about one-half mile to the east of the site. It is expected that Richmond Fire Department would continue to provide emergency services at the RBC through Phase 1 of the Project. However, the LRDP anticipates construction of an on-site fire station when sufficient development is provided within the RBC.

The overall RBC site would continue to provide multiple access points and each facility would also be designed to provide multiple access points. Thus, if one site access were blocked, the other access point(s) could be used by emergency vehicles to reach any part of the campus or specific building. In addition, all RBC buildings and internal streets would be designed to accommodate access by fire apparatus and other emergency response vehicles.

Thus, there would be adequate emergency service and access after Phase 1 and at buildout, and the Project would not cause a significant impact on emergency access.

2.7.8 CONSTRUCTION PERIOD IMPACTS

Construction of Phase 1 Project is expected to start in 2014. Construction activity at the RBC site is estimated to continue until 2050 when the proposed LRDP would be completed. During the demolition of existing buildings or construction of new buildings, roadways, and other infrastructure in the RBC site, temporary and intermittent transportation impacts may result from truck movements as well as construction worker vehicle commute trips. The construction-related traffic may temporary reduce capacities of roadways in the vicinity because of the slower movements and larger turning radii of construction trucks compared to passenger vehicles.

Construction worker and truck trips during peak commute periods (7:00 to 9:00 AM and 4:00 to 6:00 PM on weekdays) may result in short-term adverse effects during the construction period.

In addition, temporary closure of streets and paths for construction staging may also affect automobile, pedestrian, and bicycle access and circulation and may cause a significant temporary impact by increasing traffic hazards or impeding emergency access.

IMPACT 2-5: CONSTRUCTION TRAFFIC IMPACTS

The Project construction would temporarily and intermittently impact traffic operations due to truck movements and construction worker commute trips. This is a *significant* impact.

Mitigation Measure 2-5: Prepare a Construction Traffic Management Plan (CTMP) for each construction project at the RBC site to reduce the impacts of construction on traffic and parking. The University of California shall work with City of Richmond in preparing the CTMP which may consist of the following:

- Proposed truck routes
- Hours of construction and limits on number of truck trips during peak commute periods (7:00 to 9:00 AM and 4:00 to 6:00 PM) if traffic conditions demonstrate the need to reduce construction traffic to avoid causing significant delays.

- Parking management plan for construction workers.
- Tools to provide safe access for pedestrians, bicyclists, automobiles, and emergency access vehicles.
- Identification of alternative routes for temporary closure of streets and/or paths during construction.

Implementation of this mitigation measure will reduce the impact to a *less than significant* level.

2.7.9 CHANGES IN AIR TRAFFIC PATTERNS

The nearest airport to the RBC is the Oakland International Airport, which is about 15 miles to the south. The proposed LRDP would increase density and increase building heights at the RBC. However, building heights would not interfere with current flight patterns of Oakland International Airport or other nearby airports. Therefore, the proposed RBC Project would not cause a significant impact on air traffic patterns.

3.0 ALAMEDA POINT ALTERNATIVE

This chapter describes existing transportation conditions for the Alameda Point site and identifies impacts and mitigation measures of Phase 1 development of the proposed LRDP at Alameda Point under Near-Term (2018) and Cumulative (2035) conditions.

3.1 EXISTING CONDITIONS

Existing transportation conditions at Alameda Point and vicinity are described below.

3.1.1 EXISTING ROADWAY NETWORK

Figure 3-1 shows the existing Alameda Point site, the surrounding roadway system, and study intersections and freeway segments analyzed as part of this assessment. The regional and local roadways serving the project site are described below.

3.1.1.1 Regional Roadways

Interstate 880 (I-880) is a north-south eight -lane freeway, between Oakland and San Jose. Near the Alameda Point site, I-880 provides a direct connection to I-980/SR-24. Alameda Point connects to I-880 via an interchange at Broadway and Jackson Street in Oakland, the Webster/Posey Tubes and other streets in Alameda. I-880 has an AADT of 199,000 vehicles south of I-980 (Caltrans, 2011).

Webster/Posey Tubes (SR260) are each two-lane, one-way tunnels under the Oakland Estuary that connect City of Alameda to Oakland. Posey Tube provides access to Oakland from Alameda, whereas Webster Tube provides access from Oakland to Alameda. Alameda Point connects to the Webster/Posey tubes via Atlantic Avenue, Pacific Avenue, Main Street/Central Avenue, and Webster Street or Constitution Way. Each tube provides two travel lanes. Posey Tube also provides a separated pedestrian and bicycle path. The speed limit is 45 mph in the tubes. The Webster and Posey Tubes have an AADT of about 22,300 vehicles (Caltrans, 2011).

Webster Street (SR260) is a north-south major arterial that connects Central Avenue in the south to the Webster/Posey Tubes in the north. Webster Street provides two travel lanes in each direction and on-street parking and sidewalks south of Atlantic Avenue on both sides of the street. The speed limit is 25 mph.

Figure 3-1.

Alameda Point Campus Study Locations

WC12-2953_3-1_AlamedaPtCampusStudy

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Constitution Way is a north-south major arterial in Alameda that provides one of the two connections to the Webster/Posey Tubes. Constitution Way connects to Webster Tube directly and to Posey Tube via Webster Street. Constitution Way provides two travel lanes in each direction, a median, and left turn lanes at most signalized intersections and sidewalks on both sides of the roadway. South of Lincoln Avenue, Constitution Way becomes 8th Street. The speed limit is 25 mph.

Willie Stargell Avenue is an east-west arterial that connects Webster Street and Alameda Point. Between Main and 5th streets, Willie Stargell Avenue provides one travel lane in each direction. East of 5th Street, Willie Stargell Avenue widens to two travel lanes in each direction and a center median. The speed limit is 25 mph. Willie Stargell Avenue provides intermittent sidewalks on both sides of the roadway. It also provides Class 2 bicycle lanes east of 5th Street, and is a designated Class 3 bicycle route west of 5th Street.

Atlantic Avenue (Ralph Appezzato Memorial Parkway) is an east-west arterial that connects Alameda Point in the west to Webster Street, Constitution Way and points east. West of Constitution Way, Atlantic Avenue provides two travel lanes in each direction, intermittent sidewalks, a raised median, and left turn pockets at signalized intersections. East of Constitution Way, Atlantic Avenue narrows to one travel lane with class 2 bike lanes in each direction and sidewalks on both sides of the roadway. The speed limit is 35 mph between Main and Webster streets and is 25 mph east of Webster Street.

Pacific Avenue is an east-west arterial that connects Main Street in the west to Park Street in the east. Near the Project site, Pacific Avenue generally provides two travel lanes in each direction with on-street parking and sidewalks on both sides of the street. The speed limit is 25 mph.

Lincoln Avenue is generally an east-west arterial that connects Central Avenue in the west to High Street in the east. Near the Project site, Lincoln Avenue generally provides two travel lanes in each direction with on-street parking and sidewalks on both sides of the street. The speed limit is 25 mph.

Main Street is a north-south arterial that connects Central Avenue to the Alameda Main Street Ferry Terminal. Main Street provides two travel lanes in each direction and left-turn pockets at signalized intersections with intermittent sidewalks and a parallel Class 1 path. The speed limit is 35 mph. South of Pacific Avenue, Main Street becomes Central Avenue and extends through the City of Alameda.

3.1.1.2 Local Roadways

Ferry Point is a north-south collector to the west of the Alameda Point site, connecting the Project site to Atlantic Avenue and points north. In the vicinity of the Project site, Ferry Point provides one travel lane in each direction with striped shoulders, and minimal pedestrian facilities. The speed limit is 25 mph.

Viking Street is a north-south local street on the east side of the Alameda Point site connecting the Project site to Atlantic Avenue and points north. In the vicinity of the Project site, Viking Street provides one travel lane in each direction with striped shoulders, and minimal pedestrian facilities. The speed limit is 25 mph.

Hornet Avenue is an east-west local street on the south side of the Alameda Point site. In the vicinity of the Project site, Hornet Avenue provides one travel lane in each direction with striped shoulders, and minimal pedestrian facilities. A parallel Class 1 path is provided just south of Hornet Avenue. The speed limit is 25 mph.

3.1.2 INTERSECTION OPERATIONS ANALYSIS

This study analyzes existing traffic operations during typical weekday AM and PM peak hours at the following 13 intersections:

City of Alameda:
1. Willie Stargell Avenue/Webster Street
2. Main Street/Atlantic Avenue
3. Third Street/Atlantic Avenue
4. Webster Street/Atlantic Avenue
5. Constitution Way/Atlantic Street
6. Main Street/Pacific Avenue
7. Webster Street/Lincoln Avenue
8. Constitution Way/Lincoln Avenue
9. 8th Street/Central Avenue

City of Oakland:
10. Broadway/5th Street
11. Webster Street/8th Street
12. Harrison Street/7th Street
13. Jackson Street/7th Street

These intersections were selected for analysis because they are most likely to be affected by the proposed Project. **Figure 3-1** shows the location of the study.

3.1.2.1 Existing Intersection Volumes

For all study intersections, the operations analysis presented in this study is based on AM and PM peak period (7:00 to 9:00 AM and 4:00 to 6:00 PM) intersection turning movement, pedestrian, and bicycle volumes. These time periods were selected because trips generated by the proposed Project, in combination with background traffic, are expected to represent typical worst traffic conditions. Traffic counts were collected in October 2010[4] for intersections in Oakland and on December 12, 2012 for intersections in Alameda. Within the peak periods, the peak hours (i.e., the hour with the highest traffic volumes observed in the study area) are from 7:45 AM to 8:45 AM (AM peak hour) and 5:00 PM to 6:00 PM (PM peak hour).

[4] In general, traffic volume counts that are three years old or newer are considered to be valid. Considering that minimal new development or roadway modifications have occurred in the vicinity of these intersections in the last three years, the counts continue to be valid and present typical current conditions.

Because the traffic counts in Alameda were collected in December when traffic patterns maybe atypical due to irregular school schedules, holidays, and more frequent shopping trips, "check" counts were collected during the week of January 28, 2013 at two study intersections, while local schools and College of Alameda were in regular session. These "check" counts were compared to the December 2012 counts, in terms of total intersection volumes and also critical movements. In comparison, some movements were higher in December 2012 while others were higher in January 2013. The January 2013 intersections volumes were about two to ten percent higher than the December 2012 volumes, which is within the typical daily fluctuation expected in traffic volumes. Thus, the December 2012 traffic volumes represent typical conditions in the Alameda study intersections. Although the December 2012 traffic volumes represent typical conditions in the study area, they were adjusted to reflect the higher traffic volumes observed in January 2013 in order to present a more conservative analysis.

Figures 3-2A and 3-2B present the existing AM and PM peak hour intersection vehicle turn movement volumes at the study intersections. **Figures 3-3A and 3-3B** present the existing AM and PM peak hour pedestrian and bicycle volumes at the study intersections. **Appendix D** presents the detailed count sheets at the study intersections.

3.1.2.2 Existing Intersection Operations

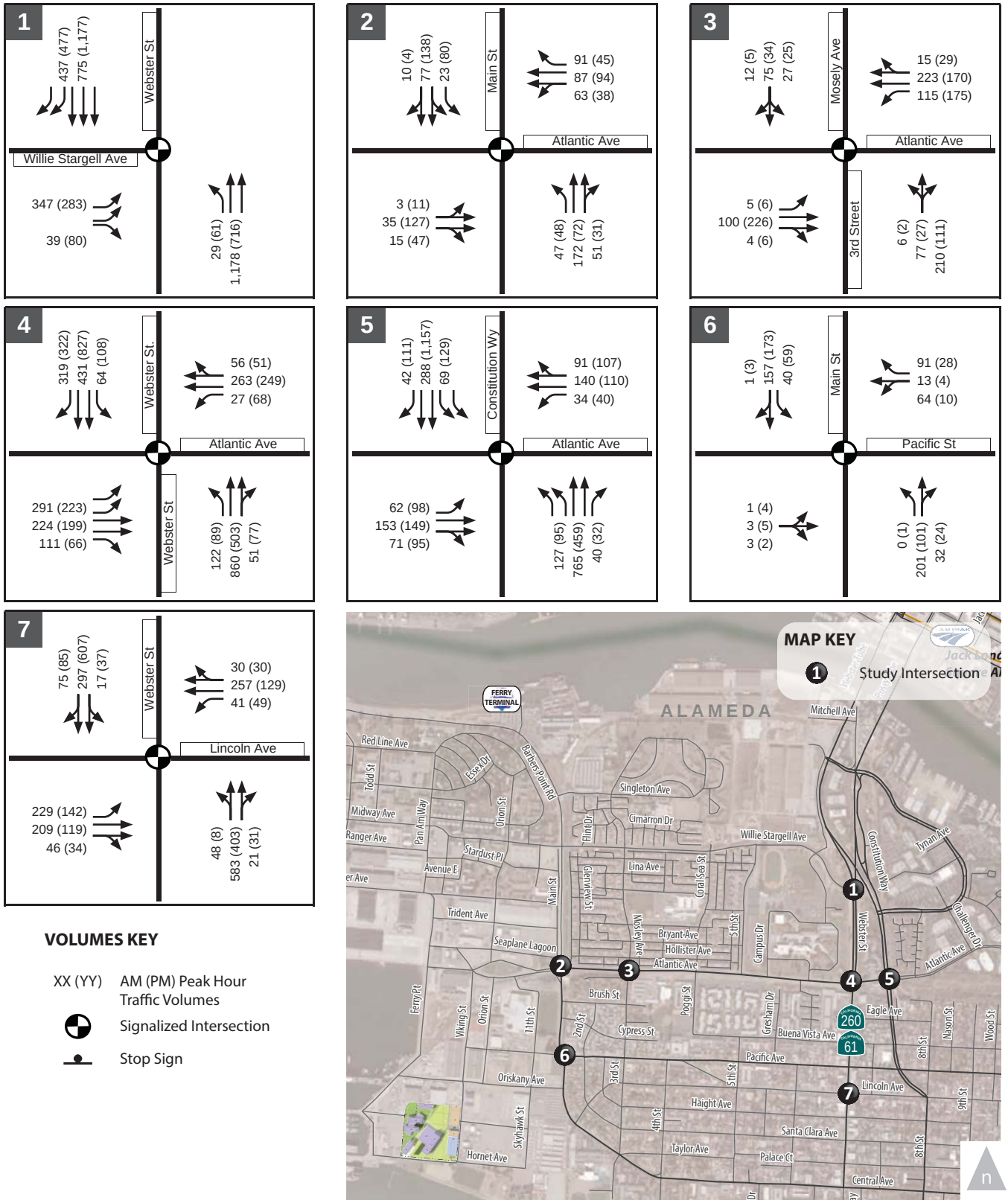
Table 3-1 summarizes existing weekday peak hour intersection LOS analysis results. **Appendix E** provides the detailed calculation work sheets. As shown in the table, all study intersections in Alameda currently operate at LOS D or better during both AM and PM peak hours. All but one study intersection in Oakland currently operate at LOS E or better during both AM and PM peak hours. The one sub-standard intersection in Oakland is the 7th Street/Harrison Street intersection which operates at LOS F during the PM peak hour.

3.1.3 FREEWAY OPERATIONS

This study analyzes existing traffic operations during typical weekday AM and PM peak hours at the following four freeway segments:

1. I-880 west of I-980
2. I-880 between I-980 and Oak Street
3. I-880 south of Oak Street
4. Webster/Posey Tubes

These freeway segments were selected for analysis because they are most likely to be affected by the proposed Project.



VOLUMES KEY

XX (YY) AM (PM) Peak Hour Traffic Volumes

Signalized Intersection

Stop Sign

Figure 3-2A.

Alameda Point Campus
Existing Peak Hour Traffic Volumes, Lane Configurations and Traffic Control

WC12-2953_3-2A_ExVol

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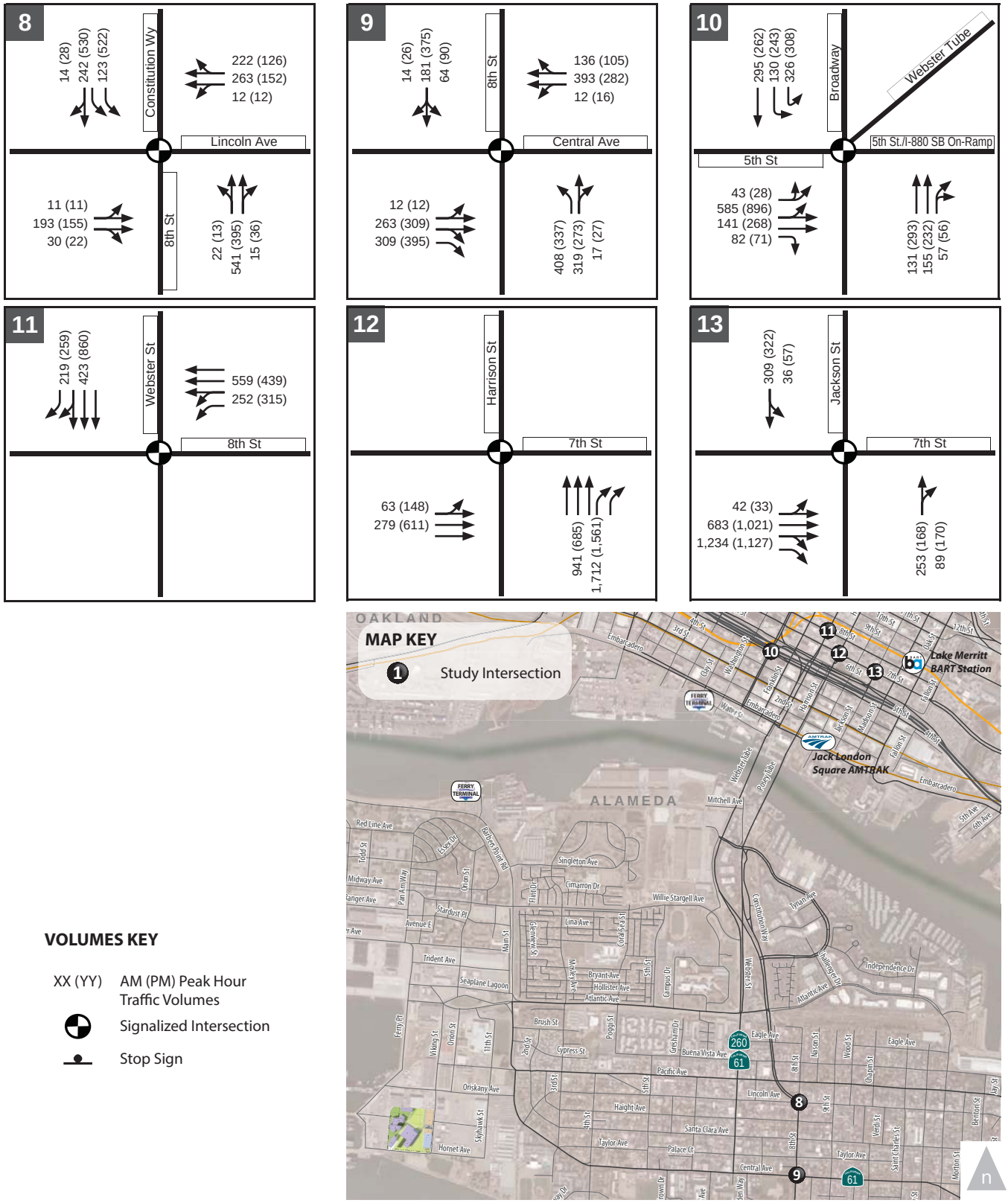


Figure 3-2B.

Alameda Point Campus
Existing Peak Hour Traffic Volumes, Lane Configurations and Traffic Control

WC12-2953_3-2B_ExVol

FEHR PEERS

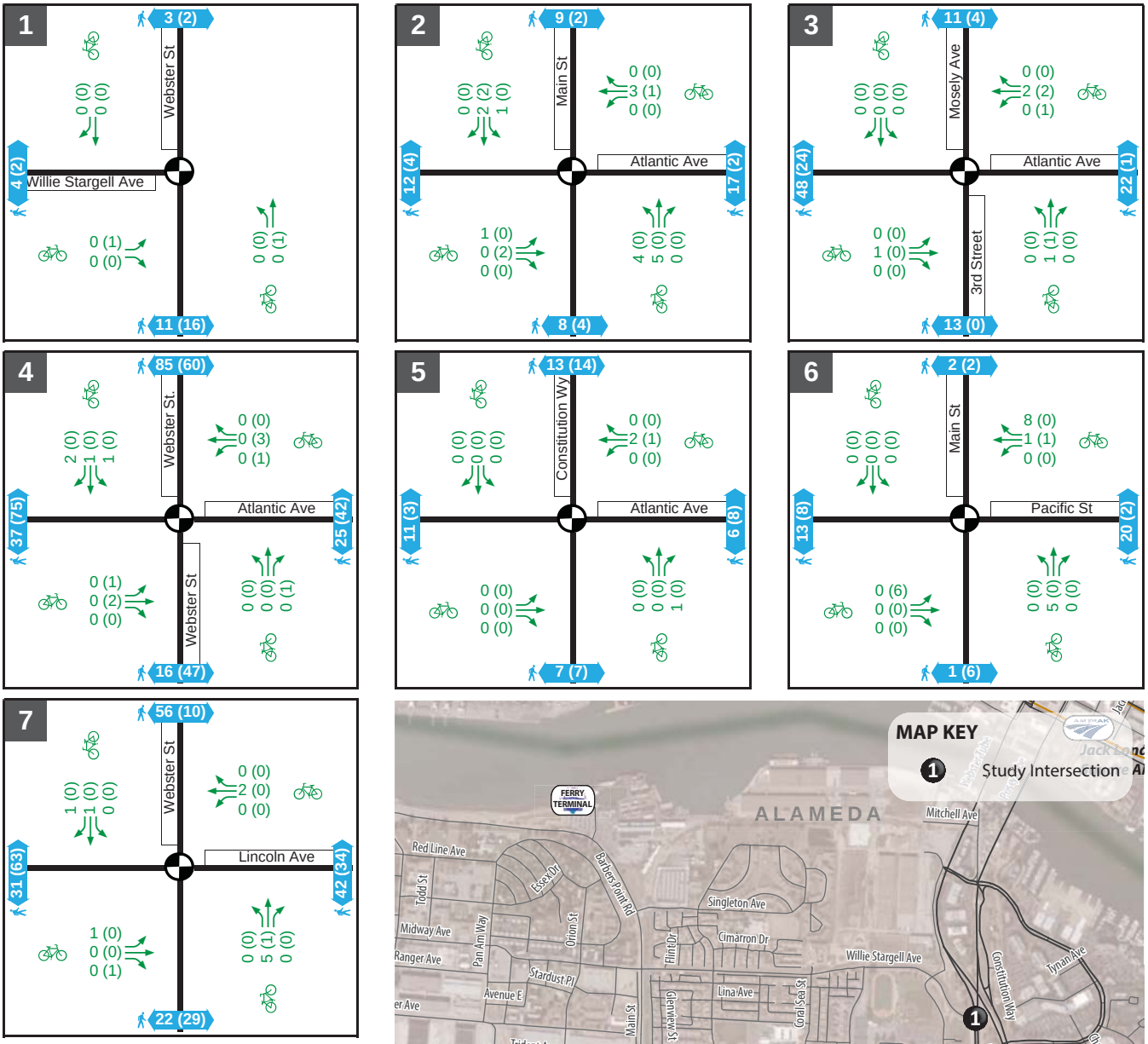
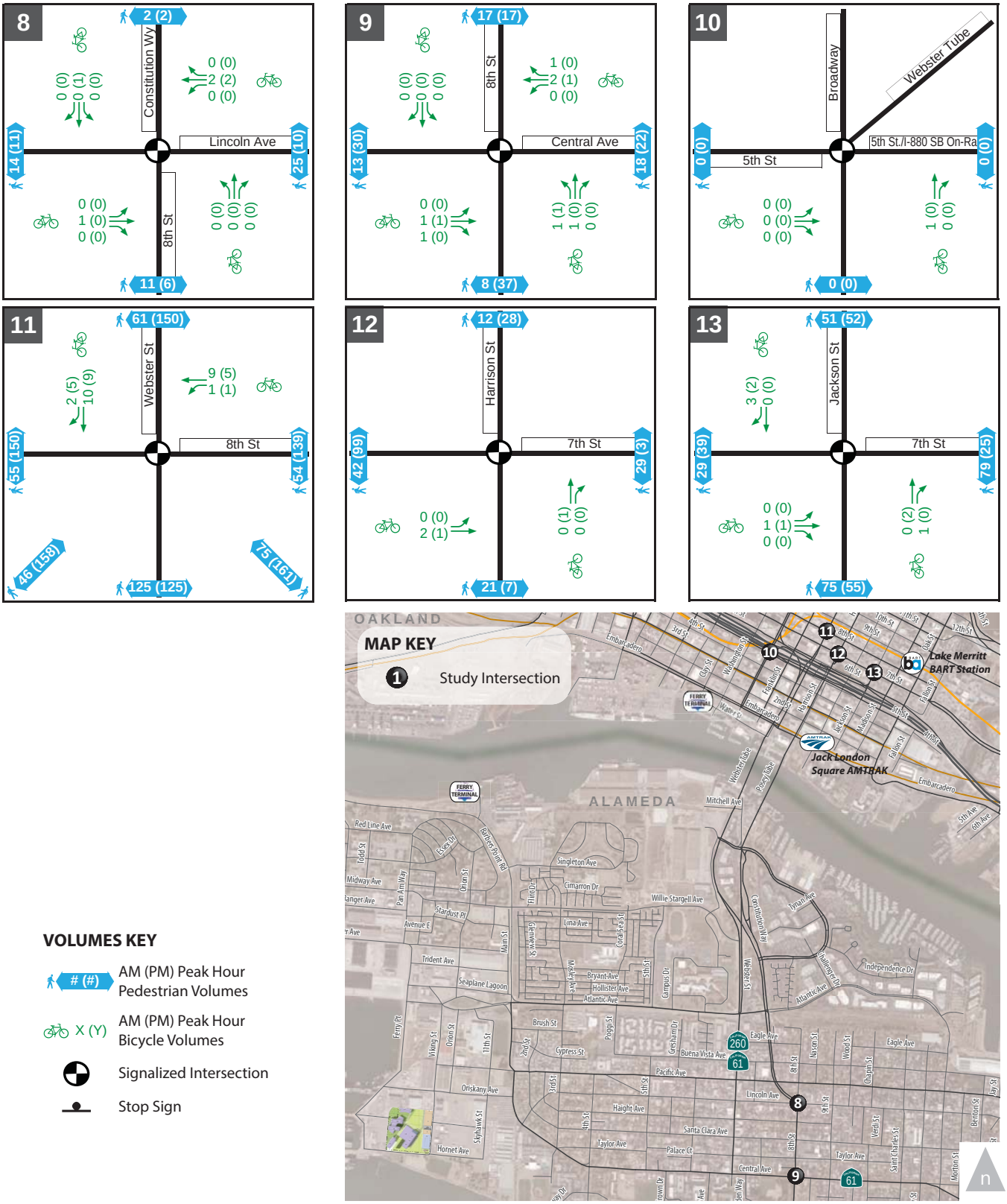


Figure 3-3A.

Alameda Point Campus
Existing Pedestrian and Bicycle Volumes

WC12-2953_3-3A_BikePedVol

FEHR PEERS



VOLUMES KEY

- # (#) — AM (PM) Peak Hour Pedestrian Volumes
- X (Y) — AM (PM) Peak Hour Bicycle Volumes
- Signalized Intersection
- Stop Sign

Figure 3-3B.

Alameda Point Campus
Existing Pedestrian and Bicycle Volumes

WC12-2953_3-3B_BikePedVol

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TABLE 3-1
ALAMEDA POINT
EXISTING CONDITIONS – STUDY INTERSECTION LOS SUMMARY

Intersection	Control	AM Peak Hour		PM Peak Hour	
		Delay (Seconds)[1]	LOS [1]	Delay (Seconds) [1]	LOS [1]
City of Alameda:					
1. Webster Street/ Willie Stargell Avenue	Signal	20.7	C	18.9	B
2. Main Street/ Atlantic Avenue	Signal	11.2	B	11.5	B
3. Third Street/ Atlantic Avenue	Signal	19.8	B	43.3	D
4. Webster Street/ Atlantic Avenue	Signal	36.1	D	28.3	C
5. Constitution Way/ Atlantic Street	Signal	20.5	C	23.1	C
6. Main Street/ Pacific Avenue	Signal	22.6	C	13.5	B
7. Webster Street/ Lincoln Avenue	Signal	16.9	B	13.9	B
8. Constitution Way/ Lincoln Avenue	Signal	20.3	C	21.1	C
9. 8th Street/ Central Avenue	Signal	39.3	D	39.9	D
City of Oakland:					
10. Broadway/ 5th Street	Signal	23.5	C	31.9	C
11. Webster Street/ 8th Street	Signal	15.3	B	16.7	B
12. Harrison Street/ 7th Street	Signal	77.4	E	**>120 (v/c=0.73)**	**F**
13. Jackson Street/ 7th Street	Signal	12.0	B	12.2	B

Notes: **Bold** indicates intersection operating at unacceptable LOS E/F in Alameda or unacceptable LOS F in Oakland.
1. Signalized and all-way stop-controlled intersection delay and LOS based on average control delay per vehicle, according to the Highway Capacity Manual, Special Report 209, Transportation Research Board, 2000.

Source: Fehr & Peers.

3.1.3.1 Existing Freeway Volumes

Existing freeway volumes are primarily derived from two sources of data: (1) October 2012 freeway volumes published by Caltrans through the California Freeway Performance Measurement System (PeMS), and (2) intersection turning movement counts at the tube termini collected in December 2012, and described in Section 3.1.2.1.

3.1.3.2 Existing Freeway Operations

Table 3-2 summarizes existing weekday AM and PM peak hour freeway LOS analysis results. **Appendix F** provides the detailed calculation work sheets. As shown in the table, both directions of I-880 west of I-980 and southbound I-880 between I-980 and Oak Street currently operate at LOS F during both peak hours. The Webster/Posey Tubes operate at LOS C or better during both peak hours.

TABLE 3-2
ALAMEDA POINT
EXISTING CONDITIONS – FREEWAY SEGMENT LOS SUMMARY

Freeway Segment	Type[1]	Dir[2]	AM Peak Hour		PM Peak Hour	
			Density[3]	LOS	Density[3]	LOS
1. I-880, west of I-980	Basic	NB	--	F	--	F
	Basic	SB	--	F	--	F
2. I-880, between I-980 and Oak Street	Basic	NB	34.7	D	36.1	E
	Basic	SB	--	F	--	F
3. I-880, south of Oak Street	Basic	NB	33.1	D	33.0	D
	Basic	SB	32.5	D	36.6	E
4. Webster/Posey Tubes	Basic	NB	22.4	C	19.0	C
	Basic	SB	14.8	B	22.0	C

1. Basic segments are analyzed as basic segments using the 2000 HCM methodologies.
2. NB = Northbound; SB = Southbound
3. Density is presented in passenger cars per lane per mile (pc/ln/mi).

Source: Fehr & Peers.

3.1.4 EXISTING TRANSIT SERVICES

The Alameda Point site is served indirectly by BART, AC Transit, ferries, and Amtrak. **Figure 3-4** shows the transit routes in the vicinity of the site. Each transit service is described below.

Figure 3-4.

Alameda Point Campus Existing Transit Service

WC12-2953_3-4_APCtransit

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3.1.4.1 BART

BART provides regional commuter rail transit in Alameda, Contra Costa, San Francisco, and San Mateo counties. Currently, BART trains operate on weekdays from 4:00 AM to midnight, on Saturdays from 6:00 AM to midnight, and on Sundays from 8:00 AM to midnight. The nearest BART station to Alameda Point is the Lake Merritt BART Station (about 2.5 miles northeast of Alameda Point) in Oakland, which is served by the Fremont-Richmond, Fremont-Daily City, and Dublin/Pleasanton-Daly City lines. Typically, the Lake Merritt BART Station is served by a train every five (peak weekday commute periods) to ten minutes (Sundays). The average weekday daily ridership for the Lake Merritt BART Station is about 11,800, riders in January 2013.

3.1.4.2 AC Transit

Local bus service in Alameda is provided by AC Transit. **Figure 3-4** illustrates the existing AC Transit routes in the vicinity of Alameda Point. **Table 3-3** describes the major bus routes serving the Project area. Most bus routes operate along Webster Street, which is about one mile east of the Alameda Point site.

3.1.4.3 Ferry Service

The Alameda Main Street Ferry Terminal is located about one mile north of the Project site. The Water Emergency Transportation Authority (WETA) provides weekday commute ferry service between the Alameda Main Street Ferry Terminal and San Francisco, South San Francisco, and Oakland Jack London Square. The Alameda Ferry Terminal is typically in operation on weekdays from 6:00 AM to 8:45 PM with seasonal service provided on weekends.

3.1.4.4 Amtrak

The Oakland Jack London Square Station, located about 3.5 miles northeast of the Alameda Point site, provides Amtrak service on three routes – the Capital Corridor (15 trains per day in each direction between San Jose and Sacramento); the San Joaquin Intercity (four trains per day in each direction to Bakersfield via Modesto and Fresno) and the Coast Starlight (one train per day in each direction between Seattle and Los Angeles).

TABLE 3-3
ALAMEDA POINT
AC TRANSIT SERVICE SUMMARY

Line	Route	Nearest Stop [1]	Weekday		Weekend	
			Hours	Frequency	Hours	Frequency
Local Routes						
20	Dimond District – Downtown Oakland	Webster St./ Central Ave. (About 1.6 miles)	5:00 AM – 10:00 PM	30 minutes	5:00 AM – 10:00 PM	30 minutes
31	Alameda Point – Macarthur BART	Main St./ Pacific Ave. (About 0.8 miles)	6:00 AM – 10:00 PM	30 minutes	6:00 AM – 10:00 PM	30 minutes
51A	Rockridge BART – Fruitvale BART	Webster St./ Santa Clara Ave. (About 1.6 miles)	5:15 AM – 12:00 AM	10-20 minutes	5:40 AM – 12:00 AM	15-20 minutes
Night Routes						
851	Downtown Berkeley – Fruitvale BART	Webster St./ Santa Clara Ave. (About 1.6 miles)	12:30 AM – 4:30 AM	60 minutes	12:30 AM – 4:30 AM	60 minutes
Transbay Routes						
O	Fruitvale BART – San Francisco	Webster St./ Santa Clara Ave. (About 1.6 miles)	5:20 AM – 9:20 PM	30 – 60 minutes	5:20 AM – 9:20 AM	60 minutes
W	Broadway & Blanding – San Francisco	Webster St./ Santa Clara Ave. (About 1.6 miles)	6:00 AM – 9:00 AM	20 – 30 minutes	N/A	N/A

1. Distance shown is current walking distance between bus stop and Ferry Point at West Hornet Avenue.
Source: AC Transit, 2013.

3.1.5 EXISTING PEDESTRIAN AND BICYCLE CIRCULATION

As the area in the vicinity of Alameda Point site is mostly industrial, few of the streets currently provide sidewalks. Most pedestrian activity occurs in the extended shoulder of the streets and along industrial driveways. Roadways in the study area that do provide pedestrian facilities include: Hornet Avenue on the south side of the street; Ferry Point north of Avenue L; and Atlantic Avenue. Although there are no sidewalks along the remaining roadways, some of the intersections include marked crosswalks. In addition to sidewalks and crosswalks, there is a multi-use trail just south of the Alameda Point site, along Alameda Park.

Based on the *City of Alameda Bicycle Master Plan Update* (November 2010), bicycle facilities in the study area can be classified into three types, including:

- ***Bicycle Paths (Class 1)*** – These facilities are located off-street and can serve both bicyclists and pedestrians.

- ***Bicycle Lanes (Class 2)*** – These facilities provide a dedicated area for bicyclists within the paved street width through the use of striping and appropriate signage.

- ***Bicycle Routes (Class 3)*** – These facilities are found along streets that do not provide sufficient width for dedicated bicycle lanes. The street is then designated as a bicycle route through the use of signage informing drivers to expect bicyclists.

Figure 3-5 identifies existing and proposed bicycle facilities in the study area. Currently, bicyclists are allowed on all roadways in the study area. Existing bicycle facilities near the project site include Class 1 bicycle paths along the shoreline in Alameda Park and adjacent to Main Street and Class 3 bicycle routes on Hancock Street between Central Avenue and the shoreline. The *2010 Alameda Bicycle Master Plan Update* proposes to extend the existing Class 1 paths adjacent to Atlantic Avenue and the shoreline further into Alameda Point. The Bicycle Master Plan Update also identifies Central and Pacific Avenues as future Class 3 bicycle routes.

As previously shown on Figures 3-3A and 3-3B, study intersections nearest to the Alameda Point site have minimal pedestrian and bicycle activity, while study intersections along Webster Street and Constitution Way have moderate pedestrian and bicycle activity, and study intersections in Oakland have high pedestrian activity as they are located in a high-density urban commercial area.

3.2 REGULATORY CONSIDERATIONS

3.2.1 ALAMEDA GENERAL PLAN

The Alameda General Plan Transportation Element contains the following objectives and supporting policies that are relevant to the Project:

<u>Objective 4.1.2:</u> Protect and enhance the service level of the transportation system.

Policy 4.1.2.a Develop multimodal level of service (LOS) standards that development will be required to maintain by encouraging the use of non-automotive modes.

<u>Objective 4.1.6</u>: Increase the efficiency of the existing transportation system by emphasizing Transportation System Management (TSM) strategies and Transportation Demand Management (TDM) techniques.

Figure 3-5.

Alameda Point Campus Existing and Future Bicycle Network

WC12-2953_3-5_APCbike

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Policy 4.1.6.a Identify, develop, and implement travel demand management strategies to reduce demand on the existing transportation system.

1. Establish peak hour trip reduction goals for all new developments as follows:
   - 10 percent peak hour trip reduction for new residential developments
   - 30 percent peak hour trip reduction for new commercial developments

Policy 4.1.6.e Support and maintain an up-to-date Transportation System Management (TSM) and Transportation Demand Management (TDM) plan consistent with state law to provide adequate traffic flow to maintain established LOS.

1. Develop a TDM plan which would include specific requirements for new developments to implement measures to mitigate their traffic impacts based on an applicable nexus.

2. Develop one or more sub-area TDM plans to help address the unique conditions of different areas within Alameda.

Policy 4.1.6.f Require monitoring programs to ensure that TSM and TDM measures mitigate impacts.

1. Develop thresholds of significance for ongoing monitoring and evaluation of TSM/ TDM measures

<u>Objective 4.2.3</u>: Plan, develop and implement a transportation system that protects and enhances air and water quality, protects and enhances views and access to the water, and minimizes noise impacts on residential areas.

Policy 4.2.3.c Identify and pursue opportunities to enhance shoreline access for pedestrians.

Policy 4.2.3.d Support and prioritize trip reduction strategies that maximize air quality benefits and reduce greenhouse gas emissions.

1. Support the use of alternative fuel vehicles for all transportation modes.

2. Encourage shift of trips to alternative transportation modes. This includes short trips, as these will have a disproportionate impact on air quality.

<u>Objective 4.2.4:</u> Develop a Transportation plan based on existing and projected land uses and plans. Encourage land use decisions that facilitate implementation of this transportation system.

Policy 4.2.4.a Encourage development patterns and land uses that promote the use of alternate modes and reduce the rate of growth in region-wide vehicle miles traveled.

Policy 4.2.4.b Integrate planning for Environmentally Friendly Modes, including transit, bicycling and walking, into the City's development review process.

Objective 4.3.1: Develop programs and infrastructure to encourage the use of high occupancy vehicles (HOVs), such as buses, ferries, vans and carpools.

Policy 4.3.1.c Actively encourage increases in public transit, including frequency and geographic coverage.

Policy 4.3.1.d Encourage and support efforts to provide information to use environmentally-friendly transportation modes.

Policy 4.3.1.e Provide amenities or support programs to make using alternative modes a more attractive option.

Policy 4.3.1.f Reduce vehicle trips through telecommuting or other options.

Policy 4.3.1.i Develop parking management strategies for both new development projects and, as appropriate, for existing development.

Objective 4.4.1: Require developers to reserve and construct (if nexus exists) rights of way, transportation corridors and dedicated transportation facilities through the development process and other means.

1. Develop design guidelines for pedestrian access in new development and redevelopment areas, including shopping centers, residential developments, and business parks.
2. In any new development or re-development, safe and convenient pedestrian connections between major origins and destinations, including connections within the development and between the development and adjacent areas, should be a high priority in evaluating the site plan.
3. Develop shoreline access design guidelines.

Objective 4.4.2: Ensure that new development implement approved transportation plans, including the goals, objectives, and policies of the Transportation Element of the General Plan and provides the transportation improvements needed to accommodate that development and cumulative development.

Policy 4.4.2.a Roadways will not be widened to create additional automobile travel lanes to accommodate additional automobile traffic volume with the exception of increasing transit exclusive lanes or non-motorized vehicle lanes.

Policy 4.4.2.b Intersections will not be widened beyond the width of the approaching roadway with the exception of a single exclusive left turn lane when necessary with the exception of increasing transit exclusive lanes or non-motorized vehicle lanes.

Policy 4.4.2.d All EIRs must include analysis of the effects of the project on the city's transit, pedestrian and bicycling environment, including adjacent neighborhoods and the overall City network.

Policy 4.4.2.e EIRs will not propose mitigations that significantly degrade the bicycle and pedestrian environment which are bellwethers for quality of life issues and staff should identify "Levels of Service" or other such measurements to ensure that the pedestrian and bicycling environment will not be significantly degraded as development takes place.

Policy 4.4.2.f Transportation related mitigations for future development should first implement TDM measures with appropriate regular monitoring; transit, bicycle and pedestrian capital projects; and more efficient use of existing infrastructure such as traffic signal re-timing in order to reduce the negative environmental effects of development, rather than attempting to accommodate them. Should appropriate regular monitoring indicate that these mitigations are unable to provide the predicted peak-hour vehicle trip reductions, additional TDM measures, development specific traffic caps, or mitigations through physical improvements of streets and intersections, consistent with policy 4.4.2.a and policy 4.4.2.b, may be implemented.

Policy 4.4.2.g After the implementation of quantifiable/verifiable TDM measures (verified through appropriate regular monitoring), and mitigation measures consistent with 4.4.2.f and identification of how multimodal infrastructure relates to congestion concerns, some congestion may be identified in an EIR process as not possible to mitigate. This unmitigated congestion should be evaluated and disclosed (including intersection delay length of time) during the EIR process, and acknowledged as a by-product of the development and accepted with the on-going funding of TDM measures.

3.3 PROJECT TRANSPORTATION CHARACTERISTICS

Similar to the Phase 1 development at the RBC site (described in Section 2.3), the proposed development at Alameda Point would include up to six new buildings providing 600,000 square feet of space and would accommodate up to 1,000 employees by 2018. The project would develop generally vacant land in the area bound by Ferry Point, Avenue L, Orion Street and West Hornet Avenue. Vehicular access to and from the site would be provided from West Hornet Avenue.

It is expected that the development would provide adequate parking in surface parking lots to meet demand at the site. This analysis also assumes that the development at Alameda Point, similar to the RBC project, would provide regular shuttle service to and from the Lake Merritt BART Station and LBNL/UC Berkeley.

3.3.1 TRIP GENERATION

Table 3-4 shows the estimated vehicle trip generation for the proposed Project at Alameda Point. This assessment uses the same trip generation used for the Phase 1 Project at the RBC site (See Section 2.3.6 for a detailed description) because the Alameda Point and RBC sites have similar characteristics such as transit availability, pedestrian and bicycle facilities, and proximity to residential and non-residential uses.

For example, both sites are more than two miles from BART and Amtrak stations, both sites have less than 5,000 residents and less than 500 retail employees within one mile of their locations.

TABLE 3-4
ALAMEDA POINT
PROJECT VEHICLE TRIP GENERATION SUMMARY

	Average Daily Population	Daily	AM Peak Hour			PM Peak Hour		
			In	Out	Total	In	Out	Total
Alameda Point Alternative [1]	1,000	2,079	182	29	211	27	172	199

1. Based on following trip generation rates:
Daily = 2.08 trips per Average Daily Population (ADP); AM Peak Hour = 0.21 trips per ADP (86% in, 14% out); PM Peak Hour = 0.20 trips per ADP (13% in, 87% out)

Source: Fehr & Peers, based on trip generation rate per average daily population at the existing LBNL site in Berkeley adjusted to reflect the different characteristics of the Alameda Point site.

It is estimated that the proposed development at Alameda Point would generate about 2,080 daily automobile trips, 210 AM peak hour trips, and 200 PM peak hour trips.

3.3.2 TRIP DISTRIBUTION AND ASSIGNMENT

Trip distribution is defined as the directions of approach and departure that vehicles would use to arrive at and depart from the Project site. The assessment of the Alameda Point site estimated the distribution of project trips based on existing travel patterns, location of complementary land uses, and results from the ACTC Travel Demand Model. **Figure 3-6** shows the resulting trip distribution. **Figures 3-7A and 3-7B** show the Project Phase 1 trip assignment at the study intersections, based on the distribution.

3.4 NEAR-TERM (2018) ANALYSIS

This section summarizes traffic operations under Near-Term (2018) No Project and Near-Term (2018) Plus Project conditions.

3.4.1 NEAR-TERM (2018) NO PROJECT CONDITIONS

The Near-Term (2018) No Project traffic volumes were developed by interpolating between the existing volumes (Figure 3-2) and the projected 2035 volumes (Figure 3-10), which were prepared using the ACTC Countywide Travel Demand Model and described in Section 3.5. **Figures 3-8A and 3-8B** show the Near-Term (2018) No Project traffic volumes.

Figure 3-6.

Alameda Point Campus Project Trip Distribution

WC12-2953_3-6_APCtripdistro

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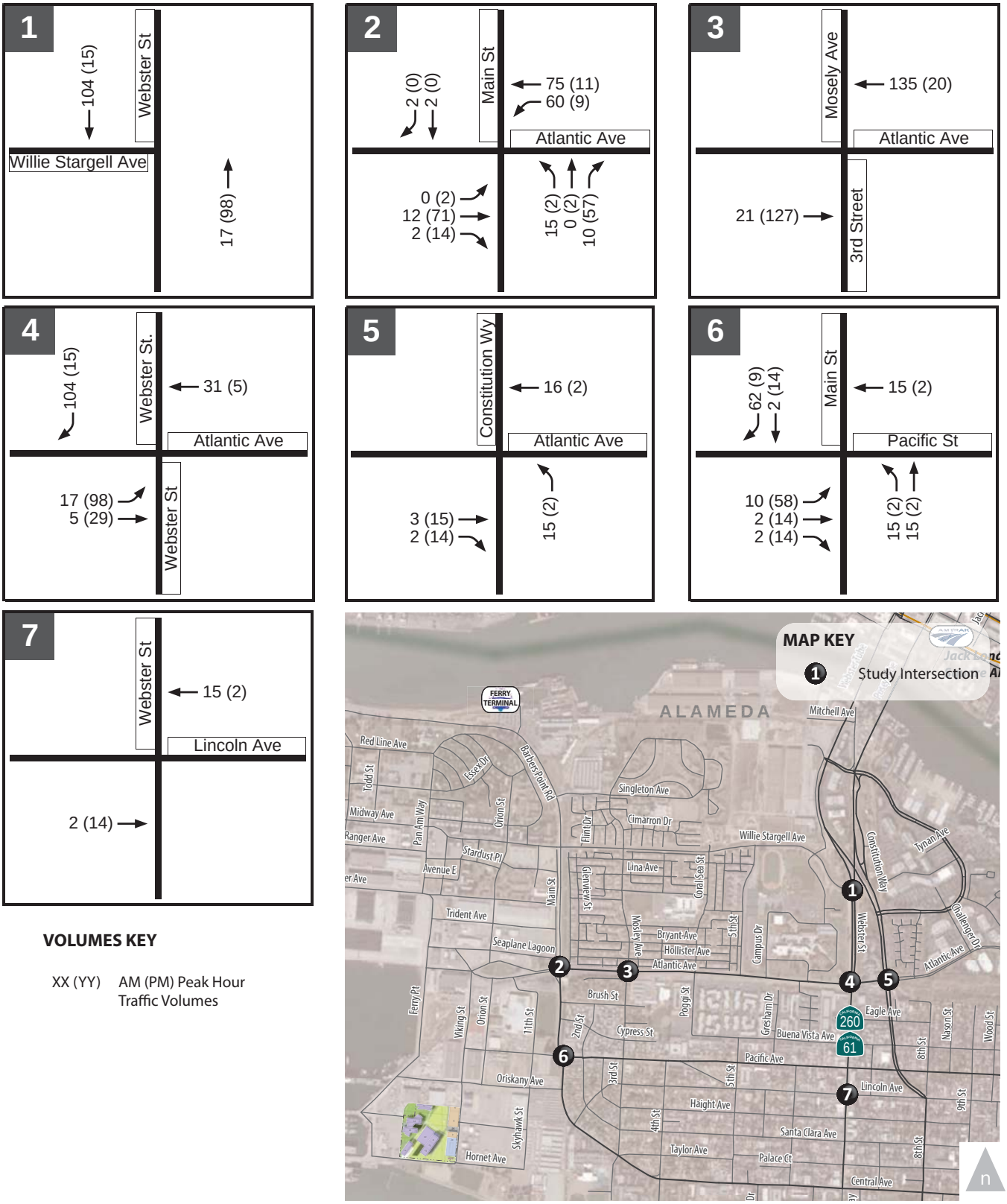


VOLUMES KEY

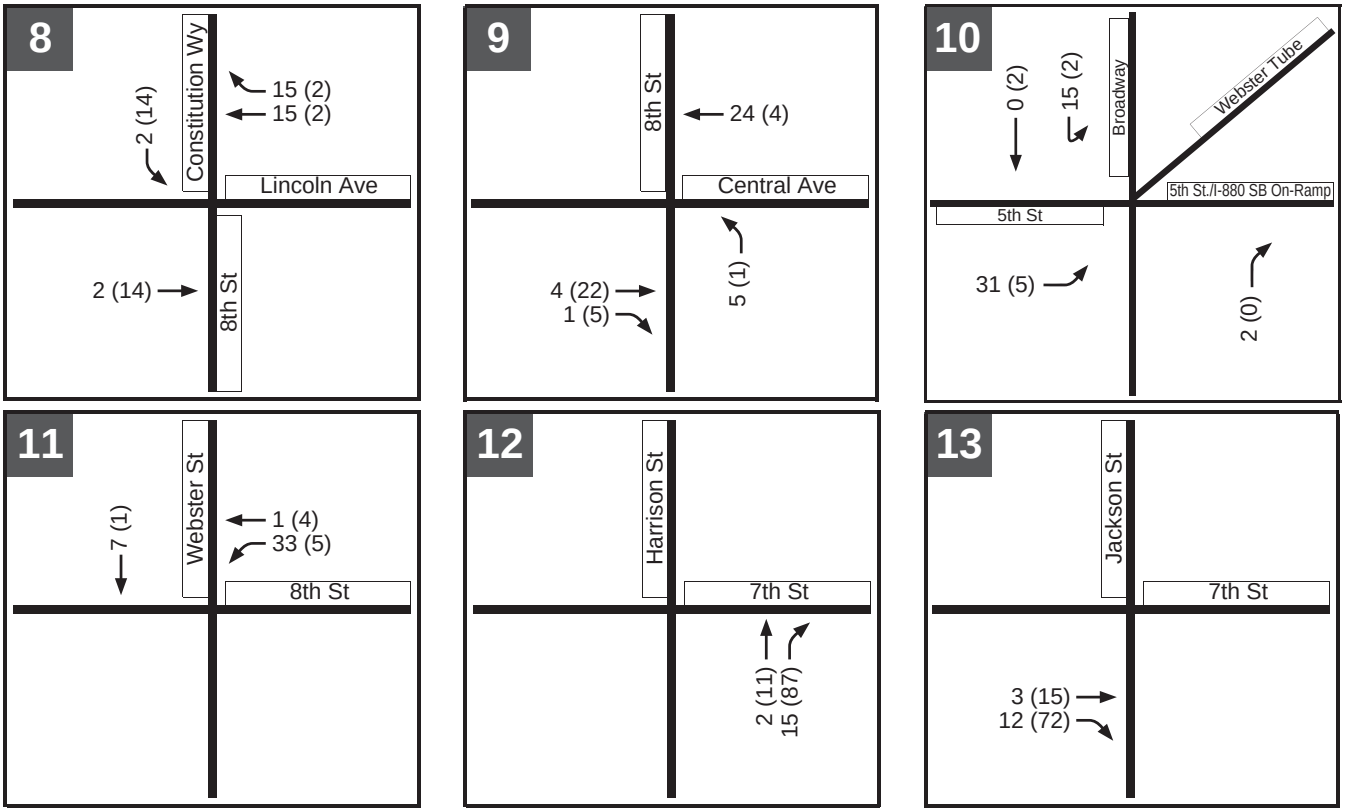
XX (YY) AM (PM) Peak Hour Traffic Volumes

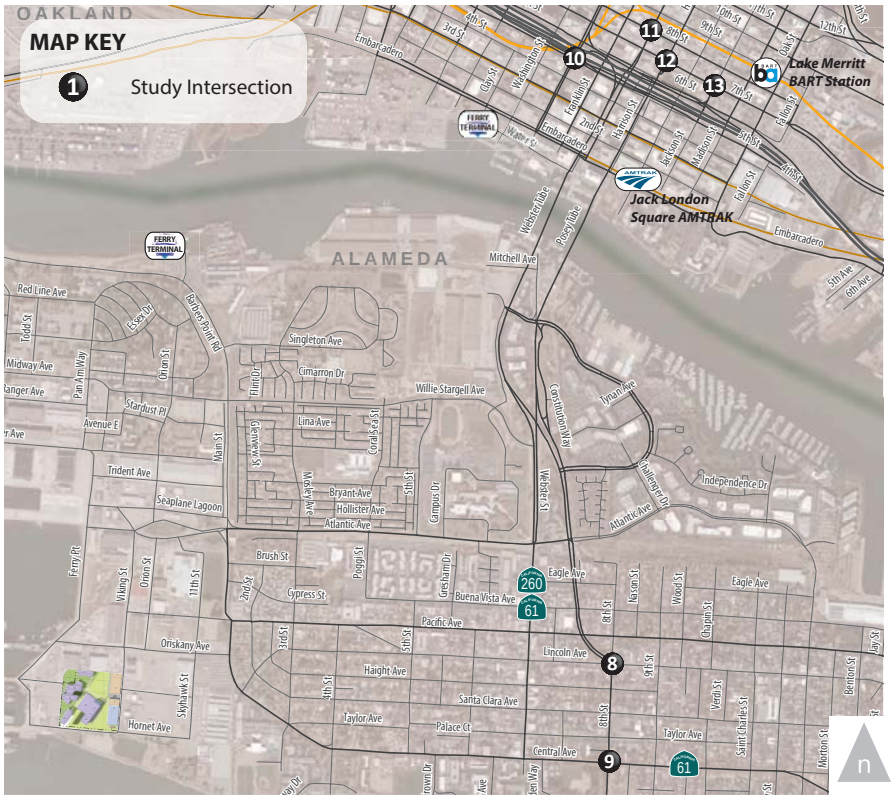
Figure 3-7A.

Alameda Point Campus
Project Trip Assignment (Phase 1)

WC12-2953_3-7A_Ph1PTA

FEHR PEERS





VOLUMES KEY

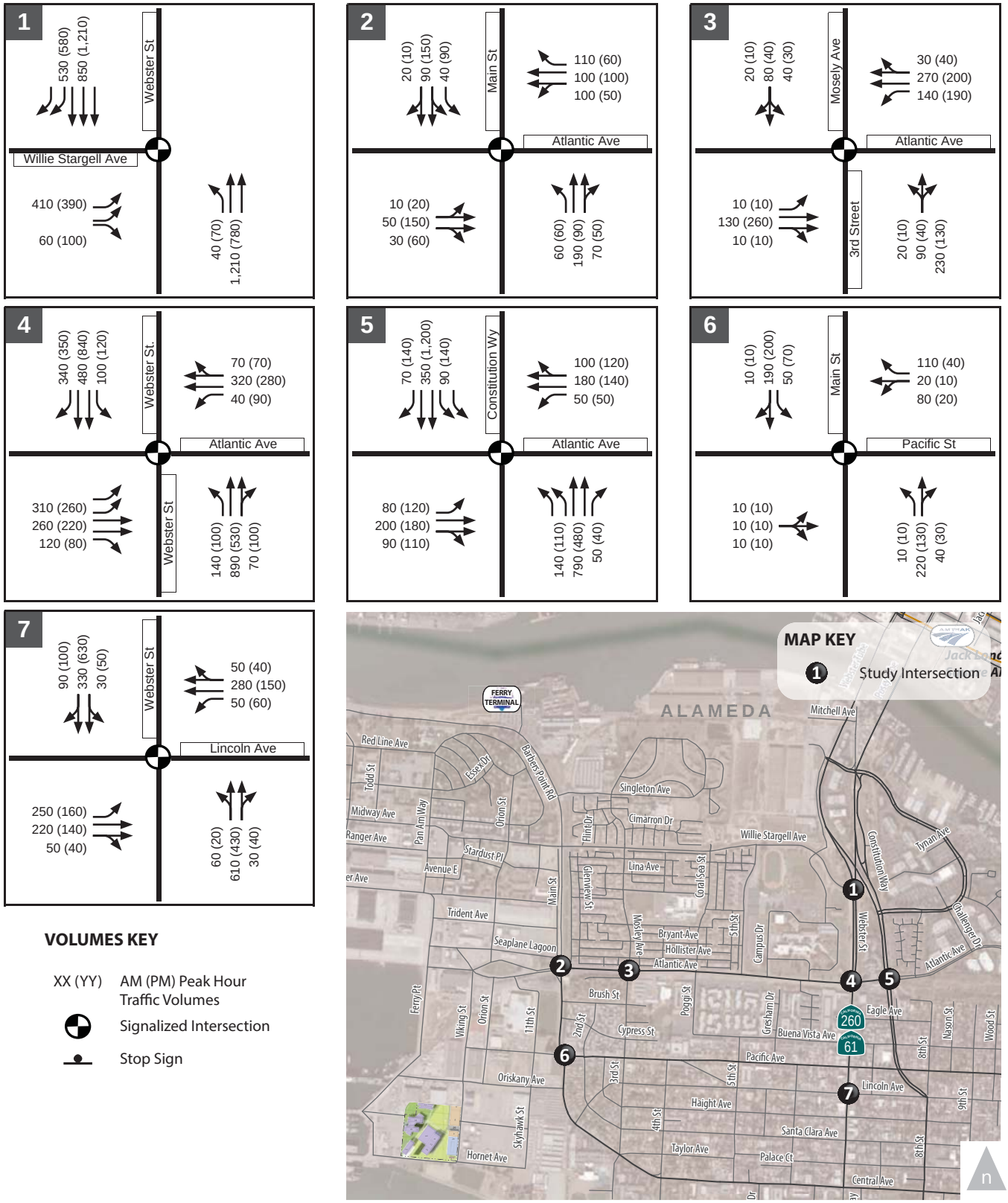
XX (YY) AM (PM) Peak Hour Traffic Volumes

Figure 3-7B.

Alameda Point Campus
Project Trip Assignment (Phase 1)

WC12-2953_3-7B_Ph1PTA

FEHR PEERS



VOLUMES KEY

XX (YY) AM (PM) Peak Hour Traffic Volumes

Signalized Intersection

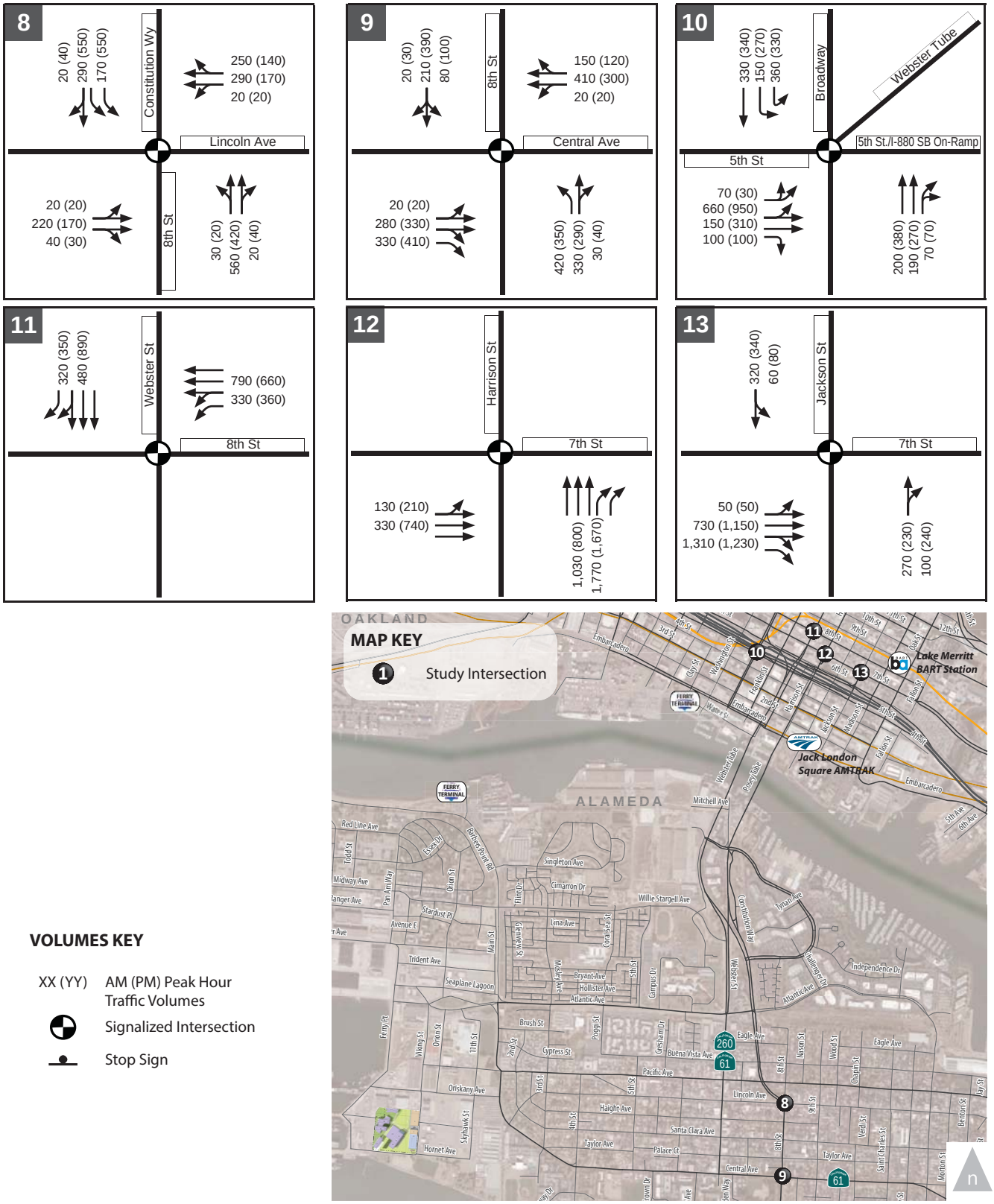
Stop Sign

Figure 3-8A.

Alameda Point Campus
Near-Term (2018) No Project Peak Hour Traffic Volumes

WC12-2953_3-8A_NT2018NPvols

FEHR PEERS



VOLUMES KEY

XX (YY)	AM (PM) Peak Hour Traffic Volumes
⊕	Signalized Intersection
⊥	Stop Sign

Figure 3-8B.

Alameda Point Campus
Near-Term (2018) No Project Peak Hour Traffic Volumes

WC12-2953_3-8B_NT2018NPvols

FEHR PEERS

The Near-Term (2018) No Project scenario assumes that signal timing parameters at the signalized study intersections in Alameda would be optimized to reflect typical signal timing updates due to changing traffic flow over time. Consistent with City of Oakland practice, this analysis assumes that signal timing parameters would not change at the study intersections in Oakland. No other roadway modifications are assumed at any of the study intersections under the Near-Term (2018) No Project scenario.

3.4.1.1 Intersection Operations

Table 3-5 summarizes the Near-Term (2018) No Project intersection LOS analysis results. **Appendix E** provides the detailed calculation work sheets.

All study intersections in Alameda would continue to operate at LOS D or better during both AM and PM peak hours under Near-Term (2018) No Project conditions. All but one study intersection in Oakland would continue to operate at LOS E or better during both AM and PM peak hours. The one sub-standard intersection in Oakland is the 7th Street/Harrison Street intersection which would deteriorate from LOS E under Existing conditions to LOS F under Near-Term (2018) No Project conditions during the AM peak hour and would continue to operate at LOS F during the PM peak hour.

3.4.1.2 Freeway Operations

Table 3-6 summarizes the AM and PM peak hour freeway LOS analysis results under Near-Term (2018) No Project conditions. **Appendix F** provides the detailed calculation work sheets. Similar to Existing Conditions, both directions of I-880 west of I-980 and southbound I-880 between I-980 and Oak Street would continue to operate at LOS F during both peak hours; Webster/Posey Tubes would continue to operate at LOS C or better during both peak hours.

3.4.2 NEAR-TERM (2018) PLUS PROJECT CONDITIONS

Figures 3-9A and 3-9B show the Near-Term (2018) Plus Project traffic volumes, which consist of traffic volumes under Near-Term (2018) No Project conditions (Figures 3-8A and 3-8B) plus Project traffic assignment (Figures 3-7A and 3-7B). This analysis assumes no roadway modifications under this scenario.

3.4.2.1 Intersection Operations

Table 3-5 summarizes intersection operations at the study intersections under the Near-Term (2018) Plus Project conditions. **Appendix E** provides the detailed calculation work sheets.

All study intersections in Alameda would continue to operate at LOS D or better during both AM and PM peak hours under the Near-Term (2018) Plus Project conditions. The Project would not cause a significant impact at the study intersections in Alameda.

TABLE 3-5
ALAMEDA POINT
NEAR-TERM (2018) CONDITIONS – STUDY INTERSECTION LOS SUMMARY

Intersection	Traffic Control	Peak Hour	Near-Term (2018) No Project		Near-Term (2018) Plus Project		Significant Impact?
			Delay[1] (seconds)	LOS[1]	Delay[1] (seconds)	LOS[1]	
City of Alameda							
1. Webster Street/ Willie Stargell Avenue	Signal	AM	19.1	B	19.8	B	No
		PM	19.3	B	19.6	B	No
2. Main Street/ Atlantic Avenue	Signal	AM	11.2	B	11.9	B	No
		PM	11.6	B	11.9	B	No
3. Third Street/ Atlantic Avenue	Signal	AM	22.2	C	22.4	C	No
		PM	40.7	D	38.3	D	No
4. Webster Street/ Atlantic Avenue	Signal	AM	42.9	D	45.3	D	No
		PM	31.6	C	34.6	C	No
5. Constitution Way/ Atlantic Street	Signal	AM	22.7	C	23.0	C	No
		PM	25.8	C	26.0	C	No
6. Main Street/ Pacific Avenue	Signal	AM	20.4	C	23.1	C	No
		PM	16.0	B	19.5	B	No
7. Webster Street/ Lincoln Avenue	Signal	AM	16.0	B	16.2	B	No
		PM	14.5	B	14.5	B	No
8. Constitution Way/ Lincoln Avenue	Signal	AM	22.0	C	22.4	C	No
		PM	23.0	C	23.1	C	No
9. 8th Street/ Central Avenue	Signal	AM	38.0	D	39.3	D	No
		PM	44.8	D	45.0	D	No
City of Oakland							
10. Broadway/ 5th Street	Signal	AM	26.4	C	27.4	C	No
		PM	35.2	D	35.3	D	No
11. Webster Street/ 8th Street	Signal	AM	15.9	B	16.0	B	No
		PM	17.3	B	17.3	B	No
12. Harrison Street/ 7th Street	Signal	AM	**100.5 (v/c=0.74)**	**F**	**104.2 (v/c=0.75)**	**F**	Yes
		PM	**>120 (v/c=0.86)**	**F**	**>120 (v/c=0.90)**	**F**	Yes
13. Jackson Street/ 7th Street	Signal	AM	16.8	B	16.7	B	No
		PM	70.9	E	69.4	E	No

Notes: **Bold** indicates intersection operating at unacceptable LOS E/ F in Alameda or unacceptable LOS F in Oakland.
1. For signalized intersections, average intersection delay and LOS based on the 2000 HCM method is shown.
Source: Fehr & Peers.

TABLE 3-6
ALAMEDA POINT
NEAR-TERM (2018) CONDITIONS – FREEWAY SEGMENT LOS SUMMARY

Freeway Segment	Type[1]	Dir[2]	Near-Term (2018) No Project				Near-Term (2018) Plus Project				Significant Impact?
			AM Peak Hour		PM Peak Hour		AM Peak Hour		PM Peak Hour		
			Density[3]	LOS	Density[3]	LOS	Density[3]	LOS	Density[3]	LOS	
1. I-880, west of I-980	Basic	NB	--	F	--	F	--	F	--	F	No
	Basic	SB	--	F	--	F	--	F	--	F	No
2. I-880, between I-980 and Oak Street	Basic	NB	35.7	E	38.8	E	35.7	E	39.3	E	No
	Basic	SB	--	F	--	F	--	F	--	F	No
3. I-880, south of Oak Street	Basic	NB	34.2	D	35.8	E	34.5	D	35.8	E	No
	Basic	SB	34.0	D	38.7	E	34.1	D	39.1	E	No
4. Webster/Posey Tubes	Basic	NB	23.4	C	20.7	C	23.5	C	21.5	C	No
	Basic	SB	17.0	B	23.7	C	17.9	B	23.9	C	No

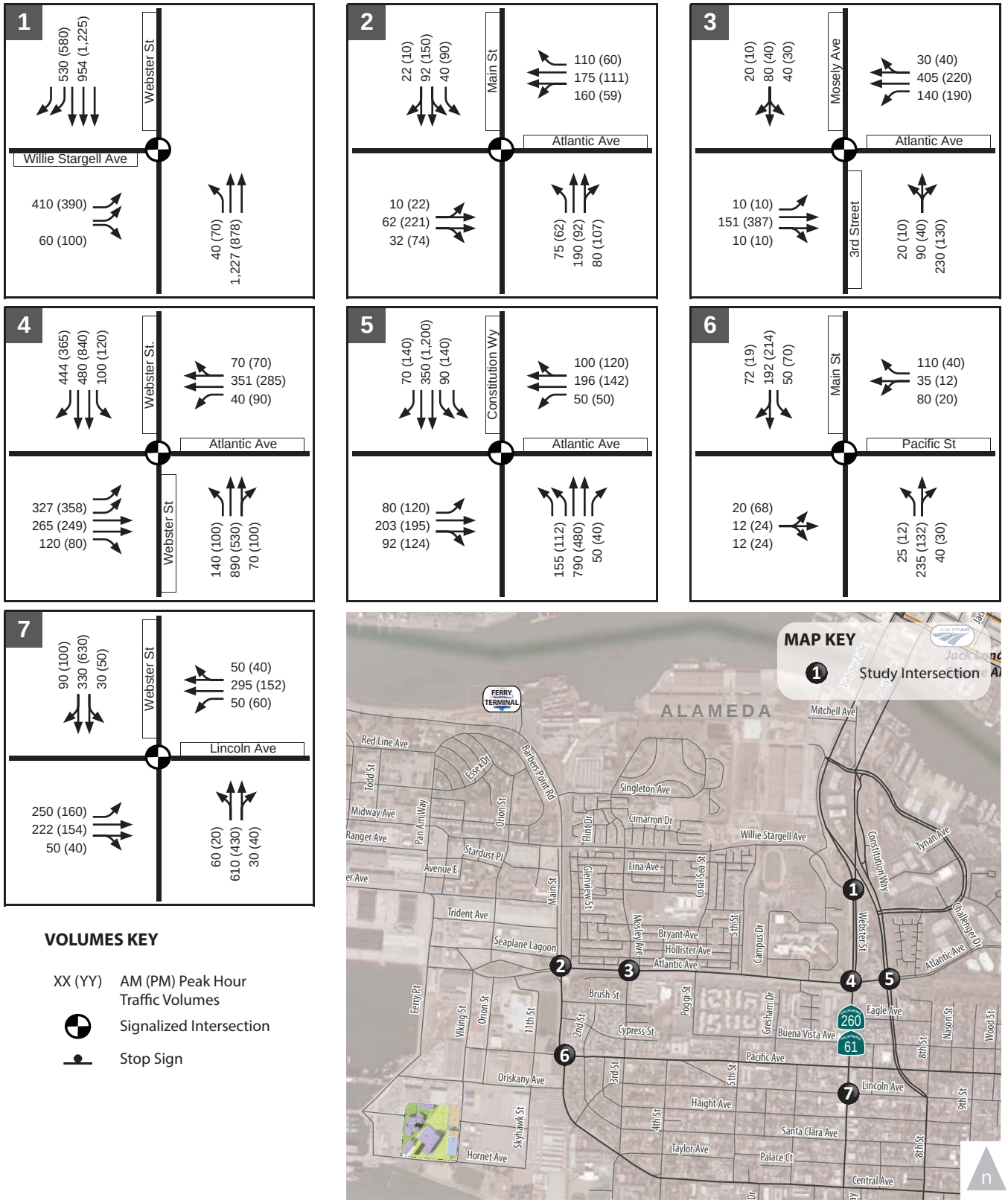
1. Segments with auxiliary lanes are classified as weave segments, and were analyzed based on the Leisch Method. Basic segments are analyzed as basic segments using the 2000 HCM methodologies.
2. NB = Northbound; SB = Southbound
3. Density is presented in passenger cars per lane per mile (pc/ln/mi).

Source: Fehr & Peers.

In Oakland, Project generated traffic would contribute to LOS F conditions at the Harrison Street/7th Street intersection during both AM and PM peak hours.

Project generated traffic would also contribute to LOS E conditions at the Jackson Street/7th Street intersection in Oakland during the PM peak hour; however, the Project would not cause an increase in the average delay for any of the critical movements by six seconds or more. Based on City of Oakland's significance criteria, the Project would not cause an impact at the Jackson Street/7th Street intersection under Near-Term (2018) No Project conditions.

The Project would cause a significant impact at one intersection in Oakland which is summarized under Impact 3-1 discussion.



VOLUMES KEY

XX (YY) AM (PM) Peak Hour Traffic Volumes

Signalized Intersection

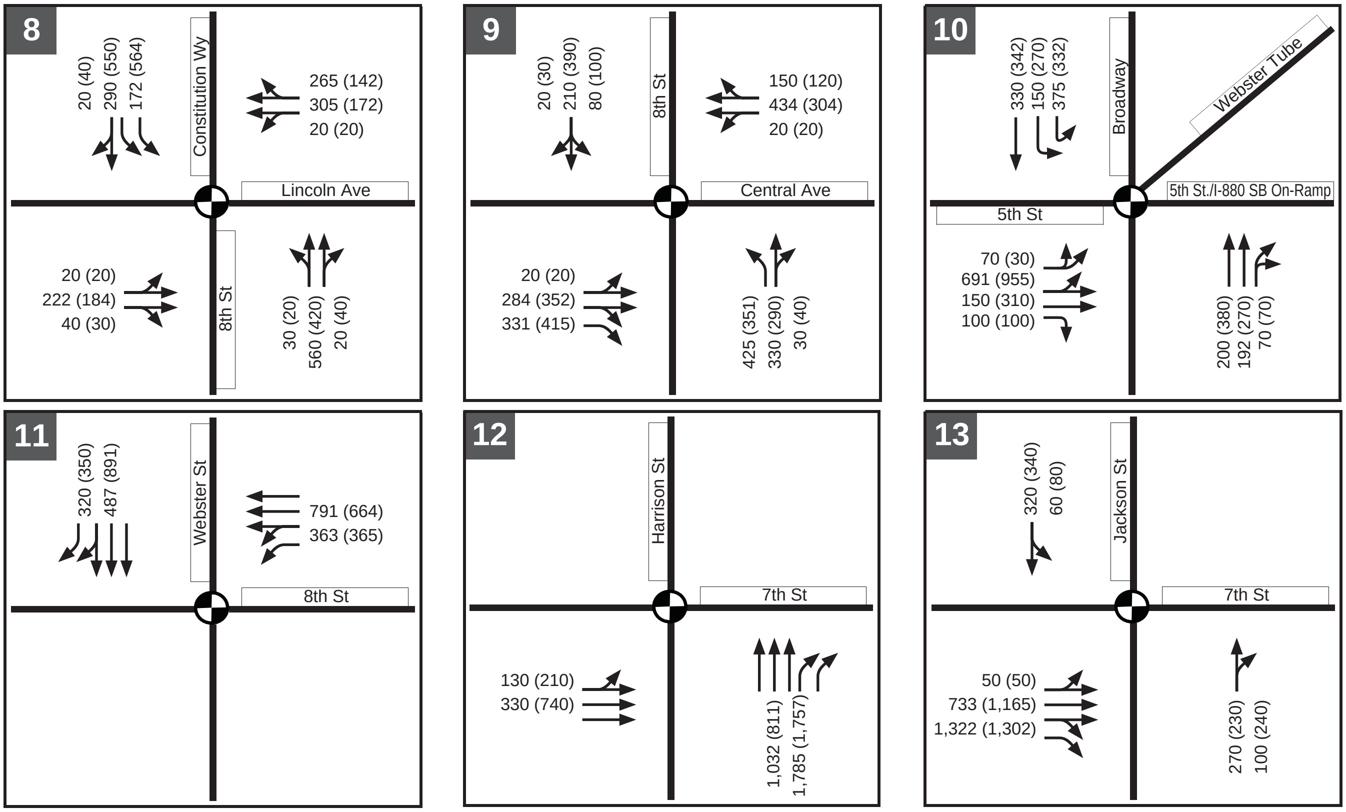
Stop Sign

Figure 3-9A.

Alameda Point Campus
Near-Term (2018) Plus Phase 1 Peak Hour Traffic Volumes

WC12-2953_3-9A_NT2018+Ph1vols

FEHR PEERS



VOLUMES KEY

XX (YY) AM (PM) Peak Hour Traffic Volumes

Signalized Intersection

Stop Sign

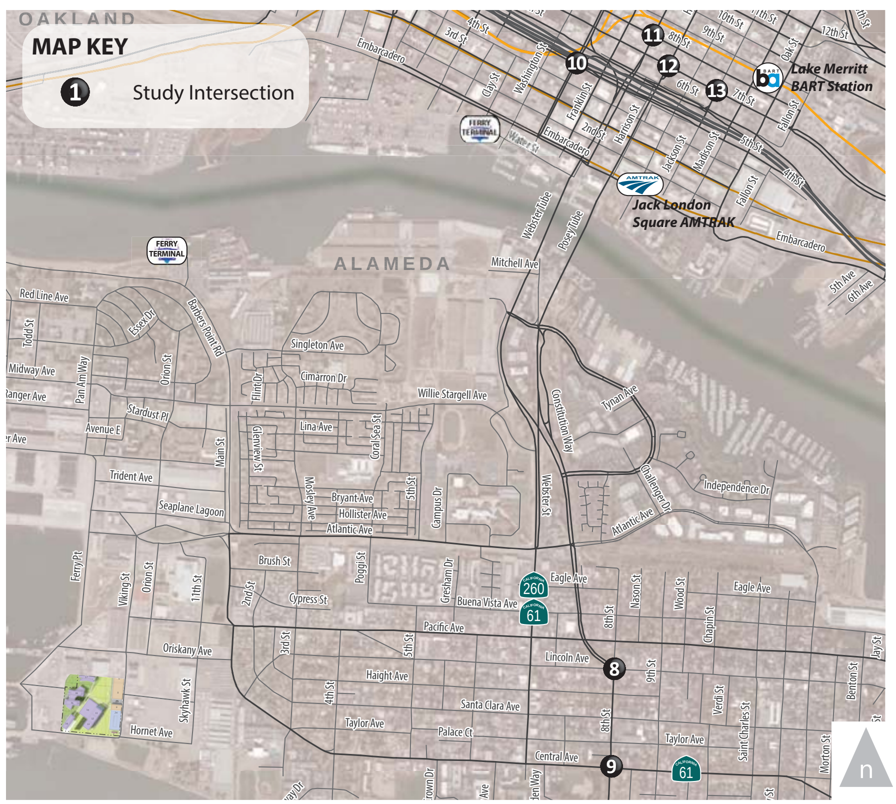


Figure 3-9B.

Alameda Point Campus
Near-Term (2018) Plus Phase 1 Peak Hour Traffic Volumes

WC12-2953_3-9B_NT2018+Ph1vols

FEHR & PEERS

IMPACT 3-1: NEAR-TERM (2018) PLUS PROJECT CONDITIONS INTERSECTION OPERATIONS

The proposed Project at Alameda Point would cause a significant impact at the following intersection under Near-Term (2018) Plus Project conditions:

A. The Project would cause a significant impact at the signalized **Harrison Street/7th Street** (Intersection 12) because it would increase the overall intersection v/c ratio by 0.01 or more and increase critical movement v/c ratio by 0.02 or more during both AM and PM peak hours at an intersection in downtown Oakland operating at LOS F regardless of the Project.

Mitigation Measure 3-1: Implement the following:

A. **Harrison Street/7th Street** (Intersection 12): Implement the following which requires coordination with City of Oakland:

- Increase traffic signal cycle length to 75 seconds and optimize traffic signal timing parameters (i.e., the amount of green signal time allocated to each intersection approach).

The intersection would continue to operate at LOS F during both AM and PM peak hours after the implementation of this mitigation measure. However, this mitigation measure would reduce the overall intersection v/c ratio and the critical movement v/c ratio to the same level or less than under Near-Term (2018) No Project conditions. Therefore, the mitigation measure would reduce the impact to less than significant if implemented.

3.4.2.2 Freeway Operations

Table 3-6 summarizes the AM and PM peak hour freeway LOS analysis results under Near-Term (2018) Plus Project conditions. **Appendix F** provides the detailed calculation work sheets.

All freeway segments are projected to continue to operate at the same LOS as under Near-Term (2018) No Project conditions during both AM and PM peak hours. The proposed Project would not increase the peak hour volume by five percent or more at the study freeway segments that are projected to operate at LOS F. Therefore, the proposed Project would not cause a significant impact at the study freeway segments under Near-Term (2018) Plus Project conditions.

3.5 CUMULATIVE (2035) ANALYSIS

This section summarizes traffic operations under Cumulative (2035) No Project and Cumulative (2035) Plus Project conditions.

3.5.1 CUMULATIVE (2035) NO PROJECT CONDITIONS

Traffic forecasts to the year 2035 were developed based on the results of the ACTC Countywide Travel Demand Model. The most recent version of the ACTC Model, released in June 2011, which reflects assumptions in residential and non-residential land use growth consistent with ABAG *Projections 2009,* served as the basis for developing AM and PM peak hour intersection turning movement forecasts for the year 2035. The Model land use database and roadway network were checked for accuracy in the vicinity of the Project. The forecasting process involved running the 2010 and 2035 models and using the model produced volumes and existing turning movement count data, to estimate year 2035 intersection turn movements using the Furness[5] method. The 2035 model run did not assume any growth at the proposed Project site. **Figures 3-10A and 3-10B** show the Cumulative (2035) No Project traffic volumes.

Similar to the Near-Term (2018) No Project conditions, the Cumulative (2035) No Project analysis assumes that signal timing parameters at the signalized study intersections in Alameda would be optimized, while signal timing parameters at the study intersection in Oakland would remain the same. No other roadway modifications are assumed in the study area under the Cumulative (2035) No Project scenario.

3.5.1.1 Intersection Operations

Table 3-7 summarizes the Cumulative (2035) No Project intersection LOS analysis results. **Appendix E** provides the detailed calculation work sheets.

All but one study intersection in Alameda would continue to operate at LOS D or better during both AM and PM peak hours under Cumulative (2035) No Project conditions.

In Oakland, the Harrison Street/7th Street intersection during both AM and PM peak hours and the Jackson Street/7th Street intersection during the PM peak hour would operate at LOS F. The other study intersections in Oakland would continue to operate at LOS E or better during both AM and PM peak hours.

3.5.1.2 Freeway Operations

Table 3-8 summarizes the AM and PM peak hour freeway LOS analysis results under Cumulative (2035) No Project conditions. **Appendix F** provides the detailed calculation work sheets. All freeway segments are projected to continue to operate at LOS D or better during both AM and PM peak hours.

[5] Furnessing is an iterative process that develops future turning movements by applying the difference between the base model volumes and the existing counts to future model approach and departure volumes.

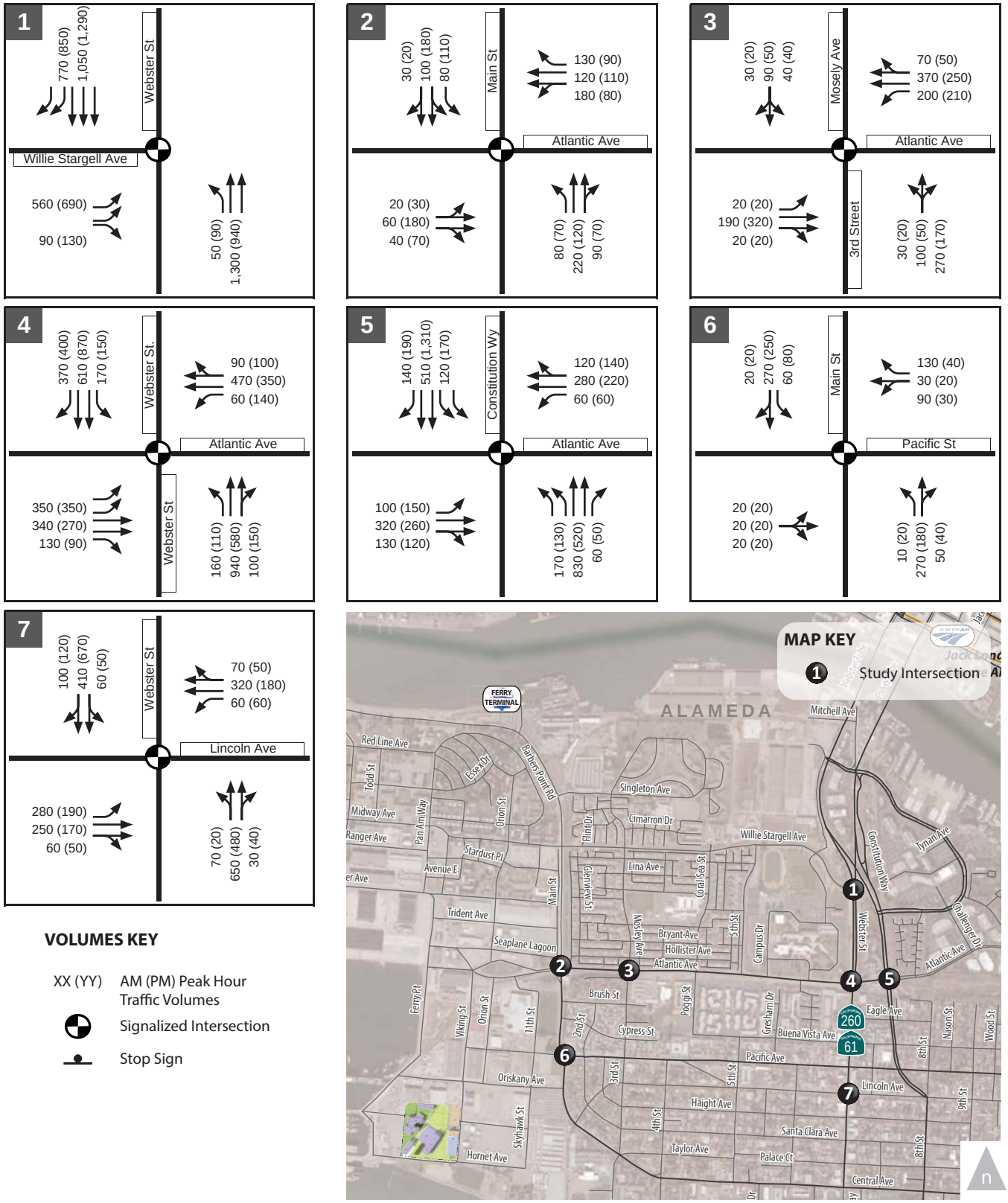
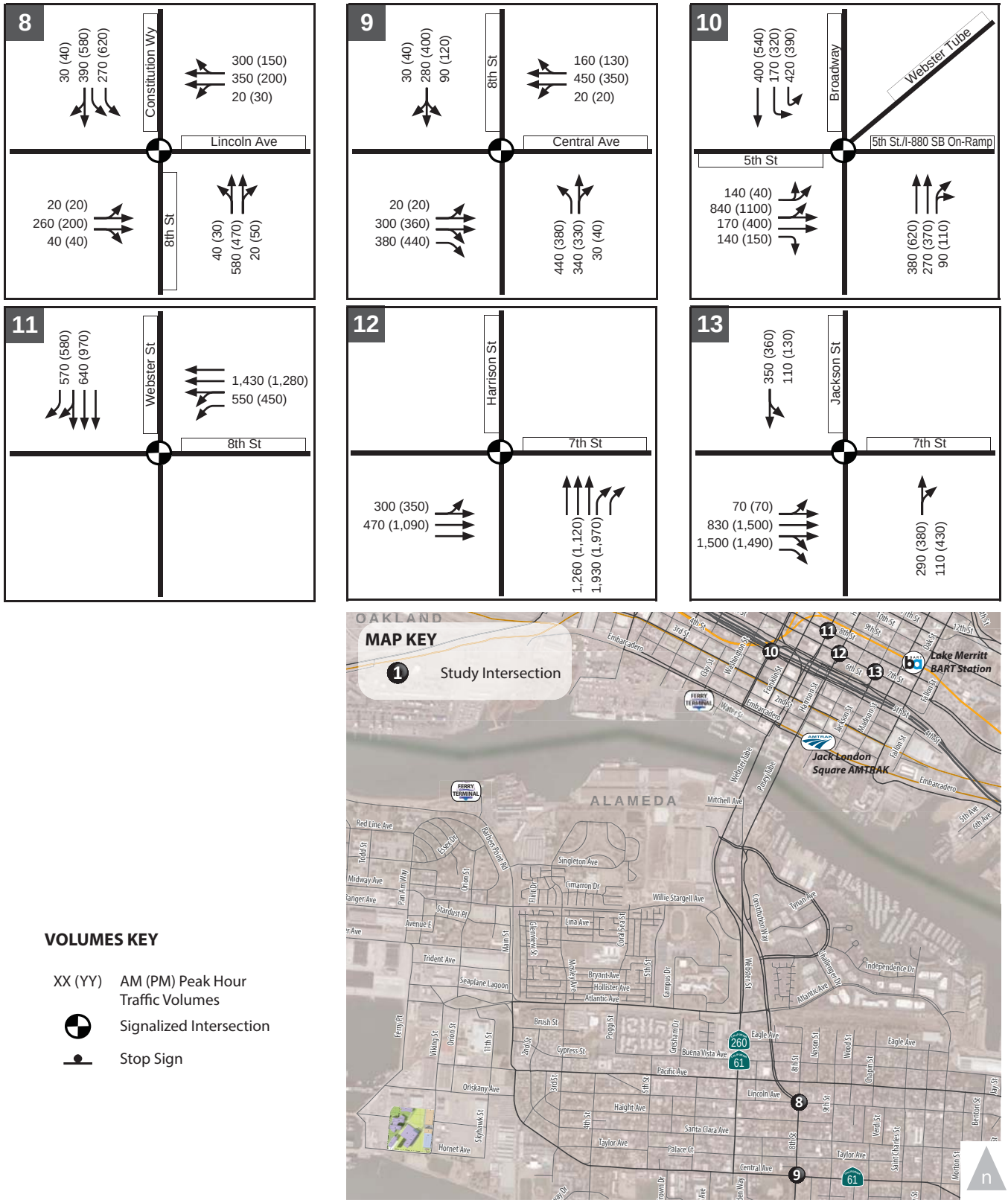


Figure 3-10A.

Alameda Point Campus
Cumulative (2035) No Project Peak Hour Traffic Volumes

WC12-2953_3-10A_Cumu2035NPvols

FEHR PEERS



VOLUMES KEY

XX (YY)	AM (PM) Peak Hour Traffic Volumes
	Signalized Intersection
	Stop Sign

Figure 3-10B.

Alameda Point Campus
Cumulative (2035) No Project Peak Hour Traffic Volumes

WC12-2953_3-10B_Cumu2035NPvols

FEHR PEERS

TABLE 3-7
ALAMEDA POINT
CUMULATIVE (2035) CONDITIONS – STUDY INTERSECTION LOS SUMMARY

Intersection	Traffic Control	Peak Hour	Cumulative (2035) No Project		Cumulative (2035) Plus Project		Significant Impact?
			Delay[1] (seconds)	LOS[1]	Delay[1] (seconds)	LOS[1]	
City of Alameda							
1. Webster Street/ Willie Stargell Avenue	Signal	AM	21.7	C	23.0	C	No
		PM	21.0	C	21.5	C	No
2. Main Street/ Atlantic Avenue	Signal	AM	12.1	B	13.1	B	No
		PM	11.9	B	12.6	B	No
3. Third Street/ Atlantic Avenue	Signal	AM	39.3	D	38.6	D	No
		PM	45.6	D	45.6	D	No
4. Webster Street/ Atlantic Avenue	Signal	AM	53.6	D	54.7	D	No
		PM	40.8	D	46.3	D	No
5. Constitution Way/ Atlantic Street	Signal	AM	28.0	C	28.6	C	No
		PM	47.0	D	49.2	D	No
6. Main Street/ Pacific Avenue	Signal	AM	26.6	C	30.2	C	No
		PM	19.9	B	23.8	C	No
7. Webster Street/ Lincoln Avenue	Signal	AM	19.5	B	20.0	B	No
		PM	15.2	B	15.2	B	No
8. Constitution Way/ Lincoln Avenue	Signal	AM	27.6	C	28.1	C	No
		PM	27.1	C	27.4	C	No
9. 8th Street/ Central Avenue	Signal	AM	44.3	D	46.5	D	No
		PM	53.4	D	53.8	D	No
City of Oakland							
10. Broadway/ 5th Street	Signal	AM	44.6	D	47.8	D	No
		PM	60.4	E	60.6	E	No
11. Webster Street/ 8th Street	Signal	AM	19.3	B	19.5	B	No
		PM	19.9	B	19.9	B	No
12. Harrison Street/ 7th Street	Signal	AM	**>120 (v/c=0.95)**	**F**	**>120 (v/c=0.95)**	**F**	No
		PM	**>120 (v/c=1.17)**	**F**	**>120 (v/c=1.21)**	**F**	**Yes**
13. Jackson Street/ 7th Street	Signal	AM	70.9	E	70.6	E	No
		PM	**>120 (v/c=2.89)**	**F**	**>120 (v/c=2.90)**	**F**	Yes

Notes: **Bold** indicates intersection operating at unacceptable LOS E/F in Alameda or unacceptable LOS F in Oakland.
1. For signalized intersections, average intersection delay and LOS based on the 2000 HCM method is shown.
Source: Fehr & Peers.

TABLE 3-8
ALAMEDA POINT
CUMULATIVE (2035) CONDITIONS – FREEWAY SEGMENT LOS SUMMARY

Freeway Segment	Type[1]	Dir[2]	Cumulative (2035) No Project				Cumulative (2035) Plus Project				Significant Impact?
			AM Peak Hour		PM Peak Hour		AM Peak Hour		PM Peak Hour		
			Density[3]	LOS	Density[3]	LOS	Density[3]	LOS	Density[3]	LOS	
1. I-880, west of I-980	Basic	NB	--	F	--	F	--	F	--	F	No
	Basic	SB	--	F	--	F	--	F	--	F	No
2. I-880, between I-980 and Oak Street	Basic	NB	38.8	E	--	F	38.9	E	--	F	No
	Basic	SB	--	F	--	F	--	F	--	F	No
3. I-880, south of Oak Street	Basic	NB	37.8	E	--	F	38.2	E	--	F	No
	Basic	SB	39.3	E	--	F	39.3	E	--	F	No
4. Webster/Posey Tubes	Basic	NB	26.6	D	25.7	C	26.7	D	26.6	D	No
	Basic	SB	23.1	C	29.2	D	24.0	C	29.3	D	No

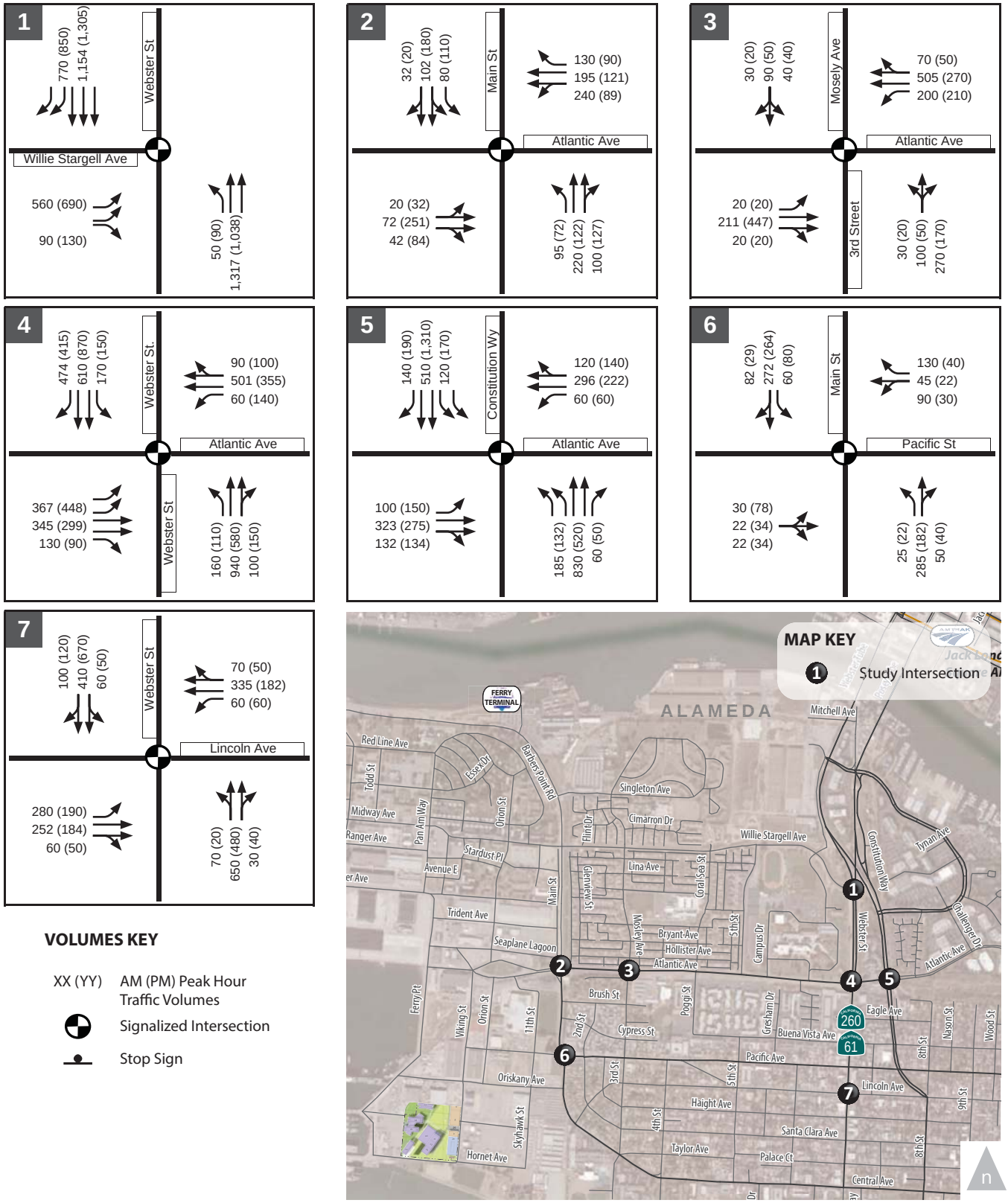
1. Segments with auxiliary lanes are classified as weave segments, and were analyzed based on the Leisch Method. Basic segments are analyzed as basic segments using the 2000 HCM methodologies.
2. NB = Northbound; SB = Southbound
3. Density is presented in passenger cars per lane per mile (pc/ln/mi).

Source: Fehr & Peers.

All three study freeway segments on I-880 would operate at LOS F during one or both peak hours. The Webster/Posey Tubes would operate at LOS D or better during both peak hours.

3.5.2 CUMULATIVE (2035) PLUS PROJECT CONDITIONS

Figures 3-11A and 3-11B show the Cumulative (2035) Plus Project traffic volumes, which consist of traffic volumes under Cumulative (2035) No Project conditions (Figures 3-10 and 3-10B) plus Project traffic assignment (Figures 3-7A and 3-7B). This analysis assumes no roadway modifications under this scenario.



VOLUMES KEY

XX (YY) AM (PM) Peak Hour Traffic Volumes

Signalized Intersection

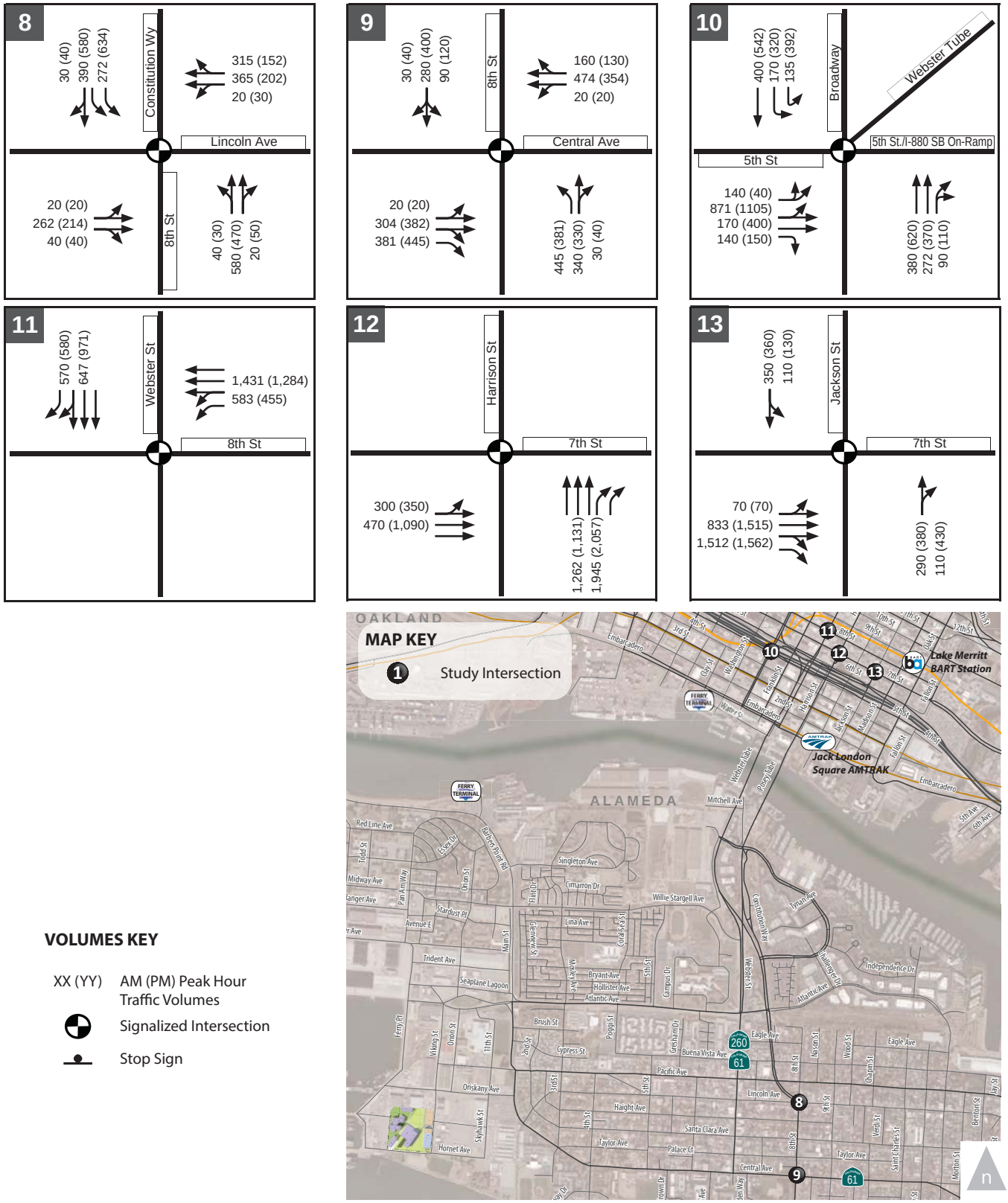
Stop Sign

Figure 3-11A.

Alameda Point Campus
Cumulative (2035) Plus Phase 1 Peak Hour Traffic Volumes

WC12-2953_3-11A_Cumu2035+Ph1vols

FEHR PEERS



VOLUMES KEY

XX (YY)	AM (PM) Peak Hour Traffic Volumes
	Signalized Intersection
	Stop Sign

Figure 3-11B.

Alameda Point Campus
Cumulative (2035) No Project Peak Hour Traffic Volumes

WC12-2953_3-11B_Cumu2035+PH1vols

FEHR PEERS

3.5.2.1 Intersection Operations

Table 3-7 summarizes intersection operations at the study intersections under the Cumulative (2035) Plus Project conditions. **Appendix E** provides the detailed calculation work sheets.

All study intersections in Alameda would continue to operate at LOS D or better during both AM and PM peak hours under the Cumulative (2035) Plus Project conditions. The Project would not cause a significant impact at the study intersections in Alameda.

In Oakland, Project generated traffic would contribute to LOS F conditions at the Harrison Street/7th Street intersection during both AM and PM peak hours and Jackson Street/7th Street intersection during the PM peak hour. The proposed project would not increase the overall intersection v/c ratio by 0.01 or more or increase critical movement v/c ratio by 0.02 or more at the Harrison Street/7th Street intersection during the AM peak hour. Therefore, the Project would not cause a significant impact at this intersection during the AM peak hour.

Project generated traffic would also contribute to LOS E conditions at the Jackson Street/7th Street intersection during the AM peak hour and at Broadway/5th Street during the PM peak hour; however, the Project would not cause an increase in the average delay for any of the critical movements by six seconds or more at either intersection. Based on City of Oakland's significance criteria, the Project would not cause a significant impact at the Jackson Street/7th Street or Broadway/5th Street intersections under Cumulative (2035) Plus Project conditions.

The Project would cause a significant impact at two intersections which are summarized under Impact 3-2 discussion.

IMPACT 3-2: CUMULATIVE (2035) PLUS PROJECT CONDITIONS INTERSECTION OPERATIONS

The proposed Project at Alameda Point would cause a significant impact at the following intersections under Cumulative (2035) Plus Project conditions:

A. The Project would cause a significant impact at the signalized **Harrison Street/7th Street** (Intersection 12) because it would increase the overall intersection v/c ratio by 0.01 or more and increase critical movement v/c ratio by 0.02 or more during the PM peak hour at an intersection in downtown Oakland operating at LOS F regardless of the Project.

B. The Project would cause a significant impact at the signalized **Jackson Street/7th Street** (Intersection 13) because it would increase the overall intersection v/c ratio by 0.01 or more and increase critical movement v/c ratio by 0.02 or more during the PM peak hour at an intersection in downtown Oakland operating at LOS F regardless of the Project.

Mitigation Measure 3-2: Implement the following:

A. **Harrison Street/7th Street** (Intersection 12): Implement the following which requires coordination with City of Oakland (Same as Mitigation Measure 3-1A):

- Increase traffic signal cycle length to 80 seconds and optimize traffic signal timing parameters (i.e., the amount of green signal time allocated to each intersection approach).

The intersection would continue to operate at LOS F during the PM peak hour. However, this mitigation measure would reduce the overall intersection v/c ratio and the critical movement v/c ratio to the same level or less than under Cumulative (2035) No Project conditions. Therefore, the mitigation measure would reduce the impact to less than significant if implemented.

B. **Jackson Street/7th Street** (Intersection 13): Implement the following which requires coordination with City of Oakland:

- Increase traffic signal cycle length to 80 seconds and optimize traffic signal timing parameters (i.e., the amount of green signal time allocated to each intersection approach).

The intersection would continue to operate at LOS F during the PM peak hour. However, this mitigation measure would reduce the overall intersection v/c ratio and the critical movement v/c ratio to the same level or less than under Cumulative (2035) No Project conditions. Therefore, the mitigation measure would reduce the impact to less than significant if implemented.

3.5.2.2 Freeway Operations

Table 3-8 summarizes the AM and PM peak hour freeway LOS analysis results under Cumulative (2035) Plus Project conditions. **Appendix F** provides the detailed calculation work sheets.

All freeway segments are projected to continue to operate at the same LOS as under Cumulative (2035) No Project conditions during both AM and PM peak hours. The proposed Project would not increase the peak hour volume by five percent or more at the study freeway segments that are projected to operate at LOS F. Therefore, the proposed Project would not cause a significant impact at the study freeway segments under Cumulative (2035) Plus Project conditions.

3.6 ADDITIONAL EMPLOYMENT ALTERNATIVE ANALYSIS

This section presents trip generation for the Additional Employment Alternative scenario and summarizes traffic operations under the Near-Term (2018) Plus Additional Employment Alternative conditions. The Additional Employment Alternative would consist of an additional 200,000 square feet of space and accommodate an additional 700 employees at the Alameda Point site.

3.6.1 TRIP GENERATION

Table 3-9 shows the estimated vehicle trip generation for the Additional Employment Alternative at the Alameda Point site. The trip generation estimates is based on the same methodology used to estimate trip generation for the Alameda Point Project as documented in section 3.3.1. The 700 additional employees under this Alternative at the Alameda Point site are expected to increase trip generation to about 3,500 daily, 360 AM peak hour, and 340 PM peak hour automobile trips.

TABLE 3-9
ALAMEDA POINT
ADDITIONAL EMPLOYMENT ALTERNATIVE VEHICLE TRIP GENERATION SUMMARY

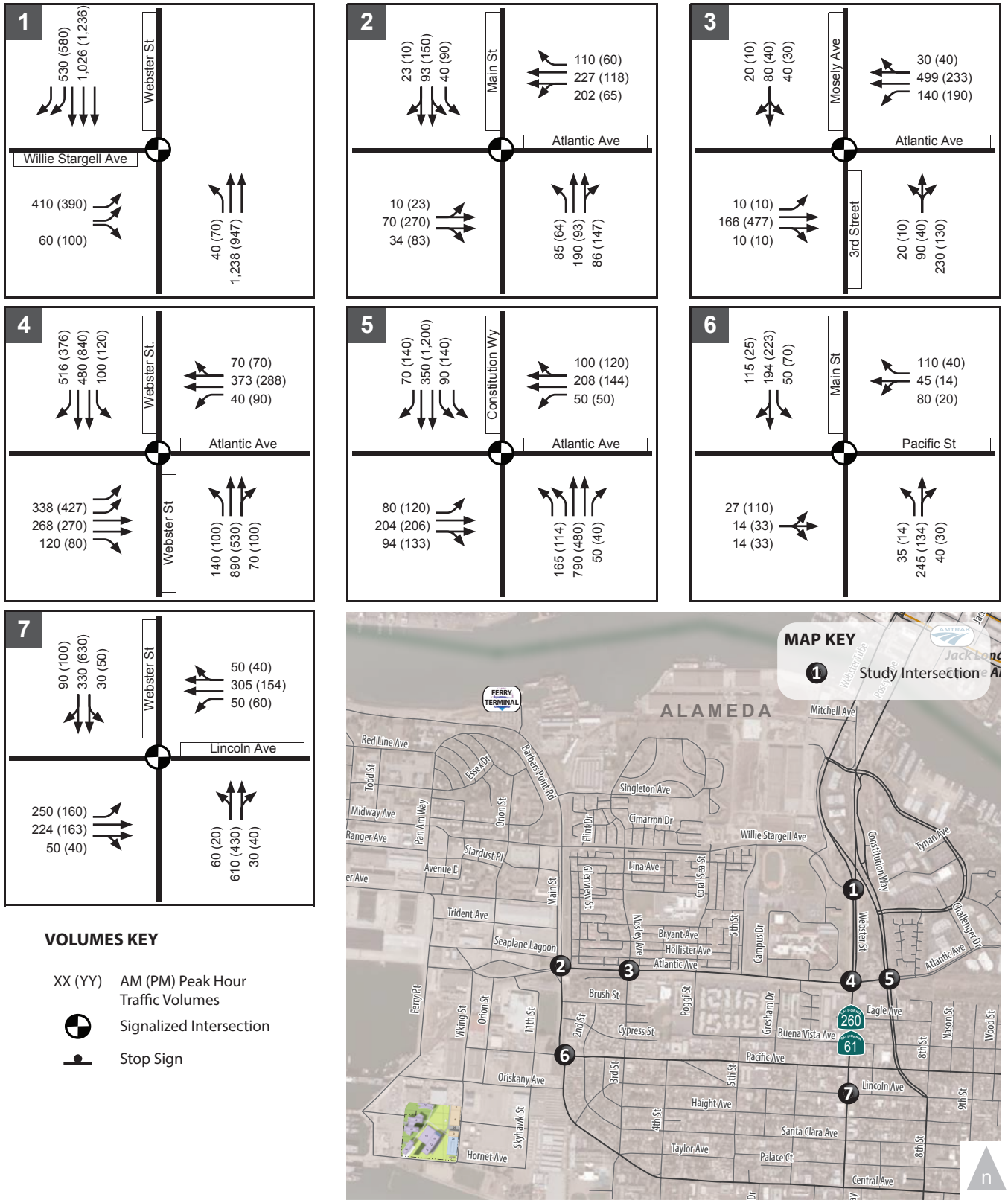
	Average Daily Population	Daily	AM Peak Hour			PM Peak Hour		
			In	Out	Total	In	Out	Total
Alameda Point Project [1]	1,000	2,079	182	29	211	27	172	199
Additional Employees [1]	700	1,455	127	20	147	18	121	139
Additional Employment Alternative Total	1,700	3,534	309	49	358	45	293	338

1. Based on following trip generation rates:
Daily = 2.08 trips per Average Daily Population (ADP); AM Peak Hour = 0.21 trips per ADP (86% in, 14% out); PM Peak Hour = 0.20 trips per ADP (13% in, 87% out)

Source: Fehr & Peers, based on trip generation rate per average daily population at the existing LBNL site in Berkeley adjusted to reflect the different characteristics of the RBC.

3.6.2 NEAR-TERM (2018) PLUS ADDITIONAL EMPLOYMENT ALTERNATIVE CONDITIONS

Figures 3-12A and 3-12B show the traffic volumes under the Near-Term (2018) Plus Additional Employment Alternative conditions, which consist of traffic volumes under Near-Term (2018) No Project conditions plus traffic generated by the 1,000 Project employees and the 700 additional employees under the Additional Employment Alternative.



VOLUMES KEY

XX (YY) AM (PM) Peak Hour Traffic Volumes

Signalized Intersection

Stop Sign

Figure 3-12A.

Alameda Point Campus Near-Term (2018)
Plus Additional Employment Alternative Peak Hour Traffic Volumes

WC12-2953_3-12A_NT2018+AEAvols

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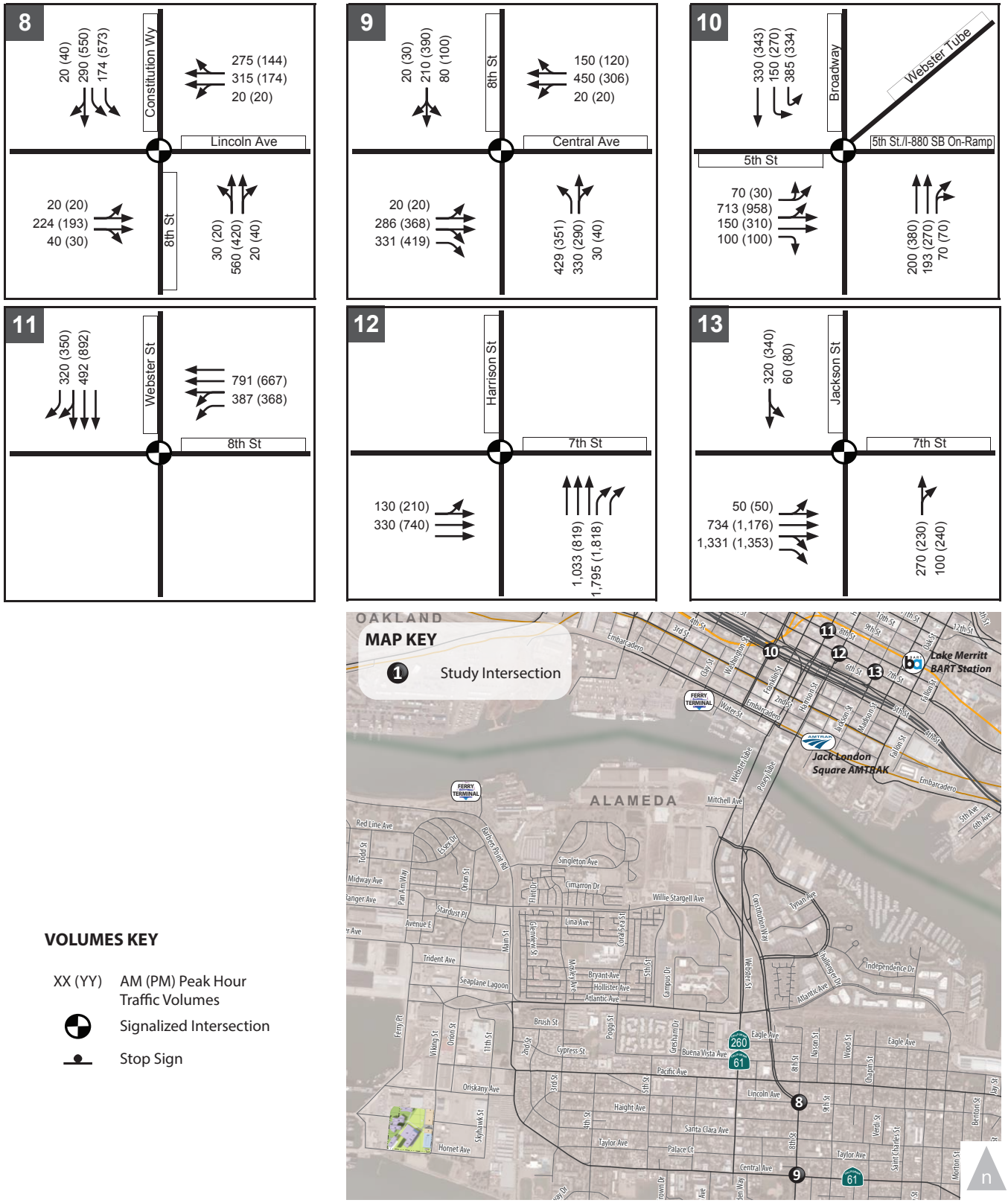

Figure 3-12B.

Alameda Point Campus Near-Term (2018)
Plus Additional Employment Alternative Peak Hour Traffic Volumes

WC12-2953_3-12B_NT2018+AEAvols

FEHR PEERS

3.6.2.1 Intersection Operations

Table 3-10 summarizes intersection operations at the study intersections under the Near-Term (2018) Plus Additional Employment Alternative conditions. **Appendix E** provides the detailed calculation work sheets.

Similar to the Near-Term (2018) Plus Project conditions, all study intersections in Alameda would continue to operate at LOS D or better during both AM and PM peak hours under the Near-Term (2018) Plus Additional Employment Alternative conditions. The Additional Employment Alternative would not cause a significant impact at the study intersections in Alameda.

In Oakland, traffic generated by the Additional Employment Alternative would contribute to LOS F conditions at the Harrison Street/7th Street intersection during both AM and PM peak hours.

Traffic generated by the Additional Employment Alternative would also contribute to LOS E conditions at the Jackson Street/7th Street intersection in Oakland during the PM peak hour; however, the Cumulative Alternative would not cause an increase in the average delay for any of the critical movements by six seconds or more. Based on City of Oakland's significance criteria, the Cumulative Alternative would not cause an impact at the Jackson Street/7th Street intersection under Near-Term (2018) conditions.

The Cumulative Alternative would cause a significant impact at one intersection in Oakland which is summarized under Impact 3-3 discussion.

IMPACT 3-3: NEAR-TERM (2018) PLUS ADDITIONAL EMPLOYMENT ALTERNATIVE CONDITIONS INTERSECTION OPERATIONS

The Additional Employment Alternative at Alameda Point would cause a significant impact at the following intersection under Near-Term (2018) Plus Additional Employment Alternative conditions:

A. The Additional Employment Alternative would cause a significant impact at the signalized **Harrison Street/7th Street** (Intersection 12) because it would increase the overall intersection v/c ratio by 0.01 or more and increase critical movement v/c ratio by 0.02 or more during both AM and PM peak hours at an intersection in downtown Oakland operating at LOS F regardless of the Alternative.

Mitigation Measure 3-3: Implement the following:

TABLE 3-10
ALAMEDA POINT
ADDITIONAL EMPLOYMENT ALTERNATIVE (2018) CONDITIONS –
STUDY INTERSECTION LOS SUMMARY

Intersection	Traffic Control	Peak Hour	Near-Term (2018) No Project		Near-Term (2018) Plus Additional Employment Alternative		Significant Impact?
			Delay[1] (seconds)	LOS[1]	Delay[1] (seconds)	LOS[1]	
City of Alameda							
1. Webster Street/ Willie Stargell Avenue	Signal	AM	19.1	B	20.4	C	No
		PM	19.3	B	19.9	B	No
2. Main Street/ Atlantic Avenue	Signal	AM	11.2	B	12.4	B	No
		PM	11.6	B	12.1	B	No
3. Third Street/ Atlantic Avenue	Signal	AM	22.2	C	23.0	C	No
		PM	40.7	D	37.4	D	No
4. Webster Street/ Atlantic Avenue	Signal	AM	42.9	D	47.4	D	No
		PM	31.6	C	37.1	D	No
5. Constitution Way/ Atlantic Street	Signal	AM	22.7	C	23.3	C	No
		PM	25.8	C	26.1	C	No
6. Main Street/ Pacific Avenue	Signal	AM	20.4	C	25.1	C	No
		PM	16.0	B	21.8	C	No
7. Webster Street/ Lincoln Avenue	Signal	AM	16.0	B	16.4	B	No
		PM	14.5	B	14.5	B	No
8. Constitution Way/ Lincoln Avenue	Signal	AM	22.0	C	22.6	C	No
		PM	23.0	C	23.4	C	No
9. 8th Street/ Central Avenue	Signal	AM	38.0	D	40.3	D	No
		PM	44.8	D	45.3	D	No
City of Oakland							
10. Broadway/ 5th Street	Signal	AM	26.4	C	28.7	C	No
		PM	35.2	D	38.4	D	No
11. Webster Street/ 8th Street	Signal	AM	15.9	B	16.0	B	No
		PM	17.3	B	17.3	B	No
12. Harrison Street/ 7th Street	Signal	AM	**100.5 (v/c=0.74)**	**F**	**106.5 (v/c=0.75)**	**F**	Yes
		PM	**>120 (v/c=0.86)**	**F**	**>120 (v/c=0.93)**	**F**	Yes
13. Jackson Street/ 7th Street	Signal	AM	16.8	B	16.7	B	No
		PM	70.9	E	68.4	E	No

Notes: **Bold** indicates intersection operating at unacceptable LOS E/ F in Alameda or unacceptable LOS F in Oakland.
1. For signalized intersections, average intersection delay and LOS based on the 2000 HCM method is shown.
Source: Fehr & Peers.

A. **Harrison Street/7th Street** (Intersection 12): Implement the following which requires coordination with City of Oakland (same as Mitigation Measure 3-1A):

- Increase traffic signal cycle length to 75 seconds and optimize traffic signal timing parameters (i.e., the amount of green signal time allocated to each intersection approach).

The intersection would continue to operate at LOS F during both AM and PM peak hours after the implementation of this mitigation measure. However, this mitigation measure would reduce the overall intersection v/c ratio and the critical movement v/c ratio to the same level or less than under Near-Term (2018) No Project conditions. Therefore, the mitigation measure would reduce the impact to less than significant if implemented.

3.6.2.2 Freeway Operations

Table 3-6 summarizes the AM and PM peak hour freeway LOS analysis results under Near-Term (2018) Plus Additional Employment Alternative conditions. **Appendix F** provides the detailed calculation work sheets.

All freeway segments operating at acceptable LOS E or better under Near-Term (2018) No Project conditions are projected to continue to operate at an acceptable LOS under Near-Term (2018) Plus Additional Employment Alternative conditions. The Additional Employment Alternative would not increase the peak hour volume by five percent or more at the study freeway segments that are projected to operate at LOS F. Therefore, the Additional Employment Alternative would not cause a significant impact at the study freeway segments under Near-Term (2018) Plus Additional Employment Alternative conditions.

1

TABLE 3-11
ALAMEDA POINT
ADDITIONAL EMPLOYMENT ALTERNATIVE (2018) CONDITIONS –
FREEWAY SEGMENT LOS SUMMARY

Freeway Segment	Type[1]	Dir[2]	Near-Term (2018) No Project				Near-Term (2018) Plus Additional Employment Alternative				Significant Impact?
			AM Peak Hour		PM Peak Hour		AM Peak Hour		PM Peak Hour		
			Density[3]	LOS	Density[3]	LOS	Density[3]	LOS	Density[3]	LOS	
1. I-880, west of I-980	Basic	NB	--	F	--	F	--	F	--	F	No
	Basic	SB	--	F	--	F	--	F	--	F	No
2. I-880, between I-980 and Oak Street	Basic	NB	35.7	E	38.8	E	35.8	E	39.6	E	No
	Basic	SB	--	F	--	F	--	F	--	F	No
3. I-880, south of Oak Street	Basic	NB	34.2	D	35.8	E	34.7	D	35.8	E	No
	Basic	SB	34.0	D	38.7	E	34.1	D	39.4	E	No
4. Webster/Posey Tubes	Basic	NB	23.4	C	20.7	C	23.6	C	22.1	C	No
	Basic	SB	17.0	B	23.7	C	18.5	C	24.0	C	No

1. Segments with auxiliary lanes are classified as weave segments, and were analyzed based on the Leisch Method. Basic segments are analyzed as basic segments using the 2000 HCM methodologies.
2. NB = Northbound; SB = Southbound
3. Density is presented in passenger cars per lane per mile (pc/ln/mi).

Source: Fehr & Peers.

2

4.0 LBNL SITE ALTERNATIVE

This chapter describes existing transportation conditions for the existing LBNL site and identifies impacts and mitigation measures of Phase 1 development of the proposed LRDP at LBNL under Near-Term (2018) and Cumulative (2035) conditions.

4.1 EXISTING CONDITIONS

Existing transportation conditions at LBNL and vicinity are described below.

4.1.1 EXISTING ROADWAY NETWORK

Figure 4-1 shows the existing LBNL site, the surrounding roadway system, and intersections analyzed as part of this analysis. The regional and local roadways serving the project site, as well as the internal circulation within the site are described below.

4.1.1.1 Regional Roadways

Interstate 80 (I-80) connects the San Francisco Bay Area with the Sacramento region and continues east. Within Berkeley, I-80 is oriented in a north-south direction along the western edge of the city and provides five lanes of travel in each direction. Access from I-80 to the city of Berkeley is provided through interchanges at Ashby Avenue, University Avenue, and Gilman Street. I-80 and the nearby I-80/I-580 interchange operate at capacity during the peak commute hours. I-80 between Emeryville and Albany is also I-580. I-80 has an AADT of 256,000 vehicles (Caltrans, 2011) between the University Avenue and Gilman Street interchanges.

State Route 24 (SR 24) links I-680 in Contra Costa County to I-80/I-580 and I-980. SR 24 provides four travel lanes in each direction near Berkeley. This is the primary route used by Berkeley-bound travelers from Contra Costa County. The primary access routes from SR 24 to the LBNL area are SR 13 (Ashby Avenue) to the Belrose-Derby-Warring-Piedmont corridor, and Telegraph Avenue. SR 24 has an AADT of 148,000 vehicles (Caltrans, 2011) east of SR 13.

State Route 13/Ashby Avenue (SR 13) connects I-580 in east Oakland to I-80, with a partial access interchange at SR 24. In Berkeley, SR 13 is Tunnel Road/Ashby Avenue, a generally east-west two to four-lane arterial through the city. Ashby Avenue intersects the major north-south roadways in Berkeley, providing several routes toward LBNL and UC Berkeley campus. It is about 1.25 miles south of the LBNL.

Figure 4-1.

LBNL Site Study Locations

WC12-2953_4-1_LBNLStudy

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During the peak commute hours, on-street parking restrictions on the north side of Ashby Avenue in the morning and the south side in the evening provide an additional travel lane for commuters. Ashby Avenue provides sidewalks on both sides of the roadway. SR 13 has an AADT of 28,500 vehicles (Caltrans, 2011) north of SR 24.

University Avenue provides one of Berkeley's three connections to I-80 to the west (along with Gilman Street and Ashby Avenue). It is an east-west major arterial that extends from the Berkeley Marina and I-80 in the west to the UC Berkeley campus in the east. The divided roadway provides a center median and left-turn pockets at major intersections. Left turns from University Avenue onto cross-streets generally are not served by a separate left-turn signal phase. University Avenue is a four-lane arterial, with parallel parking and sidewalks on both sides of the roadway.

Belrose-Derby-Warring-Piedmont Corridor. This is a heavily used route connecting SR 24 with Berkeley's Southside area (i.e., the area just south of the UC Berkeley campus), UC Berkeley, and LBNL. With a single travel lane in each direction, the route is at or near capacity for several hours during the morning and evening commute periods. The roadways in this corridor provide sidewalks on both sides of the street. Using roadway signs and notices in official mailings, the City of Berkeley and UC Berkeley have been encouraging travelers to use other routes, like Telegraph Avenue.

Hearst Avenue is a two- to four-lane, east-west street that extends between west Berkeley and LBNL's main entrance at Cyclotron Road, which diverges from Hearst Avenue just east of Gayley Road along the northern boundary of the UC Berkeley campus. Between Gayley Road/La Loma Avenue and LeRoy Avenue, Hearst Avenue provides one travel lane in each direction, with parallel parking on both sides. During the peak commute hours, on-street parking restrictions on the south side of the street in the morning and the north side in the evening provide an additional travel lane. Hearst Avenue generally provides sidewalks on both sides of the street, except between Arch Street and Euclid Avenue, where sidewalk is only provided on the north side of the roadway. Hearst Avenue is designated as a bicycle lane (Class 2 west of Shattuck Avenue and a bicycle route (Class 3) east of Shattuck Avenue.

4.1.1.2 Local Roadways

Bancroft Way is an east-west roadway extending from downtown Berkeley through the Southside area, along the southern boundary of the UC Berkeley campus. The roadway is one-way westbound, with two travel lanes from Piedmont Avenue to Telegraph Avenue and three travel lanes from Telegraph Avenue to the Bancroft Way/Oxford Street intersection. Bancroft Way provides sidewalks on both sides of the roadway.

Durant Avenue is a major east-west roadway extending from downtown Berkeley through the Southside area. East of Shattuck Avenue, the roadway is one-way eastbound with three travel lanes. Durant Avenue serves as a "one-way couplet" with Bancroft Way for east-west travel on the south side of the UC Berkeley campus. Durant Avenue provides sidewalks on both sides of the roadway.

La Loma Avenue/Gayley Road is a two-lane, north-south street that extends from Hearst Avenue through north Berkeley. South of Hearst Avenue, La Loma Avenue becomes Gayley Road and borders the east side of the UC Berkeley campus. Parking is allowed on both sides of the street north of Hearst Avenue, but is not allowed south of Hearst Avenue until the vicinity of Memorial Stadium, where Gayley Road becomes Piedmont Avenue. Both streets provide sidewalks on both sides of the roadway. Gayley Road, just north of Banroft Way, provides Class 2 bicycle lanes.

Stadium Rim Way wraps around the east and north sides of Memorial Stadium and connects the west end of Panoramic Way to Gayley Road near the Greek Theater. It provides access from Gayley Road and Prospect Street to the east side of Memorial Stadium and surrounding parking facilities. Stadium Rim Way also intersects with Centennial Drive, indirectly providing access to the Lawrence Hall of Science (LHS), the Botanical Garden, the Strawberry Canyon Recreational Area, and the LBNL gates on Centennial Drive. Stadium Rim Way generally provides pedestrian facilities on the south side of the roadway consisting of sidewalks or an at-grade path separated from the roadway with bollards.

Centennial Drive borders the east and south perimeters of LBNL. It connects Grizzly Peak Boulevard and Stadium Rim Way and provides access to LBNL through the Strawberry Canyon and Grizzly Peak gates. Centennial Drive also provides access to LHS, the Botanical Garden, Strawberry Canyon Recreational Area, and Tilden Regional Park. In the vicinity of LBNL, the speed limit is 25 miles per hour. Several sections of the roadway have steep grades and sharp curves, where the speed limit is reduced to 15 miles per hour. Centennial Drive provides intermittent sidewalks or parallel unpaved path along specific segments.

Grizzly Peak Boulevard is a two-lane, two-way roadway located in the hills of Berkeley, connecting Skyline Boulevard in the Sibley Volcanic Regional Preserve in the south, to Spruce Street near the Summit Reservoir in north Berkeley. The narrow and curvy roadway does not provide any pedestrian or bicyclist amenities south of Centennial Drive; however, it is signed as a Class 3 bicycle route. The roadway provides access to parking facilities and trails in Tilden Regional Park, and to SR 24.

4.1.1.3 Internal Circulation

The LBNL campus is served by an east-west traffic circulation system that generally conforms to the contours of the site's topography. Employees and visitors access the site through three gates. The

Blackberry Canyon Gate, on the west of the site, is accessed via Cyclotron Road and connects to Hearst Avenue. The Strawberry Canyon and Grizzly Peak Gates, on the east of the site, are accessed via Centennial Road. The three gates are attended by security personnel during business hours; the Blackberry Canyon Gate is the only one accessible by a card access system at other times. The site's main vehicle routes are two-way, except for three sections where roadside parking reduces the width, permitting only one-way travel.

4.1.2 TRAFFIC OPERATIONS ANALYSIS

This study analyzes existing traffic operations during typical weekday AM and PM peak hours at the following 14 intersections in the City of Berkeley:

1. Grizzly Peak Boulevard/Centennial Drive
2. Hearst Avenue/Shattuck Avenue
3. Hearst Avenue/Oxford Street
4. Hearst Avenue/Euclid Avenue
5. Hearst Avenue/Gayley Road/La Loma Avenue
6. University Avenue/Shattuck Avenue
7. University Avenue/Oxford Street
8. Gayley Road/Stadium Rim Way
9. Centennial Drive/Stadium Rim Way
10. Panoramic Way/Canyon Road/ Stadium Rim Way
11. Bancroft Way/Gayley Road/Piedmont Avenue
12. Durant Avenue/Piedmont Avenue
13. Channing Way/Piedmont Avenue
14. Dwight Way/Piedmont Avenue

These intersections were selected for analysis because they are most likely to be affected by the proposed Alternative. **Figure 4-1** shows the location of the study intersections and their configuration and control.

4.1.2.1 Existing Intersection Volumes

The intersection operations analysis presented in this study are based on AM and PM peak period (7:00 to 10:00 AM and 4:00 to 7:00 PM) intersection turning movement, pedestrian, and bicycle volumes collected on Wednesday, September 12, 2012, and Thursday, January 31, 2013, while UC Berkeley was in regular session. These time periods were selected because trips generated by the proposed Project, in combination with background traffic, are expected to represent typical worst traffic conditions. Within the peak periods, the peak hours (i.e., the hour with the highest traffic volumes observed in the study area) are from 8:00 AM to 9:00 AM (AM peak hour) and 5:00 PM to 6:00 PM (PM peak hour).

Figures 4-2A and 4-2B present the existing AM and PM peak hour intersection vehicle turn movement volumes at the study intersections. **Figures 4-3A and 4-3B** present the existing AM and PM peak hour pedestrian and bicycle volumes at the study intersections. **Appendix G** presents the detailed count sheets at the study intersections.

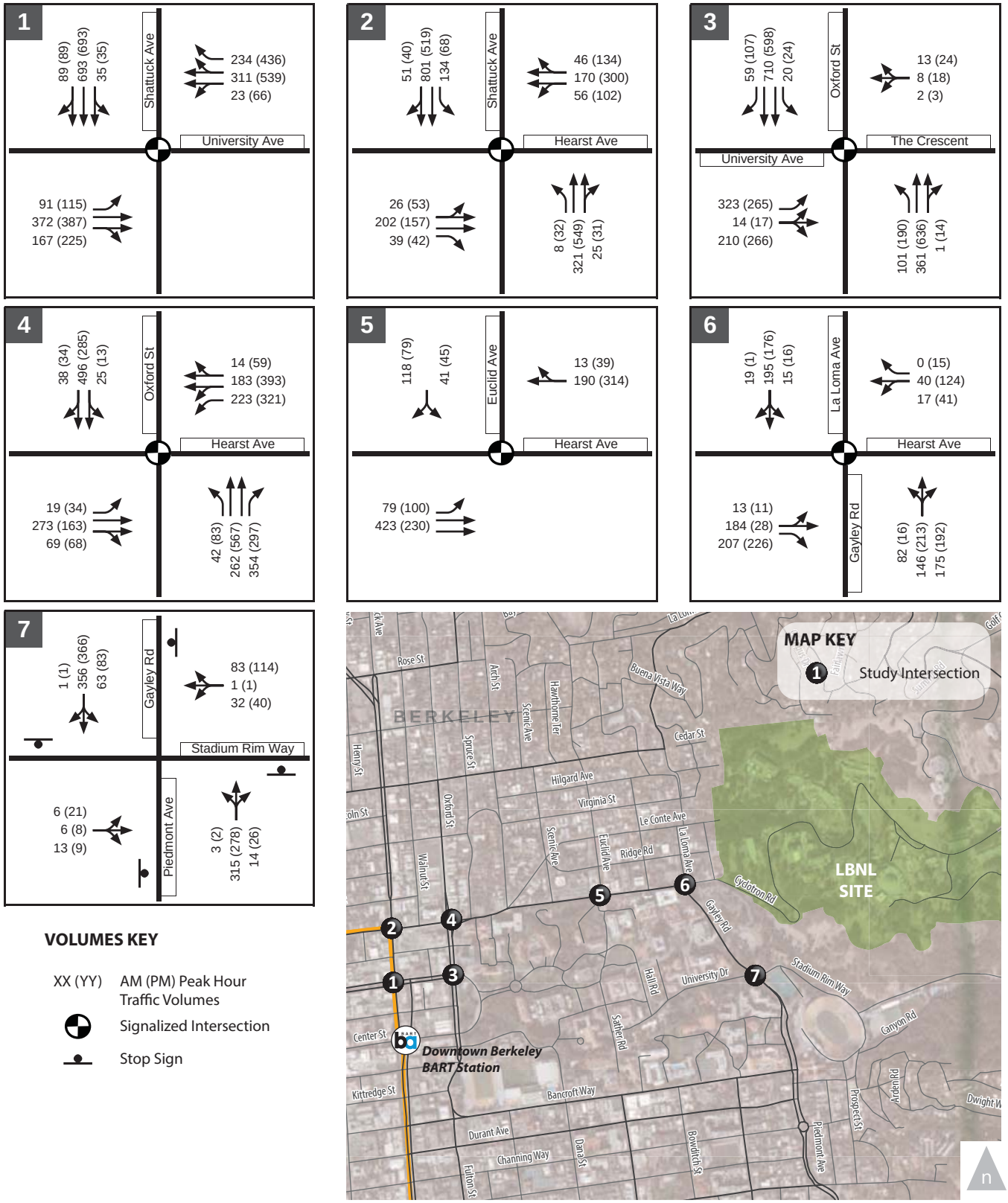

Figure 4-2A.

LBNL Site Existing
Peak Hour Traffic Volumes, Lane Configurations and Traffic Control

WC12-2953_4-2A_ExVol

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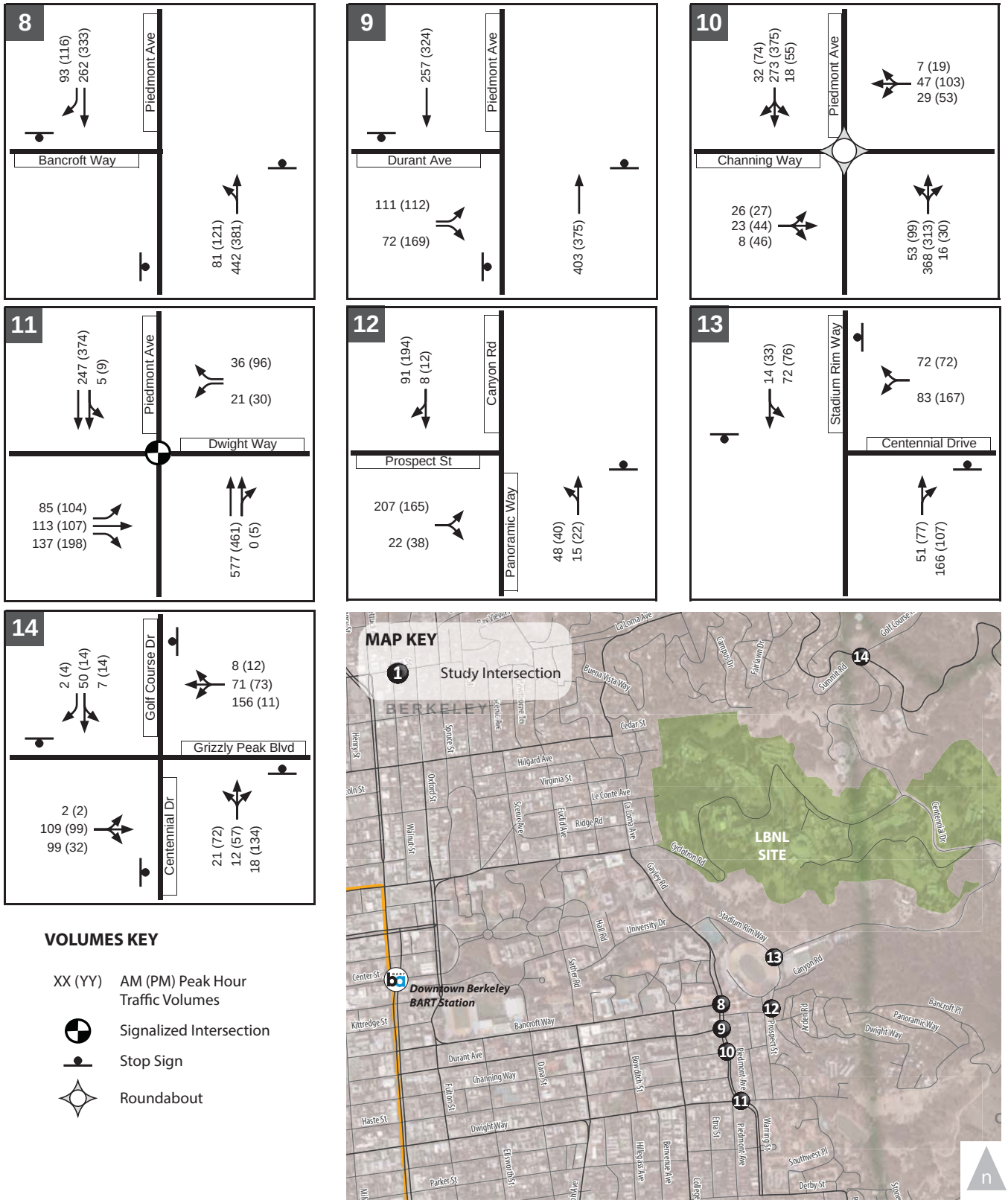

Figure 4-2B.

LBNL Site Existing
Peak Hour Traffic Volumes, Lane Configurations and Traffic Control

WC12-2953_4-2B_ExVol

FEHR PEERS

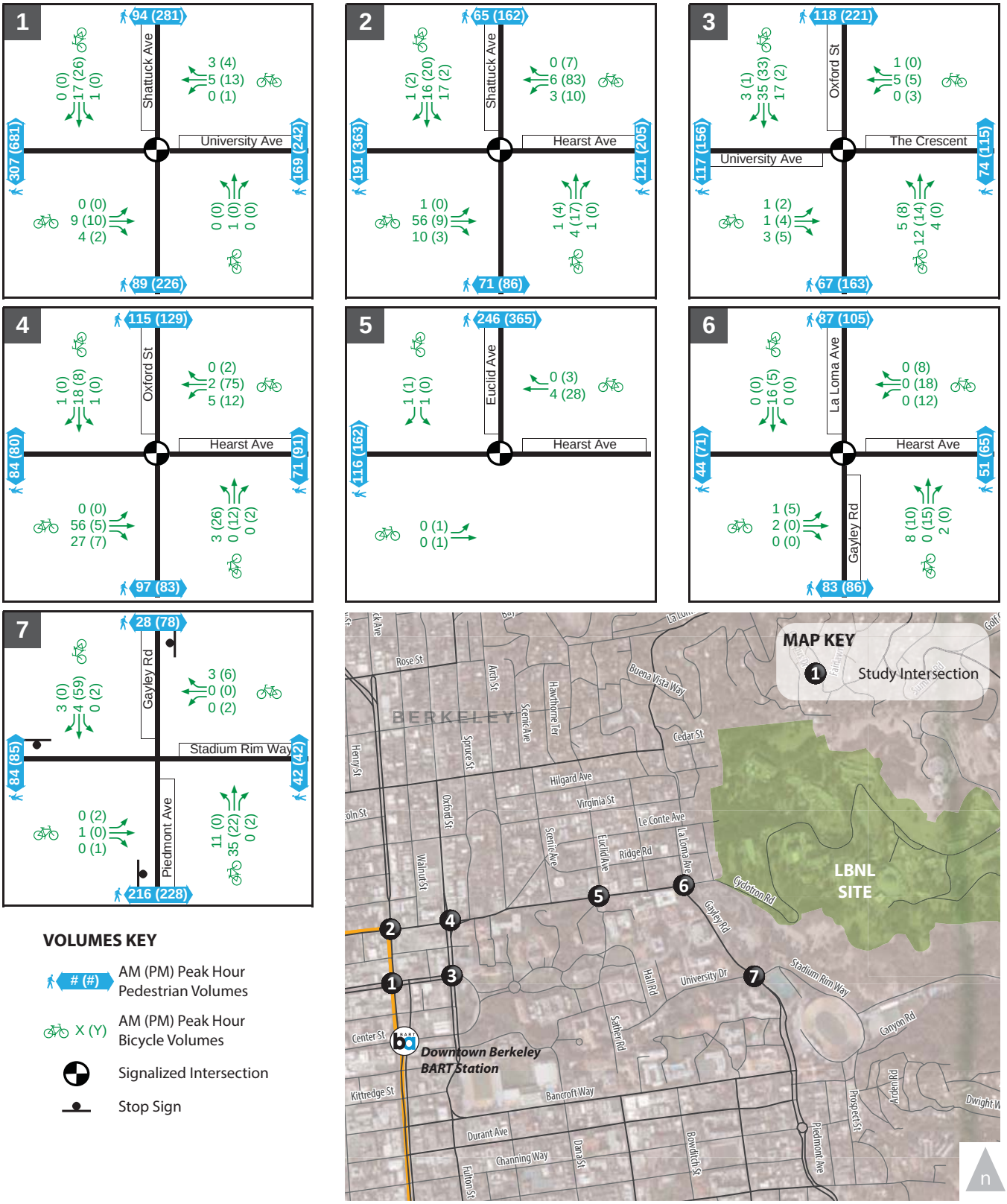

Figure 4-3A.

LBNL Site Existing Pedestrian and Bicycle Peak Hour Volumes

WC12-2953_4-3A_BikePedVol

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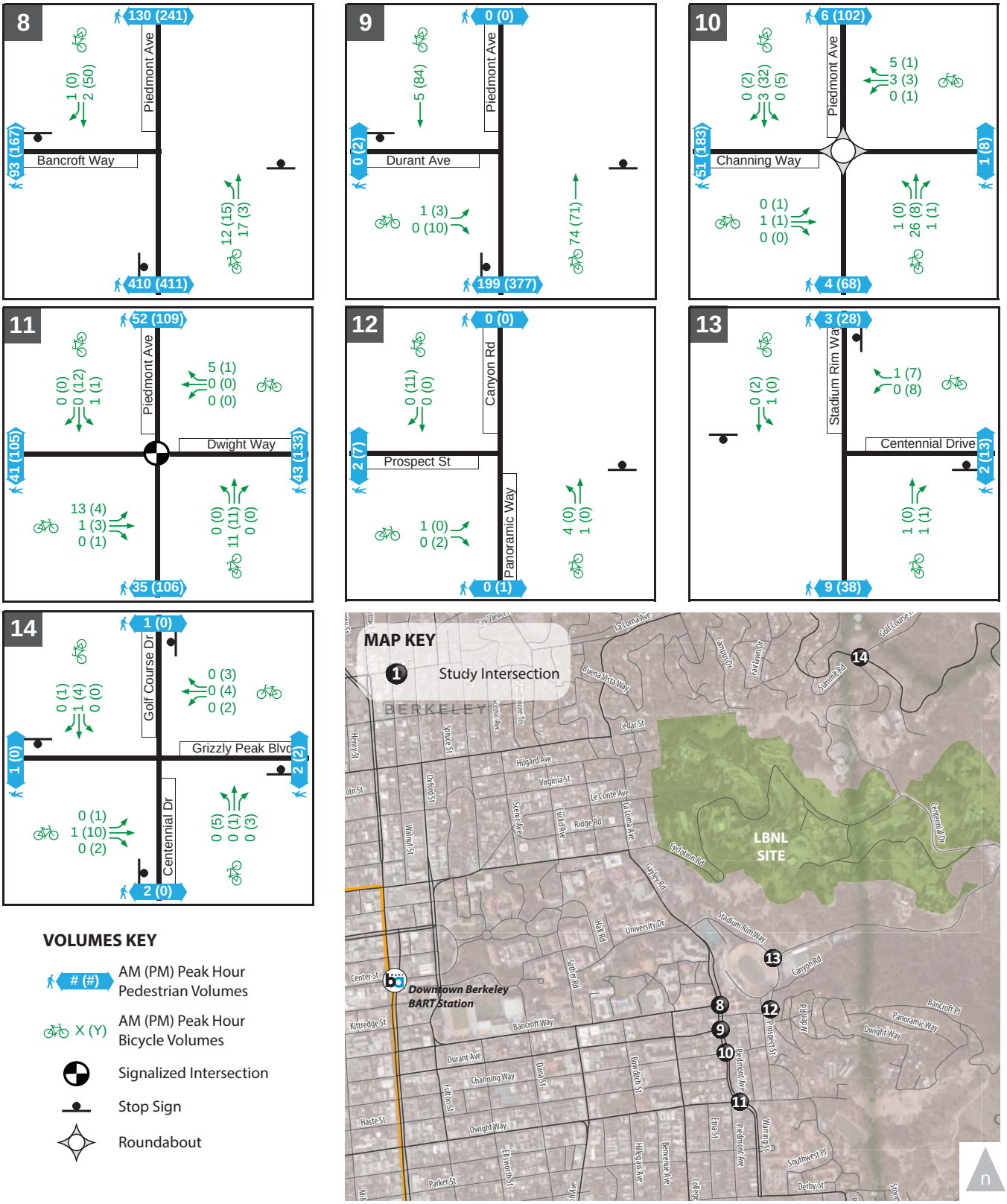

Figure 4-3B.

LBNL Site Existing Pedestrian and Bicycle Peak Hour Volumes

WC12-2953_4-3B_ExVol

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4.1.2.2 Existing Intersection Operations

Table 4-1 summarizes existing weekday peak hour intersection LOS analysis results. **Appendix H** provides the detailed calculation work sheets. As shown in the table, all study intersections currently operate at LOS D or better during the AM peak hour; and 12 of the 14 study intersections currently operate at LOS C or better during the PM peak hour.

Based on the analysis and verified by observations, the all-way stop-controlled Bancroft Way/Piedmont Avenue and Durant Avenue/Piedmont Avenue intersections operate at LOS F during the PM peak hour. Northbound and southbound vehicle flows at these intersections are impeded by the high pedestrian volumes crossing Piedmont Avenue.

4.1.3 EXISTING TRANSIT AND SHUTTLE SERVICES

The LBNL site is served indirectly by BART, AC Transit, and UC Berkeley Shuttle Service (BEAR Transit) and directly by the LBNL shuttle service. **Figure 4-4** shows the transit routes in the vicinity of the project site. Each transit service is described below.

4.1.3.1 BART

BART provides regional commuter rail transit in Alameda, Contra Costa, San Francisco, and San Mateo counties. Currently, BART trains operate on weekdays from 4:00 AM to midnight, on Saturdays from 6:00 AM to midnight, and on Sundays from 8:00 AM to midnight. The nearest BART station to the LBNL site is the Downtown Berkeley station located one block west of the UC Berkeley campus at the Center Street/ Shattuck Avenue intersection (approximately 1.25 miles east of the project site). The LBNL shuttle service provides access between the LBNL site and the Downtown Berkeley BART Station.

The Downtown Berkeley BART Station is served by the Richmond-Fremont and Richmond-Daly City/ Millbrae lines. Other destinations in the BART system can be reached by transferring at stations in Oakland. Typically, Downtown Berkeley BART Station is served by a train every seven (peak weekday commute periods) to 20 minutes (Sundays). The Downtown Berkeley BART station is one of the most highly used stations within the BART system with average weekday exits and entries of approximately 23,000 passengers in January 2013.

4.1.3.2 AC Transit

Local bus service in Berkeley is provided by AC Transit. Within the City of Berkeley, at least one AC Transit route provides service within walking distance (0.25 mile) of nearly every resident in the city. **Figure 4-4** illustrates the existing AC Transit routes in the vicinity of LBNL. Although these routes do not directly serve LBNL, the LBNL shuttle service provides access to them.

TABLE 4-1
LBNL SITE
EXISTING CONDITIONS – STUDY INTERSECTION LOS SUMMARY

Intersection	Control	AM Peak Hour		PM Peak Hour	
		Delay (Seconds)[1]	LOS [1]	Delay (Seconds) [1]	LOS [1]
1. University Avenue/ Shattuck Avenue	Signal	16.6	B	21.6	C
2. Hearst Avenue/ Shattuck Avenue	Signal	16.0	B	21.1	C
3. University Avenue/ Oxford Street	Signal	19.8	B	20.2	C
4. Hearst Avenue/ Oxford Street	Signal	28.7	C	33.7	C
5. Hearst Avenue/ Euclid Avenue	Signal	14.9	B	19.8	B
6. Hearst Avenue/Gayley Road/La Loma Avenue	Signal	13.1	B	13.8	B
7. Stadium Rim Way/ Gayley Road	All-Way Stop	13.7	B	13.8	B
8. Bancroft Way/ Piedmont Avenue [2]	All-Way Stop	34.3	D	**76.4**	**F**
9. Durant Avenue/ Piedmont Avenue [2]	All-Way Stop	16.2	C	**53.2**	**F**
10. Channing Way/ Piedmont Avenue	Roundabout	8.0	A	11.4	B
11. Dwight Way/ Piedmont Avenue	Signal	13.8	B	13.0	B
12. Panoramic Way/Canyon Road/ Stadium Rim Way	Side-Street Stop	2.0 (11.4)	A (B)	1.7 (11.4)	A (B)
13. Centennial Drive/ Stadium Rim Way	All-Way Stop	8.5	A	9.7	A
14. Centennial Drive/Grizzly Peak Boulevard	All-Way Stop	9.3	A	9.0	A

Notes: **Bold** indicates an intersection operating at unacceptable LOS E or LOS F.
1. For signalized, all-way stop-controlled, and roundabout intersections, average intersection delay and LOS based on the 2000 HCM method is shown. For side-street stop-controlled intersections, delays for worst movement and average intersection delay are shown: intersection average (worst movement).
2. Intersection analyzed using SimTraffic software because of unique conditions including heavy pedestrian volumes. Field observations validate the results shown in the table.

Source: Fehr & Peers.

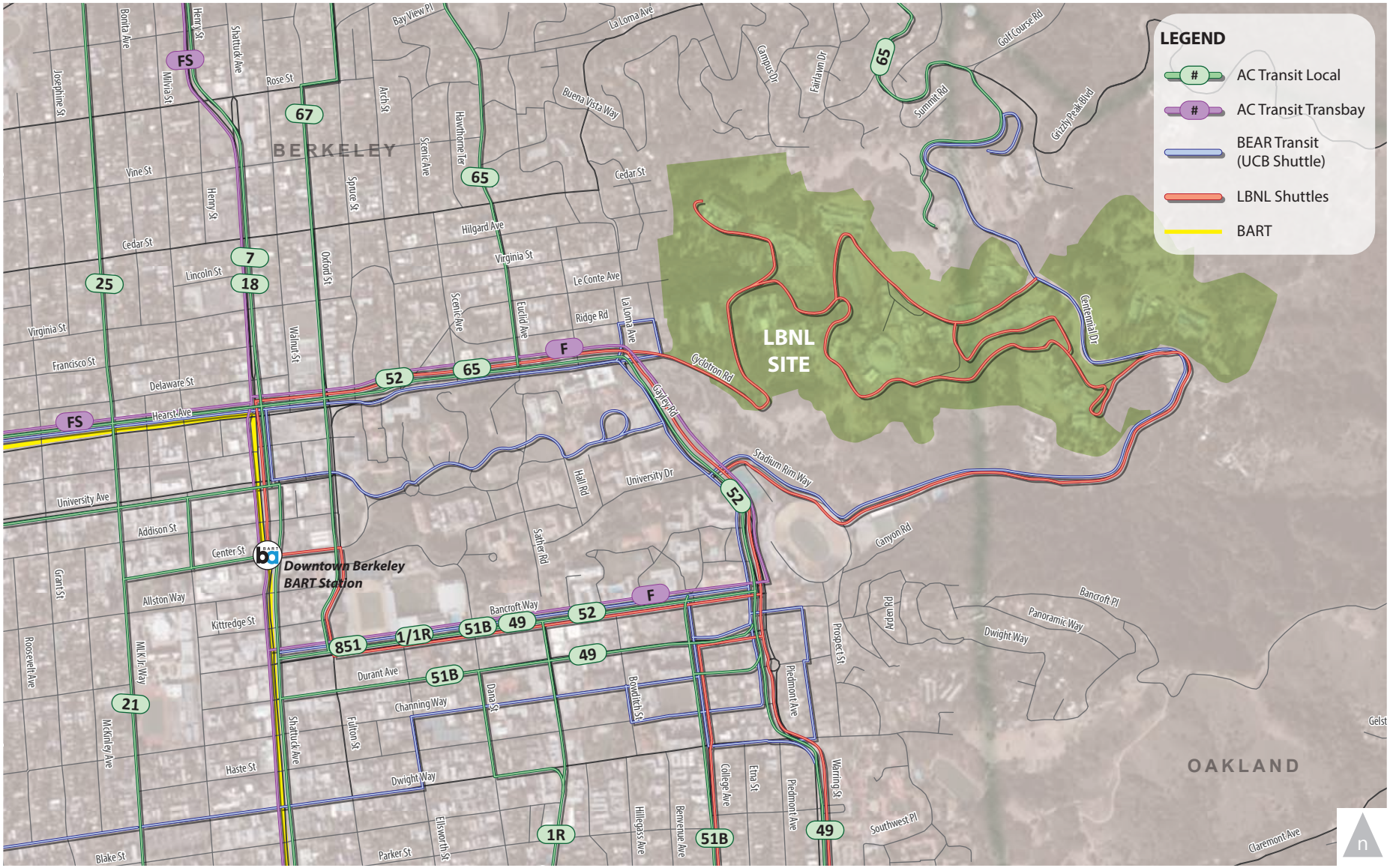

Figure 4-4.

LBNL Site Existing Transit Service

WC12-2953_4-4_LBNLTransit

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Table 4-2 describes the major bus routes serving the project area. Additional AC Transit routes can be accessed in downtown Berkeley and Southside area through the LBNL shuttles.

4.1.3.3 LBNL Shuttles

LBNL provides a free on-site and off-site shuttle service connecting LBNL to UC Berkeley, BART, AC Transit, and local neighborhoods. These shuttles are described below.

- The Orange Route operates in a clockwise loop between the LBNL Strawberry Gate, the UC Berkeley campus and the Downtown Berkeley BART Station through Hearst Avenue, Gayley Road Centennial Drive, and Bancroft Way on weekdays with 10 to 15-minute headways from 6:30 AM to 7:00 PM.

- The Blue Route operates in a clockwise loop between the Downtown Berkeley BART Station, north side of the UC Berkeley campus, and LBNL through Hearst Avenue, and Cyclotron Road on weekdays with 10-minute headways from 6:20 AM to 7:30 PM.

- The Rockridge Shuttle operates between and the Rockridge BART Station on one-hour headways from 6:40 AM to 8:40 AM and from 3:35 PM to 6:35 PM.

- The Potter Street/JBEI Route operates between LBNL, UC Berkeley Campus, Downtown Berkeley BART Station, and LBNL's remote sites in Emeryville and West Berkeley on 30-minute headways from 8:00 AM to 8:00 PM.

Although the LBNL shuttles are free, they are restricted to LBNL employees and visitors and shuttle riders are required to provide a valid identification to the driver. Shuttle stops are coordinated with AC Transit bus lines serving downtown Berkeley. The LBNL shuttles are equipped with bicycle racks for the ride up the hill. The shuttles listed above serve the project vicinity via stops on Alvarez Road near Building 56A.

4.1.3.4 BEAR Transit

BEAR Transit, operated by UC Berkeley, primarily serves the UC Berkeley community, providing service between the UC Berkeley campus, surrounding neighborhoods, and select destinations, including the Richmond Field Station (RFS) (See Section 2.1.4.4 for more detail on the RFS shuttle). In general, the daytime shuttles operate on a fixed route and schedule between 6:45 AM and 7:30 PM. The night shuttles operate on a fixed schedule between 7:30 PM and 2:00 AM, and provide door-to-door service throughout the service area between 2:00 AM and 6:00 AM.

All BEAR Transit shuttle buses, except the RFS shuttle line, are free to UC Berkeley students, faculty, staff, post-docs, and visiting scholars, who have valid university identification. Others must pay a fair of $1.00. The Bear Transit Line H serves destinations along Centennial Drive including the UC Berkeley Botanical Garden and LHS.

TABLE 4-2
LBNL SITE
AC TRANSIT SERVICE SUMMARY

Line	Route	Nearest Stop [1]	Weekday		Weekend	
			Hours	Frequency	Hours	Frequency
Local Routes						
1/1R	Between Berkeley and Bay Fair BART Stations via Telegraph Ave., International Blvd., and East 14th St.	Telegraph Avenue/ Bancroft Way (About 1.0 miles)	5:00 AM to 1:00 AM	15 minutes	5:00 AM to 1:00 AM	20 minutes
49	Loop starting at Rockridge BART via Ashby Ave., Dwight Way, Bancroft Way, Durant Ave. and Claremont Ave.	Piedmont Avenue/ Bancroft Way (About 0.9 miles)	6:00 AM to 8:15 PM	30 minutes	7:00 AM to 8:00 PM	40 minutes
51B	Between Rockridge BART and Berkeley Amtrak Station via College Ave., Bancroft Way/Durant Ave. and University Ave.	College Avenue/ Bancroft Way (About 0.9 miles)	5:00 AM to 12:30 AM	10 to 20 minutes	5:00 AM to 12:30 AM	15 to 20 minutes
52	Between UC Berkeley and Albany University Village via Bancroft Way, University Ave., San Pablo Ave., and Hearst Ave.	Leroy Avenue/ Hearst Avenue (About 0.4 miles)	6:00 AM to 12:00 AM	15 to 30 minutes	8:00 AM to 8:15 PM	30 to 40 minutes
65	Between Berkeley BART and Lawrence Hall of Science via Euclid Ave. and Grizzly Peak Blvd.	Euclid Avenue/ Hearst Avenue (About 0.5 miles)	5:30 AM to 9:00 PM	30 to 60 minutes	7:30 AM to 7:30 PM	60 minutes
Night Routes						
851	Between Fruitvale and Berkeley BART Stations via, Fruitvale Ave., Santa Clara Ave., Webster St., Broadway, College Ave., and Bancroft Way/ Durant Ave.	College Avenue/ Bancroft Way (About 0.9 miles)	12:00 AM to 5:00 AM	60 minutes	12:00 AM to 5:00 AM	60 minutes
Transbay Routes						
F	Between UC Berkeley and San Francisco Transbay Terminal	Leroy Avenue/ Hearst Avenue (About 0.4 miles)	5:00 AM to 1:00 AM	30 minutes	5:00 AM to 1:00 AM	30 minutes

1. Distance shown is current walking distance between bus stop and Blackberry Gate.
Source: AC Transit, 2013.

4.1.4 EXISTING PEDESTRIAN AND BICYCLE CIRCULATION

Most LBNL employees and visitors either drive or use transit to access the site. The hilly terrain and steep grades make walking or biking to the site rather difficult. Most walking and biking trips to the LBNL site are through the Blackberry Canyon Gate which connects to the City's sidewalks and bicycle facilities through Cyclotron Road and Hearst Avenue. The Strawberry Canyon and Grizzly Peak Gates can also be accessed by bicyclists using Centennial Drive and pedestrians using the intermittent paved sidewalks and unpaved paths along Centennial Drive. Many bicyclists also use the LBNL shuttles that are equipped with bike racks for their uphill inbound trip to the site and use their bicycles for the outbound downhill trip.

Within the site, pedestrian and bicycle paths meander and have many discontinuities. Pedestrian pathways primarily connect parking facilities and buildings. Although these paths are used for shorter trips within the site, the on-site shuttle service is typically used for longer trips.

Within the City of Berkeley, all non-residential and most residential streets provide sidewalks and crosswalks for pedestrians.

Based on the *City of Berkeley Bicycle Master Plan* (February 2005), bicycle facilities can be classified into several types, including:

- ***Bicycle Paths (Class 1)*** – These facilities are located off-street and can serve both bicyclists and pedestrians.
- ***Bicycle Lanes (Class 2)*** – These facilities provide a dedicated area for bicyclists within the paved street width through the use of striping and appropriate signage.
- ***Bicycle Routes (Class 3)*** – These facilities are found along streets that do not provide sufficient width for dedicated bicycle lanes. The street is then designated as a bicycle route through the use of signage informing drivers to expect bicyclists.
- ***Shared Bikeways (Class 2.5)*** – These facilities are found along streets with high bicycle volumes where bicycle lanes are not feasible. Typically, shared lane bicycle stencils, wide curb lanes, signage, and low speed limits are used to encourage shared use.
- ***Bicycle Boulevards*** – These facilities are installed along residential streets with low traffic volumes and prioritize bicycle travel. Assignment of right-of-way to the route, traffic calming measures and bicycle traffic signal actuation are used to prioritize through-trips for bicycles.

Figure 4-5 identifies existing and proposed bicycle facilities in the study area. Currently, bicyclists are allowed on all roadways within the study area. Existing bicycle facilities near the project site include Class 2 bicycle lanes on Gayley Road adjacent to the California Memorial Stadium and Class 3 bicycle routes on Grizzly Peak Boulevard south of Centennial Drive. The 2005 Berkeley Bicycle Plan Update identifies Gayley Road, Piedmont Avenue, and Bancroft Way as future Class 2.5 facilities (shared roadways where full bicycle lanes cannot be implemented but other improvements and amenities can be provided). Stadium Rim Way and Centennial Drive are identified as future Class 3 facilities (signed bike routes). In addition, the 2006 UC Berkeley Campus Bicycle Plan recommends Gayley Road and Stadium Rim Way as future Class 2.5 facilities. The 2005 Berkeley Bicycle Plan Update proposes Hearst Avenue as a combination of Class 2.5 and Class 3 facilities. City of Berkeley and UC Berkeley completed the *Hearst Avenue Complete Street Study* (Fehr & Peers 2012) to identify improvements along the Hearst Avenue corridor between Shattuck Avenue and Gayley Road/LaLoma Avenue that primarily benefit bicyclists and pedestrians.

As previously shown on Figures 4-3A and 4-3B, intersections in the vicinity of LBNL generally experience moderate to high pedestrian and bicycle activity.

4.2 REGULATORY CONSIDERATIONS

The LBNL campus is located within Berkeley and Oakland City boundaries. This section summarizes relevant principles, polices and guidelines contained in the Cities of Berkeley and Oakland General Plans.

4.2.1 CITY OF BERKELEY GENERAL PLAN

About 95 acres, or almost half of the LBNL site, is within the City of Berkeley. The Land Use Element of the Berkeley General Plan contains comprehensive objectives and policies that guide physical development in the city. One objective of the Land Use Element is to "minimize the negative impacts and maximize the benefits of University of California on the citizens of Berkeley."

The Transportation Element of the Berkeley General Plan contains the following policies relevant to the proposed alternative:

<u>Transportation Objective 1</u>: Maintain and improve public transportation services throughout the city.

<u>Transportation Objective 2</u>: Reduce automobile use and vehicle miles traveled in Berkeley, and the related impacts, by providing and advocating for transportation alternatives and subsidies that facilitate voluntary decisions to drive less.

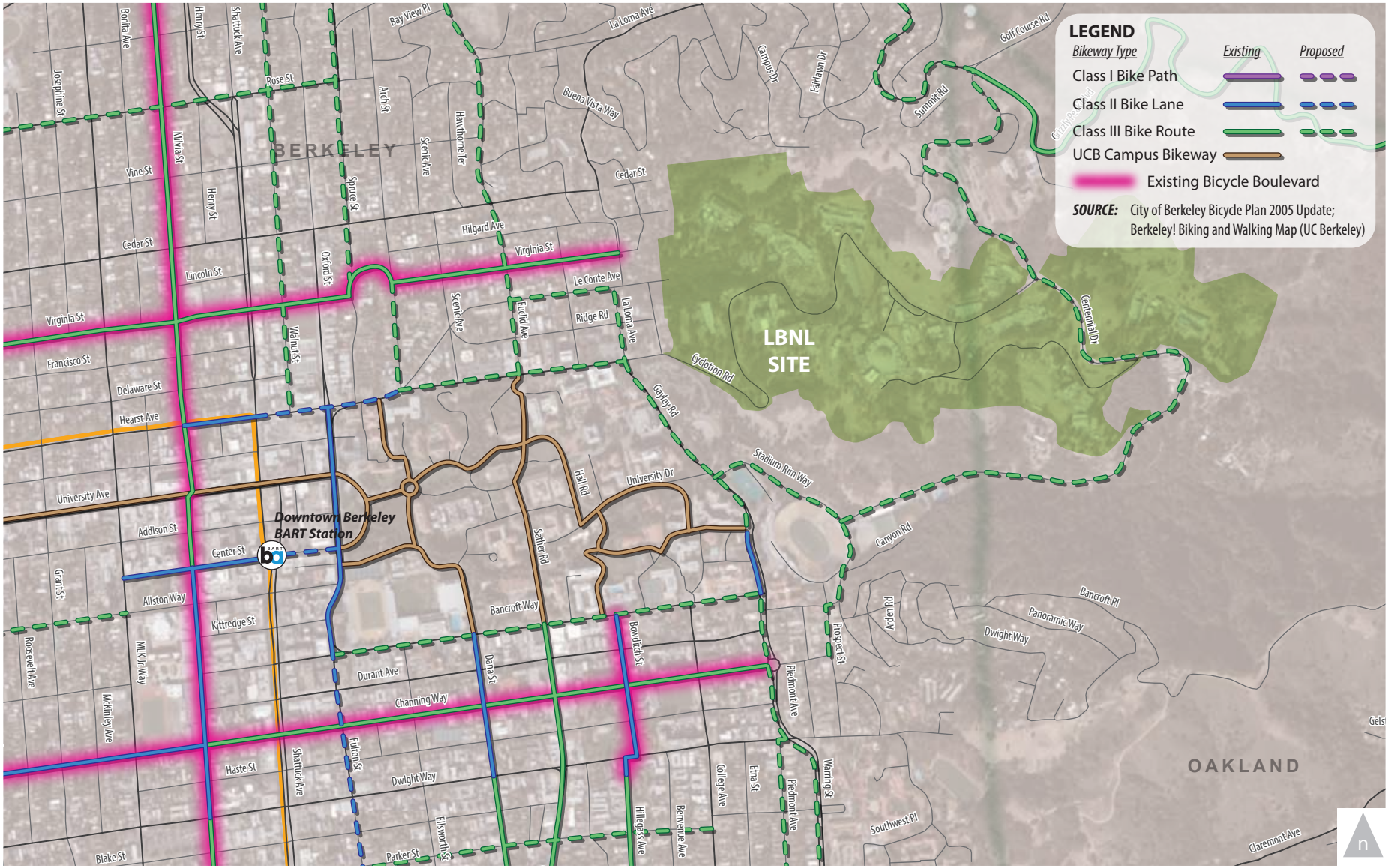

Figure 4-5.

LBNL Site Existing and Future Bicycle Network

WC12-2953_4-5_LBNLBikeNet

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Transportation Objective 6: Create a model bicycle- and pedestrian-friendly city where bicycling and walking are safe, attractive, easy, and convenient forms of transportation and recreation for people of all ages and abilities.

Policy T-2 Public Transportation Improvements: Encourage regional and local efforts to maintain and enhance public transportation services and seek additional regional funding for public and alternative transportation improvements.

Action T-2 D: Improve shuttle and transit services by:

1. Increasing shuttle and transit services from Rockridge and the Rockridge BART station to downtown BART and the UCB campus.
3. Promoting express shuttle services to complement local transit service and ensure that Berkeley residents and commuters have information about shuttle services readily available.
5. Encouraging transportation providers to coordinate and consolidate the installation of new jointly used shelters.

Policy T-10 Trip Reduction: To reduce automobile traffic and congestion and increase transit use and alternative modes in Berkeley, support, and when appropriate require, programs to encourage Berkeley citizens and commuters to reduce automobile trips, such as:

2. Participation in the Commuter Check Program.
3. Carpooling and provision of carpool parking and other necessary facilities.
4. Telecommuting programs.
8. Programs to encourage neighborhood-level initiatives to reduce traffic by encouraging residents to combine trips, carpool, telecommute, reduce the number of cars owned, shop locally, and use alternative modes.
9. Programs to reward Berkeley citizens and neighborhoods that can document reduced car use.
10. Limitations on the supply of long-term commuter parking and elimination of subsidies for commuter parking.

Policy T-13 Major Public Institutions: Work with other agencies and institutions, such as the University of California, the Berkeley Unified School District, Lawrence Berkeley Laboratory, Vista Community College, the Alameda County Court, and neighboring cities to promote Eco-Pass and to pursue other efforts to reduce automobile trips.

Action T-13A: Encourage other agencies and institutions to match or exceed the City of Berkeley's trip reduction and emission reduction programs for their employees.

Action T-13C: Encourage the University of California:

1. To maintain and improve its facilities and programs that support and encourage pedestrians, bicyclists, and transit riders.
2. To provide bicycle facilities, "all hour" bicycle paths, and timely pavement maintenance.

Action T-13H: Encourage the University of California, the Berkeley Unified School District, and other major institutions to cap parking at current levels while seeking to reduce automobile use.

Action T-13I: Encourage institutions to create incentives for their employees and students to live locally.

Action T-13J: Encourage all public and private institutions, including schools, health clubs, recreation centers, and other community destinations to organize carpools and shuttles.

<u>Policy T-18 Level of Service</u>: When considering transportation impacts under the California Environmental Quality Act, the City shall consider how a plan or project affects all modes of transportation, including transit riders, bicyclists, pedestrians, and motorists, to determine the transportation impacts of a plan or project. Significant beneficial pedestrian, bicycle, or transit impacts, or significant beneficial impacts on air quality, noise, visual quality, or safety in residential areas may offset or mitigate a significant adverse impact on vehicle Level of Service (LOS) to a level of insignificance. The number of transit riders, pedestrians, and bicyclists potentially affected will be considered when evaluating a degradation of LOS for motorists.

<u>Policy T-28 Emergency Access:</u> Provide for emergency access to all parts of the city and safe evacuation routes.

<u>Policy T-37 University of California and Large Employer Parking</u>: Encourage large employers, such as the University of California and Berkeley Unified School District, to allocate existing employee parking on the basis of a) need for a vehicle on the job, b) number of passengers carried, c) disability, and d) lack of alternative public transportation.

Action T-37A: Encourage the University of California to cap its parking supply at current levels, to postpone any plans to expand its existing (year 2000) parking supply and instead encourage transit use and alternative modes of transportation, and better manage and utilize existing parking.

Policy T-38 Inter-Jurisdictional Coordination: Establish partnerships with adjacent jurisdictions and agencies, such as the University of California and the Berkeley Unified School District, to reduce parking demand and encourage alternative modes of transportation.

Policy T-41 Structured Parking: Encourage consolidation of surface parking lots into structured parking facilities and redevelopment of surface lots with residential or commercial development where allowed by zoning.

Policy T-42 Bicycle Planning: Integrate the consideration of bicycle travel into City planning activities and capital improvement projects, and coordinate with other agencies to improve bicycle facilities and access within and connecting to Berkeley.

Policy T-54 Pathways: Develop and improve the public pedestrian pathway system.

4.2.2 CITY OF OAKLAND GENERAL PLAN

About half of the LBNL site is within the City of Oakland. The following transportation-related policies in the Oakland General Plan Land Use and Transportation Element are applicable to the proposed Project:

Policy T2.5 Linking Transportation and Activities: Link transportation facilities and infrastructure improvements to recreational uses, job centers, commercial nodes, and social services (i.e., hospitals, parks, or community centers).

Policy T3.2 Promoting Strategies to Address Congestion: The City should promote and participate in both local and regional strategies to manage traffic supply and demand where unacceptable levels of service exist or are forecast to exist.

Policy T3.6 Including Bikeways and Pedestrian Walks: The City should include bikeways and pedestrian walks in the planning of new, reconstructed, or realigned streets, wherever possible.

Policy T4.2 Creating Transportation Incentives: Through cooperation with other agencies, the City should create incentives to encourage travelers to use alternative transportation options.

Policy D3.2 Incorporating Parking Facilities: New parking facilities for cars and bicycles should be incorporated into the design of any project in a manner that encourages and promotes safe pedestrian activity.

Policies in the Open Space, Conservation, and Recreation (OSCAR) Element of the Oakland General Plan pertaining to transportation relevant to the proposed Project include the following:

Policy CO-12.1: Promote land use patterns and densities which help improve regional air quality conditions by: (a) minimizing dependence on single passenger autos; (b) promoting projects which minimize quick auto starts and stops, such as live-work development, and office development with ground-floor retail space; (c) separating land uses which are sensitive to pollution from the sources of air pollution; and (d) supporting telecommuting, flexible work hours, and behavioral changes which reduce the percentage of people in Oakland who must drive to work on a daily basis.

Policy CO-12.3: Expand existing transportation systems management and transportation demand management strategies which reduce congestion, vehicle idling, and travel in single-passenger autos.

4.3 PROJECT TRANSPORTATION CHARACTERISTICS

Similar to the Phase 1 development at the RBC site (described in Section 2.3), the proposed development at the existing LBNL site would provide up to 600,000 square feet of space and accommodate up to 1,000 new employees in four new buildings by 2018. Vehicular access to and from LBNL would continue be provided through the existing three gates. The proposed Project is not expected to modify the internal roadway system in LBNL.

It is expected that as buildings are constructed and the number of employees is increased, LBNL would increase the current parking supply and shuttle service proportionally to meet the increase demand.

4.3.1 TRIP GENERATION

Table 4-3 shows the estimated vehicle trip generation for the proposed Project at the existing LBNL site. This analysis assumes that the Project employees at the LBNL site would have the same trip making characteristics as the employees at the current LBNL site. Thus, the trip generation for the Project is based on current observed trip generation at LBNL based on data collected in 2011. It is estimated that the proposed development at LBNL would generate about 1,590 daily automobile trips, 160 AM peak hour trips, and 150 PM peak hour trips.

TABLE 4-3
EXISTING LBNL SITE
PROJECT VEHICLE TRIP GENERATION SUMMARY

	Average Daily Population	Daily	AM Peak Hour			PM Peak Hour		
			In	Out	Total	In	Out	Total
Existing LBNL [1]	4,200	6,640	581	93	674	85	551	636
LBNL Alternative [2]	1,000	1,585	139	22	161	20	132	152

1. Based on counts at existing LBNL gates conducted in April 2011.
2. Based on the following current trip generation rate per at the existing LBNL site:
   Daily = 1.58 trips per Average Daily Population (ADP); AM Peak Hour = 0.14 trips per ADP (86% in, 14% out); PM Peak Hour = 0.15 trips per ADP (13% in, 87% out)

Source: Fehr & Peers.

4.3.2 TRIP DISTRIBUTION AND ASSIGNMENT

Trip distribution is defined as the directions of approach and departure that vehicles would use to arrive at and depart from the Project site. As previously stated, this analysis assumes that the Project employees at the LBNL site would have the same trip making characteristics as the employees at the current LBNL site. Thus, the trip distribution for the proposed Project is based on the current trip distribution of current LBNL employees. **Figure 4-6** shows the resulting trip distribution. **Figures 4-7A and 4-7B** show the Project Phase 1 trip assignment at the study intersections, based on the distribution.

4.4 NEAR-TERM (2018) ANALYSIS

This section summarizes traffic operations under Near-Term (2018) No Project and Near-Term (2018) Plus Project conditions.

4.4.1 NEAR-TERM (2018) NO PROJECT TRAFFIC CONDITIONS

The Near-Term (2018) No Project traffic volumes were developed by interpolating between the existing volumes (Figure 4-2) and the projected 2035 volumes (Figure 4-10), which were prepared using the ACTC Countywide Travel Demand Model and described in Section 4.5. Since the ACTC Model did not include any growth at the LBNL site or UC Berkeley, the traffic volume forecasts were adjusted to account for the expected traffic generated by projects currently under construction or planned at both sites, which include Solar Energy Research Center (SERC), Computational Research and Theory (CRT) Facility, and Seismic Phase 1 and 2 General Purpose Lab (GPL) at LBNL, and the Maxwell Family Field Garage at UV Berkeley. **Figures 4-8A and 4-8B** show the Near-Term (2018) No Project traffic volumes.

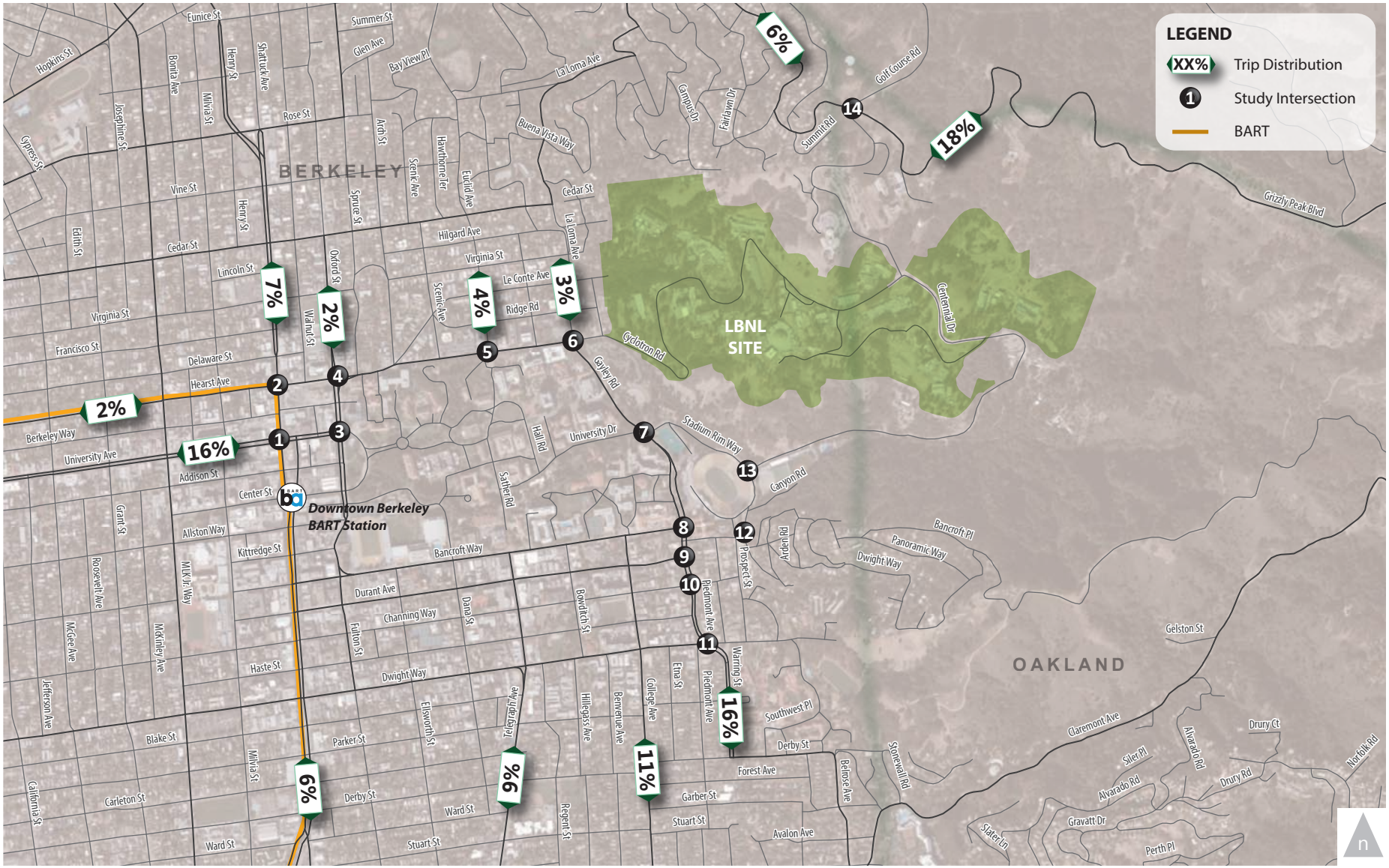

Figure 4-6.

LBNL Site Project Trip Distribution

WC12-2953_4-6_LBNLTripDistro

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Figure 4-7A.

LBNL Site
Project Trip Assignment (Phase 1)

WC12-2953_4-7A_PTA

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Figure 4-7B.

LBNL Site
Project Trip Assignment (Phase 1)

WC12-2953_4-7B_PTA

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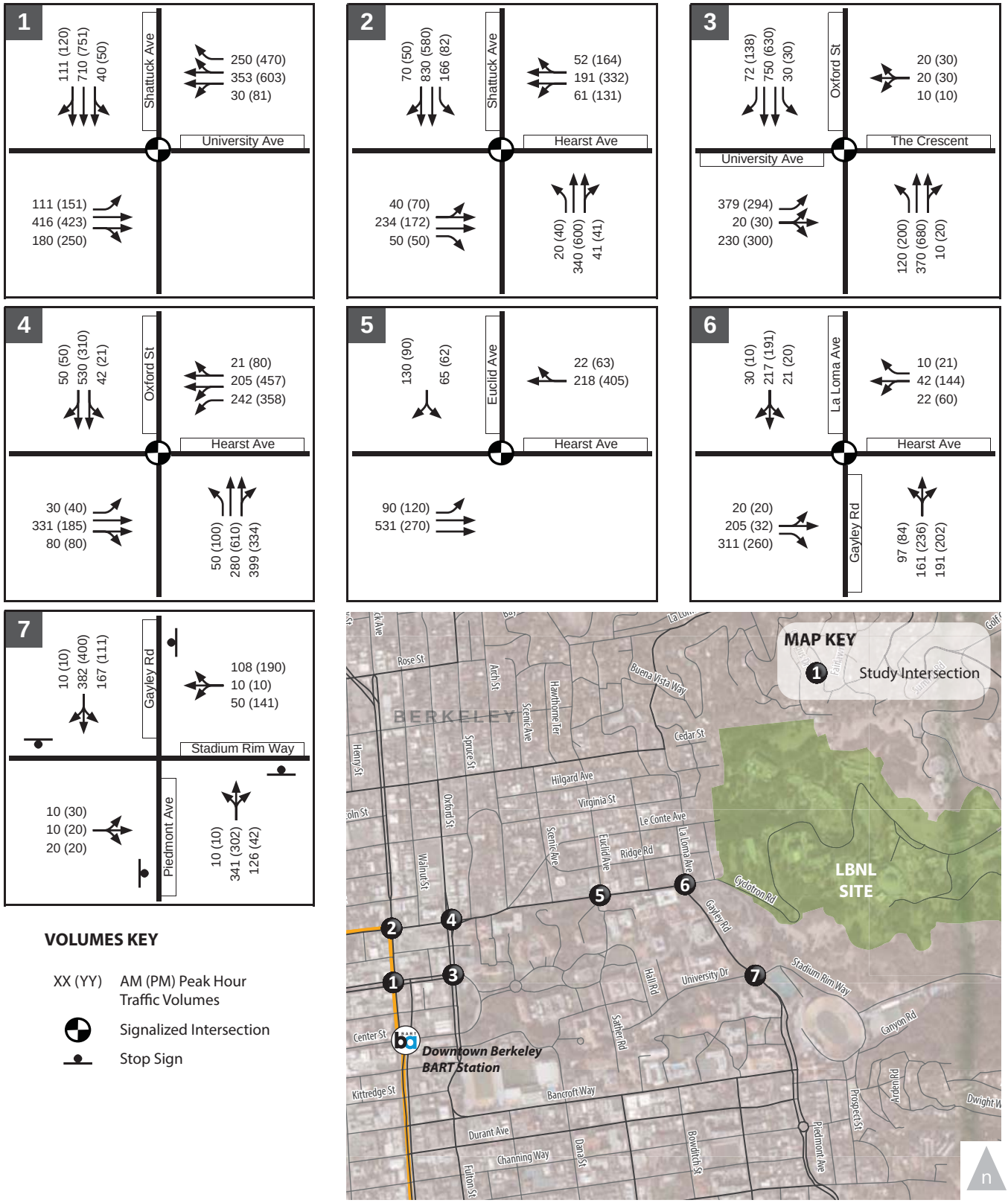


Figure 4-8A.

LBNL Site Near-Term (2018) No Project Peak Hour Traffic Volumes

WC12-2953_4-8A_NT2018NPvol

FEHR PEERS

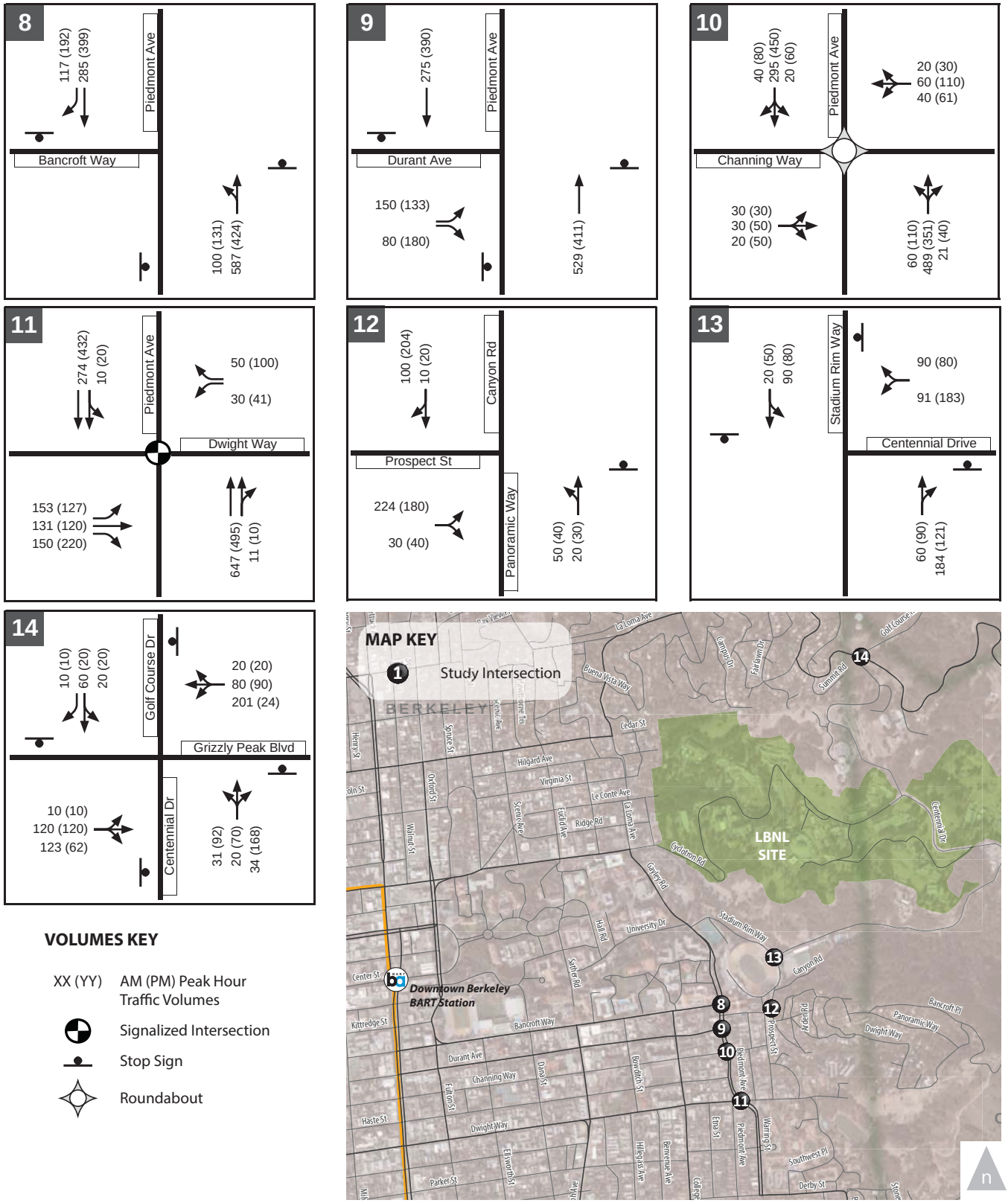


Figure 4-8B.

LBNL Site Near-Term (2018) No Project Peak Hour Traffic Volumes

WC12-2953_4-8A_NT2018NPvol

FEHR PEERS

The Near-Term (2018) No Project scenario assumes that signal timing parameters at the signalized study intersections would be optimized to reflect typical signal timing updates due to changing traffic flow over time. No other roadway modifications are assumed at any of the study intersections in Berkeley under the Near-Term (2018) No Project scenario.

Table 4-4 summarizes the Near-Term (2018) No Project intersection LOS analysis results. **Appendix H** provides the detailed calculation work sheets. In comparison to Existing Conditions, both all-way stop-controlled Bancroft Way/Piedmont Avenue and Durant Avenue/Piedmont Avenue intersections would continue to operate at LOS F during the PM peak hour. In addition, the Durant Avenue/Piedmont Avenue intersection would deteriorate to LOS F during the AM peak hour. All other study intersections would continue to operate at LOS D or better during both AM and PM peak hours.

4.4.2 NEAR-TERM (2018) PLUS PROJECT CONDITIONS

Figures 4-9A and 4-9B show the Near-Term (2018) Plus Project traffic volumes, which consist of traffic volumes under Near-Term (2018) No Project conditions (Figures 4-8A and 4-8B) plus Project traffic assignment (Figures 4-7A and 4-7B). This analysis assumes no roadway modifications under this scenario.

Table 4-4 summarizes intersection operations at the study intersections under the Near-Term (2018) Plus Project conditions. **Appendix H** provides the detailed calculation work sheets.

All signalized intersections would continue to operate at LOS D or better during both AM and PM peak hours under the Near-Term (2018) Plus Project conditions. All but two of the unsignalized study intersections would operate at LOS F during one or both peak hours.

The all-way stop-controlled Bancroft Avenue/Piedmont Avenue intersection during the PM peak hour and the all-way stop-controlled Durant Avenue/Piedmont Avenue intersection during both AM and PM peak hours would operate at LOS F under the Near-Term (2018) Plus Project conditions. However, the Project would not cause an impact at these intersections because neither intersection would satisfy the Caltrans peak hour traffic volume signal warrant.

The Project would cause a significant impact at one intersection which is summarized under Impact 4-1 discussion.

TABLE 4-4
LBNL SITE
NEAR-TERM (2018) CONDITIONS – STUDY INTERSECTION LOS SUMMARY

Intersection	Traffic Control	Peak Hour	Near-Term (2018) No Project		Near-Term (2018) Plus Project		Significant Impact?
			Delay[1] (seconds)	LOS[1]	Delay[1] (seconds)	LOS[1]	
1. University Avenue/ Shattuck Avenue	Signal	AM	17.3	B	17.4	B	No
		PM	23.2	C	23.6	C	No
2. Hearst Avenue/ Shattuck Avenue	Signal	AM	16.7	B	16.8	B	No
		PM	22.6	C	23.1	C	No
3. University Avenue/ Oxford Street	Signal	AM	26.1	C	27.0	C	No
		PM	22.1	C	22.0	C	No
4. Hearst Avenue/ Oxford Street	Signal	AM	31.4	C	32.0	C	No
		PM	41.0	D	41.5	D	No
5. Hearst Avenue/ Euclid Avenue	Signal	AM	15.6	B	15.7	B	No
		PM	25.8	C	29.4	C	No
6. Hearst Avenue/Gayley Road/La Loma Avenue	Signal	AM	14.3	B	15.3	B	No
		PM	16.3	B	17.3	B	No
7. Stadium Rim Way/ Gayley Road	All-Way Stop	AM	33.1	C	38.7	E	No
		PM	31.4	C	38.7	E	**Yes**
8. Bancroft Way/ Piedmont Avenue [2]	All-Way Stop	AM	39.7	E	41.2	E	No
		PM	**>120**	**F**	**>120**	**F**	No
9. Durant Avenue/ Piedmont Avenue [2]	All-Way Stop	AM	**>120**	**F**	**>120**	**F**	No
		PM	**>120**	**F**	**>120**	**F**	No
10. Channing Way/ Piedmont Avenue	Round-about	AM	10.1	B	10.8	B	No
		PM	15.1	C	16.6	C	No
11. Dwight Way/ Piedmont Avenue	Signal	AM	14.8	B	15.1	B	No
		PM	13.8	B	14.0	B	No
12. Panoramic Way/ Canyon Road/Stadium Rim Way	Side-Street Stop	AM	2.1 (11.9)	A (B)	2.1 (12.0)	A (B)	No
		PM	2.0 (11.8)	A (B)	2.1 (11.9)	A (B)	No
13. Centennial Drive/ Stadium Rim Way	All-way Stop	AM	8.9	A	9.0	A	No
		PM	10.4	B	10.6	B	No
14. Centennial Drive/ Grizzly Peak Boulevard	All-way Stop	AM	10.8	B	11.4	B	No
		PM	10.4	B	11.0	B	No

Notes: **Bold** indicates an intersection operating at unacceptable LOS E or LOS F.
1. For signalized, all-way stop-controlled, and roundabout intersections, average intersection delay and LOS based on the 2000 HCM method is shown. For side-street stop-controlled intersections, delays for worst movement and average intersection delay are shown: intersection average (worst movement).
2. Intersection analyzed using SimTraffic software because of unique conditions including heavy pedestrian volumes.

Source: Fehr & Peers.

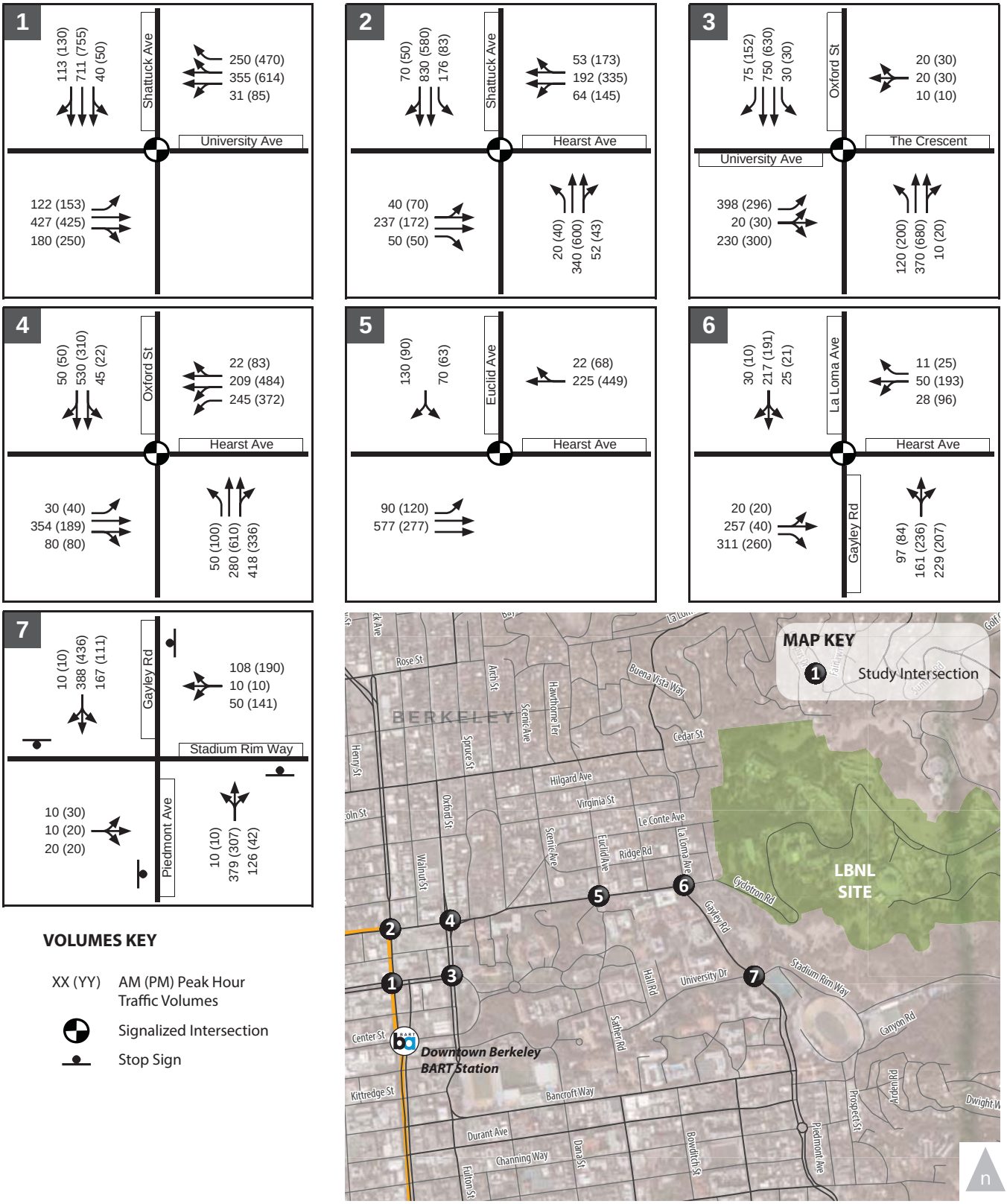


Figure 4-9A.

LBNL Site Near-Term (2018) Plus Phase 1 Project Peak Hour Traffic Volumes

WC12-2953_4-9A_NT2018+PH1vol

FEHR PEERS

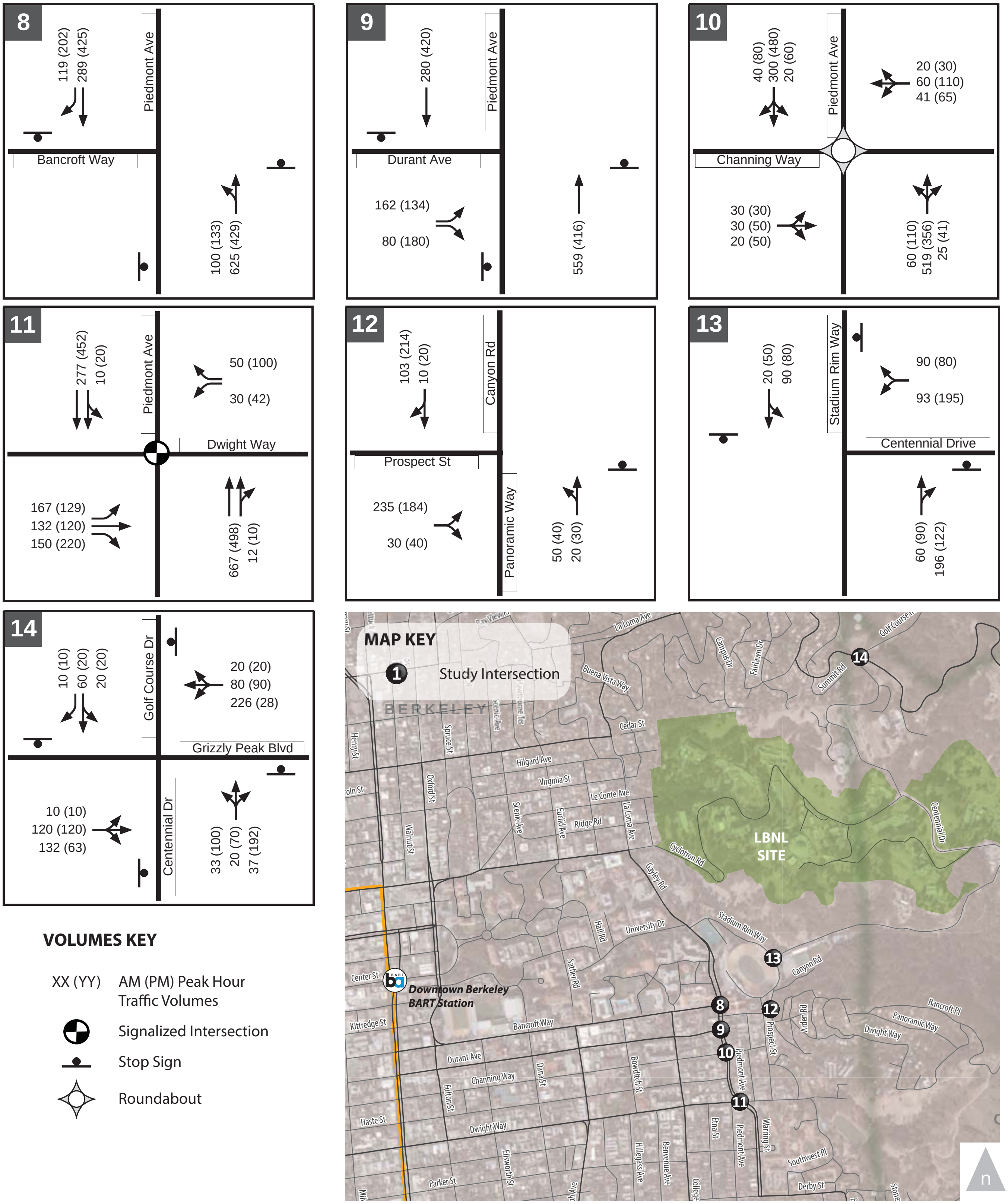


Figure 4-9B.

LBNL Site Near-Term (2018) Plus Phase 1 Project Peak Hour Traffic Volumes

WC12-2953_4-9B_NT2018+PH1vol

FEHR PEERS

IMPACT 4-1: NEAR-TERM (2018) PLUS PROJECT CONDITIONS INTERSECTION OPERATIONS

The proposed Project at LBNL site would cause a significant impact at the following intersection under Near-Term (2035) Plus Project conditions:

A. The Project would cause a significant impact at the all-way stop-controlled **Stadium Rim Way/Gayley Road** (Intersection 4) because the Project would contribute to LOS F operations for a critical movement during the PM peak hour and the intersection would satisfy the Caltrans peak hour traffic volume signal warrant.

Mitigation Measure 4-1: Implement the following:

A. **Stadium Rim Way/Gayley Road** (Intersection 4): Implement the following which requires coordination with City of Berkeley and UC Berkeley:

- Install a traffic signal at the intersection.

The intersection would improve to LOS C or better during both AM and PM peak hours after implementation of this improvement. If found to be feasible and implemented, this mitigation measure would reduce the impact to less than significant.

4.5 CUMULATIVE (2035) ANALYSIS

This section summarizes traffic operations under Cumulative (2035) No Project and Cumulative (2035) Plus Project conditions.

4.5.1 CUMULATIVE (2035) NO PROJECT CONDITIONS

Traffic forecasts to the year 2035 were developed based on the results of the ACTC Countywide Travel Demand Model. The most recent version of the ACTC Model, released in June 2011, which reflects assumptions in residential and non-residential land use growth consistent with ABAG *Projections 2009,* served as the basis for developing AM and PM peak hour intersection turning movement forecasts for the year 2035. The Model land use database and roadway network were checked for accuracy in the vicinity of the LBNL. The forecasting process involved running the 2010 and 2035 models and using the model produced volumes and existing turning movement count data, to estimate year 2035 intersection turn movements using the Furness[6] method. Since the ACTC Model did not include any growth at the LBNL site, similar to the Near-Term (2018) No Project conditions, the traffic volume forecasts were adjusted to

[6] Furnessing is an iterative process that develops future turning movements by applying the difference between the base model volumes and the existing counts to future model approach and departure volumes.

account for the expected traffic generated by projects currently under construction or planned at LBNL and UC Berkeley. **Figures 4-10A and 4-10B** shows the Cumulative (2035) No Project traffic volumes.

Similar to the Near-Term (2018) No Project conditions, the Cumulative (2035) No Project analysis assumes that signal timing parameters at the signalized study intersections would be optimized. No other roadway modifications are assumed in the study area under the Cumulative (2035) No Project scenario.

Table 4-5 summarizes the Cumulative (2035) No Project intersection LOS analysis results. **Appendix H** provides the detailed calculation work sheets.

All but one signalized study intersection would continue to operate at LOS D or better during both AM and PM peak hours under Cumulative (2035) No Project conditions. The Hearst Avenue/Oxford Street intersection would operate at LOS E during the PM peak hour.

All but three of the unsignalized intersections would continue to operate at LOS E or better during both AM and PM peak hours under Cumulative (2035) No Project conditions. The all-way stop-controlled Stadium Rim Way/Gayley Road intersection during both AM and PM peak hours, the all-way stop-controlled Bancroft Avenue/Piedmont Avenue intersection during the PM peak hour, and the all-way stop-controlled Durant Avenue/Piedmont Avenue intersection during both AM and PM peak hours would operate at LOS F.

4.5.2 CUMULATIVE (2035) PLUS PROJECT CONDITIONS

Figures 4-11A and 4-11B show the Cumulative (2035) Plus Project traffic volumes, which consist of traffic volumes under Cumulative (2035) No Project conditions (Figures 4-10A and 4-10B) plus Project traffic assignment (Figures 4-7A and 4-7B). This analysis assumes no roadway modifications under this scenario.

Table 4-5 summarizes intersection operations at the study intersections under the Cumulative (2035) Plus Project conditions. **Appendix H** provides the detailed calculation work sheets.

All but one signalized study intersection would continue to operate at LOS D or better and all but three unsignalized study intersections would continue to operate at LOS E or better during both AM and PM peak hours under Cumulative (2035) Plus Project conditions.

The signalized Hearst Avenue/Oxford Street intersection would operate at LOS E during the PM peak hour under the Cumulative (2035) Plus Project conditions. However, the Project would not cause an impact at this intersection because it would not increase intersection average delay by more than three seconds.

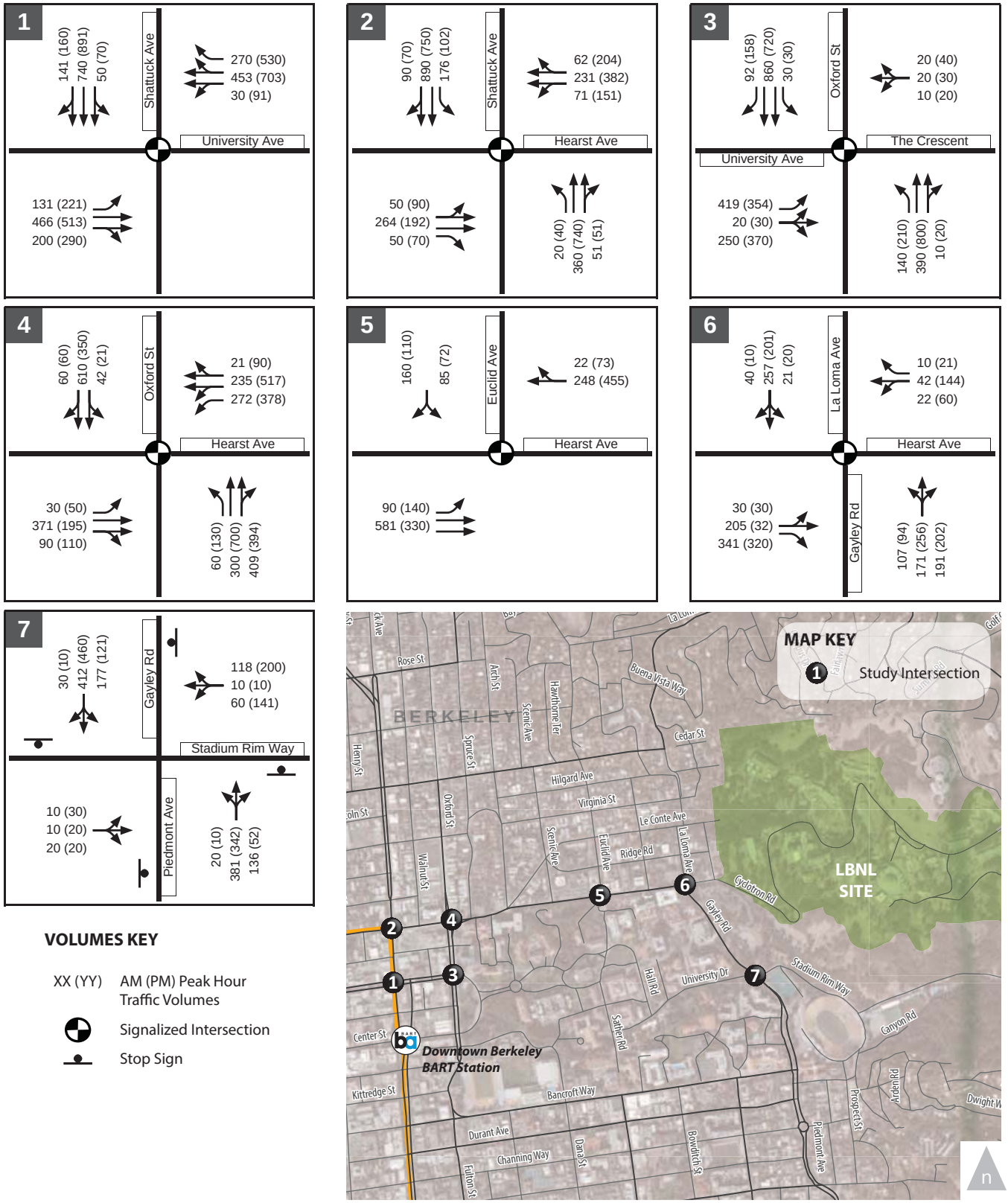


Figure 4-10A.

LBNL Site Cumulative (2035) No Project Peak Hour Traffic Volumes

WC12-2953_4-10A_Cumu2035NPvol

FEHR PEERS

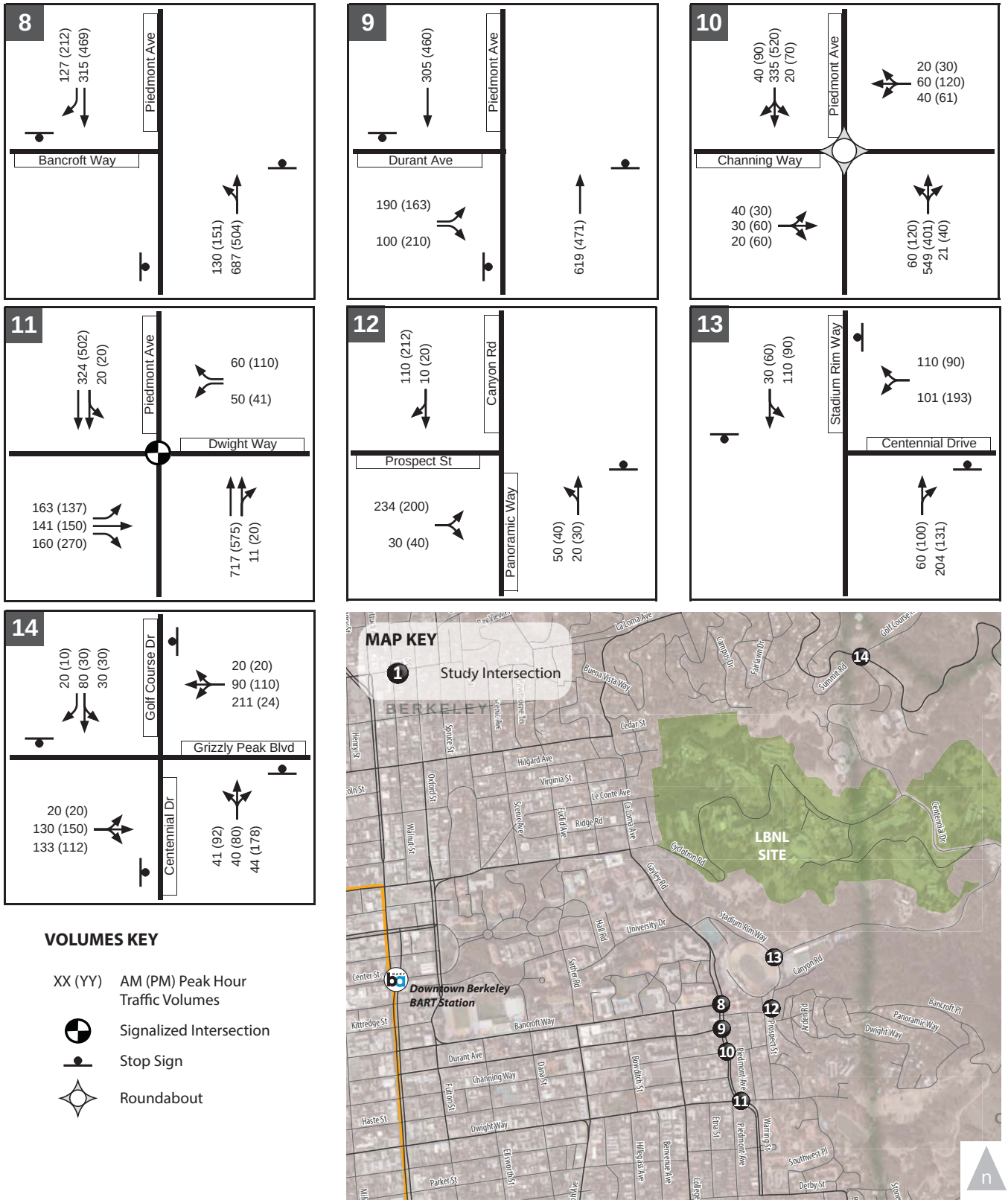


Figure 4-10B.

LBNL Site Cumulative (2035) No Project Peak Hour Traffic Volumes

WC12-2953_4-10B_Cumu2035NPvol

FEHR PEERS

TABLE 4-5
LBNL SITE
CUMULATIVE (2035) CONDITIONS – STUDY INTERSECTION LOS SUMMARY

Intersection	Traffic Control	Peak Hour	Cumulative (2035) No Project		Cumulative (2035) Plus Project		Significant Impact?
			Delay[1] (seconds)	LOS[1]	Delay[1] (seconds)	LOS[1]	
1. University Avenue/ Shattuck Avenue	Signal	AM	18.5	B	18.6	B	No
		PM	33.0	C	34.2	C	No
2. Hearst Avenue/ Shattuck Avenue	Signal	AM	17.4	B	17.6	B	No
		PM	24.1	C	24.8	C	No
3. University Avenue/ Oxford Street	Signal	AM	34.8	C	35.9	D	No
		PM	27.7	C	27.8	C	No
4. Hearst Avenue/ Oxford Street	Signal	AM	34.3	C	34.8	C	No
		PM	**65.4**	**E**	**65.9**	**E**	No
5. Hearst Avenue/ Euclid Avenue	Signal	AM	16.0	B	16.1	B	No
		PM	36.0	D	48.5	D	No
6. Hearst Avenue/Gayley Road/La Loma Avenue	Signal	AM	15.0	B	16.2	B	No
		PM	17.5	B	18.5	B	No
7. Stadium Rim Way/ Gayley Road	All-Way Stop	AM	**56.0**	**F**	**65.5**	**F**	**Yes**
		PM	**52.7**	**F**	**64.1**	**F**	**Yes**
8. Bancroft Way/ Piedmont Avenue [2]	All-Way Stop	AM	41.7	E	44.6	E	No
		PM	**>120**	**F**	**>120**	**F**	No
9. Durant Avenue/ Piedmont Avenue [2]	All-Way Stop	AM	**>120**	**F**	**>120**	**F**	**Yes**
		PM	**>120**	**F**	**>120**	**F**	**Yes**
10. Channing Way/ Piedmont Avenue	Round-about	AM	11.7	B	12.5	B	No
		PM	22.6	C	26.3	D	No
11. Dwight Way/ Piedmont Avenue	Signal	AM	16.1	B	16.6	B	No
		PM	15.2	B	15.4	B	No
12. Panoramic Way/ Canyon Road/Stadium Rim Way	Side-Street Stop	AM	2.1 (12.1)	A (B)	2.1 (12.3)	A (B)	No
		PM	1.9 (12.1)	A (B)	1.9 (12.3)	A (B)	No
13. Centennial Drive/ Stadium Rim Way	All-way Stop	AM	9.4	A	9.5	A	No
		PM	11.1	B	11.3	B	No
14. Centennial Drive/ Grizzly Peak Boulevard	All-way Stop	AM	12.4	B	13.2	B	No
		PM	12.2	B	12.9	B	No

Notes: **Bold** indicates an intersection operating at unacceptable LOS E or LOS F.
1. For signalized, all-way stop-controlled, and roundabout intersections, average intersection delay and LOS based on the 2000 HCM method is shown. For side-street stop-controlled intersections, delays for worst movement and average intersection delay are shown: intersection average (worst movement).
2. Intersection analyzed using SimTraffic software because of unique conditions including heavy pedestrian volumes.

Source: Fehr & Peers.

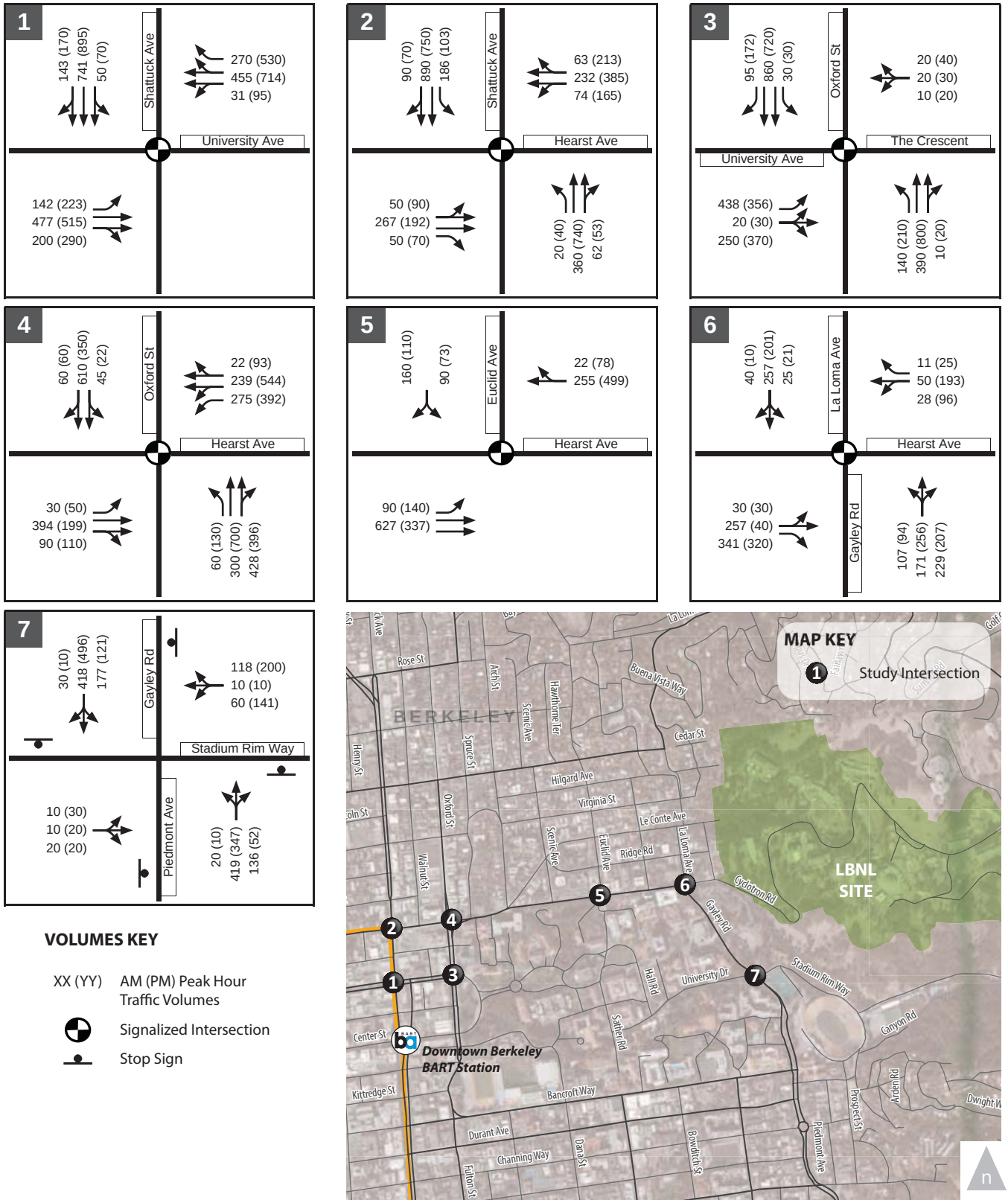


Figure 4-11A.

LBNL Site Cumulative (2035) Plus Phase 1 Project Peak Hour Traffic Volumes

WC12-2953_4-11A_Cumu2035+PH1vol

FEHR PEERS

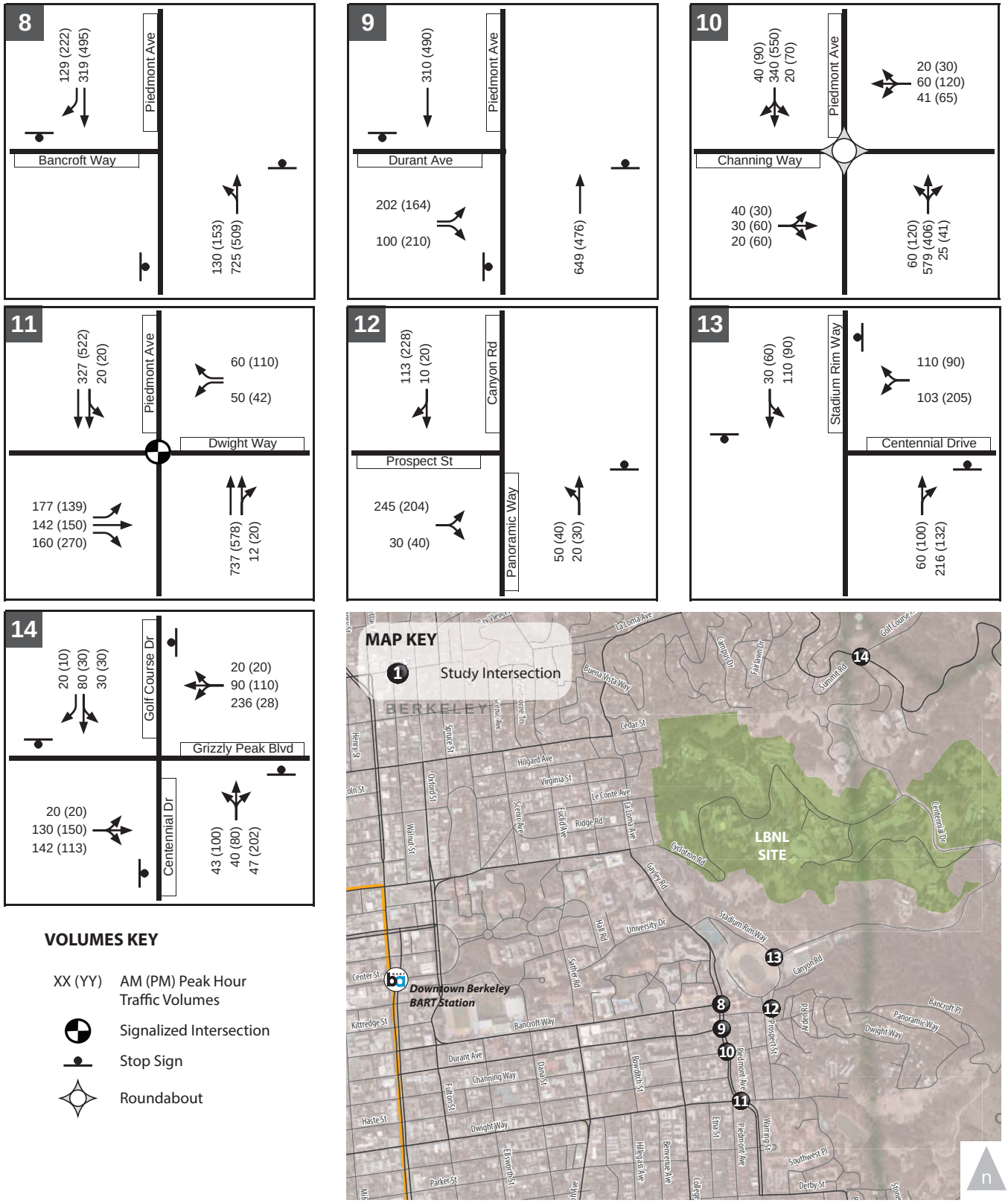


Figure 4-11B.

LBNL Site Cumulative (2035) Plus Phase 1 Project Peak Hour Traffic Volumes

WC12-2953_4-11B_Cumu2035+PH1vol

FEHR PEERS

The all-way stop-controlled Bancroft Avenue/Piedmont Avenue intersection would operate at LOS F during the PM peak hour under the Cumulative (2035) Plus Project conditions. However, the Project would not cause an impact at this intersection because the intersection would not satisfy the Caltrans peak hour traffic volume signal warrant.

The Project would cause a significant impact at two intersections which are summarized under Impact 4-2 discussion.

IMPACT 4-2: CUMULATIVE (2035) PLUS PROJECT CONDITIONS INTERSECTION OPERATIONS

The proposed Project at LBNL site would cause a significant impact at the following intersections under Cumulative (2035) Plus Project conditions:

A. The Project would cause a significant impact at the all-way stop-controlled **Stadium Rim Way/Gayley Road** (Intersection 4) because the Project would contribute to LOS F operations during both AM and PM peak hours and the intersection would satisfy the Caltrans peak hour traffic volume signal warrant.

B. The Project would cause a significant impact at the all-way stop-controlled **Durant Avenue/Piedmont Avenue** (Intersection 9) because the Project would contribute to LOS F operations during both AM and PM peak hours and the intersection would satisfy the Caltrans peak hour traffic volume signal warrant.

Mitigation Measure 4-2: Implement the following:

A. **Stadium Rim Way/Gayley Road** (Intersection 4): Implement the following which requires coordination with City of Berkeley and UC Berkeley (Same as Mitigation Measure 4-1A):

- Install a traffic signal at the intersection.

The intersection would improve to LOS C or better during both AM and PM peak hours after implementation of this improvement. If found to be feasible and implemented, this mitigation measure would reduce the impact to less than significant.

B. **Durant Avenue/Piedmont Avenue** (Intersection 9): Implement the following which requires coordination with City of Berkeley:

- Install a traffic signal at the intersection.

The intersection would improve to LOS B or better during both AM and PM peak hours after implementation of this improvement. If found to be feasible and implemented, this mitigation measure would reduce the impact to less than significant.

4.6 ADDITIONAL EMPLOYMENT ALTERNATIVE ANALYSIS

This section presents trip generation for the Additional Employment Alternative scenario and summarizes traffic operations under the Near-Term (2018) Plus Additional Employment Alternative conditions. The Additional Employment Alternative would consist of an additional 200,000 square feet of space and accommodate an additional 700 employees at the existing LBNL site.

4.6.1 TRIP GENERATION

Table 4-6 shows the estimated vehicle trip generation for the Additional Employment Alternative at the existing LBNL site. The trip generation estimates is based on the same methodology used to estimate trip generation for the Project at the LBNL site as documented in section 4.3.1. The 700 additional employees under the Alternative at the existing LBNL site are expected to increase trip generation to about 2,700 daily, 270 AM peak hour, and 260 PM peak hour automobile trips.

TABLE 4-6
EXISTING LBNL SITE
ADDITIONAL EMPLOYMENT ALTERNATIVE
VEHICLE TRIP GENERATION SUMMARY

	Average Daily Population	Daily	AM Peak Hour			PM Peak Hour		
			In	Out	Total	In	Out	Total
LBNL Project [1]	1,000	1,585	139	22	161	20	132	152
Additional Employees [1]	700	1,109	97	16	123	14	92	106
Additional Employment Alternative Total	1,700	2,694	236	38	274	34	224	258

1. Based on the following current trip generation rate per at the existing LBNL site:
   Daily = 1.58 trips per Average Daily Population (ADP); AM Peak Hour = 0.14 trips per ADP (86% in, 14% out); PM Peak Hour = 0.15 trips per ADP (13% in, 87% out)

Source: Fehr & Peers.

4.6.2 NEAR-TERM (2018) PLUS CUMULATIVE ALTERNATIVE CONDITIONS

Figures 4-12A and 4-12B show the traffic volumes under the Near-Term (2018) Plus Additional Employment Alternative conditions, which consist of traffic volumes under Near-Term (2018) No Project conditions plus traffic generated by the 1,000 Project employees and the 700 additional employees under the Additional Employment Alternative.

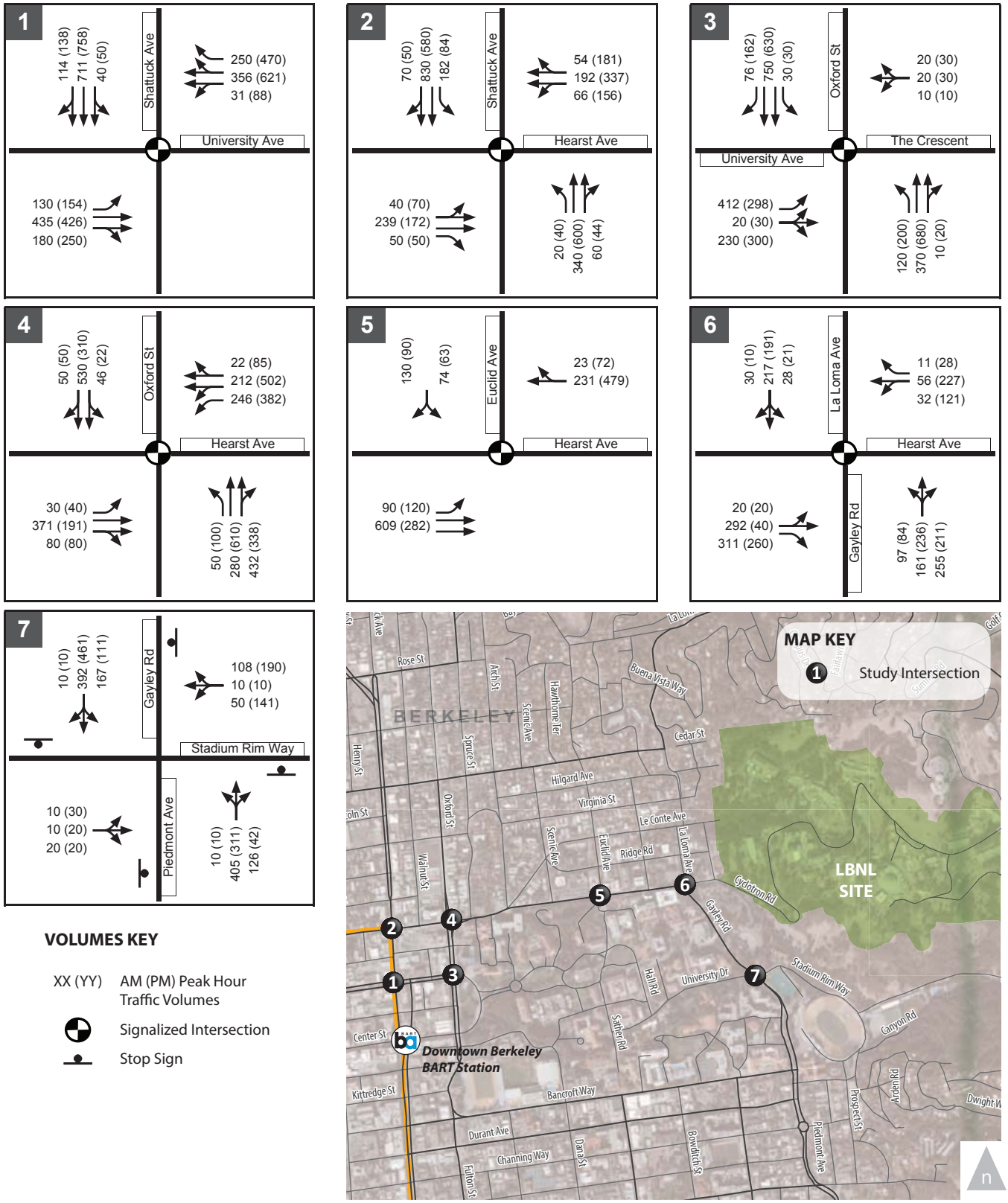
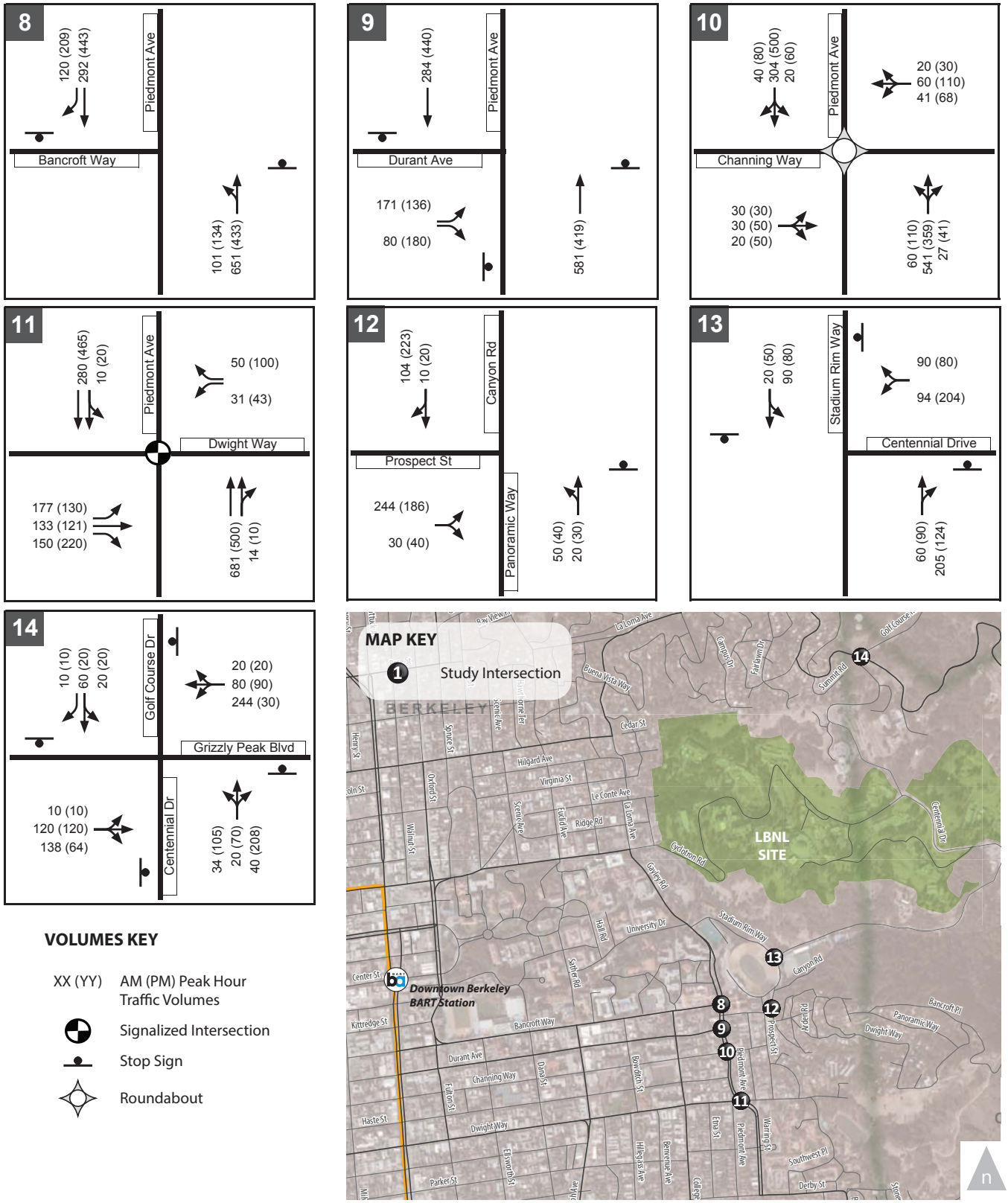


Figure 4-12A.

LBNL Site Near-Term (2018)
Plus Additional Employment Alternative Peak Hour Traffic Volumes

WC12-2953_4-12A_NT2018+AEAvol

FEHR PEERS



VOLUMES KEY

XX (YY)	AM (PM) Peak Hour Traffic Volumes
	Signalized Intersection
	Stop Sign
	Roundabout

Figure 4-12B.

LBNL Site Near-Term (2018)
Plus Additional Employment Alternative Peak Hour Traffic Volumes

WC12-2953_4-12B_NT2018+AEAvol

FEHR PEERS

Table 4-7 summarizes intersection operations at the study intersections under the Near-Term (2018) Plus Additional Employment Alternative conditions. **Appendix H** provides the detailed calculation work sheets.

All signalized intersections would continue to operate at LOS D or better during both AM and PM peak hours under the Near-Term (2018) Plus Additional Employment Alternative conditions. All but two of the unsignalized study intersections would operate at LOS F during one or both peak hours.

The all-way stop-controlled Bancroft Avenue/Piedmont Avenue and Durant Avenue/Piedmont Avenue intersections during both AM and PM peak hours would operate at LOS F under the Near-Term (2018) Plus Additional Employment Alternative conditions. However, the Additional Employment Alternative would not cause an impact at these intersections because neither intersection would satisfy the Caltrans peak hour traffic volume signal warrant.

The Additional Employment Alternative would cause a significant impact at one intersection which is summarized under Impact 4-3 discussion.

IMPACT 4-3: NEAR-TERM (2018) PLUS ADDITIONAL EMPLOYMENT ALTERNATIVE CONDITIONS INTERSECTION OPERATIONS

The Additional Employment Alternative at LBNL site would cause a significant impact at the following intersection under Near-Term (2035) Plus Additional Employment Alternative conditions:

A. The Additional Employment Alternative would cause a significant impact at the all-way stop-controlled **Stadium Rim Way/Gayley Road** (Intersection 4) because the Alternative would contribute to LOS F operations for a critical movement during the PM peak hour and the intersection would satisfy the Caltrans peak hour traffic volume signal warrant.

Mitigation Measure 4-3: Implement the following:

A. **Stadium Rim Way/Gayley Road** (Intersection 4): Implement the following which requires coordination with City of Berkeley and UC Berkeley (Same as Mitigation Measure 4-1A):

- Install a traffic signal at the intersection.

The intersection would improve to LOS C or better during both AM and PM peak hours after implementation of this improvement. If found to be feasible and implemented, this mitigation measure would reduce the impact to less than significant.

TABLE 4-7
LBNL SITE
ADDITIONAL EMPLOYMENT ALTERNATIVE (2018) CONDITIONS –
STUDY INTERSECTION LOS SUMMARY

Intersection	Traffic Control	Peak Hour	Near-Term (2018) No Project		Near-Term (2018) Plus Additional Employment Alternative		Significant Impact?
			Delay[1] (seconds)	LOS[1]	Delay[1] (seconds)	LOS[1]	
1. University Avenue/ Shattuck Avenue	Signal	AM	17.3	B	17.4	B	No
		PM	23.2	C	23.8	C	No
2. Hearst Avenue/ Shattuck Avenue	Signal	AM	16.7	B	16.9	B	No
		PM	22.6	C	23.5	C	No
3. University Avenue/ Oxford Street	Signal	AM	26.1	C	28.0	C	No
		PM	22.1	C	22.0	C	No
4. Hearst Avenue/ Oxford Street	Signal	AM	31.4	C	32.5	C	No
		PM	41.0	D	42.2	D	No
5. Hearst Avenue/ Euclid Avenue	Signal	AM	15.6	B	15.7	B	No
		PM	25.8	C	33.7	C	No
6. Hearst Avenue/Gayley Road/La Loma Avenue	Signal	AM	14.3	B	16.1	B	No
		PM	16.3	B	18.7	B	No
7. Stadium Rim Way/ Gayley Road	All-Way Stop	AM	33.1	C	43.7	E	No
		PM	31.4	C	44.3	E	**Yes**
8. Bancroft Way/ Piedmont Avenue [2]	All-Way Stop	AM	39.7	E	**75.0**	**F**	No
		PM	**>120**	**F**	**>120**	**F**	No
9. Durant Avenue/ Piedmont Avenue [2]	All-Way Stop	AM	**>120**	**F**	**>120**	**F**	No
		PM	**>120**	**F**	**>120**	**F**	No
10. Channing Way/ Piedmont Avenue	Round-about	AM	10.1	B	11.3	B	No
		PM	15.1	C	18.0	C	No
11. Dwight Way/ Piedmont Avenue	Signal	AM	14.8	B	15.4	B	No
		PM	13.8	B	14.1	B	No
12. Panoramic Way/ Canyon Road/Stadium Rim Way	Side-Street Stop	AM	2.1 (11.9)	A (B)	2.4 (12.0)	A (B)	No
		PM	2.0 (11.8)	A (B)	2.2 (12.0)	A (B)	No
13. Centennial Drive/ Stadium Rim Way	All-way Stop	AM	8.9	A	9.1	A	No
		PM	10.4	B	10.8	B	No
14. Centennial Drive/ Grizzly Peak Boulevard	All-way Stop	AM	10.8	B	11.9	B	No
		PM	10.4	B	11.4	B	No

Notes: **Bold** indicates an intersection operating at unacceptable LOS E or LOS F.
1. For signalized, all-way stop-controlled, and roundabout intersections, average intersection delay and LOS based on the 2000 HCM method is shown. For side-street stop-controlled intersections, delays for worst movement and average intersection delay are shown: intersection average (worst movement).

TABLE 4-7
LBNL SITE
ADDITIONAL EMPLOYMENT ALTERNATIVE (2018) CONDITIONS –
STUDY INTERSECTION LOS SUMMARY

2. Intersection analyzed using SimTraffic software because of unique conditions including heavy pedestrian volumes.

Source: Fehr & Peers.

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Fehr & Peers, *Hearst Avenue Complete Street Study-Final,* November 2012.

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Appendix A: Intersection Count Data Sheets
Richmond Bay Campus

FEHR PEERS

Study Name WC12-2953_1 Cutting Boulevard-23rd Street
Start Date 12/12/2012
Start Time 7:00 AM
Site Code

	Southbound Street Southbound				Westbound Street Westbound				Northbound Street Northbound				Eastbound Street Eastbound			
Start Time	Right	Thru	Left	U-Turn	Right	Thru	Left	U-Turn	Right	Thru	Left	U-Turn	Right	Thru	Left	U-Turn
7:00 AM	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
7:15 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7:30 AM	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0
7:45 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8:00 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8:15 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8:30 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
8:45 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4:00 PM	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0
4:15 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4:30 PM	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4:45 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5:00 PM	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
5:15 PM	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
5:30 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5:45 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Study Name WC12-2953_1 Cutting Boulevard-23rd Street
Start Date 12/12/2012
Start Time 7:00 AM
Site Code

	Southbound Street Southbound		Westbound Street Westbound		Northbound Street Northbound		Eastbound Street Eastbound	
Start Time	Peds CCW	Peds CW	Peds CCW	Peds CW	Peds CCW	Peds CW	Peds CCW	Peds CW
7:00 AM	1	1	0	1	0	0	2	0
7:15 AM	1	0	0	0	0	0	0	0
7:30 AM	1	1	0	0	2	2	0	1
7:45 AM	0	0	0	0	1	2	0	1
8:00 AM	6	5	1	3	1	4	1	0
8:15 AM	0	1	0	0	1	0	0	1
8:30 AM	0	0	0	0	3	1	1	0
8:45 AM	1	0	1	0	2	2	0	1
4:00 PM	0	0	1	1	0	3	0	0
4:15 PM	0	0	0	2	3	2	0	0
4:30 PM	0	0	2	3	5	5	0	0
4:45 PM	1	1	1	2	3	0	0	1
5:00 PM	2	2	0	0	1	0	3	0
5:15 PM	0	0	3	0	1	0	0	0
5:30 PM	1	0	1	1	4	2	1	0
5:45 PM	0	0	3	6	4	7	0	0

Study Name WC12-2953_1 Cutting Boulevard-23rd Street
Start Date 12/12/2012
Start Time 7:00 AM
Site Code

	Southbound Street Southbound				Westbound Street Westbound				Northbound Street Northbound				Eastbound Street Eastbound			
Start Time	Right	Thru	Left	U-Turn	Right	Thru	Left	U-Turn	Right	Thru	Left	U-Turn	Right	Thru	Left	U-Turn
7:00 AM	10	180	7	0	10	64	47	0	15	48	10	0	21	50	12	0
7:15 AM	5	191	10	0	16	57	72	0	29	46	11	0	15	38	8	0
7:30 AM	9	215	10	0	8	51	63	0	37	52	8	0	12	39	9	0
7:45 AM	4	142	13	0	22	80	50	0	27	65	12	0	17	66	11	1
8:00 AM	13	114	19	0	30	82	65	0	34	57	12	0	15	68	15	0
8:15 AM	15	119	26	0	25	106	60	0	34	52	11	0	17	97	24	0
8:30 AM	11	87	14	0	24	111	56	0	25	39	12	0	18	75	19	0
8:45 AM	8	86	19	0	24	90	69	0	32	55	9	0	8	51	16	0
4:00 PM	8	85	11	0	30	89	32	0	41	147	25	0	16	109	16	0
4:15 PM	10	68	13	0	27	83	30	0	52	146	19	0	14	72	16	0
4:30 PM	8	78	14	0	23	85	31	0	54	127	17	0	14	76	31	0
4:45 PM	4	71	16	0	25	81	33	0	46	186	27	0	8	81	17	0
5:00 PM	9	65	13	1	21	88	31	0	40	182	24	0	10	95	21	0
5:15 PM	11	84	16	0	36	92	53	0	48	180	27	0	19	78	20	0
5:30 PM	12	55	16	0	22	72	33	0	42	175	17	0	13	93	21	0
5:45 PM	9	52	14	0	26	86	33	0	35	174	28	0	11	67	19	0

Totals

Study Name WC12-2953_2 I-580 WB Ramps-23rd Street
Start Date 12/12/2012
Start Time 7:00 AM
Site Code

	Southbound Street Southbound			Westbound Street Westbound			Northbound Street Northbound		
Start Time	Right	Thru	U-Turn	Right	Thru	Left	Right	Thru	U-Turn
7:00 AM	0	0	0	1	0	0	0	0	0
7:15 AM	0	0	0	1	0	0	0	2	0
7:30 AM	0	1	0	1	0	0	0	1	0
7:45 AM	0	0	0	1	0	0	0	1	0
8:00 AM	0	0	0	0	0	0	0	0	0
8:15 AM	0	0	0	0	0	0	0	0	0
8:30 AM	0	0	0	0	0	0	0	0	0
8:45 AM	0	0	0	0	0	0	0	0	0
4:00 PM	0	0	0	0	0	0	0	0	0
4:15 PM	0	0	0	0	0	0	0	0	0
4:30 PM	0	1	0	0	0	0	0	0	0
4:45 PM	0	0	0	0	0	0	0	0	0
5:00 PM	0	0	0	0	0	0	0	0	0
5:15 PM	0	0	0	0	0	0	0	0	0
5:30 PM	0	0	0	0	0	0	0	0	0
5:45 PM	0	0	0	0	0	0	0	0	0

Pedal Bike (Road)

Study Name WC12-2953_2 I-580 WB Ramps-23rd Street
Start Date 12/12/2012
Start Time 7:00 AM
Site Code

	Southbound Street Southbound		Westbound Street Westbound		Northbound Street Northbound		Eastbound Street Eastbound	
Start Time	Peds CCW	Peds CW	Peds CCW	Peds CW	Peds CCW	Peds CW	Peds CCW	Peds CW
7:00 AM	1	0	0	0	0	1	1	0
7:15 AM	0	0	0	0	0	0	0	0
7:30 AM	1	0	0	0	0	0	1	1
7:45 AM	0	0	0	1	0	0	0	0
8:00 AM	0	0	0	0	0	0	0	0
8:15 AM	0	0	0	0	0	0	0	0
8:30 AM	0	0	0	0	0	0	0	0
8:45 AM	0	0	0	0	0	0	0	0
4:00 PM	3	0	0	0	0	0	0	0
4:15 PM	0	1	0	0	0	0	0	0
4:30 PM	0	0	0	0	0	0	0	0
4:45 PM	0	0	0	0	0	0	0	0
5:00 PM	0	0	0	0	0	0	0	0
5:15 PM	0	0	0	0	0	0	0	0
5:30 PM	0	0	0	0	0	0	0	0
5:45 PM	0	0	0	0	0	0	0	0

Study Name WC12-2953_2 I-580 WB Ramps-23rd Street
Start Date 12/12/2012
Start Time 7:00 AM
Site Code

	Southbound Street Southbound			Westbound Street Westbound			Northbound Street Northbound		
Start Time	Right	Thru	U-Turn	Right	Thru	Left	Right	Thru	U-Turn
7:00 AM	71	194	0	39	0	38	20	32	0
7:15 AM	87	227	0	38	0	54	31	49	0
7:30 AM	69	203	0	41	0	64	17	64	0
7:45 AM	57	177	0	37	0	85	15	58	0
8:00 AM	54	146	0	40	0	79	33	61	0
8:15 AM	51	159	0	45	2	80	28	52	0
8:30 AM	53	107	0	28	0	70	19	42	0
8:45 AM	42	138	0	41	0	86	28	46	0
4:00 PM	31	124	0	137	0	55	23	102	0
4:15 PM	22	99	0	129	0	57	23	111	0
4:30 PM	28	114	0	115	0	49	25	115	0
4:45 PM	23	91	0	129	3	65	31	105	0
5:00 PM	30	81	0	173	1	62	44	121	0
5:15 PM	42	110	0	130	0	68	25	113	0
5:30 PM	19	81	0	169	0	86	18	98	0
5:45 PM	22	87	0	141	1	91	26	96	0

Totals

Study Name WC12-2953_3 I-580 EB Ramps-23rd Street TMC
Start Date 12/12/2012
Start Time 7:00 AM
Site Code

	Southbound Street Southbound			Westbound Street Westbound		Northbound Street Northbound		
Start Time	Right	Thru	U-Turn	Right	Left	Right	Thru	U-Turn
7:00 AM	0	0	0	0	0	0	1	0
7:15 AM	0	0	0	0	0	0	0	0
7:30 AM	0	0	0	0	0	0	0	0
7:45 AM	0	0	0	0	0	0	0	0
8:00 AM	0	0	0	0	0	0	1	0
8:15 AM	0	0	0	0	0	0	0	0
8:30 AM	0	0	0	0	0	0	0	0
8:45 AM	0	0	0	0	0	0	0	0

Study Name WC12-2953_3 I-580 EB Ramps-23rd Street TMC
Start Date 12/12/2012
Start Time 7:00 AM
Site Code

	Southbound Street Southbound		Westbound Street Westbound		Northbound Street Northbound		Eastbound Street Eastbound	
Start Time	Peds CCW	Peds CW	Peds CCW	Peds CW	Peds CCW	Peds CW	Peds CCW	Peds CW
7:00 AM	0	0	0	1	0	0	0	0
7:15 AM	0	0	0	0	0	0	0	0
7:30 AM	0	0	0	1	0	0	0	0
7:45 AM	0	0	2	0	0	0	0	1
8:00 AM	0	0	0	0	0	0	0	0
8:15 AM	0	0	0	0	0	0	0	0
8:30 AM	0	0	0	0	0	0	0	0
8:45 AM	0	0	0	0	0	0	0	0

Study Name WC12-2953_3 I-580 EB Ramps-23rd Street TMC
Start Date 12/12/2012
Start Time 7:00 AM
Site Code

	Southbound Street Southbound			Westbound Street Westbound		Northbound Street Northbound		
Start Time	Right	Thru	U-Turn	Right	Left	Right	Thru	U-Turn
7:00 AM	87	58	0	15	7	166	70	0
7:15 AM	91	44	0	14	12	180	89	0
7:30 AM	74	60	0	16	19	173	88	0
7:45 AM	18	14	0	32	14	118	133	0
8:00 AM	107	94	0	24	15	98	135	0
8:15 AM	69	52	0	21	19	105	175	0
8:30 AM	57	55	0	33	20	70	131	0
8:45 AM	74	52	0	18	22	78	132	0

Totals

Study Name WC12-2953_3 I-580 EB Ramps-23rd Street
Start Date 12/12/2012
Start Time 4:00 PM
Site Code

	Southbound Street Southbound			Northbound Street Northbound			Eastbound Street Eastbound	
Start Time	Right	Thru	U-Turn	Right	Thru	U-Turn	Right	Left
4:00 PM	0	0	0	0	0	0	0	0
4:15 PM	0	0	0	0	0	0	0	0
4:30 PM	0	0	0	0	0	0	0	0
4:45 PM	0	0	0	0	0	0	0	0
5:00 PM	0	0	0	0	0	0	0	0
5:15 PM	0	0	0	0	1	0	0	0
5:30 PM	0	0	0	0	0	0	0	0
5:45 PM	0	0	0	0	2	0	0	0

Study Name WC12-2953_3 I-580 EB Ramps-23rd Street
Start Date 12/12/2012
Start Time 4:00 PM
Site Code

	Southbound Street Southbound		Westbound Street Westbound		Northbound Street Northbound		Eastbound Street Eastbound	
Start Time	Peds CCW	Peds CW	Peds CCW	Peds CW	Peds CCW	Peds CW	Peds CCW	Peds CW
4:00 PM	0	0	0	0	0	0	2	3
4:15 PM	0	0	1	0	0	0	0	1
4:30 PM	0	0	0	0	0	0	0	0
4:45 PM	0	0	0	0	0	0	0	1
5:00 PM	0	0	0	1	0	0	0	3
5:15 PM	0	0	0	1	0	0	0	0
5:30 PM	0	0	0	0	0	0	0	0
5:45 PM	0	0	0	0	0	0	0	1

Study Name WC12-2953_3 I-580 EB Ramps-23rd Street
Start Date 12/12/2012
Start Time 4:00 PM
Site Code

	Southbound Street Southbound			Northbound Street Northbound			Eastbound Street Eastbound	
Start Time	Right	Thru	U-Turn	Right	Thru	U-Turn	Right	Left
4:00 PM	76	101	0	75	85	0	24	51
4:15 PM	53	99	0	78	76	0	25	49
4:30 PM	70	82	0	110	76	0	29	65
4:45 PM	49	97	0	90	90	0	29	56
5:00 PM	64	98	0	151	105	0	31	52
5:15 PM	63	113	0	98	83	0	26	66
5:30 PM	52	122	0	64	54	0	40	49
5:45 PM	47	124	0	68	73	0	34	46

Totals

Study Name WC12-2953_4 Mekker Avenue-23rd Street-Marina Bay Parkway
Start Date 12/13/2012
Start Time 7:00 AM
Site Code

	Southbound Street Southbound				Westbound Street Westbound				Northbound Street Northbound				Eastbound Street Eastbound			
Start Time	Right	Thru	Left	U-Turn	Right	Thru	Left	U-Turn	Right	Thru	Left	U-Turn	Right	Thru	Left	U-Turn
7:00 AM	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7:15 AM	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0
7:30 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7:45 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8:00 AM	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8:15 AM	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
8:30 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8:45 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Study Name WC12-2953_4 Mekker Avenue-23rd Street-Marina Bay Parkway
Start Date 12/13/2012
Start Time 7:00 AM
Site Code

	Southbound Street Southbound		Westbound Street Westbound		Northbound Street Northbound		Eastbound Street Eastbound	
Start Time	Peds CCW	Peds CW	Peds CCW	Peds CW	Peds CCW	Peds CW	Peds CCW	Peds CW
7:00 AM	1	0	0	0	0	0	0	0
7:15 AM	0	1	0	0	0	0	0	0
7:30 AM	0	0	0	0	0	0	0	1
7:45 AM	1	0	0	0	0	0	1	0
8:00 AM	0	0	0	0	0	0	0	0
8:15 AM	2	0	0	0	0	0	0	0
8:30 AM	0	2	0	0	0	0	0	0
8:45 AM	1	1	0	0	0	0	0	1

Study Name WC12-2953_4 Mekker Avenue-23rd Street-Marina Bay Parkway
Start Date 12/13/2012
Start Time 7:00 AM
Site Code

	Southbound Street Southbound				Westbound Street Westbound				Northbound Street Northbound				Eastbound Street Eastbound			
Start Time	Right	Thru	Left	U-Turn	Right	Thru	Left	U-Turn	Right	Thru	Left	U-Turn	Right	Thru	Left	U-Turn
7:00 AM	8	49	23	2	4	0	0	0	4	127	6	1	4	0	11	0
7:15 AM	15	35	50	2	3	0	1	0	2	122	6	0	2	0	11	0
7:30 AM	15	48	34	0	3	0	0	0	3	126	1	0	3	1	8	0
7:45 AM	22	40	72	5	8	0	0	0	0	0	0	0	2	2	11	0
8:00 AM	20	70	73	2	4	1	0	0	4	189	10	0	7	2	12	0
8:15 AM	37	75	81	0	6	0	0	0	3	115	4	0	3	2	10	0
8:30 AM	17	72	66	1	8	0	0	0	5	101	3	0	2	0	6	0
8:45 AM	15	67	60	1	6	0	0	0	8	106	6	0	5	1	14	0

Totals

Study Name WC12-2953_4 Mekker Avenue-23rd Street-Marina Bay Parkway TMC
Start Date 12/12/2012
Start Time 4:00 PM
Site Code

	Southbound Street Southbound				Westbound Street Westbound				Northbound Street Northbound				Eastbound Street Eastbound			
Start Time	Right	Thru	Left	U-Turn	Right	Thru	Left	U-Turn	Right	Thru	Left	U-Turn	Right	Thru	Left	U-Turn
4:00 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4:15 PM	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4:30 PM	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4:45 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5:00 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5:15 PM	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0
5:30 PM	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
5:45 PM	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0

Study Name WC12-2953_4 Mekker Avenue-23rd Street-Marina Bay Parkway T
Start Date 12/12/2012
Start Time 4:00 PM
Site Code

	Southbound Street Southbound		Westbound Street Westbound		Northbound Street Northbound		Eastbound Street Eastbound	
Start Time	Peds CCW	Peds CW	Peds CCW	Peds CW	Peds CCW	Peds CW	Peds CCW	Peds CW
4:00 PM	1	2	0	0	0	0	0	4
4:15 PM	3	0	0	0	0	0	2	0
4:30 PM	0	0	0	0	0	0	0	0
4:45 PM	0	2	0	0	0	0	0	2
5:00 PM	1	0	0	2	0	2	0	0
5:15 PM	0	0	0	1	0	1	0	0
5:30 PM	0	0	1	0	0	0	0	0
5:45 PM	0	0	1	0	0	0	0	0

Study Name WC12-2953_4 Mekker Avenue-23rd Street-Marina Bay Parkway TMC
Start Date 12/12/2012
Start Time 4:00 PM
Site Code

	Southbound Street Southbound				Westbound Street Westbound				Northbound Street Northbound				Eastbound Street Eastbound			
Start Time	Right	Thru	Left	U-Turn	Right	Thru	Left	U-Turn	Right	Thru	Left	U-Turn	Right	Thru	Left	U-Turn
4:00 PM	5	102	5	3	53	1	0	0	1	80	8	0	11	1	22	0
4:15 PM	3	96	5	1	60	2	0	0	0	62	3	0	7	0	29	0
4:30 PM	4	102	4	1	65	3	1	0	0	91	2	1	11	0	25	0
4:45 PM	3	98	3	2	66	3	1	0	1	74	6	0	10	0	39	0
5:00 PM	6	95	2	2	96	3	2	0	0	81	6	0	20	1	60	0
5:15 PM	3	117	4	1	51	1	1	0	0	93	6	0	9	0	32	0
5:30 PM	3	123	2	2	38	2	3	0	0	57	6	0	14	0	17	0
5:45 PM	2	142	7	1	31	2	3	0	0	72	3	0	16	0	37	0

Totals

Study Name WC12-2953_5 Regatta Boulevard - Marina Bay Parkway TMC
Start Date 12/12/2012
Start Time 7:00 AM
Site Code

	Southbound Street Southbound				Westbound Street Westbound				Northbound Street Northbound				Eastbound Street Eastbound			
Start Time	Right	Thru	Left	U-Turn	Right	Thru	Left	U-Turn	Right	Thru	Left	U-Turn	Right	Thru	Left	U-Turn
7:00 AM	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
7:15 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7:30 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7:45 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8:00 AM	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
8:15 AM	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
8:30 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8:45 AM	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Pedal Bike (Road)

Study Name WC12-2953_5 Regatta Boulevard - Marina Bay Parkway TMC
Start Date 12/12/2012
Start Time 7:00 AM
Site Code

	Southbound Street Southbound		Westbound Street Westbound		Northbound Street Northbound		Eastbound Street Eastbound	
Start Time	Peds CCW	Peds CW	Peds CCW	Peds CW	Peds CCW	Peds CW	Peds CCW	Peds CW
7:00 AM	0	1	1	0	0	0	0	1
7:15 AM	0	0	0	0	0	0	0	0
7:30 AM	0	3	0	0	0	0	0	3
7:45 AM	0	0	0	0	0	0	0	0
8:00 AM	0	0	0	0	0	0	0	1
8:15 AM	0	0	0	0	0	0	0	0
8:30 AM	0	0	0	0	0	0	0	0
8:45 AM	0	0	0	0	0	0	0	0

Study Name WC12-2953_5 Regatta Boulevard - Marina Bay Parkway TMC
Start Date 12/12/2012
Start Time 7:00 AM
Site Code

	Southbound Street Southbound				Westbound Street Westbound				Northbound Street Northbound				Eastbound Street Eastbound			
Start Time	Right	Thru	Left	U-Turn	Right	Thru	Left	U-Turn	Right	Thru	Left	U-Turn	Right	Thru	Left	U-Turn
7:00 AM	18	12	11	0	3	1	0	0	9	76	1	0	1	1	35	0
7:15 AM	27	14	5	0	2	1	1	0	23	85	1	0	2	5	40	0
7:30 AM	23	17	5	0	6	0	0	0	21	69	1	0	2	13	40	0
7:45 AM	4	12	11	0	10	2	3	0	36	83	0	0	2	6	47	0
8:00 AM	65	22	6	0	2	3	3	0	26	99	3	0	6	2	43	0
8:15 AM	38	20	5	0	2	0	3	0	13	51	1	0	1	5	49	0
8:30 AM	31	24	4	0	2	3	4	0	16	61	2	0	5	1	32	0
8:45 AM	31	31	4	0	1	3	3	0	5	72	3	0	1	4	30	0

Totals

Study Name WC12-2953_5 Regatta Boulevard - Marina Bay Parkway
Start Date 12/12/2012
Start Time 4:00 PM
Site Code

	Southbound Street Southbound				Westbound Street Westbound				Northbound Street Northbound				Eastbound Street Eastbound			
Start Time	Right	Thru	Left	U-Turn	Right	Thru	Left	U-Turn	Right	Thru	Left	U-Turn	Right	Thru	Left	U-Turn
4:00 PM	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4:15 PM	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4:30 PM	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4:45 PM	1	1	0	0	0	0	0	0	0	0	0	0	2	0	0	0
5:00 PM	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
5:15 PM	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
5:30 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
5:45 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Study Name WC12-2953_5 Regatta Boulevard - Marina Bay Parkway
Start Date 12/12/2012
Start Time 4:00 PM
Site Code

	Southbound Street Southbound		Westbound Street Westbound		Northbound Street Northbound		Eastbound Street Eastbound	
Start Time	Peds CCW	Peds CW	Peds CCW	Peds CW	Peds CCW	Peds CW	Peds CCW	Peds CW
4:00 PM	0	0	2	0	0	0	0	0
4:15 PM	0	1	0	0	0	0	0	1
4:30 PM	0	0	0	0	0	0	0	0
4:45 PM	1	0	0	0	0	0	0	1
5:00 PM	0	0	1	0	0	0	4	0
5:15 PM	0	0	0	0	0	0	3	0
5:30 PM	0	0	0	0	0	0	0	1
5:45 PM	0	0	0	0	0	0	5	3

Study Name WC12-2953_5 Regatta Boulevard - Marina Bay Parkway
Start Date 12/12/2012
Start Time 4:00 PM
Site Code

	Southbound Street Southbound				Westbound Street Westbound				Northbound Street Northbound				Eastbound Street Eastbound			
Start Time	Right	Thru	Left	U-Turn	Right	Thru	Left	U-Turn	Right	Thru	Left	U-Turn	Right	Thru	Left	U-Turn
4:00 PM	31	57	4	0	6	1	7	0	4	34	2	0	5	0	28	0
4:15 PM	30	56	4	0	2	2	10	0	3	27	3	0	5	0	24	0
4:30 PM	43	48	2	0	11	4	7	0	4	27	1	0	5	0	51	0
4:45 PM	43	64	1	0	4	2	8	0	1	39	2	0	4	3	20	0
5:00 PM	34	65	0	0	6	2	9	0	5	37	2	0	6	4	51	0
5:15 PM	33	81	2	1	6	1	3	0	5	41	5	0	4	0	49	0
5:30 PM	49	80	1	0	3	3	3	0	1	30	3	0	2	0	28	0
5:45 PM	49	91	2	0	7	2	11	0	4	33	4	0	1	3	28	0

Totals

Study Name WC12-2953_6 I-580 WB Ramps - Juliga Woods Street
Start Date 12/12/2012
Start Time 7:00 AM
Site Code

	Southbound Street Southbound			Northbound Street Northbound			Eastbound Street Eastbound		
Start Time	Right	Thru	U-Turn	Thru	Left	U-Turn	Right	Left	U-Turn
7:00 AM	0	0	0	0	0	0	0	0	0
7:15 AM	0	0	0	0	0	0	0	0	0
7:30 AM	0	0	0	0	0	0	0	0	0
7:45 AM	0	0	0	0	0	0	0	0	0
8:00 AM	0	1	0	0	0	0	0	0	0
8:15 AM	0	0	0	0	0	0	0	0	0
8:30 AM	0	0	0	0	0	0	0	0	0
8:45 AM	0	1	0	0	0	0	0	0	0
4:00 PM	0	0	0	0	0	0	0	0	0
4:15 PM	0	0	0	0	0	0	0	0	0
4:30 PM	0	0	0	1	0	0	0	0	0
4:45 PM	0	0	0	0	0	0	0	0	0
5:00 PM	0	1	0	0	0	0	0	0	0
5:15 PM	0	0	0	1	0	0	0	0	0
5:30 PM	0	0	0	0	0	0	0	0	0
5:45 PM	0	0	0	0	0	0	0	0	0

Study Name WC12-2953_6 I-580 WB Ramps - Juliga Woods
Start Date 12/12/2012
Start Time 7:00 AM
Site Code

	Southbound Street Southbound		Northbound Street Northbound		Eastbound Street Eastbound	
Start Time	Peds CCW	Peds CW	Peds CCW	Peds CW	Peds CCW	Peds CW
7:00 AM	0	0	0	0	0	0
7:15 AM	0	0	0	0	0	0
7:30 AM	0	0	0	0	0	0
7:45 AM	0	0	0	0	0	0
8:00 AM	0	0	0	0	0	0
8:15 AM	0	0	0	0	0	0
8:30 AM	0	0	0	0	0	0
8:45 AM	0	0	0	0	0	0
4:00 PM	0	0	0	0	0	0
4:15 PM	0	0	0	0	0	0
4:30 PM	0	0	0	0	0	0
4:45 PM	0	0	0	0	0	0
5:00 PM	0	0	0	0	0	0
5:15 PM	0	0	0	0	0	0
5:30 PM	0	0	0	0	0	0
5:45 PM	0	0	0	0	0	0

Study Name WC12-2953_6 I-580 WB Ramps - Juliga Woods Street
Start Date 12/12/2012
Start Time 7:00 AM
Site Code

	Southbound Street Southbound			Northbound Street Northbound			Eastbound Street Eastbound				
Start Time	Right	Thru	U-Turn	Thru	Left	U-Turn	Right	Left	U-Turn	Hourly Total	15-min Total
7:00 AM	25	41	0	14	3	0	10	5	0	417	98
7:15 AM	33	60	0	9	3	0	16	10	0	429	131
7:30 AM	36	33	0	15	2	0	12	10	0	398	108
7:45 AM	19	25	0	12	3	0	12	9	0	390	80
8:00 AM	21	35	0	25	5	0	11	13	0	373	110
8:15 AM	31	32	0	13	3	0	8	13	0		100
8:30 AM	26	25	0	18	8	0	14	8	1		100
8:45 AM	15	15	0	10	5	0	5	13	0		63
4:00 PM	12	16	0	38	17	1	11	17	0	404	112
4:15 PM	9	15	0	27	9	0	7	27	1	392	95
4:30 PM	11	20	0	28	10	0	5	20	2	405	96
4:45 PM	14	18	0	33	6	1	7	22	0	423	101
5:00 PM	7	20	0	37	6	0	4	26	0	413	100
5:15 PM	14	14	0	38	2	0	10	28	2		108
5:30 PM	10	11	0	41	5	0	6	40	1		114
5:45 PM	9	11	1	26	3	0	7	34	0		91

Totals

Study Name WC12-2953_7 I-580 EB Ramps - Regatta Boulevard - Meade Street
Start Date 12/12/2012
Start Time 4:00 PM
Site Code

	Southbound Street Southbound				Westbound Street Westbound				Northbound Street Northbound				Eastbound Street Eastbound			
Start Time	Right	Thru	Left	U-Turn	Right	Thru	Left	U-Turn	Right	Thru	Left	U-Turn	Right	Thru	Left	U-Turn
4:00 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4:15 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4:30 PM	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
4:45 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5:00 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5:15 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5:30 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5:45 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7:00 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7:15 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7:30 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7:45 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8:00 AM	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
8:15 AM	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
8:30 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8:45 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Study Name WC12-2953_7 I-580 EB Ramps - Regatta Boulevard - Meade Stree
Start Date 12/12/2012
Start Time 4:00 PM
Site Code

	Southbound Street Southbound		Westbound Street Westbound		Northbound Street Northbound		Eastbound Street Eastbound	
Start Time	Peds CCW	Peds CW	Peds CCW	Peds CW	Peds CCW	Peds CW	Peds CCW	Peds CW
4:00 PM	0	0	0	0	0	0	0	0
4:15 PM	0	0	0	0	0	0	0	0
4:30 PM	0	0	0	0	0	0	0	0
4:45 PM	0	0	0	0	0	0	0	0
5:00 PM	0	0	0	0	0	0	0	0
5:15 PM	0	0	0	0	0	0	0	0
5:30 PM	0	0	0	0	0	0	0	0
5:45 PM	0	0	0	0	0	0	0	0
7:00 AM	0	0	0	0	0	0	0	0
7:15 AM	0	0	1	2	0	0	0	0
7:30 AM	0	0	0	0	0	0	0	0
7:45 AM	0	0	0	1	0	0	0	0
8:00 AM	0	0	0	0	0	0	0	0
8:15 AM	0	0	0	1	0	0	0	0
8:30 AM	0	0	0	0	0	0	0	0
8:45 AM	0	0	0	0	0	0	0	0

Study Name WC12-2953_7 I-580 EB Ramps - Regatta Boulevard - Meade Street
Start Date 12/12/2012
Start Time 4:00 PM
Site Code

	Southbound Street Southbound				Westbound Street Westbound				Northbound Street Northbound				Eastbound Street Eastbound			
Start Time	Right	Thru	Left	U-Turn	Right	Thru	Left	U-Turn	Right	Thru	Left	U-Turn	Right	Thru	Left	U-Turn
4:00 PM	16	3	10	0	21	10	0	0	0	15	3	0	0	1	18	0
4:15 PM	7	0	13	0	12	5	2	0	1	6	2	0	2	4	16	1
4:30 PM	18	0	6	0	16	7	0	0	0	6	4	0	1	4	14	1
4:45 PM	11	5	9	0	10	6	1	0	2	6	2	0	0	2	26	1
5:00 PM	16	2	7	0	17	9	1	0	0	4	2	0	0	1	20	0
5:15 PM	10	4	8	0	8	2	0	0	2	2	2	0	0	3	29	0
5:30 PM	11	1	6	0	10	8	0	0	0	5	3	0	0	1	38	0
5:45 PM	7	1	12	0	7	8	0	0	0	0	1	0	1	3	19	0
7:00 AM	30	4	21	0	7	7	0	0	1	0	0	0	2	2	11	0
7:15 AM	33	20	15	0	3	7	1	0	0	5	1	0	4	2	4	0
7:30 AM	36	7	8	0	4	7	0	0	1	1	0	0	3	3	5	1
7:45 AM	19	6	4	0	15	5	2	0	3	3	1	0	5	6	10	7
8:00 AM	26	0	19	0	24	24	4	0	1	4	1	0	4	6	7	0
8:15 AM	17	8	17	0	7	5	1	0	3	3	1	0	1	3	15	0
8:30 AM	16	0	16	0	2	8	0	0	3	1	1	0	5	3	7	0
8:45 AM	12	5	12	0	8	3	0	0	2	2	1	0	0	6	10	0

Totals

Study Name WC12-2953_8 Meade Street - Seaver Avenue
Start Date 12/12/2012
Start Time 7:00 AM
Site Code

	Southbound Street Southbound			Northbound Street Northbound			Eastbound Street Eastbound		
Start Time	Right	Thru	U-Turn	Thru	Left	U-Turn	Right	Left	U-Turn
7:00 AM	0	0	0	0	0	0	0	0	0
7:15 AM	0	0	0	0	0	0	0	0	0
7:30 AM	0	0	0	0	0	0	0	0	0
7:45 AM	0	0	0	0	0	0	0	0	0
8:00 AM	0	0	0	0	1	0	0	0	0
8:15 AM	0	0	0	0	0	0	0	0	0
8:30 AM	0	0	0	0	1	0	0	0	0
8:45 AM	1	0	0	0	0	0	0	0	0
4:00 PM	0	0	0	0	0	0	0	0	0
4:15 PM	0	0	0	0	0	0	0	0	0
4:30 PM	0	0	0	0	0	0	0	1	0
4:45 PM	0	0	0	2	0	0	0	0	0
5:00 PM	0	0	0	0	0	0	0	0	0
5:15 PM	0	0	0	0	0	0	0	0	0
5:30 PM	0	0	0	0	0	0	0	0	0
5:45 PM	0	0	0	0	0	0	0	0	0

Study Name WC12-2953_8 Meade Street - Seaver Avenue
Start Date 12/12/2012
Start Time 7:00 AM
Site Code

	Southbound Street Southbound		Northbound Street Northbound		Eastbound Street Eastbound	
Start Time	Peds CCW	Peds CW	Peds CCW	Peds CW	Peds CCW	Peds CW
7:00 AM	0	0	0	0	0	0
7:15 AM	0	0	0	0	0	0
7:30 AM	0	0	0	0	0	0
7:45 AM	0	0	0	0	0	0
8:00 AM	0	0	0	0	0	0
8:15 AM	0	0	0	0	0	0
8:30 AM	0	0	0	0	0	0
8:45 AM	0	0	0	0	0	0
4:00 PM	0	0	0	0	0	0
4:15 PM	0	0	0	0	0	0
4:30 PM	0	0	0	0	0	0
4:45 PM	0	0	0	0	0	0
5:00 PM	0	0	0	0	0	0
5:15 PM	0	0	0	0	0	0
5:30 PM	0	0	0	0	0	0
5:45 PM	0	0	0	0	0	0

Study Name WC12-2953_8 Meade Street - Seaver Avenue
Start Date 12/12/2012
Start Time 7:00 AM
Site Code

	Southbound Street Southbound			Northbound Street Northbound			Eastbound Street Eastbound				
Start Time	Right	Thru	U-Turn	Thru	Left	U-Turn	Right	Left	U-Turn	Hourly Total	15-min Total
7:00 AM	2	13	0	4	8	0	0	0	0	174	27
7:15 AM	2	23	0	9	5	0	0	0	0	206	39
7:30 AM	1	35	0	2	4	0	2	0	0	217	44
7:45 AM	3	46	0	5	9	0	1	0	0	216	64
8:00 AM	3	38	0	4	12	0	1	1	0	186	59
8:15 AM	3	29	0	8	9	0	0	1	0		50
8:30 AM	1	18	0	11	11	0	1	1	0		43
8:45 AM	2	13	0	2	14	0	1	2	0		34
4:00 PM	3	15	0	10	2	0	5	2	0	157	37
4:15 PM	0	13	1	14	1	0	10	1	0	160	40
4:30 PM	1	17	0	12	2	0	9	3	0	157	44
4:45 PM	0	10	0	14	0	0	11	1	0	130	36
5:00 PM	0	10	0	12	2	0	12	4	0	125	40
5:15 PM	2	14	0	4	0	0	14	3	0		37
5:30 PM	0	5	0	6	1	0	2	3	0		17
5:45 PM	0	9	0	12	1	0	8	1	0		31

Totals

Study Name WC12-2953_9 Seaprot Avenue - I-580 EB Ramps
Start Date 12/12/2012
Start Time 4:00 PM
Site Code

	Southbound Street Southbound				Westbound Street Westbound				Northbound Street Northbound				Eastbound Street Eastbound			
Start Time	Right	Thru	Left	U-Turn	Right	Thru	Left	U-Turn	Right	Thru	Left	U-Turn	Right	Thru	Left	U-Turn
4:00 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4:15 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
4:30 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4:45 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5:00 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5:15 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
5:30 PM	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
5:45 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7:00 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7:15 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7:30 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7:45 AM	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
8:00 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8:15 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
8:30 AM	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
8:45 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Study Name WC12-2953_9 Seaprot Avenue - I-580 EB Ramps
Start Date 12/12/2012
Start Time 4:00 PM
Site Code

	Southbound Street Southbound		Westbound Street Westbound		Northbound Street Northbound		Eastbound Street Eastbound	
Start Time	Peds CCW	Peds CW	Peds CCW	Peds CW	Peds CCW	Peds CW	Peds CCW	Peds CW
4:00 PM	0	0	0	2	0	1	0	0
4:15 PM	0	0	0	0	0	0	0	0
4:30 PM	0	0	0	0	0	0	0	0
4:45 PM	0	0	0	0	0	0	0	0
5:00 PM	0	0	0	0	1	1	0	0
5:15 PM	0	0	0	0	0	0	0	0
5:30 PM	0	0	0	0	0	0	0	0
5:45 PM	0	0	0	0	0	0	0	0
7:00 AM	0	0	0	0	0	0	0	0
7:15 AM	0	0	0	0	0	0	0	0
7:30 AM	0	0	0	0	0	0	0	0
7:45 AM	0	0	0	0	0	0	0	0
8:00 AM	0	0	0	0	0	0	0	0
8:15 AM	0	0	0	0	0	0	0	0
8:30 AM	0	0	0	0	0	0	0	0
8:45 AM	0	0	0	0	0	0	0	0

Study Name WC12-2953_9 Seaprot Avenue - I-580 EB Ramps
Start Date 12/12/2012
Start Time 4:00 PM
Site Code

	Southbound Street Southbound				Westbound Street Westbound				Northbound Street Northbound				Eastbound Street Eastbound			
Start Time	Right	Thru	Left	U-Turn	Right	Thru	Left	U-Turn	Right	Thru	Left	U-Turn	Right	Thru	Left	U-Turn
4:00 PM	3	1	70	0	18	12	0	1	9	1	0	0	0	16	7	1
4:15 PM	1	1	74	0	18	16	1	1	7	2	1	0	0	19	12	0
4:30 PM	0	1	122	0	21	16	3	0	12	8	0	0	0	16	19	0
4:45 PM	0	0	89	0	16	9	2	0	8	0	0	0	1	14	11	1
5:00 PM	2	0	110	0	16	15	5	0	3	6	0	0	0	19	12	0
5:15 PM	1	0	115	0	15	1	2	1	1	3	0	0	0	17	12	2
5:30 PM	1	0	83	0	15	8	0	1	2	0	0	0	1	17	7	0
5:45 PM	1	0	92	0	16	11	0	0	1	1	0	0	2	12	7	1
7:00 AM	0	1	28	0	36	13	7	0	3	1	0	0	0	9	4	0
7:15 AM	0	0	48	0	55	20	5	0	2	1	0	0	1	9	9	0
7:30 AM	3	1	95	2	58	29	12	0	0	2	1	0	0	29	18	0
7:45 AM	6	2	125	5	46	34	4	1	0	0	2	0	2	39	32	0
8:00 AM	3	2	135	2	31	29	2	0	3	1	2	0	0	45	30	0
8:15 AM	3	2	90	0	37	26	12	0	4	3	0	0	1	19	13	1
8:30 AM	1	0	65	0	37	28	10	0	2	3	2	0	1	11	13	1
8:45 AM	1	1	42	0	34	32	3	0	0	1	1	0	0	13	9	0

Totals

Study Name WC12-2953_10 Bayview Avenue - I-580 WB Ramps
Start Date 12/12/2012
Start Time 7:00 AM
Site Code

	Southbound Street Southbound			Westbound Street Westbound			Northbound Street Northbound		
Start Time	Right	Thru	U-Turn	Right	Thru	Left	Thru	Left	U-Turn
7:00 AM	0	0	0	0	0	0	0	0	0
7:15 AM	0	1	0	0	0	0	0	0	0
7:30 AM	0	0	0	0	0	0	0	0	0
7:45 AM	0	1	0	0	0	0	0	0	0
8:00 AM	0	0	0	0	0	0	0	0	0
8:15 AM	0	0	0	0	0	0	2	0	0
8:30 AM	0	0	0	0	0	0	0	0	0
8:45 AM	0	0	0	0	0	0	0	0	0
4:00 PM	0	2	0	0	0	0	1	0	0
4:15 PM	0	0	0	0	0	0	1	0	0
4:30 PM	0	0	0	0	0	0	1	0	0
4:45 PM	0	1	0	0	0	0	0	0	0
5:00 PM	0	0	0	0	0	0	0	0	0
5:15 PM	0	0	0	0	0	1	1	0	0
5:30 PM	0	0	0	0	0	0	0	0	0
5:45 PM	0	0	0	0	0	0	0	0	0

Study Name WC12-2953_10 Bayview Avenue - I-580 WB Ramps
Start Date 12/12/2012
Start Time 7:00 AM
Site Code

	Southbound Street Southbound		Westbound Street Westbound		Northbound Street Northbound		Eastbound Street Eastbound	
Start Time	Peds CCW	Peds CW	Peds CCW	Peds CW	Peds CCW	Peds CW	Peds CCW	Peds CW
7:00 AM	0	0	0	0	0	0	0	0
7:15 AM	0	0	0	0	0	0	0	0
7:30 AM	0	0	0	0	0	0	0	0
7:45 AM	0	0	0	0	0	0	0	0
8:00 AM	0	0	0	0	0	0	1	0
8:15 AM	0	0	0	0	0	0	0	0
8:30 AM	0	0	0	0	0	0	1	0
8:45 AM	0	0	0	0	0	0	0	0
4:00 PM	0	0	2	0	0	0	0	0
4:15 PM	0	0	0	0	0	0	0	0
4:30 PM	0	0	0	0	0	0	0	0
4:45 PM	0	0	0	0	0	0	0	0
5:00 PM	0	0	1	0	0	0	1	0
5:15 PM	0	0	0	0	0	0	0	0
5:30 PM	0	0	0	0	0	0	0	0
5:45 PM	0	0	0	1	0	0	0	0

Study Name WC12-2953_10 Bayview Avenue - I-580 WB Ramps
Start Date 12/12/2012
Start Time 7:00 AM
Site Code

	Southbound Street Southbound			Westbound Street Westbound			Northbound Street Northbound				
Start Time	Right	Thru	U-Turn	Right	Thru	Left	Thru	Left	U-Turn	Hourly Total	15-min Total
7:00 AM	59	58	0	13	0	9	49	1	0	1058	189
7:15 AM	71	77	0	9	0	13	62	2	0	1184	234
7:30 AM	96	65	0	11	0	9	107	4	0	1204	292
7:45 AM	96	54	0	15	0	17	159	2	0	1161	343
8:00 AM	103	46	0	17	0	15	132	2	0	1024	315
8:15 AM	78	44	0	20	0	22	90	0	0		254
8:30 AM	87	73	0	18	1	17	51	2	0		249
8:45 AM	68	57	0	13	0	8	58	2	0		206
4:00 PM	48	25	0	61	1	9	92	4	0	1072	240
4:15 PM	49	29	0	64	1	9	99	1	0	1165	252
4:30 PM	54	30	0	64	0	3	153	2	0	1241	306
4:45 PM	54	23	0	77	2	8	109	1	0	1277	274
5:00 PM	65	23	0	106	0	10	127	2	0	1303	333
5:15 PM	60	18	0	113	0	4	133	0	0		328
5:30 PM	80	29	1	117	0	2	109	4	0		342
5:45 PM	82	17	0	96	0	8	97	0	0		300

Totals

Study Name WC12-2953_11 Carlson Boulevard - Bayview Avenue
Start Date 12/12/2012
Start Time 7:00 AM
Site Code

	Southbound Street Southbound				Westbound Street Westbound				Northbound Street Northbound				Eastbound Street Eastbound			
Start Time	Right	Thru	Left	U-Turn	Right	Thru	Left	U-Turn	Right	Thru	Left	U-Turn	Right	Thru	Left	U-Turn
7:00 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7:15 AM	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
7:30 AM	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
7:45 AM	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
8:00 AM	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8:15 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8:30 AM	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0
8:45 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4:00 PM	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0
4:15 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4:30 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4:45 PM	0	1	0	0	0	2	0	0	0	0	0	0	0	0	0	0
5:00 PM	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
5:15 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5:30 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5:45 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Study Name WC12-2953_11 Carlson Boulevard - Bayview Avenue
Start Date 12/12/2012
Start Time 7:00 AM
Site Code

	Southbound Street Southbound		Westbound Street Westbound		Northbound Street Northbound		Eastbound Street Eastbound	
Start Time	Peds CCW	Peds CW	Peds CCW	Peds CW	Peds CCW	Peds CW	Peds CCW	Peds CW
7:00 AM	0	0	0	0	0	0	0	0
7:15 AM	0	0	0	0	0	0	0	0
7:30 AM	0	0	0	1	0	0	0	0
7:45 AM	1	0	0	0	0	0	0	0
8:00 AM	0	0	1	0	0	0	0	0
8:15 AM	0	0	0	0	0	0	0	0
8:30 AM	0	0	0	0	0	0	0	0
8:45 AM	2	0	0	0	0	0	0	0
4:00 PM	0	1	0	0	0	0	0	0
4:15 PM	0	0	0	0	0	0	0	0
4:30 PM	2	0	0	0	0	1	0	0
4:45 PM	0	0	0	0	0	0	0	0
5:00 PM	0	0	0	1	0	0	0	0
5:15 PM	0	0	0	0	0	0	0	0
5:30 PM	0	0	0	1	0	0	0	0
5:45 PM	0	0	0	0	0	0	0	0

Study Name WC12-2953_11 Carlson Boulevard - Bayview Avenue
Start Date 12/12/2012
Start Time 7:00 AM
Site Code

	Southbound Street Southbound				Westbound Street Westbound				Northbound Street Northbound				Eastbound Street Eastbound			
Start Time	Right	Thru	Left	U-Turn	Right	Thru	Left	U-Turn	Right	Thru	Left	U-Turn	Right	Thru	Left	U-Turn
7:00 AM	0	21	4	0	5	13	58	1	32	12	8	0	35	33	2	0
7:15 AM	6	26	11	0	3	10	59	0	59	11	7	0	59	52	0	0
7:30 AM	2	23	13	0	5	15	82	1	81	11	8	0	47	87	0	0
7:45 AM	2	35	6	0	6	13	70	0	148	17	13	0	39	101	3	0
8:00 AM	5	40	16	0	6	22	68	0	127	11	15	0	40	101	2	0
8:15 AM	6	27	10	0	1	28	66	1	75	19	14	0	27	74	3	0
8:30 AM	3	30	7	0	6	30	72	1	46	13	16	0	38	61	4	0
8:45 AM	5	28	7	0	4	19	59	0	57	4	15	0	28	41	3	0
4:00 PM	9	11	4	0	8	44	38	0	72	30	44	0	20	32	6	0
4:15 PM	3	11	3	0	4	43	51	1	92	18	48	0	23	27	5	0
4:30 PM	10	13	7	0	14	40	45	0	121	32	53	0	17	37	6	0
4:45 PM	8	11	3	0	8	48	51	1	99	38	64	0	18	25	4	1
5:00 PM	7	13	3	0	10	54	58	1	109	44	78	0	15	40	4	0
5:15 PM	13	8	3	0	9	54	52	0	112	48	74	0	12	46	7	0
5:30 PM	8	1	6	0	13	75	80	0	93	44	71	0	15	41	8	0
5:45 PM	10	13	3	0	7	69	71	0	97	36	79	0	14	36	6	0

Totals

Study Name WC12-2953_12 Carlson Boulevard - I-80 EB Ramps
Start Date 12/12/2012
Start Time 7:00 AM
Site Code

	Southbound Street Southbound			Westbound Street Westbound			Eastbound Street Eastbound		
Start Time	Right	Thru	Left	Thru	Left	U-Turn	Right	Thru	U-Turn
7:00 AM	0	0	0	0	0	0	0	1	0
7:15 AM	0	0	0	0	0	0	0	0	0
7:30 AM	0	0	0	1	0	0	0	0	0
7:45 AM	0	0	0	1	0	0	0	0	0
8:00 AM	0	0	0	0	0	0	0	0	0
8:15 AM	0	0	0	0	0	0	0	0	0
8:30 AM	0	0	0	0	0	0	0	0	0
8:45 AM	0	0	0	0	0	0	0	1	0
4:00 PM	0	0	0	0	0	0	0	2	0
4:15 PM	0	0	0	0	0	0	0	1	0
4:30 PM	0	0	0	1	0	0	0	0	0
4:45 PM	0	0	0	1	0	0	0	0	0
5:00 PM	0	0	0	2	0	0	0	0	0
5:15 PM	0	0	0	1	0	0	0	0	0
5:30 PM	0	0	0	0	0	0	0	0	0
5:45 PM	0	0	0	0	0	0	0	0	0

Study Name WC12-2953_12 Carlson Boulevard - I-80 EB Ramps
Start Date 12/12/2012
Start Time 7:00 AM
Site Code

	Southbound Street Southbound		Westbound Street Westbound		Northbound Street Northbound		Eastbound Street Eastbound	
Start Time	Peds CCW	Peds CW	Peds CCW	Peds CW	Peds CCW	Peds CW	Peds CCW	Peds CW
7:00 AM	0	0	0	0	0	0	0	0
7:15 AM	0	0	0	0	1	0	0	0
7:30 AM	0	0	0	0	6	0	0	0
7:45 AM	1	2	0	0	0	0	0	0
8:00 AM	0	0	0	0	1	1	0	0
8:15 AM	1	1	0	0	1	0	0	0
8:30 AM	2	1	1	0	0	0	1	0
8:45 AM	0	1	0	0	0	0	0	0
4:00 PM	0	0	0	0	1	2	0	0
4:15 PM	2	0	0	0	1	0	0	0
4:30 PM	1	1	0	0	0	0	0	0
4:45 PM	1	0	1	0	0	0	0	0
5:00 PM	0	0	0	0	1	2	0	0
5:15 PM	2	1	0	0	2	0	0	0
5:30 PM	0	0	0	0	2	0	0	0
5:45 PM	0	0	0	0	0	1	0	0

Study Name WC12-2953_12 Carlson Boulevard - I-80 EB Ramps
Start Date 12/12/2012
Start Time 7:00 AM
Site Code

	Southbound Street Southbound			Westbound Street Westbound			Eastbound Street Eastbound				
Start Time	Right	Thru	Left	Thru	Left	U-Turn	Right	Thru	U-Turn	Hourly Total	15-min Total
7:00 AM	54	3	43	47	21	0	18	63	0	1490	249
7:15 AM	41	5	73	31	17	1	18	108	0	1765	294
7:30 AM	51	2	93	68	20	0	32	163	0	1928	429
7:45 AM	43	9	112	67	16	0	33	238	0	1885	518
8:00 AM	40	5	87	85	20	0	34	253	0	1689	524
8:15 AM	47	7	96	87	22	0	23	175	0		457
8:30 AM	42	6	77	95	24	0	20	122	0		386
8:45 AM	46	7	71	59	16	0	15	108	0		322
4:00 PM	46	1	57	72	12	0	17	128	0	1400	333
4:15 PM	37	0	64	86	18	0	12	121	0	1453	338
4:30 PM	41	0	59	87	15	0	13	149	0	1515	364
4:45 PM	32	0	50	100	10	0	22	151	0	1574	365
5:00 PM	46	0	67	95	13	0	16	149	0	1623	386
5:15 PM	43	0	74	101	14	0	16	152	0		400
5:30 PM	51	1	67	131	11	0	23	139	0		423
5:45 PM	47	0	75	121	15	0	15	141	0		414

Totals

Study Name WC12-2953_13 Carlson Boulevard - I-80 WB Ramps
Start Date 12/12/2012
Start Time 7:00 AM
Site Code

	Westbound Street Westbound			Northbound Street Northbound			Eastbound Street Eastbound		
Start Time	Right	Thru	U-Turn	Right	Thru	Left	Thru	Left	U-Turn
7:00 AM	1	0	0	0	0	0	1	0	0
7:15 AM	0	1	0	0	0	0	0	0	0
7:30 AM	0	1	0	0	0	0	0	0	0
7:45 AM	0	2	0	0	0	0	0	0	0
8:00 AM	0	0	0	0	0	0	0	0	0
8:15 AM	0	0	0	0	0	0	0	0	0
8:30 AM	0	0	0	0	0	0	0	0	0
8:45 AM	0	0	0	0	0	0	1	0	0
4:00 PM	0	2	0	0	0	0	1	1	0
4:15 PM	0	1	0	0	0	0	1	0	0
4:30 PM	0	1	0	0	0	0	0	0	0
4:45 PM	0	1	0	0	0	0	0	1	0
5:00 PM	0	0	0	0	0	0	0	0	0
5:15 PM	0	0	0	0	0	0	0	0	0
5:30 PM	0	0	0	0	0	0	0	0	0
5:45 PM	0	0	0	0	0	0	0	0	0

Study Name WC12-2953_13 Carlson Boulevard - I-80 WB Ramps
Start Date 12/12/2012
Start Time 7:00 AM
Site Code

	Southbound Street Southbound		Westbound Street Westbound		Northbound Street Northbound		Eastbound Street Eastbound	
Start Time	Peds CCW	Peds CW	Peds CCW	Peds CW	Peds CCW	Peds CW	Peds CCW	Peds CW
7:00 AM	0	1	0	0	1	0	0	0
7:15 AM	0	1	0	0	4	0	0	0
7:30 AM	0	0	0	0	4	0	0	0
7:45 AM	1	2	0	0	0	0	0	0
8:00 AM	0	0	0	0	1	1	0	0
8:15 AM	1	1	0	1	1	0	0	0
8:30 AM	2	1	0	0	0	0	0	0
8:45 AM	0	0	0	0	0	0	0	0
4:00 PM	0	1	0	0	0	2	0	0
4:15 PM	1	0	0	0	1	0	0	0
4:30 PM	0	1	0	0	0	0	0	0
4:45 PM	1	1	0	0	0	0	0	0
5:00 PM	1	0	0	0	1	2	0	0
5:15 PM	1	0	0	0	2	0	0	0
5:30 PM	0	0	0	0	2	0	0	0
5:45 PM	0	0	0	0	0	0	0	0

Study Name WC12-2953_13 Carlson Boulevard - I-80 WB Ramps
Start Date 12/12/2012
Start Time 7:00 AM
Site Code

	Westbound Street Westbound			Northbound Street Northbound			Eastbound Street Eastbound				
Start Time	Right	Thru	U-Turn	Right	Thru	Left	Thru	Left	U-Turn	Hourly Total	15-min Total
7:00 AM	40	58	0	10	1	4	78	37	0	1551	228
7:15 AM	44	56	0	8	0	2	155	34	0	1876	299
7:30 AM	73	76	0	11	0	5	218	63	0	2051	446
7:45 AM	107	94	0	11	0	3	317	46	0	2009	578
8:00 AM	114	108	0	12	1	9	251	58	0	1756	553
8:15 AM	87	102	0	20	1	6	215	43	0		474
8:30 AM	77	98	0	25	2	4	158	40	0		404
8:45 AM	71	61	0	18	2	9	126	38	0		325
4:00 PM	107	79	0	18	13	10	101	49	0	1672	377
4:15 PM	76	82	0	27	21	17	117	75	1	1774	416
4:30 PM	101	94	0	26	27	14	140	82	0	1866	484
4:45 PM	75	77	0	26	20	21	112	64	0	1895	395
5:00 PM	98	94	0	30	23	12	158	64	0	1967	479
5:15 PM	98	98	0	21	43	19	173	56	0		508
5:30 PM	104	132	0	26	41	14	148	48	0		513
5:45 PM	77	112	0	23	34	16	162	43	0		467

Totals

Study Name WC12-2953_4 Mekker Avenue-23rd Street-Marina Bay Parkway TMC
Start Date 01/31/2013
Start Time 7:00 AM
Site Code WC12-2953_#4

	Southbound Street Southbound				Westbound Street Westbound				Northbound Street Northbound				Eastbound Street Eastbound			
Start Time	Right	Thru	Left	U-Turn	Right	Thru	Left	U-Turn	Right	Thru	Left	U-Turn	Right	Thru	Left	U-Turn
7:00 AM	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
7:15 AM	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7:30 AM	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7:45 AM	1	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0
8:00 AM	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
8:15 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8:30 AM	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
8:45 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4:00 PM	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
4:15 PM	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0
4:30 PM	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4:45 PM	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5:00 PM	0	1	0	0	0	0	0	0	0	1	1	0	0	0	0	0
5:15 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5:30 PM	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0
5:45 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Study Name WC12-2953_4 Mekker Avenue-23rd Street-Marina Bay Parkway T
Start Date 01/31/2013
Start Time 7:00 AM
Site Code WC12-2953_#4

	Southbound Street Southbound		Westbound Street Westbound		Northbound Street Northbound		Eastbound Street Eastbound	
Start Time	Peds CCW	Peds CW	Peds CCW	Peds CW	Peds CCW	Peds CW	Peds CCW	Peds CW
7:00 AM	0	0	0	0	0	0	0	1
7:15 AM	1	1	1	0	0	0	1	0
7:30 AM	0	0	0	1	0	0	0	1
7:45 AM	1	1	0	0	0	0	0	0
8:00 AM	2	0	0	0	0	0	0	0
8:15 AM	0	3	0	0	0	0	1	1
8:30 AM	0	0	0	1	0	0	1	1
8:45 AM	4	0	0	0	0	0	0	1
4:00 PM	1	2	0	0	0	1	1	4
4:15 PM	1	0	0	0	0	0	3	0
4:30 PM	0	0	1	0	0	0	1	0
4:45 PM	0	0	0	0	0	0	0	1
5:00 PM	2	0	0	0	0	1	0	4
5:15 PM	0	2	0	0	0	0	3	0
5:30 PM	0	1	0	0	0	0	0	1
5:45 PM	0	0	0	0	0	0	0	1

Study Name WC12-2953_4 Mekker Avenue-23rd Street-Marina Bay Parkway TMC
Start Date 01/31/2013
Start Time 7:00 AM
Site Code WC12-2953_#4

	Southbound Street Southbound				Westbound Street Westbound				Northbound Street Northbound				Eastbound Street Eastbound			
Start Time	Right	Thru	Left	U-Turn	Right	Thru	Left	U-Turn	Right	Thru	Left	U-Turn	Right	Thru	Left	U-Turn
7:00 AM	7	46	29	0	2	0	0	0	0	115	4	0	5	1	8	0
7:15 AM	17	34	34	1	3	0	0	0	2	134	4	0	2	2	16	0
7:30 AM	10	54	55	1	4	0	0	0	2	150	2	0	0	2	13	0
7:45 AM	21	73	74	1	7	2	0	0	2	117	8	0	3	3	9	0
8:00 AM	27	51	90	0	7	0	1	0	3	143	8	0	4	4	19	0
8:15 AM	25	75	63	5	5	1	1	0	3	139	1	0	4	0	9	0
8:30 AM	18	75	72	2	4	0	1	0	3	86	1	0	4	1	8	0
8:45 AM	16	57	63	0	9	0	1	0	3	89	3	0	5	0	7	0
4:00 PM	8	86	7	2	37	2	0	0	0	86	5	0	12	0	33	0
4:15 PM	9	100	3	1	43	1	2	0	0	80	6	0	12	1	25	0
4:30 PM	13	106	6	1	78	5	0	0	1	99	4	0	5	1	22	0
4:45 PM	6	96	3	1	50	1	0	0	1	63	6	0	18	0	26	0
5:00 PM	7	113	2	4	98	1	3	0	1	90	10	0	19	0	73	0
5:15 PM	5	102	5	1	55	3	3	0	0	79	2	0	14	1	28	0
5:30 PM	6	117	2	3	46	2	3	0	0	80	6	0	15	1	34	0
5:45 PM	4	125	3	1	23	2	1	0	0	79	9	0	9	0	32	0

Totals

Study Name Regatta Blvd-Meade St/Regatta Blvd TMC
Start Date 01/31/2013
Start Time 7:00 AM
Site Code WC12-2953_#8

	Westbound Street Westbound			Northbound Street Northbound			Eastbound Street Eastbound		
Start Time	Thru	Left	U-Turn	Right	Left	U-Turn	Right	Thru	U-Turn
7:00 AM	0	0	0	0	0	0	0	0	0
7:15 AM	0	0	0	0	0	0	1	0	0
7:30 AM	0	0	0	0	0	0	0	0	0
7:45 AM	0	0	0	0	0	0	0	0	0
8:00 AM	0	0	0	0	0	0	4	0	0
8:15 AM	0	1	0	2	0	0	1	1	0
8:30 AM	0	0	0	0	0	0	0	0	0
8:45 AM	0	0	0	0	0	0	0	1	0
4:00 PM	0	0	0	1	0	0	0	0	0
4:15 PM	0	0	0	1	0	0	0	0	0
4:30 PM	0	0	0	0	0	0	0	0	0
4:45 PM	0	0	0	0	0	0	0	0	0
5:00 PM	0	0	0	0	0	0	0	0	0
5:15 PM	0	0	0	0	0	0	0	0	0
5:30 PM	0	0	0	0	0	0	0	0	0
5:45 PM	1	0	0	0	0	0	0	0	0

Study Name Regatta Blvd-Meade St/Regatta Blvd TMC
Start Date 01/31/2013
Start Time 7:00 AM
Site Code WC12-2953_#8

	Southbound Street Southbound		Westbound Street Westbound		Northbound Street Northbound		Eastbound Street Eastbound	
Start Time	Peds CCW	Peds CW	Peds CCW	Peds CW	Peds CCW	Peds CW	Peds CCW	Peds CW
7:00 AM	0	0	0	0	0	0	0	0
7:15 AM	0	0	0	0	0	0	0	0
7:30 AM	0	0	0	0	0	0	0	0
7:45 AM	0	0	0	0	0	0	0	0
8:00 AM	0	0	0	0	0	0	0	0
8:15 AM	0	0	0	0	0	0	0	0
8:30 AM	0	0	0	0	0	0	0	0
8:45 AM	0	0	0	0	0	0	0	0
4:00 PM	0	0	0	0	0	0	0	0
4:15 PM	0	0	0	0	0	0	0	0
4:30 PM	0	0	0	0	0	0	0	0
4:45 PM	0	0	0	0	0	0	0	0
5:00 PM	0	0	0	0	0	0	0	0
5:15 PM	0	0	0	0	0	0	0	0
5:30 PM	0	0	0	0	0	0	0	0
5:45 PM	0	0	0	0	0	0	0	0

Study Name Regatta Blvd-Meade St/Regatta Blvd TMC
Start Date 01/31/2013
Start Time 7:00 AM
Site Code WC12-2953_#8

	Westbound Street Westbound			Northbound Street Northbound			Eastbound Street Eastbound						
Start Time	Thru	Left	U-Turn	Right	Left	U-Turn	Right	Thru	U-Turn	Hourly Total	15-min Total		
7:00 AM	0	9	0	17	7	0	17	1	0	289	51		
7:15 AM	1	6	0	23	7	0	22	4	0	336	63		
7:30 AM	0	7	0	32	14	0	13	7	0	346	73		
7:45 AM	2	4	0	39	16	0	27	14	0	337	102		
8:00 AM	0	6	0	44	17	0	28	3	0	321	98		
8:15 AM	0	7	0	30	12	0	18	6	0		73	10	40
8:30 AM	1	7	0	24	18	0	10	4	0		64	11	5
8:45 AM	4	5	0	26	17	0	28	6	0		86	94	5
4:00 PM	6	13	0	20	28	0	8	2	0	233	77	88	30
4:15 PM	4	13	0	10	11	0	11	2	0	220	51	10	23
4:30 PM	6	3	0	16	18	0	9	4	0	214	56	64	35
4:45 PM	1	6	0	10	14	0	13	5	0	199	49		
5:00 PM	4	8	0	18	25	0	7	2	0	177	64		
5:15 PM	6	10	0	8	8	0	9	4	0		45		
5:30 PM	5	10	0	7	11	0	8	0	0		41	0.249097473	
5:45 PM	3	8	0	4	2	0	6	4	0		27	0.282608696	

Totals

Study Name Carlson Blvd/Bayview Ave TMC
Start Date 01/31/2013
Start Time 7:00 AM
Site Code WC12-2953_#12

	Southbound Street Southbound				Westbound Street Westbound				Northbound Street Northbound				Eastbound Street Eastbound			
Start Time	Right	Thru	Left	U-Turn	Right	Thru	Left	U-Turn	Right	Thru	Left	U-Turn	Right	Thru	Left	U-Turn
7:00 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7:15 AM	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
7:30 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7:45 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
8:00 AM	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0
8:15 AM	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
8:30 AM	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8:45 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4:00 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
4:15 PM	0	0	0	0	0	0	0	0	1	2	0	0	0	0	0	0
4:30 PM	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
4:45 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5:00 PM	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0
5:15 PM	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
5:30 PM	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
5:45 PM	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0

Study Name Carlson Blvd/Bayview Ave TMC
Start Date 01/31/2013
Start Time 7:00 AM
Site Code WC12-2953_#12

	Southbound Street Southbound		Westbound Street Westbound		Northbound Street Northbound		Eastbound Street Eastbound	
Start Time	Peds CCW	Peds CW	Peds CCW	Peds CW	Peds CCW	Peds CW	Peds CCW	Peds CW
7:00 AM	0	0	0	0	0	0	0	0
7:15 AM	0	0	0	0	0	0	0	0
7:30 AM	0	0	0	0	0	0	0	0
7:45 AM	0	0	0	1	0	0	0	0
8:00 AM	0	1	0	0	0	0	0	0
8:15 AM	0	0	1	0	0	0	0	0
8:30 AM	0	0	0	0	0	0	0	0
8:45 AM	1	0	1	0	0	0	0	0
4:00 PM	5	1	1	0	0	0	0	0
4:15 PM	0	0	1	0	0	0	0	0
4:30 PM	3	3	0	0	0	0	0	0
4:45 PM	2	4	1	1	0	0	0	0
5:00 PM	1	0	3	1	0	0	0	0
5:15 PM	0	0	0	0	0	0	0	0
5:30 PM	1	1	1	1	0	0	0	0
5:45 PM	0	0	1	0	0	0	0	0

Study Name Carlson Blvd/Bayview Ave TMC
Start Date 01/31/2013
Start Time 7:00 AM
Site Code WC12-2953_#12

	Southbound Street Southbound				Westbound Street Westbound				Northbound Street Northbound				Eastbound Street Eastbound			
Start Time	Right	Thru	Left	U-Turn	Right	Thru	Left	U-Turn	Right	Thru	Left	U-Turn	Right	Thru	Left	U-Turn
7:00 AM	6	19	1	0	5	8	71	0	29	8	11	0	35	35	2	1
7:15 AM	2	24	6	0	3	6	88	1	59	14	7	0	60	44	4	0
7:30 AM	4	27	11	0	6	13	68	0	69	11	11	0	68	85	0	0
7:45 AM	2	22	10	0	8	17	70	3	116	21	12	0	43	105	2	0
8:00 AM	8	33	15	0	3	18	83	0	100	16	18	0	38	84	1	0
8:15 AM	5	33	16	0	1	24	78	1	58	19	14	0	50	67	4	0
8:30 AM	3	34	12	0	5	18	64	1	61	15	18	0	44	59	5	0
8:45 AM	1	25	7	0	6	24	60	0	53	12	18	0	23	51	2	0
4:00 PM	7	13	6	0	11	50	66	1	96	37	47	0	17	33	8	0
4:15 PM	7	9	11	0	10	40	52	1	97	27	49	0	19	42	6	0
4:30 PM	10	17	10	0	9	45	46	0	110	43	48	0	16	29	10	0
4:45 PM	15	23	17	0	3	21	16	3	99	42	64	0	22	37	4	0
5:00 PM	6	23	14	0	6	30	18	2	113	49	71	0	18	37	4	0
5:15 PM	9	22	6	0	11	34	31	1	118	36	66	0	24	26	4	0
5:30 PM	4	14	8	0	10	49	54	3	102	44	69	0	14	39	7	0
5:45 PM	8	12	8	0	7	49	60	1	81	36	60	0	11	24	3	1

Totals

Appendix B: Intersection LOS Calculation
Richmond Bay Campus

FEHR PEERS

Existing Conditions

FEHR PEERS

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	60	270	61	238	319	85	43	226	132	68	590	41
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	4.0	4.0	3.0	4.0	4.0	3.0	3.0	3.0	3.0	3.0	
Lane Util. Factor	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	
Frpb, ped/bikes	1.00	1.00	0.98	1.00	1.00	0.98	1.00	1.00	0.98	1.00	1.00	
Flpb, ped/bikes	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	0.99	
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	
Satd. Flow (prot)	1736	3471	1517	1736	3471	1514	1736	3471	1529	1736	3434	
Flt Permitted	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	
Satd. Flow (perm)	1736	3471	1517	1736	3471	1514	1736	3471	1529	1736	3434	
Peak-hour factor, PHF	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91
Adj. Flow (vph)	66	297	67	262	351	93	47	248	145	75	648	45
RTOR Reduction (vph)	0	0	30	0	0	42	0	0	108	0	4	0
Lane Group Flow (vph)	66	297	37	262	351	51	47	248	37	75	689	0
Confl. Peds. (#/hr)	14		13	13		14	4		4	4		4
Confl. Bikes (#/hr)						1						1
Heavy Vehicles (%)	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%
Turn Type	Prot		Perm	Prot		Perm	Prot		Perm	Prot		
Protected Phases	5	2		1	6		3	8		7	4	
Permitted Phases			2			6			8			
Actuated Green, G (s)	6.3	16.7	16.7	16.6	25.0	25.0	4.1	18.4	18.4	6.7	21.0	
Effective Green, g (s)	6.3	16.7	16.7	16.6	25.0	25.0	4.1	18.4	18.4	6.7	21.0	
Actuated g/C Ratio	0.09	0.23	0.23	0.23	0.35	0.35	0.06	0.26	0.26	0.09	0.29	
Clearance Time (s)	5.0	4.0	4.0	3.0	4.0	4.0	3.0	3.0	3.0	3.0	3.0	
Vehicle Extension (s)	2.0	4.0	4.0	2.0	4.0	4.0	2.0	2.0	2.0	2.0	2.0	
Lane Grp Cap (vph)	153	812	355	404	1215	530	100	894	394	163	1010	
v/s Ratio Prot	0.04	c0.09		c0.15	0.10		0.03	0.07		c0.04	c0.20	
v/s Ratio Perm			0.02			0.03			0.02			
v/c Ratio	0.43	0.37	0.10	0.65	0.29	0.10	0.47	0.28	0.09	0.46	0.68	
Uniform Delay, d1	30.9	22.9	21.5	24.8	16.8	15.6	32.6	21.2	20.2	30.6	22.3	
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	
Incremental Delay, d2	0.7	0.4	0.2	2.7	0.2	0.1	1.3	0.1	0.0	0.8	1.5	
Delay (s)	31.6	23.3	21.7	27.4	17.0	15.7	33.9	21.2	20.2	31.4	23.8	
Level of Service	C	C	C	C	B	B	C	C	C	C	C	
Approach Delay (s)		24.3			20.7			22.3			24.5	
Approach LOS		C			C			C			C	

Intersection Summary			
HCM Average Control Delay	22.9	HCM Level of Service	C
HCM Volume to Capacity ratio	0.57		
Actuated Cycle Length (s)	71.4	Sum of lost time (s)	13.0
Intersection Capacity Utilization	60.3%	ICU Level of Service	B
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	0	0	308	2	163	0	235	130	0	685	231
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)				4.0	4.0	4.0		4.0	4.0		4.0	
Lane Util. Factor				0.95	0.91	0.95		0.91	1.00		0.91	
Frpb, ped/bikes				1.00	1.00	0.99		1.00	0.98		0.99	
Flpb, ped/bikes				1.00	1.00	1.00		1.00	1.00		1.00	
Frt				1.00	0.99	0.85		1.00	0.85		0.96	
Flt Protected				0.95	0.96	1.00		1.00	1.00		1.00	
Satd. Flow (prot)				1665	1582	1471		5036	1535		4817	
Flt Permitted				0.95	0.96	1.00		1.00	1.00		1.00	
Satd. Flow (perm)				1665	1582	1471		5036	1535		4817	
Peak-hour factor, PHF	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94
Adj. Flow (vph)	0	0	0	328	2	173	0	250	138	0	729	246
RTOR Reduction (vph)	0	0	0	0	8	103	0	0	0	0	86	0
Lane Group Flow (vph)	0	0	0	174	165	53	0	250	138	0	889	0
Confl. Peds. (#/hr)	1					1	2		1	1		2
Confl. Bikes (#/hr)									2			1
Heavy Vehicles (%)	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%
Turn Type				Split		Perm			Free			
Protected Phases				8	8			2			6	
Permitted Phases						8			Free			
Actuated Green, G (s)				12.1	12.1	12.1		15.7	35.8		15.7	
Effective Green, g (s)				12.1	12.1	12.1		15.7	35.8		15.7	
Actuated g/C Ratio				0.34	0.34	0.34		0.44	1.00		0.44	
Clearance Time (s)				4.0	4.0	4.0		4.0			4.0	
Vehicle Extension (s)				3.0	3.0	3.0		3.0			3.0	
Lane Grp Cap (vph)				563	535	497		2209	1535		2112	
v/s Ratio Prot				c0.10	0.10			0.05			c0.18	
v/s Ratio Perm						0.04			0.09			
v/c Ratio				0.31	0.31	0.11		0.11	0.09		0.42	
Uniform Delay, d1				8.8	8.8	8.1		5.9	0.0		6.9	
Progression Factor				1.00	1.00	1.00		1.00	1.00		1.00	
Incremental Delay, d2				0.3	0.3	0.1		0.0	0.1		0.1	
Delay (s)				9.1	9.1	8.2		6.0	0.1		7.1	
Level of Service				A	A	A		A	A		A	
Approach Delay (s)		0.0			8.8			3.9			7.1	
Approach LOS		A			A			A			A	

Intersection Summary			
HCM Average Control Delay	6.9	HCM Level of Service	A
HCM Volume to Capacity ratio	0.37		
Actuated Cycle Length (s)	35.8	Sum of lost time (s)	8.0
Intersection Capacity Utilization	35.9%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	67	0	93	0	0	0	0	298	313	0	521	472
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0		4.0					4.0			4.0	4.0
Lane Util. Factor	1.00		1.00					0.91			0.95	1.00
Frpb, ped/bikes	1.00		1.00					0.99			1.00	0.98
Flpb, ped/bikes	1.00		1.00					1.00			1.00	1.00
Frt	1.00		0.85					0.92			1.00	0.85
Flt Protected	0.95		1.00					1.00			1.00	1.00
Satd. Flow (prot)	1752		1568					4593			3505	1536
Flt Permitted	0.95		1.00					1.00			1.00	1.00
Satd. Flow (perm)	1752		1568					4593			3505	1536
Peak-hour factor, PHF	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88
Adj. Flow (vph)	76	0	106	0	0	0	0	339	356	0	592	536
RTOR Reduction (vph)	0	0	84	0	0	0	0	179	0	0	0	0
Lane Group Flow (vph)	76	0	22	0	0	0	0	516	0	0	592	536
Confl. Peds. (#/hr)							1		3	3		1
Confl. Bikes (#/hr)									1			
Heavy Vehicles (%)	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%
Turn Type	Split		Perm									Free
Protected Phases	8	8						2			6	
Permitted Phases			8									Free
Actuated Green, G (s)	5.6		5.6					13.5			13.5	27.1
Effective Green, g (s)	5.6		5.6					13.5			13.5	27.1
Actuated g/C Ratio	0.21		0.21					0.50			0.50	1.00
Clearance Time (s)	4.0		4.0					4.0			4.0	
Vehicle Extension (s)	3.0		3.0					3.0			3.0	
Lane Grp Cap (vph)	362		324					2288			1746	1536
v/s Ratio Prot	0.04							0.11			0.17	
v/s Ratio Perm			0.01									c0.35
v/c Ratio	0.21		0.07					0.23			0.34	0.35
Uniform Delay, d1	8.9		8.6					3.8			4.1	0.0
Progression Factor	1.00		1.00					1.00			1.00	1.00
Incremental Delay, d2	0.3		0.1					0.1			0.1	0.6
Delay (s)	9.2		8.7					3.9			4.2	0.6
Level of Service	A		A					A			A	A
Approach Delay (s)		8.9			0.0			3.9			2.5	
Approach LOS		A			A			A			A	

Intersection Summary			
HCM Average Control Delay	3.6	HCM Level of Service	A
HCM Volume to Capacity ratio	0.35		
Actuated Cycle Length (s)	27.1	Sum of lost time (s)	0.0
Intersection Capacity Utilization	26.9%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	41	7	15	0	1	21	15	549	10	267	233	94
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0			4.0			4.0		4.0	4.0	
Lane Util. Factor		1.00			1.00			0.95		1.00	0.95	
Frpb, ped/bikes		1.00			0.99			1.00		1.00	0.99	
Flpb, ped/bikes		1.00			1.00			1.00		1.00	1.00	
Frt		0.97			0.85			1.00		1.00	0.96	
Flt Protected		0.97			1.00			1.00		0.95	1.00	
Satd. Flow (prot)		1711			1542			3457		1736	3299	
Flt Permitted		1.00			1.00			0.94		0.95	1.00	
Satd. Flow (perm)		1767			1542			3248		1736	3299	
Peak-hour factor, PHF	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72
Adj. Flow (vph)	57	10	21	0	1	29	21	762	14	371	324	131
RTOR Reduction (vph)	0	12	0	0	26	0	0	1	0	0	26	0
Lane Group Flow (vph)	0	76	0	0	4	0	0	796	0	371	429	0
Confl. Peds. (#/hr)	3					3	2					2
Confl. Bikes (#/hr)												1
Heavy Vehicles (%)	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%
Turn Type	Perm			Perm			Perm			Prot		
Protected Phases		3			4			2		1	6	
Permitted Phases	3			4			2					
Actuated Green, G (s)		2.2			6.8			22.1		12.0	38.1	
Effective Green, g (s)		2.2			6.8			22.1		12.0	38.1	
Actuated g/C Ratio		0.04			0.12			0.37		0.20	0.64	
Clearance Time (s)		4.0			4.0			4.0		4.0	4.0	
Vehicle Extension (s)		3.0			3.0			3.0		3.0	3.0	
Lane Grp Cap (vph)		66			177			1215		352	2127	
v/s Ratio Prot					c0.00					c0.21	0.13	
v/s Ratio Perm		c0.04						c0.25				
v/c Ratio		1.16			0.02			0.65		1.05	0.20	
Uniform Delay, d1		28.4			23.2			15.3		23.6	4.3	
Progression Factor		1.00			1.00			1.00		1.00	1.00	
Incremental Delay, d2		160.0			0.1			1.3		62.9	0.0	
Delay (s)		188.5			23.3			16.6		86.4	4.3	
Level of Service		F			C			B		F	A	
Approach Delay (s)		188.5			23.3			16.6			41.2	
Approach LOS		F			C			B			D	

Intersection Summary			
HCM Average Control Delay	37.1	HCM Level of Service	D
HCM Volume to Capacity ratio	0.69		
Actuated Cycle Length (s)	59.1	Sum of lost time (s)	16.0
Intersection Capacity Utilization	51.3%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	179	26	11	9	5	30	5	352	96	27	71	130
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0		4.0	4.0		4.0	4.0	
Lane Util. Factor	1.00	0.95	1.00	1.00	0.95		1.00	0.95		1.00	0.95	
Frpb, ped/bikes	1.00	1.00	1.00	1.00	0.99		1.00	1.00		1.00	0.99	
Flpb, ped/bikes	1.00	1.00	1.00	1.00	1.00		1.00	1.00		1.00	1.00	
Frt	1.00	1.00	0.85	1.00	0.87		1.00	0.97		1.00	0.90	
Flt Protected	0.95	1.00	1.00	0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1770	3539	1583	1770	3045		1767	3416		1770	3165	
Flt Permitted	0.95	1.00	1.00	0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (perm)	1770	3539	1583	1770	3045		1767	3416		1770	3165	
Peak-hour factor, PHF	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79
Adj. Flow (vph)	227	33	14	11	6	38	6	446	122	34	90	165
RTOR Reduction (vph)	0	0	11	0	34	0	0	27	0	0	100	0
Lane Group Flow (vph)	227	33	3	11	10	0	6	541	0	34	155	0
Confl. Peds. (#/hr)	3					3	4					4
Confl. Bikes (#/hr)									1			1
Turn Type	Prot		Perm	Prot			Prot			Prot		
Protected Phases	7	4		3	8		5	2		1	6	
Permitted Phases			4									
Actuated Green, G (s)	5.5	9.8	9.8	0.2	4.5		0.2	15.8		1.6	17.2	
Effective Green, g (s)	5.5	9.8	9.8	0.2	4.5		0.2	15.8		1.6	17.2	
Actuated g/C Ratio	0.13	0.23	0.23	0.00	0.10		0.00	0.36		0.04	0.40	
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0		4.0	4.0		4.0	4.0	
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	224	799	357	8	316		8	1244		65	1254	
v/s Ratio Prot	c0.13	c0.01		0.01	0.00		0.00	c0.16		c0.02	0.05	
v/s Ratio Perm			0.00									
v/c Ratio	1.01	0.04	0.01	1.38	0.03		0.75	0.44		0.52	0.12	
Uniform Delay, d1	18.9	13.1	13.0	21.6	17.5		21.6	10.4		20.5	8.3	
Progression Factor	1.00	1.00	1.00	1.00	1.00		1.00	1.00		1.00	1.00	
Incremental Delay, d2	63.6	0.0	0.0	466.9	0.0		166.2	0.2		7.4	0.0	
Delay (s)	82.6	13.2	13.0	488.5	17.5		187.8	10.7		27.9	8.4	
Level of Service	F	B	B	F	B		F	B		C	A	
Approach Delay (s)		70.7			111.7			12.5			10.7	
Approach LOS		E			F			B			B	

Intersection Summary			
HCM Average Control Delay	30.0	HCM Level of Service	C
HCM Volume to Capacity ratio	0.43		
Actuated Cycle Length (s)	43.4	Sum of lost time (s)	12.0
Intersection Capacity Utilization	42.7%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Volume (veh/h)	135	107	19	87	45	50
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90
Hourly flow rate (vph)	150	119	21	97	50	56
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)				1133		
pX, platoon unblocked						
vC, conflicting volume			269		289	150
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			269		289	150
tC, single (s)			4.2		6.5	6.3
tC, 2 stage (s)						
tF (s)			2.3		3.6	3.4
p0 queue free %			98		93	94
cM capacity (veh/h)			1250		673	876

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	NB 1	NB 2
Volume Total	150	119	21	97	50	56
Volume Left	0	0	21	0	50	0
Volume Right	0	119	0	0	0	56
cSH	1700	1700	1250	1700	673	876
Volume to Capacity	0.09	0.07	0.02	0.06	0.07	0.06
Queue Length 95th (ft)	0	0	1	0	6	5
Control Delay (s)	0.0	0.0	7.9	0.0	10.8	9.4
Lane LOS			A		B	A
Approach Delay (s)	0.0		1.4		10.0	
Approach LOS					B	

Intersection Summary			
Average Delay	2.5		
Intersection Capacity Utilization	23.8%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	45	36	13	7	41	50	3	11	15	65	21	99
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0		4.0	4.0			4.0	
Lane Util. Factor	1.00	1.00		1.00	1.00		1.00	1.00			1.00	
Frpb, ped/bikes	1.00	1.00		1.00	1.00		1.00	0.99			1.00	
Flpb, ped/bikes	1.00	1.00		1.00	1.00		1.00	1.00			1.00	
Frt	1.00	0.96		1.00	0.92		1.00	0.91			0.93	
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00			0.98	
Satd. Flow (prot)	1556	1573		1556	1503		1556	1471			1492	
Flt Permitted	0.95	1.00		0.95	1.00		0.74	1.00			0.88	
Satd. Flow (perm)	1556	1573		1556	1503		1206	1471			1330	
Peak-hour factor, PHF	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76
Adj. Flow (vph)	59	47	17	9	54	66	4	14	20	86	28	130
RTOR Reduction (vph)	0	13	0	0	55	0	0	14	0	0	64	0
Lane Group Flow (vph)	59	51	0	9	65	0	4	20	0	0	180	0
Confl. Peds. (#/hr)									2	2		
Confl. Bikes (#/hr)									2			
Heavy Vehicles (%)	16%	16%	16%	16%	16%	16%	16%	16%	16%	16%	16%	16%
Turn Type	Prot			Prot			Perm			Perm		
Protected Phases	7	4		3	8			2			6	
Permitted Phases							2			6		
Actuated Green, G (s)	1.9	5.7		0.8	4.6		8.5	8.5			8.5	
Effective Green, g (s)	1.9	5.7		0.8	4.6		8.5	8.5			8.5	
Actuated g/C Ratio	0.07	0.21		0.03	0.17		0.31	0.31			0.31	
Clearance Time (s)	4.0	4.0		4.0	4.0		4.0	4.0			4.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0			3.0	
Lane Grp Cap (vph)	109	332		46	256		380	463			419	
v/s Ratio Prot	c0.04	0.03		0.01	c0.04			0.01				
v/s Ratio Perm							0.00				c0.14	
v/c Ratio	0.54	0.15		0.20	0.25		0.01	0.04			0.43	
Uniform Delay, d1	12.1	8.7		12.8	9.7		6.4	6.4			7.3	
Progression Factor	1.00	1.00		1.00	1.00		1.00	1.00			1.00	
Incremental Delay, d2	5.4	0.2		2.1	0.5		0.0	0.0			0.7	
Delay (s)	17.5	8.9		14.9	10.2		6.4	6.5			8.0	
Level of Service	B	A		B	B		A	A			A	
Approach Delay (s)		13.0			10.6			6.5			8.0	
Approach LOS		B			B			A			A	

Intersection Summary			
HCM Average Control Delay	9.7	HCM Level of Service	A
HCM Volume to Capacity ratio	0.39		
Actuated Cycle Length (s)	27.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	33.3%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Volume (veh/h)	30	86	24	20	78	126
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.85	0.85	0.85	0.85	0.85	0.85
Hourly flow rate (vph)	35	101	28	24	92	148
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)	322					
pX, platoon unblocked						
vC, conflicting volume			35		166	86
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			35		166	86
tC, single (s)			4.2		6.5	6.3
tC, 2 stage (s)						
tF (s)			2.3		3.6	3.4
p0 queue free %			98		88	84
cM capacity (veh/h)			1514		787	946

Direction, Lane #	EB 1	WB 1	WB 2	NB 1
Volume Total	136	28	24	240
Volume Left	0	28	0	92
Volume Right	101	0	0	148
cSH	1700	1514	1700	878
Volume to Capacity	0.08	0.02	0.01	0.27
Queue Length 95th (ft)	0	1	0	28
Control Delay (s)	0.0	7.4	0.0	10.6
Lane LOS		A		B
Approach Delay (s)	0.0	4.0		10.6
Approach LOS				B

Intersection Summary			
Average Delay	6.4		
Intersection Capacity Utilization	26.7%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Volume (veh/h)	148	10	34	42	2	4
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.85	0.85	0.85	0.85	0.85	0.85
Hourly flow rate (vph)	174	12	40	49	2	5
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume			186		309	180
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			186		309	180
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			97		100	99
cM capacity (veh/h)			1371		657	855

Direction, Lane #	EB 1	WB 1	WB 2	NB 1
Volume Total	186	40	49	7
Volume Left	0	40	0	2
Volume Right	12	0	0	5
cSH	1700	1371	1700	777
Volume to Capacity	0.11	0.03	0.03	0.01
Queue Length 95th (ft)	0	2	0	1
Control Delay (s)	0.0	7.7	0.0	9.7
Lane LOS		A		A
Approach Delay (s)	0.0	3.4		9.7
Approach LOS				A

Intersection Summary			
Average Delay	1.3		
Intersection Capacity Utilization	25.1%	ICU Level of Service	A
Analysis Period (min)	15		

Intersection	
Intersection Delay (sec/veh)	27.6
Intersection LOS	D

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Volume (vph)	5	6	7	412	7	15	26	100	146	94	122	3
Peak Hour Factor	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88
Heavy Vehicles(%)	4	4	4	4	4	4	4	4	4	4	4	4
Movement Flow Rate	6	7	8	468	8	17	30	114	166	107	139	3
Number of Lanes	0	1	0	1	1	0	1	2	0	1	2	0

Approach	EB	WB	NB	SB
Opposing Approach	WB	EB	SB	NB
Opposing Lanes	2	1	3	3
Conflicting Approach Left	SB	NB	EB	WB
Conflicting Lanes Left	3	3	1	2
Conflicting Approach Right	NB	SB	WB	EB
Conflicting Lanes Right	3	3	2	1
HCM Control Delay	11	45.1	13	12.4
HCM LOS	B	E	B	B

Lane	NBLn1	NBLn2	NBLn3	EBLn1	WBLn1	WBLn2	SBLn1	SBLn2	SBLn3
Volume Left (%)	100%	0%	0%	28%	100%	0%	100%	0%	0%
Volume Thru (%)	0%	100%	19%	33%	0%	32%	0%	100%	93%
Volume Right (%)	0%	0%	81%	39%	0%	68%	0%	0%	7%
Sign Control	Stop	Stop	Stop	Stop	Stop	Stop	Stop	Stop	Stop
Traffic Volume by Lane	26	67	179	18	412	22	94	81	44
Left Turning Volume	0	67	33	6	0	7	0	81	41
Through Volume	0	0	146	7	0	15	0	0	3
Right Turning Volume	26	0	0	5	412	0	94	0	0
Lane Flow Rate	30	76	204	20	468	25	107	92	50
Geometry Group	8	8	8	8	8	8	8	8	8
Degree of Utilization, X	0.065	0.156	0.388	0.045	0.909	0.042	0.239	0.194	0.103
Departure Headway, Hd	7.948	7.434	6.848	7.873	7.097	6.119	8.056	7.542	7.492
Convergence(Y/N)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Capacity	453	485	528	456	515	589	448	478	480
Service Time	5.661	5.147	4.561	5.602	4.797	3.819	5.772	5.257	5.207
HCM Lane V/C Ratio	0.066	0.157	0.386	0.044	0.909	0.042	0.239	0.192	0.104
HCM Control Delay	11.2	11.5	13.8	11	47	9.1	13.3	12.1	11.1
HCM Lane LOS	B	B	B	B	E	A	B	B	B
HCM 95th Percentile Queue	0.2	0.6	1.9	0.1	27.7	0.1	0.9	0.7	0.3

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	0	0	63	0	63	10	531	0	0	209	373
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)				4.0	4.0		4.0	4.0			4.0	
Lane Util. Factor				1.00	1.00		1.00	0.95			0.95	
Frpb, ped/bikes				1.00	1.00		1.00	1.00			0.99	
Flpb, ped/bikes				1.00	1.00		1.00	1.00			1.00	
Frt				1.00	0.85		1.00	1.00			0.90	
Flt Protected				0.95	1.00		0.95	1.00			1.00	
Satd. Flow (prot)				1736	1553		1736	3471			3093	
Flt Permitted				0.95	1.00		0.95	1.00			1.00	
Satd. Flow (perm)				1736	1553		1736	3471			3093	
Peak-hour factor, PHF	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88
Adj. Flow (vph)	0	0	0	72	0	72	11	603	0	0	238	424
RTOR Reduction (vph)	0	0	0	0	68	0	0	0	0	0	241	0
Lane Group Flow (vph)	0	0	0	72	4	0	11	603	0	0	421	0
Confl. Peds. (#/hr)							1					1
Confl. Bikes (#/hr)									2			1
Heavy Vehicles (%)	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%
Turn Type				Split			Prot					
Protected Phases				8	8		5	2			6	
Permitted Phases												
Actuated Green, G (s)				1.7	1.7		1.8	17.6			11.8	
Effective Green, g (s)				1.7	1.7		1.8	17.6			11.8	
Actuated g/C Ratio				0.06	0.06		0.07	0.64			0.43	
Clearance Time (s)				4.0	4.0		4.0	4.0			4.0	
Vehicle Extension (s)				3.0	3.0		3.0	3.0			3.0	
Lane Grp Cap (vph)				108	97		114	2238			1337	
v/s Ratio Prot				c0.04	0.00		0.01	c0.17			0.14	
v/s Ratio Perm												
v/c Ratio				0.67	0.05		0.10	0.27			0.32	
Uniform Delay, d1				12.5	12.0		12.0	2.1			5.1	
Progression Factor				1.00	1.00		1.00	1.00			1.00	
Incremental Delay, d2				14.5	0.2		0.4	0.1			0.1	
Delay (s)				27.0	12.2		12.4	2.2			5.2	
Level of Service				C	B		B	A			A	
Approach Delay (s)		0.0			19.6			2.3			5.2	
Approach LOS		A			B			A			A	

Intersection Summary			
HCM Average Control Delay	5.4	HCM Level of Service	A
HCM Volume to Capacity ratio	0.30		
Actuated Cycle Length (s)	27.3	Sum of lost time (s)	8.0
Intersection Capacity Utilization	28.4%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	8	363	157	296	78	18	55	64	475	45	129	15
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0		4.0	4.0	4.0		4.0	
Lane Util. Factor	1.00	0.95		0.91	0.91		0.95	0.95	1.00		1.00	
Frpb, ped/bikes	1.00	1.00		1.00	1.00		1.00	1.00	0.99		1.00	
Flpb, ped/bikes	1.00	1.00		1.00	1.00		1.00	1.00	1.00		1.00	
Frt	1.00	0.95		1.00	0.99		1.00	1.00	0.85		0.99	
Flt Protected	0.95	1.00		0.95	0.97		0.95	1.00	1.00		0.99	
Satd. Flow (prot)	1752	3333		1595	3217		1665	1746	1547		1801	
Flt Permitted	0.95	1.00		0.95	0.97		0.95	1.00	1.00		0.99	
Satd. Flow (perm)	1752	3333		1595	3217		1665	1746	1547		1801	
Peak-hour factor, PHF	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Adj. Flow (vph)	9	403	174	329	87	20	61	71	528	50	143	17
RTOR Reduction (vph)	0	48	0	0	6	0	0	0	436	0	3	0
Lane Group Flow (vph)	9	529	0	164	266	0	55	77	92	0	207	0
Confl. Peds. (#/hr)	1					1			2	2		
Confl. Bikes (#/hr)			1			1						1
Heavy Vehicles (%)	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%
Turn Type	Split			Split			Split		Perm	Split		
Protected Phases	4	4		8	8		2	2		6	6	
Permitted Phases									2			
Actuated Green, G (s)	16.0	16.0		12.7	12.7		12.1	12.1	12.1		13.0	
Effective Green, g (s)	16.0	16.0		12.7	12.7		12.1	12.1	12.1		13.0	
Actuated g/C Ratio	0.23	0.23		0.18	0.18		0.17	0.17	0.17		0.19	
Clearance Time (s)	4.0	4.0		4.0	4.0		4.0	4.0	4.0		4.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0	3.0		3.0	
Lane Grp Cap (vph)	402	764		290	585		289	303	268		335	
v/s Ratio Prot	0.01	c0.16		c0.10	0.08		0.03	0.04			c0.11	
v/s Ratio Perm									c0.06			
v/c Ratio	0.02	0.69		0.57	0.46		0.19	0.25	0.34		0.62	
Uniform Delay, d1	20.8	24.6		26.0	25.5		24.7	24.9	25.3		26.1	
Progression Factor	1.00	1.00		1.00	1.00		1.00	1.00	1.00		1.00	
Incremental Delay, d2	0.0	2.7		2.5	0.6		0.3	0.4	0.8		3.4	
Delay (s)	20.9	27.4		28.6	26.0		25.0	25.4	26.1		29.5	
Level of Service	C	C		C	C		C	C	C		C	
Approach Delay (s)		27.3			27.0			25.9			29.5	
Approach LOS		C			C			C			C	

Intersection Summary			
HCM Average Control Delay	27.0	HCM Level of Service	C
HCM Volume to Capacity ratio	0.57		
Actuated Cycle Length (s)	69.8	Sum of lost time (s)	16.0
Intersection Capacity Utilization	64.9%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	826	122	78	316	0	0	0	0	388	23	181
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0			4.0						4.0	
Lane Util. Factor		0.95			0.95						1.00	
Frpb, ped/bikes		1.00			1.00						1.00	
Flpb, ped/bikes		1.00			1.00						1.00	
Frt		0.98			1.00						0.96	
Flt Protected		1.00			0.99						0.97	
Satd. Flow (prot)		3456			3503						1729	
Flt Permitted		1.00			0.62						0.97	
Satd. Flow (perm)		3456			2198						1729	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	0	898	133	85	343	0	0	0	0	422	25	197
RTOR Reduction (vph)	0	27	0	0	0	0	0	0	0	0	15	0
Lane Group Flow (vph)	0	1004	0	0	428	0	0	0	0	0	629	0
Confl. Peds. (#/hr)	5		9	9		5						
Confl. Bikes (#/hr)						2						
Turn Type				Perm						Split		
Protected Phases		4			8					6	6	
Permitted Phases				8								
Actuated Green, G (s)		33.2			33.2						33.8	
Effective Green, g (s)		33.2			33.2						33.8	
Actuated g/C Ratio		0.44			0.44						0.45	
Clearance Time (s)		4.0			4.0						4.0	
Vehicle Extension (s)		3.0			3.0						3.0	
Lane Grp Cap (vph)		1530			973						779	
v/s Ratio Prot		c0.29									c0.36	
v/s Ratio Perm					0.19							
v/c Ratio		0.66			0.44						0.81	
Uniform Delay, d1		16.4			14.5						17.8	
Progression Factor		1.00			0.87						1.00	
Incremental Delay, d2		1.0			0.3						8.8	
Delay (s)		17.4			12.9						26.6	
Level of Service		B			B						C	
Approach Delay (s)		17.4			12.9			0.0			26.6	
Approach LOS		B			B			A			C	

Intersection Summary			
HCM Average Control Delay	19.3	HCM Level of Service	B
HCM Volume to Capacity ratio	0.73		
Actuated Cycle Length (s)	75.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	83.1%	ICU Level of Service	E
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	210	1004	0	0	371	381	23	2	54	0	0	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0			4.0		4.0	4.0	4.0			
Lane Util. Factor		0.95			0.95		0.95	0.95	1.00			
Frpb, ped/bikes		1.00			0.99		1.00	1.00	1.00			
Flpb, ped/bikes		1.00			1.00		1.00	1.00	1.00			
Frt		1.00			0.92		1.00	1.00	0.85			
Flt Protected		0.99			1.00		0.95	0.96	1.00			
Satd. Flow (prot)		3508			3229		1681	1697	1583			
Flt Permitted		0.64			1.00		0.95	0.96	1.00			
Satd. Flow (perm)		2255			3229		1681	1697	1583			
Peak-hour factor, PHF	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89
Adj. Flow (vph)	236	1128	0	0	417	428	26	2	61	0	0	0
RTOR Reduction (vph)	0	0	0	0	134	0	0	0	48	0	0	0
Lane Group Flow (vph)	0	1364	0	0	711	0	14	14	13	0	0	0
Confl. Peds. (#/hr)	5		7	7		5			1	1		
Confl. Bikes (#/hr)						3						
Turn Type	Perm						Split		Prot			
Protected Phases		4			8		2	2	2			
Permitted Phases	4											
Actuated Green, G (s)		51.5			51.5		15.5	15.5	15.5			
Effective Green, g (s)		51.5			51.5		15.5	15.5	15.5			
Actuated g/C Ratio		0.69			0.69		0.21	0.21	0.21			
Clearance Time (s)		4.0			4.0		4.0	4.0	4.0			
Vehicle Extension (s)		3.0			3.0		3.0	3.0	3.0			
Lane Grp Cap (vph)		1548			2217		347	351	327			
v/s Ratio Prot					0.22		c0.01	0.01	0.01			
v/s Ratio Perm		c0.60										
v/c Ratio		0.88			0.32		0.04	0.04	0.04			
Uniform Delay, d1		9.3			4.7		23.8	23.8	23.8			
Progression Factor		0.86			1.00		1.00	1.00	1.00			
Incremental Delay, d2		5.4			0.1		0.2	0.2	0.2			
Delay (s)		13.4			4.8		24.0	24.0	24.0			
Level of Service		B			A		C	C	C			
Approach Delay (s)		13.4			4.8			24.0			0.0	
Approach LOS		B			A			C			A	

Intersection Summary			
HCM Average Control Delay	10.7	HCM Level of Service	B
HCM Volume to Capacity ratio	0.69		
Actuated Cycle Length (s)	75.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	83.1%	ICU Level of Service	E
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	81	333	53	150	338	105	96	711	165	60	256	41
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	4.0	4.0	3.0	4.0	4.0	3.0	3.0	3.0	3.0	3.0	
Lane Util. Factor	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	
Frpb, ped/bikes	1.00	1.00	0.97	1.00	1.00	0.98	1.00	1.00	0.98	1.00	1.00	
Flpb, ped/bikes	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	0.98	
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	
Satd. Flow (prot)	1770	3539	1538	1770	3539	1556	1770	3539	1544	1770	3458	
Flt Permitted	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	
Satd. Flow (perm)	1770	3539	1538	1770	3539	1556	1770	3539	1544	1770	3458	
Peak-hour factor, PHF	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Adj. Flow (vph)	90	370	59	167	376	117	107	790	183	67	284	46
RTOR Reduction (vph)	0	0	20	0	0	54	0	0	59	0	10	0
Lane Group Flow (vph)	90	370	39	167	376	63	107	790	124	67	320	0
Confl. Peds. (#/hr)	5		19	19		5	4		14	14		4
Confl. Bikes (#/hr)						1			1			
Turn Type	Prot		Perm	Prot		Perm	Prot		Perm	Prot		
Protected Phases	5	2		1	6		3	8		7	4	
Permitted Phases			2			6			8			
Actuated Green, G (s)	7.0	17.6	17.6	12.1	20.7	20.7	7.6	23.6	23.6	6.1	22.1	
Effective Green, g (s)	7.0	17.6	17.6	12.1	20.7	20.7	7.6	23.6	23.6	6.1	22.1	
Actuated g/C Ratio	0.10	0.24	0.24	0.17	0.29	0.29	0.10	0.33	0.33	0.08	0.31	
Clearance Time (s)	5.0	4.0	4.0	3.0	4.0	4.0	3.0	3.0	3.0	3.0	3.0	
Vehicle Extension (s)	2.0	4.0	4.0	2.0	4.0	4.0	2.0	2.0	2.0	2.0	2.0	
Lane Grp Cap (vph)	171	860	374	296	1012	445	186	1154	503	149	1056	
v/s Ratio Prot	0.05	c0.10		c0.09	0.11		c0.06	c0.22		0.04	0.09	
v/s Ratio Perm			0.03			0.04			0.08			
v/c Ratio	0.53	0.43	0.10	0.56	0.37	0.14	0.58	0.68	0.25	0.45	0.30	
Uniform Delay, d1	31.1	23.2	21.3	27.7	20.7	19.2	30.9	21.2	17.9	31.6	19.3	
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	
Incremental Delay, d2	1.3	0.5	0.2	1.5	0.3	0.2	2.7	1.4	0.1	0.8	0.1	
Delay (s)	32.5	23.6	21.4	29.2	21.0	19.4	33.5	22.5	18.0	32.3	19.3	
Level of Service	C	C	C	C	C	B	C	C	B	C	B	
Approach Delay (s)		24.9			22.8			22.8			21.5	
Approach LOS		C			C			C			C	

Intersection Summary			
HCM Average Control Delay	23.0	HCM Level of Service	C
HCM Volume to Capacity ratio	0.55		
Actuated Cycle Length (s)	72.4	Sum of lost time (s)	10.0
Intersection Capacity Utilization	59.3%	ICU Level of Service	B
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	0	0	307	2	613	0	406	108	0	359	113
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)				4.0	4.0	4.0		4.0	4.0		4.0	
Lane Util. Factor				0.95	0.91	0.95		0.91	1.00		0.91	
Frt				1.00	0.87	0.85		1.00	0.85		0.96	
Flt Protected				0.95	1.00	1.00		1.00	1.00		1.00	
Satd. Flow (prot)				1698	1474	1519		5136	1599		4951	
Flt Permitted				0.95	1.00	1.00		1.00	1.00		1.00	
Satd. Flow (perm)				1698	1474	1519		5136	1599		4951	
Peak-hour factor, PHF	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94
Adj. Flow (vph)	0	0	0	327	2	652	0	432	115	0	382	120
RTOR Reduction (vph)	0	0	0	0	138	138	0	0	0	0	85	0
Lane Group Flow (vph)	0	0	0	294	210	201	0	432	115	0	417	0
Heavy Vehicles (%)	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%
Turn Type				Split		Perm			Free			
Protected Phases				8	8			2			6	
Permitted Phases						8			Free			
Actuated Green, G (s)				14.4	14.4	14.4		9.2	31.6		9.2	
Effective Green, g (s)				14.4	14.4	14.4		9.2	31.6		9.2	
Actuated g/C Ratio				0.46	0.46	0.46		0.29	1.00		0.29	
Clearance Time (s)				4.0	4.0	4.0		4.0			4.0	
Vehicle Extension (s)				3.0	3.0	3.0		3.0			3.0	
Lane Grp Cap (vph)				774	672	692		1495	1599		1441	
v/s Ratio Prot				c0.17	0.14			0.08			c0.08	
v/s Ratio Perm						0.13			0.07			
v/c Ratio				0.38	0.31	0.29		0.29	0.07		0.29	
Uniform Delay, d1				5.7	5.5	5.4		8.7	0.0		8.7	
Progression Factor				1.00	1.00	1.00		1.00	1.00		1.00	
Incremental Delay, d2				0.3	0.3	0.2		0.1	0.1		0.1	
Delay (s)				6.0	5.7	5.6		8.8	0.1		8.8	
Level of Service				A	A	A		A	A		A	
Approach Delay (s)		0.0			5.8			6.9			8.8	
Approach LOS		A			A			A			A	

Intersection Summary			
HCM Average Control Delay	6.8	HCM Level of Service	A
HCM Volume to Capacity ratio	0.34		
Actuated Cycle Length (s)	31.6	Sum of lost time (s)	8.0
Intersection Capacity Utilization	39.8%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	213	0	131	0	0	0	0	301	364	0	446	220
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0		4.0					4.0			4.0	4.0
Lane Util. Factor	1.00		1.00					0.91			0.95	1.00
Frpb, ped/bikes	1.00		1.00					0.99			1.00	0.98
Flpb, ped/bikes	1.00		1.00					1.00			1.00	1.00
Frt	1.00		0.85					0.92			1.00	0.85
Flt Protected	0.95		1.00					1.00			1.00	1.00
Satd. Flow (prot)	1770		1583					4602			3539	1549
Flt Permitted	0.95		1.00					1.00			1.00	1.00
Satd. Flow (perm)	1770		1583					4602			3539	1549
Peak-hour factor, PHF	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86
Adj. Flow (vph)	248	0	152	0	0	0	0	350	423	0	519	256
RTOR Reduction (vph)	0	0	94	0	0	0	0	269	0	0	0	0
Lane Group Flow (vph)	248	0	58	0	0	0	0	504	0	0	519	256
Confl. Peds. (#/hr)							4		2	2		4
Confl. Bikes (#/hr)									3			
Turn Type	Split		Perm									Free
Protected Phases	8	8						2			6	
Permitted Phases			8									Free
Actuated Green, G (s)	11.9		11.9					11.4			11.4	31.3
Effective Green, g (s)	11.9		11.9					11.4			11.4	31.3
Actuated g/C Ratio	0.38		0.38					0.36			0.36	1.00
Clearance Time (s)	4.0		4.0					4.0			4.0	
Vehicle Extension (s)	3.0		3.0					3.0			3.0	
Lane Grp Cap (vph)	673		602					1676			1289	1549
v/s Ratio Prot	c0.14							0.11			c0.15	
v/s Ratio Perm			0.04									0.17
v/c Ratio	0.37		0.10					0.30			0.40	0.17
Uniform Delay, d1	7.0		6.2					7.1			7.4	0.0
Progression Factor	1.00		1.00					1.00			1.00	1.00
Incremental Delay, d2	0.3		0.1					0.1			0.2	0.2
Delay (s)	7.3		6.3					7.2			7.6	0.2
Level of Service	A		A					A			A	A
Approach Delay (s)		6.9			0.0			7.2			5.2	
Approach LOS		A			A			A			A	

Intersection Summary			
HCM Average Control Delay	6.3	HCM Level of Service	A
HCM Volume to Capacity ratio	0.39		
Actuated Cycle Length (s)	31.3	Sum of lost time (s)	8.0
Intersection Capacity Utilization	32.6%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	146	1	59	9	8	216	21	303	0	11	475	91
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0		4.0	4.0			4.0		4.0	4.0	
Lane Util. Factor		1.00		1.00	1.00			0.95		1.00	0.95	
Frpb, ped/bikes		0.99		1.00	0.99			1.00		1.00	1.00	
Flpb, ped/bikes		1.00		1.00	1.00			1.00		0.94	1.00	
Frt		0.96		1.00	0.86			1.00		1.00	0.98	
Flt Protected		0.97		0.95	1.00			1.00		0.95	1.00	
Satd. Flow (prot)		1699		1751	1557			3493		1643	3409	
Flt Permitted		1.00		0.61	1.00			0.90		0.95	1.00	
Satd. Flow (perm)		1759		1122	1557			3141		1643	3409	
Peak-hour factor, PHF	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85
Adj. Flow (vph)	172	1	69	11	9	254	25	356	0	13	559	107
RTOR Reduction (vph)	0	14	0	0	191	0	0	0	0	0	15	0
Lane Group Flow (vph)	0	228	0	11	72	0	0	381	0	13	651	0
Confl. Peds. (#/hr)	1		3	3		1			5	5		
Confl. Bikes (#/hr)						1			2			1
Heavy Vehicles (%)	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%
Turn Type	Perm			Perm			Perm			Prot		
Protected Phases		3			4			2		1	6	
Permitted Phases	3			4			2					
Actuated Green, G (s)		2.4		11.1	11.1			14.6		0.7	19.3	
Effective Green, g (s)		2.4		11.1	11.1			14.6		0.7	19.3	
Actuated g/C Ratio		0.05		0.25	0.25			0.33		0.02	0.43	
Clearance Time (s)		4.0		4.0	4.0			4.0		4.0	4.0	
Vehicle Extension (s)		3.0		3.0	3.0			3.0		3.0	3.0	
Lane Grp Cap (vph)		94		278	386			1024		26	1469	
v/s Ratio Prot					c0.05					0.01	c0.19	
v/s Ratio Perm		c0.13		0.01				0.12				
v/c Ratio		2.42		0.04	0.19			0.37		0.50	0.44	
Uniform Delay, d1		21.2		12.8	13.3			11.6		21.9	9.0	
Progression Factor		1.00		1.00	1.00			1.00		1.00	1.00	
Incremental Delay, d2		671.6		0.1	0.2			0.2		14.3	0.2	
Delay (s)		692.8		12.9	13.5			11.8		36.2	9.2	
Level of Service		F		B	B			B		D	A	
Approach Delay (s)		692.8			13.5			11.8			9.7	
Approach LOS		F			B			B			A	

Intersection Summary			
HCM Average Control Delay	115.8	HCM Level of Service	F
HCM Volume to Capacity ratio	0.50		
Actuated Cycle Length (s)	44.8	Sum of lost time (s)	12.0
Intersection Capacity Utilization	60.9%	ICU Level of Service	B
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	156	7	13	26	8	22	14	141	15	6	317	165
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0		4.0	4.0		4.0	4.0	
Lane Util. Factor	1.00	0.95	1.00	1.00	0.95		1.00	0.95		1.00	0.95	
Frpb, ped/bikes	1.00	1.00	1.00	1.00	0.99		1.00	1.00		1.00	0.99	
Flpb, ped/bikes	1.00	1.00	1.00	1.00	1.00		1.00	1.00		0.99	1.00	
Frt	1.00	1.00	0.85	1.00	0.89		1.00	0.99		1.00	0.95	
Flt Protected	0.95	1.00	1.00	0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1770	3539	1583	1770	3100		1764	3483		1756	3336	
Flt Permitted	0.95	1.00	1.00	0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (perm)	1770	3539	1583	1770	3100		1764	3483		1756	3336	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	164	7	14	27	8	23	15	148	16	6	334	174
RTOR Reduction (vph)	0	0	11	0	23	0	0	9	0	0	77	0
Lane Group Flow (vph)	164	7	3	27	8	0	15	155	0	6	431	0
Confl. Peds. (#/hr)							16		1	1		16
Confl. Bikes (#/hr)						1			1			
Turn Type	Prot		Perm	Prot			Prot			Prot		
Protected Phases	7	4		3	8		5	2		1	6	
Permitted Phases			4									
Actuated Green, G (s)	5.9	6.4	6.4	0.2	0.7		0.2	10.9		0.2	10.9	
Effective Green, g (s)	5.9	6.4	6.4	0.2	0.7		0.2	10.9		0.2	10.9	
Actuated g/C Ratio	0.18	0.19	0.19	0.01	0.02		0.01	0.32		0.01	0.32	
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0		4.0	4.0		4.0	4.0	
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	310	672	301	11	64		10	1127		10	1079	
v/s Ratio Prot	c0.09	0.00		0.02	c0.00		c0.01	0.04		0.00	c0.13	
v/s Ratio Perm			0.00									
v/c Ratio	0.53	0.01	0.01	2.45	0.13		1.50	0.14		0.60	0.40	
Uniform Delay, d1	12.6	11.1	11.1	16.8	16.2		16.8	8.1		16.7	8.9	
Progression Factor	1.00	1.00	1.00	1.00	1.00		1.00	1.00		1.00	1.00	
Incremental Delay, d2	1.6	0.0	0.0	863.8	0.9		478.8	0.1		70.6	0.2	
Delay (s)	14.3	11.1	11.1	880.5	17.1		495.5	8.1		87.3	9.1	
Level of Service	B	B	B	F	B		F	A		F	A	
Approach Delay (s)		13.9			419.1			49.0			10.0	
Approach LOS		B			F			D			B	

Intersection Summary			
HCM Average Control Delay	43.6	HCM Level of Service	D
HCM Volume to Capacity ratio	0.44		
Actuated Cycle Length (s)	33.7	Sum of lost time (s)	16.0
Intersection Capacity Utilization	38.8%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Volume (veh/h)	68	40	16	143	131	32
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.91	0.91	0.91	0.91	0.91	0.91
Hourly flow rate (vph)	75	44	18	157	144	35
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)				1133		
pX, platoon unblocked						
vC, conflicting volume			119		267	75
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			119		267	75
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			99		80	96
cM capacity (veh/h)			1457		709	981

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	NB 1	NB 2
Volume Total	75	44	18	157	144	35
Volume Left	0	0	18	0	144	0
Volume Right	0	44	0	0	0	35
cSH	1700	1700	1457	1700	709	981
Volume to Capacity	0.04	0.03	0.01	0.09	0.20	0.04
Queue Length 95th (ft)	0	0	1	0	19	3
Control Delay (s)	0.0	0.0	7.5	0.0	11.4	8.8
Lane LOS			A		B	A
Approach Delay (s)	0.0		0.8		10.9	
Approach LOS					B	

Intersection Summary			
Average Delay	4.4		
Intersection Capacity Utilization	21.5%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	106	8	1	1	27	42	8	11	2	48	8	44
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0		4.0	4.0			4.0	
Lane Util. Factor	1.00	1.00		1.00	1.00		1.00	1.00			1.00	
Frt	1.00	0.98		1.00	0.91		1.00	0.98			0.94	
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00			0.98	
Satd. Flow (prot)	1626	1686		1626	1556		1626	1675			1572	
Flt Permitted	0.95	1.00		0.95	1.00		0.98	1.00			0.84	
Satd. Flow (perm)	1626	1686		1626	1556		1670	1675			1352	
Peak-hour factor, PHF	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88
Adj. Flow (vph)	120	9	1	1	31	48	9	12	2	55	9	50
RTOR Reduction (vph)	0	1	0	0	42	0	0	2	0	0	41	0
Lane Group Flow (vph)	120	9	0	1	37	0	9	12	0	0	73	0
Heavy Vehicles (%)	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%
Turn Type	Prot			Prot			Perm			Perm		
Protected Phases	7	4		3	8			2			6	
Permitted Phases							2			6		
Actuated Green, G (s)	3.6	5.6		0.8	2.8		4.1	4.1			4.1	
Effective Green, g (s)	3.6	5.6		0.8	2.8		4.1	4.1			4.1	
Actuated g/C Ratio	0.16	0.25		0.04	0.12		0.18	0.18			0.18	
Clearance Time (s)	4.0	4.0		4.0	4.0		4.0	4.0			4.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0			3.0	
Lane Grp Cap (vph)	260	420		58	194		304	305			246	
v/s Ratio Prot	c0.07	c0.01		0.00	c0.02			0.01				
v/s Ratio Perm							0.01				c0.05	
v/c Ratio	0.46	0.02		0.02	0.19		0.03	0.04			0.30	
Uniform Delay, d1	8.6	6.4		10.5	8.8		7.6	7.6			8.0	
Progression Factor	1.00	1.00		1.00	1.00		1.00	1.00			1.00	
Incremental Delay, d2	1.3	0.0		0.1	0.5		0.0	0.1			0.7	
Delay (s)	9.9	6.4		10.6	9.3		7.6	7.6			8.6	
Level of Service	A	A		B	A		A	A			A	
Approach Delay (s)		9.6			9.3			7.6			8.6	
Approach LOS		A			A			A			A	

Intersection Summary			
HCM Average Control Delay	9.1	HCM Level of Service	A
HCM Volume to Capacity ratio	0.43		
Actuated Cycle Length (s)	22.5	Sum of lost time (s)	16.0
Intersection Capacity Utilization	31.6%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Volume (veh/h)	19	39	36	21	49	37
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.69	0.69	0.69	0.69	0.69	0.69
Hourly flow rate (vph)	28	57	52	30	71	54
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)	322					
pX, platoon unblocked						
vC, conflicting volume			28		191	56
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			28		191	56
tC, single (s)			4.2		6.5	6.3
tC, 2 stage (s)						
tF (s)			2.3		3.6	3.4
p0 queue free %			97		91	95
cM capacity (veh/h)			1530		752	986

Direction, Lane #	EB 1	WB 1	WB 2	NB 1
Volume Total	84	52	30	125
Volume Left	0	52	0	71
Volume Right	57	0	0	54
cSH	1700	1530	1700	837
Volume to Capacity	0.05	0.03	0.02	0.15
Queue Length 95th (ft)	0	3	0	13
Control Delay (s)	0.0	7.4	0.0	10.0
Lane LOS		A		B
Approach Delay (s)	0.0	4.7		10.0
Approach LOS				B

Intersection Summary			
Average Delay	5.6		
Intersection Capacity Utilization	20.3%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Volume (veh/h)	54	2	4	46	11	36
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.78	0.78	0.78	0.78	0.78	0.78
Hourly flow rate (vph)	69	3	5	59	14	46
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume			72		140	71
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			72		140	71
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			100		98	95
cM capacity (veh/h)			1528		850	992

Direction, Lane #	EB 1	WB 1	WB 2	NB 1
Volume Total	72	5	59	60
Volume Left	0	5	0	14
Volume Right	3	0	0	46
cSH	1700	1528	1700	955
Volume to Capacity	0.04	0.00	0.03	0.06
Queue Length 95th (ft)	0	0	0	5
Control Delay (s)	0.0	7.4	0.0	9.0
Lane LOS		A		A
Approach Delay (s)	0.0	0.6		9.0
Approach LOS				A

Intersection Summary			
Average Delay	3.0		
Intersection Capacity Utilization	13.3%	ICU Level of Service	A
Analysis Period (min)	15		

Intersection	
Intersection Delay (sec/veh)	20
Intersection LOS	C

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Volume (vph)	0	10	7	400	0	5	9	35	62	41	65	3
Peak Hour Factor	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85
Heavy Vehicles(%)	2	2	2	2	2	2	2	2	2	2	2	2
Movement Flow Rate	0	12	8	471	0	6	11	41	73	48	76	4
Number of Lanes	0	1	0	1	1	0	1	2	0	1	2	0

Approach	EB	WB	NB	SB
Opposing Approach	WB	EB	SB	NB
Opposing Lanes	2	1	3	3
Conflicting Approach Left	SB	NB	EB	WB
Conflicting Lanes Left	3	3	1	2
Conflicting Approach Right	NB	SB	WB	EB
Conflicting Lanes Right	3	3	2	1
HCM Control Delay	9.2	25.8	9.8	10.1
HCM LOS	A	D	A	B

Lane	NBLn1	NBLn2	NBLn3	EBLn1	WBLn1	WBLn2	SBLn1	SBLn2	SBLn3
Volume Left (%)	100%	0%	0%	0%	100%	0%	100%	0%	0%
Volume Thru (%)	0%	100%	16%	59%	0%	0%	0%	100%	88%
Volume Right (%)	0%	0%	84%	41%	0%	100%	0%	0%	12%
Sign Control	Stop	Stop	Stop	Stop	Stop	Stop	Stop	Stop	Stop
Traffic Volume by Lane	9	23	74	17	400	5	41	43	25
Left Turning Volume	0	23	12	10	0	0	0	43	22
Through Volume	0	0	62	7	0	5	0	0	3
Right Turning Volume	9	0	0	0	400	0	41	0	0
Lane Flow Rate	11	27	87	20	471	6	48	51	29
Geometry Group	8	8	8	8	8	8	8	8	8
Degree of Utilization, X	0.021	0.051	0.145	0.035	0.774	0.008	0.095	0.093	0.052
Departure Headway, Hd	7.134	6.624	6.023	6.256	5.921	4.723	7.104	6.594	6.507
Convergence(Y/N)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Capacity	502	541	595	572	612	759	505	543	550
Service Time	4.874	4.364	3.763	3.996	3.64	2.442	4.844	4.334	4.247
HCM Lane V/C Ratio	0.022	0.05	0.146	0.035	0.77	0.008	0.095	0.094	0.053
HCM Control Delay	10	9.7	9.8	9.2	26	7.5	10.6	10	9.6
HCM Lane LOS	A	A	A	A	D	A	B	A	A
HCM 95th Percentile Queue	0.1	0.2	0.5	0.1	10.2	0	0.3	0.3	0.2

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	0	0	24	0	432	6	466	0	0	82	287
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)				4.0	4.0		4.0	4.0			4.0	
Lane Util. Factor				1.00	1.00		1.00	0.95			0.95	
Frpb, ped/bikes				1.00	1.00		1.00	1.00			0.98	
Flpb, ped/bikes				1.00	1.00		1.00	1.00			1.00	
Frt				1.00	0.85		1.00	1.00			0.88	
Flt Protected				0.95	1.00		0.95	1.00			1.00	
Satd. Flow (prot)				1787	1599		1787	3574			3104	
Flt Permitted				0.95	1.00		0.95	1.00			1.00	
Satd. Flow (perm)				1787	1599		1787	3574			3104	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	0	0	0	25	0	455	6	491	0	0	86	302
RTOR Reduction (vph)	0	0	0	0	414	0	0	0	0	0	193	0
Lane Group Flow (vph)	0	0	0	25	41	0	6	491	0	0	195	0
Confl. Peds. (#/hr)							1		2	2		1
Confl. Bikes (#/hr)			1						1			
Heavy Vehicles (%)	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%
Turn Type				Split			Prot					
Protected Phases				8	8		5	2			6	
Permitted Phases												
Actuated Green, G (s)				2.3	2.3		2.0	15.2			9.2	
Effective Green, g (s)				2.3	2.3		2.0	15.2			9.2	
Actuated g/C Ratio				0.09	0.09		0.08	0.60			0.36	
Clearance Time (s)				4.0	4.0		4.0	4.0			4.0	
Vehicle Extension (s)				3.0	3.0		3.0	3.0			3.0	
Lane Grp Cap (vph)				161	144		140	2130			1120	
v/s Ratio Prot				0.01	c0.03		0.00	c0.14			0.06	
v/s Ratio Perm												
v/c Ratio				0.16	0.28		0.04	0.23			0.17	
Uniform Delay, d1				10.7	10.8		10.9	2.4			5.6	
Progression Factor				1.00	1.00		1.00	1.00			1.00	
Incremental Delay, d2				0.5	1.1		0.1	0.1			0.1	
Delay (s)				11.2	11.9		11.0	2.5			5.6	
Level of Service				B	B		B	A			A	
Approach Delay (s)		0.0			11.9			2.6			5.6	
Approach LOS		A			B			A			A	

Intersection Summary			
HCM Average Control Delay	6.7	HCM Level of Service	A
HCM Volume to Capacity ratio	0.24		
Actuated Cycle Length (s)	25.5	Sum of lost time (s)	8.0
Intersection Capacity Utilization	46.5%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	25	163	59	273	252	39	306	175	417	15	37	38
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0		4.0	4.0	4.0		4.0	
Lane Util. Factor	1.00	0.95		0.91	0.91		0.95	0.95	1.00		1.00	
Frpb, ped/bikes	1.00	1.00		1.00	1.00		1.00	1.00	0.99		1.00	
Flpb, ped/bikes	1.00	1.00		1.00	1.00		1.00	1.00	1.00		1.00	
Frt	1.00	0.96		1.00	0.98		1.00	1.00	0.85		0.94	
Flt Protected	0.95	1.00		0.95	0.99		0.95	0.99	1.00		0.99	
Satd. Flow (prot)	1787	3431		1626	3333		1698	1762	1576		1759	
Flt Permitted	0.95	1.00		0.95	0.99		0.95	0.99	1.00		0.99	
Satd. Flow (perm)	1787	3431		1626	3333		1698	1762	1576		1759	
Peak-hour factor, PHF	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97
Adj. Flow (vph)	26	168	61	281	260	40	315	180	430	15	38	39
RTOR Reduction (vph)	0	40	0	0	9	0	0	0	308	0	31	0
Lane Group Flow (vph)	26	189	0	191	381	0	243	252	122	0	61	0
Confl. Peds. (#/hr)									2	2		
Confl. Bikes (#/hr)									1			
Heavy Vehicles (%)	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%
Turn Type	Split			Split			Split		Perm	Split		
Protected Phases	4	4		8	8		2	2		6	6	
Permitted Phases									2			
Actuated Green, G (s)	9.5	9.5		14.0	14.0		18.1	18.1	18.1		6.3	
Effective Green, g (s)	9.5	9.5		14.0	14.0		18.1	18.1	18.1		6.3	
Actuated g/C Ratio	0.15	0.15		0.22	0.22		0.28	0.28	0.28		0.10	
Clearance Time (s)	4.0	4.0		4.0	4.0		4.0	4.0	4.0		4.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0	3.0		3.0	
Lane Grp Cap (vph)	266	510		356	730		481	499	446		173	
v/s Ratio Prot	0.01	c0.06		c0.12	0.11		c0.14	0.14			c0.03	
v/s Ratio Perm									0.08			
v/c Ratio	0.10	0.37		0.54	0.52		0.51	0.51	0.27		0.35	
Uniform Delay, d1	23.5	24.5		22.1	22.0		19.2	19.2	17.8		26.9	
Progression Factor	1.00	1.00		1.00	1.00		1.00	1.00	1.00		1.00	
Incremental Delay, d2	0.2	0.5		1.6	0.7		0.8	0.8	0.3		1.3	
Delay (s)	23.7	25.0		23.6	22.7		20.0	20.0	18.1		28.2	
Level of Service	C	C		C	C		B	B	B		C	
Approach Delay (s)		24.8			23.0			19.1			28.2	
Approach LOS		C			C			B			C	

Intersection Summary			
HCM Average Control Delay	21.6	HCM Level of Service	C
HCM Volume to Capacity ratio	0.47		
Actuated Cycle Length (s)	63.9	Sum of lost time (s)	16.0
Intersection Capacity Utilization	47.5%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	581	70	53	446	0	0	0	0	283	1	187
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0			4.0						4.0	
Lane Util. Factor		0.95			0.95						1.00	
Frpb, ped/bikes		1.00			1.00						1.00	
Flpb, ped/bikes		1.00			1.00						1.00	
Frt		0.98			1.00						0.95	
Flt Protected		1.00			0.99						0.97	
Satd. Flow (prot)		3505			3554						1728	
Flt Permitted		1.00			0.74						0.97	
Satd. Flow (perm)		3505			2627						1728	
Peak-hour factor, PHF	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96
Adj. Flow (vph)	0	605	73	55	465	0	0	0	0	295	1	195
RTOR Reduction (vph)	0	28	0	0	0	0	0	0	0	0	16	0
Lane Group Flow (vph)	0	650	0	0	520	0	0	0	0	0	475	0
Confl. Peds. (#/hr)	3		8	8		3						
Confl. Bikes (#/hr)						3						
Heavy Vehicles (%)	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%
Turn Type				Perm						Split		
Protected Phases		4			8					6	6	
Permitted Phases				8								
Actuated Green, G (s)		21.3			21.3						45.7	
Effective Green, g (s)		21.3			21.3						45.7	
Actuated g/C Ratio		0.28			0.28						0.61	
Clearance Time (s)		4.0			4.0						4.0	
Vehicle Extension (s)		3.0			3.0						3.0	
Lane Grp Cap (vph)		995			746						1053	
v/s Ratio Prot		0.19									c0.28	
v/s Ratio Perm					c0.20							
v/c Ratio		0.65			0.70						0.45	
Uniform Delay, d1		23.6			24.0						7.9	
Progression Factor		1.00			0.86						1.00	
Incremental Delay, d2		1.6			2.7						1.4	
Delay (s)		25.2			23.3						9.3	
Level of Service		C			C						A	
Approach Delay (s)		25.2			23.3			0.0			9.3	
Approach LOS		C			C			A			A	

Intersection Summary			
HCM Average Control Delay	20.0	HCM Level of Service	B
HCM Volume to Capacity ratio	0.53		
Actuated Cycle Length (s)	75.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	70.7%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	214	650	0	0	438	377	61	141	100	0	0	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0			4.0		4.0	4.0	4.0			
Lane Util. Factor		0.95			0.95		0.95	0.95	1.00			
Frpb, ped/bikes		1.00			0.99		1.00	1.00	1.00			
Flpb, ped/bikes		1.00			1.00		1.00	1.00	1.00			
Frt		1.00			0.93		1.00	1.00	0.85			
Flt Protected		0.99			1.00		0.95	1.00	1.00			
Satd. Flow (prot)		3530			3290		1698	1784	1599			
Flt Permitted		0.59			1.00		0.95	1.00	1.00			
Satd. Flow (perm)		2096			3290		1698	1784	1599			
Peak-hour factor, PHF	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96
Adj. Flow (vph)	223	677	0	0	456	393	64	147	104	0	0	0
RTOR Reduction (vph)	0	0	0	0	162	0	0	0	72	0	0	0
Lane Group Flow (vph)	0	900	0	0	687	0	58	153	32	0	0	0
Confl. Peds. (#/hr)	2		7	7		2						
Confl. Bikes (#/hr)						3						
Heavy Vehicles (%)	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%
Turn Type	Perm						Split		Prot			
Protected Phases		4			8		2	2	2			
Permitted Phases	4											
Actuated Green, G (s)		44.0			44.0		23.0	23.0	23.0			
Effective Green, g (s)		44.0			44.0		23.0	23.0	23.0			
Actuated g/C Ratio		0.59			0.59		0.31	0.31	0.31			
Clearance Time (s)		4.0			4.0		4.0	4.0	4.0			
Vehicle Extension (s)		3.0			3.0		3.0	3.0	3.0			
Lane Grp Cap (vph)		1230			1930		521	547	490			
v/s Ratio Prot					0.21		0.03	c0.09	0.02			
v/s Ratio Perm		c0.43										
v/c Ratio		0.73			0.36		0.11	0.28	0.07			
Uniform Delay, d1		11.2			8.1		18.7	19.7	18.4			
Progression Factor		0.51			1.00		1.00	1.00	1.00			
Incremental Delay, d2		2.2			0.1		0.4	1.3	0.3			
Delay (s)		7.9			8.2		19.1	21.0	18.6			
Level of Service		A			A		B	C	B			
Approach Delay (s)		7.9			8.2			19.9			0.0	
Approach LOS		A			A			B			A	

Intersection Summary			
HCM Average Control Delay	9.8	HCM Level of Service	A
HCM Volume to Capacity ratio	0.58		
Actuated Cycle Length (s)	75.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	67.8%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

Existing Plus Phase 1 Project Conditions

FEHR PEERS

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	60	272	65	238	319	86	44	227	132	72	597	41
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	4.0	4.0	3.0	4.0	4.0	3.0	3.0	3.0	3.0	3.0	
Lane Util. Factor	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	
Frpb, ped/bikes	1.00	1.00	0.98	1.00	1.00	0.98	1.00	1.00	0.98	1.00	1.00	
Flpb, ped/bikes	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	0.99	
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	
Satd. Flow (prot)	1736	3471	1516	1736	3471	1514	1736	3471	1529	1736	3434	
Flt Permitted	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	
Satd. Flow (perm)	1736	3471	1516	1736	3471	1514	1736	3471	1529	1736	3434	
Peak-hour factor, PHF	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91
Adj. Flow (vph)	66	299	71	262	351	95	48	249	145	79	656	45
RTOR Reduction (vph)	0	0	31	0	0	42	0	0	108	0	4	0
Lane Group Flow (vph)	66	299	40	262	351	53	48	249	37	79	697	0
Confl. Peds. (#/hr)	14		13	13		14	4		4	4		4
Confl. Bikes (#/hr)						1						1
Heavy Vehicles (%)	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%
Turn Type	Prot		Perm	Prot		Perm	Prot		Perm	Prot		
Protected Phases	5	2		1	6		3	8		7	4	
Permitted Phases			2			6			8			
Actuated Green, G (s)	6.3	16.7	16.7	16.7	25.1	25.1	4.1	18.5	18.5	6.9	21.3	
Effective Green, g (s)	6.3	16.7	16.7	16.7	25.1	25.1	4.1	18.5	18.5	6.9	21.3	
Actuated g/C Ratio	0.09	0.23	0.23	0.23	0.35	0.35	0.06	0.26	0.26	0.10	0.30	
Clearance Time (s)	5.0	4.0	4.0	3.0	4.0	4.0	3.0	3.0	3.0	3.0	3.0	
Vehicle Extension (s)	2.0	4.0	4.0	2.0	4.0	4.0	2.0	2.0	2.0	2.0	2.0	
Lane Grp Cap (vph)	152	807	353	404	1213	529	99	894	394	167	1019	
v/s Ratio Prot	0.04	c0.09		c0.15	0.10		0.03	0.07		c0.05	c0.20	
v/s Ratio Perm			0.03			0.03			0.02			
v/c Ratio	0.43	0.37	0.11	0.65	0.29	0.10	0.48	0.28	0.09	0.47	0.68	
Uniform Delay, d1	31.1	23.1	21.7	24.9	16.9	15.7	32.8	21.3	20.3	30.7	22.3	
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	
Incremental Delay, d2	0.7	0.4	0.2	2.7	0.2	0.1	1.4	0.1	0.0	0.8	1.5	
Delay (s)	31.8	23.5	21.9	27.6	17.1	15.8	34.2	21.4	20.3	31.5	23.8	
Level of Service	C	C	C	C	B	B	C	C	C	C	C	
Approach Delay (s)		24.5			20.8			22.4			24.6	
Approach LOS		C			C			C			C	

Intersection Summary			
HCM Average Control Delay	23.0	HCM Level of Service	C
HCM Volume to Capacity ratio	0.57		
Actuated Cycle Length (s)	71.8	Sum of lost time (s)	13.0
Intersection Capacity Utilization	60.5%	ICU Level of Service	B
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	0	0	308	2	164	0	236	130	0	696	231
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)				4.0	4.0	4.0		4.0	4.0		4.0	
Lane Util. Factor				0.95	0.91	0.95		0.91	1.00		0.91	
Frpb, ped/bikes				1.00	1.00	0.99		1.00	0.98		0.99	
Flpb, ped/bikes				1.00	1.00	1.00		1.00	1.00		1.00	
Frt				1.00	0.99	0.85		1.00	0.85		0.96	
Flt Protected				0.95	0.96	1.00		1.00	1.00		1.00	
Satd. Flow (prot)				1665	1581	1471		5036	1535		4820	
Flt Permitted				0.95	0.96	1.00		1.00	1.00		1.00	
Satd. Flow (perm)				1665	1581	1471		5036	1535		4820	
Peak-hour factor, PHF	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94
Adj. Flow (vph)	0	0	0	328	2	174	0	251	138	0	740	246
RTOR Reduction (vph)	0	0	0	0	8	104	0	0	0	0	84	0
Lane Group Flow (vph)	0	0	0	174	165	53	0	251	138	0	902	0
Confl. Peds. (#/hr)	1					1	2		1	1		2
Confl. Bikes (#/hr)									2			1
Heavy Vehicles (%)	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%
Turn Type				Split		Perm			Free			
Protected Phases				8	8			2			6	
Permitted Phases						8			Free			
Actuated Green, G (s)				12.2	12.2	12.2		15.7	35.9		15.7	
Effective Green, g (s)				12.2	12.2	12.2		15.7	35.9		15.7	
Actuated g/C Ratio				0.34	0.34	0.34		0.44	1.00		0.44	
Clearance Time (s)				4.0	4.0	4.0		4.0			4.0	
Vehicle Extension (s)				3.0	3.0	3.0		3.0			3.0	
Lane Grp Cap (vph)				566	537	500		2202	1535		2108	
v/s Ratio Prot				c0.10	0.10			0.05			c0.19	
v/s Ratio Perm						0.04			0.09			
v/c Ratio				0.31	0.31	0.11		0.11	0.09		0.43	
Uniform Delay, d1				8.7	8.7	8.1		6.0	0.0		7.0	
Progression Factor				1.00	1.00	1.00		1.00	1.00		1.00	
Incremental Delay, d2				0.3	0.3	0.1		0.0	0.1		0.1	
Delay (s)				9.0	9.1	8.2		6.0	0.1		7.1	
Level of Service				A	A	A		A	A		A	
Approach Delay (s)		0.0			8.8			3.9			7.1	
Approach LOS		A			A			A			A	

Intersection Summary			
HCM Average Control Delay	6.9	HCM Level of Service	A
HCM Volume to Capacity ratio	0.38		
Actuated Cycle Length (s)	35.9	Sum of lost time (s)	8.0
Intersection Capacity Utilization	36.1%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	67	0	93	0	0	0	0	299	313	0	526	477
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0		4.0					4.0			4.0	4.0
Lane Util. Factor	1.00		1.00					0.91			0.95	1.00
Frpb, ped/bikes	1.00		1.00					0.99			1.00	0.98
Flpb, ped/bikes	1.00		1.00					1.00			1.00	1.00
Frt	1.00		0.85					0.92			1.00	0.85
Flt Protected	0.95		1.00					1.00			1.00	1.00
Satd. Flow (prot)	1752		1568					4593			3505	1536
Flt Permitted	0.95		1.00					1.00			1.00	1.00
Satd. Flow (perm)	1752		1568					4593			3505	1536
Peak-hour factor, PHF	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88
Adj. Flow (vph)	76	0	106	0	0	0	0	340	356	0	598	542
RTOR Reduction (vph)	0	0	84	0	0	0	0	178	0	0	0	0
Lane Group Flow (vph)	76	0	22	0	0	0	0	518	0	0	598	542
Confl. Peds. (#/hr)							1		3	3		1
Confl. Bikes (#/hr)									1			
Heavy Vehicles (%)	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%
Turn Type	Split		Perm									Free
Protected Phases	8	8						2			6	
Permitted Phases			8									Free
Actuated Green, G (s)	5.6		5.6					13.6			13.6	27.2
Effective Green, g (s)	5.6		5.6					13.6			13.6	27.2
Actuated g/C Ratio	0.21		0.21					0.50			0.50	1.00
Clearance Time (s)	4.0		4.0					4.0			4.0	
Vehicle Extension (s)	3.0		3.0					3.0			3.0	
Lane Grp Cap (vph)	361		323					2297			1753	1536
v/s Ratio Prot	0.04							0.11			0.17	
v/s Ratio Perm			0.01									c0.35
v/c Ratio	0.21		0.07					0.23			0.34	0.35
Uniform Delay, d1	9.0		8.7					3.8			4.1	0.0
Progression Factor	1.00		1.00					1.00			1.00	1.00
Incremental Delay, d2	0.3		0.1					0.1			0.1	0.6
Delay (s)	9.3		8.8					3.9			4.2	0.6
Level of Service	A		A					A			A	A
Approach Delay (s)		9.0			0.0			3.9			2.5	
Approach LOS		A			A			A			A	

Intersection Summary			
HCM Average Control Delay	3.6	HCM Level of Service	A
HCM Volume to Capacity ratio	0.35		
Actuated Cycle Length (s)	27.2	Sum of lost time (s)	0.0
Intersection Capacity Utilization	27.1%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	41	7	15	0	1	21	15	550	10	267	238	94
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0			4.0			4.0		4.0	4.0	
Lane Util. Factor		1.00			1.00			0.95		1.00	0.95	
Frpb, ped/bikes		1.00			0.99			1.00		1.00	0.99	
Flpb, ped/bikes		1.00			1.00			1.00		1.00	1.00	
Frt		0.97			0.85			1.00		1.00	0.96	
Flt Protected		0.97			1.00			1.00		0.95	1.00	
Satd. Flow (prot)		1711			1542			3457		1736	3302	
Flt Permitted		1.00			1.00			0.94		0.95	1.00	
Satd. Flow (perm)		1767			1542			3247		1736	3302	
Peak-hour factor, PHF	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72
Adj. Flow (vph)	57	10	21	0	1	29	21	764	14	371	331	131
RTOR Reduction (vph)	0	12	0	0	26	0	0	1	0	0	25	0
Lane Group Flow (vph)	0	76	0	0	4	0	0	798	0	371	437	0
Confl. Peds. (#/hr)	3					3	2					2
Confl. Bikes (#/hr)												1
Heavy Vehicles (%)	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%
Turn Type	Perm			Perm			Perm			Prot		
Protected Phases		3			4			2		1	6	
Permitted Phases	3			4			2					
Actuated Green, G (s)		2.2			6.8			22.1		12.0	38.1	
Effective Green, g (s)		2.2			6.8			22.1		12.0	38.1	
Actuated g/C Ratio		0.04			0.12			0.37		0.20	0.64	
Clearance Time (s)		4.0			4.0			4.0		4.0	4.0	
Vehicle Extension (s)		3.0			3.0			3.0		3.0	3.0	
Lane Grp Cap (vph)		66			177			1214		352	2129	
v/s Ratio Prot					c0.00					c0.21	0.13	
v/s Ratio Perm		c0.04						c0.25				
v/c Ratio		1.16			0.02			0.66		1.05	0.21	
Uniform Delay, d1		28.4			23.2			15.4		23.6	4.3	
Progression Factor		1.00			1.00			1.00		1.00	1.00	
Incremental Delay, d2		160.0			0.1			1.3		62.9	0.0	
Delay (s)		188.5			23.3			16.7		86.4	4.3	
Level of Service		F			C			B		F	A	
Approach Delay (s)		188.5			23.3			16.7			40.9	
Approach LOS		F			C			B			D	

Intersection Summary			
HCM Average Control Delay	36.9	HCM Level of Service	D
HCM Volume to Capacity ratio	0.69		
Actuated Cycle Length (s)	59.1	Sum of lost time (s)	16.0
Intersection Capacity Utilization	51.4%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	179	30	11	10	6	31	5	352	100	32	71	130
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0		4.0	4.0		4.0	4.0	
Lane Util. Factor	1.00	0.95	1.00	1.00	0.95		1.00	0.95		1.00	0.95	
Frpb, ped/bikes	1.00	1.00	1.00	1.00	0.99		1.00	1.00		1.00	0.99	
Flpb, ped/bikes	1.00	1.00	1.00	1.00	1.00		1.00	1.00		1.00	1.00	
Frt	1.00	1.00	0.85	1.00	0.88		1.00	0.97		1.00	0.90	
Flt Protected	0.95	1.00	1.00	0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1770	3539	1583	1770	3064		1767	3412		1770	3165	
Flt Permitted	0.95	1.00	1.00	0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (perm)	1770	3539	1583	1770	3064		1767	3412		1770	3165	
Peak-hour factor, PHF	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79
Adj. Flow (vph)	227	38	14	13	8	39	6	446	127	41	90	165
RTOR Reduction (vph)	0	0	11	0	35	0	0	27	0	0	95	0
Lane Group Flow (vph)	227	38	3	13	12	0	6	546	0	41	160	0
Confl. Peds. (#/hr)	3					3	4					4
Confl. Bikes (#/hr)									1			1
Turn Type	Prot		Perm	Prot			Prot			Prot		
Protected Phases	7	4		3	8		5	2		1	6	
Permitted Phases			4									
Actuated Green, G (s)	5.1	9.6	9.6	0.2	4.7		0.2	17.3		2.2	19.3	
Effective Green, g (s)	5.1	9.6	9.6	0.2	4.7		0.2	17.3		2.2	19.3	
Actuated g/C Ratio	0.11	0.21	0.21	0.00	0.10		0.00	0.38		0.05	0.43	
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0		4.0	4.0		4.0	4.0	
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	199	750	335	8	318		8	1303		86	1348	
v/s Ratio Prot	c0.13	c0.01		0.01	0.00		0.00	c0.16		c0.02	0.05	
v/s Ratio Perm			0.00									
v/c Ratio	1.14	0.05	0.01	1.62	0.04		0.75	0.42		0.48	0.12	
Uniform Delay, d1	20.1	14.2	14.1	22.5	18.3		22.5	10.3		21.0	7.9	
Progression Factor	1.00	1.00	1.00	1.00	1.00		1.00	1.00		1.00	1.00	
Incremental Delay, d2	106.8	0.0	0.0	569.9	0.0		166.2	0.2		4.1	0.0	
Delay (s)	126.9	14.2	14.1	592.5	18.3		188.7	10.5		25.1	7.9	
Level of Service	F	B	B	F	B		F	B		C	A	
Approach Delay (s)		105.9			142.7			12.4			10.3	
Approach LOS		F			F			B			B	

Intersection Summary			
HCM Average Control Delay	39.8	HCM Level of Service	D
HCM Volume to Capacity ratio	0.43		
Actuated Cycle Length (s)	45.3	Sum of lost time (s)	12.0
Intersection Capacity Utilization	42.8%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Volume (veh/h)	157	107	27	90	45	50
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90
Hourly flow rate (vph)	174	119	30	100	50	56
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)				1133		
pX, platoon unblocked						
vC, conflicting volume			293		334	174
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			293		334	174
tC, single (s)			4.2		6.5	6.3
tC, 2 stage (s)						
tF (s)			2.3		3.6	3.4
p0 queue free %			98		92	93
cM capacity (veh/h)			1224		629	849

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	NB 1	NB 2
Volume Total	174	119	30	100	50	56
Volume Left	0	0	30	0	50	0
Volume Right	0	119	0	0	0	56
cSH	1700	1700	1224	1700	629	849
Volume to Capacity	0.10	0.07	0.02	0.06	0.08	0.07
Queue Length 95th (ft)	0	0	2	0	6	5
Control Delay (s)	0.0	0.0	8.0	0.0	11.2	9.5
Lane LOS			A		B	A
Approach Delay (s)	0.0		1.8		10.3	
Approach LOS					B	

Intersection Summary			
Average Delay	2.5		
Intersection Capacity Utilization	24.9%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	45	83	13	7	41	61	3	11	15	87	21	99
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0		4.0	4.0			4.0	
Lane Util. Factor	1.00	1.00		1.00	1.00		1.00	1.00			1.00	
Frpb, ped/bikes	1.00	1.00		1.00	1.00		1.00	0.99			1.00	
Flpb, ped/bikes	1.00	1.00		1.00	1.00		1.00	1.00			1.00	
Frt	1.00	0.98		1.00	0.91		1.00	0.91			0.94	
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00			0.98	
Satd. Flow (prot)	1556	1605		1556	1491		1556	1472			1499	
Flt Permitted	0.95	1.00		0.95	1.00		0.67	1.00			0.86	
Satd. Flow (perm)	1556	1605		1556	1491		1104	1472			1321	
Peak-hour factor, PHF	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76
Adj. Flow (vph)	59	109	17	9	54	80	4	14	20	114	28	130
RTOR Reduction (vph)	0	13	0	0	67	0	0	12	0	0	46	0
Lane Group Flow (vph)	59	113	0	9	67	0	4	22	0	0	226	0
Confl. Peds. (#/hr)									2	2		
Confl. Bikes (#/hr)									2			
Heavy Vehicles (%)	16%	16%	16%	16%	16%	16%	16%	16%	16%	16%	16%	16%
Turn Type	Prot			Prot			Perm			Perm		
Protected Phases	7	4		3	8			2			6	
Permitted Phases							2			6		
Actuated Green, G (s)	1.9	5.9		0.8	4.8		11.9	11.9			11.9	
Effective Green, g (s)	1.9	5.9		0.8	4.8		11.9	11.9			11.9	
Actuated g/C Ratio	0.06	0.19		0.03	0.16		0.39	0.39			0.39	
Clearance Time (s)	4.0	4.0		4.0	4.0		4.0	4.0			4.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0			3.0	
Lane Grp Cap (vph)	97	309		41	234		429	572			514	
v/s Ratio Prot	c0.04	c0.07		0.01	0.04			0.01				
v/s Ratio Perm							0.00				c0.17	
v/c Ratio	0.61	0.37		0.22	0.28		0.01	0.04			0.44	
Uniform Delay, d1	14.0	10.7		14.6	11.4		5.7	5.8			6.9	
Progression Factor	1.00	1.00		1.00	1.00		1.00	1.00			1.00	
Incremental Delay, d2	10.3	0.7		2.7	0.7		0.0	0.0			0.6	
Delay (s)	24.3	11.5		17.3	12.1		5.7	5.8			7.5	
Level of Service	C	B		B	B		A	A			A	
Approach Delay (s)		15.6			12.4			5.8			7.5	
Approach LOS		B			B			A			A	

Intersection Summary			
HCM Average Control Delay	10.8	HCM Level of Service	B
HCM Volume to Capacity ratio	0.38		
Actuated Cycle Length (s)	30.6	Sum of lost time (s)	8.0
Intersection Capacity Utilization	34.5%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Volume (veh/h)	99	86	26	31	78	139
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.80	0.80	0.80	0.80	0.80	0.80
Hourly flow rate (vph)	124	108	32	39	98	174
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)	322					
pX, platoon unblocked						
vC, conflicting volume			124		281	178
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			124		281	178
tC, single (s)			4.3		6.6	6.4
tC, 2 stage (s)						
tF (s)			2.3		3.6	3.4
p0 queue free %			98		85	79
cM capacity (veh/h)			1381		664	831

Direction, Lane #	EB 1	WB 1	WB 2	NB 1
Volume Total	231	32	39	271
Volume Left	0	32	0	98
Volume Right	108	0	0	174
cSH	1700	1381	1700	762
Volume to Capacity	0.14	0.02	0.02	0.36
Queue Length 95th (ft)	0	2	0	40
Control Delay (s)	0.0	7.7	0.0	12.3
Lane LOS		A		B
Approach Delay (s)	0.0	3.5		12.3
Approach LOS				B

Intersection Summary			
Average Delay	6.3		
Intersection Capacity Utilization	36.7%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Volume (veh/h)	148	92	134	42	15	20
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.85	0.85	0.85	0.85	0.85	0.85
Hourly flow rate (vph)	174	108	158	49	18	24
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume			282		593	228
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			282		593	228
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			88		96	97
cM capacity (veh/h)			1263		406	804

Direction, Lane #	EB 1	WB 1	WB 2	NB 1
Volume Total	282	158	49	41
Volume Left	0	158	0	18
Volume Right	108	0	0	24
cSH	1700	1263	1700	566
Volume to Capacity	0.17	0.12	0.03	0.07
Queue Length 95th (ft)	0	11	0	6
Control Delay (s)	0.0	8.3	0.0	11.9
Lane LOS		A		B
Approach Delay (s)	0.0	6.3		11.9
Approach LOS				B

Intersection Summary			
Average Delay	3.4		
Intersection Capacity Utilization	34.2%	ICU Level of Service	A
Analysis Period (min)	15		

Intersection	
Intersection Delay (sec/veh)	33.3
Intersection LOS	D

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Volume (vph)	5	6	7	412	7	15	26	200	146	104	128	3
Peak Hour Factor	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88
Heavy Vehicles(%)	4	4	4	4	4	4	4	4	4	4	4	4
Movement Flow Rate	6	7	8	468	8	17	30	227	166	118	145	3
Number of Lanes	0	1	0	1	1	0	1	2	0	1	2	0

Approach	EB	WB	NB	SB
Opposing Approach	WB	EB	SB	NB
Opposing Lanes	2	1	3	3
Conflicting Approach Left	SB	NB	EB	WB
Conflicting Lanes Left	3	3	1	2
Conflicting Approach Right	NB	SB	WB	EB
Conflicting Lanes Right	3	3	2	1
HCM Control Delay	11.7	60.5	15.2	13.4
HCM LOS	B	F	C	B

Lane	NBLn1	NBLn2	NBLn3	EBLn1	WBLn1	WBLn2	SBLn1	SBLn2	SBLn3
Volume Left (%)	100%	0%	0%	28%	100%	0%	100%	0%	0%
Volume Thru (%)	0%	100%	31%	33%	0%	32%	0%	100%	93%
Volume Right (%)	0%	0%	69%	39%	0%	68%	0%	0%	7%
Sign Control	Stop	Stop	Stop	Stop	Stop	Stop	Stop	Stop	Stop
Traffic Volume by Lane	26	133	213	18	412	22	104	85	46
Left Turning Volume	0	133	67	6	0	7	0	85	43
Through Volume	0	0	146	7	0	15	0	0	3
Right Turning Volume	26	0	0	5	412	0	104	0	0
Lane Flow Rate	30	152	242	20	468	25	118	97	52
Geometry Group	8	8	8	8	8	8	8	8	8
Degree of Utilization, X	0.067	0.322	0.48	0.048	0.978	0.045	0.279	0.215	0.114
Departure Headway, Hd	8.161	7.645	7.15	8.453	7.517	6.537	8.491	7.974	7.927
Convergence(Y/N)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Capacity	439	470	503	423	482	548	423	450	452
Service Time	5.912	5.396	4.9	6.224	5.26	4.28	6.246	5.729	5.681
HCM Lane V/C Ratio	0.068	0.323	0.481	0.047	0.971	0.046	0.279	0.216	0.115
HCM Control Delay	11.5	14	16.4	11.7	63.2	9.6	14.5	12.9	11.7
HCM Lane LOS	B	B	C	B	F	A	B	B	B
HCM 95th Percentile Queue	0.2	1.4	2.8	0.2	70.4	0.1	1.2	0.8	0.4

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	0	0	127	0	63	10	537	0	0	245	373
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)				4.0	4.0		4.0	4.0			4.0	
Lane Util. Factor				1.00	1.00		1.00	0.95			0.95	
Frpb, ped/bikes				1.00	1.00		1.00	1.00			0.99	
Flpb, ped/bikes				1.00	1.00		1.00	1.00			1.00	
Frt				1.00	0.85		1.00	1.00			0.91	
Flt Protected				0.95	1.00		0.95	1.00			1.00	
Satd. Flow (prot)				1736	1553		1736	3471			3115	
Flt Permitted				0.95	1.00		0.95	1.00			1.00	
Satd. Flow (perm)				1736	1553		1736	3471			3115	
Peak-hour factor, PHF	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88
Adj. Flow (vph)	0	0	0	144	0	72	11	610	0	0	278	424
RTOR Reduction (vph)	0	0	0	0	66	0	0	0	0	0	248	0
Lane Group Flow (vph)	0	0	0	144	6	0	11	610	0	0	454	0
Confl. Peds. (#/hr)							1					1
Confl. Bikes (#/hr)									2			1
Heavy Vehicles (%)	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%
Turn Type				Split			Prot					
Protected Phases				8	8		5	2			6	
Permitted Phases												
Actuated Green, G (s)				2.4	2.4		1.9	17.5			11.6	
Effective Green, g (s)				2.4	2.4		1.9	17.5			11.6	
Actuated g/C Ratio				0.09	0.09		0.07	0.63			0.42	
Clearance Time (s)				4.0	4.0		4.0	4.0			4.0	
Vehicle Extension (s)				3.0	3.0		3.0	3.0			3.0	
Lane Grp Cap (vph)				149	134		118	2177			1295	
v/s Ratio Prot				c0.08	0.00		0.01	c0.18			c0.15	
v/s Ratio Perm												
v/c Ratio				0.97	0.05		0.09	0.28			0.35	
Uniform Delay, d1				12.7	11.7		12.2	2.4			5.6	
Progression Factor				1.00	1.00		1.00	1.00			1.00	
Incremental Delay, d2				63.0	0.1		0.3	0.1			0.2	
Delay (s)				75.7	11.8		12.5	2.4			5.7	
Level of Service				E	B		B	A			A	
Approach Delay (s)		0.0			54.4			2.6			5.7	
Approach LOS		A			D			A			A	

Intersection Summary			
HCM Average Control Delay	11.3	HCM Level of Service	B
HCM Volume to Capacity ratio	0.46		
Actuated Cycle Length (s)	27.9	Sum of lost time (s)	12.0
Intersection Capacity Utilization	32.6%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	8	363	157	332	78	18	55	64	481	45	129	15
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0		4.0	4.0	4.0		4.0	
Lane Util. Factor	1.00	0.95		0.91	0.91		0.95	0.95	1.00		1.00	
Frpb, ped/bikes	1.00	1.00		1.00	1.00		1.00	1.00	0.99		1.00	
Flpb, ped/bikes	1.00	1.00		1.00	1.00		1.00	1.00	1.00		1.00	
Frt	1.00	0.95		1.00	0.99		1.00	1.00	0.85		0.99	
Flt Protected	0.95	1.00		0.95	0.97		0.95	1.00	1.00		0.99	
Satd. Flow (prot)	1752	3333		1595	3215		1665	1746	1547		1801	
Flt Permitted	0.95	1.00		0.95	0.97		0.95	1.00	1.00		0.99	
Satd. Flow (perm)	1752	3333		1595	3215		1665	1746	1547		1801	
Peak-hour factor, PHF	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Adj. Flow (vph)	9	403	174	369	87	20	61	71	534	50	143	17
RTOR Reduction (vph)	0	48	0	0	6	0	0	0	443	0	3	0
Lane Group Flow (vph)	9	529	0	184	286	0	55	77	91	0	207	0
Confl. Peds. (#/hr)	1					1			2	2		
Confl. Bikes (#/hr)			1			1						1
Heavy Vehicles (%)	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%
Turn Type	Split			Split			Split		Perm	Split		
Protected Phases	4	4		8	8		2	2		6	6	
Permitted Phases									2			
Actuated Green, G (s)	16.0	16.0		13.6	13.6		12.1	12.1	12.1		13.0	
Effective Green, g (s)	16.0	16.0		13.6	13.6		12.1	12.1	12.1		13.0	
Actuated g/C Ratio	0.23	0.23		0.19	0.19		0.17	0.17	0.17		0.18	
Clearance Time (s)	4.0	4.0		4.0	4.0		4.0	4.0	4.0		4.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0	3.0		3.0	
Lane Grp Cap (vph)	396	754		307	618		285	299	265		331	
v/s Ratio Prot	0.01	c0.16		c0.12	0.09		0.03	0.04			c0.11	
v/s Ratio Perm									c0.06			
v/c Ratio	0.02	0.70		0.60	0.46		0.19	0.26	0.34		0.62	
Uniform Delay, d1	21.3	25.2		26.1	25.3		25.1	25.4	25.8		26.6	
Progression Factor	1.00	1.00		1.00	1.00		1.00	1.00	1.00		1.00	
Incremental Delay, d2	0.0	3.0		3.1	0.6		0.3	0.5	0.8		3.6	
Delay (s)	21.3	28.1		29.2	25.9		25.4	25.9	26.6		30.2	
Level of Service	C	C		C	C		C	C	C		C	
Approach Delay (s)		28.0			27.2			26.4			30.2	
Approach LOS		C			C			C			C	

Intersection Summary			
HCM Average Control Delay	27.5	HCM Level of Service	C
HCM Volume to Capacity ratio	0.58		
Actuated Cycle Length (s)	70.7	Sum of lost time (s)	16.0
Intersection Capacity Utilization	65.2%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	832	122	78	320	0	0	0	0	388	23	214
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0			4.0						4.0	
Lane Util. Factor		0.95			0.95						1.00	
Frpb, ped/bikes		1.00			1.00						1.00	
Flpb, ped/bikes		1.00			1.00						1.00	
Frt		0.98			1.00						0.95	
Flt Protected		1.00			0.99						0.97	
Satd. Flow (prot)		3456			3503						1723	
Flt Permitted		1.00			0.62						0.97	
Satd. Flow (perm)		3456			2198						1723	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	0	904	133	85	348	0	0	0	0	422	25	233
RTOR Reduction (vph)	0	27	0	0	0	0	0	0	0	0	18	0
Lane Group Flow (vph)	0	1010	0	0	433	0	0	0	0	0	662	0
Confl. Peds. (#/hr)	5		9	9		5						
Confl. Bikes (#/hr)						2						
Turn Type				Perm						Split		
Protected Phases		4			8					6	6	
Permitted Phases				8								
Actuated Green, G (s)		33.3			33.3						33.7	
Effective Green, g (s)		33.3			33.3						33.7	
Actuated g/C Ratio		0.44			0.44						0.45	
Clearance Time (s)		4.0			4.0						4.0	
Vehicle Extension (s)		3.0			3.0						3.0	
Lane Grp Cap (vph)		1534			976						774	
v/s Ratio Prot		c0.29									c0.38	
v/s Ratio Perm					0.20							
v/c Ratio		0.66			0.44						0.86	
Uniform Delay, d1		16.4			14.4						18.5	
Progression Factor		1.00			0.87						1.00	
Incremental Delay, d2		1.0			0.3						11.7	
Delay (s)		17.4			12.9						30.2	
Level of Service		B			B						C	
Approach Delay (s)		17.4			12.9			0.0			30.2	
Approach LOS		B			B			A			C	

Intersection Summary			
HCM Average Control Delay	20.5	HCM Level of Service	C
HCM Volume to Capacity ratio	0.76		
Actuated Cycle Length (s)	75.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	85.4%	ICU Level of Service	E
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	215	1005	0	0	375	381	23	2	54	0	0	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0			4.0		4.0	4.0	4.0			
Lane Util. Factor		0.95			0.95		0.95	0.95	1.00			
Frpb, ped/bikes		1.00			0.99		1.00	1.00	1.00			
Flpb, ped/bikes		1.00			1.00		1.00	1.00	1.00			
Frt		1.00			0.92		1.00	1.00	0.85			
Flt Protected		0.99			1.00		0.95	0.96	1.00			
Satd. Flow (prot)		3508			3230		1681	1697	1583			
Flt Permitted		0.63			1.00		0.95	0.96	1.00			
Satd. Flow (perm)		2243			3230		1681	1697	1583			
Peak-hour factor, PHF	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89
Adj. Flow (vph)	242	1129	0	0	421	428	26	2	61	0	0	0
RTOR Reduction (vph)	0	0	0	0	134	0	0	0	48	0	0	0
Lane Group Flow (vph)	0	1371	0	0	715	0	14	14	13	0	0	0
Confl. Peds. (#/hr)	5		7	7		5			1	1		
Confl. Bikes (#/hr)						3						
Turn Type	Perm						Split		Prot			
Protected Phases		4			8		2	2	2			
Permitted Phases	4											
Actuated Green, G (s)		51.5			51.5		15.5	15.5	15.5			
Effective Green, g (s)		51.5			51.5		15.5	15.5	15.5			
Actuated g/C Ratio		0.69			0.69		0.21	0.21	0.21			
Clearance Time (s)		4.0			4.0		4.0	4.0	4.0			
Vehicle Extension (s)		3.0			3.0		3.0	3.0	3.0			
Lane Grp Cap (vph)		1540			2218		347	351	327			
v/s Ratio Prot					0.22		c0.01	0.01	0.01			
v/s Ratio Perm		c0.61										
v/c Ratio		0.89			0.32		0.04	0.04	0.04			
Uniform Delay, d1		9.5			4.7		23.8	23.8	23.8			
Progression Factor		0.86			1.00		1.00	1.00	1.00			
Incremental Delay, d2		5.9			0.1		0.2	0.2	0.2			
Delay (s)		14.1			4.8		24.0	24.0	24.0			
Level of Service		B			A		C	C	C			
Approach Delay (s)		14.1			4.8			24.0			0.0	
Approach LOS		B			A			C			A	

Intersection Summary			
HCM Average Control Delay	11.0	HCM Level of Service	B
HCM Volume to Capacity ratio	0.69		
Actuated Cycle Length (s)	75.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	83.4%	ICU Level of Service	E
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	81	333	54	150	340	108	99	718	165	61	257	41
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	4.0	4.0	3.0	4.0	4.0	3.0	3.0	3.0	3.0	3.0	
Lane Util. Factor	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	
Frpb, ped/bikes	1.00	1.00	0.97	1.00	1.00	0.98	1.00	1.00	0.98	1.00	1.00	
Flpb, ped/bikes	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	0.98	
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	
Satd. Flow (prot)	1770	3539	1537	1770	3539	1556	1770	3539	1544	1770	3458	
Flt Permitted	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	
Satd. Flow (perm)	1770	3539	1537	1770	3539	1556	1770	3539	1544	1770	3458	
Peak-hour factor, PHF	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Adj. Flow (vph)	90	370	60	167	378	120	110	798	183	68	286	46
RTOR Reduction (vph)	0	0	21	0	0	55	0	0	58	0	10	0
Lane Group Flow (vph)	90	370	39	167	378	65	110	798	125	68	322	0
Confl. Peds. (#/hr)	5		19	19		5	4		14	14		4
Confl. Bikes (#/hr)						1			1			
Turn Type	Prot		Perm	Prot		Perm	Prot		Perm	Prot		
Protected Phases	5	2		1	6		3	8		7	4	
Permitted Phases			2			6			8			
Actuated Green, G (s)	7.0	17.6	17.6	12.1	20.7	20.7	7.7	24.1	24.1	6.1	22.5	
Effective Green, g (s)	7.0	17.6	17.6	12.1	20.7	20.7	7.7	24.1	24.1	6.1	22.5	
Actuated g/C Ratio	0.10	0.24	0.24	0.17	0.28	0.28	0.11	0.33	0.33	0.08	0.31	
Clearance Time (s)	5.0	4.0	4.0	3.0	4.0	4.0	3.0	3.0	3.0	3.0	3.0	
Vehicle Extension (s)	2.0	4.0	4.0	2.0	4.0	4.0	2.0	2.0	2.0	2.0	2.0	
Lane Grp Cap (vph)	170	854	371	294	1005	442	187	1170	510	148	1067	
v/s Ratio Prot	0.05	c0.10		c0.09	0.11		c0.06	c0.23		0.04	0.09	
v/s Ratio Perm			0.03			0.04			0.08			
v/c Ratio	0.53	0.43	0.10	0.57	0.38	0.15	0.59	0.68	0.24	0.46	0.30	
Uniform Delay, d1	31.4	23.4	21.5	28.0	20.9	19.5	31.1	21.1	17.8	31.8	19.2	
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	
Incremental Delay, d2	1.4	0.5	0.2	1.5	0.3	0.2	3.0	1.3	0.1	0.8	0.1	
Delay (s)	32.8	23.9	21.7	29.5	21.2	19.7	34.1	22.4	17.9	32.7	19.3	
Level of Service	C	C	C	C	C	B	C	C	B	C	B	
Approach Delay (s)		25.2			23.0			22.8			21.5	
Approach LOS		C			C			C			C	

Intersection Summary			
HCM Average Control Delay	23.1	HCM Level of Service	C
HCM Volume to Capacity ratio	0.55		
Actuated Cycle Length (s)	72.9	Sum of lost time (s)	10.0
Intersection Capacity Utilization	59.5%	ICU Level of Service	B
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	0	0	307	2	618	0	411	108	0	361	113
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)				4.0	4.0	4.0		4.0	4.0		4.0	
Lane Util. Factor				0.95	0.91	0.95		0.91	1.00		0.91	
Frt				1.00	0.86	0.85		1.00	0.85		0.96	
Flt Protected				0.95	1.00	1.00		1.00	1.00		1.00	
Satd. Flow (prot)				1698	1474	1519		5136	1599		4952	
Flt Permitted				0.95	1.00	1.00		1.00	1.00		1.00	
Satd. Flow (perm)				1698	1474	1519		5136	1599		4952	
Peak-hour factor, PHF	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94
Adj. Flow (vph)	0	0	0	327	2	657	0	437	115	0	384	120
RTOR Reduction (vph)	0	0	0	0	134	134	0	0	0	0	85	0
Lane Group Flow (vph)	0	0	0	294	216	208	0	437	115	0	419	0
Heavy Vehicles (%)	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%
Turn Type				Split		Perm			Free			
Protected Phases				8	8			2			6	
Permitted Phases						8			Free			
Actuated Green, G (s)				14.7	14.7	14.7		9.2	31.9		9.2	
Effective Green, g (s)				14.7	14.7	14.7		9.2	31.9		9.2	
Actuated g/C Ratio				0.46	0.46	0.46		0.29	1.00		0.29	
Clearance Time (s)				4.0	4.0	4.0		4.0			4.0	
Vehicle Extension (s)				3.0	3.0	3.0		3.0			3.0	
Lane Grp Cap (vph)				782	679	700		1481	1599		1428	
v/s Ratio Prot				c0.17	0.15			c0.09			0.08	
v/s Ratio Perm						0.14			0.07			
v/c Ratio				0.38	0.32	0.30		0.30	0.07		0.29	
Uniform Delay, d1				5.6	5.4	5.4		8.8	0.0		8.8	
Progression Factor				1.00	1.00	1.00		1.00	1.00		1.00	
Incremental Delay, d2				0.3	0.3	0.2		0.1	0.1		0.1	
Delay (s)				5.9	5.7	5.6		8.9	0.1		8.9	
Level of Service				A	A	A		A	A		A	
Approach Delay (s)		0.0			5.7			7.1			8.9	
Approach LOS		A			A			A			A	

Intersection Summary			
HCM Average Control Delay	6.9	HCM Level of Service	A
HCM Volume to Capacity ratio	0.34		
Actuated Cycle Length (s)	31.9	Sum of lost time (s)	8.0
Intersection Capacity Utilization	40.1%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	213	0	131	0	0	0	0	306	364	0	447	221
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0		4.0					4.0			4.0	4.0
Lane Util. Factor	1.00		1.00					0.91			0.95	1.00
Frpb, ped/bikes	1.00		1.00					0.99			1.00	0.98
Flpb, ped/bikes	1.00		1.00					1.00			1.00	1.00
Frt	1.00		0.85					0.92			1.00	0.85
Flt Protected	0.95		1.00					1.00			1.00	1.00
Satd. Flow (prot)	1770		1583					4606			3539	1549
Flt Permitted	0.95		1.00					1.00			1.00	1.00
Satd. Flow (perm)	1770		1583					4606			3539	1549
Peak-hour factor, PHF	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86
Adj. Flow (vph)	248	0	152	0	0	0	0	356	423	0	520	257
RTOR Reduction (vph)	0	0	94	0	0	0	0	269	0	0	0	0
Lane Group Flow (vph)	248	0	58	0	0	0	0	510	0	0	520	257
Confl. Peds. (#/hr)							4		2	2		4
Confl. Bikes (#/hr)									3			
Turn Type	Split		Perm									Free
Protected Phases	8	8						2			6	
Permitted Phases			8									Free
Actuated Green, G (s)	11.9		11.9					11.4			11.4	31.3
Effective Green, g (s)	11.9		11.9					11.4			11.4	31.3
Actuated g/C Ratio	0.38		0.38					0.36			0.36	1.00
Clearance Time (s)	4.0		4.0					4.0			4.0	
Vehicle Extension (s)	3.0		3.0					3.0			3.0	
Lane Grp Cap (vph)	673		602					1678			1289	1549
v/s Ratio Prot	c0.14							0.11			c0.15	
v/s Ratio Perm			0.04									0.17
v/c Ratio	0.37		0.10					0.30			0.40	0.17
Uniform Delay, d1	7.0		6.2					7.1			7.4	0.0
Progression Factor	1.00		1.00					1.00			1.00	1.00
Incremental Delay, d2	0.3		0.1					0.1			0.2	0.2
Delay (s)	7.3		6.3					7.2			7.6	0.2
Level of Service	A		A					A			A	A
Approach Delay (s)		6.9			0.0			7.2			5.2	
Approach LOS		A			A			A			A	

Intersection Summary			
HCM Average Control Delay	6.4	HCM Level of Service	A
HCM Volume to Capacity ratio	0.39		
Actuated Cycle Length (s)	31.3	Sum of lost time (s)	8.0
Intersection Capacity Utilization	32.7%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	146	1	59	9	8	216	21	308	0	11	476	91
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0		4.0	4.0			4.0		4.0	4.0	
Lane Util. Factor		1.00		1.00	1.00			0.95		1.00	0.95	
Frpb, ped/bikes		0.99		1.00	0.99			1.00		1.00	1.00	
Flpb, ped/bikes		1.00		1.00	1.00			1.00		0.94	1.00	
Frt		0.96		1.00	0.86			1.00		1.00	0.98	
Flt Protected		0.97		0.95	1.00			1.00		0.95	1.00	
Satd. Flow (prot)		1699		1751	1557			3494		1644	3409	
Flt Permitted		1.00		0.61	1.00			0.90		0.95	1.00	
Satd. Flow (perm)		1759		1122	1557			3144		1644	3409	
Peak-hour factor, PHF	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85
Adj. Flow (vph)	172	1	69	11	9	254	25	362	0	13	560	107
RTOR Reduction (vph)	0	14	0	0	191	0	0	0	0	0	15	0
Lane Group Flow (vph)	0	228	0	11	72	0	0	387	0	13	652	0
Confl. Peds. (#/hr)	1		3	3		1			5	5		
Confl. Bikes (#/hr)						1			2			1
Heavy Vehicles (%)	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%
Turn Type	Perm			Perm			Perm			Prot		
Protected Phases		3			4			2		1	6	
Permitted Phases	3			4			2					
Actuated Green, G (s)		2.4		11.1	11.1			14.6		0.7	19.3	
Effective Green, g (s)		2.4		11.1	11.1			14.6		0.7	19.3	
Actuated g/C Ratio		0.05		0.25	0.25			0.33		0.02	0.43	
Clearance Time (s)		4.0		4.0	4.0			4.0		4.0	4.0	
Vehicle Extension (s)		3.0		3.0	3.0			3.0		3.0	3.0	
Lane Grp Cap (vph)		94		278	386			1025		26	1469	
v/s Ratio Prot					c0.05					0.01	c0.19	
v/s Ratio Perm		c0.13		0.01				0.12				
v/c Ratio		2.42		0.04	0.19			0.38		0.50	0.44	
Uniform Delay, d1		21.2		12.8	13.3			11.6		21.9	9.0	
Progression Factor		1.00		1.00	1.00			1.00		1.00	1.00	
Incremental Delay, d2		671.6		0.1	0.2			0.2		14.3	0.2	
Delay (s)		692.8		12.9	13.5			11.8		36.2	9.2	
Level of Service		F		B	B			B		D	A	
Approach Delay (s)		692.8			13.5			11.8			9.7	
Approach LOS		F			B			B			A	

Intersection Summary			
HCM Average Control Delay	115.3	HCM Level of Service	F
HCM Volume to Capacity ratio	0.50		
Actuated Cycle Length (s)	44.8	Sum of lost time (s)	12.0
Intersection Capacity Utilization	61.0%	ICU Level of Service	B
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	156	8	13	29	11	27	14	141	16	7	317	165
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0		4.0	4.0		4.0	4.0	
Lane Util. Factor	1.00	0.95	1.00	1.00	0.95		1.00	0.95		1.00	0.95	
Frpb, ped/bikes	1.00	1.00	1.00	1.00	0.99		1.00	1.00		1.00	0.99	
Flpb, ped/bikes	1.00	1.00	1.00	1.00	1.00		1.00	1.00		0.99	1.00	
Frt	1.00	1.00	0.85	1.00	0.90		1.00	0.98		1.00	0.95	
Flt Protected	0.95	1.00	1.00	0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1770	3539	1583	1770	3124		1764	3480		1756	3336	
Flt Permitted	0.95	1.00	1.00	0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (perm)	1770	3539	1583	1770	3124		1764	3480		1756	3336	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	164	8	14	31	12	28	15	148	17	7	334	174
RTOR Reduction (vph)	0	0	11	0	27	0	0	10	0	0	77	0
Lane Group Flow (vph)	164	8	3	31	13	0	15	155	0	7	431	0
Confl. Peds. (#/hr)							16		1	1		16
Confl. Bikes (#/hr)						1			1			
Turn Type	Prot		Perm	Prot			Prot			Prot		
Protected Phases	7	4		3	8		5	2		1	6	
Permitted Phases			4									
Actuated Green, G (s)	5.9	6.4	6.4	0.2	0.7		0.2	10.8		0.2	10.8	
Effective Green, g (s)	5.9	6.4	6.4	0.2	0.7		0.2	10.8		0.2	10.8	
Actuated g/C Ratio	0.18	0.19	0.19	0.01	0.02		0.01	0.32		0.01	0.32	
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0		4.0	4.0		4.0	4.0	
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	311	674	302	11	65		11	1119		10	1072	
v/s Ratio Prot	c0.09	0.00		0.02	c0.00		c0.01	0.04		0.00	c0.13	
v/s Ratio Perm			0.00									
v/c Ratio	0.53	0.01	0.01	2.82	0.19		1.36	0.14		0.70	0.40	
Uniform Delay, d1	12.6	11.0	11.0	16.7	16.2		16.7	8.1		16.7	8.9	
Progression Factor	1.00	1.00	1.00	1.00	1.00		1.00	1.00		1.00	1.00	
Incremental Delay, d2	1.6	0.0	0.0	1021.4	1.5		409.1	0.1		117.6	0.2	
Delay (s)	14.2	11.0	11.0	1038.1	17.6		425.8	8.2		134.3	9.1	
Level of Service	B	B	B	F	B		F	A		F	A	
Approach Delay (s)		13.8			463.2			43.0			10.8	
Approach LOS		B			F			D			B	

Intersection Summary			
HCM Average Control Delay	51.2	HCM Level of Service	D
HCM Volume to Capacity ratio	0.45		
Actuated Cycle Length (s)	33.6	Sum of lost time (s)	16.0
Intersection Capacity Utilization	38.8%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Volume (veh/h)	71	40	61	164	131	32
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.91	0.91	0.91	0.91	0.91	0.91
Hourly flow rate (vph)	78	44	67	180	144	35
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)				1133		
pX, platoon unblocked						
vC, conflicting volume			122		392	78
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			122		392	78
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			95		75	96
cM capacity (veh/h)			1453		580	977

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	NB 1	NB 2
Volume Total	78	44	67	180	144	35
Volume Left	0	0	67	0	144	0
Volume Right	0	44	0	0	0	35
cSH	1700	1700	1453	1700	580	977
Volume to Capacity	0.05	0.03	0.05	0.11	0.25	0.04
Queue Length 95th (ft)	0	0	4	0	24	3
Control Delay (s)	0.0	0.0	7.6	0.0	13.2	8.8
Lane LOS			A		B	A
Approach Delay (s)	0.0		2.1		12.4	
Approach LOS					B	

Intersection Summary			
Average Delay	5.0		
Intersection Capacity Utilization	24.0%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	106	15	1	1	27	107	8	11	2	51	8	44
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0		4.0	4.0			4.0	
Lane Util. Factor	1.00	1.00		1.00	1.00		1.00	1.00			1.00	
Frt	1.00	0.99		1.00	0.88		1.00	0.98			0.94	
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00			0.98	
Satd. Flow (prot)	1626	1697		1626	1507		1626	1675			1574	
Flt Permitted	0.95	1.00		0.95	1.00		1.00	1.00			0.84	
Satd. Flow (perm)	1626	1697		1626	1507		1712	1675			1348	
Peak-hour factor, PHF	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88
Adj. Flow (vph)	120	17	1	1	31	122	9	12	2	58	9	50
RTOR Reduction (vph)	0	1	0	0	90	0	0	2	0	0	42	0
Lane Group Flow (vph)	120	17	0	1	63	0	9	12	0	0	75	0
Heavy Vehicles (%)	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%
Turn Type	Prot			Prot			Perm			Perm		
Protected Phases	7	4		3	8			2			6	
Permitted Phases							2			6		
Actuated Green, G (s)	3.4	9.4		0.8	6.8		4.0	4.0			4.0	
Effective Green, g (s)	3.4	9.4		0.8	6.8		4.0	4.0			4.0	
Actuated g/C Ratio	0.13	0.36		0.03	0.26		0.15	0.15			0.15	
Clearance Time (s)	4.0	4.0		4.0	4.0		4.0	4.0			4.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0			3.0	
Lane Grp Cap (vph)	211	609		50	391		261	256			206	
v/s Ratio Prot	c0.07	c0.01		0.00	c0.04			0.01				
v/s Ratio Perm							0.01				c0.06	
v/c Ratio	0.57	0.03		0.02	0.16		0.03	0.05			0.36	
Uniform Delay, d1	10.7	5.4		12.3	7.5		9.5	9.5			10.0	
Progression Factor	1.00	1.00		1.00	1.00		1.00	1.00			1.00	
Incremental Delay, d2	3.5	0.0		0.2	0.2		0.1	0.1			1.1	
Delay (s)	14.2	5.5		12.5	7.7		9.5	9.6			11.0	
Level of Service	B	A		B	A		A	A			B	
Approach Delay (s)		13.1			7.7			9.5			11.0	
Approach LOS		B			A			A			B	

Intersection Summary			
HCM Average Control Delay	10.4	HCM Level of Service	B
HCM Volume to Capacity ratio	0.38		
Actuated Cycle Length (s)	26.2	Sum of lost time (s)	16.0
Intersection Capacity Utilization	36.5%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Volume (veh/h)	29	39	48	86	49	39
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	32	42	52	93	53	42
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)	322					
pX, platoon unblocked						
vC, conflicting volume			32		251	53
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			32		251	53
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			97		93	96
cM capacity (veh/h)			1581		714	1015

Direction, Lane #	EB 1	WB 1	WB 2	NB 1
Volume Total	74	52	93	96
Volume Left	0	52	0	53
Volume Right	42	0	0	42
cSH	1700	1581	1700	822
Volume to Capacity	0.04	0.03	0.05	0.12
Queue Length 95th (ft)	0	3	0	10
Control Delay (s)	0.0	7.4	0.0	10.0
Lane LOS		A		A
Approach Delay (s)	0.0	2.6		10.0
Approach LOS				A

Intersection Summary			
Average Delay	4.2		
Intersection Capacity Utilization	21.1%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Volume (veh/h)	54	14	19	46	88	131
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.78	0.78	0.78	0.78	0.78	0.78
Hourly flow rate (vph)	69	18	24	59	113	168
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume			87		186	78
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			87		186	78
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			98		86	83
cM capacity (veh/h)			1509		790	982

Direction, Lane #	EB 1	WB 1	WB 2	NB 1
Volume Total	87	24	59	281
Volume Left	0	24	0	113
Volume Right	18	0	0	168
cSH	1700	1509	1700	895
Volume to Capacity	0.05	0.02	0.03	0.31
Queue Length 95th (ft)	0	1	0	34
Control Delay (s)	0.0	7.4	0.0	10.8
Lane LOS		A		B
Approach Delay (s)	0.0	2.2		10.8
Approach LOS				B

Intersection Summary			
Average Delay	7.2		
Intersection Capacity Utilization	27.3%	ICU Level of Service	A
Analysis Period (min)	15		

Intersection	
Intersection Delay (sec/veh)	22.9
Intersection LOS	C

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Volume (vph)	0	10	7	400	0	5	9	50	62	101	99	3
Peak Hour Factor	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85
Heavy Vehicles(%)	2	2	2	2	2	2	2	2	2	2	2	2
Movement Flow Rate	0	12	8	471	0	6	11	59	73	119	116	4
Number of Lanes	0	1	0	1	1	0	1	2	0	1	2	0

Approach	EB	WB	NB	SB
Opposing Approach	WB	EB	SB	NB
Opposing Lanes	2	1	3	3
Conflicting Approach Left	SB	NB	EB	WB
Conflicting Lanes Left	3	3	1	2
Conflicting Approach Right	NB	SB	WB	EB
Conflicting Lanes Right	3	3	2	1
HCM Control Delay	9.8	32.9	10.5	11.4
HCM LOS	A	D	B	B

Lane	NBLn1	NBLn2	NBLn3	EBLn1	WBLn1	WBLn2	SBLn1	SBLn2	SBLn3
Volume Left (%)	100%	0%	0%	0%	100%	0%	100%	0%	0%
Volume Thru (%)	0%	100%	21%	59%	0%	0%	0%	100%	92%
Volume Right (%)	0%	0%	79%	41%	0%	100%	0%	0%	8%
Sign Control	Stop	Stop	Stop	Stop	Stop	Stop	Stop	Stop	Stop
Traffic Volume by Lane	9	33	79	17	400	5	101	66	36
Left Turning Volume	0	33	17	10	0	0	0	66	33
Through Volume	0	0	62	7	0	5	0	0	3
Right Turning Volume	9	0	0	0	400	0	101	0	0
Lane Flow Rate	11	39	93	20	471	6	119	78	42
Geometry Group	8	8	8	8	8	8	8	8	8
Degree of Utilization, X	0.022	0.077	0.166	0.038	0.832	0.008	0.24	0.146	0.079
Departure Headway, Hd	7.549	7.037	6.472	6.785	6.362	5.164	7.281	6.77	6.711
Convergence(Y/N)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Capacity	472	507	552	525	569	692	492	528	532
Service Time	5.323	4.81	4.245	4.559	4.101	2.903	5.047	4.536	4.476
HCM Lane V/C Ratio	0.023	0.077	0.168	0.038	0.828	0.009	0.242	0.148	0.079
HCM Control Delay	10.5	10.4	10.5	9.8	33.2	7.9	12.4	10.7	10.1
HCM Lane LOS	B	B	B	A	D	A	B	B	B
HCM 95th Percentile Queue	0.1	0.3	0.6	0.1	14.6	0	0.9	0.5	0.3

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	0	0	33	0	432	6	500	0	0	87	287
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)				4.0	4.0		4.0	4.0			4.0	
Lane Util. Factor				1.00	1.00		1.00	0.95			0.95	
Frpb, ped/bikes				1.00	1.00		1.00	1.00			0.98	
Flpb, ped/bikes				1.00	1.00		1.00	1.00			1.00	
Frt				1.00	0.85		1.00	1.00			0.89	
Flt Protected				0.95	1.00		0.95	1.00			1.00	
Satd. Flow (prot)				1787	1599		1787	3574			3112	
Flt Permitted				0.95	1.00		0.95	1.00			1.00	
Satd. Flow (perm)				1787	1599		1787	3574			3112	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	0	0	0	35	0	455	6	526	0	0	92	302
RTOR Reduction (vph)	0	0	0	0	400	0	0	0	0	0	189	0
Lane Group Flow (vph)	0	0	0	35	55	0	6	526	0	0	205	0
Confl. Peds. (#/hr)							1		2	2		1
Confl. Bikes (#/hr)			1						1			
Heavy Vehicles (%)	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%
Turn Type				Split			Prot					
Protected Phases				8	8		5	2			6	
Permitted Phases												
Actuated Green, G (s)				2.3	2.3		2.0	15.7			9.7	
Effective Green, g (s)				2.3	2.3		2.0	15.7			9.7	
Actuated g/C Ratio				0.09	0.09		0.08	0.60			0.37	
Clearance Time (s)				4.0	4.0		4.0	4.0			4.0	
Vehicle Extension (s)				3.0	3.0		3.0	3.0			3.0	
Lane Grp Cap (vph)				158	141		137	2158			1161	
v/s Ratio Prot				0.02	c0.03		0.00	c0.15			0.07	
v/s Ratio Perm												
v/c Ratio				0.22	0.39		0.04	0.24			0.18	
Uniform Delay, d1				11.0	11.2		11.1	2.4			5.5	
Progression Factor				1.00	1.00		1.00	1.00			1.00	
Incremental Delay, d2				0.7	1.8		0.1	0.1			0.1	
Delay (s)				11.7	13.0		11.2	2.5			5.5	
Level of Service				B	B		B	A			A	
Approach Delay (s)		0.0			12.9			2.6			5.5	
Approach LOS		A			B			A			A	

Intersection Summary			
HCM Average Control Delay	7.0	HCM Level of Service	A
HCM Volume to Capacity ratio	0.26		
Actuated Cycle Length (s)	26.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	47.4%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	25	163	59	278	252	39	306	175	451	15	37	38
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0		4.0	4.0	4.0		4.0	
Lane Util. Factor	1.00	0.95		0.91	0.91		0.95	0.95	1.00		1.00	
Frpb, ped/bikes	1.00	1.00		1.00	1.00		1.00	1.00	0.99		1.00	
Flpb, ped/bikes	1.00	1.00		1.00	1.00		1.00	1.00	1.00		1.00	
Frt	1.00	0.96		1.00	0.98		1.00	1.00	0.85		0.94	
Flt Protected	0.95	1.00		0.95	0.99		0.95	0.99	1.00		0.99	
Satd. Flow (prot)	1787	3431		1626	3332		1698	1762	1576		1759	
Flt Permitted	0.95	1.00		0.95	0.99		0.95	0.99	1.00		0.99	
Satd. Flow (perm)	1787	3431		1626	3332		1698	1762	1576		1759	
Peak-hour factor, PHF	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97
Adj. Flow (vph)	26	168	61	287	260	40	315	180	465	15	38	39
RTOR Reduction (vph)	0	40	0	0	9	0	0	0	332	0	31	0
Lane Group Flow (vph)	26	189	0	192	386	0	243	252	133	0	61	0
Confl. Peds. (#/hr)									2	2		
Confl. Bikes (#/hr)									1			
Heavy Vehicles (%)	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%
Turn Type	Split			Split			Split		Perm	Split		
Protected Phases	4	4		8	8		2	2		6	6	
Permitted Phases									2			
Actuated Green, G (s)	9.5	9.5		14.0	14.0		18.3	18.3	18.3		6.3	
Effective Green, g (s)	9.5	9.5		14.0	14.0		18.3	18.3	18.3		6.3	
Actuated g/C Ratio	0.15	0.15		0.22	0.22		0.29	0.29	0.29		0.10	
Clearance Time (s)	4.0	4.0		4.0	4.0		4.0	4.0	4.0		4.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0	3.0		3.0	
Lane Grp Cap (vph)	265	508		355	728		485	503	450		173	
v/s Ratio Prot	0.01	c0.06		c0.12	0.12		c0.14	0.14			c0.03	
v/s Ratio Perm									0.08			
v/c Ratio	0.10	0.37		0.54	0.53		0.50	0.50	0.30		0.35	
Uniform Delay, d1	23.6	24.6		22.2	22.1		19.1	19.1	17.9		27.0	
Progression Factor	1.00	1.00		1.00	1.00		1.00	1.00	1.00		1.00	
Incremental Delay, d2	0.2	0.5		1.7	0.7		0.8	0.8	0.4		1.3	
Delay (s)	23.8	25.1		23.9	22.9		19.9	19.9	18.2		28.3	
Level of Service	C	C		C	C		B	B	B		C	
Approach Delay (s)		24.9			23.2			19.1			28.3	
Approach LOS		C			C			B			C	

Intersection Summary			
HCM Average Control Delay	21.6	HCM Level of Service	C
HCM Volume to Capacity ratio	0.47		
Actuated Cycle Length (s)	64.1	Sum of lost time (s)	16.0
Intersection Capacity Utilization	49.6%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	615	70	53	447	0	0	0	0	283	1	192
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0			4.0						4.0	
Lane Util. Factor		0.95			0.95						1.00	
Frpb, ped/bikes		1.00			1.00						1.00	
Flpb, ped/bikes		1.00			1.00						1.00	
Frt		0.98			1.00						0.95	
Flt Protected		1.00			0.99						0.97	
Satd. Flow (prot)		3508			3554						1727	
Flt Permitted		1.00			0.74						0.97	
Satd. Flow (perm)		3508			2633						1727	
Peak-hour factor, PHF	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96
Adj. Flow (vph)	0	641	73	55	466	0	0	0	0	295	1	200
RTOR Reduction (vph)	0	25	0	0	0	0	0	0	0	0	17	0
Lane Group Flow (vph)	0	689	0	0	521	0	0	0	0	0	479	0
Confl. Peds. (#/hr)	3		8	8		3						
Confl. Bikes (#/hr)						3						
Heavy Vehicles (%)	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%
Turn Type				Perm						Split		
Protected Phases		4			8					6	6	
Permitted Phases				8								
Actuated Green, G (s)		22.6			22.6						44.4	
Effective Green, g (s)		22.6			22.6						44.4	
Actuated g/C Ratio		0.30			0.30						0.59	
Clearance Time (s)		4.0			4.0						4.0	
Vehicle Extension (s)		3.0			3.0						3.0	
Lane Grp Cap (vph)		1057			793						1022	
v/s Ratio Prot		0.20									c0.28	
v/s Ratio Perm					c0.20							
v/c Ratio		0.65			0.66						0.47	
Uniform Delay, d1		22.8			22.8						8.6	
Progression Factor		1.00			0.86						1.00	
Incremental Delay, d2		1.5			1.9						1.5	
Delay (s)		24.2			21.6						10.2	
Level of Service		C			C						B	
Approach Delay (s)		24.2			21.6			0.0			10.2	
Approach LOS		C			C			A			B	

Intersection Summary			
HCM Average Control Delay	19.4	HCM Level of Service	B
HCM Volume to Capacity ratio	0.53		
Actuated Cycle Length (s)	75.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	71.7%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	245	653	0	0	439	377	61	141	100	0	0	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0			4.0		4.0	4.0	4.0			
Lane Util. Factor		0.95			0.95		0.95	0.95	1.00			
Frpb, ped/bikes		1.00			0.99		1.00	1.00	1.00			
Flpb, ped/bikes		1.00			1.00		1.00	1.00	1.00			
Frt		1.00			0.93		1.00	1.00	0.85			
Flt Protected		0.99			1.00		0.95	1.00	1.00			
Satd. Flow (prot)		3526			3291		1698	1784	1599			
Flt Permitted		0.58			1.00		0.95	1.00	1.00			
Satd. Flow (perm)		2074			3291		1698	1784	1599			
Peak-hour factor, PHF	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96
Adj. Flow (vph)	255	680	0	0	457	393	64	147	104	0	0	0
RTOR Reduction (vph)	0	0	0	0	154	0	0	0	74	0	0	0
Lane Group Flow (vph)	0	935	0	0	696	0	58	153	30	0	0	0
Confl. Peds. (#/hr)	2		7	7		2						
Confl. Bikes (#/hr)						3						
Heavy Vehicles (%)	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%
Turn Type	Perm						Split		Prot			
Protected Phases		4			8		2	2	2			
Permitted Phases	4											
Actuated Green, G (s)		45.6			45.6		21.4	21.4	21.4			
Effective Green, g (s)		45.6			45.6		21.4	21.4	21.4			
Actuated g/C Ratio		0.61			0.61		0.29	0.29	0.29			
Clearance Time (s)		4.0			4.0		4.0	4.0	4.0			
Vehicle Extension (s)		3.0			3.0		3.0	3.0	3.0			
Lane Grp Cap (vph)		1261			2001		484	509	456			
v/s Ratio Prot					0.21		0.03	c0.09	0.02			
v/s Ratio Perm		c0.45										
v/c Ratio		0.74			0.35		0.12	0.30	0.07			
Uniform Delay, d1		10.5			7.3		19.8	20.9	19.5			
Progression Factor		0.53			1.00		1.00	1.00	1.00			
Incremental Delay, d2		2.3			0.1		0.5	1.5	0.3			
Delay (s)		7.8			7.4		20.3	22.5	19.8			
Level of Service		A			A		C	C	B			
Approach Delay (s)		7.8			7.4			21.2			0.0	
Approach LOS		A			A			C			A	

Intersection Summary			
HCM Average Control Delay	9.7	HCM Level of Service	A
HCM Volume to Capacity ratio	0.60		
Actuated Cycle Length (s)	75.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	68.6%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

Existing Plus Project Buildout Conditions

FEHR PEERS

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	60	270	114	238	319	85	51	243	132	68	696	41
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	4.0	4.0	3.0	4.0	4.0	3.0	3.0	3.0	3.0	3.0	
Lane Util. Factor	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	
Frpb, ped/bikes	1.00	1.00	0.98	1.00	1.00	0.97	1.00	1.00	0.98	1.00	1.00	
Flpb, ped/bikes	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	0.99	
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	
Satd. Flow (prot)	1736	3471	1515	1736	3471	1512	1736	3471	1529	1736	3439	
Flt Permitted	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	
Satd. Flow (perm)	1736	3471	1515	1736	3471	1512	1736	3471	1529	1736	3439	
Peak-hour factor, PHF	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91
Adj. Flow (vph)	66	297	125	262	351	93	56	267	145	75	765	45
RTOR Reduction (vph)	0	0	56	0	0	43	0	0	101	0	3	0
Lane Group Flow (vph)	66	297	69	262	351	50	56	267	44	75	807	0
Confl. Peds. (#/hr)	14		13	13		14	4		4	4		4
Confl. Bikes (#/hr)						1						1
Heavy Vehicles (%)	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%
Turn Type	Prot		Perm	Prot		Perm	Prot		Perm	Prot		
Protected Phases	5	2		1	6		3	8		7	4	
Permitted Phases			2			6			8			
Actuated Green, G (s)	6.4	17.2	17.2	17.3	26.1	26.1	5.9	23.8	23.8	6.8	24.7	
Effective Green, g (s)	6.4	17.2	17.2	17.3	26.1	26.1	5.9	23.8	23.8	6.8	24.7	
Actuated g/C Ratio	0.08	0.22	0.22	0.22	0.33	0.33	0.08	0.30	0.30	0.09	0.32	
Clearance Time (s)	5.0	4.0	4.0	3.0	4.0	4.0	3.0	3.0	3.0	3.0	3.0	
Vehicle Extension (s)	2.0	4.0	4.0	2.0	4.0	4.0	2.0	2.0	2.0	2.0	2.0	
Lane Grp Cap (vph)	142	764	334	385	1160	505	131	1058	466	151	1088	
v/s Ratio Prot	0.04	c0.09		c0.15	0.10		0.03	0.08		c0.04	c0.23	
v/s Ratio Perm			0.05			0.03			0.03			
v/c Ratio	0.46	0.39	0.21	0.68	0.30	0.10	0.43	0.25	0.09	0.50	0.74	
Uniform Delay, d1	34.2	26.0	24.9	27.9	19.3	17.9	34.5	20.4	19.4	34.0	23.8	
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	
Incremental Delay, d2	0.9	0.4	0.4	3.9	0.2	0.1	0.8	0.0	0.0	0.9	2.4	
Delay (s)	35.1	26.4	25.3	31.8	19.5	18.0	35.3	20.5	19.5	35.0	26.3	
Level of Service	D	C	C	C	B	B	D	C	B	C	C	
Approach Delay (s)		27.3			23.8			21.9			27.0	
Approach LOS		C			C			C			C	

Intersection Summary			
HCM Average Control Delay	25.3	HCM Level of Service	C
HCM Volume to Capacity ratio	0.59		
Actuated Cycle Length (s)	78.1	Sum of lost time (s)	10.0
Intersection Capacity Utilization	62.9%	ICU Level of Service	B
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	0	0	308	2	176	0	248	163	0	844	231
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)				4.0	4.0	4.0		4.0	4.0		4.0	
Lane Util. Factor				0.95	0.91	0.95		0.91	1.00		0.91	
Frpb, ped/bikes				1.00	1.00	0.99		1.00	0.98		1.00	
Flpb, ped/bikes				1.00	1.00	1.00		1.00	1.00		1.00	
Frt				1.00	0.98	0.85		1.00	0.85		0.97	
Flt Protected				0.95	0.96	1.00		1.00	1.00		1.00	
Satd. Flow (prot)				1665	1572	1471		5036	1535		4850	
Flt Permitted				0.95	0.96	1.00		1.00	1.00		1.00	
Satd. Flow (perm)				1665	1572	1471		5036	1535		4850	
Peak-hour factor, PHF	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94
Adj. Flow (vph)	0	0	0	328	2	187	0	264	173	0	898	246
RTOR Reduction (vph)	0	0	0	0	13	109	0	0	0	0	66	0
Lane Group Flow (vph)	0	0	0	180	163	52	0	264	173	0	1078	0
Confl. Peds. (#/hr)	1					1	2		1	1		2
Confl. Bikes (#/hr)									2			1
Heavy Vehicles (%)	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%
Turn Type				Split		Perm			Free			
Protected Phases				8	8			2			6	
Permitted Phases						8			Free			
Actuated Green, G (s)				12.5	12.5	12.5		18.2	38.7		18.2	
Effective Green, g (s)				12.5	12.5	12.5		18.2	38.7		18.2	
Actuated g/C Ratio				0.32	0.32	0.32		0.47	1.00		0.47	
Clearance Time (s)				4.0	4.0	4.0		4.0			4.0	
Vehicle Extension (s)				3.0	3.0	3.0		3.0			3.0	
Lane Grp Cap (vph)				538	508	475		2368	1535		2281	
v/s Ratio Prot				c0.11	0.10			0.05			c0.22	
v/s Ratio Perm						0.04			0.11			
v/c Ratio				0.33	0.32	0.11		0.11	0.11		0.47	
Uniform Delay, d1				9.9	9.9	9.2		5.7	0.0		7.0	
Progression Factor				1.00	1.00	1.00		1.00	1.00		1.00	
Incremental Delay, d2				0.4	0.4	0.1		0.0	0.1		0.2	
Delay (s)				10.3	10.3	9.3		5.8	0.1		7.1	
Level of Service				B	B	A		A	A		A	
Approach Delay (s)		0.0			10.0			3.5			7.1	
Approach LOS		A			A			A			A	

Intersection Summary			
HCM Average Control Delay	7.1	HCM Level of Service	A
HCM Volume to Capacity ratio	0.42		
Actuated Cycle Length (s)	38.7	Sum of lost time (s)	8.0
Intersection Capacity Utilization	39.0%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	67	0	297	0	0	0	0	343	313	0	601	552
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0		4.0					4.0			4.0	4.0
Lane Util. Factor	1.00		1.00					0.91			0.95	1.00
Frpb, ped/bikes	1.00		1.00					0.99			1.00	0.98
Flpb, ped/bikes	1.00		1.00					1.00			1.00	1.00
Frt	1.00		0.85					0.93			1.00	0.85
Flt Protected	0.95		1.00					1.00			1.00	1.00
Satd. Flow (prot)	1752		1568					4621			3505	1536
Flt Permitted	0.95		1.00					1.00			1.00	1.00
Satd. Flow (perm)	1752		1568					4621			3505	1536
Peak-hour factor, PHF	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88
Adj. Flow (vph)	76	0	338	0	0	0	0	390	356	0	683	627
RTOR Reduction (vph)	0	0	116	0	0	0	0	207	0	0	0	0
Lane Group Flow (vph)	76	0	222	0	0	0	0	539	0	0	683	627
Confl. Peds. (#/hr)							1		3	3		1
Confl. Bikes (#/hr)									1			
Heavy Vehicles (%)	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%
Turn Type	Split		Perm									Free
Protected Phases	8	8						2			6	
Permitted Phases			8									Free
Actuated Green, G (s)	11.5		11.5					14.1			14.1	33.6
Effective Green, g (s)	11.5		11.5					14.1			14.1	33.6
Actuated g/C Ratio	0.34		0.34					0.42			0.42	1.00
Clearance Time (s)	4.0		4.0					4.0			4.0	
Vehicle Extension (s)	3.0		3.0					3.0			3.0	
Lane Grp Cap (vph)	600		537					1939			1471	1536
v/s Ratio Prot	0.04							0.12			0.19	
v/s Ratio Perm			0.14									c0.41
v/c Ratio	0.13		0.41					0.28			0.46	0.41
Uniform Delay, d1	7.6		8.5					6.4			7.0	0.0
Progression Factor	1.00		1.00					1.00			1.00	1.00
Incremental Delay, d2	0.1		0.5					0.1			0.2	0.8
Delay (s)	7.7		9.0					6.5			7.3	0.8
Level of Service	A		A					A			A	A
Approach Delay (s)		8.7			0.0			6.5			4.2	
Approach LOS		A			A			A			A	

Intersection Summary			
HCM Average Control Delay	5.6	HCM Level of Service	A
HCM Volume to Capacity ratio	0.41		
Actuated Cycle Length (s)	33.6	Sum of lost time (s)	0.0
Intersection Capacity Utilization	41.7%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	41	7	15	0	1	21	15	594	10	267	516	94
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0			4.0			4.0		4.0	4.0	
Lane Util. Factor		1.00			1.00			0.95		1.00	0.95	
Frpb, ped/bikes		1.00			0.99			1.00		1.00	1.00	
Flpb, ped/bikes		1.00			1.00			1.00		1.00	1.00	
Frt		0.97			0.85			1.00		1.00	0.98	
Flt Protected		0.97			1.00			1.00		0.95	1.00	
Satd. Flow (prot)		1711			1542			3458		1736	3379	
Flt Permitted		1.00			1.00			0.93		0.95	1.00	
Satd. Flow (perm)		1767			1542			3205		1736	3379	
Peak-hour factor, PHF	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72
Adj. Flow (vph)	57	10	21	0	1	29	21	825	14	371	717	131
RTOR Reduction (vph)	0	12	0	0	26	0	0	1	0	0	9	0
Lane Group Flow (vph)	0	76	0	0	4	0	0	859	0	371	839	0
Confl. Peds. (#/hr)	3					3	2					2
Confl. Bikes (#/hr)												1
Heavy Vehicles (%)	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%
Turn Type	Perm			Perm			Perm			Prot		
Protected Phases		3			4			2		1	6	
Permitted Phases	3			4			2					
Actuated Green, G (s)		2.2			6.8			22.1		12.0	38.1	
Effective Green, g (s)		2.2			6.8			22.1		12.0	38.1	
Actuated g/C Ratio		0.04			0.12			0.37		0.20	0.64	
Clearance Time (s)		4.0			4.0			4.0		4.0	4.0	
Vehicle Extension (s)		3.0			3.0			3.0		3.0	3.0	
Lane Grp Cap (vph)		66			177			1198		352	2178	
v/s Ratio Prot					c0.00					c0.21	0.25	
v/s Ratio Perm		c0.04						c0.27				
v/c Ratio		1.16			0.02			0.72		1.05	0.39	
Uniform Delay, d1		28.4			23.2			15.8		23.6	5.0	
Progression Factor		1.00			1.00			1.00		1.00	1.00	
Incremental Delay, d2		160.0			0.1			2.1		62.9	0.1	
Delay (s)		188.5			23.3			17.9		86.4	5.1	
Level of Service		F			C			B		F	A	
Approach Delay (s)		188.5			23.3			17.9			29.8	
Approach LOS		F			C			B			C	

Intersection Summary			
HCM Average Control Delay	31.4	HCM Level of Service	C
HCM Volume to Capacity ratio	0.72		
Actuated Cycle Length (s)	59.1	Sum of lost time (s)	16.0
Intersection Capacity Utilization	54.9%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	179	61	11	15	11	75	5	352	131	310	71	130
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0		4.0	4.0		4.0	4.0	
Lane Util. Factor	1.00	0.95	1.00	1.00	0.95		1.00	0.95		1.00	0.95	
Frpb, ped/bikes	1.00	1.00	1.00	1.00	0.99		1.00	1.00		1.00	0.99	
Flpb, ped/bikes	1.00	1.00	1.00	1.00	1.00		1.00	1.00		1.00	1.00	
Frt	1.00	1.00	0.85	1.00	0.87		1.00	0.96		1.00	0.90	
Flt Protected	0.95	1.00	1.00	0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1770	3539	1583	1770	3040		1767	3384		1770	3165	
Flt Permitted	0.95	1.00	1.00	0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (perm)	1770	3539	1583	1770	3040		1767	3384		1770	3165	
Peak-hour factor, PHF	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79
Adj. Flow (vph)	227	77	14	19	14	95	6	446	166	392	90	165
RTOR Reduction (vph)	0	0	10	0	77	0	0	42	0	0	99	0
Lane Group Flow (vph)	227	77	4	19	32	0	6	570	0	392	156	0
Confl. Peds. (#/hr)	3					3	4					4
Confl. Bikes (#/hr)									1			1
Turn Type	Prot		Perm	Prot			Prot			Prot		
Protected Phases	7	4		3	8		5	2		1	6	
Permitted Phases			4									
Actuated Green, G (s)	3.3	12.4	12.4	0.2	9.3		0.2	17.4		2.2	19.4	
Effective Green, g (s)	3.3	12.4	12.4	0.2	9.3		0.2	17.4		2.2	19.4	
Actuated g/C Ratio	0.07	0.26	0.26	0.00	0.19		0.00	0.36		0.05	0.40	
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0		4.0	4.0		4.0	4.0	
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	121	910	407	7	587		7	1222		81	1274	
v/s Ratio Prot	c0.13	c0.02		0.01	0.01		0.00	c0.17		c0.22	0.05	
v/s Ratio Perm			0.00									
v/c Ratio	1.88	0.08	0.01	2.71	0.06		0.86	0.47		4.84	0.12	
Uniform Delay, d1	22.5	13.6	13.3	24.0	15.9		24.0	11.8		23.0	9.1	
Progression Factor	1.00	1.00	1.00	1.00	1.00		1.00	1.00		1.00	1.00	
Incremental Delay, d2	423.8	0.0	0.0	1066.1	0.0		244.3	0.3		1755.3	0.0	
Delay (s)	446.3	13.6	13.3	1090.1	15.9		268.3	12.1		1778.3	9.1	
Level of Service	F	B	B	F	B		F	B		F	A	
Approach Delay (s)		322.5			175.3			14.6			1081.0	
Approach LOS		F			F			B			F	

Intersection Summary			
HCM Average Control Delay	487.1	HCM Level of Service	F
HCM Volume to Capacity ratio	0.64		
Actuated Cycle Length (s)	48.2	Sum of lost time (s)	16.0
Intersection Capacity Utilization	57.7%	ICU Level of Service	B
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Volume (veh/h)	294	107	64	112	45	211
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90
Hourly flow rate (vph)	327	119	71	124	50	234
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)				1133		
pX, platoon unblocked						
vC, conflicting volume			446		593	327
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			446		593	327
tC, single (s)			4.2		6.5	6.3
tC, 2 stage (s)						
tF (s)			2.3		3.6	3.4
p0 queue free %			93		88	66
cM capacity (veh/h)			1074		425	696

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	NB 1	NB 2
Volume Total	327	119	71	124	50	234
Volume Left	0	0	71	0	50	0
Volume Right	0	119	0	0	0	234
cSH	1700	1700	1074	1700	425	696
Volume to Capacity	0.19	0.07	0.07	0.07	0.12	0.34
Queue Length 95th (ft)	0	0	5	0	10	37
Control Delay (s)	0.0	0.0	8.6	0.0	14.6	12.8
Lane LOS			A		B	B
Approach Delay (s)	0.0		3.1		13.1	
Approach LOS					B	

Intersection Summary			
Average Delay	4.7		
Intersection Capacity Utilization	35.2%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	45	319	13	7	67	121	3	11	15	385	21	99
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0		4.0	4.0			4.0	
Lane Util. Factor	1.00	1.00		1.00	1.00		1.00	1.00			1.00	
Frpb, ped/bikes	1.00	1.00		1.00	1.00		1.00	0.99			1.00	
Flpb, ped/bikes	1.00	1.00		1.00	1.00		1.00	1.00			1.00	
Frt	1.00	0.99		1.00	0.90		1.00	0.91			0.97	
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00			0.96	
Satd. Flow (prot)	1556	1628		1556	1480		1556	1472			1533	
Flt Permitted	0.95	1.00		0.95	1.00		0.66	1.00			0.75	
Satd. Flow (perm)	1556	1628		1556	1480		1077	1472			1201	
Peak-hour factor, PHF	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76
Adj. Flow (vph)	59	420	17	9	88	159	4	14	20	507	28	130
RTOR Reduction (vph)	0	3	0	0	107	0	0	13	0	0	13	0
Lane Group Flow (vph)	59	434	0	9	140	0	4	21	0	0	652	0
Confl. Peds. (#/hr)									2	2		
Confl. Bikes (#/hr)									2			
Heavy Vehicles (%)	16%	16%	16%	16%	16%	16%	16%	16%	16%	16%	16%	16%
Turn Type	Prot			Prot			Perm			Perm		
Protected Phases	7	4		3	8			2			6	
Permitted Phases							2			6		
Actuated Green, G (s)	2.3	16.4		1.0	15.1		16.7	16.7			16.7	
Effective Green, g (s)	2.3	16.4		1.0	15.1		16.7	16.7			16.7	
Actuated g/C Ratio	0.05	0.36		0.02	0.33		0.36	0.36			0.36	
Clearance Time (s)	4.0	4.0		4.0	4.0		4.0	4.0			4.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0			3.0	
Lane Grp Cap (vph)	78	579		34	485		390	533			435	
v/s Ratio Prot	c0.04	c0.27		0.01	0.09			0.01				
v/s Ratio Perm							0.00				c0.54	
v/c Ratio	0.76	0.75		0.26	0.29		0.01	0.04			1.50	
Uniform Delay, d1	21.6	13.1		22.2	11.5		9.4	9.5			14.7	
Progression Factor	1.00	1.00		1.00	1.00		1.00	1.00			1.00	
Incremental Delay, d2	33.5	5.4		4.1	0.3		0.0	0.0			236.5	
Delay (s)	55.1	18.5		26.3	11.8		9.4	9.5			251.2	
Level of Service	E	B		C	B		A	A			F	
Approach Delay (s)		22.8			12.4			9.5			251.2	
Approach LOS		C			B			A			F	

Intersection Summary			
HCM Average Control Delay	125.0	HCM Level of Service	F
HCM Volume to Capacity ratio	1.03		
Actuated Cycle Length (s)	46.1	Sum of lost time (s)	8.0
Intersection Capacity Utilization	66.0%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Volume (veh/h)	554	166	27	104	91	144
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.80	0.80	0.80	0.80	0.80	0.80
Hourly flow rate (vph)	692	208	34	130	114	180
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)	322					
pX, platoon unblocked			0.80		0.80	0.80
vC, conflicting volume			692		994	796
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			492		868	621
tC, single (s)			4.3		6.6	6.4
tC, 2 stage (s)						
tF (s)			2.3		3.6	3.4
p0 queue free %			96		51	51
cM capacity (veh/h)			803		234	371

Direction, Lane #	EB 1	WB 1	WB 2	NB 1
Volume Total	900	34	130	294
Volume Left	0	34	0	114
Volume Right	208	0	0	180
cSH	1700	803	1700	302
Volume to Capacity	0.53	0.04	0.08	0.97
Queue Length 95th (ft)	0	3	0	249
Control Delay (s)	0.0	9.7	0.0	82.9
Lane LOS		A		F
Approach Delay (s)	0.0	2.0		82.9
Approach LOS				F

Intersection Summary			
Average Delay	18.2		
Intersection Capacity Utilization	59.8%	ICU Level of Service	B
Analysis Period (min)	15		

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Volume (veh/h)	192	367	571	317	59	90
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.85	0.85	0.85	0.85	0.85	0.85
Hourly flow rate (vph)	226	432	672	373	69	106
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume			658		2158	442
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			658		2158	442
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			27		0	83
cM capacity (veh/h)			916		14	609

Direction, Lane #	EB 1	WB 1	WB 2	NB 1
Volume Total	658	672	373	175
Volume Left	0	672	0	69
Volume Right	432	0	0	106
cSH	1700	916	1700	33
Volume to Capacity	0.39	0.73	0.22	5.25
Queue Length 95th (ft)	0	169	0	Err
Control Delay (s)	0.0	18.9	0.0	Err
Lane LOS		C		F
Approach Delay (s)	0.0	12.2		Err
Approach LOS				F

Intersection Summary			
Average Delay	940.3		
Intersection Capacity Utilization	83.1%	ICU Level of Service	E
Analysis Period (min)	15		

Intersection	
Intersection Delay (sec/veh)	60.2
Intersection LOS	F

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Volume (vph)	5	6	7	412	7	15	26	912	146	167	179	3
Peak Hour Factor	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88
Heavy Vehicles(%)	4	4	4	4	4	4	4	4	4	4	4	4
Movement Flow Rate	6	7	8	468	8	17	30	1036	166	190	203	3
Number of Lanes	0	1	0	1	1	0	1	2	0	1	2	0

Approach	EB	WB	NB	SB
Opposing Approach	WB	EB	SB	NB
Opposing Lanes	2	1	3	3
Conflicting Approach Left	SB	NB	EB	WB
Conflicting Lanes Left	3	3	1	2
Conflicting Approach Right	NB	SB	WB	EB
Conflicting Lanes Right	3	3	2	1
HCM Control Delay	13.9	73.6	69.1	18.3
HCM LOS	B	F	F	C

Lane	NBLn1	NBLn2	NBLn3	EBLn1	WBLn1	WBLn2	SBLn1	SBLn2	SBLn3
Volume Left (%)	100%	0%	0%	28%	100%	0%	100%	0%	0%
Volume Thru (%)	0%	100%	68%	33%	0%	32%	0%	100%	95%
Volume Right (%)	0%	0%	32%	39%	0%	68%	0%	0%	5%
Sign Control	Stop	Stop	Stop	Stop	Stop	Stop	Stop	Stop	Stop
Traffic Volume by Lane	26	608	450	18	412	22	167	119	63
Left Turning Volume	0	608	304	6	0	7	0	119	60
Through Volume	0	0	146	7	0	15	0	0	3
Right Turning Volume	26	0	0	5	412	0	167	0	0
Lane Flow Rate	30	691	511	20	468	25	190	136	71
Geometry Group	8	8	8	8	8	8	8	8	8
Degree of Utilization, X	0.07	1	1	0.06	1	0.058	0.501	0.339	0.177
Departure Headway, Hd	8.525	8.027	7.801	10.518	9.313	8.34	9.5	9	8.967
Convergence(Y/N)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Capacity	421	456	465	342	393	430	381	401	402
Service Time	6.256	5.758	5.532	8.25	7.049	6.076	7.213	6.714	6.68
HCM Lane V/C Ratio	0.071	1.515	1.099	0.058	1.191	0.058	0.499	0.339	0.177
HCM Control Delay	11.9	71	69.9	13.9	76.9	11.6	21.4	16.3	13.6
HCM Lane LOS	B	F	F	B	F	B	C	C	B
HCM 95th Percentile Queue	0.2	100.3	101.7	0.2	93.1	0.2	3	1.5	0.6

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	0	0	521	0	63	10	588	0	0	563	373
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)				4.0	4.0		4.0	4.0			4.0	
Lane Util. Factor				1.00	1.00		1.00	0.95			0.95	
Frpb, ped/bikes				1.00	1.00		1.00	1.00			0.99	
Flpb, ped/bikes				1.00	1.00		1.00	1.00			1.00	
Frt				1.00	0.85		1.00	1.00			0.94	
Flt Protected				0.95	1.00		0.95	1.00			1.00	
Satd. Flow (prot)				1736	1553		1736	3471			3235	
Flt Permitted				0.95	1.00		0.95	1.00			1.00	
Satd. Flow (perm)				1736	1553		1736	3471			3235	
Peak-hour factor, PHF	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88
Adj. Flow (vph)	0	0	0	592	0	72	11	668	0	0	640	424
RTOR Reduction (vph)	0	0	0	0	67	0	0	0	0	0	218	0
Lane Group Flow (vph)	0	0	0	592	5	0	11	668	0	0	846	0
Confl. Peds. (#/hr)							1					1
Confl. Bikes (#/hr)									2			1
Heavy Vehicles (%)	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%
Turn Type				Split			Prot					
Protected Phases				8	8		5	2			6	
Permitted Phases												
Actuated Green, G (s)				2.3	2.3		2.1	21.6			15.5	
Effective Green, g (s)				2.3	2.3		2.1	21.6			15.5	
Actuated g/C Ratio				0.07	0.07		0.07	0.68			0.49	
Clearance Time (s)				4.0	4.0		4.0	4.0			4.0	
Vehicle Extension (s)				3.0	3.0		3.0	3.0			3.0	
Lane Grp Cap (vph)				125	112		114	2350			1572	
v/s Ratio Prot				c0.34	0.00		0.01	c0.19			c0.26	
v/s Ratio Perm												
v/c Ratio				4.74	0.05		0.10	0.28			0.54	
Uniform Delay, d1				14.8	13.8		14.0	2.1			5.7	
Progression Factor				1.00	1.00		1.00	1.00			1.00	
Incremental Delay, d2				1699.3	0.2		0.4	0.1			0.4	
Delay (s)				1714.1	14.0		14.4	2.1			6.1	
Level of Service				F	B		B	A			A	
Approach Delay (s)		0.0			1529.7			2.3			6.1	
Approach LOS		A			F			A			A	

Intersection Summary			
HCM Average Control Delay	425.3	HCM Level of Service	F
HCM Volume to Capacity ratio	1.02		
Actuated Cycle Length (s)	31.9	Sum of lost time (s)	12.0
Intersection Capacity Utilization	63.1%	ICU Level of Service	B
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	8	363	157	650	78	18	55	64	532	45	129	15
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0		4.0	4.0	4.0		4.0	
Lane Util. Factor	1.00	0.95		0.91	0.91		0.95	0.95	1.00		1.00	
Frpb, ped/bikes	1.00	1.00		1.00	1.00		1.00	1.00	0.99		1.00	
Flpb, ped/bikes	1.00	1.00		1.00	1.00		1.00	1.00	1.00		1.00	
Frt	1.00	0.95		1.00	0.99		1.00	1.00	0.85		0.99	
Flt Protected	0.95	1.00		0.95	0.96		0.95	1.00	1.00		0.99	
Satd. Flow (prot)	1752	3333		1595	3209		1665	1746	1546		1801	
Flt Permitted	0.95	1.00		0.95	0.96		0.95	1.00	1.00		0.99	
Satd. Flow (perm)	1752	3333		1595	3209		1665	1746	1546		1801	
Peak-hour factor, PHF	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Adj. Flow (vph)	9	403	174	722	87	20	61	71	591	50	143	17
RTOR Reduction (vph)	0	49	0	0	3	0	0	0	493	0	3	0
Lane Group Flow (vph)	9	528	0	361	465	0	55	77	98	0	207	0
Confl. Peds. (#/hr)	1					1			2	2		
Confl. Bikes (#/hr)			1			1						1
Heavy Vehicles (%)	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%
Turn Type	Split			Split			Split		Perm	Split		
Protected Phases	4	4		8	8		2	2		6	6	
Permitted Phases									2			
Actuated Green, G (s)	16.2	16.2		18.4	18.4		12.7	12.7	12.7		13.2	
Effective Green, g (s)	16.2	16.2		18.4	18.4		12.7	12.7	12.7		13.2	
Actuated g/C Ratio	0.21	0.21		0.24	0.24		0.17	0.17	0.17		0.17	
Clearance Time (s)	4.0	4.0		4.0	4.0		4.0	4.0	4.0		4.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0	3.0		3.0	
Lane Grp Cap (vph)	371	706		384	772		276	290	257		311	
v/s Ratio Prot	0.01	c0.16		c0.23	0.14		0.03	0.04			c0.11	
v/s Ratio Perm									c0.06			
v/c Ratio	0.02	0.75		0.94	0.90dl		0.20	0.27	0.38		0.66	
Uniform Delay, d1	23.9	28.2		28.5	25.8		27.5	27.8	28.4		29.6	
Progression Factor	1.00	1.00		1.00	1.00		1.00	1.00	1.00		1.00	
Incremental Delay, d2	0.0	4.3		31.0	1.3		0.4	0.5	0.9		5.3	
Delay (s)	23.9	32.6		59.5	27.1		27.9	28.3	29.4		34.9	
Level of Service	C	C		E	C		C	C	C		C	
Approach Delay (s)		32.5			41.2			29.1			34.9	
Approach LOS		C			D			C			C	

Intersection Summary			
HCM Average Control Delay	34.7	HCM Level of Service	C
HCM Volume to Capacity ratio	0.71		
Actuated Cycle Length (s)	76.5	Sum of lost time (s)	16.0
Intersection Capacity Utilization	68.4%	ICU Level of Service	C
Analysis Period (min)	15		

dl Defacto Left Lane. Recode with 1 though lane as a left lane.
c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	883	122	78	351	0	0	0	0	388	23	500
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0			4.0						4.0	
Lane Util. Factor		0.95			0.95						1.00	
Frpb, ped/bikes		1.00			1.00						1.00	
Flpb, ped/bikes		1.00			1.00						1.00	
Frt		0.98			1.00						0.93	
Flt Protected		1.00			0.99						0.98	
Satd. Flow (prot)		3461			3506						1689	
Flt Permitted		1.00			0.63						0.98	
Satd. Flow (perm)		3461			2212						1689	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	0	960	133	85	382	0	0	0	0	422	25	543
RTOR Reduction (vph)	0	24	0	0	0	0	0	0	0	0	43	0
Lane Group Flow (vph)	0	1069	0	0	467	0	0	0	0	0	947	0
Confl. Peds. (#/hr)	5		9	9		5						
Confl. Bikes (#/hr)						2						
Turn Type				Perm						Split		
Protected Phases		4			8					6	6	
Permitted Phases				8								
Actuated Green, G (s)		35.2			35.2						31.8	
Effective Green, g (s)		35.2			35.2						31.8	
Actuated g/C Ratio		0.47			0.47						0.42	
Clearance Time (s)		4.0			4.0						4.0	
Vehicle Extension (s)		3.0			3.0						3.0	
Lane Grp Cap (vph)		1624			1038						716	
v/s Ratio Prot		c0.31									c0.56	
v/s Ratio Perm					0.21							
v/c Ratio		0.66			0.45						1.32	
Uniform Delay, d1		15.3			13.4						21.6	
Progression Factor		1.00			0.86						1.00	
Incremental Delay, d2		1.0			0.3						155.1	
Delay (s)		16.3			11.8						176.7	
Level of Service		B			B						F	
Approach Delay (s)		16.3			11.8			0.0			176.7	
Approach LOS		B			B			A			F	

Intersection Summary			
HCM Average Control Delay	77.7	HCM Level of Service	E
HCM Volume to Capacity ratio	0.97		
Actuated Cycle Length (s)	75.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	105.1%	ICU Level of Service	G
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	261	1010	0	0	406	381	23	2	54	0	0	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0			4.0		4.0	4.0	4.0			
Lane Util. Factor		0.95			0.95		0.95	0.95	1.00			
Frpb, ped/bikes		1.00			0.99		1.00	1.00	1.00			
Flpb, ped/bikes		1.00			1.00		1.00	1.00	1.00			
Frt		1.00			0.93		1.00	1.00	0.85			
Flt Protected		0.99			1.00		0.95	0.96	1.00			
Satd. Flow (prot)		3503			3242		1681	1697	1583			
Flt Permitted		0.61			1.00		0.95	0.96	1.00			
Satd. Flow (perm)		2156			3242		1681	1697	1583			
Peak-hour factor, PHF	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89
Adj. Flow (vph)	293	1135	0	0	456	428	26	2	61	0	0	0
RTOR Reduction (vph)	0	0	0	0	131	0	0	0	49	0	0	0
Lane Group Flow (vph)	0	1428	0	0	753	0	14	14	12	0	0	0
Confl. Peds. (#/hr)	5		7	7		5			1	1		
Confl. Bikes (#/hr)						3						
Turn Type	Perm						Split		Prot			
Protected Phases		4			8		2	2	2			
Permitted Phases	4											
Actuated Green, G (s)		52.0			52.0		15.0	15.0	15.0			
Effective Green, g (s)		52.0			52.0		15.0	15.0	15.0			
Actuated g/C Ratio		0.69			0.69		0.20	0.20	0.20			
Clearance Time (s)		4.0			4.0		4.0	4.0	4.0			
Vehicle Extension (s)		3.0			3.0		3.0	3.0	3.0			
Lane Grp Cap (vph)		1495			2248		336	339	317			
v/s Ratio Prot					0.23		c0.01	0.01	0.01			
v/s Ratio Perm		c0.66										
v/c Ratio		0.96			0.33		0.04	0.04	0.04			
Uniform Delay, d1		10.4			4.6		24.2	24.2	24.2			
Progression Factor		0.90			1.00		1.00	1.00	1.00			
Incremental Delay, d2		10.8			0.1		0.2	0.2	0.2			
Delay (s)		20.2			4.7		24.4	24.4	24.4			
Level of Service		C			A		C	C	C			
Approach Delay (s)		20.2			4.7			24.4			0.0	
Approach LOS		C			A			C			A	

Intersection Summary			
HCM Average Control Delay	14.6	HCM Level of Service	B
HCM Volume to Capacity ratio	0.75		
Actuated Cycle Length (s)	75.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	85.6%	ICU Level of Service	E
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	41	7	15	0	1	21	15	594	10	267	516	94
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0			4.0			4.0		4.0	4.0	
Lane Util. Factor	1.00	1.00			1.00			0.95		1.00	0.95	
Frpb, ped/bikes	1.00	1.00			0.99			1.00		1.00	1.00	
Flpb, ped/bikes	1.00	1.00			1.00			1.00		1.00	1.00	
Frt	1.00	0.90			0.85			1.00		1.00	0.98	
Flt Protected	0.95	1.00			1.00			1.00		0.95	1.00	
Satd. Flow (prot)	1736	1641			1542			3458		1736	3379	
Flt Permitted	0.95	1.00			1.00			0.92		0.95	1.00	
Satd. Flow (perm)	1736	1641			1542			3199		1736	3379	
Peak-hour factor, PHF	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72
Adj. Flow (vph)	57	10	21	0	1	29	21	825	14	371	717	131
RTOR Reduction (vph)	0	16	0	0	26	0	0	1	0	0	9	0
Lane Group Flow (vph)	57	15	0	0	4	0	0	859	0	371	839	0
Confl. Peds. (#/hr)	3					3	2					2
Confl. Bikes (#/hr)												1
Heavy Vehicles (%)	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%
Turn Type	Prot			Prot			Perm			Prot		
Protected Phases	3	8		7	4			2		1	6	
Permitted Phases							2					
Actuated Green, G (s)	4.0	14.8			6.8			18.3		13.4	35.7	
Effective Green, g (s)	4.0	14.8			6.8			18.3		13.4	35.7	
Actuated g/C Ratio	0.07	0.25			0.12			0.31		0.23	0.61	
Clearance Time (s)	4.0	4.0			4.0			4.0		4.0	4.0	
Vehicle Extension (s)	3.0	3.0			3.0			3.0		3.0	3.0	
Lane Grp Cap (vph)	119	415			179			1001		398	2062	
v/s Ratio Prot	c0.03	c0.01			0.00					c0.21	0.25	
v/s Ratio Perm								c0.27				
v/c Ratio	0.48	0.04			0.02			0.86		0.93	0.41	
Uniform Delay, d1	26.2	16.5			22.9			18.9		22.1	5.9	
Progression Factor	1.00	1.00			1.00			1.00		1.00	1.00	
Incremental Delay, d2	3.0	0.0			0.1			7.4		28.5	0.1	
Delay (s)	29.3	16.5			23.0			26.3		50.6	6.0	
Level of Service	C	B			C			C		D	A	
Approach Delay (s)		24.8			23.0			26.3			19.6	
Approach LOS		C			C			C			B	

Intersection Summary			
HCM Average Control Delay	22.5	HCM Level of Service	C
HCM Volume to Capacity ratio	0.66		
Actuated Cycle Length (s)	58.5	Sum of lost time (s)	12.0
Intersection Capacity Utilization	53.7%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	179	61	11	15	11	75	5	352	131	310	71	130
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0		4.0	4.0		4.0	4.0	
Lane Util. Factor	1.00	0.95	1.00	1.00	0.95		1.00	0.95		1.00	0.95	
Frpb, ped/bikes	1.00	1.00	1.00	1.00	0.99		1.00	1.00		1.00	0.99	
Flpb, ped/bikes	1.00	1.00	1.00	1.00	1.00		1.00	1.00		1.00	1.00	
Frt	1.00	1.00	0.85	1.00	0.87		1.00	0.96		1.00	0.90	
Flt Protected	0.95	1.00	1.00	0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1770	3539	1583	1770	3037		1765	3383		1770	3162	
Flt Permitted	0.95	1.00	1.00	0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (perm)	1770	3539	1583	1770	3037		1765	3383		1770	3162	
Peak-hour factor, PHF	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79
Adj. Flow (vph)	227	77	14	19	14	95	6	446	166	392	90	165
RTOR Reduction (vph)	0	0	10	0	83	0	0	39	0	0	82	0
Lane Group Flow (vph)	227	77	4	19	26	0	6	573	0	392	173	0
Confl. Peds. (#/hr)	3					3	4					4
Confl. Bikes (#/hr)									1			1
Turn Type	Prot		Perm	Prot			Prot			Prot		
Protected Phases	7	4		3	8		5	2		1	6	
Permitted Phases			4									
Actuated Green, G (s)	12.3	21.5	21.5	0.6	9.8		0.6	19.8		20.4	39.6	
Effective Green, g (s)	12.3	21.5	21.5	0.6	9.8		0.6	19.8		20.4	39.6	
Actuated g/C Ratio	0.16	0.27	0.27	0.01	0.13		0.01	0.25		0.26	0.51	
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0		4.0	4.0		4.0	4.0	
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	278	972	435	14	380		14	855		461	1599	
v/s Ratio Prot	c0.13	c0.02		0.01	0.01		0.00	c0.17		c0.22	0.05	
v/s Ratio Perm			0.00									
v/c Ratio	0.82	0.08	0.01	1.36	0.07		0.43	0.67		0.85	0.11	
Uniform Delay, d1	31.9	21.1	20.7	38.9	30.2		38.7	26.3		27.5	10.1	
Progression Factor	1.00	1.00	1.00	1.00	1.00		1.00	1.00		1.00	1.00	
Incremental Delay, d2	16.7	0.0	0.0	371.9	0.1		19.7	2.1		14.0	0.0	
Delay (s)	48.6	21.1	20.7	410.7	30.3		58.4	28.4		41.5	10.1	
Level of Service	D	C	C	F	C		E	C		D	B	
Approach Delay (s)		40.7			86.8			28.7			29.1	
Approach LOS		D			F			C			C	

Intersection Summary			
HCM Average Control Delay	35.4	HCM Level of Service	D
HCM Volume to Capacity ratio	0.63		
Actuated Cycle Length (s)	78.3	Sum of lost time (s)	12.0
Intersection Capacity Utilization	57.7%	ICU Level of Service	B
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	45	319	13	7	67	121	3	11	15	385	21	99
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0		4.0	4.0			4.0	
Lane Util. Factor	1.00	1.00		1.00	1.00		1.00	1.00			1.00	
Frpb, ped/bikes	1.00	1.00		1.00	1.00		1.00	0.99			1.00	
Flpb, ped/bikes	1.00	1.00		1.00	1.00		1.00	1.00			1.00	
Frt	1.00	0.99		1.00	0.90		1.00	0.91			0.97	
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00			0.96	
Satd. Flow (prot)	1556	1628		1556	1480		1556	1473			1534	
Flt Permitted	0.95	1.00		0.95	1.00		0.50	1.00			0.75	
Satd. Flow (perm)	1556	1628		1556	1480		814	1473			1202	
Peak-hour factor, PHF	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76
Adj. Flow (vph)	59	420	17	9	88	159	4	14	20	507	28	130
RTOR Reduction (vph)	0	1	0	0	59	0	0	8	0	0	6	0
Lane Group Flow (vph)	59	436	0	9	188	0	4	26	0	0	659	0
Confl. Peds. (#/hr)									2	2		
Confl. Bikes (#/hr)									2			
Heavy Vehicles (%)	16%	16%	16%	16%	16%	16%	16%	16%	16%	16%	16%	16%
Turn Type	Prot			Prot			Perm			Perm		
Protected Phases	7	4		3	8			2			6	
Permitted Phases							2			6		
Actuated Green, G (s)	7.3	31.2		1.4	25.3		62.1	62.1			62.1	
Effective Green, g (s)	7.3	31.2		1.4	25.3		62.1	62.1			62.1	
Actuated g/C Ratio	0.07	0.29		0.01	0.24		0.58	0.58			0.58	
Clearance Time (s)	4.0	4.0		4.0	4.0		4.0	4.0			4.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0			3.0	
Lane Grp Cap (vph)	106	476		20	351		474	857			700	
v/s Ratio Prot	c0.04	c0.27		0.01	0.13			0.02				
v/s Ratio Perm							0.00				c0.55	
v/c Ratio	0.56	0.92		0.45	0.54		0.01	0.03			0.94	
Uniform Delay, d1	48.1	36.5		52.3	35.6		9.4	9.5			20.6	
Progression Factor	1.00	1.00		1.00	1.00		1.00	1.00			1.00	
Incremental Delay, d2	6.2	22.1		15.3	1.6		0.0	0.0			20.8	
Delay (s)	54.3	58.6		67.5	37.2		9.4	9.5			41.4	
Level of Service	D	E		E	D		A	A			D	
Approach Delay (s)		58.1			38.2			9.5			41.4	
Approach LOS		E			D			A			D	

Intersection Summary			
HCM Average Control Delay	45.7	HCM Level of Service	D
HCM Volume to Capacity ratio	0.94		
Actuated Cycle Length (s)	106.7	Sum of lost time (s)	12.0
Intersection Capacity Utilization	66.0%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Volume (vph)	192	367	571	317	59	90
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0		4.0	4.0	4.0	4.0
Lane Util. Factor	1.00		1.00	1.00	1.00	1.00
Frt	0.91		1.00	1.00	1.00	0.85
Flt Protected	1.00		0.95	1.00	0.95	1.00
Satd. Flow (prot)	1649		1719	1810	1719	1538
Flt Permitted	1.00		0.11	1.00	0.95	1.00
Satd. Flow (perm)	1649		207	1810	1719	1538
Peak-hour factor, PHF	0.85	0.85	0.85	0.85	0.85	0.85
Adj. Flow (vph)	226	432	672	373	69	106
RTOR Reduction (vph)	73	0	0	0	0	95
Lane Group Flow (vph)	585	0	672	373	69	11
Heavy Vehicles (%)	5%	5%	5%	5%	5%	5%
Turn Type			pm+pt			Perm
Protected Phases	4		3	8	2	
Permitted Phases			8			2
Actuated Green, G (s)	31.0		65.0	65.0	8.6	8.6
Effective Green, g (s)	31.0		65.0	65.0	8.6	8.6
Actuated g/C Ratio	0.38		0.80	0.80	0.11	0.11
Clearance Time (s)	4.0		4.0	4.0	4.0	4.0
Vehicle Extension (s)	3.0		3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	626		721	1442	181	162
v/s Ratio Prot	0.36		c0.34	0.21	c0.04	
v/s Ratio Perm			c0.40			0.01
v/c Ratio	0.94		0.93	0.26	0.38	0.07
Uniform Delay, d1	24.3		20.3	2.1	34.0	32.9
Progression Factor	1.00		1.00	1.00	1.00	1.00
Incremental Delay, d2	21.3		18.8	0.1	1.3	0.2
Delay (s)	45.6		39.1	2.2	35.4	33.1
Level of Service	D		D	A	D	C
Approach Delay (s)	45.6			25.9	34.0	
Approach LOS	D			C	C	

Intersection Summary			
HCM Average Control Delay	33.6	HCM Level of Service	C
HCM Volume to Capacity ratio	0.85		
Actuated Cycle Length (s)	81.6	Sum of lost time (s)	8.0
Intersection Capacity Utilization	77.6%	ICU Level of Service	D
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	5	6	7	412	7	15	26	912	146	167	179	3
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Lane Util. Factor		1.00		1.00	1.00		1.00	0.95		0.97	1.00	
Frpb, ped/bikes		1.00		1.00	1.00		1.00	1.00		1.00	1.00	
Flpb, ped/bikes		1.00		1.00	1.00		1.00	1.00		1.00	1.00	
Frt		0.95		1.00	0.90		1.00	0.98		1.00	1.00	
Flt Protected		0.99		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)		1700		1736	1641		1736	3399		3367	1822	
Flt Permitted		0.96		0.74	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (perm)		1661		1359	1641		1736	3399		3367	1822	
Peak-hour factor, PHF	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88
Adj. Flow (vph)	6	7	8	468	8	17	30	1036	166	190	203	3
RTOR Reduction (vph)	0	5	0	0	11	0	0	14	0	0	1	0
Lane Group Flow (vph)	0	16	0	468	14	0	30	1188	0	190	205	0
Confl. Bikes (#/hr)			1									1
Heavy Vehicles (%)	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%
Turn Type	Perm			Perm			Prot			Prot		
Protected Phases		4			8		5	2		1	6	
Permitted Phases	4			8								
Actuated Green, G (s)		32.2		32.2	32.2		3.4	35.8		6.1	38.5	
Effective Green, g (s)		32.2		32.2	32.2		3.4	35.8		6.1	38.5	
Actuated g/C Ratio		0.37		0.37	0.37		0.04	0.42		0.07	0.45	
Clearance Time (s)		4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Vehicle Extension (s)		3.0		3.0	3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)		621		508	614		69	1413		239	815	
v/s Ratio Prot					0.01		0.02	c0.35		c0.06	c0.11	
v/s Ratio Perm		0.01		c0.34								
v/c Ratio		0.03		0.92	0.02		0.43	0.84		0.79	0.25	
Uniform Delay, d1		17.0		25.7	17.0		40.4	22.6		39.4	14.8	
Progression Factor		1.00		1.00	1.00		1.00	1.00		1.00	1.00	
Incremental Delay, d2		0.0		22.2	0.0		4.3	4.7		16.5	0.2	
Delay (s)		17.1		48.0	17.0		44.8	27.3		55.9	15.0	
Level of Service		B		D	B		D	C		E	B	
Approach Delay (s)		17.1			46.4			27.7			34.6	
Approach LOS		B			D			C			C	

Intersection Summary			
HCM Average Control Delay	33.2	HCM Level of Service	C
HCM Volume to Capacity ratio	0.91		
Actuated Cycle Length (s)	86.1	Sum of lost time (s)	16.0
Intersection Capacity Utilization	74.1%	ICU Level of Service	D
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	0	0	521	0	63	10	588	0	0	563	373
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)				4.0	4.0		4.0	4.0			4.0	
Lane Util. Factor				1.00	1.00		1.00	0.95			0.95	
Frpb, ped/bikes				1.00	1.00		1.00	1.00			0.99	
Flpb, ped/bikes				1.00	1.00		1.00	1.00			1.00	
Frt				1.00	0.85		1.00	1.00			0.94	
Flt Protected				0.95	1.00		0.95	1.00			1.00	
Satd. Flow (prot)				1736	1553		1736	3471			3235	
Flt Permitted				0.95	1.00		0.95	1.00			1.00	
Satd. Flow (perm)				1736	1553		1736	3471			3235	
Peak-hour factor, PHF	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88
Adj. Flow (vph)	0	0	0	592	0	72	11	668	0	0	640	424
RTOR Reduction (vph)	0	0	0	0	42	0	0	0	0	0	86	0
Lane Group Flow (vph)	0	0	0	592	30	0	11	668	0	0	978	0
Confl. Peds. (#/hr)							1					1
Confl. Bikes (#/hr)									2			1
Heavy Vehicles (%)	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%
Turn Type				Split			Prot					
Protected Phases				8	8		5	2			6	
Permitted Phases												
Actuated Green, G (s)				36.7	36.7		3.9	42.6			34.7	
Effective Green, g (s)				36.7	36.7		3.9	42.6			34.7	
Actuated g/C Ratio				0.42	0.42		0.04	0.49			0.40	
Clearance Time (s)				4.0	4.0		4.0	4.0			4.0	
Vehicle Extension (s)				3.0	3.0		3.0	3.0			3.0	
Lane Grp Cap (vph)				730	653		78	1694			1286	
v/s Ratio Prot				c0.34	0.02		0.01	c0.19			c0.30	
v/s Ratio Perm												
v/c Ratio				0.81	0.05		0.14	0.39			0.76	
Uniform Delay, d1				22.2	15.0		40.1	14.2			22.7	
Progression Factor				1.00	1.00		1.00	1.00			1.00	
Incremental Delay, d2				6.8	0.0		0.8	0.2			2.7	
Delay (s)				29.1	15.0		40.9	14.3			25.4	
Level of Service				C	B		D	B			C	
Approach Delay (s)		0.0			27.5			14.8			25.4	
Approach LOS		A			C			B			C	

Intersection Summary			
HCM Average Control Delay	23.0	HCM Level of Service	C
HCM Volume to Capacity ratio	0.77		
Actuated Cycle Length (s)	87.3	Sum of lost time (s)	12.0
Intersection Capacity Utilization	63.1%	ICU Level of Service	B
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	883	122	78	351	0	0	0	0	388	23	500
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0			4.0						4.0	
Lane Util. Factor		0.95			0.95						1.00	
Frpb, ped/bikes		1.00			1.00						1.00	
Flpb, ped/bikes		1.00			1.00						1.00	
Frt		0.98			1.00						0.93	
Flt Protected		1.00			0.99						0.98	
Satd. Flow (prot)		3461			3506						1689	
Flt Permitted		1.00			0.55						0.98	
Satd. Flow (perm)		3461			1943						1689	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	0	960	133	85	382	0	0	0	0	422	25	543
RTOR Reduction (vph)	0	14	0	0	0	0	0	0	0	0	58	0
Lane Group Flow (vph)	0	1079	0	0	467	0	0	0	0	0	932	0
Confl. Peds. (#/hr)	5		9	9		5						
Confl. Bikes (#/hr)						2						
Turn Type				Perm						Split		
Protected Phases		4			8					6	6	
Permitted Phases				8								
Actuated Green, G (s)		25.9			25.9						41.1	
Effective Green, g (s)		25.9			25.9						41.1	
Actuated g/C Ratio		0.35			0.35						0.55	
Clearance Time (s)		4.0			4.0						4.0	
Vehicle Extension (s)		3.0			3.0						3.0	
Lane Grp Cap (vph)		1195			671						926	
v/s Ratio Prot		c0.31									c0.55	
v/s Ratio Perm					0.24							
v/c Ratio		0.90			0.86dl						1.01	
Uniform Delay, d1		23.4			21.2						16.9	
Progression Factor		1.00			0.94						1.00	
Incremental Delay, d2		9.6			3.0						31.1	
Delay (s)		33.0			22.9						48.0	
Level of Service		C			C						D	
Approach Delay (s)		33.0			22.9			0.0			48.0	
Approach LOS		C			C			A			D	

Intersection Summary			
HCM Average Control Delay	37.0	HCM Level of Service	D
HCM Volume to Capacity ratio	0.97		
Actuated Cycle Length (s)	75.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	105.1%	ICU Level of Service	G
Analysis Period (min)	15		

dl Defacto Left Lane. Recode with 1 though lane as a left lane.
c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	81	333	61	150	338	105	146	812	165	60	272	41
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	4.0	4.0	3.0	4.0	4.0	3.0	3.0	3.0	3.0	3.0	
Lane Util. Factor	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	
Frpb, ped/bikes	1.00	1.00	0.97	1.00	1.00	0.98	1.00	1.00	0.97	1.00	1.00	
Flpb, ped/bikes	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	0.98	
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	
Satd. Flow (prot)	1770	3539	1536	1770	3539	1555	1770	3539	1543	1770	3462	
Flt Permitted	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	
Satd. Flow (perm)	1770	3539	1536	1770	3539	1555	1770	3539	1543	1770	3462	
Peak-hour factor, PHF	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Adj. Flow (vph)	90	370	68	167	376	117	162	902	183	67	302	46
RTOR Reduction (vph)	0	0	24	0	0	56	0	0	48	0	10	0
Lane Group Flow (vph)	90	370	44	167	376	61	162	902	135	67	338	0
Confl. Peds. (#/hr)	5		19	19		5	4		14	14		4
Confl. Bikes (#/hr)						1			1			
Turn Type	Prot		Perm	Prot		Perm	Prot		Perm	Prot		
Protected Phases	5	2		1	6		3	8		7	4	
Permitted Phases			2			6			8			
Actuated Green, G (s)	7.1	17.0	17.0	12.0	19.9	19.9	11.8	29.8	29.8	6.2	24.2	
Effective Green, g (s)	7.1	17.0	17.0	12.0	19.9	19.9	11.8	29.8	29.8	6.2	24.2	
Actuated g/C Ratio	0.09	0.22	0.22	0.15	0.26	0.26	0.15	0.38	0.38	0.08	0.31	
Clearance Time (s)	5.0	4.0	4.0	3.0	4.0	4.0	3.0	3.0	3.0	3.0	3.0	
Vehicle Extension (s)	2.0	4.0	4.0	2.0	4.0	4.0	2.0	2.0	2.0	2.0	2.0	
Lane Grp Cap (vph)	161	771	335	272	903	397	268	1352	590	141	1074	
v/s Ratio Prot	0.05	c0.10		c0.09	c0.11		c0.09	c0.25		0.04	0.10	
v/s Ratio Perm			0.03			0.04			0.09			
v/c Ratio	0.56	0.48	0.13	0.61	0.42	0.15	0.60	0.67	0.23	0.48	0.32	
Uniform Delay, d1	34.0	26.6	24.6	30.8	24.2	22.5	30.9	20.0	16.3	34.3	20.6	
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	
Incremental Delay, d2	2.4	0.6	0.2	2.9	0.4	0.2	2.6	1.0	0.1	0.9	0.1	
Delay (s)	36.3	27.3	24.8	33.7	24.6	22.8	33.6	21.0	16.4	35.3	20.6	
Level of Service	D	C	C	C	C	C	C	C	B	D	C	
Approach Delay (s)		28.5			26.6			21.9			23.0	
Approach LOS		C			C			C			C	

Intersection Summary			
HCM Average Control Delay	24.4	HCM Level of Service	C
HCM Volume to Capacity ratio	0.61		
Actuated Cycle Length (s)	78.0	Sum of lost time (s)	14.0
Intersection Capacity Utilization	61.7%	ICU Level of Service	B
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	0	0	307	2	689	0	482	301	0	382	113
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)				4.0	4.0	4.0		4.0	4.0		4.0	
Lane Util. Factor				0.95	0.91	0.95		0.91	1.00		0.91	
Frt				1.00	0.86	0.85		1.00	0.85		0.97	
Flt Protected				0.95	1.00	1.00		1.00	1.00		1.00	
Satd. Flow (prot)				1698	1472	1519		5136	1599		4960	
Flt Permitted				0.95	1.00	1.00		1.00	1.00		1.00	
Satd. Flow (perm)				1698	1472	1519		5136	1599		4960	
Peak-hour factor, PHF	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94
Adj. Flow (vph)	0	0	0	327	2	733	0	513	320	0	406	120
RTOR Reduction (vph)	0	0	0	0	100	100	0	0	0	0	85	0
Lane Group Flow (vph)	0	0	0	294	287	281	0	513	320	0	441	0
Heavy Vehicles (%)	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%
Turn Type				Split		Perm			Free			
Protected Phases				8	8			2			6	
Permitted Phases						8			Free			
Actuated Green, G (s)				16.1	16.1	16.1		9.9	34.0		9.9	
Effective Green, g (s)				16.1	16.1	16.1		9.9	34.0		9.9	
Actuated g/C Ratio				0.47	0.47	0.47		0.29	1.00		0.29	
Clearance Time (s)				4.0	4.0	4.0		4.0			4.0	
Vehicle Extension (s)				3.0	3.0	3.0		3.0			3.0	
Lane Grp Cap (vph)				804	697	719		1495	1599		1444	
v/s Ratio Prot				0.17	c0.19			c0.10			0.09	
v/s Ratio Perm						0.18			0.20			
v/c Ratio				0.37	0.41	0.39		0.34	0.20		0.31	
Uniform Delay, d1				5.7	5.9	5.8		9.5	0.0		9.4	
Progression Factor				1.00	1.00	1.00		1.00	1.00		1.00	
Incremental Delay, d2				0.3	0.4	0.4		0.1	0.3		0.1	
Delay (s)				6.0	6.3	6.1		9.6	0.3		9.5	
Level of Service				A	A	A		A	A		A	
Approach Delay (s)		0.0			6.1			6.0			9.5	
Approach LOS		A			A			A			A	

Intersection Summary			
HCM Average Control Delay	6.8	HCM Level of Service	A
HCM Volume to Capacity ratio	0.39		
Actuated Cycle Length (s)	34.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	44.4%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	213	0	161	0	0	0	0	569	364	0	458	232
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0		4.0					4.0			4.0	4.0
Lane Util. Factor	1.00		1.00					0.91			0.95	1.00
Frpb, ped/bikes	1.00		1.00					0.99			1.00	0.98
Flpb, ped/bikes	1.00		1.00					1.00			1.00	1.00
Frt	1.00		0.85					0.94			1.00	0.85
Flt Protected	0.95		1.00					1.00			1.00	1.00
Satd. Flow (prot)	1770		1583					4742			3539	1549
Flt Permitted	0.95		1.00					1.00			1.00	1.00
Satd. Flow (perm)	1770		1583					4742			3539	1549
Peak-hour factor, PHF	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86
Adj. Flow (vph)	248	0	187	0	0	0	0	662	423	0	533	270
RTOR Reduction (vph)	0	0	124	0	0	0	0	166	0	0	0	0
Lane Group Flow (vph)	248	0	63	0	0	0	0	919	0	0	533	270
Confl. Peds. (#/hr)							4		2	2		4
Confl. Bikes (#/hr)									3			
Turn Type	Split		Perm									Free
Protected Phases	8	8						2			6	
Permitted Phases			8									Free
Actuated Green, G (s)	12.8		12.8					17.4			17.4	38.2
Effective Green, g (s)	12.8		12.8					17.4			17.4	38.2
Actuated g/C Ratio	0.34		0.34					0.46			0.46	1.00
Clearance Time (s)	4.0		4.0					4.0			4.0	
Vehicle Extension (s)	3.0		3.0					3.0			3.0	
Lane Grp Cap (vph)	593		530					2160			1612	1549
v/s Ratio Prot	c0.14							c0.19			0.15	
v/s Ratio Perm			0.04									0.17
v/c Ratio	0.42		0.12					0.43			0.33	0.17
Uniform Delay, d1	9.8		8.8					7.0			6.7	0.0
Progression Factor	1.00		1.00					1.00			1.00	1.00
Incremental Delay, d2	0.5		0.1					0.1			0.1	0.2
Delay (s)	10.3		8.9					7.2			6.8	0.2
Level of Service	B		A					A			A	A
Approach Delay (s)		9.7			0.0			7.2			4.6	
Approach LOS		A			A			A			A	

Intersection Summary			
HCM Average Control Delay	6.7	HCM Level of Service	A
HCM Volume to Capacity ratio	0.42		
Actuated Cycle Length (s)	38.2	Sum of lost time (s)	8.0
Intersection Capacity Utilization	37.7%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	146	1	59	9	8	216	21	571	0	11	516	91
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0		4.0	4.0			4.0		4.0	4.0	
Lane Util. Factor		1.00		1.00	1.00			0.95		1.00	0.95	
Frpb, ped/bikes		0.99		1.00	0.99			1.00		1.00	1.00	
Flpb, ped/bikes		1.00		1.00	1.00			1.00		0.95	1.00	
Frt		0.96		1.00	0.86			1.00		1.00	0.98	
Flt Protected		0.97		0.95	1.00			1.00		0.95	1.00	
Satd. Flow (prot)		1697		1751	1557			3499		1671	3415	
Flt Permitted		1.00		0.61	1.00			0.92		0.95	1.00	
Satd. Flow (perm)		1757		1122	1557			3224		1671	3415	
Peak-hour factor, PHF	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85
Adj. Flow (vph)	172	1	69	11	9	254	25	672	0	13	607	107
RTOR Reduction (vph)	0	14	0	0	199	0	0	0	0	0	12	0
Lane Group Flow (vph)	0	228	0	11	64	0	0	697	0	13	702	0
Confl. Peds. (#/hr)	1		3	3		1			5	5		
Confl. Bikes (#/hr)						1			2			1
Heavy Vehicles (%)	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%
Turn Type	Perm			Perm			Perm			Prot		
Protected Phases		3			4			2		1	6	
Permitted Phases	3			4			2					
Actuated Green, G (s)		2.3		11.2	11.2			21.4		0.8	26.2	
Effective Green, g (s)		2.3		11.2	11.2			21.4		0.8	26.2	
Actuated g/C Ratio		0.04		0.22	0.22			0.41		0.02	0.51	
Clearance Time (s)		4.0		4.0	4.0			4.0		4.0	4.0	
Vehicle Extension (s)		3.0		3.0	3.0			3.0		3.0	3.0	
Lane Grp Cap (vph)		78		243	337			1334		26	1731	
v/s Ratio Prot					c0.04					0.01	c0.21	
v/s Ratio Perm		c0.13		0.01				c0.22				
v/c Ratio		2.92		0.05	0.19			0.52		0.50	0.41	
Uniform Delay, d1		24.7		16.0	16.5			11.3		25.3	7.9	
Progression Factor		1.00		1.00	1.00			1.00		1.00	1.00	
Incremental Delay, d2		897.2		0.1	0.3			0.4		14.3	0.2	
Delay (s)		921.9		16.1	16.8			11.7		39.6	8.1	
Level of Service		F		B	B			B		D	A	
Approach Delay (s)		921.9			16.8			11.7			8.6	
Approach LOS		F			B			B			A	

Intersection Summary			
HCM Average Control Delay	124.8	HCM Level of Service	F
HCM Volume to Capacity ratio	0.59		
Actuated Cycle Length (s)	51.7	Sum of lost time (s)	16.0
Intersection Capacity Utilization	67.8%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	156	12	13	60	42	290	14	141	20	47	317	165
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0		4.0	4.0		4.0	4.0	
Lane Util. Factor	1.00	0.95	1.00	1.00	0.95		1.00	0.95		1.00	0.95	
Frpb, ped/bikes	1.00	1.00	1.00	1.00	0.99		1.00	1.00		1.00	0.99	
Flpb, ped/bikes	1.00	1.00	1.00	1.00	1.00		1.00	1.00		1.00	1.00	
Frt	1.00	1.00	0.85	1.00	0.87		1.00	0.98		1.00	0.95	
Flt Protected	0.95	1.00	1.00	0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1770	3539	1583	1770	3041		1763	3467		1770	3334	
Flt Permitted	0.95	1.00	1.00	0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (perm)	1770	3539	1583	1770	3041		1763	3467		1770	3334	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	164	13	14	63	44	305	15	148	21	49	334	174
RTOR Reduction (vph)	0	0	14	0	229	0	0	14	0	0	78	0
Lane Group Flow (vph)	164	13	0	63	120	0	15	155	0	49	430	0
Confl. Peds. (#/hr)							16		1	1		16
Confl. Bikes (#/hr)						1			1			
Turn Type	Prot		Perm	Prot			Prot			Prot		
Protected Phases	7	4		3	8		5	2		1	6	
Permitted Phases			4									
Actuated Green, G (s)	2.1	1.3	1.3	11.3	10.5		0.3	10.2		3.5	13.4	
Effective Green, g (s)	2.1	1.3	1.3	11.3	10.5		0.3	10.2		3.5	13.4	
Actuated g/C Ratio	0.05	0.03	0.03	0.27	0.25		0.01	0.24		0.08	0.32	
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0		4.0	4.0		4.0	4.0	
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	88	109	49	473	755		13	836		146	1056	
v/s Ratio Prot	c0.09	0.00		0.04	c0.04		0.01	0.04		c0.03	c0.13	
v/s Ratio Perm			0.00									
v/c Ratio	1.86	0.12	0.01	0.13	0.16		1.15	0.18		0.34	0.41	
Uniform Delay, d1	20.1	19.9	19.9	11.8	12.4		21.0	12.7		18.3	11.3	
Progression Factor	1.00	1.00	1.00	1.00	1.00		1.00	1.00		1.00	1.00	
Incremental Delay, d2	428.7	0.5	0.1	0.1	0.1		305.0	0.1		1.4	0.3	
Delay (s)	448.8	20.4	19.9	11.9	12.5		326.0	12.9		19.7	11.6	
Level of Service	F	C	B	B	B		F	B		B	B	
Approach Delay (s)		388.2			12.4			38.4			12.3	
Approach LOS		F			B			D			B	

Intersection Summary			
HCM Average Control Delay	69.3	HCM Level of Service	E
HCM Volume to Capacity ratio	0.44		
Actuated Cycle Length (s)	42.3	Sum of lost time (s)	16.0
Intersection Capacity Utilization	52.7%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Volume (veh/h)	91	40	284	294	131	56
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.91	0.91	0.91	0.91	0.91	0.91
Hourly flow rate (vph)	100	44	312	323	144	62
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)				1133		
pX, platoon unblocked						
vC, conflicting volume			144		1047	100
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			144		1047	100
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			78		26	94
cM capacity (veh/h)			1426		196	950

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	NB 1	NB 2
Volume Total	100	44	312	323	144	62
Volume Left	0	0	312	0	144	0
Volume Right	0	44	0	0	0	62
cSH	1700	1700	1426	1700	196	950
Volume to Capacity	0.06	0.03	0.22	0.19	0.74	0.06
Queue Length 95th (ft)	0	0	21	0	120	5
Control Delay (s)	0.0	0.0	8.2	0.0	62.1	9.1
Lane LOS			A		F	A
Approach Delay (s)	0.0		4.0		46.2	
Approach LOS					E	

Intersection Summary			
Average Delay	12.3		
Intersection Capacity Utilization	36.3%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	106	49	1	1	179	462	8	11	2	95	8	44
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0		4.0	4.0			4.0	
Lane Util. Factor	1.00	1.00		1.00	1.00		1.00	1.00			1.00	
Frt	1.00	1.00		1.00	0.89		1.00	0.98			0.96	
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00			0.97	
Satd. Flow (prot)	1626	1707		1626	1527		1626	1675			1591	
Flt Permitted	0.95	1.00		0.95	1.00		0.69	1.00			0.80	
Satd. Flow (perm)	1626	1707		1626	1527		1188	1675			1308	
Peak-hour factor, PHF	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88
Adj. Flow (vph)	120	56	1	1	203	525	9	12	2	108	9	50
RTOR Reduction (vph)	0	0	0	0	130	0	0	2	0	0	29	0
Lane Group Flow (vph)	120	57	0	1	598	0	9	12	0	0	138	0
Heavy Vehicles (%)	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%
Turn Type	Prot			Prot			Perm			Perm		
Protected Phases	7	4		3	8			2			6	
Permitted Phases							2			6		
Actuated Green, G (s)	4.8	30.3		0.9	26.4		8.3	8.3			8.3	
Effective Green, g (s)	4.8	30.3		0.9	26.4		8.3	8.3			8.3	
Actuated g/C Ratio	0.09	0.59		0.02	0.51		0.16	0.16			0.16	
Clearance Time (s)	4.0	4.0		4.0	4.0		4.0	4.0			4.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0			3.0	
Lane Grp Cap (vph)	152	1004		28	783		191	270			211	
v/s Ratio Prot	c0.07	c0.03		0.00	c0.39			0.01				
v/s Ratio Perm							0.01				c0.11	
v/c Ratio	0.79	0.06		0.04	0.76		0.05	0.05			0.65	
Uniform Delay, d1	22.9	4.5		24.9	10.1		18.3	18.3			20.2	
Progression Factor	1.00	1.00		1.00	1.00		1.00	1.00			1.00	
Incremental Delay, d2	23.2	0.0		0.5	4.5		0.1	0.1			7.0	
Delay (s)	46.1	4.5		25.4	14.5		18.4	18.3			27.3	
Level of Service	D	A		C	B		B	B			C	
Approach Delay (s)		32.7			14.5			18.3			27.3	
Approach LOS		C			B			B			C	

Intersection Summary			
HCM Average Control Delay	19.5	HCM Level of Service	B
HCM Volume to Capacity ratio	0.78		
Actuated Cycle Length (s)	51.5	Sum of lost time (s)	16.0
Intersection Capacity Utilization	68.7%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Volume (veh/h)	96	51	53	518	125	40
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	104	55	58	563	136	43
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)	322					
pX, platoon unblocked						
vC, conflicting volume			104		810	132
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			104		810	132
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			96		60	95
cM capacity (veh/h)			1487		336	917

Direction, Lane #	EB 1	WB 1	WB 2	NB 1
Volume Total	160	58	563	179
Volume Left	0	58	0	136
Volume Right	55	0	0	43
cSH	1700	1487	1700	397
Volume to Capacity	0.09	0.04	0.33	0.45
Queue Length 95th (ft)	0	3	0	57
Control Delay (s)	0.0	7.5	0.0	21.4
Lane LOS		A		C
Approach Delay (s)	0.0	0.7		21.4
Approach LOS				C

Intersection Summary			
Average Delay	4.4		
Intersection Capacity Utilization	43.3%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Volume (veh/h)	315	54	83	86	349	545
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.78	0.78	0.78	0.78	0.78	0.78
Hourly flow rate (vph)	404	69	106	110	447	699
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume			473		762	438
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			473		762	438
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			90		0	0
cM capacity (veh/h)			1089		337	618

Direction, Lane #	EB 1	WB 1	WB 2	NB 1
Volume Total	473	106	110	1146
Volume Left	0	106	0	447
Volume Right	69	0	0	699
cSH	1700	1089	1700	466
Volume to Capacity	0.28	0.10	0.06	2.46
Queue Length 95th (ft)	0	8	0	2245
Control Delay (s)	0.0	8.7	0.0	682.1
Lane LOS		A		F
Approach Delay (s)	0.0	4.3		682.1
Approach LOS				F

Intersection Summary			
Average Delay	426.3		
Intersection Capacity Utilization	87.3%	ICU Level of Service	E
Analysis Period (min)	15		

Intersection	
Intersection Delay (sec/veh)	49.4
Intersection LOS	E

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Volume (vph)	0	10	7	400	0	5	9	154	62	476	401	3
Peak Hour Factor	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85
Heavy Vehicles(%)	2	2	2	2	2	2	2	2	2	2	2	2
Movement Flow Rate	0	12	8	471	0	6	11	181	73	560	472	4
Number of Lanes	0	1	0	1	1	0	1	2	0	1	2	0

Approach	EB	WB	NB	SB
Opposing Approach	WB	EB	SB	NB
Opposing Lanes	2	1	3	3
Conflicting Approach Left	SB	NB	EB	WB
Conflicting Lanes Left	3	3	1	2
Conflicting Approach Right	NB	SB	WB	EB
Conflicting Lanes Right	3	3	2	1
HCM Control Delay	12.9	73.3	15.1	47.8
HCM LOS	B	F	C	E

Lane	NBLn1	NBLn2	NBLn3	EBLn1	WBLn1	WBLn2	SBLn1	SBLn2	SBLn3
Volume Left (%)	100%	0%	0%	0%	100%	0%	100%	0%	0%
Volume Thru (%)	0%	100%	45%	59%	0%	0%	0%	100%	98%
Volume Right (%)	0%	0%	55%	41%	0%	100%	0%	0%	2%
Sign Control	Stop	Stop	Stop	Stop	Stop	Stop	Stop	Stop	Stop
Traffic Volume by Lane	9	103	113	17	400	5	476	267	137
Left Turning Volume	0	103	51	10	0	0	0	267	134
Through Volume	0	0	62	7	0	5	0	0	3
Right Turning Volume	9	0	0	0	400	0	476	0	0
Lane Flow Rate	11	121	133	20	471	6	560	315	161
Geometry Group	8	8	8	8	8	8	8	8	8
Degree of Utilization, X	0.028	0.297	0.314	0.053	1	0.012	1	0.659	0.336
Departure Headway, Hd	9.365	8.867	8.485	9.601	8.684	7.496	8.036	7.539	7.523
Convergence(Y/N)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Capacity	383	407	425	374	419	477	454	481	479
Service Time	7.094	6.596	6.214	7.343	6.43	5.241	5.756	5.258	5.243
HCM Lane V/C Ratio	0.029	0.297	0.313	0.053	1.124	0.013	1.233	0.655	0.336
HCM Control Delay	12.4	15.3	15.1	12.9	74.1	10.3	71	23.7	14
HCM Lane LOS	B	C	C	B	F	B	F	C	B
HCM 95th Percentile Queue	0.1	1.3	1.4	0.2	96.3	0	100.3	5.8	1.5

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	0	0	91	0	432	6	802	0	0	134	287
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)				4.0	4.0		4.0	4.0			4.0	
Lane Util. Factor				1.00	1.00		1.00	0.95			0.95	
Frpb, ped/bikes				1.00	1.00		1.00	1.00			0.99	
Flpb, ped/bikes				1.00	1.00		1.00	1.00			1.00	
Frt				1.00	0.85		1.00	1.00			0.90	
Flt Protected				0.95	1.00		0.95	1.00			1.00	
Satd. Flow (prot)				1787	1599		1787	3574			3163	
Flt Permitted				0.95	1.00		0.95	1.00			1.00	
Satd. Flow (perm)				1787	1599		1787	3574			3163	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	0	0	0	96	0	455	6	844	0	0	141	302
RTOR Reduction (vph)	0	0	0	0	231	0	0	0	0	0	170	0
Lane Group Flow (vph)	0	0	0	96	224	0	6	844	0	0	273	0
Confl. Peds. (#/hr)							1		2	2		1
Confl. Bikes (#/hr)			1						1			
Heavy Vehicles (%)	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%
Turn Type				Split			Prot					
Protected Phases				8	8		5	2			6	
Permitted Phases												
Actuated Green, G (s)				2.2	2.2		2.2	18.9			12.7	
Effective Green, g (s)				2.2	2.2		2.2	18.9			12.7	
Actuated g/C Ratio				0.08	0.08		0.08	0.65			0.44	
Clearance Time (s)				4.0	4.0		4.0	4.0			4.0	
Vehicle Extension (s)				3.0	3.0		3.0	3.0			3.0	
Lane Grp Cap (vph)				135	121		135	2321			1380	
v/s Ratio Prot				0.05	c0.14		0.00	c0.24			0.09	
v/s Ratio Perm												
v/c Ratio				0.71	1.85		0.04	0.36			0.20	
Uniform Delay, d1				13.1	13.5		12.5	2.3			5.1	
Progression Factor				1.00	1.00		1.00	1.00			1.00	
Incremental Delay, d2				16.2	412.7		0.1	0.1			0.1	
Delay (s)				29.3	426.2		12.6	2.4			5.1	
Level of Service				C	F		B	A			A	
Approach Delay (s)		0.0			357.0			2.5			5.1	
Approach LOS		A			F			A			A	

Intersection Summary			
HCM Average Control Delay	109.1	HCM Level of Service	F
HCM Volume to Capacity ratio	0.52		
Actuated Cycle Length (s)	29.1	Sum of lost time (s)	8.0
Intersection Capacity Utilization	55.6%	ICU Level of Service	B
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	25	163	59	325	252	39	306	175	753	15	37	38
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0		4.0	4.0	4.0		4.0	
Lane Util. Factor	1.00	0.95		0.91	0.91		0.95	0.95	1.00		1.00	
Frpb, ped/bikes	1.00	1.00		1.00	1.00		1.00	1.00	0.99		1.00	
Flpb, ped/bikes	1.00	1.00		1.00	1.00		1.00	1.00	1.00		1.00	
Frt	1.00	0.96		1.00	0.99		1.00	1.00	0.85		0.94	
Flt Protected	0.95	1.00		0.95	0.99		0.95	0.99	1.00		0.99	
Satd. Flow (prot)	1787	3431		1626	3326		1698	1762	1576		1759	
Flt Permitted	0.95	1.00		0.95	0.99		0.95	0.99	1.00		0.99	
Satd. Flow (perm)	1787	3431		1626	3326		1698	1762	1576		1759	
Peak-hour factor, PHF	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97
Adj. Flow (vph)	26	168	61	335	260	40	315	180	776	15	38	39
RTOR Reduction (vph)	0	40	0	0	8	0	0	0	536	0	31	0
Lane Group Flow (vph)	26	189	0	208	419	0	243	252	240	0	61	0
Confl. Peds. (#/hr)									2	2		
Confl. Bikes (#/hr)									1			
Heavy Vehicles (%)	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%
Turn Type	Split			Split			Split		Perm	Split		
Protected Phases	4	4		8	8		2	2		6	6	
Permitted Phases									2			
Actuated Green, G (s)	9.6	9.6		14.8	14.8		21.0	21.0	21.0		6.4	
Effective Green, g (s)	9.6	9.6		14.8	14.8		21.0	21.0	21.0		6.4	
Actuated g/C Ratio	0.14	0.14		0.22	0.22		0.31	0.31	0.31		0.09	
Clearance Time (s)	4.0	4.0		4.0	4.0		4.0	4.0	4.0		4.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0	3.0		3.0	
Lane Grp Cap (vph)	253	486		355	726		526	546	488		166	
v/s Ratio Prot	0.01	c0.05		c0.13	0.13		0.14	0.14			c0.03	
v/s Ratio Perm									c0.15			
v/c Ratio	0.10	0.39		0.59	0.58		0.46	0.46	0.49		0.37	
Uniform Delay, d1	25.3	26.4		23.8	23.7		18.8	18.8	19.1		28.8	
Progression Factor	1.00	1.00		1.00	1.00		1.00	1.00	1.00		1.00	
Incremental Delay, d2	0.2	0.5		2.5	1.1		0.6	0.6	0.8		1.4	
Delay (s)	25.5	26.9		26.2	24.8		19.5	19.5	19.8		30.2	
Level of Service	C	C		C	C		B	B	B		C	
Approach Delay (s)		26.8			25.3			19.7			30.2	
Approach LOS		C			C			B			C	

Intersection Summary			
HCM Average Control Delay	22.5	HCM Level of Service	C
HCM Volume to Capacity ratio	0.48		
Actuated Cycle Length (s)	67.8	Sum of lost time (s)	16.0
Intersection Capacity Utilization	68.3%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	917	70	53	451	0	0	0	0	283	1	234
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0			4.0						4.0	
Lane Util. Factor		0.95			0.95						1.00	
Frpb, ped/bikes		1.00			1.00						1.00	
Flpb, ped/bikes		1.00			1.00						1.00	
Frt		0.99			1.00						0.94	
Flt Protected		1.00			0.99						0.97	
Satd. Flow (prot)		3528			3555						1719	
Flt Permitted		1.00			0.73						0.97	
Satd. Flow (perm)		3528			2623						1719	
Peak-hour factor, PHF	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96
Adj. Flow (vph)	0	955	73	55	470	0	0	0	0	295	1	244
RTOR Reduction (vph)	0	13	0	0	0	0	0	0	0	0	27	0
Lane Group Flow (vph)	0	1015	0	0	525	0	0	0	0	0	513	0
Confl. Peds. (#/hr)	3		8	8		3						
Confl. Bikes (#/hr)						3						
Heavy Vehicles (%)	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%
Turn Type				Perm						Split		
Protected Phases		4			8					6	6	
Permitted Phases				8								
Actuated Green, G (s)		33.1			33.1						33.9	
Effective Green, g (s)		33.1			33.1						33.9	
Actuated g/C Ratio		0.44			0.44						0.45	
Clearance Time (s)		4.0			4.0						4.0	
Vehicle Extension (s)		3.0			3.0						3.0	
Lane Grp Cap (vph)		1557			1158						777	
v/s Ratio Prot		c0.29									c0.30	
v/s Ratio Perm					0.20							
v/c Ratio		0.65			0.45						0.66	
Uniform Delay, d1		16.4			14.6						16.0	
Progression Factor		1.00			0.88						1.00	
Incremental Delay, d2		1.0			0.3						4.4	
Delay (s)		17.4			13.1						20.4	
Level of Service		B			B						C	
Approach Delay (s)		17.4			13.1			0.0			20.4	
Approach LOS		B			B			A			C	

Intersection Summary			
HCM Average Control Delay	17.1	HCM Level of Service	B
HCM Volume to Capacity ratio	0.66		
Actuated Cycle Length (s)	75.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	82.4%	ICU Level of Service	E
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	516	684	0	0	443	377	61	141	100	0	0	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0			4.0		4.0	4.0	4.0			
Lane Util. Factor		0.95			0.95		0.95	0.95	1.00			
Frpb, ped/bikes		1.00			0.99		1.00	1.00	1.00			
Flpb, ped/bikes		1.00			1.00		1.00	1.00	1.00			
Frt		1.00			0.93		1.00	1.00	0.85			
Flt Protected		0.98			1.00		0.95	1.00	1.00			
Satd. Flow (prot)		3498			3292		1698	1784	1599			
Flt Permitted		0.55			1.00		0.95	1.00	1.00			
Satd. Flow (perm)		1963			3292		1698	1784	1599			
Peak-hour factor, PHF	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96
Adj. Flow (vph)	538	712	0	0	461	393	64	147	104	0	0	0
RTOR Reduction (vph)	0	0	0	0	122	0	0	0	83	0	0	0
Lane Group Flow (vph)	0	1250	0	0	732	0	58	153	21	0	0	0
Confl. Peds. (#/hr)	2		7	7		2						
Confl. Bikes (#/hr)						3						
Heavy Vehicles (%)	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%
Turn Type	Perm						Split		Prot			
Protected Phases		4			8		2	2	2			
Permitted Phases	4											
Actuated Green, G (s)		51.7			51.7		15.3	15.3	15.3			
Effective Green, g (s)		51.7			51.7		15.3	15.3	15.3			
Actuated g/C Ratio		0.69			0.69		0.20	0.20	0.20			
Clearance Time (s)		4.0			4.0		4.0	4.0	4.0			
Vehicle Extension (s)		3.0			3.0		3.0	3.0	3.0			
Lane Grp Cap (vph)		1353			2269		346	364	326			
v/s Ratio Prot					0.22		0.03	c0.09	0.01			
v/s Ratio Perm		c0.64										
v/c Ratio		1.35dl			0.32		0.17	0.42	0.07			
Uniform Delay, d1		10.0			4.7		24.6	26.0	24.1			
Progression Factor		0.75			1.00		1.00	1.00	1.00			
Incremental Delay, d2		9.7			0.1		1.0	3.5	0.4			
Delay (s)		17.3			4.7		25.6	29.5	24.5			
Level of Service		B			A		C	C	C			
Approach Delay (s)		17.3			4.7			27.1			0.0	
Approach LOS		B			A			C			A	

Intersection Summary			
HCM Average Control Delay	14.1	HCM Level of Service	B
HCM Volume to Capacity ratio	0.81		
Actuated Cycle Length (s)	75.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	77.0%	ICU Level of Service	D
Analysis Period (min)	15		

dl Defacto Left Lane. Recode with 1 though lane as a left lane.
c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	146	1	59	9	8	216	21	571	0	11	516	91
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0			4.0		4.0	4.0	
Lane Util. Factor	1.00	1.00		1.00	1.00			0.95		1.00	0.95	
Frpb, ped/bikes	1.00	0.99		1.00	0.99			1.00		1.00	1.00	
Flpb, ped/bikes	1.00	1.00		0.95	1.00			1.00		0.94	1.00	
Frt	1.00	0.85		1.00	0.86			1.00		1.00	0.98	
Flt Protected	0.95	1.00		0.95	1.00			1.00		0.95	1.00	
Satd. Flow (prot)	1752	1550		1664	1557			3499		1649	3415	
Flt Permitted	0.95	1.00		0.95	1.00			0.92		0.95	1.00	
Satd. Flow (perm)	1752	1550		1664	1557			3208		1649	3415	
Peak-hour factor, PHF	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85
Adj. Flow (vph)	172	1	69	11	9	254	25	672	0	13	607	107
RTOR Reduction (vph)	0	39	0	0	117	0	0	0	0	0	13	0
Lane Group Flow (vph)	172	31	0	11	146	0	0	697	0	13	701	0
Confl. Peds. (#/hr)	1		3	3		1			5	5		
Confl. Bikes (#/hr)						1			2			1
Heavy Vehicles (%)	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%
Turn Type	Prot			Prot			Perm			Prot		
Protected Phases	3	8		7	4			2		1	6	
Permitted Phases							2					
Actuated Green, G (s)	11.3	28.7		0.2	17.6			20.3		0.2	24.5	
Effective Green, g (s)	11.3	28.7		0.2	17.6			20.3		0.2	24.5	
Actuated g/C Ratio	0.17	0.44		0.00	0.27			0.31		0.00	0.37	
Clearance Time (s)	4.0	4.0		4.0	4.0			4.0		4.0	4.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0			3.0		3.0	3.0	
Lane Grp Cap (vph)	303	680		5	419			996		5	1279	
v/s Ratio Prot	c0.10	0.02		0.01	c0.09					0.01	c0.21	
v/s Ratio Perm								c0.22				
v/c Ratio	0.57	0.05		2.20	0.35			0.70		2.60	0.55	
Uniform Delay, d1	24.8	10.5		32.6	19.3			19.9		32.6	16.1	
Progression Factor	1.00	1.00		1.00	1.00			1.00		1.00	1.00	
Incremental Delay, d2	2.4	0.0		925.2	0.5			2.2		1102.2	0.5	
Delay (s)	27.2	10.5		957.8	19.8			22.0		1134.8	16.6	
Level of Service	C	B		F	B			C		F	B	
Approach Delay (s)		22.4			57.4			22.0			36.6	
Approach LOS		C			E			C			D	

Intersection Summary			
HCM Average Control Delay	32.5	HCM Level of Service	C
HCM Volume to Capacity ratio	0.56		
Actuated Cycle Length (s)	65.4	Sum of lost time (s)	16.0
Intersection Capacity Utilization	63.9%	ICU Level of Service	B
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	156	12	13	60	42	290	14	141	20	47	317	165
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0		4.0	4.0		4.0	4.0	
Lane Util. Factor	1.00	0.95	1.00	1.00	0.95		1.00	0.95		1.00	0.95	
Frpb, ped/bikes	1.00	1.00	1.00	1.00	0.99		1.00	1.00		1.00	0.99	
Flpb, ped/bikes	1.00	1.00	1.00	1.00	1.00		1.00	1.00		1.00	1.00	
Frt	1.00	1.00	0.85	1.00	0.87		1.00	0.98		1.00	0.95	
Flt Protected	0.95	1.00	1.00	0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1770	3539	1583	1770	3040		1762	3467		1770	3333	
Flt Permitted	0.95	1.00	1.00	0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (perm)	1770	3539	1583	1770	3040		1762	3467		1770	3333	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	164	13	14	63	44	305	15	148	21	49	334	174
RTOR Reduction (vph)	0	0	10	0	241	0	0	12	0	0	81	0
Lane Group Flow (vph)	164	13	4	63	108	0	15	157	0	49	427	0
Confl. Peds. (#/hr)							16		1	1		16
Confl. Bikes (#/hr)						1			1			
Turn Type	Prot		Perm	Prot			Prot			Prot		
Protected Phases	7	4		3	8		5	2		1	6	
Permitted Phases			4									
Actuated Green, G (s)	7.9	13.2	13.2	4.9	10.2		0.5	12.1		2.5	14.1	
Effective Green, g (s)	7.9	13.2	13.2	4.9	10.2		0.5	12.1		2.5	14.1	
Actuated g/C Ratio	0.16	0.27	0.27	0.10	0.21		0.01	0.25		0.05	0.29	
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0		4.0	4.0		4.0	4.0	
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	287	959	429	178	637		18	861		91	965	
v/s Ratio Prot	c0.09	c0.00		0.04	c0.04		0.01	0.05		c0.03	c0.13	
v/s Ratio Perm			0.00									
v/c Ratio	0.57	0.01	0.01	0.35	0.17		0.83	0.18		0.54	0.44	
Uniform Delay, d1	18.8	13.0	13.0	20.4	15.8		24.1	14.4		22.5	14.1	
Progression Factor	1.00	1.00	1.00	1.00	1.00		1.00	1.00		1.00	1.00	
Incremental Delay, d2	2.7	0.0	0.0	1.2	0.1		131.9	0.1		6.0	0.3	
Delay (s)	21.6	13.0	13.0	21.6	15.9		156.0	14.5		28.5	14.4	
Level of Service	C	B	B	C	B		F	B		C	B	
Approach Delay (s)		20.4			16.8			26.0			15.7	
Approach LOS		C			B			C			B	

Intersection Summary			
HCM Average Control Delay	18.1	HCM Level of Service	B
HCM Volume to Capacity ratio	0.39		
Actuated Cycle Length (s)	48.7	Sum of lost time (s)	16.0
Intersection Capacity Utilization	52.7%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Volume (vph)	315	54	83	86	349	545
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0		4.0	4.0	4.0	4.0
Lane Util. Factor	1.00		1.00	1.00	1.00	1.00
Frt	0.98		1.00	1.00	1.00	0.85
Flt Protected	1.00		0.95	1.00	0.95	1.00
Satd. Flow (prot)	1826		1770	1863	1770	1583
Flt Permitted	1.00		0.20	1.00	0.95	1.00
Satd. Flow (perm)	1826		365	1863	1770	1583
Peak-hour factor, PHF	0.78	0.78	0.78	0.78	0.78	0.78
Adj. Flow (vph)	404	69	106	110	447	699
RTOR Reduction (vph)	10	0	0	0	0	216
Lane Group Flow (vph)	463	0	106	110	447	483
Turn Type			pm+pt			Perm
Protected Phases	4		3	8	2	
Permitted Phases			8			2
Actuated Green, G (s)	16.5		23.4	23.4	19.7	19.7
Effective Green, g (s)	16.5		23.4	23.4	19.7	19.7
Actuated g/C Ratio	0.32		0.46	0.46	0.39	0.39
Clearance Time (s)	4.0		4.0	4.0	4.0	4.0
Vehicle Extension (s)	3.0		3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	590		247	853	682	610
v/s Ratio Prot	c0.25		c0.02	0.06	0.25	
v/s Ratio Perm			0.17			c0.30
v/c Ratio	0.78		0.43	0.13	0.66	0.79
Uniform Delay, d1	15.7		9.7	8.0	12.9	13.9
Progression Factor	1.00		1.00	1.00	1.00	1.00
Incremental Delay, d2	6.8		1.2	0.1	2.3	6.9
Delay (s)	22.5		10.9	8.0	15.2	20.8
Level of Service	C		B	A	B	C
Approach Delay (s)	22.5			9.4	18.6	
Approach LOS	C			A	B	

Intersection Summary			
HCM Average Control Delay	18.5	HCM Level of Service	B
HCM Volume to Capacity ratio	0.77		
Actuated Cycle Length (s)	51.1	Sum of lost time (s)	12.0
Intersection Capacity Utilization	60.3%	ICU Level of Service	B
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	10	7	400	0	5	9	154	62	476	401	3
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Lane Util. Factor		1.00		1.00	1.00		1.00	0.95		0.97	1.00	
Frpb, ped/bikes		0.99		1.00	1.00		1.00	1.00		1.00	1.00	
Flpb, ped/bikes		1.00		1.00	1.00		1.00	1.00		1.00	1.00	
Frt		0.95		1.00	0.85		1.00	0.96		1.00	1.00	
Flt Protected		1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)		1751		1765	1583		1770	3387		3433	1860	
Flt Permitted		1.00		0.74	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (perm)		1751		1383	1583		1770	3387		3433	1860	
Peak-hour factor, PHF	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85
Adj. Flow (vph)	0	12	8	471	0	6	11	181	73	560	472	4
RTOR Reduction (vph)	0	5	0	0	4	0	0	48	0	0	1	0
Lane Group Flow (vph)	0	15	0	471	2	0	11	206	0	560	475	0
Confl. Peds. (#/hr)			2	2								
Confl. Bikes (#/hr)			1									
Turn Type	Perm			Perm			Prot			Prot		
Protected Phases		4			8		5	2		1	6	
Permitted Phases	4			8								
Actuated Green, G (s)		28.6		28.6	28.6		0.6	14.1		16.3	29.8	
Effective Green, g (s)		28.6		28.6	28.6		0.6	14.1		16.3	29.8	
Actuated g/C Ratio		0.40		0.40	0.40		0.01	0.20		0.23	0.42	
Clearance Time (s)		4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Vehicle Extension (s)		3.0		3.0	3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)		705		557	638		15	673		788	781	
v/s Ratio Prot		0.01			0.00		0.01	0.06		c0.16	c0.26	
v/s Ratio Perm				c0.34								
v/c Ratio		0.02		0.85	0.00		0.73	0.31		0.71	0.61	
Uniform Delay, d1		12.8		19.2	12.7		35.1	24.3		25.2	16.1	
Progression Factor		1.00		1.00	1.00		1.00	1.00		1.00	1.00	
Incremental Delay, d2		0.0		11.3	0.0		103.2	0.3		3.0	1.4	
Delay (s)		12.8		30.5	12.7		138.4	24.5		28.2	17.4	
Level of Service		B		C	B		F	C		C	B	
Approach Delay (s)		12.8			30.3			29.3			23.3	
Approach LOS		B			C			C			C	

Intersection Summary			
HCM Average Control Delay	25.9	HCM Level of Service	C
HCM Volume to Capacity ratio	0.73		
Actuated Cycle Length (s)	71.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	63.4%	ICU Level of Service	B
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	0	0	91	0	432	6	802	0	0	134	287
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)				4.0	4.0		4.0	4.0			4.0	
Lane Util. Factor				1.00	1.00		1.00	0.95			0.95	
Frpb, ped/bikes				1.00	1.00		1.00	1.00			0.99	
Flpb, ped/bikes				1.00	1.00		1.00	1.00			1.00	
Frt				1.00	0.85		1.00	1.00			0.90	
Flt Protected				0.95	1.00		0.95	1.00			1.00	
Satd. Flow (prot)				1787	1599		1787	3574			3162	
Flt Permitted				0.95	1.00		0.95	1.00			1.00	
Satd. Flow (perm)				1787	1599		1787	3574			3162	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	0	0	0	96	0	455	6	844	0	0	141	302
RTOR Reduction (vph)	0	0	0	0	123	0	0	0	0	0	194	0
Lane Group Flow (vph)	0	0	0	96	332	0	6	844	0	0	249	0
Confl. Peds. (#/hr)							1		2	2		1
Confl. Bikes (#/hr)			1						1			
Heavy Vehicles (%)	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%
Turn Type				Split			Prot					
Protected Phases				8	8		5	2			6	
Permitted Phases												
Actuated Green, G (s)				13.8	13.8		2.6	22.4			15.8	
Effective Green, g (s)				13.8	13.8		2.6	22.4			15.8	
Actuated g/C Ratio				0.31	0.31		0.06	0.51			0.36	
Clearance Time (s)				4.0	4.0		4.0	4.0			4.0	
Vehicle Extension (s)				3.0	3.0		3.0	3.0			3.0	
Lane Grp Cap (vph)				558	499		105	1811			1130	
v/s Ratio Prot				0.05	c0.21		0.00	c0.24			0.08	
v/s Ratio Perm												
v/c Ratio				0.17	0.67		0.06	0.47			0.22	
Uniform Delay, d1				11.0	13.2		19.6	7.0			9.9	
Progression Factor				1.00	1.00		1.00	1.00			1.00	
Incremental Delay, d2				0.1	3.3		0.2	0.2			0.1	
Delay (s)				11.2	16.5		19.9	7.2			10.0	
Level of Service				B	B		B	A			B	
Approach Delay (s)		0.0			15.6			7.3			10.0	
Approach LOS		A			B			A			B	

Intersection Summary			
HCM Average Control Delay	10.4	HCM Level of Service	B
HCM Volume to Capacity ratio	0.54		
Actuated Cycle Length (s)	44.2	Sum of lost time (s)	8.0
Intersection Capacity Utilization	55.6%	ICU Level of Service	B
Analysis Period (min)	15		

c Critical Lane Group

Near-Term (2018) No Project Conditions

FEHR PEERS

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	80	280	80	290	360	130	50	270	150	70	660	50
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	4.0	4.0	3.0	4.0	4.0	3.0	3.0	3.0	3.0	3.0	
Lane Util. Factor	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	
Frpb, ped/bikes	1.00	1.00	0.98	1.00	1.00	0.98	1.00	1.00	0.98	1.00	1.00	
Flpb, ped/bikes	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	0.99	
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	
Satd. Flow (prot)	1736	3471	1518	1736	3471	1516	1736	3471	1530	1736	3431	
Flt Permitted	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	
Satd. Flow (perm)	1736	3471	1518	1736	3471	1516	1736	3471	1530	1736	3431	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	87	304	87	315	391	141	54	293	163	76	717	54
RTOR Reduction (vph)	0	0	59	0	0	92	0	0	120	0	7	0
Lane Group Flow (vph)	87	304	28	315	391	49	54	293	43	76	764	0
Confl. Peds. (#/hr)	14		13	13		14	4		4	4		4
Confl. Bikes (#/hr)						1						1
Heavy Vehicles (%)	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%
Turn Type	Prot		Perm	Prot		Perm	Prot		Perm	Prot		
Protected Phases	5	2		1	6		3	8		7	4	
Permitted Phases			2			6			8			
Actuated Green, G (s)	6.1	15.2	15.2	14.5	21.6	21.6	2.1	16.9	16.9	4.2	19.0	
Effective Green, g (s)	6.1	15.2	15.2	14.5	21.6	21.6	2.1	16.9	16.9	4.2	19.0	
Actuated g/C Ratio	0.10	0.24	0.24	0.23	0.34	0.34	0.03	0.26	0.26	0.07	0.30	
Clearance Time (s)	5.0	4.0	4.0	3.0	4.0	4.0	3.0	3.0	3.0	3.0	3.0	
Vehicle Extension (s)	2.0	4.0	4.0	2.0	4.0	4.0	2.0	2.0	2.0	2.0	2.0	
Lane Grp Cap (vph)	166	827	362	395	1175	513	57	919	405	114	1022	
v/s Ratio Prot	0.05	0.09		c0.18	c0.11		c0.03	0.08		0.04	c0.22	
v/s Ratio Perm			0.02			0.03			0.03			
v/c Ratio	0.52	0.37	0.08	0.80	0.33	0.10	0.95	0.32	0.11	0.67	0.75	
Uniform Delay, d1	27.5	20.3	18.9	23.3	15.7	14.4	30.8	18.8	17.7	29.1	20.2	
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	
Incremental Delay, d2	1.4	0.4	0.1	10.0	0.2	0.1	98.4	0.1	0.0	10.8	2.6	
Delay (s)	28.8	20.7	19.0	33.3	16.0	14.5	129.2	18.9	17.8	40.0	22.9	
Level of Service	C	C	B	C	B	B	F	B	B	D	C	
Approach Delay (s)		21.8			22.2			30.2			24.4	
Approach LOS		C			C			C			C	

Intersection Summary			
HCM Average Control Delay	24.4	HCM Level of Service	C
HCM Volume to Capacity ratio	0.58		
Actuated Cycle Length (s)	63.8	Sum of lost time (s)	6.0
Intersection Capacity Utilization	65.2%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	0	0	330	10	190	0	270	140	0	790	250
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)				4.0	4.0	4.0		4.0	4.0		4.0	
Lane Util. Factor				0.95	0.91	0.95		0.91	1.00		0.91	
Frpb, ped/bikes				1.00	1.00	0.99		1.00	0.98		0.99	
Flpb, ped/bikes				1.00	1.00	1.00		1.00	1.00		1.00	
Frt				1.00	0.98	0.85		1.00	0.85		0.96	
Flt Protected				0.95	0.96	1.00		1.00	1.00		1.00	
Satd. Flow (prot)				1665	1576	1471		5036	1535		4827	
Flt Permitted				0.95	0.96	1.00		1.00	1.00		1.00	
Satd. Flow (perm)				1665	1576	1471		5036	1535		4827	
Peak-hour factor, PHF	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94
Adj. Flow (vph)	0	0	0	351	11	202	0	287	149	0	840	266
RTOR Reduction (vph)	0	0	0	0	13	116	0	0	0	0	77	0
Lane Group Flow (vph)	0	0	0	197	180	58	0	287	149	0	1029	0
Confl. Peds. (#/hr)	1					1	2		1	1		2
Confl. Bikes (#/hr)									2			1
Heavy Vehicles (%)	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%
Turn Type				Split		Perm			Free			
Protected Phases				8	8			2			6	
Permitted Phases						8			Free			
Actuated Green, G (s)				12.9	12.9	12.9		17.6	38.5		17.6	
Effective Green, g (s)				12.9	12.9	12.9		17.6	38.5		17.6	
Actuated g/C Ratio				0.34	0.34	0.34		0.46	1.00		0.46	
Clearance Time (s)				4.0	4.0	4.0		4.0			4.0	
Vehicle Extension (s)				3.0	3.0	3.0		3.0			3.0	
Lane Grp Cap (vph)				558	528	493		2302	1535		2207	
v/s Ratio Prot				c0.12	0.11			0.06			c0.21	
v/s Ratio Perm						0.04			0.10			
v/c Ratio				0.35	0.34	0.12		0.12	0.10		0.47	
Uniform Delay, d1				9.7	9.6	8.9		6.0	0.0		7.2	
Progression Factor				1.00	1.00	1.00		1.00	1.00		1.00	
Incremental Delay, d2				0.4	0.4	0.1		0.0	0.1		0.2	
Delay (s)				10.0	10.0	9.0		6.0	0.1		7.4	
Level of Service				B	A	A		A	A		A	
Approach Delay (s)		0.0			9.7			4.0			7.4	
Approach LOS		A			A			A			A	

Intersection Summary			
HCM Average Control Delay	7.3	HCM Level of Service	A
HCM Volume to Capacity ratio	0.42		
Actuated Cycle Length (s)	38.5	Sum of lost time (s)	8.0
Intersection Capacity Utilization	39.4%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	80	0	130	0	0	0	0	330	330	0	550	570
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0		4.0					4.0			4.0	4.0
Lane Util. Factor	1.00		1.00					0.91			0.95	1.00
Frpb, ped/bikes	1.00		1.00					0.99			1.00	0.98
Flpb, ped/bikes	1.00		1.00					1.00			1.00	1.00
Frt	1.00		0.85					0.93			1.00	0.85
Flt Protected	0.95		1.00					1.00			1.00	1.00
Satd. Flow (prot)	1752		1568					4602			3505	1536
Flt Permitted	0.95		1.00					1.00			1.00	1.00
Satd. Flow (perm)	1752		1568					4602			3505	1536
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	87	0	141	0	0	0	0	359	359	0	598	620
RTOR Reduction (vph)	0	0	92	0	0	0	0	198	0	0	0	0
Lane Group Flow (vph)	87	0	49	0	0	0	0	520	0	0	598	620
Confl. Peds. (#/hr)							1		3	3		1
Confl. Bikes (#/hr)									1			
Heavy Vehicles (%)	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%
Turn Type	Split		Perm									Free
Protected Phases	8	8						2			6	
Permitted Phases			8									Free
Actuated Green, G (s)	7.7		7.7					12.8			12.8	28.5
Effective Green, g (s)	7.7		7.7					12.8			12.8	28.5
Actuated g/C Ratio	0.27		0.27					0.45			0.45	1.00
Clearance Time (s)	4.0		4.0					4.0			4.0	
Vehicle Extension (s)	3.0		3.0					3.0			3.0	
Lane Grp Cap (vph)	473		424					2067			1574	1536
v/s Ratio Prot	0.05							0.11			0.17	
v/s Ratio Perm			0.03									c0.40
v/c Ratio	0.18		0.12					0.25			0.38	0.40
Uniform Delay, d1	8.0		7.8					4.9			5.2	0.0
Progression Factor	1.00		1.00					1.00			1.00	1.00
Incremental Delay, d2	0.2		0.1					0.1			0.2	0.8
Delay (s)	8.2		8.0					4.9			5.4	0.8
Level of Service	A		A					A			A	A
Approach Delay (s)		8.0			0.0			4.9			3.0	
Approach LOS		A			A			A			A	

Intersection Summary			
HCM Average Control Delay	4.2	HCM Level of Service	A
HCM Volume to Capacity ratio	0.40		
Actuated Cycle Length (s)	28.5	Sum of lost time (s)	0.0
Intersection Capacity Utilization	30.0%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	50	20	30	10	10	30	30	580	20	290	280	110
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0		4.0	4.0			4.0		4.0	4.0	
Lane Util. Factor		1.00		1.00	1.00			0.95		1.00	0.95	
Frpb, ped/bikes		1.00		1.00	0.99			1.00		1.00	0.99	
Flpb, ped/bikes		1.00		1.00	1.00			1.00		1.00	1.00	
Frt		0.96		1.00	0.89			1.00		1.00	0.96	
Flt Protected		0.98		0.95	1.00			1.00		0.95	1.00	
Satd. Flow (prot)		1709		1736	1605			3446		1736	3302	
Flt Permitted		1.00		0.69	1.00			0.92		0.95	1.00	
Satd. Flow (perm)		1751		1255	1605			3181		1736	3302	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	54	22	33	11	11	33	33	630	22	315	304	120
RTOR Reduction (vph)	0	16	0	0	28	0	0	2	0	0	26	0
Lane Group Flow (vph)	0	93	0	11	16	0	0	683	0	315	398	0
Confl. Peds. (#/hr)	3					3	2					2
Confl. Bikes (#/hr)												1
Heavy Vehicles (%)	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%
Turn Type	Perm			Perm			Perm			Prot		
Protected Phases		3			4			2		1	6	
Permitted Phases	3			4			2					
Actuated Green, G (s)		2.2		8.4	8.4			21.7		11.9	37.6	
Effective Green, g (s)		2.2		8.4	8.4			21.7		11.9	37.6	
Actuated g/C Ratio		0.04		0.14	0.14			0.36		0.20	0.62	
Clearance Time (s)		4.0		4.0	4.0			4.0		4.0	4.0	
Vehicle Extension (s)		3.0		3.0	3.0			3.0		3.0	3.0	
Lane Grp Cap (vph)		64		175	224			1147		343	2062	
v/s Ratio Prot					c0.01					c0.18	0.12	
v/s Ratio Perm		c0.05		0.01				c0.21				
v/c Ratio		1.45		0.06	0.07			0.60		0.92	0.19	
Uniform Delay, d1		29.0		22.5	22.5			15.7		23.7	4.8	
Progression Factor		1.00		1.00	1.00			1.00		1.00	1.00	
Incremental Delay, d2		269.3		0.2	0.1			0.8		28.5	0.0	
Delay (s)		298.3		22.6	22.6			16.5		52.1	4.9	
Level of Service		F		C	C			B		D	A	
Approach Delay (s)		298.3			22.6			16.5			25.0	
Approach LOS		F			C			B			C	

Intersection Summary			
HCM Average Control Delay	40.0	HCM Level of Service	D
HCM Volume to Capacity ratio	0.62		
Actuated Cycle Length (s)	60.2	Sum of lost time (s)	16.0
Intersection Capacity Utilization	56.2%	ICU Level of Service	B
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	220	40	20	20	10	40	10	370	110	40	100	160
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0		4.0	4.0		4.0	4.0	
Lane Util. Factor	1.00	0.95	1.00	1.00	0.95		1.00	0.95		1.00	0.95	
Frpb, ped/bikes	1.00	1.00	1.00	1.00	0.96		1.00	1.00		1.00	0.99	
Flpb, ped/bikes	1.00	1.00	1.00	1.00	1.00		1.00	1.00		1.00	1.00	
Frt	1.00	1.00	0.85	1.00	0.88		1.00	0.97		1.00	0.91	
Flt Protected	0.95	1.00	1.00	0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1770	3539	1583	1770	2995		1767	3407		1770	3183	
Flt Permitted	0.95	1.00	1.00	0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (perm)	1770	3539	1583	1770	2995		1767	3407		1770	3183	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	239	43	22	22	11	43	11	402	120	43	109	174
RTOR Reduction (vph)	0	0	14	0	38	0	0	35	0	0	122	0
Lane Group Flow (vph)	239	43	8	22	16	0	11	487	0	43	161	0
Confl. Peds. (#/hr)	3					3	4					4
Confl. Bikes (#/hr)						20			1			1
Turn Type	Prot		Perm	Prot			Prot			Prot		
Protected Phases	7	4		3	8		5	2		1	6	
Permitted Phases			4									
Actuated Green, G (s)	13.1	19.0	19.0	0.6	6.5		0.5	14.2		1.7	15.4	
Effective Green, g (s)	13.1	19.0	19.0	0.6	6.5		0.5	14.2		1.7	15.4	
Actuated g/C Ratio	0.25	0.37	0.37	0.01	0.13		0.01	0.28		0.03	0.30	
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0		4.0	4.0		4.0	4.0	
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	450	1306	584	21	378		17	939		58	952	
v/s Ratio Prot	c0.14	c0.01		0.01	0.01		0.01	c0.14		c0.02	0.05	
v/s Ratio Perm			0.01									
v/c Ratio	0.53	0.03	0.01	1.05	0.04		0.65	0.52		0.74	0.17	
Uniform Delay, d1	16.6	10.4	10.3	25.4	19.8		25.4	15.8		24.7	13.3	
Progression Factor	1.00	1.00	1.00	1.00	1.00		1.00	1.00		1.00	1.00	
Incremental Delay, d2	1.2	0.0	0.0	212.0	0.0		62.0	0.5		39.6	0.1	
Delay (s)	17.8	10.4	10.3	237.5	19.8		87.4	16.2		64.3	13.4	
Level of Service	B	B	B	F	B		F	B		E	B	
Approach Delay (s)		16.2			82.8			17.7			20.1	
Approach LOS		B			F			B			C	

Intersection Summary			
HCM Average Control Delay	22.0	HCM Level of Service	C
HCM Volume to Capacity ratio	0.40		
Actuated Cycle Length (s)	51.5	Sum of lost time (s)	12.0
Intersection Capacity Utilization	45.9%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Volume (veh/h)	200	120	50	110	60	70
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	217	130	54	120	65	76
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)				1133		
pX, platoon unblocked						
vC, conflicting volume			348		446	217
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			348		446	217
tC, single (s)			4.2		6.5	6.3
tC, 2 stage (s)						
tF (s)			2.3		3.6	3.4
p0 queue free %			95		88	91
cM capacity (veh/h)			1168		530	803

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	NB 1	NB 2
Volume Total	217	130	54	120	65	76
Volume Left	0	0	54	0	65	0
Volume Right	0	130	0	0	0	76
cSH	1700	1700	1168	1700	530	803
Volume to Capacity	0.13	0.08	0.05	0.07	0.12	0.09
Queue Length 95th (ft)	0	0	4	0	10	8
Control Delay (s)	0.0	0.0	8.2	0.0	12.7	10.0
Lane LOS			A		B	A
Approach Delay (s)	0.0		2.6		11.2	
Approach LOS					B	

Intersection Summary			
Average Delay	3.1		
Intersection Capacity Utilization	27.2%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	60	40	20	20	50	70	10	20	20	80	30	160
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0		4.0	4.0			4.0	
Lane Util. Factor	1.00	1.00		1.00	1.00		1.00	1.00			1.00	
Frpb, ped/bikes	1.00	1.00		1.00	1.00		1.00	0.99			1.00	
Flpb, ped/bikes	1.00	1.00		1.00	1.00		1.00	1.00			1.00	
Frt	1.00	0.95		1.00	0.91		1.00	0.93			0.92	
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00			0.99	
Satd. Flow (prot)	1556	1555		1556	1494		1556	1496			1484	
Flt Permitted	0.95	1.00		0.95	1.00		0.66	1.00			0.90	
Satd. Flow (perm)	1556	1555		1556	1494		1081	1496			1356	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	65	43	22	22	54	76	11	22	22	87	33	174
RTOR Reduction (vph)	0	18	0	0	64	0	0	14	0	0	74	0
Lane Group Flow (vph)	65	47	0	22	66	0	11	30	0	0	220	0
Confl. Peds. (#/hr)									2	2		
Confl. Bikes (#/hr)									2			
Heavy Vehicles (%)	16%	16%	16%	16%	16%	16%	16%	16%	16%	16%	16%	16%
Turn Type	Prot			Prot			Perm			Perm		
Protected Phases	7	4		3	8			2			6	
Permitted Phases							2			6		
Actuated Green, G (s)	1.9	5.6		0.9	4.6		11.1	11.1			11.1	
Effective Green, g (s)	1.9	5.6		0.9	4.6		11.1	11.1			11.1	
Actuated g/C Ratio	0.06	0.19		0.03	0.16		0.37	0.37			0.37	
Clearance Time (s)	4.0	4.0		4.0	4.0		4.0	4.0			4.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0			3.0	
Lane Grp Cap (vph)	100	294		47	232		405	561			509	
v/s Ratio Prot	c0.04	0.03		0.01	c0.04			0.02				
v/s Ratio Perm							0.01				c0.16	
v/c Ratio	0.65	0.16		0.47	0.28		0.03	0.05			0.43	
Uniform Delay, d1	13.5	10.0		14.1	11.0		5.8	5.9			6.9	
Progression Factor	1.00	1.00		1.00	1.00		1.00	1.00			1.00	
Incremental Delay, d2	14.1	0.3		7.2	0.7		0.0	0.0			0.6	
Delay (s)	27.6	10.3		21.3	11.7		5.9	5.9			7.5	
Level of Service	C	B		C	B		A	A			A	
Approach Delay (s)		19.0			13.1			5.9			7.5	
Approach LOS		B			B			A			A	

Intersection Summary			
HCM Average Control Delay	11.1	HCM Level of Service	B
HCM Volume to Capacity ratio	0.42		
Actuated Cycle Length (s)	29.6	Sum of lost time (s)	12.0
Intersection Capacity Utilization	39.2%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Volume (veh/h)	50	100	30	40	100	150
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	54	109	33	43	109	163
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)	322					
pX, platoon unblocked						
vC, conflicting volume			54		217	109
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			54		217	109
tC, single (s)			4.3		6.6	6.4
tC, 2 stage (s)						
tF (s)			2.3		3.6	3.4
p0 queue free %			98		85	82
cM capacity (veh/h)			1466		724	908

Direction, Lane #	EB 1	WB 1	WB 2	NB 1
Volume Total	163	33	43	272
Volume Left	0	33	0	109
Volume Right	109	0	0	163
cSH	1700	1466	1700	824
Volume to Capacity	0.10	0.02	0.03	0.33
Queue Length 95th (ft)	0	2	0	36
Control Delay (s)	0.0	7.5	0.0	11.5
Lane LOS		A		B
Approach Delay (s)	0.0	3.2		11.5
Approach LOS				B

Intersection Summary			
Average Delay	6.6		
Intersection Capacity Utilization	36.9%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Volume (veh/h)	180	20	40	60	10	10
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	196	22	43	65	11	11
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume			217		359	207
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			217		359	207
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			97		98	99
cM capacity (veh/h)			1335		613	826

Direction, Lane #	EB 1	WB 1	WB 2	NB 1
Volume Total	217	43	65	22
Volume Left	0	43	0	11
Volume Right	22	0	0	11
cSH	1700	1335	1700	704
Volume to Capacity	0.13	0.03	0.04	0.03
Queue Length 95th (ft)	0	3	0	2
Control Delay (s)	0.0	7.8	0.0	10.3
Lane LOS		A		B
Approach Delay (s)	0.0	3.1		10.3
Approach LOS				B

Intersection Summary			
Average Delay	1.6		
Intersection Capacity Utilization	27.4%	ICU Level of Service	A
Analysis Period (min)	15		

Intersection	
Intersection Delay (sec/veh)	27.2
Intersection LOS	D

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Volume (vph)	10	10	10	420	10	20	30	110	160	110	130	10
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Heavy Vehicles(%)	4	4	4	4	4	4	4	4	4	4	4	4
Movement Flow Rate	11	11	11	457	11	22	33	120	174	120	141	11
Number of Lanes	0	1	0	1	1	0	1	2	0	1	2	0

Approach	EB	WB	NB	SB
Opposing Approach	WB	EB	SB	NB
Opposing Lanes	2	1	3	3
Conflicting Approach Left	SB	NB	EB	WB
Conflicting Lanes Left	3	3	1	2
Conflicting Approach Right	NB	SB	WB	EB
Conflicting Lanes Right	3	3	2	1
HCM Control Delay	11.5	45.3	13.6	12.8
HCM LOS	B	E	B	B

Lane	NBLn1	NBLn2	NBLn3	EBLn1	WBLn1	WBLn2	SBLn1	SBLn2	SBLn3
Volume Left (%)	100%	0%	0%	33%	100%	0%	100%	0%	0%
Volume Thru (%)	0%	100%	19%	33%	0%	33%	0%	100%	81%
Volume Right (%)	0%	0%	81%	33%	0%	67%	0%	0%	19%
Sign Control	Stop	Stop	Stop	Stop	Stop	Stop	Stop	Stop	Stop
Traffic Volume by Lane	30	73	197	30	420	30	110	87	53
Left Turning Volume	0	73	37	10	0	10	0	87	43
Through Volume	0	0	160	10	0	20	0	0	10
Right Turning Volume	30	0	0	10	420	0	110	0	0
Lane Flow Rate	33	80	214	33	457	33	120	94	58
Geometry Group	8	8	8	8	8	8	8	8	8
Degree of Utilization, X	0.073	0.168	0.415	0.073	0.909	0.056	0.272	0.201	0.121
Departure Headway, Hd	8.085	7.57	6.984	8.112	7.298	6.33	8.181	7.666	7.53
Convergence(Y/N)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Capacity	445	476	517	442	502	569	441	470	478
Service Time	5.801	5.286	4.7	5.849	4.998	4.03	5.899	5.384	5.248
HCM Lane V/C Ratio	0.074	0.168	0.414	0.075	0.91	0.058	0.272	0.2	0.121
HCM Control Delay	11.4	11.8	14.6	11.5	47.9	9.4	13.9	12.3	11.3
HCM Lane LOS	B	B	B	B	E	A	B	B	B
HCM 95th Percentile Queue	0.2	0.6	2.1	0.2	27.7	0.2	1.1	0.8	0.4

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	0	0	70	10	70	20	540	0	0	220	420
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)				4.0	4.0		4.0	4.0			4.0	
Lane Util. Factor				1.00	1.00		1.00	0.95			0.95	
Frpb, ped/bikes				1.00	1.00		1.00	1.00			0.99	
Flpb, ped/bikes				1.00	1.00		1.00	1.00			1.00	
Frt				1.00	0.87		1.00	1.00			0.90	
Flt Protected				0.95	1.00		0.95	1.00			1.00	
Satd. Flow (prot)				1736	1588		1736	3471			3084	
Flt Permitted				0.95	1.00		0.95	1.00			1.00	
Satd. Flow (perm)				1736	1588		1736	3471			3084	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	0	0	0	76	11	76	22	587	0	0	239	457
RTOR Reduction (vph)	0	0	0	0	67	0	0	0	0	0	260	0
Lane Group Flow (vph)	0	0	0	76	20	0	22	587	0	0	436	0
Confl. Peds. (#/hr)							1					1
Confl. Bikes (#/hr)									2			1
Heavy Vehicles (%)	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%
Turn Type				Split			Prot					
Protected Phases				8	8		5	2			6	
Permitted Phases												
Actuated Green, G (s)				3.8	3.8		1.8	19.1			13.3	
Effective Green, g (s)				3.8	3.8		1.8	19.1			13.3	
Actuated g/C Ratio				0.12	0.12		0.06	0.62			0.43	
Clearance Time (s)				4.0	4.0		4.0	4.0			4.0	
Vehicle Extension (s)				3.0	3.0		3.0	3.0			3.0	
Lane Grp Cap (vph)				213	195		101	2146			1327	
v/s Ratio Prot				c0.04	0.01		0.01	c0.17			c0.14	
v/s Ratio Perm												
v/c Ratio				0.36	0.10		0.22	0.27			0.33	
Uniform Delay, d1				12.4	12.0		13.9	2.7			5.8	
Progression Factor				1.00	1.00		1.00	1.00			1.00	
Incremental Delay, d2				1.0	0.2		1.1	0.1			0.1	
Delay (s)				13.5	12.3		15.0	2.8			6.0	
Level of Service				B	B		B	A			A	
Approach Delay (s)		0.0			12.8			3.2			6.0	
Approach LOS		A			B			A			A	

Intersection Summary			
HCM Average Control Delay	5.6	HCM Level of Service	A
HCM Volume to Capacity ratio	0.35		
Actuated Cycle Length (s)	30.9	Sum of lost time (s)	12.0
Intersection Capacity Utilization	31.2%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	10	390	160	350	100	30	60	70	490	50	140	20
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0		4.0	4.0	4.0		4.0	
Lane Util. Factor	1.00	0.95		0.91	0.91		0.95	0.95	1.00		1.00	
Frpb, ped/bikes	1.00	1.00		1.00	1.00		1.00	1.00	0.99		1.00	
Flpb, ped/bikes	1.00	1.00		1.00	1.00		1.00	1.00	1.00		1.00	
Frt	1.00	0.96		1.00	0.99		1.00	1.00	0.85		0.99	
Flt Protected	0.95	1.00		0.95	0.97		0.95	1.00	1.00		0.99	
Satd. Flow (prot)	1752	3339		1595	3208		1665	1745	1547		1797	
Flt Permitted	0.95	1.00		0.95	0.97		0.95	1.00	1.00		0.99	
Satd. Flow (perm)	1752	3339		1595	3208		1665	1745	1547		1797	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	11	424	174	380	109	33	65	76	533	54	152	22
RTOR Reduction (vph)	0	45	0	0	8	0	0	0	443	0	4	0
Lane Group Flow (vph)	11	553	0	190	324	0	58	83	90	0	224	0
Confl. Peds. (#/hr)	1					1			2	2		
Confl. Bikes (#/hr)			1			1						1
Heavy Vehicles (%)	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%
Turn Type	Split			Split			Split		Perm	Split		
Protected Phases	4	4		8	8		2	2		6	6	
Permitted Phases									2			
Actuated Green, G (s)	16.8	16.8		14.0	14.0		12.3	12.3	12.3		13.7	
Effective Green, g (s)	16.8	16.8		14.0	14.0		12.3	12.3	12.3		13.7	
Actuated g/C Ratio	0.23	0.23		0.19	0.19		0.17	0.17	0.17		0.19	
Clearance Time (s)	4.0	4.0		4.0	4.0		4.0	4.0	4.0		4.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0	3.0		3.0	
Lane Grp Cap (vph)	404	771		307	617		281	295	261		338	
v/s Ratio Prot	0.01	c0.17		c0.12	0.10		0.03	0.05			c0.12	
v/s Ratio Perm									c0.06			
v/c Ratio	0.03	0.72		0.62	0.52		0.21	0.28	0.35		0.66	
Uniform Delay, d1	21.7	25.8		27.0	26.4		26.0	26.4	26.7		27.4	
Progression Factor	1.00	1.00		1.00	1.00		1.00	1.00	1.00		1.00	
Incremental Delay, d2	0.0	3.2		3.7	0.8		0.4	0.5	0.8		4.8	
Delay (s)	21.7	29.0		30.6	27.2		26.4	26.9	27.5		32.2	
Level of Service	C	C		C	C		C	C	C		C	
Approach Delay (s)		28.9			28.5			27.3			32.2	
Approach LOS		C			C			C			C	

Intersection Summary			
HCM Average Control Delay	28.6	HCM Level of Service	C
HCM Volume to Capacity ratio	0.60		
Actuated Cycle Length (s)	72.8	Sum of lost time (s)	16.0
Intersection Capacity Utilization	67.8%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	840	160	100	330	0	0	0	0	420	30	220
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0			4.0						4.0	
Lane Util. Factor		0.95			0.95						1.00	
Frpb, ped/bikes		1.00			1.00						1.00	
Flpb, ped/bikes		1.00			1.00						1.00	
Frt		0.98			1.00						0.96	
Flt Protected		1.00			0.99						0.97	
Satd. Flow (prot)		3437			3497						1726	
Flt Permitted		1.00			0.56						0.97	
Satd. Flow (perm)		3437			1980						1726	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	0	913	174	109	359	0	0	0	0	457	33	239
RTOR Reduction (vph)	0	27	0	0	0	0	0	0	0	0	28	0
Lane Group Flow (vph)	0	1060	0	0	468	0	0	0	0	0	701	0
Confl. Peds. (#/hr)	5		9	9		5						
Confl. Bikes (#/hr)						2						
Turn Type				Perm						Split		
Protected Phases		4			8					6	6	
Permitted Phases				8								
Actuated Green, G (s)		23.7			23.7						28.3	
Effective Green, g (s)		23.7			23.7						28.3	
Actuated g/C Ratio		0.39			0.39						0.47	
Clearance Time (s)		4.0			4.0						4.0	
Vehicle Extension (s)		3.0			3.0						3.0	
Lane Grp Cap (vph)		1358			782						814	
v/s Ratio Prot		c0.31									c0.41	
v/s Ratio Perm					0.24							
v/c Ratio		0.78			0.88dl						0.86	
Uniform Delay, d1		15.9			14.4						14.1	
Progression Factor		1.00			1.00						1.00	
Incremental Delay, d2		3.0			1.2						11.6	
Delay (s)		18.9			15.6						25.7	
Level of Service		B			B						C	
Approach Delay (s)		18.9			15.6			0.0			25.7	
Approach LOS		B			B			A			C	

Intersection Summary			
HCM Average Control Delay	20.4	HCM Level of Service	C
HCM Volume to Capacity ratio	0.82		
Actuated Cycle Length (s)	60.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	90.1%	ICU Level of Service	E
Analysis Period (min)	15		

dl Defacto Left Lane. Recode with 1 though lane as a left lane.
c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	230	1030	0	0	390	410	40	10	80	0	0	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0			4.0		4.0	4.0	4.0			
Lane Util. Factor		0.95			0.95		0.95	0.95	1.00			
Frpb, ped/bikes		1.00			0.99		1.00	1.00	1.00			
Flpb, ped/bikes		1.00			1.00		1.00	1.00	1.00			
Frt		1.00			0.92		1.00	1.00	0.85			
Flt Protected		0.99			1.00		0.95	0.97	1.00			
Satd. Flow (prot)		3507			3225		1681	1719	1583			
Flt Permitted		0.62			1.00		0.95	0.97	1.00			
Satd. Flow (perm)		2206			3225		1681	1719	1583			
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	250	1120	0	0	424	446	43	11	87	0	0	0
RTOR Reduction (vph)	0	0	0	0	135	0	0	0	69	0	0	0
Lane Group Flow (vph)	0	1370	0	0	735	0	27	27	18	0	0	0
Confl. Peds. (#/hr)	5		7	7		5			1	1		
Confl. Bikes (#/hr)						3						
Turn Type	Perm						Split		Prot			
Protected Phases		4			8		2	2	2			
Permitted Phases	4											
Actuated Green, G (s)		55.7			55.7		16.3	16.3	16.3			
Effective Green, g (s)		55.7			55.7		16.3	16.3	16.3			
Actuated g/C Ratio		0.70			0.70		0.20	0.20	0.20			
Clearance Time (s)		4.0			4.0		4.0	4.0	4.0			
Vehicle Extension (s)		3.0			3.0		3.0	3.0	3.0			
Lane Grp Cap (vph)		1536			2245		343	350	323			
v/s Ratio Prot					0.23		c0.02	0.02	0.01			
v/s Ratio Perm		c0.62										
v/c Ratio		0.89			0.33		0.08	0.08	0.05			
Uniform Delay, d1		9.7			4.8		25.8	25.8	25.6			
Progression Factor		1.00			1.00		1.00	1.00	1.00			
Incremental Delay, d2		7.0			0.1		0.4	0.4	0.3			
Delay (s)		16.7			4.9		26.2	26.2	26.0			
Level of Service		B			A		C	C	C			
Approach Delay (s)		16.7			4.9			26.1			0.0	
Approach LOS		B			A			C			A	

Intersection Summary			
HCM Average Control Delay	12.9	HCM Level of Service	B
HCM Volume to Capacity ratio	0.71		
Actuated Cycle Length (s)	80.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	85.6%	ICU Level of Service	E
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	100	410	60	180	360	140	100	800	210	100	320	50
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	4.0	4.0	3.0	4.0	4.0	3.0	3.0	3.0	3.0	3.0	
Lane Util. Factor	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	
Frpb, ped/bikes	1.00	1.00	0.97	1.00	1.00	0.98	1.00	1.00	0.91	1.00	1.00	
Flpb, ped/bikes	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	0.98	
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	
Satd. Flow (prot)	1770	3539	1539	1770	3539	1557	1770	3539	1437	1770	3461	
Flt Permitted	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	
Satd. Flow (perm)	1770	3539	1539	1770	3539	1557	1770	3539	1437	1770	3461	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	109	446	65	196	391	152	109	870	228	109	348	54
RTOR Reduction (vph)	0	0	30	0	0	105	0	0	114	0	16	0
Lane Group Flow (vph)	109	446	35	196	391	47	109	870	114	109	386	0
Confl. Peds. (#/hr)	5		19	19		5	4		14	14		4
Confl. Bikes (#/hr)						1			100			
Turn Type	Prot		Perm	Prot		Perm	Prot		Perm	Prot		
Protected Phases	5	2		1	6		3	8		7	4	
Permitted Phases			2			6			8			
Actuated Green, G (s)	5.4	17.4	17.4	9.9	19.9	19.9	6.1	21.4	21.4	6.1	21.4	
Effective Green, g (s)	5.4	17.4	17.4	9.9	19.9	19.9	6.1	21.4	21.4	6.1	21.4	
Actuated g/C Ratio	0.08	0.26	0.26	0.15	0.29	0.29	0.09	0.32	0.32	0.09	0.32	
Clearance Time (s)	5.0	4.0	4.0	3.0	4.0	4.0	3.0	3.0	3.0	3.0	3.0	
Vehicle Extension (s)	2.0	4.0	4.0	2.0	4.0	4.0	2.0	2.0	2.0	2.0	2.0	
Lane Grp Cap (vph)	141	908	395	258	1039	457	159	1117	454	159	1092	
v/s Ratio Prot	0.06	c0.13		c0.11	0.11		c0.06	c0.25		0.06	0.11	
v/s Ratio Perm			0.02			0.03			0.08			
v/c Ratio	0.77	0.49	0.09	0.76	0.38	0.10	0.69	0.78	0.25	0.69	0.35	
Uniform Delay, d1	30.6	21.4	19.2	27.8	19.0	17.5	29.9	21.1	17.2	29.9	17.9	
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	
Incremental Delay, d2	20.9	0.6	0.1	10.8	0.3	0.1	9.4	3.2	0.1	9.4	0.1	
Delay (s)	51.5	22.0	19.3	38.6	19.3	17.6	39.3	24.2	17.4	39.3	17.9	
Level of Service	D	C	B	D	B	B	D	C	B	D	B	
Approach Delay (s)		26.9			24.1			24.3			22.5	
Approach LOS		C			C			C			C	

Intersection Summary			
HCM Average Control Delay	24.5	HCM Level of Service	C
HCM Volume to Capacity ratio	0.65		
Actuated Cycle Length (s)	67.8	Sum of lost time (s)	13.0
Intersection Capacity Utilization	66.4%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	0	0	300	10	670	0	490	140	0	430	140
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)				4.0	4.0	4.0		4.0	4.0		4.0	
Lane Util. Factor				0.95	0.91	0.95		0.91	1.00		0.91	
Frt				1.00	0.87	0.85		1.00	0.85		0.96	
Flt Protected				0.95	1.00	1.00		1.00	1.00		1.00	
Satd. Flow (prot)				1698	1478	1519		5136	1599		4946	
Flt Permitted				0.95	1.00	1.00		1.00	1.00		1.00	
Satd. Flow (perm)				1698	1478	1519		5136	1599		4946	
Peak-hour factor, PHF	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94
Adj. Flow (vph)	0	0	0	319	11	713	0	521	149	0	457	149
RTOR Reduction (vph)	0	0	0	0	99	99	0	0	0	0	103	0
Lane Group Flow (vph)	0	0	0	287	279	279	0	521	149	0	503	0
Heavy Vehicles (%)	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%
Turn Type				Split		Perm			Free			
Protected Phases				8	8			2			6	
Permitted Phases						8			Free			
Actuated Green, G (s)				16.1	16.1	16.1		10.4	34.5		10.4	
Effective Green, g (s)				16.1	16.1	16.1		10.4	34.5		10.4	
Actuated g/C Ratio				0.47	0.47	0.47		0.30	1.00		0.30	
Clearance Time (s)				4.0	4.0	4.0		4.0			4.0	
Vehicle Extension (s)				3.0	3.0	3.0		3.0			3.0	
Lane Grp Cap (vph)				792	690	709		1548	1599		1491	
v/s Ratio Prot				0.17	c0.19			0.10			c0.10	
v/s Ratio Perm						0.18			0.09			
v/c Ratio				0.36	0.40	0.39		0.34	0.09		0.34	
Uniform Delay, d1				5.9	6.0	6.0		9.4	0.0		9.4	
Progression Factor				1.00	1.00	1.00		1.00	1.00		1.00	
Incremental Delay, d2				0.3	0.4	0.4		0.1	0.1		0.1	
Delay (s)				6.2	6.4	6.4		9.5	0.1		9.5	
Level of Service				A	A	A		A	A		A	
Approach Delay (s)		0.0			6.3			7.4			9.5	
Approach LOS		A			A			A			A	

Intersection Summary			
HCM Average Control Delay	7.5	HCM Level of Service	A
HCM Volume to Capacity ratio	0.38		
Actuated Cycle Length (s)	34.5	Sum of lost time (s)	8.0
Intersection Capacity Utilization	43.8%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	260	0	170	0	0	0	0	370	370	0	480	260
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0		4.0					4.0			4.0	4.0
Lane Util. Factor	1.00		1.00					0.91			0.95	1.00
Frpb, ped/bikes	1.00		1.00					0.99			1.00	0.98
Flpb, ped/bikes	1.00		1.00					1.00			1.00	1.00
Frt	1.00		0.85					0.93			1.00	0.85
Flt Protected	0.95		1.00					1.00			1.00	1.00
Satd. Flow (prot)	1770		1583					4643			3539	1549
Flt Permitted	0.95		1.00					1.00			1.00	1.00
Satd. Flow (perm)	1770		1583					4643			3539	1549
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	283	0	185	0	0	0	0	402	402	0	522	283
RTOR Reduction (vph)	0	0	100	0	0	0	0	255	0	0	0	0
Lane Group Flow (vph)	283	0	85	0	0	0	0	549	0	0	522	283
Confl. Peds. (#/hr)							4		2	2		4
Confl. Bikes (#/hr)									3			
Turn Type	Split		Perm									Free
Protected Phases	8	8						2			6	
Permitted Phases			8									Free
Actuated Green, G (s)	12.4		12.4					11.7			11.7	32.1
Effective Green, g (s)	12.4		12.4					11.7			11.7	32.1
Actuated g/C Ratio	0.39		0.39					0.36			0.36	1.00
Clearance Time (s)	4.0		4.0					4.0			4.0	
Vehicle Extension (s)	3.0		3.0					3.0			3.0	
Lane Grp Cap (vph)	684		612					1692			1290	1549
v/s Ratio Prot	c0.16							0.12			c0.15	
v/s Ratio Perm			0.05									0.18
v/c Ratio	0.41		0.14					0.32			0.40	0.18
Uniform Delay, d1	7.2		6.4					7.4			7.6	0.0
Progression Factor	1.00		1.00					1.00			1.00	1.00
Incremental Delay, d2	0.4		0.1					0.1			0.2	0.3
Delay (s)	7.6		6.5					7.5			7.8	0.3
Level of Service	A		A					A			A	A
Approach Delay (s)		7.2			0.0			7.5			5.2	
Approach LOS		A			A			A			A	

Intersection Summary			
HCM Average Control Delay	6.5	HCM Level of Service	A
HCM Volume to Capacity ratio	0.41		
Actuated Cycle Length (s)	32.1	Sum of lost time (s)	8.0
Intersection Capacity Utilization	36.6%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	170	10	70	20	20	230	30	340	10	20	530	110
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0		4.0	4.0			4.0		4.0	4.0	
Lane Util. Factor		1.00		1.00	1.00			0.95		1.00	0.95	
Frpb, ped/bikes		0.99		1.00	0.99			1.00		1.00	1.00	
Flpb, ped/bikes		1.00		1.00	1.00			1.00		0.94	1.00	
Frt		0.96		1.00	0.86			1.00		1.00	0.97	
Flt Protected		0.97		0.95	1.00			1.00		0.95	1.00	
Satd. Flow (prot)		1703		1751	1571			3474		1645	3402	
Flt Permitted		1.00		0.59	1.00			0.88		0.95	1.00	
Satd. Flow (perm)		1761		1091	1571			3058		1645	3402	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	185	11	76	22	22	250	33	370	11	22	576	120
RTOR Reduction (vph)	0	14	0	0	188	0	0	2	0	0	16	0
Lane Group Flow (vph)	0	258	0	22	84	0	0	412	0	22	680	0
Confl. Peds. (#/hr)	1		3	3		1			5	5		
Confl. Bikes (#/hr)						1			2			1
Heavy Vehicles (%)	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%
Turn Type	Perm			Perm			Perm			Prot		
Protected Phases		3			4			2		1	6	
Permitted Phases	3			4			2					
Actuated Green, G (s)		2.4		11.4	11.4			15.4		0.8	20.2	
Effective Green, g (s)		2.4		11.4	11.4			15.4		0.8	20.2	
Actuated g/C Ratio		0.05		0.25	0.25			0.33		0.02	0.44	
Clearance Time (s)		4.0		4.0	4.0			4.0		4.0	4.0	
Vehicle Extension (s)		3.0		3.0	3.0			3.0		3.0	3.0	
Lane Grp Cap (vph)		92		270	389			1024		29	1494	
v/s Ratio Prot					c0.05					0.01	c0.20	
v/s Ratio Perm		c0.15		0.02				0.13				
v/c Ratio		2.80		0.08	0.22			0.40		0.76	0.45	
Uniform Delay, d1		21.8		13.3	13.7			11.8		22.5	9.0	
Progression Factor		1.00		1.00	1.00			1.00		1.00	1.00	
Incremental Delay, d2		840.3		0.1	0.3			0.3		71.7	0.2	
Delay (s)		862.1		13.4	14.0			12.0		94.2	9.3	
Level of Service		F		B	B			B		F	A	
Approach Delay (s)		862.1			14.0			12.0			11.9	
Approach LOS		F			B			B			B	

Intersection Summary			
HCM Average Control Delay	148.5	HCM Level of Service	F
HCM Volume to Capacity ratio	0.54		
Actuated Cycle Length (s)	46.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	72.9%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	170	20	30	40	40	30	30	160	50	20	350	210
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0		4.0	4.0		4.0	4.0	
Lane Util. Factor	1.00	0.95	1.00	1.00	0.95		1.00	0.95		1.00	0.95	
Frpb, ped/bikes	1.00	1.00	1.00	1.00	0.99		1.00	1.00		1.00	0.99	
Flpb, ped/bikes	1.00	1.00	1.00	1.00	1.00		1.00	1.00		1.00	1.00	
Frt	1.00	1.00	0.85	1.00	0.94		1.00	0.96		1.00	0.94	
Flt Protected	0.95	1.00	1.00	0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1770	3539	1583	1770	3289		1770	3401		1770	3314	
Flt Permitted	0.95	1.00	1.00	0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (perm)	1770	3539	1583	1770	3289		1770	3401		1770	3314	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	179	21	32	42	42	32	32	168	53	21	368	221
RTOR Reduction (vph)	0	0	24	0	29	0	0	32	0	0	117	0
Lane Group Flow (vph)	179	21	8	42	45	0	32	189	0	21	472	0
Confl. Peds. (#/hr)							16		1	1		16
Confl. Bikes (#/hr)						1			1			
Turn Type	Prot		Perm	Prot			Prot			Prot		
Protected Phases	7	4		3	8		5	2		1	6	
Permitted Phases			4									
Actuated Green, G (s)	9.2	11.6	11.6	1.7	4.1		1.4	14.2		1.0	13.8	
Effective Green, g (s)	9.2	11.6	11.6	1.7	4.1		1.4	14.2		1.0	13.8	
Actuated g/C Ratio	0.21	0.26	0.26	0.04	0.09		0.03	0.32		0.02	0.31	
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0		4.0	4.0		4.0	4.0	
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	366	923	413	68	303		56	1085		40	1028	
v/s Ratio Prot	c0.10	0.01		0.02	c0.01		c0.02	0.06		0.01	c0.14	
v/s Ratio Perm			0.01									
v/c Ratio	0.49	0.02	0.02	0.62	0.15		0.57	0.17		0.53	0.46	
Uniform Delay, d1	15.6	12.2	12.2	21.1	18.6		21.3	10.9		21.5	12.3	
Progression Factor	1.00	1.00	1.00	1.00	1.00		1.00	1.00		1.00	1.00	
Incremental Delay, d2	1.0	0.0	0.0	15.5	0.2		13.3	0.1		11.9	0.3	
Delay (s)	16.6	12.2	12.2	36.6	18.8		34.6	11.0		33.4	12.7	
Level of Service	B	B	B	D	B		C	B		C	B	
Approach Delay (s)		15.6			25.3			14.0			13.4	
Approach LOS		B			C			B			B	

Intersection Summary			
HCM Average Control Delay	15.1	HCM Level of Service	B
HCM Volume to Capacity ratio	0.43		
Actuated Cycle Length (s)	44.5	Sum of lost time (s)	16.0
Intersection Capacity Utilization	47.7%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Volume (veh/h)	80	50	30	170	180	70
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	87	54	33	185	196	76
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)				1133		
pX, platoon unblocked						
vC, conflicting volume			141		337	87
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			141		337	87
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			98		69	92
cM capacity (veh/h)			1429		640	966

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	NB 1	NB 2
Volume Total	87	54	33	185	196	76
Volume Left	0	0	33	0	196	0
Volume Right	0	54	0	0	0	76
cSH	1700	1700	1429	1700	640	966
Volume to Capacity	0.05	0.03	0.02	0.11	0.31	0.08
Queue Length 95th (ft)	0	0	2	0	32	6
Control Delay (s)	0.0	0.0	7.6	0.0	13.1	9.0
Lane LOS			A		B	A
Approach Delay (s)	0.0		1.1		12.0	
Approach LOS					B	

Intersection Summary			
Average Delay	5.5		
Intersection Capacity Utilization	25.6%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	110	20	10	10	50	70	20	20	10	80	20	60
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0		4.0	4.0			4.0	
Lane Util. Factor	1.00	1.00		1.00	1.00		1.00	1.00			1.00	
Frt	1.00	0.95		1.00	0.91		1.00	0.95			0.95	
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00			0.98	
Satd. Flow (prot)	1626	1626		1626	1562		1626	1626			1586	
Flt Permitted	0.95	1.00		0.95	1.00		0.79	1.00			0.82	
Satd. Flow (perm)	1626	1626		1626	1562		1353	1626			1341	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	120	22	11	11	54	76	22	22	11	87	22	65
RTOR Reduction (vph)	0	7	0	0	59	0	0	8	0	0	37	0
Lane Group Flow (vph)	120	26	0	11	71	0	22	25	0	0	137	0
Heavy Vehicles (%)	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%
Turn Type	Prot			Prot			Perm			Perm		
Protected Phases	7	4		3	8			2			6	
Permitted Phases							2			6		
Actuated Green, G (s)	4.4	10.5		0.9	7.0		7.4	7.4			7.4	
Effective Green, g (s)	4.4	10.5		0.9	7.0		7.4	7.4			7.4	
Actuated g/C Ratio	0.14	0.34		0.03	0.23		0.24	0.24			0.24	
Clearance Time (s)	4.0	4.0		4.0	4.0		4.0	4.0			4.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0			3.0	
Lane Grp Cap (vph)	232	554		48	355		325	391			322	
v/s Ratio Prot	c0.07	c0.02		0.01	c0.05			0.02				
v/s Ratio Perm							0.02				c0.10	
v/c Ratio	0.52	0.05		0.23	0.20		0.07	0.06			0.42	
Uniform Delay, d1	12.2	6.8		14.6	9.6		9.0	9.0			9.9	
Progression Factor	1.00	1.00		1.00	1.00		1.00	1.00			1.00	
Incremental Delay, d2	1.9	0.0		2.4	0.3		0.1	0.1			0.9	
Delay (s)	14.2	6.8		17.0	9.9		9.1	9.1			10.8	
Level of Service	B	A		B	A		A	A			B	
Approach Delay (s)		12.6			10.5			9.1			10.8	
Approach LOS		B			B			A			B	

Intersection Summary			
HCM Average Control Delay	11.1	HCM Level of Service	B
HCM Volume to Capacity ratio	0.39		
Actuated Cycle Length (s)	30.8	Sum of lost time (s)	16.0
Intersection Capacity Utilization	35.2%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Volume (veh/h)	40	60	50	40	80	60
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	43	65	54	43	87	65
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)	322					
pX, platoon unblocked						
vC, conflicting volume			43		228	76
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			43		228	76
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			97		88	93
cM capacity (veh/h)			1565		734	985

Direction, Lane #	EB 1	WB 1	WB 2	NB 1
Volume Total	109	54	43	152
Volume Left	0	54	0	87
Volume Right	65	0	0	65
cSH	1700	1565	1700	824
Volume to Capacity	0.06	0.03	0.03	0.18
Queue Length 95th (ft)	0	3	0	17
Control Delay (s)	0.0	7.4	0.0	10.4
Lane LOS		A		B
Approach Delay (s)	0.0	4.1		10.4
Approach LOS				B

Intersection Summary			
Average Delay	5.5		
Intersection Capacity Utilization	24.2%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Volume (veh/h)	90	10	10	70	20	40
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	98	11	11	76	22	43
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume			109		201	103
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			109		201	103
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			99		97	95
cM capacity (veh/h)			1482		782	952

Direction, Lane #	EB 1	WB 1	WB 2	NB 1
Volume Total	109	11	76	65
Volume Left	0	11	0	22
Volume Right	11	0	0	43
cSH	1700	1482	1700	887
Volume to Capacity	0.06	0.01	0.04	0.07
Queue Length 95th (ft)	0	1	0	6
Control Delay (s)	0.0	7.4	0.0	9.4
Lane LOS		A		A
Approach Delay (s)	0.0	0.9		9.4
Approach LOS				A

Intersection Summary			
Average Delay	2.7		
Intersection Capacity Utilization	17.5%	ICU Level of Service	A
Analysis Period (min)	15		

Intersection	
Intersection Delay (sec/veh)	20.8
Intersection LOS	C

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Volume (vph)	10	20	10	430	10	20	10	50	70	60	80	10
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Heavy Vehicles(%)	2	2	2	2	2	2	2	2	2	2	2	2
Movement Flow Rate	11	22	11	467	11	22	11	54	76	65	87	11
Number of Lanes	0	1	0	1	1	0	1	2	0	1	2	0

Approach	EB	WB	NB	SB
Opposing Approach	WB	EB	SB	NB
Opposing Lanes	2	1	3	3
Conflicting Approach Left	SB	NB	EB	WB
Conflicting Lanes Left	3	3	1	2
Conflicting Approach Right	NB	SB	WB	EB
Conflicting Lanes Right	3	3	2	1
HCM Control Delay	10.1	28	10.3	10.6
HCM LOS	B	D	B	B

Lane	NBLn1	NBLn2	NBLn3	EBLn1	WBLn1	WBLn2	SBLn1	SBLn2	SBLn3
Volume Left (%)	100%	0%	0%	25%	100%	0%	100%	0%	0%
Volume Thru (%)	0%	100%	19%	50%	0%	33%	0%	100%	73%
Volume Right (%)	0%	0%	81%	25%	0%	67%	0%	0%	27%
Sign Control	Stop	Stop	Stop	Stop	Stop	Stop	Stop	Stop	Stop
Traffic Volume by Lane	10	33	87	40	430	30	60	53	37
Left Turning Volume	0	33	17	20	0	10	0	53	27
Through Volume	0	0	70	10	0	20	0	0	10
Right Turning Volume	10	0	0	10	430	0	60	0	0
Lane Flow Rate	11	36	94	43	467	33	65	58	40
Geometry Group	8	8	8	8	8	8	8	8	8
Degree of Utilization, X	0.022	0.069	0.165	0.082	0.802	0.047	0.133	0.11	0.073
Departure Headway, Hd	7.411	6.9	6.322	6.761	6.18	5.215	7.332	6.82	6.625
Convergence(Y/N)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Capacity	482	518	566	529	584	687	488	525	540
Service Time	5.169	4.657	4.078	4.518	3.913	2.947	5.087	4.575	4.38
HCM Lane V/C Ratio	0.023	0.069	0.166	0.081	0.8	0.048	0.133	0.11	0.074
HCM Control Delay	10.3	10.2	10.3	10.1	29.4	8.2	11.2	10.4	9.9
HCM Lane LOS	B	B	B	B	D	A	B	B	A
HCM 95th Percentile Queue	0.1	0.2	0.6	0.3	12	0.1	0.5	0.4	0.2

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	0	0	40	10	450	20	500	0	0	90	300
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)				4.0	4.0		4.0	4.0			4.0	
Lane Util. Factor				1.00	1.00		1.00	0.95			0.95	
Frpb, ped/bikes				1.00	1.00		1.00	1.00			0.98	
Flpb, ped/bikes				1.00	1.00		1.00	1.00			1.00	
Frt				1.00	0.85		1.00	1.00			0.88	
Flt Protected				0.95	1.00		0.95	1.00			1.00	
Satd. Flow (prot)				1787	1605		1787	3574			3110	
Flt Permitted				0.95	1.00		0.95	1.00			1.00	
Satd. Flow (perm)				1787	1605		1787	3574			3110	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	0	0	0	42	11	474	21	526	0	0	95	316
RTOR Reduction (vph)	0	0	0	0	255	0	0	0	0	0	218	0
Lane Group Flow (vph)	0	0	0	42	230	0	21	526	0	0	193	0
Confl. Peds. (#/hr)							1		2	2		1
Confl. Bikes (#/hr)			1						1			
Heavy Vehicles (%)	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%
Turn Type				Split			Prot					
Protected Phases				8	8		5	2			6	
Permitted Phases												
Actuated Green, G (s)				10.1	10.1		2.1	16.9			10.8	
Effective Green, g (s)				10.1	10.1		2.1	16.9			10.8	
Actuated g/C Ratio				0.29	0.29		0.06	0.48			0.31	
Clearance Time (s)				4.0	4.0		4.0	4.0			4.0	
Vehicle Extension (s)				3.0	3.0		3.0	3.0			3.0	
Lane Grp Cap (vph)				516	463		107	1726			960	
v/s Ratio Prot				0.02	c0.14		0.01	c0.15			0.06	
v/s Ratio Perm												
v/c Ratio				0.08	0.50		0.20	0.30			0.20	
Uniform Delay, d1				9.1	10.3		15.6	5.5			8.9	
Progression Factor				1.00	1.00		1.00	1.00			1.00	
Incremental Delay, d2				0.1	0.8		0.9	0.1			0.1	
Delay (s)				9.1	11.2		16.5	5.6			9.0	
Level of Service				A	B		B	A			A	
Approach Delay (s)		0.0			11.0			6.0			9.0	
Approach LOS		A			B			A			A	

Intersection Summary			
HCM Average Control Delay	8.6	HCM Level of Service	A
HCM Volume to Capacity ratio	0.38		
Actuated Cycle Length (s)	35.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	51.7%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	40	260	70	280	290	50	310	180	460	20	40	50
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0		4.0	4.0	4.0		4.0	
Lane Util. Factor	1.00	0.95		0.91	0.91		0.95	0.95	1.00		1.00	
Frpb, ped/bikes	1.00	1.00		1.00	1.00		1.00	1.00	0.99		1.00	
Flpb, ped/bikes	1.00	1.00		1.00	1.00		1.00	1.00	1.00		1.00	
Frt	1.00	0.97		1.00	0.98		1.00	1.00	0.85		0.94	
Flt Protected	0.95	1.00		0.95	0.99		0.95	0.99	1.00		0.99	
Satd. Flow (prot)	1787	3461		1626	3331		1698	1763	1576		1749	
Flt Permitted	0.95	1.00		0.95	0.99		0.95	0.99	1.00		0.99	
Satd. Flow (perm)	1787	3461		1626	3331		1698	1763	1576		1749	
Peak-hour factor, PHF	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97
Adj. Flow (vph)	41	268	72	289	299	52	320	186	474	21	41	52
RTOR Reduction (vph)	0	26	0	0	11	0	0	0	346	0	34	0
Lane Group Flow (vph)	41	314	0	211	418	0	250	256	128	0	80	0
Confl. Peds. (#/hr)									2	2		
Confl. Bikes (#/hr)									1			
Heavy Vehicles (%)	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%
Turn Type	Split			Split			Split		Perm	Split		
Protected Phases	4	4		8	8		2	2		6	6	
Permitted Phases									2			
Actuated Green, G (s)	12.3	12.3		15.9	15.9		19.0	19.0	19.0		7.2	
Effective Green, g (s)	12.3	12.3		15.9	15.9		19.0	19.0	19.0		7.2	
Actuated g/C Ratio	0.17	0.17		0.23	0.23		0.27	0.27	0.27		0.10	
Clearance Time (s)	4.0	4.0		4.0	4.0		4.0	4.0	4.0		4.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0	3.0		3.0	
Lane Grp Cap (vph)	312	605		367	752		458	476	425		179	
v/s Ratio Prot	0.02	c0.09		c0.13	0.13		c0.15	0.15			c0.05	
v/s Ratio Perm									0.08			
v/c Ratio	0.13	0.52		0.57	0.56		0.55	0.54	0.30		0.45	
Uniform Delay, d1	24.5	26.4		24.2	24.1		22.0	21.9	20.4		29.7	
Progression Factor	1.00	1.00		1.00	1.00		1.00	1.00	1.00		1.00	
Incremental Delay, d2	0.2	0.8		2.2	0.9		1.3	1.2	0.4		1.8	
Delay (s)	24.7	27.1		26.4	25.0		23.3	23.1	20.8		31.5	
Level of Service	C	C		C	C		C	C	C		C	
Approach Delay (s)		26.9			25.5			22.1			31.5	
Approach LOS		C			C			C			C	

Intersection Summary			
HCM Average Control Delay	24.5	HCM Level of Service	C
HCM Volume to Capacity ratio	0.54		
Actuated Cycle Length (s)	70.4	Sum of lost time (s)	16.0
Intersection Capacity Utilization	54.7%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	620	150	90	450	0	0	0	0	360	10	240
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0			4.0						4.0	
Lane Util. Factor		0.95			0.95						1.00	
Frpb, ped/bikes		0.99			1.00						1.00	
Flpb, ped/bikes		1.00			1.00						1.00	
Frt		0.97			1.00						0.95	
Flt Protected		1.00			0.99						0.97	
Satd. Flow (prot)		3451			3543						1730	
Flt Permitted		1.00			0.67						0.97	
Satd. Flow (perm)		3451			2378						1730	
Peak-hour factor, PHF	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96
Adj. Flow (vph)	0	646	156	94	469	0	0	0	0	375	10	250
RTOR Reduction (vph)	0	45	0	0	0	0	0	0	0	0	35	0
Lane Group Flow (vph)	0	757	0	0	563	0	0	0	0	0	600	0
Confl. Peds. (#/hr)	3		8	8		3						
Confl. Bikes (#/hr)						3						
Heavy Vehicles (%)	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%
Turn Type				Perm						Split		
Protected Phases		4			8					6	6	
Permitted Phases				8								
Actuated Green, G (s)		19.3			19.3						27.7	
Effective Green, g (s)		19.3			19.3						27.7	
Actuated g/C Ratio		0.35			0.35						0.50	
Clearance Time (s)		4.0			4.0						4.0	
Vehicle Extension (s)		3.0			3.0						3.0	
Lane Grp Cap (vph)		1211			834						871	
v/s Ratio Prot		0.22									c0.35	
v/s Ratio Perm					c0.24							
v/c Ratio		0.62			0.68						0.69	
Uniform Delay, d1		14.8			15.2						10.4	
Progression Factor		1.00			1.00						1.00	
Incremental Delay, d2		1.0			2.2						4.4	
Delay (s)		15.9			17.4						14.8	
Level of Service		B			B						B	
Approach Delay (s)		15.9			17.4			0.0			14.8	
Approach LOS		B			B			A			B	

Intersection Summary			
HCM Average Control Delay	15.9	HCM Level of Service	B
HCM Volume to Capacity ratio	0.68		
Actuated Cycle Length (s)	55.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	82.8%	ICU Level of Service	E
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	240	740	0	0	470	430	80	140	140	0	0	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0			4.0		4.0	4.0	4.0			
Lane Util. Factor		0.95			0.95		0.95	0.95	1.00			
Frpb, ped/bikes		1.00			0.99		1.00	1.00	1.00			
Flpb, ped/bikes		1.00			1.00		1.00	1.00	1.00			
Frt		1.00			0.93		1.00	1.00	0.85			
Flt Protected		0.99			1.00		0.95	1.00	1.00			
Satd. Flow (prot)		3531			3281		1698	1782	1599			
Flt Permitted		0.57			1.00		0.95	1.00	1.00			
Satd. Flow (perm)		2045			3281		1698	1782	1599			
Peak-hour factor, PHF	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96
Adj. Flow (vph)	250	771	0	0	490	448	83	146	146	0	0	0
RTOR Reduction (vph)	0	0	0	0	149	0	0	0	109	0	0	0
Lane Group Flow (vph)	0	1021	0	0	789	0	75	154	37	0	0	0
Confl. Peds. (#/hr)	2		7	7		2						
Confl. Bikes (#/hr)						3						
Heavy Vehicles (%)	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%
Turn Type	Perm						Split		Prot			
Protected Phases		4			8		2	2	2			
Permitted Phases	4											
Actuated Green, G (s)		51.9			51.9		20.1	20.1	20.1			
Effective Green, g (s)		51.9			51.9		20.1	20.1	20.1			
Actuated g/C Ratio		0.65			0.65		0.25	0.25	0.25			
Clearance Time (s)		4.0			4.0		4.0	4.0	4.0			
Vehicle Extension (s)		3.0			3.0		3.0	3.0	3.0			
Lane Grp Cap (vph)		1327			2129		427	448	402			
v/s Ratio Prot					0.24		0.04	c0.09	0.02			
v/s Ratio Perm		c0.50										
v/c Ratio		0.77			0.37		0.18	0.34	0.09			
Uniform Delay, d1		9.9			6.5		23.5	24.5	23.0			
Progression Factor		1.00			1.00		1.00	1.00	1.00			
Incremental Delay, d2		2.8			0.1		0.9	2.1	0.4			
Delay (s)		12.6			6.6		24.4	26.6	23.4			
Level of Service		B			A		C	C	C			
Approach Delay (s)		12.6			6.6			24.9			0.0	
Approach LOS		B			A			C			A	

Intersection Summary			
HCM Average Control Delay	12.2	HCM Level of Service	B
HCM Volume to Capacity ratio	0.65		
Actuated Cycle Length (s)	80.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	72.8%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

Near-Term (2018) Plus Phase 1 Project Conditions

FEHR PEERS

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	80	282	84	290	360	131	51	271	150	74	667	50
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	4.0	4.0	3.0	4.0	4.0	3.0	3.0	3.0	3.0	3.0	
Lane Util. Factor	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	
Frpb, ped/bikes	1.00	1.00	0.98	1.00	1.00	0.98	1.00	1.00	0.98	1.00	1.00	
Flpb, ped/bikes	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	0.99	
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	
Satd. Flow (prot)	1736	3471	1518	1736	3471	1516	1736	3471	1530	1736	3431	
Flt Permitted	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	
Satd. Flow (perm)	1736	3471	1518	1736	3471	1516	1736	3471	1530	1736	3431	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	87	307	91	315	391	142	55	295	163	80	725	54
RTOR Reduction (vph)	0	0	60	0	0	92	0	0	120	0	7	0
Lane Group Flow (vph)	87	307	31	315	391	50	55	295	43	80	772	0
Confl. Peds. (#/hr)	14		13	13		14	4		4	4		4
Confl. Bikes (#/hr)						1						1
Heavy Vehicles (%)	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%
Turn Type	Prot		Perm	Prot		Perm	Prot		Perm	Prot		
Protected Phases	5	2		1	6		3	8		7	4	
Permitted Phases			2			6			8			
Actuated Green, G (s)	6.1	15.4	15.4	14.5	21.8	21.8	2.1	17.1	17.1	4.2	19.2	
Effective Green, g (s)	6.1	15.4	15.4	14.5	21.8	21.8	2.1	17.1	17.1	4.2	19.2	
Actuated g/C Ratio	0.10	0.24	0.24	0.23	0.34	0.34	0.03	0.27	0.27	0.07	0.30	
Clearance Time (s)	5.0	4.0	4.0	3.0	4.0	4.0	3.0	3.0	3.0	3.0	3.0	
Vehicle Extension (s)	2.0	4.0	4.0	2.0	4.0	4.0	2.0	2.0	2.0	2.0	2.0	
Lane Grp Cap (vph)	165	833	364	392	1179	515	57	925	408	114	1026	
v/s Ratio Prot	0.05	0.09		c0.18	c0.11		c0.03	0.08		0.05	c0.22	
v/s Ratio Perm			0.02			0.03			0.03			
v/c Ratio	0.53	0.37	0.09	0.80	0.33	0.10	0.96	0.32	0.11	0.70	0.75	
Uniform Delay, d1	27.7	20.3	18.9	23.5	15.8	14.5	31.0	18.9	17.8	29.4	20.4	
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	
Incremental Delay, d2	1.4	0.4	0.1	10.7	0.2	0.1	105.2	0.1	0.0	14.7	2.8	
Delay (s)	29.1	20.7	19.1	34.2	16.0	14.6	136.2	19.0	17.8	44.1	23.2	
Level of Service	C	C	B	C	B	B	F	B	B	D	C	
Approach Delay (s)		21.9			22.5			31.2			25.1	
Approach LOS		C			C			C			C	

Intersection Summary			
HCM Average Control Delay	24.9	HCM Level of Service	C
HCM Volume to Capacity ratio	0.59		
Actuated Cycle Length (s)	64.2	Sum of lost time (s)	6.0
Intersection Capacity Utilization	65.3%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	0	0	330	10	191	0	271	140	0	801	250
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)				4.0	4.0	4.0		4.0	4.0		4.0	
Lane Util. Factor				0.95	0.91	0.95		0.91	1.00		0.91	
Frpb, ped/bikes				1.00	1.00	0.99		1.00	0.98		0.99	
Flpb, ped/bikes				1.00	1.00	1.00		1.00	1.00		1.00	
Frt				1.00	0.98	0.85		1.00	0.85		0.96	
Flt Protected				0.95	0.96	1.00		1.00	1.00		1.00	
Satd. Flow (prot)				1665	1576	1471		5036	1535		4830	
Flt Permitted				0.95	0.96	1.00		1.00	1.00		1.00	
Satd. Flow (perm)				1665	1576	1471		5036	1535		4830	
Peak-hour factor, PHF	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94
Adj. Flow (vph)	0	0	0	351	11	203	0	288	149	0	852	266
RTOR Reduction (vph)	0	0	0	0	13	117	0	0	0	0	76	0
Lane Group Flow (vph)	0	0	0	197	180	58	0	288	149	0	1042	0
Confl. Peds. (#/hr)	1					1	2		1	1		2
Confl. Bikes (#/hr)									2			1
Heavy Vehicles (%)	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%
Turn Type				Split		Perm			Free			
Protected Phases				8	8			2			6	
Permitted Phases						8			Free			
Actuated Green, G (s)				12.9	12.9	12.9		17.9	38.8		17.9	
Effective Green, g (s)				12.9	12.9	12.9		17.9	38.8		17.9	
Actuated g/C Ratio				0.33	0.33	0.33		0.46	1.00		0.46	
Clearance Time (s)				4.0	4.0	4.0		4.0			4.0	
Vehicle Extension (s)				3.0	3.0	3.0		3.0			3.0	
Lane Grp Cap (vph)				554	524	489		2323	1535		2228	
v/s Ratio Prot				c0.12	0.11			0.06			c0.22	
v/s Ratio Perm						0.04			0.10			
v/c Ratio				0.36	0.34	0.12		0.12	0.10		0.47	
Uniform Delay, d1				9.8	9.8	9.0		6.0	0.0		7.2	
Progression Factor				1.00	1.00	1.00		1.00	1.00		1.00	
Incremental Delay, d2				0.4	0.4	0.1		0.0	0.1		0.2	
Delay (s)				10.2	10.2	9.1		6.0	0.1		7.3	
Level of Service				B	B	A		A	A		A	
Approach Delay (s)		0.0			9.8			4.0			7.3	
Approach LOS		A			A			A			A	

Intersection Summary			
HCM Average Control Delay	7.3	HCM Level of Service	A
HCM Volume to Capacity ratio	0.42		
Actuated Cycle Length (s)	38.8	Sum of lost time (s)	8.0
Intersection Capacity Utilization	39.6%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	80	0	130	0	0	0	0	331	330	0	555	575
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0		4.0					4.0			4.0	4.0
Lane Util. Factor	1.00		1.00					0.91			0.95	1.00
Frpb, ped/bikes	1.00		1.00					0.99			1.00	0.98
Flpb, ped/bikes	1.00		1.00					1.00			1.00	1.00
Frt	1.00		0.85					0.93			1.00	0.85
Flt Protected	0.95		1.00					1.00			1.00	1.00
Satd. Flow (prot)	1752		1568					4603			3505	1536
Flt Permitted	0.95		1.00					1.00			1.00	1.00
Satd. Flow (perm)	1752		1568					4603			3505	1536
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	87	0	141	0	0	0	0	360	359	0	603	625
RTOR Reduction (vph)	0	0	90	0	0	0	0	197	0	0	0	0
Lane Group Flow (vph)	87	0	51	0	0	0	0	522	0	0	603	625
Confl. Peds. (#/hr)							1		3	3		1
Confl. Bikes (#/hr)									1			
Heavy Vehicles (%)	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%
Turn Type	Split		Perm									Free
Protected Phases	8	8						2			6	
Permitted Phases			8									Free
Actuated Green, G (s)	7.7		7.7					12.9			12.9	28.6
Effective Green, g (s)	7.7		7.7					12.9			12.9	28.6
Actuated g/C Ratio	0.27		0.27					0.45			0.45	1.00
Clearance Time (s)	4.0		4.0					4.0			4.0	
Vehicle Extension (s)	3.0		3.0					3.0			3.0	
Lane Grp Cap (vph)	472		422					2076			1581	1536
v/s Ratio Prot	0.05							0.11			0.17	
v/s Ratio Perm			0.03									c0.41
v/c Ratio	0.18		0.12					0.25			0.38	0.41
Uniform Delay, d1	8.0		7.9					4.9			5.2	0.0
Progression Factor	1.00		1.00					1.00			1.00	1.00
Incremental Delay, d2	0.2		0.1					0.1			0.2	0.8
Delay (s)	8.2		8.0					4.9			5.4	0.8
Level of Service	A		A					A			A	A
Approach Delay (s)		8.1			0.0			4.9			3.0	
Approach LOS		A			A			A			A	

Intersection Summary			
HCM Average Control Delay	4.2	HCM Level of Service	A
HCM Volume to Capacity ratio	0.41		
Actuated Cycle Length (s)	28.6	Sum of lost time (s)	0.0
Intersection Capacity Utilization	30.1%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	50	20	30	10	10	30	30	581	20	290	285	110
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0		4.0	4.0			4.0		4.0	4.0	
Lane Util. Factor		1.00		1.00	1.00			0.95		1.00	0.95	
Frpb, ped/bikes		1.00		1.00	0.99			1.00		1.00	0.99	
Flpb, ped/bikes		1.00		1.00	1.00			1.00		1.00	1.00	
Frt		0.96		1.00	0.89			1.00		1.00	0.96	
Flt Protected		0.98		0.95	1.00			1.00		0.95	1.00	
Satd. Flow (prot)		1709		1736	1605			3446		1736	3305	
Flt Permitted		1.00		0.69	1.00			0.92		0.95	1.00	
Satd. Flow (perm)		1751		1255	1605			3180		1736	3305	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	54	22	33	11	11	33	33	632	22	315	310	120
RTOR Reduction (vph)	0	16	0	0	28	0	0	2	0	0	26	0
Lane Group Flow (vph)	0	93	0	11	16	0	0	685	0	315	404	0
Confl. Peds. (#/hr)	3					3	2					2
Confl. Bikes (#/hr)												1
Heavy Vehicles (%)	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%
Turn Type	Perm			Perm			Perm			Prot		
Protected Phases		3			4			2		1	6	
Permitted Phases	3			4			2					
Actuated Green, G (s)		2.2		8.4	8.4			21.7		11.9	37.6	
Effective Green, g (s)		2.2		8.4	8.4			21.7		11.9	37.6	
Actuated g/C Ratio		0.04		0.14	0.14			0.36		0.20	0.62	
Clearance Time (s)		4.0		4.0	4.0			4.0		4.0	4.0	
Vehicle Extension (s)		3.0		3.0	3.0			3.0		3.0	3.0	
Lane Grp Cap (vph)		64		175	224			1146		343	2064	
v/s Ratio Prot					c0.01					c0.18	0.12	
v/s Ratio Perm		c0.05		0.01				c0.22				
v/c Ratio		1.45		0.06	0.07			0.60		0.92	0.20	
Uniform Delay, d1		29.0		22.5	22.5			15.7		23.7	4.8	
Progression Factor		1.00		1.00	1.00			1.00		1.00	1.00	
Incremental Delay, d2		269.3		0.2	0.1			0.8		28.5	0.0	
Delay (s)		298.3		22.6	22.6			16.5		52.1	4.9	
Level of Service		F		C	C			B		D	A	
Approach Delay (s)		298.3			22.6			16.5			24.9	
Approach LOS		F			C			B			C	

Intersection Summary			
HCM Average Control Delay	39.9	HCM Level of Service	D
HCM Volume to Capacity ratio	0.63		
Actuated Cycle Length (s)	60.2	Sum of lost time (s)	16.0
Intersection Capacity Utilization	56.3%	ICU Level of Service	B
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	220	44	20	21	11	41	10	370	114	45	100	160
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0		4.0	4.0		4.0	4.0	
Lane Util. Factor	1.00	0.95	1.00	1.00	0.95		1.00	0.95		1.00	0.95	
Frpb, ped/bikes	1.00	1.00	1.00	1.00	0.96		1.00	1.00		1.00	0.99	
Flpb, ped/bikes	1.00	1.00	1.00	1.00	1.00		1.00	1.00		1.00	1.00	
Frt	1.00	1.00	0.85	1.00	0.88		1.00	0.96		1.00	0.91	
Flt Protected	0.95	1.00	1.00	0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1770	3539	1583	1770	2994		1767	3404		1770	3183	
Flt Permitted	0.95	1.00	1.00	0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (perm)	1770	3539	1583	1770	2994		1767	3404		1770	3183	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	239	48	22	23	12	45	11	402	124	49	109	174
RTOR Reduction (vph)	0	0	14	0	40	0	0	36	0	0	117	0
Lane Group Flow (vph)	239	48	8	23	17	0	11	490	0	49	166	0
Confl. Peds. (#/hr)	3					3	4					4
Confl. Bikes (#/hr)						20			1			1
Turn Type	Prot		Perm	Prot			Prot			Prot		
Protected Phases	7	4		3	8		5	2		1	6	
Permitted Phases			4									
Actuated Green, G (s)	13.2	19.0	19.0	0.6	6.4		0.5	15.0		2.9	17.4	
Effective Green, g (s)	13.2	19.0	19.0	0.6	6.4		0.5	15.0		2.9	17.4	
Actuated g/C Ratio	0.25	0.36	0.36	0.01	0.12		0.01	0.28		0.05	0.33	
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0		4.0	4.0		4.0	4.0	
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	437	1257	562	20	358		17	954		96	1035	
v/s Ratio Prot	c0.14	c0.01		0.01	0.01		0.01	c0.14		c0.03	0.05	
v/s Ratio Perm			0.00									
v/c Ratio	0.55	0.04	0.01	1.15	0.05		0.65	0.51		0.51	0.16	
Uniform Delay, d1	17.5	11.3	11.2	26.4	20.9		26.4	16.2		24.6	12.8	
Progression Factor	1.00	1.00	1.00	1.00	1.00		1.00	1.00		1.00	1.00	
Incremental Delay, d2	1.4	0.0	0.0	252.2	0.1		62.0	0.5		4.5	0.1	
Delay (s)	18.9	11.3	11.2	278.6	20.9		88.4	16.7		29.1	12.9	
Level of Service	B	B	B	F	C		F	B		C	B	
Approach Delay (s)		17.2			95.0			18.1			15.3	
Approach LOS		B			F			B			B	

Intersection Summary			
HCM Average Control Delay	22.0	HCM Level of Service	C
HCM Volume to Capacity ratio	0.39		
Actuated Cycle Length (s)	53.5	Sum of lost time (s)	12.0
Intersection Capacity Utilization	46.1%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Volume (veh/h)	222	120	58	113	60	70
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	241	130	63	123	65	76
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)				1133		
pX, platoon unblocked						
vC, conflicting volume			372		490	241
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			372		490	241
tC, single (s)			4.2		6.5	6.3
tC, 2 stage (s)						
tF (s)			2.3		3.6	3.4
p0 queue free %			94		87	90
cM capacity (veh/h)			1144		494	778

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	NB 1	NB 2
Volume Total	241	130	63	123	65	76
Volume Left	0	0	63	0	65	0
Volume Right	0	130	0	0	0	76
cSH	1700	1700	1144	1700	494	778
Volume to Capacity	0.14	0.08	0.06	0.07	0.13	0.10
Queue Length 95th (ft)	0	0	4	0	11	8
Control Delay (s)	0.0	0.0	8.3	0.0	13.4	10.1
Lane LOS			A		B	B
Approach Delay (s)	0.0		2.8		11.6	
Approach LOS					B	

Intersection Summary			
Average Delay	3.1		
Intersection Capacity Utilization	28.4%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	60	87	20	20	50	81	10	20	20	102	30	160
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0		4.0	4.0			4.0	
Lane Util. Factor	1.00	1.00		1.00	1.00		1.00	1.00			1.00	
Frpb, ped/bikes	1.00	1.00		1.00	1.00		1.00	0.99			1.00	
Flpb, ped/bikes	1.00	1.00		1.00	1.00		1.00	1.00			1.00	
Frt	1.00	0.97		1.00	0.91		1.00	0.93			0.93	
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00			0.98	
Satd. Flow (prot)	1556	1592		1556	1486		1556	1497			1490	
Flt Permitted	0.95	1.00		0.95	1.00		0.63	1.00			0.88	
Satd. Flow (perm)	1556	1592		1556	1486		1029	1497			1338	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	65	95	22	22	54	88	11	22	22	111	33	174
RTOR Reduction (vph)	0	16	0	0	75	0	0	13	0	0	58	0
Lane Group Flow (vph)	65	101	0	22	67	0	11	31	0	0	260	0
Confl. Peds. (#/hr)									2	2		
Confl. Bikes (#/hr)									2			
Heavy Vehicles (%)	16%	16%	16%	16%	16%	16%	16%	16%	16%	16%	16%	16%
Turn Type	Prot			Prot			Perm			Perm		
Protected Phases	7	4		3	8			2			6	
Permitted Phases							2			6		
Actuated Green, G (s)	1.9	5.7		1.0	4.8		13.1	13.1			13.1	
Effective Green, g (s)	1.9	5.7		1.0	4.8		13.1	13.1			13.1	
Actuated g/C Ratio	0.06	0.18		0.03	0.15		0.41	0.41			0.41	
Clearance Time (s)	4.0	4.0		4.0	4.0		4.0	4.0			4.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0			3.0	
Lane Grp Cap (vph)	93	285		49	224		424	617			551	
v/s Ratio Prot	c0.04	c0.06		0.01	0.05			0.02				
v/s Ratio Perm							0.01				c0.19	
v/c Ratio	0.70	0.36		0.45	0.30		0.03	0.05			0.47	
Uniform Delay, d1	14.7	11.4		15.1	12.0		5.6	5.6			6.8	
Progression Factor	1.00	1.00		1.00	1.00		1.00	1.00			1.00	
Incremental Delay, d2	20.5	0.8		6.4	0.8		0.0	0.0			0.6	
Delay (s)	35.1	12.2		21.5	12.8		5.6	5.6			7.5	
Level of Service	D	B		C	B		A	A			A	
Approach Delay (s)		20.4			13.9			5.6			7.5	
Approach LOS		C			B			A			A	

Intersection Summary			
HCM Average Control Delay	12.1	HCM Level of Service	B
HCM Volume to Capacity ratio	0.40		
Actuated Cycle Length (s)	31.8	Sum of lost time (s)	8.0
Intersection Capacity Utilization	44.6%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Volume (veh/h)	119	100	32	51	100	163
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	129	109	35	55	109	177
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)	322					
pX, platoon unblocked						
vC, conflicting volume			129		309	184
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			129		309	184
tC, single (s)			4.3		6.6	6.4
tC, 2 stage (s)						
tF (s)			2.3		3.6	3.4
p0 queue free %			97		83	78
cM capacity (veh/h)			1374		639	824

Direction, Lane #	EB 1	WB 1	WB 2	NB 1
Volume Total	238	35	55	286
Volume Left	0	35	0	109
Volume Right	109	0	0	177
cSH	1700	1374	1700	742
Volume to Capacity	0.14	0.03	0.03	0.39
Queue Length 95th (ft)	0	2	0	46
Control Delay (s)	0.0	7.7	0.0	12.9
Lane LOS		A		B
Approach Delay (s)	0.0	3.0		12.9
Approach LOS				B

Intersection Summary			
Average Delay	6.4		
Intersection Capacity Utilization	41.3%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Volume (veh/h)	180	102	140	60	23	26
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	196	111	152	65	25	28
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume			307		621	251
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			307		621	251
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			88		94	96
cM capacity (veh/h)			1237		391	780

Direction, Lane #	EB 1	WB 1	WB 2	NB 1
Volume Total	307	152	65	53
Volume Left	0	152	0	25
Volume Right	111	0	0	28
cSH	1700	1237	1700	532
Volume to Capacity	0.18	0.12	0.04	0.10
Queue Length 95th (ft)	0	10	0	8
Control Delay (s)	0.0	8.3	0.0	12.5
Lane LOS		A		B
Approach Delay (s)	0.0	5.8		12.5
Approach LOS				B

Intersection Summary			
Average Delay	3.3		
Intersection Capacity Utilization	36.8%	ICU Level of Service	A
Analysis Period (min)	15		

Intersection	
Intersection Delay (sec/veh)	32.6
Intersection LOS	D

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Volume (vph)	10	10	10	420	10	20	30	210	160	120	136	10
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Heavy Vehicles(%)	4	4	4	4	4	4	4	4	4	4	4	4
Movement Flow Rate	11	11	11	457	11	22	33	228	174	130	148	11
Number of Lanes	0	1	0	1	1	0	1	2	0	1	2	0

Approach	EB	WB	NB	SB
Opposing Approach	WB	EB	SB	NB
Opposing Lanes	2	1	3	3
Conflicting Approach Left	SB	NB	EB	WB
Conflicting Lanes Left	3	3	1	2
Conflicting Approach Right	NB	SB	WB	EB
Conflicting Lanes Right	3	3	2	1
HCM Control Delay	12.2	60	15.8	13.8
HCM LOS	B	F	C	B

Lane	NBLn1	NBLn2	NBLn3	EBLn1	WBLn1	WBLn2	SBLn1	SBLn2	SBLn3
Volume Left (%)	100%	0%	0%	33%	100%	0%	100%	0%	0%
Volume Thru (%)	0%	100%	30%	33%	0%	33%	0%	100%	82%
Volume Right (%)	0%	0%	70%	33%	0%	67%	0%	0%	18%
Sign Control	Stop	Stop	Stop	Stop	Stop	Stop	Stop	Stop	Stop
Traffic Volume by Lane	30	140	230	30	420	30	120	91	55
Left Turning Volume	0	140	70	10	0	10	0	91	45
Through Volume	0	0	160	10	0	20	0	0	10
Right Turning Volume	30	0	0	10	420	0	120	0	0
Lane Flow Rate	33	152	250	33	457	33	130	99	60
Geometry Group	8	8	8	8	8	8	8	8	8
Degree of Utilization, X	0.075	0.329	0.505	0.079	0.976	0.061	0.312	0.221	0.133
Departure Headway, Hd	8.295	7.779	7.276	8.673	7.7	6.73	8.603	8.085	7.955
Convergence(Y/N)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Capacity	431	461	495	412	470	532	417	443	450
Service Time	6.052	5.536	5.033	6.452	5.45	4.479	6.365	5.847	5.716
HCM Lane V/C Ratio	0.077	0.33	0.505	0.08	0.972	0.062	0.312	0.223	0.133
HCM Control Delay	11.7	14.3	17.3	12.2	63.6	9.9	15.2	13.1	11.9
HCM Lane LOS	B	B	C	B	F	A	C	B	B
HCM 95th Percentile Queue	0.2	1.5	3.1	0.3	67.5	0.2	1.4	0.9	0.5

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	0	0	134	10	70	20	546	0	0	256	420
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)				4.0	4.0		4.0	4.0			4.0	
Lane Util. Factor				1.00	1.00		1.00	0.95			0.95	
Frpb, ped/bikes				1.00	1.00		1.00	1.00			0.99	
Flpb, ped/bikes				1.00	1.00		1.00	1.00			1.00	
Frt				1.00	0.87		1.00	1.00			0.91	
Flt Protected				0.95	1.00		0.95	1.00			1.00	
Satd. Flow (prot)				1736	1588		1736	3471			3104	
Flt Permitted				0.95	1.00		0.95	1.00			1.00	
Satd. Flow (perm)				1736	1588		1736	3471			3104	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	0	0	0	146	11	76	22	593	0	0	278	457
RTOR Reduction (vph)	0	0	0	0	61	0	0	0	0	0	280	0
Lane Group Flow (vph)	0	0	0	146	26	0	22	593	0	0	455	0
Confl. Peds. (#/hr)							1					1
Confl. Bikes (#/hr)									2			1
Heavy Vehicles (%)	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%
Turn Type				Split			Prot					
Protected Phases				8	8		5	2			6	
Permitted Phases												
Actuated Green, G (s)				6.8	6.8		1.9	19.0			13.1	
Effective Green, g (s)				6.8	6.8		1.9	19.0			13.1	
Actuated g/C Ratio				0.20	0.20		0.06	0.56			0.39	
Clearance Time (s)				4.0	4.0		4.0	4.0			4.0	
Vehicle Extension (s)				3.0	3.0		3.0	3.0			3.0	
Lane Grp Cap (vph)				349	319		98	1951			1203	
v/s Ratio Prot				c0.08	0.02		0.01	c0.17			c0.15	
v/s Ratio Perm												
v/c Ratio				0.42	0.08		0.22	0.30			0.38	
Uniform Delay, d1				11.8	11.0		15.2	3.9			7.4	
Progression Factor				1.00	1.00		1.00	1.00			1.00	
Incremental Delay, d2				0.8	0.1		1.2	0.1			0.2	
Delay (s)				12.6	11.1		16.4	4.0			7.6	
Level of Service				B	B		B	A			A	
Approach Delay (s)		0.0			12.0			4.4			7.6	
Approach LOS		A			B			A			A	

Intersection Summary			
HCM Average Control Delay	7.0	HCM Level of Service	A
HCM Volume to Capacity ratio	0.41		
Actuated Cycle Length (s)	33.8	Sum of lost time (s)	12.0
Intersection Capacity Utilization	34.8%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	10	390	160	386	100	30	60	70	496	50	140	20
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0		4.0	4.0	4.0		4.0	
Lane Util. Factor	1.00	0.95		0.91	0.91		0.95	0.95	1.00		1.00	
Frpb, ped/bikes	1.00	1.00		1.00	1.00		1.00	1.00	0.99		1.00	
Flpb, ped/bikes	1.00	1.00		1.00	1.00		1.00	1.00	1.00		1.00	
Frt	1.00	0.96		1.00	0.99		1.00	1.00	0.85		0.99	
Flt Protected	0.95	1.00		0.95	0.97		0.95	1.00	1.00		0.99	
Satd. Flow (prot)	1752	3339		1595	3207		1665	1745	1547		1797	
Flt Permitted	0.95	1.00		0.95	0.97		0.95	1.00	1.00		0.99	
Satd. Flow (perm)	1752	3339		1595	3207		1665	1745	1547		1797	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	11	424	174	420	109	33	65	76	539	54	152	22
RTOR Reduction (vph)	0	45	0	0	8	0	0	0	448	0	4	0
Lane Group Flow (vph)	11	553	0	210	344	0	58	83	91	0	224	0
Confl. Peds. (#/hr)	1					1			2	2		
Confl. Bikes (#/hr)			1			1						1
Heavy Vehicles (%)	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%
Turn Type	Split			Split			Split		Perm	Split		
Protected Phases	4	4		8	8		2	2		6	6	
Permitted Phases									2			
Actuated Green, G (s)	16.8	16.8		14.7	14.7		12.4	12.4	12.4		13.8	
Effective Green, g (s)	16.8	16.8		14.7	14.7		12.4	12.4	12.4		13.8	
Actuated g/C Ratio	0.23	0.23		0.20	0.20		0.17	0.17	0.17		0.19	
Clearance Time (s)	4.0	4.0		4.0	4.0		4.0	4.0	4.0		4.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0	3.0		3.0	
Lane Grp Cap (vph)	399	761		318	640		280	294	260		336	
v/s Ratio Prot	0.01	c0.17		c0.13	0.11		0.03	0.05			c0.12	
v/s Ratio Perm									c0.06			
v/c Ratio	0.03	0.73		0.66	0.54		0.21	0.28	0.35		0.67	
Uniform Delay, d1	22.1	26.3		27.2	26.5		26.4	26.8	27.1		27.8	
Progression Factor	1.00	1.00		1.00	1.00		1.00	1.00	1.00		1.00	
Incremental Delay, d2	0.0	3.5		5.1	0.9		0.4	0.5	0.8		4.9	
Delay (s)	22.1	29.8		32.3	27.3		26.8	27.3	27.9		32.7	
Level of Service	C	C		C	C		C	C	C		C	
Approach Delay (s)		29.7			29.2			27.7			32.7	
Approach LOS		C			C			C			C	

Intersection Summary			
HCM Average Control Delay	29.2	HCM Level of Service	C
HCM Volume to Capacity ratio	0.61		
Actuated Cycle Length (s)	73.7	Sum of lost time (s)	16.0
Intersection Capacity Utilization	68.2%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	846	160	100	334	0	0	0	0	420	30	253
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0			4.0						4.0	
Lane Util. Factor		0.95			0.95						1.00	
Frpb, ped/bikes		1.00			1.00						1.00	
Flpb, ped/bikes		1.00			1.00						1.00	
Frt		0.98			1.00						0.95	
Flt Protected		1.00			0.99						0.97	
Satd. Flow (prot)		3438			3497						1721	
Flt Permitted		1.00			0.56						0.97	
Satd. Flow (perm)		3438			1976						1721	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	0	920	174	109	363	0	0	0	0	457	33	275
RTOR Reduction (vph)	0	27	0	0	0	0	0	0	0	0	32	0
Lane Group Flow (vph)	0	1067	0	0	472	0	0	0	0	0	733	0
Confl. Peds. (#/hr)	5		9	9		5						
Confl. Bikes (#/hr)						2						
Turn Type				Perm						Split		
Protected Phases		4			8					6	6	
Permitted Phases				8								
Actuated Green, G (s)		23.7			23.7						28.3	
Effective Green, g (s)		23.7			23.7						28.3	
Actuated g/C Ratio		0.39			0.39						0.47	
Clearance Time (s)		4.0			4.0						4.0	
Vehicle Extension (s)		3.0			3.0						3.0	
Lane Grp Cap (vph)		1358			781						812	
v/s Ratio Prot		c0.31									c0.43	
v/s Ratio Perm					0.24							
v/c Ratio		0.79			0.88dl						0.90	
Uniform Delay, d1		15.9			14.4						14.6	
Progression Factor		1.00			1.00						1.00	
Incremental Delay, d2		3.1			1.3						15.2	
Delay (s)		19.0			15.8						29.8	
Level of Service		B			B						C	
Approach Delay (s)		19.0			15.8			0.0			29.8	
Approach LOS		B			B			A			C	

Intersection Summary			
HCM Average Control Delay	21.9	HCM Level of Service	C
HCM Volume to Capacity ratio	0.85		
Actuated Cycle Length (s)	60.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	92.4%	ICU Level of Service	F
Analysis Period (min)	15		

dl Defacto Left Lane. Recode with 1 though lane as a left lane.
c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	235	1031	0	0	394	410	40	10	80	0	0	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0			4.0		4.0	4.0	4.0			
Lane Util. Factor		0.95			0.95		0.95	0.95	1.00			
Frpb, ped/bikes		1.00			0.99		1.00	1.00	1.00			
Flpb, ped/bikes		1.00			1.00		1.00	1.00	1.00			
Frt		1.00			0.92		1.00	1.00	0.85			
Flt Protected		0.99			1.00		0.95	0.97	1.00			
Satd. Flow (prot)		3506			3226		1681	1719	1583			
Flt Permitted		0.62			1.00		0.95	0.97	1.00			
Satd. Flow (perm)		2196			3226		1681	1719	1583			
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	255	1121	0	0	428	446	43	11	87	0	0	0
RTOR Reduction (vph)	0	0	0	0	135	0	0	0	69	0	0	0
Lane Group Flow (vph)	0	1376	0	0	739	0	27	27	18	0	0	0
Confl. Peds. (#/hr)	5		7	7		5			1	1		
Confl. Bikes (#/hr)						3						
Turn Type	Perm						Split		Prot			
Protected Phases		4			8		2	2	2			
Permitted Phases	4											
Actuated Green, G (s)		55.7			55.7		16.3	16.3	16.3			
Effective Green, g (s)		55.7			55.7		16.3	16.3	16.3			
Actuated g/C Ratio		0.70			0.70		0.20	0.20	0.20			
Clearance Time (s)		4.0			4.0		4.0	4.0	4.0			
Vehicle Extension (s)		3.0			3.0		3.0	3.0	3.0			
Lane Grp Cap (vph)		1529			2246		343	350	323			
v/s Ratio Prot					0.23		c0.02	0.02	0.01			
v/s Ratio Perm		c0.63										
v/c Ratio		0.90			0.33		0.08	0.08	0.05			
Uniform Delay, d1		9.9			4.8		25.8	25.8	25.6			
Progression Factor		1.00			1.00		1.00	1.00	1.00			
Incremental Delay, d2		7.5			0.1		0.4	0.4	0.3			
Delay (s)		17.4			4.9		26.2	26.2	26.0			
Level of Service		B			A		C	C	C			
Approach Delay (s)		17.4			4.9			26.1			0.0	
Approach LOS		B			A			C			A	

Intersection Summary			
HCM Average Control Delay	13.3	HCM Level of Service	B
HCM Volume to Capacity ratio	0.71		
Actuated Cycle Length (s)	80.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	85.9%	ICU Level of Service	E
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	100	410	61	180	362	143	103	807	210	101	321	50
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	4.0	4.0	3.0	4.0	4.0	3.0	3.0	3.0	3.0	3.0	
Lane Util. Factor	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	
Frpb, ped/bikes	1.00	1.00	0.97	1.00	1.00	0.98	1.00	1.00	0.91	1.00	1.00	
Flpb, ped/bikes	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	0.98	
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	
Satd. Flow (prot)	1770	3539	1539	1770	3539	1557	1770	3539	1438	1770	3461	
Flt Permitted	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	
Satd. Flow (perm)	1770	3539	1539	1770	3539	1557	1770	3539	1438	1770	3461	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	109	446	66	196	393	155	112	877	228	110	349	54
RTOR Reduction (vph)	0	0	30	0	0	106	0	0	113	0	16	0
Lane Group Flow (vph)	109	446	36	196	393	49	112	877	115	110	387	0
Confl. Peds. (#/hr)	5		19	19		5	4		14	14		4
Confl. Bikes (#/hr)						1			100			
Turn Type	Prot		Perm	Prot		Perm	Prot		Perm	Prot		
Protected Phases	5	2		1	6		3	8		7	4	
Permitted Phases			2			6			8			
Actuated Green, G (s)	5.4	17.4	17.4	9.9	19.9	19.9	6.1	21.5	21.5	6.1	21.5	
Effective Green, g (s)	5.4	17.4	17.4	9.9	19.9	19.9	6.1	21.5	21.5	6.1	21.5	
Actuated g/C Ratio	0.08	0.26	0.26	0.15	0.29	0.29	0.09	0.32	0.32	0.09	0.32	
Clearance Time (s)	5.0	4.0	4.0	3.0	4.0	4.0	3.0	3.0	3.0	3.0	3.0	
Vehicle Extension (s)	2.0	4.0	4.0	2.0	4.0	4.0	2.0	2.0	2.0	2.0	2.0	
Lane Grp Cap (vph)	141	907	394	258	1037	456	159	1121	455	159	1096	
v/s Ratio Prot	0.06	c0.13		c0.11	0.11		c0.06	c0.25		0.06	0.11	
v/s Ratio Perm			0.02			0.03			0.08			
v/c Ratio	0.77	0.49	0.09	0.76	0.38	0.11	0.70	0.78	0.25	0.69	0.35	
Uniform Delay, d1	30.6	21.5	19.2	27.9	19.1	17.5	30.0	21.1	17.2	30.0	17.9	
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	
Incremental Delay, d2	20.9	0.6	0.1	10.8	0.3	0.1	11.0	3.3	0.1	10.0	0.1	
Delay (s)	51.6	22.1	19.4	38.7	19.4	17.7	41.0	24.4	17.3	40.0	17.9	
Level of Service	D	C	B	D	B	B	D	C	B	D	B	
Approach Delay (s)		27.0			24.1			24.6			22.7	
Approach LOS		C			C			C			C	

Intersection Summary			
HCM Average Control Delay	24.6	HCM Level of Service	C
HCM Volume to Capacity ratio	0.65		
Actuated Cycle Length (s)	67.9	Sum of lost time (s)	13.0
Intersection Capacity Utilization	66.6%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	0	0	300	10	675	0	495	140	0	432	140
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)				4.0	4.0	4.0		4.0	4.0		4.0	
Lane Util. Factor				0.95	0.91	0.95		0.91	1.00		0.91	
Frt				1.00	0.87	0.85		1.00	0.85		0.96	
Flt Protected				0.95	1.00	1.00		1.00	1.00		1.00	
Satd. Flow (prot)				1698	1478	1519		5136	1599		4947	
Flt Permitted				0.95	1.00	1.00		1.00	1.00		1.00	
Satd. Flow (perm)				1698	1478	1519		5136	1599		4947	
Peak-hour factor, PHF	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94
Adj. Flow (vph)	0	0	0	319	11	718	0	527	149	0	460	149
RTOR Reduction (vph)	0	0	0	0	97	97	0	0	0	0	102	0
Lane Group Flow (vph)	0	0	0	287	283	284	0	527	149	0	507	0
Heavy Vehicles (%)	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%
Turn Type				Split		Perm			Free			
Protected Phases				8	8			2			6	
Permitted Phases						8			Free			
Actuated Green, G (s)				16.1	16.1	16.1		10.5	34.6		10.5	
Effective Green, g (s)				16.1	16.1	16.1		10.5	34.6		10.5	
Actuated g/C Ratio				0.47	0.47	0.47		0.30	1.00		0.30	
Clearance Time (s)				4.0	4.0	4.0		4.0			4.0	
Vehicle Extension (s)				3.0	3.0	3.0		3.0			3.0	
Lane Grp Cap (vph)				790	688	707		1559	1599		1501	
v/s Ratio Prot				0.17	c0.19			c0.10			0.10	
v/s Ratio Perm						0.19			0.09			
v/c Ratio				0.36	0.41	0.40		0.34	0.09		0.34	
Uniform Delay, d1				6.0	6.1	6.1		9.4	0.0		9.4	
Progression Factor				1.00	1.00	1.00		1.00	1.00		1.00	
Incremental Delay, d2				0.3	0.4	0.4		0.1	0.1		0.1	
Delay (s)				6.2	6.5	6.5		9.5	0.1		9.5	
Level of Service				A	A	A		A	A		A	
Approach Delay (s)		0.0			6.4			7.4			9.5	
Approach LOS		A			A			A			A	

Intersection Summary			
HCM Average Control Delay	7.5	HCM Level of Service	A
HCM Volume to Capacity ratio	0.38		
Actuated Cycle Length (s)	34.6	Sum of lost time (s)	8.0
Intersection Capacity Utilization	44.1%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	260	0	170	0	0	0	0	375	370	0	481	261
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0		4.0					4.0			4.0	4.0
Lane Util. Factor	1.00		1.00					0.91			0.95	1.00
Frpb, ped/bikes	1.00		1.00					0.99			1.00	0.98
Flpb, ped/bikes	1.00		1.00					1.00			1.00	1.00
Frt	1.00		0.85					0.93			1.00	0.85
Flt Protected	0.95		1.00					1.00			1.00	1.00
Satd. Flow (prot)	1770		1583					4647			3539	1549
Flt Permitted	0.95		1.00					1.00			1.00	1.00
Satd. Flow (perm)	1770		1583					4647			3539	1549
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	283	0	185	0	0	0	0	408	402	0	523	284
RTOR Reduction (vph)	0	0	100	0	0	0	0	255	0	0	0	0
Lane Group Flow (vph)	283	0	85	0	0	0	0	555	0	0	523	284
Confl. Peds. (#/hr)							4		2	2		4
Confl. Bikes (#/hr)									3			
Turn Type	Split		Perm									Free
Protected Phases	8	8						2			6	
Permitted Phases			8									Free
Actuated Green, G (s)	12.4		12.4					11.8			11.8	32.2
Effective Green, g (s)	12.4		12.4					11.8			11.8	32.2
Actuated g/C Ratio	0.39		0.39					0.37			0.37	1.00
Clearance Time (s)	4.0		4.0					4.0			4.0	
Vehicle Extension (s)	3.0		3.0					3.0			3.0	
Lane Grp Cap (vph)	682		610					1703			1297	1549
v/s Ratio Prot	c0.16							0.12			c0.15	
v/s Ratio Perm			0.05									0.18
v/c Ratio	0.41		0.14					0.33			0.40	0.18
Uniform Delay, d1	7.2		6.4					7.3			7.6	0.0
Progression Factor	1.00		1.00					1.00			1.00	1.00
Incremental Delay, d2	0.4		0.1					0.1			0.2	0.3
Delay (s)	7.7		6.5					7.5			7.8	0.3
Level of Service	A		A					A			A	A
Approach Delay (s)		7.2			0.0			7.5			5.1	
Approach LOS		A			A			A			A	

Intersection Summary			
HCM Average Control Delay	6.5	HCM Level of Service	A
HCM Volume to Capacity ratio	0.41		
Actuated Cycle Length (s)	32.2	Sum of lost time (s)	8.0
Intersection Capacity Utilization	36.7%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	170	10	70	20	20	230	30	345	10	20	531	110
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0		4.0	4.0			4.0		4.0	4.0	
Lane Util. Factor		1.00		1.00	1.00			0.95		1.00	0.95	
Frpb, ped/bikes		0.99		1.00	0.99			1.00		1.00	1.00	
Flpb, ped/bikes		1.00		1.00	1.00			1.00		0.94	1.00	
Frt		0.96		1.00	0.86			1.00		1.00	0.97	
Flt Protected		0.97		0.95	1.00			1.00		0.95	1.00	
Satd. Flow (prot)		1703		1751	1571			3475		1646	3402	
Flt Permitted		1.00		0.59	1.00			0.88		0.95	1.00	
Satd. Flow (perm)		1761		1091	1571			3060		1646	3402	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	185	11	76	22	22	250	33	375	11	22	577	120
RTOR Reduction (vph)	0	14	0	0	188	0	0	2	0	0	16	0
Lane Group Flow (vph)	0	258	0	22	84	0	0	417	0	22	681	0
Confl. Peds. (#/hr)	1		3	3		1			5	5		
Confl. Bikes (#/hr)						1			2			1
Heavy Vehicles (%)	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%
Turn Type	Perm			Perm			Perm			Prot		
Protected Phases		3			4			2		1	6	
Permitted Phases	3			4			2					
Actuated Green, G (s)		2.4		11.4	11.4			15.4		0.8	20.2	
Effective Green, g (s)		2.4		11.4	11.4			15.4		0.8	20.2	
Actuated g/C Ratio		0.05		0.25	0.25			0.33		0.02	0.44	
Clearance Time (s)		4.0		4.0	4.0			4.0		4.0	4.0	
Vehicle Extension (s)		3.0		3.0	3.0			3.0		3.0	3.0	
Lane Grp Cap (vph)		92		270	389			1024		29	1494	
v/s Ratio Prot					c0.05					0.01	c0.20	
v/s Ratio Perm		c0.15		0.02				0.14				
v/c Ratio		2.80		0.08	0.22			0.41		0.76	0.46	
Uniform Delay, d1		21.8		13.3	13.7			11.8		22.5	9.0	
Progression Factor		1.00		1.00	1.00			1.00		1.00	1.00	
Incremental Delay, d2		840.3		0.1	0.3			0.3		71.7	0.2	
Delay (s)		862.1		13.4	14.0			12.0		94.2	9.3	
Level of Service		F		B	B			B		F	A	
Approach Delay (s)		862.1			14.0			12.0			11.9	
Approach LOS		F			B			B			B	

Intersection Summary			
HCM Average Control Delay	148.0	HCM Level of Service	F
HCM Volume to Capacity ratio	0.54		
Actuated Cycle Length (s)	46.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	73.1%	ICU Level of Service	D
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	170	21	30	43	43	35	30	160	51	21	350	210
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0		4.0	4.0		4.0	4.0	
Lane Util. Factor	1.00	0.95	1.00	1.00	0.95		1.00	0.95		1.00	0.95	
Frpb, ped/bikes	1.00	1.00	1.00	1.00	0.99		1.00	1.00		1.00	0.99	
Flpb, ped/bikes	1.00	1.00	1.00	1.00	1.00		1.00	1.00		1.00	1.00	
Frt	1.00	1.00	0.85	1.00	0.93		1.00	0.96		1.00	0.94	
Flt Protected	0.95	1.00	1.00	0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1770	3539	1583	1770	3278		1770	3399		1770	3314	
Flt Permitted	0.95	1.00	1.00	0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (perm)	1770	3539	1583	1770	3278		1770	3399		1770	3314	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	179	22	32	45	45	37	32	168	54	22	368	221
RTOR Reduction (vph)	0	0	24	0	34	0	0	33	0	0	117	0
Lane Group Flow (vph)	179	22	8	45	48	0	32	189	0	22	472	0
Confl. Peds. (#/hr)							16		1	1		16
Confl. Bikes (#/hr)						1			1			
Turn Type	Prot		Perm	Prot			Prot			Prot		
Protected Phases	7	4		3	8		5	2		1	6	
Permitted Phases			4									
Actuated Green, G (s)	9.2	11.6	11.6	1.7	4.1		1.4	14.2		1.0	13.8	
Effective Green, g (s)	9.2	11.6	11.6	1.7	4.1		1.4	14.2		1.0	13.8	
Actuated g/C Ratio	0.21	0.26	0.26	0.04	0.09		0.03	0.32		0.02	0.31	
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0		4.0	4.0		4.0	4.0	
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	366	923	413	68	302		56	1085		40	1028	
v/s Ratio Prot	c0.10	0.01		0.03	c0.01		c0.02	0.06		0.01	c0.14	
v/s Ratio Perm			0.01									
v/c Ratio	0.49	0.02	0.02	0.66	0.16		0.57	0.17		0.55	0.46	
Uniform Delay, d1	15.6	12.2	12.2	21.1	18.6		21.3	10.9		21.5	12.3	
Progression Factor	1.00	1.00	1.00	1.00	1.00		1.00	1.00		1.00	1.00	
Incremental Delay, d2	1.0	0.0	0.0	21.6	0.3		13.3	0.1		15.3	0.3	
Delay (s)	16.6	12.2	12.2	42.7	18.9		34.6	11.0		36.9	12.7	
Level of Service	B	B	B	D	B		C	B		D	B	
Approach Delay (s)		15.6			27.3			14.0			13.5	
Approach LOS		B			C			B			B	

Intersection Summary			
HCM Average Control Delay	15.5	HCM Level of Service	B
HCM Volume to Capacity ratio	0.43		
Actuated Cycle Length (s)	44.5	Sum of lost time (s)	16.0
Intersection Capacity Utilization	47.7%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Volume (veh/h)	83	50	75	191	180	70
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	90	54	82	208	196	76
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)				1133		
pX, platoon unblocked						
vC, conflicting volume			145		461	90
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			145		461	90
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			94		63	92
cM capacity (veh/h)			1426		523	962

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	NB 1	NB 2
Volume Total	90	54	82	208	196	76
Volume Left	0	0	82	0	196	0
Volume Right	0	54	0	0	0	76
cSH	1700	1700	1426	1700	523	962
Volume to Capacity	0.05	0.03	0.06	0.12	0.37	0.08
Queue Length 95th (ft)	0	0	5	0	43	6
Control Delay (s)	0.0	0.0	7.7	0.0	15.9	9.1
Lane LOS			A		C	A
Approach Delay (s)	0.0		2.2		14.0	
Approach LOS					B	

Intersection Summary			
Average Delay	6.3		
Intersection Capacity Utilization	27.5%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	110	27	10	10	50	135	20	20	10	83	20	60
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0		4.0	4.0			4.0	
Lane Util. Factor	1.00	1.00		1.00	1.00		1.00	1.00			1.00	
Frt	1.00	0.96		1.00	0.89		1.00	0.95			0.95	
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00			0.98	
Satd. Flow (prot)	1626	1641		1626	1524		1626	1626			1587	
Flt Permitted	0.95	1.00		0.95	1.00		0.78	1.00			0.82	
Satd. Flow (perm)	1626	1641		1626	1524		1332	1626			1338	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	120	29	11	11	54	147	22	22	11	90	22	65
RTOR Reduction (vph)	0	7	0	0	112	0	0	8	0	0	36	0
Lane Group Flow (vph)	120	33	0	11	89	0	22	25	0	0	141	0
Heavy Vehicles (%)	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%
Turn Type	Prot			Prot			Perm			Perm		
Protected Phases	7	4		3	8			2			6	
Permitted Phases							2			6		
Actuated Green, G (s)	4.4	10.9		0.9	7.4		7.6	7.6			7.6	
Effective Green, g (s)	4.4	10.9		0.9	7.4		7.6	7.6			7.6	
Actuated g/C Ratio	0.14	0.35		0.03	0.24		0.24	0.24			0.24	
Clearance Time (s)	4.0	4.0		4.0	4.0		4.0	4.0			4.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0			3.0	
Lane Grp Cap (vph)	228	570		47	359		322	394			324	
v/s Ratio Prot	c0.07	c0.02		0.01	c0.06			0.02				
v/s Ratio Perm							0.02				c0.11	
v/c Ratio	0.53	0.06		0.23	0.25		0.07	0.06			0.44	
Uniform Delay, d1	12.5	6.8		14.9	9.7		9.2	9.2			10.1	
Progression Factor	1.00	1.00		1.00	1.00		1.00	1.00			1.00	
Incremental Delay, d2	2.2	0.0		2.6	0.4		0.1	0.1			0.9	
Delay (s)	14.7	6.9		17.5	10.1		9.3	9.2			11.0	
Level of Service	B	A		B	B		A	A			B	
Approach Delay (s)		12.8			10.5			9.2			11.0	
Approach LOS		B			B			A			B	

Intersection Summary			
HCM Average Control Delay	11.1	HCM Level of Service	B
HCM Volume to Capacity ratio	0.42		
Actuated Cycle Length (s)	31.4	Sum of lost time (s)	16.0
Intersection Capacity Utilization	43.0%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Volume (veh/h)	50	60	62	105	80	62
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	54	65	67	114	87	67
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)	322					
pX, platoon unblocked						
vC, conflicting volume			54		336	87
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			54		336	87
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			96		86	93
cM capacity (veh/h)			1551		631	972

Direction, Lane #	EB 1	WB 1	WB 2	NB 1
Volume Total	120	67	114	154
Volume Left	0	67	0	87
Volume Right	65	0	0	67
cSH	1700	1551	1700	745
Volume to Capacity	0.07	0.04	0.07	0.21
Queue Length 95th (ft)	0	3	0	19
Control Delay (s)	0.0	7.4	0.0	11.1
Lane LOS		A		B
Approach Delay (s)	0.0	2.8		11.1
Approach LOS				B

Intersection Summary			
Average Delay	4.9		
Intersection Capacity Utilization	25.0%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Volume (veh/h)	90	22	25	70	97	135
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	98	24	27	76	105	147
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume			122		240	110
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			122		240	110
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			98		86	84
cM capacity (veh/h)			1466		734	944

Direction, Lane #	EB 1	WB 1	WB 2	NB 1
Volume Total	122	27	76	252
Volume Left	0	27	0	105
Volume Right	24	0	0	147
cSH	1700	1466	1700	843
Volume to Capacity	0.07	0.02	0.04	0.30
Queue Length 95th (ft)	0	1	0	31
Control Delay (s)	0.0	7.5	0.0	11.1
Lane LOS		A		B
Approach Delay (s)	0.0	2.0		11.1
Approach LOS				B

Intersection Summary			
Average Delay	6.3		
Intersection Capacity Utilization	28.4%	ICU Level of Service	A
Analysis Period (min)	15		

Intersection	
Intersection Delay (sec/veh)	23.8
Intersection LOS	C

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Volume (vph)	10	20	10	430	10	20	10	65	70	120	114	10
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Heavy Vehicles(%)	2	2	2	2	2	2	2	2	2	2	2	2
Movement Flow Rate	11	22	11	467	11	22	11	71	76	130	124	11
Number of Lanes	0	1	0	1	1	0	1	2	0	1	2	0

Approach	EB	WB	NB	SB
Opposing Approach	WB	EB	SB	NB
Opposing Lanes	2	1	3	3
Conflicting Approach Left	SB	NB	EB	WB
Conflicting Lanes Left	3	3	1	2
Conflicting Approach Right	NB	SB	WB	EB
Conflicting Lanes Right	3	3	2	1
HCM Control Delay	10.8	35.2	11	11.9
HCM LOS	B	E	B	B

Lane	NBLn1	NBLn2	NBLn3	EBLn1	WBLn1	WBLn2	SBLn1	SBLn2	SBLn3
Volume Left (%)	100%	0%	0%	25%	100%	0%	100%	0%	0%
Volume Thru (%)	0%	100%	24%	50%	0%	33%	0%	100%	79%
Volume Right (%)	0%	0%	76%	25%	0%	67%	0%	0%	21%
Sign Control	Stop	Stop	Stop	Stop	Stop	Stop	Stop	Stop	Stop
Traffic Volume by Lane	10	43	92	40	430	30	120	76	48
Left Turning Volume	0	43	22	20	0	10	0	76	38
Through Volume	0	0	70	10	0	20	0	0	10
Right Turning Volume	10	0	0	10	430	0	120	0	0
Lane Flow Rate	11	47	100	43	467	33	130	83	52
Geometry Group	8	8	8	8	8	8	8	8	8
Degree of Utilization, X	0.024	0.095	0.187	0.088	0.856	0.051	0.272	0.16	0.099
Departure Headway, Hd	7.804	7.29	6.741	7.257	6.596	5.63	7.505	6.993	6.843
Convergence(Y/N)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Capacity	456	488	528	490	547	634	476	510	521
Service Time	5.598	5.084	4.534	5.053	4.354	3.387	5.289	4.776	4.627
HCM Lane V/C Ratio	0.024	0.096	0.189	0.088	0.854	0.052	0.273	0.163	0.1
HCM Control Delay	10.8	10.9	11.1	10.8	37.1	8.7	13.1	11.1	10.4
HCM Lane LOS	B	B	B	B	E	A	B	B	B
HCM 95th Percentile Queue	0.1	0.3	0.7	0.3	17.3	0.2	1.1	0.6	0.3

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	0	0	49	10	450	20	534	0	0	95	300
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)				4.0	4.0		4.0	4.0			4.0	
Lane Util. Factor				1.00	1.00		1.00	0.95			0.95	
Frpb, ped/bikes				1.00	1.00		1.00	1.00			0.98	
Flpb, ped/bikes				1.00	1.00		1.00	1.00			1.00	
Frt				1.00	0.85		1.00	1.00			0.89	
Flt Protected				0.95	1.00		0.95	1.00			1.00	
Satd. Flow (prot)				1787	1605		1787	3574			3115	
Flt Permitted				0.95	1.00		0.95	1.00			1.00	
Satd. Flow (perm)				1787	1605		1787	3574			3115	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	0	0	0	52	11	474	21	562	0	0	100	316
RTOR Reduction (vph)	0	0	0	0	235	0	0	0	0	0	216	0
Lane Group Flow (vph)	0	0	0	52	250	0	21	562	0	0	200	0
Confl. Peds. (#/hr)							1		2	2		1
Confl. Bikes (#/hr)			1						1			
Heavy Vehicles (%)	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%
Turn Type				Split			Prot					
Protected Phases				8	8		5	2			6	
Permitted Phases												
Actuated Green, G (s)				10.7	10.7		2.2	17.8			11.6	
Effective Green, g (s)				10.7	10.7		2.2	17.8			11.6	
Actuated g/C Ratio				0.29	0.29		0.06	0.49			0.32	
Clearance Time (s)				4.0	4.0		4.0	4.0			4.0	
Vehicle Extension (s)				3.0	3.0		3.0	3.0			3.0	
Lane Grp Cap (vph)				524	471		108	1743			990	
v/s Ratio Prot				0.03	c0.16		0.01	c0.16			0.06	
v/s Ratio Perm												
v/c Ratio				0.10	0.53		0.19	0.32			0.20	
Uniform Delay, d1				9.4	10.8		16.3	5.7			9.1	
Progression Factor				1.00	1.00		1.00	1.00			1.00	
Incremental Delay, d2				0.1	1.2		0.9	0.1			0.1	
Delay (s)				9.5	12.0		17.2	5.8			9.2	
Level of Service				A	B		B	A			A	
Approach Delay (s)		0.0			11.7			6.2			9.2	
Approach LOS		A			B			A			A	

Intersection Summary			
HCM Average Control Delay	8.9	HCM Level of Service	A
HCM Volume to Capacity ratio	0.40		
Actuated Cycle Length (s)	36.5	Sum of lost time (s)	8.0
Intersection Capacity Utilization	51.7%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	40	260	70	285	290	50	310	180	494	20	40	50
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0		4.0	4.0	4.0		4.0	
Lane Util. Factor	1.00	0.95		0.91	0.91		0.95	0.95	1.00		1.00	
Frpb, ped/bikes	1.00	1.00		1.00	1.00		1.00	1.00	0.99		1.00	
Flpb, ped/bikes	1.00	1.00		1.00	1.00		1.00	1.00	1.00		1.00	
Frt	1.00	0.97		1.00	0.98		1.00	1.00	0.85		0.94	
Flt Protected	0.95	1.00		0.95	0.99		0.95	0.99	1.00		0.99	
Satd. Flow (prot)	1787	3461		1626	3331		1698	1763	1576		1749	
Flt Permitted	0.95	1.00		0.95	0.99		0.95	0.99	1.00		0.99	
Satd. Flow (perm)	1787	3461		1626	3331		1698	1763	1576		1749	
Peak-hour factor, PHF	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97
Adj. Flow (vph)	41	268	72	294	299	52	320	186	509	21	41	52
RTOR Reduction (vph)	0	26	0	0	11	0	0	0	371	0	34	0
Lane Group Flow (vph)	41	314	0	212	422	0	250	256	138	0	80	0
Confl. Peds. (#/hr)									2	2		
Confl. Bikes (#/hr)									1			
Heavy Vehicles (%)	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%
Turn Type	Split			Split			Split		Perm	Split		
Protected Phases	4	4		8	8		2	2		6	6	
Permitted Phases									2			
Actuated Green, G (s)	12.3	12.3		16.1	16.1		19.2	19.2	19.2		7.2	
Effective Green, g (s)	12.3	12.3		16.1	16.1		19.2	19.2	19.2		7.2	
Actuated g/C Ratio	0.17	0.17		0.23	0.23		0.27	0.27	0.27		0.10	
Clearance Time (s)	4.0	4.0		4.0	4.0		4.0	4.0	4.0		4.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0	3.0		3.0	
Lane Grp Cap (vph)	310	601		370	757		460	478	427		178	
v/s Ratio Prot	0.02	c0.09		c0.13	0.13		c0.15	0.15			c0.05	
v/s Ratio Perm									0.09			
v/c Ratio	0.13	0.52		0.57	0.56		0.54	0.54	0.32		0.45	
Uniform Delay, d1	24.7	26.6		24.3	24.2		22.1	22.0	20.6		29.9	
Progression Factor	1.00	1.00		1.00	1.00		1.00	1.00	1.00		1.00	
Incremental Delay, d2	0.2	0.8		2.1	0.9		1.3	1.2	0.4		1.8	
Delay (s)	24.9	27.4		26.4	25.1		23.4	23.2	21.1		31.7	
Level of Service	C	C		C	C		C	C	C		C	
Approach Delay (s)		27.1			25.5			22.2			31.7	
Approach LOS		C			C			C			C	

Intersection Summary			
HCM Average Control Delay	24.6	HCM Level of Service	C
HCM Volume to Capacity ratio	0.54		
Actuated Cycle Length (s)	70.8	Sum of lost time (s)	16.0
Intersection Capacity Utilization	56.5%	ICU Level of Service	B
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	654	150	90	451	0	0	0	0	360	10	245
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0			4.0						4.0	
Lane Util. Factor		0.95			0.95						1.00	
Frpb, ped/bikes		0.99			1.00						1.00	
Flpb, ped/bikes		1.00			1.00						1.00	
Frt		0.97			1.00						0.95	
Flt Protected		1.00			0.99						0.97	
Satd. Flow (prot)		3456			3543						1729	
Flt Permitted		1.00			0.66						0.97	
Satd. Flow (perm)		3456			2357						1729	
Peak-hour factor, PHF	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96
Adj. Flow (vph)	0	681	156	94	470	0	0	0	0	375	10	255
RTOR Reduction (vph)	0	42	0	0	0	0	0	0	0	0	36	0
Lane Group Flow (vph)	0	795	0	0	564	0	0	0	0	0	604	0
Confl. Peds. (#/hr)	3		8	8		3						
Confl. Bikes (#/hr)						3						
Heavy Vehicles (%)	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%
Turn Type				Perm						Split		
Protected Phases		4			8					6	6	
Permitted Phases				8								
Actuated Green, G (s)		19.8			19.8						27.2	
Effective Green, g (s)		19.8			19.8						27.2	
Actuated g/C Ratio		0.36			0.36						0.49	
Clearance Time (s)		4.0			4.0						4.0	
Vehicle Extension (s)		3.0			3.0						3.0	
Lane Grp Cap (vph)		1244			849						855	
v/s Ratio Prot		0.23									c0.35	
v/s Ratio Perm					c0.24							
v/c Ratio		0.64			0.66						0.71	
Uniform Delay, d1		14.6			14.8						10.8	
Progression Factor		1.00			1.00						1.00	
Incremental Delay, d2		1.1			2.0						4.9	
Delay (s)		15.7			16.8						15.7	
Level of Service		B			B						B	
Approach Delay (s)		15.7			16.8			0.0			15.7	
Approach LOS		B			B			A			B	

Intersection Summary			
HCM Average Control Delay	16.0	HCM Level of Service	B
HCM Volume to Capacity ratio	0.69		
Actuated Cycle Length (s)	55.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	84.1%	ICU Level of Service	E
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	271	743	0	0	471	430	80	140	140	0	0	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0			4.0		4.0	4.0	4.0			
Lane Util. Factor		0.95			0.95		0.95	0.95	1.00			
Frpb, ped/bikes		1.00			0.99		1.00	1.00	1.00			
Flpb, ped/bikes		1.00			1.00		1.00	1.00	1.00			
Frt		1.00			0.93		1.00	1.00	0.85			
Flt Protected		0.99			1.00		0.95	1.00	1.00			
Satd. Flow (prot)		3527			3282		1698	1782	1599			
Flt Permitted		0.57			1.00		0.95	1.00	1.00			
Satd. Flow (perm)		2023			3282		1698	1782	1599			
Peak-hour factor, PHF	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96
Adj. Flow (vph)	282	774	0	0	491	448	83	146	146	0	0	0
RTOR Reduction (vph)	0	0	0	0	144	0	0	0	111	0	0	0
Lane Group Flow (vph)	0	1056	0	0	795	0	75	154	35	0	0	0
Confl. Peds. (#/hr)	2		7	7		2						
Confl. Bikes (#/hr)						3						
Heavy Vehicles (%)	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%
Turn Type	Perm						Split		Prot			
Protected Phases		4			8		2	2	2			
Permitted Phases	4											
Actuated Green, G (s)		52.9			52.9		19.1	19.1	19.1			
Effective Green, g (s)		52.9			52.9		19.1	19.1	19.1			
Actuated g/C Ratio		0.66			0.66		0.24	0.24	0.24			
Clearance Time (s)		4.0			4.0		4.0	4.0	4.0			
Vehicle Extension (s)		3.0			3.0		3.0	3.0	3.0			
Lane Grp Cap (vph)		1338			2170		405	425	382			
v/s Ratio Prot					0.24		0.04	c0.09	0.02			
v/s Ratio Perm		c0.52										
v/c Ratio		0.79			0.37		0.19	0.36	0.09			
Uniform Delay, d1		9.6			6.1		24.3	25.4	23.7			
Progression Factor		1.00			1.00		1.00	1.00	1.00			
Incremental Delay, d2		3.2			0.1		1.0	2.4	0.5			
Delay (s)		12.8			6.2		25.3	27.8	24.2			
Level of Service		B			A		C	C	C			
Approach Delay (s)		12.8			6.2			25.9			0.0	
Approach LOS		B			A			C			A	

Intersection Summary			
HCM Average Control Delay	12.2	HCM Level of Service	B
HCM Volume to Capacity ratio	0.68		
Actuated Cycle Length (s)	80.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	73.8%	ICU Level of Service	D
Analysis Period (min)	15		

c Critical Lane Group

Cumulative (2035) No Project Conditions

FEHR PEERS

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	110	300	100	400	470	220	60	370	170	70	830	50
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	4.0	4.0	3.0	4.0	4.0	3.0	3.0	3.0	3.0	3.0	
Lane Util. Factor	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	
Frpb, ped/bikes	1.00	1.00	0.97	1.00	1.00	0.97	1.00	1.00	0.98	1.00	1.00	
Flpb, ped/bikes	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	0.99	
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	
Satd. Flow (prot)	1736	3471	1514	1736	3471	1511	1736	3471	1528	1736	3439	
Flt Permitted	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	
Satd. Flow (perm)	1736	3471	1514	1736	3471	1511	1736	3471	1528	1736	3439	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	120	326	109	435	511	239	65	402	185	76	902	54
RTOR Reduction (vph)	0	0	61	0	0	108	0	0	125	0	5	0
Lane Group Flow (vph)	120	326	48	435	511	131	65	402	60	76	951	0
Confl. Peds. (#/hr)	14		13	13		14	4		4	4		4
Confl. Bikes (#/hr)						1						1
Heavy Vehicles (%)	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%
Turn Type	Prot		Perm	Prot		Perm	Prot		Perm	Prot		
Protected Phases	5	2		1	6		3	8		7	4	
Permitted Phases			2			6			8			
Actuated Green, G (s)	8.0	16.3	16.3	22.2	28.5	28.5	4.0	26.4	26.4	3.9	26.3	
Effective Green, g (s)	8.0	16.3	16.3	22.2	28.5	28.5	4.0	26.4	26.4	3.9	26.3	
Actuated g/C Ratio	0.10	0.20	0.20	0.27	0.35	0.35	0.05	0.32	0.32	0.05	0.32	
Clearance Time (s)	5.0	4.0	4.0	3.0	4.0	4.0	3.0	3.0	3.0	3.0	3.0	
Vehicle Extension (s)	2.0	4.0	4.0	2.0	4.0	4.0	2.0	2.0	2.0	2.0	2.0	
Lane Grp Cap (vph)	170	692	302	471	1209	526	85	1120	493	83	1106	
v/s Ratio Prot	0.07	0.09		c0.25	c0.15		0.04	0.12		c0.04	c0.28	
v/s Ratio Perm			0.03			0.09			0.04			
v/c Ratio	0.71	0.47	0.16	0.92	0.42	0.25	0.76	0.36	0.12	0.92	0.86	
Uniform Delay, d1	35.8	28.9	27.1	29.0	20.4	19.0	38.4	21.2	19.5	38.8	26.0	
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	
Incremental Delay, d2	10.4	0.7	0.3	23.5	0.3	0.3	30.0	0.1	0.0	69.6	6.8	
Delay (s)	46.1	29.6	27.4	52.5	20.7	19.4	68.5	21.3	19.6	108.4	32.8	
Level of Service	D	C	C	D	C	B	E	C	B	F	C	
Approach Delay (s)		32.8			32.1			25.5			38.4	
Approach LOS		C			C			C			D	

Intersection Summary			
HCM Average Control Delay	32.8	HCM Level of Service	C
HCM Volume to Capacity ratio	0.75		
Actuated Cycle Length (s)	81.8	Sum of lost time (s)	9.0
Intersection Capacity Utilization	75.8%	ICU Level of Service	D
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	0	0	380	10	230	0	350	150	0	1060	290
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)				4.0	4.0	4.0		4.0	4.0		4.0	
Lane Util. Factor				0.95	0.91	0.95		0.91	1.00		0.91	
Frpb, ped/bikes				1.00	1.00	0.99		1.00	0.98		1.00	
Flpb, ped/bikes				1.00	1.00	1.00		1.00	1.00		1.00	
Frt				1.00	0.97	0.85		1.00	0.85		0.97	
Flt Protected				0.95	0.96	1.00		1.00	1.00		1.00	
Satd. Flow (prot)				1665	1571	1471		5036	1535		4850	
Flt Permitted				0.95	0.96	1.00		1.00	1.00		1.00	
Satd. Flow (perm)				1665	1571	1471		5036	1535		4850	
Peak-hour factor, PHF	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94
Adj. Flow (vph)	0	0	0	404	11	245	0	372	160	0	1128	309
RTOR Reduction (vph)	0	0	0	0	15	140	0	0	0	0	63	0
Lane Group Flow (vph)	0	0	0	226	213	66	0	372	160	0	1374	0
Confl. Peds. (#/hr)	1					1	2		1	1		2
Confl. Bikes (#/hr)									2			1
Heavy Vehicles (%)	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%
Turn Type				Split		Perm			Free			
Protected Phases				8	8			2			6	
Permitted Phases						8			Free			
Actuated Green, G (s)				14.5	14.5	14.5		22.9	45.4		22.9	
Effective Green, g (s)				14.5	14.5	14.5		22.9	45.4		22.9	
Actuated g/C Ratio				0.32	0.32	0.32		0.50	1.00		0.50	
Clearance Time (s)				4.0	4.0	4.0		4.0			4.0	
Vehicle Extension (s)				3.0	3.0	3.0		3.0			3.0	
Lane Grp Cap (vph)				532	502	470		2540	1535		2446	
v/s Ratio Prot				c0.14	0.14			0.07			c0.28	
v/s Ratio Perm						0.04			0.10			
v/c Ratio				0.42	0.42	0.14		0.15	0.10		0.56	
Uniform Delay, d1				12.2	12.2	11.0		6.0	0.0		7.8	
Progression Factor				1.00	1.00	1.00		1.00	1.00		1.00	
Incremental Delay, d2				0.5	0.6	0.1		0.0	0.1		0.3	
Delay (s)				12.7	12.7	11.1		6.0	0.1		8.1	
Level of Service				B	B	B		A	A		A	
Approach Delay (s)		0.0			12.2			4.3			8.1	
Approach LOS		A			B			A			A	

Intersection Summary			
HCM Average Control Delay	8.4	HCM Level of Service	A
HCM Volume to Capacity ratio	0.51		
Actuated Cycle Length (s)	45.4	Sum of lost time (s)	8.0
Intersection Capacity Utilization	47.2%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	100	0	230	0	0	0	0	400	360	0	630	820
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0		4.0					4.0			4.0	4.0
Lane Util. Factor	1.00		1.00					0.91			0.95	1.00
Frpb, ped/bikes	1.00		1.00					0.99			1.00	0.98
Flpb, ped/bikes	1.00		1.00					1.00			1.00	1.00
Frt	1.00		0.85					0.93			1.00	0.85
Flt Protected	0.95		1.00					1.00			1.00	1.00
Satd. Flow (prot)	1752		1568					4625			3505	1536
Flt Permitted	0.95		1.00					1.00			1.00	1.00
Satd. Flow (perm)	1752		1568					4625			3505	1536
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	109	0	250	0	0	0	0	435	391	0	685	891
RTOR Reduction (vph)	0	0	65	0	0	0	0	210	0	0	0	0
Lane Group Flow (vph)	109	0	185	0	0	0	0	616	0	0	685	891
Confl. Peds. (#/hr)							1		3	3		1
Confl. Bikes (#/hr)									1			
Heavy Vehicles (%)	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%
Turn Type	Split		Perm									Free
Protected Phases	8	8						2			6	
Permitted Phases			8									Free
Actuated Green, G (s)	9.0		9.0					14.6			14.6	31.6
Effective Green, g (s)	9.0		9.0					14.6			14.6	31.6
Actuated g/C Ratio	0.28		0.28					0.46			0.46	1.00
Clearance Time (s)	4.0		4.0					4.0			4.0	
Vehicle Extension (s)	3.0		3.0					3.0			3.0	
Lane Grp Cap (vph)	499		447					2137			1619	1536
v/s Ratio Prot	0.06							0.13			0.20	
v/s Ratio Perm			0.12									c0.58
v/c Ratio	0.22		0.41					0.29			0.42	0.58
Uniform Delay, d1	8.6		9.2					5.3			5.7	0.0
Progression Factor	1.00		1.00					1.00			1.00	1.00
Incremental Delay, d2	0.2		0.6					0.1			0.2	1.6
Delay (s)	8.8		9.8					5.3			5.9	1.6
Level of Service	A		A					A			A	A
Approach Delay (s)		9.5			0.0			5.3			3.5	
Approach LOS		A			A			A			A	

Intersection Summary			
HCM Average Control Delay	4.8	HCM Level of Service	A
HCM Volume to Capacity ratio	0.58		
Actuated Cycle Length (s)	31.6	Sum of lost time (s)	0.0
Intersection Capacity Utilization	38.3%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	70	20	40	10	10	40	40	650	30	320	390	130
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0		4.0	4.0			4.0		4.0	4.0	
Lane Util. Factor		1.00		1.00	1.00			0.95		1.00	0.95	
Frpb, ped/bikes		1.00		1.00	0.99			1.00		1.00	0.99	
Flpb, ped/bikes		1.00		1.00	1.00			1.00		1.00	1.00	
Frt		0.96		1.00	0.88			0.99		1.00	0.96	
Flt Protected		0.97		0.95	1.00			1.00		0.95	1.00	
Satd. Flow (prot)		1705		1736	1592			3440		1736	3322	
Flt Permitted		1.00		0.67	1.00			0.90		0.95	1.00	
Satd. Flow (perm)		1751		1219	1592			3104		1736	3322	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	76	22	43	11	11	43	43	707	33	348	424	141
RTOR Reduction (vph)	0	16	0	0	37	0	0	3	0	0	20	0
Lane Group Flow (vph)	0	125	0	11	17	0	0	780	0	348	545	0
Confl. Peds. (#/hr)	3					3	2					2
Confl. Bikes (#/hr)												1
Heavy Vehicles (%)	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%
Turn Type	Perm			Perm			Perm			Prot		
Protected Phases		3			4			2		1	6	
Permitted Phases	3			4			2					
Actuated Green, G (s)		2.2		8.4	8.4			21.8		11.9	37.7	
Effective Green, g (s)		2.2		8.4	8.4			21.8		11.9	37.7	
Actuated g/C Ratio		0.04		0.14	0.14			0.36		0.20	0.63	
Clearance Time (s)		4.0		4.0	4.0			4.0		4.0	4.0	
Vehicle Extension (s)		3.0		3.0	3.0			3.0		3.0	3.0	
Lane Grp Cap (vph)		64		170	222			1122		343	2077	
v/s Ratio Prot					c0.01					c0.20	0.16	
v/s Ratio Perm		c0.07		0.01				c0.25				
v/c Ratio		1.95		0.06	0.08			0.70		1.01	0.26	
Uniform Delay, d1		29.0		22.5	22.6			16.4		24.2	5.1	
Progression Factor		1.00		1.00	1.00			1.00		1.00	1.00	
Incremental Delay, d2		477.8		0.2	0.1			1.9		52.3	0.1	
Delay (s)		506.9		22.7	22.7			18.3		76.5	5.1	
Level of Service		F		C	C			B		E	A	
Approach Delay (s)		506.9			22.7			18.3			32.4	
Approach LOS		F			C			B			C	

Intersection Summary			
HCM Average Control Delay	61.4	HCM Level of Service	E
HCM Volume to Capacity ratio	0.73		
Actuated Cycle Length (s)	60.3	Sum of lost time (s)	16.0
Intersection Capacity Utilization	62.1%	ICU Level of Service	B
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	300	70	20	20	20	50	20	400	140	40	150	230
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0		4.0	4.0		4.0	4.0	
Lane Util. Factor	1.00	0.95	1.00	1.00	0.95		1.00	0.95		1.00	0.95	
Frpb, ped/bikes	1.00	1.00	1.00	1.00	0.96		1.00	1.00		1.00	0.99	
Flpb, ped/bikes	1.00	1.00	1.00	1.00	1.00		1.00	1.00		1.00	1.00	
Frt	1.00	1.00	0.85	1.00	0.89		1.00	0.96		1.00	0.91	
Flt Protected	0.95	1.00	1.00	0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1770	3539	1583	1770	3044		1767	3390		1770	3187	
Flt Permitted	0.95	1.00	1.00	0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (perm)	1770	3539	1583	1770	3044		1767	3390		1770	3187	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	326	76	22	22	22	54	22	435	152	43	163	250
RTOR Reduction (vph)	0	0	13	0	48	0	0	33	0	0	172	0
Lane Group Flow (vph)	326	76	9	22	28	0	22	554	0	43	241	0
Confl. Peds. (#/hr)	3					3	4					4
Confl. Bikes (#/hr)						20			1			1
Turn Type	Prot		Perm	Prot			Prot			Prot		
Protected Phases	7	4		3	8		5	2		1	6	
Permitted Phases			4									
Actuated Green, G (s)	18.1	24.5	24.5	0.6	7.0		0.6	17.0		2.6	19.0	
Effective Green, g (s)	18.1	24.5	24.5	0.6	7.0		0.6	17.0		2.6	19.0	
Actuated g/C Ratio	0.30	0.40	0.40	0.01	0.12		0.01	0.28		0.04	0.31	
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0		4.0	4.0		4.0	4.0	
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	528	1428	639	17	351		17	949		76	998	
v/s Ratio Prot	c0.18	0.02		0.01	c0.01		0.01	c0.16		c0.02	0.08	
v/s Ratio Perm			0.01									
v/c Ratio	0.62	0.05	0.01	1.29	0.08		1.29	0.58		0.57	0.24	
Uniform Delay, d1	18.3	11.0	10.9	30.1	24.0		30.1	18.8		28.5	15.5	
Progression Factor	1.00	1.00	1.00	1.00	1.00		1.00	1.00		1.00	1.00	
Incremental Delay, d2	2.2	0.0	0.0	323.2	0.1		323.2	0.9		9.3	0.1	
Delay (s)	20.5	11.0	10.9	353.2	24.1		353.2	19.7		37.8	15.6	
Level of Service	C	B	B	F	C		F	B		D	B	
Approach Delay (s)		18.3			98.0			31.8			17.7	
Approach LOS		B			F			C			B	

Intersection Summary			
HCM Average Control Delay	28.2	HCM Level of Service	C
HCM Volume to Capacity ratio	0.51		
Actuated Cycle Length (s)	60.7	Sum of lost time (s)	16.0
Intersection Capacity Utilization	52.2%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Volume (veh/h)	360	140	100	160	100	100
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	391	152	109	174	109	109
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)				1133		
pX, platoon unblocked						
vC, conflicting volume			543		783	391
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			543		783	391
tC, single (s)			4.2		6.5	6.3
tC, 2 stage (s)						
tF (s)			2.3		3.6	3.4
p0 queue free %			89		66	83
cM capacity (veh/h)			996		316	644

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	NB 1	NB 2
Volume Total	391	152	109	174	109	109
Volume Left	0	0	109	0	109	0
Volume Right	0	152	0	0	0	109
cSH	1700	1700	996	1700	316	644
Volume to Capacity	0.23	0.09	0.11	0.10	0.34	0.17
Queue Length 95th (ft)	0	0	9	0	37	15
Control Delay (s)	0.0	0.0	9.1	0.0	22.3	11.7
Lane LOS			A		C	B
Approach Delay (s)	0.0		3.5		17.0	
Approach LOS					C	

Intersection Summary			
Average Delay	4.5		
Intersection Capacity Utilization	40.0%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	80	50	30	20	70	100	20	30	30	120	40	300
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0		4.0	4.0			4.0	
Lane Util. Factor	1.00	1.00		1.00	1.00		1.00	1.00			1.00	
Frpb, ped/bikes	1.00	1.00		1.00	1.00		1.00	0.99			1.00	
Flpb, ped/bikes	1.00	1.00		1.00	1.00		1.00	1.00			1.00	
Frt	1.00	0.94		1.00	0.91		1.00	0.93			0.91	
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00			0.99	
Satd. Flow (prot)	1671	1659		1671	1604		1671	1608			1583	
Flt Permitted	0.95	1.00		0.95	1.00		0.43	1.00			0.90	
Satd. Flow (perm)	1671	1659		1671	1604		751	1608			1442	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	87	54	33	22	76	109	22	33	33	130	43	326
RTOR Reduction (vph)	0	15	0	0	44	0	0	19	0	0	75	0
Lane Group Flow (vph)	87	72	0	22	141	0	22	47	0	0	424	0
Confl. Peds. (#/hr)									2	2		
Confl. Bikes (#/hr)									2			
Heavy Vehicles (%)	8%	8%	8%	8%	8%	8%	8%	8%	8%	8%	8%	8%
Turn Type	Prot			Prot			Perm			Perm		
Protected Phases	7	4		3	8			2			6	
Permitted Phases							2			6		
Actuated Green, G (s)	6.6	18.9		1.1	13.4		22.4	22.4			22.4	
Effective Green, g (s)	6.6	18.9		1.1	13.4		22.4	22.4			22.4	
Actuated g/C Ratio	0.12	0.35		0.02	0.25		0.41	0.41			0.41	
Clearance Time (s)	4.0	4.0		4.0	4.0		4.0	4.0			4.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0			3.0	
Lane Grp Cap (vph)	203	576		34	395		309	662			594	
v/s Ratio Prot	c0.05	0.04		0.01	c0.09			0.03				
v/s Ratio Perm							0.03				c0.29	
v/c Ratio	0.43	0.12		0.65	0.36		0.07	0.07			0.71	
Uniform Delay, d1	22.2	12.1		26.5	16.9		9.7	9.7			13.3	
Progression Factor	1.00	1.00		1.00	1.00		1.00	1.00			1.00	
Incremental Delay, d2	1.5	0.1		35.3	0.6		0.1	0.0			4.0	
Delay (s)	23.6	12.2		61.7	17.5		9.8	9.7			17.4	
Level of Service	C	B		E	B		A	A			B	
Approach Delay (s)		17.9			22.2			9.8			17.4	
Approach LOS		B			C			A			B	

Intersection Summary			
HCM Average Control Delay	17.8	HCM Level of Service	B
HCM Volume to Capacity ratio	0.56		
Actuated Cycle Length (s)	54.4	Sum of lost time (s)	12.0
Intersection Capacity Utilization	58.1%	ICU Level of Service	B
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Volume (veh/h)	70	130	40	60	130	200
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	76	141	43	65	141	217
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)	322					
pX, platoon unblocked						
vC, conflicting volume			76		299	147
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			76		299	147
tC, single (s)			4.2		6.5	6.3
tC, 2 stage (s)						
tF (s)			2.3		3.6	3.4
p0 queue free %			97		79	75
cM capacity (veh/h)			1486		660	885

Direction, Lane #	EB 1	WB 1	WB 2	NB 1
Volume Total	217	43	65	359
Volume Left	0	43	0	141
Volume Right	141	0	0	217
cSH	1700	1486	1700	780
Volume to Capacity	0.13	0.03	0.04	0.46
Queue Length 95th (ft)	0	2	0	61
Control Delay (s)	0.0	7.5	0.0	13.5
Lane LOS		A		B
Approach Delay (s)	0.0	3.0		13.5
Approach LOS				B

Intersection Summary			
Average Delay	7.5		
Intersection Capacity Utilization	44.5%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Volume (veh/h)	250	20	50	90	10	10
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	272	22	54	98	11	11
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume			293		489	283
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			293		489	283
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			96		98	99
cM capacity (veh/h)			1251		510	749

Direction, Lane #	EB 1	WB 1	WB 2	NB 1
Volume Total	293	54	98	22
Volume Left	0	54	0	11
Volume Right	22	0	0	11
cSH	1700	1251	1700	607
Volume to Capacity	0.17	0.04	0.06	0.04
Queue Length 95th (ft)	0	3	0	3
Control Delay (s)	0.0	8.0	0.0	11.2
Lane LOS		A		B
Approach Delay (s)	0.0	2.9		11.2
Approach LOS				B

Intersection Summary			
Average Delay	1.5		
Intersection Capacity Utilization	31.0%	ICU Level of Service	A
Analysis Period (min)	15		

Intersection	
Intersection Delay (sec/veh)	30.9
Intersection LOS	D

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Volume (vph)	10	10	10	420	10	30	30	130	170	130	150	10
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Heavy Vehicles(%)	4	4	4	4	4	4	4	4	4	4	4	4
Movement Flow Rate	11	11	11	457	11	33	33	141	185	141	163	11
Number of Lanes	0	1	0	1	1	0	1	2	0	1	2	0

Approach	EB	WB	NB	SB
Opposing Approach	WB	EB	SB	NB
Opposing Lanes	2	1	3	3
Conflicting Approach Left	SB	NB	EB	WB
Conflicting Lanes Left	3	3	1	2
Conflicting Approach Right	NB	SB	WB	EB
Conflicting Lanes Right	3	3	2	1
HCM Control Delay	12	54.4	14.9	13.8
HCM LOS	B	F	B	B

Lane	NBLn1	NBLn2	NBLn3	EBLn1	WBLn1	WBLn2	SBLn1	SBLn2	SBLn3
Volume Left (%)	100%	0%	0%	33%	100%	0%	100%	0%	0%
Volume Thru (%)	0%	100%	20%	33%	0%	25%	0%	100%	83%
Volume Right (%)	0%	0%	80%	33%	0%	75%	0%	0%	17%
Sign Control	Stop	Stop	Stop	Stop	Stop	Stop	Stop	Stop	Stop
Traffic Volume by Lane	30	87	213	30	420	40	130	100	60
Left Turning Volume	0	87	43	10	0	10	0	100	50
Through Volume	0	0	170	10	0	30	0	0	10
Right Turning Volume	30	0	0	10	420	0	130	0	0
Lane Flow Rate	33	94	232	33	457	43	141	109	65
Geometry Group	8	8	8	8	8	8	8	8	8
Degree of Utilization, X	0.075	0.204	0.466	0.077	0.957	0.079	0.329	0.238	0.14
Departure Headway, Hd	8.319	7.803	7.227	8.492	7.547	6.518	8.385	7.869	7.748
Convergence(Y/N)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Capacity	430	460	499	421	479	549	428	455	462
Service Time	6.074	5.557	4.981	6.264	5.291	4.262	6.142	5.625	5.505
HCM Lane V/C Ratio	0.077	0.204	0.465	0.078	0.954	0.078	0.329	0.24	0.141
HCM Control Delay	11.8	12.6	16.2	12	58.6	9.8	15.2	13.1	11.8
HCM Lane LOS	B	B	C	B	F	A	C	B	B
HCM 95th Percentile Queue	0.2	0.8	2.6	0.3	50.3	0.3	1.5	0.9	0.5

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	0	0	80	10	80	20	560	0	0	250	530
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)				4.0	4.0		4.0	4.0			4.0	
Lane Util. Factor				1.00	1.00		1.00	0.95			0.95	
Frpb, ped/bikes				1.00	1.00		1.00	1.00			0.99	
Flpb, ped/bikes				1.00	1.00		1.00	1.00			1.00	
Frt				1.00	0.87		1.00	1.00			0.90	
Flt Protected				0.95	1.00		0.95	1.00			1.00	
Satd. Flow (prot)				1736	1584		1736	3471			3071	
Flt Permitted				0.95	1.00		0.95	1.00			1.00	
Satd. Flow (perm)				1736	1584		1736	3471			3071	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	0	0	0	87	11	87	22	609	0	0	272	576
RTOR Reduction (vph)	0	0	0	0	72	0	0	0	0	0	291	0
Lane Group Flow (vph)	0	0	0	87	26	0	22	609	0	0	557	0
Confl. Peds. (#/hr)							1					1
Confl. Bikes (#/hr)									2			1
Heavy Vehicles (%)	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%
Turn Type				Split			Prot					
Protected Phases				8	8		5	2			6	
Permitted Phases												
Actuated Green, G (s)				6.3	6.3		1.9	21.2			15.3	
Effective Green, g (s)				6.3	6.3		1.9	21.2			15.3	
Actuated g/C Ratio				0.18	0.18		0.05	0.60			0.43	
Clearance Time (s)				4.0	4.0		4.0	4.0			4.0	
Vehicle Extension (s)				3.0	3.0		3.0	3.0			3.0	
Lane Grp Cap (vph)				308	281		93	2073			1324	
v/s Ratio Prot				c0.05	0.02		0.01	c0.18			c0.18	
v/s Ratio Perm												
v/c Ratio				0.28	0.09		0.24	0.29			0.42	
Uniform Delay, d1				12.6	12.2		16.1	3.5			7.0	
Progression Factor				1.00	1.00		1.00	1.00			1.00	
Incremental Delay, d2				0.5	0.1		1.3	0.1			0.2	
Delay (s)				13.1	12.4		17.4	3.6			7.2	
Level of Service				B	B		B	A			A	
Approach Delay (s)		0.0			12.7			4.1			7.2	
Approach LOS		A			B			A			A	

Intersection Summary			
HCM Average Control Delay	6.6	HCM Level of Service	A
HCM Volume to Capacity ratio	0.39		
Actuated Cycle Length (s)	35.5	Sum of lost time (s)	12.0
Intersection Capacity Utilization	36.2%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	10	450	160	480	150	30	60	70	510	60	140	20
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0		4.0	4.0	4.0		4.0	
Lane Util. Factor	1.00	0.95		0.91	0.91		0.95	0.95	1.00		1.00	
Frpb, ped/bikes	1.00	1.00		1.00	1.00		1.00	1.00	0.99		1.00	
Flpb, ped/bikes	1.00	1.00		1.00	1.00		1.00	1.00	1.00		1.00	
Frt	1.00	0.96		1.00	0.99		1.00	1.00	0.85		0.99	
Flt Protected	0.95	1.00		0.95	0.97		0.95	1.00	1.00		0.99	
Satd. Flow (prot)	1752	3355		1595	3223		1665	1745	1546		1795	
Flt Permitted	0.95	1.00		0.95	0.97		0.95	1.00	1.00		0.99	
Satd. Flow (perm)	1752	3355		1595	3223		1665	1745	1546		1795	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	11	489	174	522	163	33	65	76	554	65	152	22
RTOR Reduction (vph)	0	32	0	0	5	0	0	0	469	0	3	0
Lane Group Flow (vph)	11	631	0	261	452	0	58	83	85	0	236	0
Confl. Peds. (#/hr)	1					1			2	2		
Confl. Bikes (#/hr)			1			1						1
Heavy Vehicles (%)	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%
Turn Type	Split			Split			Split		Perm	Split		
Protected Phases	4	4		8	8		2	2		6	6	
Permitted Phases									2			
Actuated Green, G (s)	18.6	18.6		19.6	19.6		12.6	12.6	12.6		15.0	
Effective Green, g (s)	18.6	18.6		19.6	19.6		12.6	12.6	12.6		15.0	
Actuated g/C Ratio	0.23	0.23		0.24	0.24		0.15	0.15	0.15		0.18	
Clearance Time (s)	4.0	4.0		4.0	4.0		4.0	4.0	4.0		4.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0	3.0		3.0	
Lane Grp Cap (vph)	398	763		382	772		256	269	238		329	
v/s Ratio Prot	0.01	c0.19		c0.16	0.14		0.03	0.05			c0.13	
v/s Ratio Perm									c0.06			
v/c Ratio	0.03	0.83		0.68	0.59		0.23	0.31	0.36		0.72	
Uniform Delay, d1	24.6	30.1		28.3	27.5		30.3	30.7	31.0		31.4	
Progression Factor	1.00	1.00		1.00	1.00		1.00	1.00	1.00		1.00	
Incremental Delay, d2	0.0	7.4		5.0	1.1		0.5	0.7	0.9		7.2	
Delay (s)	24.6	37.4		33.3	28.6		30.8	31.4	31.9		38.7	
Level of Service	C	D		C	C		C	C	C		D	
Approach Delay (s)		37.2			30.3			31.8			38.7	
Approach LOS		D			C			C			D	

Intersection Summary			
HCM Average Control Delay	33.6	HCM Level of Service	C
HCM Volume to Capacity ratio	0.67		
Actuated Cycle Length (s)	81.8	Sum of lost time (s)	16.0
Intersection Capacity Utilization	71.3%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	850	250	160	350	0	0	0	0	510	40	300
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0			4.0						4.0	
Lane Util. Factor		0.95			0.95						1.00	
Frpb, ped/bikes		0.99			1.00						1.00	
Flpb, ped/bikes		1.00			1.00						1.00	
Frt		0.97			1.00						0.95	
Flt Protected		1.00			0.98						0.97	
Satd. Flow (prot)		3391			3484						1722	
Flt Permitted		1.00			0.56						0.97	
Satd. Flow (perm)		3391			1986						1722	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	0	924	272	174	380	0	0	0	0	554	43	326
RTOR Reduction (vph)	0	30	0	0	0	0	0	0	0	0	22	0
Lane Group Flow (vph)	0	1166	0	0	554	0	0	0	0	0	901	0
Confl. Peds. (#/hr)	5		9	9		5						
Confl. Bikes (#/hr)						2						
Turn Type				Perm						Split		
Protected Phases		4			8					6	6	
Permitted Phases				8								
Actuated Green, G (s)		31.0			31.0						51.0	
Effective Green, g (s)		31.0			31.0						51.0	
Actuated g/C Ratio		0.34			0.34						0.57	
Clearance Time (s)		4.0			4.0						4.0	
Vehicle Extension (s)		3.0			3.0						3.0	
Lane Grp Cap (vph)		1168			684						976	
v/s Ratio Prot		c0.34									c0.52	
v/s Ratio Perm					0.28							
v/c Ratio		1.00			2.10dl						0.92	
Uniform Delay, d1		29.5			26.8						17.7	
Progression Factor		1.00			0.98						1.00	
Incremental Delay, d2		25.9			9.6						15.4	
Delay (s)		55.4			35.8						33.1	
Level of Service		E			D						C	
Approach Delay (s)		55.4			35.8			0.0			33.1	
Approach LOS		E			D			A			C	

Intersection Summary			
HCM Average Control Delay	43.6	HCM Level of Service	D
HCM Volume to Capacity ratio	0.95		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	111.2%	ICU Level of Service	H
Analysis Period (min)	15		

dl Defacto Left Lane. Recode with 1 though lane as a left lane.
c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	280	1080	0	0	430	480	80	10	120	0	0	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0			4.0		4.0	4.0	4.0			
Lane Util. Factor		0.95			0.95		0.95	0.95	1.00			
Frpb, ped/bikes		1.00			0.99		1.00	1.00	1.00			
Flpb, ped/bikes		1.00			1.00		1.00	1.00	1.00			
Frt		1.00			0.92		1.00	1.00	0.85			
Flt Protected		0.99			1.00		0.95	0.96	1.00			
Satd. Flow (prot)		3502			3215		1681	1704	1583			
Flt Permitted		0.58			1.00		0.95	0.96	1.00			
Satd. Flow (perm)		2062			3215		1681	1704	1583			
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	304	1174	0	0	467	522	87	11	130	0	0	0
RTOR Reduction (vph)	0	0	0	0	139	0	0	0	105	0	0	0
Lane Group Flow (vph)	0	1478	0	0	850	0	49	49	25	0	0	0
Confl. Peds. (#/hr)	5		7	7		5			1	1		
Confl. Bikes (#/hr)						3						
Turn Type	Perm						Split		Prot			
Protected Phases		4			8		2	2	2			
Permitted Phases	4											
Actuated Green, G (s)		66.0			66.0		16.0	16.0	16.0			
Effective Green, g (s)		66.0			66.0		16.0	16.0	16.0			
Actuated g/C Ratio		0.73			0.73		0.18	0.18	0.18			
Clearance Time (s)		4.0			4.0		4.0	4.0	4.0			
Vehicle Extension (s)		3.0			3.0		3.0	3.0	3.0			
Lane Grp Cap (vph)		1512			2358		299	303	281			
v/s Ratio Prot					0.26		c0.03	0.03	0.02			
v/s Ratio Perm		c0.72										
v/c Ratio		0.98			0.36		0.16	0.16	0.09			
Uniform Delay, d1		11.3			4.3		31.3	31.3	30.9			
Progression Factor		0.71			1.00		1.00	1.00	1.00			
Incremental Delay, d2		8.1			0.4		1.2	1.1	0.6			
Delay (s)		16.1			4.8		32.5	32.5	31.5			
Level of Service		B			A		C	C	C			
Approach Delay (s)		16.1			4.8			31.9			0.0	
Approach LOS		B			A			C			A	

Intersection Summary			
HCM Average Control Delay	13.3	HCM Level of Service	B
HCM Volume to Capacity ratio	0.82		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	104.7%	ICU Level of Service	G
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	120	620	60	240	420	220	100	1030	320	210	490	70
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	4.0	4.0	3.0	4.0	4.0	3.0	3.0	3.0	3.0	3.0	
Lane Util. Factor	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	
Frpb, ped/bikes	1.00	1.00	0.96	1.00	1.00	0.98	1.00	1.00	0.91	1.00	1.00	
Flpb, ped/bikes	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	0.98	
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	
Satd. Flow (prot)	1770	3539	1526	1770	3539	1553	1770	3539	1447	1770	3466	
Flt Permitted	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	
Satd. Flow (perm)	1770	3539	1526	1770	3539	1553	1770	3539	1447	1770	3466	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	130	674	65	261	457	239	109	1120	348	228	533	76
RTOR Reduction (vph)	0	0	13	0	0	96	0	0	102	0	10	0
Lane Group Flow (vph)	130	674	52	261	457	143	109	1120	246	228	599	0
Confl. Peds. (#/hr)	5		19	19		5	4		14	14		4
Confl. Bikes (#/hr)						1			100			
Turn Type	Prot		Perm	Prot		Perm	Prot		Perm	Prot		
Protected Phases	5	2		1	6		3	8		7	4	
Permitted Phases			2			6			8			
Actuated Green, G (s)	10.1	23.2	23.2	15.1	26.2	26.2	10.8	39.5	39.5	13.1	41.8	
Effective Green, g (s)	10.1	23.2	23.2	15.1	26.2	26.2	10.8	39.5	39.5	13.1	41.8	
Actuated g/C Ratio	0.10	0.22	0.22	0.15	0.25	0.25	0.10	0.38	0.38	0.13	0.40	
Clearance Time (s)	5.0	4.0	4.0	3.0	4.0	4.0	3.0	3.0	3.0	3.0	3.0	
Vehicle Extension (s)	2.0	4.0	4.0	2.0	4.0	4.0	2.0	2.0	2.0	2.0	2.0	
Lane Grp Cap (vph)	172	790	341	257	892	392	184	1345	550	223	1394	
v/s Ratio Prot	0.07	c0.19		c0.15	c0.13		0.06	c0.32		c0.13	0.17	
v/s Ratio Perm			0.03			0.09			0.17			
v/c Ratio	0.76	0.85	0.15	1.02	0.51	0.37	0.59	0.83	0.45	1.02	0.43	
Uniform Delay, d1	45.7	38.7	32.4	44.4	33.4	32.0	44.4	29.2	24.1	45.4	22.4	
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	
Incremental Delay, d2	15.3	9.2	0.3	60.2	0.7	0.8	3.4	4.4	0.2	66.2	0.1	
Delay (s)	61.0	47.9	32.7	104.6	34.0	32.8	47.8	33.6	24.3	111.6	22.5	
Level of Service	E	D	C	F	C	C	D	C	C	F	C	
Approach Delay (s)		48.7			53.0			32.5			46.8	
Approach LOS		D			D			C			D	

Intersection Summary			
HCM Average Control Delay	43.3	HCM Level of Service	D
HCM Volume to Capacity ratio	0.89		
Actuated Cycle Length (s)	103.9	Sum of lost time (s)	17.0
Intersection Capacity Utilization	85.2%	ICU Level of Service	E
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	0	0	280	10	800	0	690	230	0	610	190
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)				4.0	4.0	4.0		4.0	4.0		4.0	
Lane Util. Factor				0.95	0.91	0.95		0.91	1.00		0.91	
Frt				1.00	0.86	0.85		1.00	0.85		0.96	
Flt Protected				0.95	1.00	1.00		1.00	1.00		1.00	
Satd. Flow (prot)				1698	1474	1519		5136	1599		4953	
Flt Permitted				0.95	1.00	1.00		1.00	1.00		1.00	
Satd. Flow (perm)				1698	1474	1519		5136	1599		4953	
Peak-hour factor, PHF	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94
Adj. Flow (vph)	0	0	0	298	11	851	0	734	245	0	649	202
RTOR Reduction (vph)	0	0	0	0	45	45	0	0	0	0	92	0
Lane Group Flow (vph)	0	0	0	268	404	398	0	734	245	0	759	0
Heavy Vehicles (%)	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%
Turn Type				Split		Perm			Free			
Protected Phases				8	8			2			6	
Permitted Phases						8			Free			
Actuated Green, G (s)				20.6	20.6	20.6		15.0	43.6		15.0	
Effective Green, g (s)				20.6	20.6	20.6		15.0	43.6		15.0	
Actuated g/C Ratio				0.47	0.47	0.47		0.34	1.00		0.34	
Clearance Time (s)				4.0	4.0	4.0		4.0			4.0	
Vehicle Extension (s)				3.0	3.0	3.0		3.0			3.0	
Lane Grp Cap (vph)				802	696	718		1767	1599		1704	
v/s Ratio Prot				0.16	c0.27			0.14			c0.15	
v/s Ratio Perm						0.26			0.15			
v/c Ratio				0.33	0.58	0.55		0.42	0.15		0.45	
Uniform Delay, d1				7.2	8.4	8.2		10.9	0.0		11.1	
Progression Factor				1.00	1.00	1.00		1.00	1.00		1.00	
Incremental Delay, d2				0.2	1.2	0.9		0.2	0.2		0.2	
Delay (s)				7.5	9.5	9.1		11.1	0.2		11.3	
Level of Service				A	A	A		B	A		B	
Approach Delay (s)		0.0			8.9			8.4			11.3	
Approach LOS		A			A			A			B	

Intersection Summary			
HCM Average Control Delay	9.4	HCM Level of Service	A
HCM Volume to Capacity ratio	0.52		
Actuated Cycle Length (s)	43.6	Sum of lost time (s)	8.0
Intersection Capacity Utilization	53.0%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	390	0	250	0	0	0	0	530	370	0	550	340
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0		4.0					4.0			4.0	4.0
Lane Util. Factor	1.00		1.00					0.91			0.95	1.00
Frpb, ped/bikes	1.00		1.00					0.99			1.00	0.98
Flpb, ped/bikes	1.00		1.00					1.00			1.00	1.00
Frt	1.00		0.85					0.94			1.00	0.85
Flt Protected	0.95		1.00					1.00			1.00	1.00
Satd. Flow (prot)	1770		1583					4722			3539	1549
Flt Permitted	0.95		1.00					1.00			1.00	1.00
Satd. Flow (perm)	1770		1583					4722			3539	1549
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	424	0	272	0	0	0	0	576	402	0	598	370
RTOR Reduction (vph)	0	0	73	0	0	0	0	204	0	0	0	0
Lane Group Flow (vph)	424	0	199	0	0	0	0	774	0	0	598	370
Confl. Peds. (#/hr)							4		2	2		4
Confl. Bikes (#/hr)									3			
Turn Type	Split		Perm									Free
Protected Phases	8	8						2			6	
Permitted Phases			8									Free
Actuated Green, G (s)	15.8		15.8					14.9			14.9	38.7
Effective Green, g (s)	15.8		15.8					14.9			14.9	38.7
Actuated g/C Ratio	0.41		0.41					0.39			0.39	1.00
Clearance Time (s)	4.0		4.0					4.0			4.0	
Vehicle Extension (s)	3.0		3.0					3.0			3.0	
Lane Grp Cap (vph)	723		646					1818			1363	1549
v/s Ratio Prot	c0.24							0.16			c0.17	
v/s Ratio Perm			0.13									0.24
v/c Ratio	0.59		0.31					0.43			0.44	0.24
Uniform Delay, d1	8.9		7.8					8.8			8.8	0.0
Progression Factor	1.00		1.00					1.00			1.00	1.00
Incremental Delay, d2	1.2		0.3					0.2			0.2	0.4
Delay (s)	10.1		8.0					8.9			9.0	0.4
Level of Service	B		A					A			A	A
Approach Delay (s)		9.3			0.0			8.9			5.7	
Approach LOS		A			A			A			A	

Intersection Summary			
HCM Average Control Delay	7.8	HCM Level of Service	A
HCM Volume to Capacity ratio	0.51		
Actuated Cycle Length (s)	38.7	Sum of lost time (s)	8.0
Intersection Capacity Utilization	46.9%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	200	20	100	20	20	260	30	440	10	20	650	130
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0		4.0	4.0			4.0		4.0	4.0	
Lane Util. Factor		1.00		1.00	1.00			0.95		1.00	0.95	
Frpb, ped/bikes		0.99		1.00	0.99			1.00		1.00	1.00	
Flpb, ped/bikes		1.00		1.00	1.00			1.00		0.94	1.00	
Frt		0.96		1.00	0.86			1.00		1.00	0.98	
Flt Protected		0.97		0.95	1.00			1.00		0.95	1.00	
Satd. Flow (prot)		1697		1751	1568			3481		1654	3406	
Flt Permitted		1.00		0.55	1.00			0.88		0.95	1.00	
Satd. Flow (perm)		1750		1018	1568			3066		1654	3406	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	217	22	109	22	22	283	33	478	11	22	707	141
RTOR Reduction (vph)	0	17	0	0	216	0	0	1	0	0	15	0
Lane Group Flow (vph)	0	331	0	22	89	0	0	521	0	22	833	0
Confl. Peds. (#/hr)	1		3	3		1			5	5		
Confl. Bikes (#/hr)						1			2			1
Heavy Vehicles (%)	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%
Turn Type	Perm			Perm			Perm			Prot		
Protected Phases		3			4			2		1	6	
Permitted Phases	3			4			2					
Actuated Green, G (s)		2.4		11.5	11.5			18.0		0.9	22.9	
Effective Green, g (s)		2.4		11.5	11.5			18.0		0.9	22.9	
Actuated g/C Ratio		0.05		0.24	0.24			0.37		0.02	0.47	
Clearance Time (s)		4.0		4.0	4.0			4.0		4.0	4.0	
Vehicle Extension (s)		3.0		3.0	3.0			3.0		3.0	3.0	
Lane Grp Cap (vph)		86		240	370			1131		31	1598	
v/s Ratio Prot					c0.06					0.01	c0.24	
v/s Ratio Perm		c0.19		0.02				0.17				
v/c Ratio		3.85		0.09	0.24			0.46		0.71	0.52	
Uniform Delay, d1		23.2		14.6	15.1			11.7		23.8	9.1	
Progression Factor		1.00		1.00	1.00			1.00		1.00	1.00	
Incremental Delay, d2		1309.1		0.2	0.3			0.3		54.2	0.3	
Delay (s)		1332.3		14.7	15.4			12.0		78.0	9.4	
Level of Service		F		B	B			B		E	A	
Approach Delay (s)		1332.3			15.4			12.0			11.1	
Approach LOS		F			B			B			B	

Intersection Summary			
HCM Average Control Delay	234.5	HCM Level of Service	F
HCM Volume to Capacity ratio	0.65		
Actuated Cycle Length (s)	48.8	Sum of lost time (s)	12.0
Intersection Capacity Utilization	81.4%	ICU Level of Service	D
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	190	50	50	50	120	50	50	190	130	40	440	300
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0		4.0	4.0		4.0	4.0	
Lane Util. Factor	1.00	0.95	1.00	1.00	0.95		1.00	0.95		1.00	0.95	
Frpb, ped/bikes	1.00	1.00	1.00	1.00	1.00		1.00	0.99		1.00	0.99	
Flpb, ped/bikes	1.00	1.00	1.00	1.00	1.00		1.00	1.00		1.00	1.00	
Frt	1.00	1.00	0.85	1.00	0.96		1.00	0.94		1.00	0.94	
Flt Protected	0.95	1.00	1.00	0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1770	3539	1583	1770	3368		1770	3305		1770	3294	
Flt Permitted	0.95	1.00	1.00	0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (perm)	1770	3539	1583	1770	3368		1770	3305		1770	3294	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	200	53	53	53	126	53	53	200	137	42	463	316
RTOR Reduction (vph)	0	0	41	0	46	0	0	90	0	0	149	0
Lane Group Flow (vph)	200	53	12	53	133	0	53	247	0	42	630	0
Confl. Peds. (#/hr)							16		1	1		16
Confl. Bikes (#/hr)						1			1			
Turn Type	Prot		Perm	Prot			Prot			Prot		
Protected Phases	7	4		3	8		5	2		1	6	
Permitted Phases			4									
Actuated Green, G (s)	9.0	11.9	11.9	4.0	6.9		3.0	18.0		2.6	17.6	
Effective Green, g (s)	9.0	11.9	11.9	4.0	6.9		3.0	18.0		2.6	17.6	
Actuated g/C Ratio	0.17	0.23	0.23	0.08	0.13		0.06	0.34		0.05	0.34	
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0		4.0	4.0		4.0	4.0	
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	303	802	359	135	443		101	1133		88	1104	
v/s Ratio Prot	c0.11	0.01		0.03	c0.04		c0.03	0.07		0.02	c0.19	
v/s Ratio Perm			0.01									
v/c Ratio	0.66	0.07	0.03	0.39	0.30		0.52	0.22		0.48	0.57	
Uniform Delay, d1	20.3	15.9	15.8	23.1	20.6		24.1	12.3		24.3	14.3	
Progression Factor	1.00	1.00	1.00	1.00	1.00		1.00	1.00		1.00	1.00	
Incremental Delay, d2	5.3	0.0	0.0	1.9	0.4		4.8	0.1		4.0	0.7	
Delay (s)	25.6	16.0	15.9	25.0	21.0		28.9	12.3		28.3	15.1	
Level of Service	C	B	B	C	C		C	B		C	B	
Approach Delay (s)		22.3			21.9			14.6			15.7	
Approach LOS		C			C			B			B	

Intersection Summary			
HCM Average Control Delay	17.4	HCM Level of Service	B
HCM Volume to Capacity ratio	0.54		
Actuated Cycle Length (s)	52.5	Sum of lost time (s)	16.0
Intersection Capacity Utilization	54.5%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Volume (veh/h)	110	60	60	210	290	150
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	120	65	65	228	315	163
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)				1133		
pX, platoon unblocked						
vC, conflicting volume			185		478	120
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			185		478	120
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			95		39	82
cM capacity (veh/h)			1378		517	927

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	NB 1	NB 2
Volume Total	120	65	65	228	315	163
Volume Left	0	0	65	0	315	0
Volume Right	0	65	0	0	0	163
cSH	1700	1700	1378	1700	517	927
Volume to Capacity	0.07	0.04	0.05	0.13	0.61	0.18
Queue Length 95th (ft)	0	0	4	0	101	16
Control Delay (s)	0.0	0.0	7.7	0.0	22.3	9.7
Lane LOS			A		C	A
Approach Delay (s)	0.0		1.7		18.0	
Approach LOS					C	

Intersection Summary			
Average Delay	9.5		
Intersection Capacity Utilization	33.8%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	120	20	10	10	80	130	20	20	10	170	20	70
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0		4.0	4.0			4.0	
Lane Util. Factor	1.00	1.00		1.00	1.00		1.00	1.00			1.00	
Frt	1.00	0.95		1.00	0.91		1.00	0.95			0.96	
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00			0.97	
Satd. Flow (prot)	1671	1671		1671	1596		1671	1671			1642	
Flt Permitted	0.95	1.00		0.95	1.00		0.64	1.00			0.78	
Satd. Flow (perm)	1671	1671		1671	1596		1121	1671			1327	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	130	22	11	11	87	141	22	22	11	185	22	76
RTOR Reduction (vph)	0	7	0	0	109	0	0	7	0	0	20	0
Lane Group Flow (vph)	130	26	0	11	119	0	22	26	0	0	263	0
Heavy Vehicles (%)	8%	8%	8%	8%	8%	8%	8%	8%	8%	8%	8%	8%
Turn Type	Prot			Prot			Perm			Perm		
Protected Phases	7	4		3	8			2			6	
Permitted Phases							2			6		
Actuated Green, G (s)	5.4	13.1		1.1	8.8		12.7	12.7			12.7	
Effective Green, g (s)	5.4	13.1		1.1	8.8		12.7	12.7			12.7	
Actuated g/C Ratio	0.14	0.34		0.03	0.23		0.33	0.33			0.33	
Clearance Time (s)	4.0	4.0		4.0	4.0		4.0	4.0			4.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0			3.0	
Lane Grp Cap (vph)	232	563		47	361		366	546			433	
v/s Ratio Prot	c0.08	0.02		0.01	c0.07			0.02				
v/s Ratio Perm							0.02				c0.20	
v/c Ratio	0.56	0.05		0.23	0.33		0.06	0.05			0.61	
Uniform Delay, d1	15.6	8.7		18.5	12.6		9.0	9.0			11.0	
Progression Factor	1.00	1.00		1.00	1.00		1.00	1.00			1.00	
Incremental Delay, d2	3.1	0.0		2.6	0.5		0.1	0.0			2.4	
Delay (s)	18.7	8.7		21.0	13.1		9.1	9.0			13.4	
Level of Service	B	A		C	B		A	A			B	
Approach Delay (s)		16.7			13.5			9.0			13.4	
Approach LOS		B			B			A			B	

Intersection Summary			
HCM Average Control Delay	13.8	HCM Level of Service	B
HCM Volume to Capacity ratio	0.51		
Actuated Cycle Length (s)	38.9	Sum of lost time (s)	12.0
Intersection Capacity Utilization	50.2%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Volume (veh/h)	90	110	70	60	160	100
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	98	120	76	65	174	109
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)	322					
pX, platoon unblocked						
vC, conflicting volume			98		375	158
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			98		375	158
tC, single (s)			4.2		6.5	6.3
tC, 2 stage (s)						
tF (s)			2.3		3.6	3.4
p0 queue free %			95		70	88
cM capacity (veh/h)			1458		582	872

Direction, Lane #	EB 1	WB 1	WB 2	NB 1
Volume Total	217	76	65	283
Volume Left	0	76	0	174
Volume Right	120	0	0	109
cSH	1700	1458	1700	668
Volume to Capacity	0.13	0.05	0.04	0.42
Queue Length 95th (ft)	0	4	0	53
Control Delay (s)	0.0	7.6	0.0	14.3
Lane LOS		A		B
Approach Delay (s)	0.0	4.1		14.3
Approach LOS				B

Intersection Summary			
Average Delay	7.2		
Intersection Capacity Utilization	40.3%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Volume (veh/h)	180	10	10	110	20	50
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	196	11	11	120	22	54
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume			207		342	201
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			207		342	201
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			99		97	94
cM capacity (veh/h)			1365		649	840

Direction, Lane #	EB 1	WB 1	WB 2	NB 1
Volume Total	207	11	120	76
Volume Left	0	11	0	22
Volume Right	11	0	0	54
cSH	1700	1365	1700	775
Volume to Capacity	0.12	0.01	0.07	0.10
Queue Length 95th (ft)	0	1	0	8
Control Delay (s)	0.0	7.7	0.0	10.2
Lane LOS		A		B
Approach Delay (s)	0.0	0.6		10.2
Approach LOS				B

Intersection Summary			
Average Delay	2.1		
Intersection Capacity Utilization	20.9%	ICU Level of Service	A
Analysis Period (min)	15		

Intersection	
Intersection Delay (sec/veh)	39.3
Intersection LOS	E

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Volume (vph)	10	20	10	510	10	30	10	90	70	90	100	10
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Heavy Vehicles(%)	2	2	2	2	2	2	2	2	2	2	2	2
Movement Flow Rate	11	22	11	554	11	33	11	98	76	98	109	11
Number of Lanes	0	1	0	1	1	0	1	2	0	1	2	0

Approach	EB	WB	NB	SB
Opposing Approach	WB	EB	SB	NB
Opposing Lanes	2	1	3	3
Conflicting Approach Left	SB	NB	EB	WB
Conflicting Lanes Left	3	3	1	2
Conflicting Approach Right	NB	SB	WB	EB
Conflicting Lanes Right	3	3	2	1
HCM Control Delay	11	60	11.4	11.7
HCM LOS	B	F	B	B

Lane	NBLn1	NBLn2	NBLn3	EBLn1	WBLn1	WBLn2	SBLn1	SBLn2	SBLn3
Volume Left (%)	100%	0%	0%	25%	100%	0%	100%	0%	0%
Volume Thru (%)	0%	100%	30%	50%	0%	25%	0%	100%	77%
Volume Right (%)	0%	0%	70%	25%	0%	75%	0%	0%	23%
Sign Control	Stop	Stop	Stop	Stop	Stop	Stop	Stop	Stop	Stop
Traffic Volume by Lane	10	60	100	40	510	40	90	67	43
Left Turning Volume	0	60	30	20	0	10	0	67	33
Through Volume	0	0	70	10	0	30	0	0	10
Right Turning Volume	10	0	0	10	510	0	90	0	0
Lane Flow Rate	11	65	109	43	554	43	98	72	47
Geometry Group	8	8	8	8	8	8	8	8	8
Degree of Utilization, X	0.024	0.136	0.212	0.09	1	0.067	0.212	0.149	0.095
Departure Headway, Hd	7.925	7.423	7.021	7.492	6.592	5.567	7.815	7.414	7.248
Convergence(Y/N)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Capacity	455	486	521	478	549	641	462	493	504
Service Time	5.621	5.123	4.635	5.24	4.346	3.321	5.515	5.017	4.857
HCM Lane V/C Ratio	0.024	0.134	0.209	0.09	1.009	0.067	0.212	0.146	0.093
HCM Control Delay	10.8	11.3	11.5	11	64	8.7	12.6	11.3	10.6
HCM Lane LOS	B	B	B	B	F	A	B	B	B
HCM 95th Percentile Queue	0.1	0.5	0.8	0.3	110.4	0.2	0.8	0.5	0.3

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	0	0	70	10	480	30	590	0	0	90	330
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)				4.0	4.0		4.0	4.0			4.0	
Lane Util. Factor				1.00	1.00		1.00	0.95			0.95	
Frpb, ped/bikes				1.00	1.00		1.00	1.00			0.98	
Flpb, ped/bikes				1.00	1.00		1.00	1.00			1.00	
Frt				1.00	0.85		1.00	1.00			0.88	
Flt Protected				0.95	1.00		0.95	1.00			1.00	
Satd. Flow (prot)				1787	1605		1787	3574			3100	
Flt Permitted				0.95	1.00		0.95	1.00			1.00	
Satd. Flow (perm)				1787	1605		1787	3574			3100	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	0	0	0	74	11	505	32	621	0	0	95	347
RTOR Reduction (vph)	0	0	0	0	173	0	0	0	0	0	247	0
Lane Group Flow (vph)	0	0	0	74	343	0	32	621	0	0	195	0
Confl. Peds. (#/hr)							1		2	2		1
Confl. Bikes (#/hr)			1						1			
Heavy Vehicles (%)	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%
Turn Type				Split			Prot					
Protected Phases				8	8		5	2			6	
Permitted Phases												
Actuated Green, G (s)				14.1	14.1		3.5	19.5			12.0	
Effective Green, g (s)				14.1	14.1		3.5	19.5			12.0	
Actuated g/C Ratio				0.34	0.34		0.08	0.47			0.29	
Clearance Time (s)				4.0	4.0		4.0	4.0			4.0	
Vehicle Extension (s)				3.0	3.0		3.0	3.0			3.0	
Lane Grp Cap (vph)				606	544		150	1675			894	
v/s Ratio Prot				0.04	c0.21		0.02	c0.17			0.06	
v/s Ratio Perm												
v/c Ratio				0.12	0.63		0.21	0.37			0.22	
Uniform Delay, d1				9.5	11.6		17.8	7.1			11.2	
Progression Factor				1.00	1.00		1.00	1.00			1.00	
Incremental Delay, d2				0.1	2.4		0.7	0.1			0.1	
Delay (s)				9.6	13.9		18.5	7.2			11.4	
Level of Service				A	B		B	A			B	
Approach Delay (s)		0.0			13.4			7.8			11.4	
Approach LOS		A			B			A			B	

Intersection Summary			
HCM Average Control Delay	10.7	HCM Level of Service	B
HCM Volume to Capacity ratio	0.48		
Actuated Cycle Length (s)	41.6	Sum of lost time (s)	8.0
Intersection Capacity Utilization	56.8%	ICU Level of Service	B
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	50	530	90	290	370	60	310	180	580	30	40	50
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0		4.0	4.0	4.0		4.0	
Lane Util. Factor	1.00	0.95		0.91	0.91		0.95	0.95	1.00		1.00	
Frpb, ped/bikes	1.00	1.00		1.00	1.00		1.00	1.00	0.99		1.00	
Flpb, ped/bikes	1.00	1.00		1.00	1.00		1.00	1.00	1.00		1.00	
Frt	1.00	0.98		1.00	0.98		1.00	1.00	0.85		0.94	
Flt Protected	0.95	1.00		0.95	0.99		0.95	0.99	1.00		0.99	
Satd. Flow (prot)	1787	3496		1626	3342		1698	1763	1576		1753	
Flt Permitted	0.95	1.00		0.95	0.99		0.95	0.99	1.00		0.99	
Satd. Flow (perm)	1787	3496		1626	3342		1698	1763	1576		1753	
Peak-hour factor, PHF	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97
Adj. Flow (vph)	52	546	93	299	381	62	320	186	598	31	41	52
RTOR Reduction (vph)	0	13	0	0	11	0	0	0	437	0	30	0
Lane Group Flow (vph)	52	626	0	245	486	0	250	256	161	0	94	0
Confl. Peds. (#/hr)									2	2		
Confl. Bikes (#/hr)									1			
Heavy Vehicles (%)	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%
Turn Type	Split			Split			Split		Perm	Split		
Protected Phases	4	4		8	8		2	2		6	6	
Permitted Phases									2			
Actuated Green, G (s)	16.8	16.8		16.3	16.3		21.1	21.1	21.1		8.0	
Effective Green, g (s)	16.8	16.8		16.3	16.3		21.1	21.1	21.1		8.0	
Actuated g/C Ratio	0.21	0.21		0.21	0.21		0.27	0.27	0.27		0.10	
Clearance Time (s)	4.0	4.0		4.0	4.0		4.0	4.0	4.0		4.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0	3.0		3.0	
Lane Grp Cap (vph)	384	751		339	697		458	476	425		179	
v/s Ratio Prot	0.03	c0.18		c0.15	0.15		c0.15	0.15			c0.05	
v/s Ratio Perm									0.10			
v/c Ratio	0.14	0.83		0.72	0.70		0.55	0.54	0.38		0.53	
Uniform Delay, d1	24.8	29.4		28.8	28.7		24.4	24.4	23.2		33.3	
Progression Factor	1.00	1.00		1.00	1.00		1.00	1.00	1.00		1.00	
Incremental Delay, d2	0.2	7.9		7.4	3.0		1.3	1.2	0.6		2.8	
Delay (s)	25.0	37.2		36.3	31.7		25.8	25.6	23.8		36.1	
Level of Service	C	D		D	C		C	C	C		D	
Approach Delay (s)		36.3			33.2			24.7			36.1	
Approach LOS		D			C			C			D	

Intersection Summary			
HCM Average Control Delay	30.6	HCM Level of Service	C
HCM Volume to Capacity ratio	0.67		
Actuated Cycle Length (s)	78.2	Sum of lost time (s)	16.0
Intersection Capacity Utilization	70.5%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	720	370	170	460	0	0	0	0	570	20	390
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0			4.0						4.0	
Lane Util. Factor		0.95			0.95						1.00	
Frpb, ped/bikes		0.99			1.00						1.00	
Flpb, ped/bikes		1.00			1.00						1.00	
Frt		0.95			1.00						0.95	
Flt Protected		1.00			0.99						0.97	
Satd. Flow (prot)		3348			3527						1730	
Flt Permitted		1.00			0.51						0.97	
Satd. Flow (perm)		3348			1837						1730	
Peak-hour factor, PHF	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96
Adj. Flow (vph)	0	750	385	177	479	0	0	0	0	594	21	406
RTOR Reduction (vph)	0	54	0	0	0	0	0	0	0	0	20	0
Lane Group Flow (vph)	0	1081	0	0	656	0	0	0	0	0	1001	0
Confl. Peds. (#/hr)	3		8	8		3						
Confl. Bikes (#/hr)						3						
Heavy Vehicles (%)	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%
Turn Type				Perm						Split		
Protected Phases		4			8					6	6	
Permitted Phases				8								
Actuated Green, G (s)		49.0			49.0						63.0	
Effective Green, g (s)		49.0			49.0						63.0	
Actuated g/C Ratio		0.41			0.41						0.52	
Clearance Time (s)		4.0			4.0						4.0	
Vehicle Extension (s)		3.0			3.0						3.0	
Lane Grp Cap (vph)		1367			750						908	
v/s Ratio Prot		0.32									c0.58	
v/s Ratio Perm					c0.36							
v/c Ratio		0.79			2.53dl						1.10	
Uniform Delay, d1		31.0			32.7						28.5	
Progression Factor		1.00			1.04						1.00	
Incremental Delay, d2		4.7			12.6						62.0	
Delay (s)		35.7			46.5						90.5	
Level of Service		D			D						F	
Approach Delay (s)		35.7			46.5			0.0			90.5	
Approach LOS		D			D			A			F	

Intersection Summary			
HCM Average Control Delay	58.1	HCM Level of Service	E
HCM Volume to Capacity ratio	1.00		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	119.4%	ICU Level of Service	H
Analysis Period (min)	15		

dl Defacto Left Lane. Recode with 1 though lane as a left lane.
c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	310	980	0	0	530	550	100	140	220	0	0	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0			4.0		4.0	4.0	4.0			
Lane Util. Factor		0.95			0.95		0.95	0.95	1.00			
Frpb, ped/bikes		1.00			0.99		1.00	1.00	1.00			
Flpb, ped/bikes		1.00			1.00		1.00	1.00	1.00			
Frt		1.00			0.92		1.00	1.00	0.85			
Flt Protected		0.99			1.00		0.95	1.00	1.00			
Satd. Flow (prot)		3531			3261		1698	1781	1599			
Flt Permitted		0.54			1.00		0.95	1.00	1.00			
Satd. Flow (perm)		1946			3261		1698	1781	1599			
Peak-hour factor, PHF	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96
Adj. Flow (vph)	323	1021	0	0	552	573	104	146	229	0	0	0
RTOR Reduction (vph)	0	0	0	0	53	0	0	0	173	0	0	0
Lane Group Flow (vph)	0	1344	0	0	1072	0	94	156	56	0	0	0
Confl. Peds. (#/hr)	2		7	7		2						
Confl. Bikes (#/hr)						3						
Heavy Vehicles (%)	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%
Turn Type	Perm						Split		Prot			
Protected Phases		4			8		2	2	2			
Permitted Phases	4											
Actuated Green, G (s)		96.0			96.0		16.0	16.0	16.0			
Effective Green, g (s)		96.0			96.0		16.0	16.0	16.0			
Actuated g/C Ratio		0.80			0.80		0.13	0.13	0.13			
Clearance Time (s)		4.0			4.0		4.0	4.0	4.0			
Vehicle Extension (s)		3.0			3.0		3.0	3.0	3.0			
Lane Grp Cap (vph)		1557			2609		226	237	213			
v/s Ratio Prot					0.33		0.06	c0.09	0.03			
v/s Ratio Perm		c0.69										
v/c Ratio		0.92dl			0.41		0.42	0.66	0.26			
Uniform Delay, d1		7.8			3.6		47.7	49.4	46.7			
Progression Factor		0.84			1.00		1.00	1.00	1.00			
Incremental Delay, d2		2.5			0.5		5.6	13.5	3.0			
Delay (s)		9.0			4.1		53.3	62.9	49.7			
Level of Service		A			A		D	E	D			
Approach Delay (s)		9.0			4.1			54.7			0.0	
Approach LOS		A			A			D			A	

Intersection Summary			
HCM Average Control Delay	14.6	HCM Level of Service	B
HCM Volume to Capacity ratio	0.83		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	96.8%	ICU Level of Service	F
Analysis Period (min)	15		

dl Defacto Left Lane. Recode with 1 though lane as a left lane.
c Critical Lane Group

Cumulative (2035) Plus Project Buildout Conditions

FEHR PEERS

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	110	300	153	400	470	220	68	387	170	70	936	50
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	4.0	4.0	3.0	4.0	4.0	3.0	3.0	3.0	3.0	3.0	
Lane Util. Factor	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	
Frpb, ped/bikes	1.00	1.00	0.97	1.00	1.00	0.97	1.00	1.00	0.98	1.00	1.00	
Flpb, ped/bikes	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	0.99	
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	
Satd. Flow (prot)	1736	3471	1514	1736	3471	1511	1736	3471	1528	1736	3442	
Flt Permitted	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	
Satd. Flow (perm)	1736	3471	1514	1736	3471	1511	1736	3471	1528	1736	3442	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	120	326	166	435	511	239	74	421	185	76	1017	54
RTOR Reduction (vph)	0	0	93	0	0	109	0	0	123	0	4	0
Lane Group Flow (vph)	120	326	73	435	511	130	74	421	62	76	1067	0
Confl. Peds. (#/hr)	14		13	13		14	4		4	4		4
Confl. Bikes (#/hr)						1						1
Heavy Vehicles (%)	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%
Turn Type	Prot		Perm	Prot		Perm	Prot		Perm	Prot		
Protected Phases	5	2		1	6		3	8		7	4	
Permitted Phases			2			6			8			
Actuated Green, G (s)	8.2	16.4	16.4	22.1	28.3	28.3	4.0	27.8	27.8	3.9	27.7	
Effective Green, g (s)	8.2	16.4	16.4	22.1	28.3	28.3	4.0	27.8	27.8	3.9	27.7	
Actuated g/C Ratio	0.10	0.20	0.20	0.27	0.34	0.34	0.05	0.33	0.33	0.05	0.33	
Clearance Time (s)	5.0	4.0	4.0	3.0	4.0	4.0	3.0	3.0	3.0	3.0	3.0	
Vehicle Extension (s)	2.0	4.0	4.0	2.0	4.0	4.0	2.0	2.0	2.0	2.0	2.0	
Lane Grp Cap (vph)	171	684	298	461	1181	514	83	1160	511	81	1146	
v/s Ratio Prot	0.07	0.09		c0.25	c0.15		0.04	0.12		c0.04	c0.31	
v/s Ratio Perm			0.05			0.09			0.04			
v/c Ratio	0.70	0.48	0.24	0.94	0.43	0.25	0.89	0.36	0.12	0.94	0.93	
Uniform Delay, d1	36.3	29.6	28.2	29.9	21.2	19.8	39.4	21.0	19.2	39.5	26.8	
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	
Incremental Delay, d2	10.1	0.7	0.6	27.8	0.3	0.4	62.6	0.1	0.0	77.7	13.1	
Delay (s)	46.4	30.3	28.8	57.7	21.6	20.2	102.0	21.1	19.3	117.3	39.9	
Level of Service	D	C	C	E	C	C	F	C	B	F	D	
Approach Delay (s)		33.1			34.6			29.4			45.0	
Approach LOS		C			C			C			D	

Intersection Summary			
HCM Average Control Delay	36.6	HCM Level of Service	D
HCM Volume to Capacity ratio	0.79		
Actuated Cycle Length (s)	83.2	Sum of lost time (s)	9.0
Intersection Capacity Utilization	79.2%	ICU Level of Service	D
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	0	0	380	10	243	0	363	183	0	1219	290
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)				4.0	4.0	4.0		4.0	4.0		4.0	
Lane Util. Factor				0.95	0.91	0.95		0.91	1.00		0.91	
Frpb, ped/bikes				1.00	1.00	0.99		1.00	0.98		1.00	
Flpb, ped/bikes				1.00	1.00	1.00		1.00	1.00		1.00	
Frt				1.00	0.97	0.85		1.00	0.85		0.97	
Flt Protected				0.95	0.96	1.00		1.00	1.00		1.00	
Satd. Flow (prot)				1665	1563	1471		5036	1535		4869	
Flt Permitted				0.95	0.96	1.00		1.00	1.00		1.00	
Satd. Flow (perm)				1665	1563	1471		5036	1535		4869	
Peak-hour factor, PHF	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94
Adj. Flow (vph)	0	0	0	404	11	259	0	386	195	0	1297	309
RTOR Reduction (vph)	0	0	0	0	20	145	0	0	0	0	49	0
Lane Group Flow (vph)	0	0	0	234	210	65	0	386	195	0	1557	0
Confl. Peds. (#/hr)	1					1	2		1	1		2
Confl. Bikes (#/hr)									2			1
Heavy Vehicles (%)	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%
Turn Type				Split		Perm			Free			
Protected Phases				8	8			2			6	
Permitted Phases						8			Free			
Actuated Green, G (s)				14.7	14.7	14.7		24.6	47.3		24.6	
Effective Green, g (s)				14.7	14.7	14.7		24.6	47.3		24.6	
Actuated g/C Ratio				0.31	0.31	0.31		0.52	1.00		0.52	
Clearance Time (s)				4.0	4.0	4.0		4.0			4.0	
Vehicle Extension (s)				3.0	3.0	3.0		3.0			3.0	
Lane Grp Cap (vph)				517	486	457		2619	1535		2532	
v/s Ratio Prot				c0.14	0.13			0.08			c0.32	
v/s Ratio Perm						0.04			0.13			
v/c Ratio				0.45	0.43	0.14		0.15	0.13		0.61	
Uniform Delay, d1				13.1	13.0	11.8		5.9	0.0		8.0	
Progression Factor				1.00	1.00	1.00		1.00	1.00		1.00	
Incremental Delay, d2				0.6	0.6	0.1		0.0	0.2		0.4	
Delay (s)				13.7	13.6	11.9		5.9	0.2		8.5	
Level of Service				B	B	B		A	A		A	
Approach Delay (s)		0.0			13.1			4.0			8.5	
Approach LOS		A			B			A			A	

Intersection Summary			
HCM Average Control Delay	8.6	HCM Level of Service	A
HCM Volume to Capacity ratio	0.55		
Actuated Cycle Length (s)	47.3	Sum of lost time (s)	8.0
Intersection Capacity Utilization	50.4%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	100	0	434	0	0	0	0	445	360	0	710	900
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0		4.0					4.0			4.0	4.0
Lane Util. Factor	1.00		1.00					0.91			0.95	1.00
Frpb, ped/bikes	1.00		1.00					0.99			1.00	0.98
Flpb, ped/bikes	1.00		1.00					1.00			1.00	1.00
Frt	1.00		0.85					0.93			1.00	0.85
Flt Protected	0.95		1.00					1.00			1.00	1.00
Satd. Flow (prot)	1752		1568					4646			3505	1536
Flt Permitted	0.95		1.00					1.00			1.00	1.00
Satd. Flow (perm)	1752		1568					4646			3505	1536
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	109	0	472	0	0	0	0	484	391	0	772	978
RTOR Reduction (vph)	0	0	38	0	0	0	0	237	0	0	0	0
Lane Group Flow (vph)	109	0	434	0	0	0	0	638	0	0	772	978
Confl. Peds. (#/hr)							1		3	3		1
Confl. Bikes (#/hr)									1			
Heavy Vehicles (%)	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%
Turn Type	Split		Perm									Free
Protected Phases	8	8						2			6	
Permitted Phases			8									Free
Actuated Green, G (s)	17.4		17.4					16.0			16.0	41.4
Effective Green, g (s)	17.4		17.4					16.0			16.0	41.4
Actuated g/C Ratio	0.42		0.42					0.39			0.39	1.00
Clearance Time (s)	4.0		4.0					4.0			4.0	
Vehicle Extension (s)	3.0		3.0					3.0			3.0	
Lane Grp Cap (vph)	736		659					1796			1355	1536
v/s Ratio Prot	0.06							0.14			0.22	
v/s Ratio Perm			0.28									c0.64
v/c Ratio	0.15		0.66					0.36			0.57	0.64
Uniform Delay, d1	7.4		9.6					9.0			10.0	0.0
Progression Factor	1.00		1.00					1.00			1.00	1.00
Incremental Delay, d2	0.1		2.4					0.1			0.6	2.0
Delay (s)	7.5		12.0					9.2			10.5	2.0
Level of Service	A		B					A			B	A
Approach Delay (s)		11.2			0.0			9.2			5.8	
Approach LOS		B			A			A			A	

Intersection Summary			
HCM Average Control Delay	7.7	HCM Level of Service	A
HCM Volume to Capacity ratio	0.64		
Actuated Cycle Length (s)	41.4	Sum of lost time (s)	0.0
Intersection Capacity Utilization	53.2%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	70	20	40	10	10	40	40	695	30	320	673	130
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0		4.0	4.0			4.0		4.0	4.0	
Lane Util. Factor		1.00		1.00	1.00			0.95		1.00	0.95	
Frpb, ped/bikes		1.00		1.00	0.99			1.00		1.00	1.00	
Flpb, ped/bikes		1.00		1.00	1.00			1.00		1.00	1.00	
Frt		0.96		1.00	0.88			0.99		1.00	0.98	
Flt Protected		0.97		0.95	1.00			1.00		0.95	1.00	
Satd. Flow (prot)		1705		1736	1592			3441		1736	3375	
Flt Permitted		1.00		0.67	1.00			0.87		0.95	1.00	
Satd. Flow (perm)		1751		1219	1592			3018		1736	3375	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	76	22	43	11	11	43	43	755	33	348	732	141
RTOR Reduction (vph)	0	16	0	0	37	0	0	3	0	0	10	0
Lane Group Flow (vph)	0	125	0	11	17	0	0	828	0	348	863	0
Confl. Peds. (#/hr)	3					3	2					2
Confl. Bikes (#/hr)												1
Heavy Vehicles (%)	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%
Turn Type	Perm			Perm			Perm			Prot		
Protected Phases		3			4			2		1	6	
Permitted Phases	3			4			2					
Actuated Green, G (s)		2.2		8.4	8.4			21.8		11.9	37.7	
Effective Green, g (s)		2.2		8.4	8.4			21.8		11.9	37.7	
Actuated g/C Ratio		0.04		0.14	0.14			0.36		0.20	0.63	
Clearance Time (s)		4.0		4.0	4.0			4.0		4.0	4.0	
Vehicle Extension (s)		3.0		3.0	3.0			3.0		3.0	3.0	
Lane Grp Cap (vph)		64		170	222			1091		343	2110	
v/s Ratio Prot					c0.01					c0.20	0.26	
v/s Ratio Perm		c0.07		0.01				c0.27				
v/c Ratio		1.95		0.06	0.08			0.76		1.01	0.41	
Uniform Delay, d1		29.0		22.5	22.6			16.9		24.2	5.7	
Progression Factor		1.00		1.00	1.00			1.00		1.00	1.00	
Incremental Delay, d2		477.8		0.2	0.1			3.1		52.3	0.1	
Delay (s)		506.9		22.7	22.7			20.0		76.5	5.8	
Level of Service		F		C	C			C		E	A	
Approach Delay (s)		506.9			22.7			20.0			26.0	
Approach LOS		F			C			C			C	

Intersection Summary			
HCM Average Control Delay	53.7	HCM Level of Service	D
HCM Volume to Capacity ratio	0.76		
Actuated Cycle Length (s)	60.3	Sum of lost time (s)	16.0
Intersection Capacity Utilization	68.2%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	300	105	20	26	26	95	20	400	175	323	150	230
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0		4.0	4.0		4.0	4.0	
Lane Util. Factor	1.00	0.95	1.00	1.00	0.95		1.00	0.95		1.00	0.95	
Frpb, ped/bikes	1.00	1.00	1.00	1.00	0.96		1.00	1.00		1.00	0.99	
Flpb, ped/bikes	1.00	1.00	1.00	1.00	1.00		1.00	1.00		1.00	1.00	
Frt	1.00	1.00	0.85	1.00	0.88		1.00	0.95		1.00	0.91	
Flt Protected	0.95	1.00	1.00	0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1770	3539	1583	1770	3010		1770	3364		1770	3186	
Flt Permitted	0.95	1.00	1.00	0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (perm)	1770	3539	1583	1770	3010		1770	3364		1770	3186	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	326	114	22	28	28	103	22	435	190	351	163	250
RTOR Reduction (vph)	0	0	15	0	88	0	0	52	0	0	145	0
Lane Group Flow (vph)	326	114	7	28	43	0	22	573	0	351	268	0
Confl. Peds. (#/hr)	3					3	4					4
Confl. Bikes (#/hr)						20			1			1
Turn Type	Prot		Perm	Prot			Prot			Prot		
Protected Phases	7	4		3	8		5	2		1	6	
Permitted Phases			4									
Actuated Green, G (s)	17.1	26.9	26.9	1.9	11.7		1.9	17.7		18.1	33.9	
Effective Green, g (s)	17.1	26.9	26.9	1.9	11.7		1.9	17.7		18.1	33.9	
Actuated g/C Ratio	0.21	0.33	0.33	0.02	0.15		0.02	0.22		0.22	0.42	
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0		4.0	4.0		4.0	4.0	
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	376	1181	528	42	437		42	739		397	1340	
v/s Ratio Prot	c0.18	c0.03		0.02	0.01		0.01	c0.17		c0.20	0.08	
v/s Ratio Perm			0.00									
v/c Ratio	0.87	0.10	0.01	0.67	0.10		0.52	0.78		0.88	0.20	
Uniform Delay, d1	30.7	18.5	18.0	39.0	29.9		38.9	29.6		30.2	14.8	
Progression Factor	1.00	1.00	1.00	1.00	1.00		1.00	1.00		1.00	1.00	
Incremental Delay, d2	18.5	0.0	0.0	33.4	0.1		11.3	5.1		20.2	0.1	
Delay (s)	49.2	18.5	18.0	72.4	30.0		50.2	34.7		50.4	14.8	
Level of Service	D	B	B	E	C		D	C		D	B	
Approach Delay (s)		40.1			37.4			35.2			31.2	
Approach LOS		D			D			D			C	

Intersection Summary			
HCM Average Control Delay	35.0	HCM Level of Service	C
HCM Volume to Capacity ratio	0.67		
Actuated Cycle Length (s)	80.6	Sum of lost time (s)	12.0
Intersection Capacity Utilization	70.1%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Volume (veh/h)	519	140	145	185	100	261
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	564	152	158	201	109	284
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)				1133		
pX, platoon unblocked						
vC, conflicting volume			716		1080	564
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			716		1080	564
tC, single (s)			4.1		6.5	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.6	3.3
p0 queue free %			82		44	45
cM capacity (veh/h)			871		192	519

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	NB 1	NB 2
Volume Total	564	152	158	201	109	284
Volume Left	0	0	158	0	109	0
Volume Right	0	152	0	0	0	284
cSH	1700	1700	871	1700	192	519
Volume to Capacity	0.33	0.09	0.18	0.12	0.56	0.55
Queue Length 95th (ft)	0	0	16	0	76	81
Control Delay (s)	0.0	0.0	10.0	0.0	45.6	20.0
Lane LOS			B		E	C
Approach Delay (s)	0.0		4.4		27.1	
Approach LOS					D	

Intersection Summary			
Average Delay	8.3		
Intersection Capacity Utilization	50.9%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	80	333	30	20	96	171	20	30	30	440	40	300
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0		4.0	4.0			4.0	
Lane Util. Factor	1.00	1.00		1.00	1.00		1.00	1.00			1.00	
Frpb, ped/bikes	1.00	1.00		1.00	1.00		1.00	0.99			1.00	
Flpb, ped/bikes	1.00	1.00		1.00	1.00		1.00	1.00			1.00	
Frt	1.00	0.99		1.00	0.90		1.00	0.93			0.95	
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00			0.97	
Satd. Flow (prot)	1671	1783		1671	1635		1671	1609			1647	
Flt Permitted	0.95	1.00		0.95	1.00		0.41	1.00			0.79	
Satd. Flow (perm)	1671	1783		1671	1635		717	1609			1335	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	87	362	33	22	104	186	22	33	33	478	43	326
RTOR Reduction (vph)	0	2	0	0	56	0	0	13	0	0	17	0
Lane Group Flow (vph)	87	393	0	22	234	0	22	53	0	0	830	0
Confl. Peds. (#/hr)									2	2		
Confl. Bikes (#/hr)									2			
Heavy Vehicles (%)	8%	5%	8%	8%	5%	5%	8%	8%	8%	5%	8%	8%
Turn Type	Prot			Prot			Perm			Perm		
Protected Phases	7	4		3	8			2			6	
Permitted Phases							2			6		
Actuated Green, G (s)	7.7	29.4		3.2	24.9		67.3	67.3			67.3	
Effective Green, g (s)	7.7	29.4		3.2	24.9		67.3	67.3			67.3	
Actuated g/C Ratio	0.07	0.26		0.03	0.22		0.60	0.60			0.60	
Clearance Time (s)	4.0	4.0		4.0	4.0		4.0	4.0			4.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0			3.0	
Lane Grp Cap (vph)	115	468		48	364		431	968			803	
v/s Ratio Prot	c0.05	c0.22		0.01	0.14			0.03				
v/s Ratio Perm							0.03				c0.62	
v/c Ratio	0.76	0.84		0.46	0.64		0.05	0.05			1.03	
Uniform Delay, d1	51.2	39.0		53.5	39.5		9.2	9.2			22.3	
Progression Factor	1.00	1.00		1.00	1.00		1.00	1.00			1.00	
Incremental Delay, d2	24.3	12.5		6.8	3.9		0.0	0.0			40.7	
Delay (s)	75.5	51.5		60.3	43.3		9.2	9.2			63.0	
Level of Service	E	D		E	D		A	A			E	
Approach Delay (s)		55.8			44.5			9.2			63.0	
Approach LOS		E			D			A			E	

Intersection Summary			
HCM Average Control Delay	54.9	HCM Level of Service	D
HCM Volume to Capacity ratio	0.95		
Actuated Cycle Length (s)	111.9	Sum of lost time (s)	8.0
Intersection Capacity Utilization	84.2%	ICU Level of Service	E
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Volume (veh/h)	594	210	43	144	143	218
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	646	228	47	157	155	237
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)	322					
pX, platoon unblocked			0.80		0.80	0.80
vC, conflicting volume			646		1010	760
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			428		885	571
tC, single (s)			4.2		6.5	6.3
tC, 2 stage (s)						
tF (s)			2.3		3.6	3.4
p0 queue free %			95		33	42
cM capacity (veh/h)			877		232	406

Direction, Lane #	EB 1	WB 1	WB 2	NB 1
Volume Total	874	47	157	392
Volume Left	0	47	0	155
Volume Right	228	0	0	237
cSH	1700	877	1700	313
Volume to Capacity	0.51	0.05	0.09	1.25
Queue Length 95th (ft)	0	4	0	451
Control Delay (s)	0.0	9.3	0.0	172.1
Lane LOS		A		F
Approach Delay (s)	0.0	2.1		172.1
Approach LOS				F

Intersection Summary			
Average Delay	46.3		
Intersection Capacity Utilization	72.0%	ICU Level of Service	C
Analysis Period (min)	15		

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Volume (veh/h)	294	377	587	365	67	96
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	320	410	638	397	73	104
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume			729		2197	524
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			729		2197	524
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			26		0	81
cM capacity (veh/h)			861		13	547

Direction, Lane #	EB 1	WB 1	WB 2	NB 1
Volume Total	729	638	397	177
Volume Left	0	638	0	73
Volume Right	410	0	0	104
cSH	1700	861	1700	30
Volume to Capacity	0.43	0.74	0.23	6.00
Queue Length 95th (ft)	0	172	0	Err
Control Delay (s)	0.0	20.1	0.0	Err
Lane LOS		C		F
Approach Delay (s)	0.0	12.4		Err
Approach LOS				F

Intersection Summary			
Average Delay	919.2		
Intersection Capacity Utilization	90.7%	ICU Level of Service	E
Analysis Period (min)	15		

Intersection	
Intersection Delay (sec/veh)	59.8
Intersection LOS	F

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Volume (vph)	10	10	10	420	10	30	30	942	170	203	207	10
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Heavy Vehicles(%)	4	4	4	4	4	4	4	4	4	4	4	4
Movement Flow Rate	11	11	11	457	11	33	33	1024	185	221	225	11
Number of Lanes	0	1	0	1	1	0	1	2	0	1	2	0

Approach	EB	WB	NB	SB
Opposing Approach	WB	EB	SB	NB
Opposing Lanes	2	1	3	3
Conflicting Approach Left	SB	NB	EB	WB
Conflicting Lanes Left	3	3	1	2
Conflicting Approach Right	NB	SB	WB	EB
Conflicting Lanes Right	3	3	2	1
HCM Control Delay	14.8	72.6	70.3	20.6
HCM LOS	B	F	F	C

Lane	NBLn1	NBLn2	NBLn3	EBLn1	WBLn1	WBLn2	SBLn1	SBLn2	SBLn3
Volume Left (%)	100%	0%	0%	33%	100%	0%	100%	0%	0%
Volume Thru (%)	0%	100%	65%	33%	0%	25%	0%	100%	87%
Volume Right (%)	0%	0%	35%	33%	0%	75%	0%	0%	13%
Sign Control	Stop	Stop	Stop	Stop	Stop	Stop	Stop	Stop	Stop
Traffic Volume by Lane	30	628	484	30	420	40	203	138	79
Left Turning Volume	0	628	314	10	0	10	0	138	69
Through Volume	0	0	170	10	0	30	0	0	10
Right Turning Volume	30	0	0	10	420	0	203	0	0
Lane Flow Rate	33	683	526	33	457	43	221	150	86
Geometry Group	8	8	8	8	8	8	8	8	8
Degree of Utilization, X	0.08	1	1	0.098	1	0.104	0.59	0.381	0.216
Departure Headway, Hd	8.799	8.301	8.056	10.852	9.612	8.591	9.633	9.134	9.046
Convergence(Y/N)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Capacity	408	444	452	331	379	417	375	396	398
Service Time	6.546	6.049	5.804	8.599	7.365	6.345	7.356	6.857	6.768
HCM Lane V/C Ratio	0.081	1.538	1.164	0.1	1.206	0.103	0.589	0.379	0.216
HCM Control Delay	12.3	72.3	71.2	14.8	78.3	12.3	25.3	17.4	14.2
HCM Lane LOS	B	F	F	B	F	B	D	C	B
HCM 95th Percentile Queue	0.3	98.5	100	0.3	91.5	0.3	4.3	1.8	0.8

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	0	0	538	10	80	20	617	0	0	604	530
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)				4.0	4.0		4.0	4.0			4.0	
Lane Util. Factor				1.00	1.00		1.00	0.95			0.95	
Frpb, ped/bikes				1.00	1.00		1.00	1.00			0.99	
Flpb, ped/bikes				1.00	1.00		1.00	1.00			1.00	
Frt				1.00	0.87		1.00	1.00			0.93	
Flt Protected				0.95	1.00		0.95	1.00			1.00	
Satd. Flow (prot)				1736	1584		1736	3471			3195	
Flt Permitted				0.95	1.00		0.95	1.00			1.00	
Satd. Flow (perm)				1736	1584		1736	3471			3195	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	0	0	0	585	11	87	22	671	0	0	657	576
RTOR Reduction (vph)	0	0	0	0	52	0	0	0	0	0	121	0
Lane Group Flow (vph)	0	0	0	585	46	0	22	671	0	0	1112	0
Confl. Peds. (#/hr)							1					1
Confl. Bikes (#/hr)									2			1
Heavy Vehicles (%)	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%
Turn Type				Split			Prot					
Protected Phases				8	8		5	2			6	
Permitted Phases												
Actuated Green, G (s)				38.6	38.6		4.4	49.0			40.6	
Effective Green, g (s)				38.6	38.6		4.4	49.0			40.6	
Actuated g/C Ratio				0.40	0.40		0.05	0.51			0.42	
Clearance Time (s)				4.0	4.0		4.0	4.0			4.0	
Vehicle Extension (s)				3.0	3.0		3.0	3.0			3.0	
Lane Grp Cap (vph)				701	640		80	1779			1357	
v/s Ratio Prot				c0.34	0.03		0.01	c0.19			c0.35	
v/s Ratio Perm												
v/c Ratio				0.83	0.07		0.28	0.38			0.82	
Uniform Delay, d1				25.6	17.5		44.1	14.1			24.3	
Progression Factor				1.00	1.00		1.00	1.00			1.00	
Incremental Delay, d2				8.5	0.0		1.9	0.1			4.0	
Delay (s)				34.1	17.6		45.9	14.2			28.2	
Level of Service				C	B		D	B			C	
Approach Delay (s)		0.0			31.7			15.2			28.2	
Approach LOS		A			C			B			C	

Intersection Summary			
HCM Average Control Delay	25.7	HCM Level of Service	C
HCM Volume to Capacity ratio	0.81		
Actuated Cycle Length (s)	95.6	Sum of lost time (s)	12.0
Intersection Capacity Utilization	70.2%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	10	450	160	834	150	30	60	70	567	60	140	20
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0		4.0	4.0	4.0		4.0	
Lane Util. Factor	1.00	0.95		0.91	0.91		0.95	0.95	1.00		1.00	
Frpb, ped/bikes	1.00	1.00		1.00	1.00		1.00	1.00	0.99		1.00	
Flpb, ped/bikes	1.00	1.00		1.00	1.00		1.00	1.00	1.00		1.00	
Frt	1.00	0.96		1.00	0.99		1.00	1.00	0.85		0.99	
Flt Protected	0.95	1.00		0.95	0.97		0.95	1.00	1.00		0.99	
Satd. Flow (prot)	1752	3355		1595	3215		1665	1745	1546		1795	
Flt Permitted	0.95	1.00		0.95	0.97		0.95	1.00	1.00		0.99	
Satd. Flow (perm)	1752	3355		1595	3215		1665	1745	1546		1795	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	11	489	174	907	163	33	65	76	616	65	152	22
RTOR Reduction (vph)	0	33	0	0	3	0	0	0	527	0	3	0
Lane Group Flow (vph)	11	630	0	453	647	0	58	83	89	0	236	0
Confl. Peds. (#/hr)	1					1			2	2		
Confl. Bikes (#/hr)			1			1						1
Heavy Vehicles (%)	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%
Turn Type	Split			Split			Split		Perm	Split		
Protected Phases	4	4		8	8		2	2		6	6	
Permitted Phases									2			
Actuated Green, G (s)	18.1	18.1		29.2	29.2		13.2	13.2	13.2		15.3	
Effective Green, g (s)	18.1	18.1		29.2	29.2		13.2	13.2	13.2		15.3	
Actuated g/C Ratio	0.20	0.20		0.32	0.32		0.14	0.14	0.14		0.17	
Clearance Time (s)	4.0	4.0		4.0	4.0		4.0	4.0	4.0		4.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0	3.0		3.0	
Lane Grp Cap (vph)	345	661		507	1023		239	251	222		299	
v/s Ratio Prot	0.01	c0.19		c0.28	0.20		0.03	0.05			c0.13	
v/s Ratio Perm									c0.06			
v/c Ratio	0.03	0.95		0.89	0.85dl		0.24	0.33	0.40		0.79	
Uniform Delay, d1	29.8	36.4		29.8	26.7		34.9	35.3	35.7		36.7	
Progression Factor	1.00	1.00		1.00	1.00		1.00	1.00	1.00		1.00	
Incremental Delay, d2	0.0	23.9		17.9	1.3		0.5	0.8	1.2		12.9	
Delay (s)	29.8	60.3		47.7	28.0		35.4	36.1	36.9		49.6	
Level of Service	C	E		D	C		D	D	D		D	
Approach Delay (s)		59.8			36.1			36.7			49.6	
Approach LOS		E			D			D			D	

Intersection Summary			
HCM Average Control Delay	43.2	HCM Level of Service	D
HCM Volume to Capacity ratio	0.80		
Actuated Cycle Length (s)	91.8	Sum of lost time (s)	16.0
Intersection Capacity Utilization	74.8%	ICU Level of Service	D
Analysis Period (min)	15		

dl Defacto Left Lane. Recode with 1 though lane as a left lane.
c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	907	250	160	385	0	0	0	0	510	40	619
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0			4.0						4.0	
Lane Util. Factor		0.95			0.95						1.00	
Frpb, ped/bikes		0.99			1.00						1.00	
Flpb, ped/bikes		1.00			1.00						1.00	
Frt		0.97			1.00						0.93	
Flt Protected		1.00			0.99						0.98	
Satd. Flow (prot)		3398			3488						1693	
Flt Permitted		1.00			0.56						0.98	
Satd. Flow (perm)		3398			1996						1693	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	0	986	272	174	418	0	0	0	0	554	43	673
RTOR Reduction (vph)	0	28	0	0	0	0	0	0	0	0	45	0
Lane Group Flow (vph)	0	1230	0	0	592	0	0	0	0	0	1225	0
Confl. Peds. (#/hr)	5		9	9		5						
Confl. Bikes (#/hr)						2						
Turn Type				Perm						Split		
Protected Phases		4			8					6	6	
Permitted Phases				8								
Actuated Green, G (s)		31.0			31.0						51.0	
Effective Green, g (s)		31.0			31.0						51.0	
Actuated g/C Ratio		0.34			0.34						0.57	
Clearance Time (s)		4.0			4.0						4.0	
Vehicle Extension (s)		3.0			3.0						3.0	
Lane Grp Cap (vph)		1170			688						959	
v/s Ratio Prot		c0.36									c0.72	
v/s Ratio Perm					0.30							
v/c Ratio		1.05			2.10dl						1.28	
Uniform Delay, d1		29.5			27.5						19.5	
Progression Factor		1.00			0.97						1.00	
Incremental Delay, d2		40.8			12.7						132.9	
Delay (s)		70.3			39.4						152.4	
Level of Service		E			D						F	
Approach Delay (s)		70.3			39.4			0.0			152.4	
Approach LOS		E			D			A			F	

Intersection Summary			
HCM Average Control Delay	97.9	HCM Level of Service	F
HCM Volume to Capacity ratio	1.19		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	132.4%	ICU Level of Service	H
Analysis Period (min)	15		

dl Defacto Left Lane. Recode with 1 though lane as a left lane.
c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	331	1086	0	0	465	480	80	10	120	0	0	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0			4.0		4.0	4.0	4.0			
Lane Util. Factor		0.95			0.95		0.95	0.95	1.00			
Frpb, ped/bikes		1.00			0.99		1.00	1.00	1.00			
Flpb, ped/bikes		1.00			1.00		1.00	1.00	1.00			
Frt		1.00			0.92		1.00	1.00	0.85			
Flt Protected		0.99			1.00		0.95	0.96	1.00			
Satd. Flow (prot)		3498			3227		1681	1704	1583			
Flt Permitted		0.56			1.00		0.95	0.96	1.00			
Satd. Flow (perm)		1994			3227		1681	1704	1583			
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	360	1180	0	0	505	522	87	11	130	0	0	0
RTOR Reduction (vph)	0	0	0	0	139	0	0	0	104	0	0	0
Lane Group Flow (vph)	0	1540	0	0	888	0	49	49	26	0	0	0
Confl. Peds. (#/hr)	5		7	7		5			1	1		
Confl. Bikes (#/hr)						3						
Turn Type	Perm						Split		Prot			
Protected Phases		4			8		2	2	2			
Permitted Phases	4											
Actuated Green, G (s)		66.0			66.0		16.0	16.0	16.0			
Effective Green, g (s)		66.0			66.0		16.0	16.0	16.0			
Actuated g/C Ratio		0.73			0.73		0.18	0.18	0.18			
Clearance Time (s)		4.0			4.0		4.0	4.0	4.0			
Vehicle Extension (s)		3.0			3.0		3.0	3.0	3.0			
Lane Grp Cap (vph)		1462			2366		299	303	281			
v/s Ratio Prot					0.28		c0.03	0.03	0.02			
v/s Ratio Perm		c0.77										
v/c Ratio		1.05			0.38		0.16	0.16	0.09			
Uniform Delay, d1		12.0			4.4		31.3	31.3	30.9			
Progression Factor		0.75			1.00		1.00	1.00	1.00			
Incremental Delay, d2		26.0			0.5		1.2	1.1	0.6			
Delay (s)		35.0			4.9		32.5	32.5	31.6			
Level of Service		C			A		C	C	C			
Approach Delay (s)		35.0			4.9			32.0			0.0	
Approach LOS		C			A			C			A	

Intersection Summary			
HCM Average Control Delay	23.7	HCM Level of Service	C
HCM Volume to Capacity ratio	0.88		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	106.3%	ICU Level of Service	G
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Volume (vph)	519	140	145	185	100	261
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00
Frpb, ped/bikes	1.00	0.98	1.00	1.00	1.00	1.00
Flpb, ped/bikes	1.00	1.00	1.00	1.00	1.00	1.00
Frt	1.00	0.85	1.00	1.00	1.00	0.85
Flt Protected	1.00	1.00	0.95	1.00	0.95	1.00
Satd. Flow (prot)	1810	1464	1719	1810	1671	1538
Flt Permitted	1.00	1.00	0.35	1.00	0.95	1.00
Satd. Flow (perm)	1810	1464	637	1810	1671	1538
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	564	152	158	201	109	284
RTOR Reduction (vph)	0	78	0	0	0	166
Lane Group Flow (vph)	564	74	158	201	109	118
Confl. Bikes (#/hr)		1				
Heavy Vehicles (%)	5%	8%	5%	5%	8%	5%
Turn Type		Perm	Perm			Perm
Protected Phases	4			8	2	
Permitted Phases		4	8			2
Actuated Green, G (s)	15.3	15.3	15.3	15.3	8.2	8.2
Effective Green, g (s)	15.3	15.3	15.3	15.3	8.2	8.2
Actuated g/C Ratio	0.49	0.49	0.49	0.49	0.26	0.26
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	879	711	309	879	435	400
v/s Ratio Prot	c0.31			0.11	0.07	
v/s Ratio Perm		0.05	0.25			c0.08
v/c Ratio	0.64	0.10	0.51	0.23	0.25	0.29
Uniform Delay, d1	6.1	4.4	5.5	4.7	9.2	9.3
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	1.6	0.1	1.4	0.1	0.3	0.4
Delay (s)	7.7	4.5	7.0	4.8	9.5	9.7
Level of Service	A	A	A	A	A	A
Approach Delay (s)	7.0			5.8	9.7	
Approach LOS	A			A	A	

Intersection Summary			
HCM Average Control Delay	7.4	HCM Level of Service	A
HCM Volume to Capacity ratio	0.52		
Actuated Cycle Length (s)	31.5	Sum of lost time (s)	8.0
Intersection Capacity Utilization	50.9%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Volume (vph)	594	210	43	144	143	218
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0		4.0	4.0	4.0	
Lane Util. Factor	1.00		1.00	1.00	1.00	
Frt	0.96		1.00	1.00	0.92	
Flt Protected	1.00		0.95	1.00	0.98	
Satd. Flow (prot)	1733		1671	1810	1611	
Flt Permitted	1.00		0.20	1.00	0.98	
Satd. Flow (perm)	1733		356	1810	1611	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	646	228	47	157	155	237
RTOR Reduction (vph)	12	0	0	0	65	0
Lane Group Flow (vph)	862	0	47	157	327	0
Heavy Vehicles (%)	5%	8%	8%	5%	8%	5%
Turn Type			Perm			
Protected Phases	4			8	2	
Permitted Phases			8			
Actuated Green, G (s)	60.1		60.1	60.1	21.9	
Effective Green, g (s)	60.1		60.1	60.1	21.9	
Actuated g/C Ratio	0.67		0.67	0.67	0.24	
Clearance Time (s)	4.0		4.0	4.0	4.0	
Vehicle Extension (s)	3.0		3.0	3.0	3.0	
Lane Grp Cap (vph)	1157		238	1209	392	
v/s Ratio Prot	c0.50			0.09	c0.20	
v/s Ratio Perm			0.13			
v/c Ratio	0.74		0.20	0.13	0.83	
Uniform Delay, d1	9.9		5.7	5.4	32.3	
Progression Factor	0.87		1.00	1.00	1.00	
Incremental Delay, d2	1.9		1.9	0.2	14.1	
Delay (s)	10.5		7.6	5.7	46.4	
Level of Service	B		A	A	D	
Approach Delay (s)	10.5			6.1	46.4	
Approach LOS	B			A	D	

Intersection Summary			
HCM Average Control Delay	19.5	HCM Level of Service	B
HCM Volume to Capacity ratio	0.77		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	72.0%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Volume (vph)	294	377	587	365	67	96
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0		4.0	4.0	4.0	4.0
Lane Util. Factor	1.00		1.00	1.00	1.00	1.00
Frt	0.92		1.00	1.00	1.00	0.85
Flt Protected	1.00		0.95	1.00	0.95	1.00
Satd. Flow (prot)	1672		1719	1810	1719	1538
Flt Permitted	1.00		0.10	1.00	0.95	1.00
Satd. Flow (perm)	1672		190	1810	1719	1538
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	320	410	638	397	73	104
RTOR Reduction (vph)	48	0	0	0	0	93
Lane Group Flow (vph)	682	0	638	397	73	11
Heavy Vehicles (%)	5%	5%	5%	5%	5%	5%
Turn Type			pm+pt			Perm
Protected Phases	4		3	8	2	
Permitted Phases			8			2
Actuated Green, G (s)	34.1		66.1	66.1	8.8	8.8
Effective Green, g (s)	34.1		66.1	66.1	8.8	8.8
Actuated g/C Ratio	0.41		0.80	0.80	0.11	0.11
Clearance Time (s)	4.0		4.0	4.0	4.0	4.0
Vehicle Extension (s)	3.0		3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	688		668	1443	182	163
v/s Ratio Prot	0.41		c0.32	0.22	c0.04	
v/s Ratio Perm			c0.44			0.01
v/c Ratio	0.99		0.96	0.28	0.40	0.07
Uniform Delay, d1	24.2		22.3	2.2	34.6	33.4
Progression Factor	1.00		1.00	1.00	1.00	1.00
Incremental Delay, d2	31.9		24.1	0.1	1.4	0.2
Delay (s)	56.1		46.4	2.3	36.0	33.5
Level of Service	E		D	A	D	C
Approach Delay (s)	56.1			29.5	34.6	
Approach LOS	E			C	C	

Intersection Summary			
HCM Average Control Delay	40.0	HCM Level of Service	D
HCM Volume to Capacity ratio	0.87		
Actuated Cycle Length (s)	82.9	Sum of lost time (s)	8.0
Intersection Capacity Utilization	84.8%	ICU Level of Service	E
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	10	10	10	420	10	30	30	942	170	203	207	10
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Lane Util. Factor		1.00		1.00	1.00		1.00	0.95		0.97	1.00	
Frpb, ped/bikes		1.00		1.00	1.00		1.00	1.00		1.00	1.00	
Flpb, ped/bikes		1.00		1.00	1.00		1.00	1.00		1.00	1.00	
Frt		0.95		1.00	0.89		1.00	0.98		1.00	0.99	
Flt Protected		0.98		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)		1709		1736	1621		1736	3391		3367	1812	
Flt Permitted		0.94		0.74	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (perm)		1640		1344	1621		1736	3391		3367	1812	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	11	11	11	457	11	33	33	1024	185	221	225	11
RTOR Reduction (vph)	0	7	0	0	21	0	0	16	0	0	2	0
Lane Group Flow (vph)	0	26	0	457	23	0	33	1193	0	221	234	0
Confl. Bikes (#/hr)			1									1
Heavy Vehicles (%)	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%
Turn Type	Perm			Perm			Prot			Prot		
Protected Phases		4			8		5	2		1	6	
Permitted Phases	4			8								
Actuated Green, G (s)		31.8		31.8	31.8		3.4	35.9		7.1	39.6	
Effective Green, g (s)		31.8		31.8	31.8		3.4	35.9		7.1	39.6	
Actuated g/C Ratio		0.37		0.37	0.37		0.04	0.41		0.08	0.46	
Clearance Time (s)		4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Vehicle Extension (s)		3.0		3.0	3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)		601		492	594		68	1402		275	827	
v/s Ratio Prot					0.01		0.02	c0.35		c0.07	c0.13	
v/s Ratio Perm		0.02		c0.34								
v/c Ratio		0.04		0.93	0.04		0.49	0.85		0.80	0.28	
Uniform Delay, d1		17.7		26.4	17.7		40.8	23.0		39.2	14.7	
Progression Factor		1.00		1.00	1.00		1.00	1.00		1.00	1.00	
Incremental Delay, d2		0.0		23.9	0.0		5.4	5.2		15.5	0.2	
Delay (s)		17.7		50.3	17.7		46.2	28.2		54.7	14.9	
Level of Service		B		D	B		D	C		D	B	
Approach Delay (s)		17.7			47.4			28.7			34.1	
Approach LOS		B			D			C			C	

Intersection Summary			
HCM Average Control Delay	33.8	HCM Level of Service	C
HCM Volume to Capacity ratio	0.91		
Actuated Cycle Length (s)	86.8	Sum of lost time (s)	16.0
Intersection Capacity Utilization	77.2%	ICU Level of Service	D
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	907	250	160	385	0	0	0	0	510	40	619
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0			4.0						4.0	4.0
Lane Util. Factor		0.95			0.95						1.00	1.00
Frpb, ped/bikes		0.99			1.00						1.00	1.00
Flpb, ped/bikes		1.00			1.00						1.00	1.00
Frt		0.97			1.00						1.00	0.85
Flt Protected		1.00			0.99						0.96	1.00
Satd. Flow (prot)		3398			3486						1780	1583
Flt Permitted		1.00			0.52						0.96	1.00
Satd. Flow (perm)		3398			1837						1780	1583
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	0	986	272	174	418	0	0	0	0	554	43	673
RTOR Reduction (vph)	0	28	0	0	0	0	0	0	0	0	0	203
Lane Group Flow (vph)	0	1230	0	0	592	0	0	0	0	0	597	470
Confl. Peds. (#/hr)	5		9	9		5						
Confl. Bikes (#/hr)						2						
Turn Type				Perm						Split		Perm
Protected Phases		4			8					6	6	
Permitted Phases				8								6
Actuated Green, G (s)		44.0			44.0						38.0	38.0
Effective Green, g (s)		44.0			44.0						38.0	38.0
Actuated g/C Ratio		0.49			0.49						0.42	0.42
Clearance Time (s)		4.0			4.0						4.0	4.0
Vehicle Extension (s)		3.0			3.0						3.0	3.0
Lane Grp Cap (vph)		1661			898						752	668
v/s Ratio Prot		c0.36									c0.34	
v/s Ratio Perm					0.32							0.30
v/c Ratio		0.74			1.79dl						0.79	0.70
Uniform Delay, d1		18.4			17.3						22.6	21.4
Progression Factor		1.00			1.07						1.00	1.00
Incremental Delay, d2		3.0			3.6						8.4	6.1
Delay (s)		21.4			22.1						31.0	27.5
Level of Service		C			C						C	C
Approach Delay (s)		21.4			22.1			0.0			29.2	
Approach LOS		C			C			A			C	

Intersection Summary			
HCM Average Control Delay	24.7	HCM Level of Service	C
HCM Volume to Capacity ratio	0.77		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	94.4%	ICU Level of Service	F
Analysis Period (min)	15		

dl Defacto Left Lane. Recode with 1 though lane as a left lane.
c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	120	620	68	240	420	220	150	1131	320	210	506	70
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	4.0	4.0	3.0	4.0	4.0	3.0	3.0	3.0	3.0	3.0	
Lane Util. Factor	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	
Frpb, ped/bikes	1.00	1.00	0.96	1.00	1.00	0.98	1.00	1.00	0.92	1.00	1.00	
Flpb, ped/bikes	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	0.98	
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	
Satd. Flow (prot)	1770	3539	1525	1770	3539	1553	1770	3539	1450	1770	3468	
Flt Permitted	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	
Satd. Flow (perm)	1770	3539	1525	1770	3539	1553	1770	3539	1450	1770	3468	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	130	674	74	261	457	239	163	1229	348	228	550	76
RTOR Reduction (vph)	0	0	15	0	0	97	0	0	90	0	9	0
Lane Group Flow (vph)	130	674	59	261	457	142	163	1229	258	228	617	0
Confl. Peds. (#/hr)	5		19	19		5	4		14	14		4
Confl. Bikes (#/hr)						1			100			
Turn Type	Prot		Perm	Prot		Perm	Prot		Perm	Prot		
Protected Phases	5	2		1	6		3	8		7	4	
Permitted Phases			2			6			8			
Actuated Green, G (s)	10.2	23.4	23.4	15.0	26.2	26.2	13.7	42.1	42.1	13.0	41.4	
Effective Green, g (s)	10.2	23.4	23.4	15.0	26.2	26.2	13.7	42.1	42.1	13.0	41.4	
Actuated g/C Ratio	0.10	0.22	0.22	0.14	0.25	0.25	0.13	0.40	0.40	0.12	0.39	
Clearance Time (s)	5.0	4.0	4.0	3.0	4.0	4.0	3.0	3.0	3.0	3.0	3.0	
Vehicle Extension (s)	2.0	4.0	4.0	2.0	4.0	4.0	2.0	2.0	2.0	2.0	2.0	
Lane Grp Cap (vph)	170	778	335	249	871	382	228	1399	573	216	1348	
v/s Ratio Prot	0.07	c0.19		c0.15	c0.13		0.09	c0.35		c0.13	0.18	
v/s Ratio Perm			0.04			0.09			0.18			
v/c Ratio	0.76	0.87	0.18	1.05	0.52	0.37	0.71	0.88	0.45	1.06	0.46	
Uniform Delay, d1	47.0	40.0	33.7	45.8	34.8	33.3	44.5	29.8	23.7	46.8	24.2	
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	
Incremental Delay, d2	16.7	10.3	0.3	70.2	0.7	0.8	8.5	6.4	0.2	76.6	0.1	
Delay (s)	63.6	50.3	34.1	116.0	35.5	34.2	53.1	36.2	23.9	123.4	24.3	
Level of Service	E	D	C	F	D	C	D	D	C	F	C	
Approach Delay (s)		50.9			57.1			35.3			50.8	
Approach LOS		D			E			D			D	

Intersection Summary			
HCM Average Control Delay	46.1	HCM Level of Service	D
HCM Volume to Capacity ratio	0.91		
Actuated Cycle Length (s)	106.5	Sum of lost time (s)	14.0
Intersection Capacity Utilization	88.0%	ICU Level of Service	E
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	0	0	280	10	876	0	766	423	0	633	190
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)				4.0	4.0	4.0		4.0	4.0		4.0	
Lane Util. Factor				0.95	0.91	0.95		0.91	1.00		0.91	
Frt				1.00	0.86	0.85		1.00	0.85		0.97	
Flt Protected				0.95	1.00	1.00		1.00	1.00		1.00	
Satd. Flow (prot)				1698	1472	1519		5136	1599		4958	
Flt Permitted				0.95	1.00	1.00		1.00	1.00		1.00	
Satd. Flow (perm)				1698	1472	1519		5136	1599		4958	
Peak-hour factor, PHF	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94
Adj. Flow (vph)	0	0	0	298	11	932	0	815	450	0	673	202
RTOR Reduction (vph)	0	0	0	0	32	32	0	0	0	0	90	0
Lane Group Flow (vph)	0	0	0	268	456	453	0	815	450	0	785	0
Heavy Vehicles (%)	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%
Turn Type				Split		Perm			Free			
Protected Phases				8	8			2			6	
Permitted Phases						8			Free			
Actuated Green, G (s)				23.0	23.0	23.0		15.7	46.7		15.7	
Effective Green, g (s)				23.0	23.0	23.0		15.7	46.7		15.7	
Actuated g/C Ratio				0.49	0.49	0.49		0.34	1.00		0.34	
Clearance Time (s)				4.0	4.0	4.0		4.0			4.0	
Vehicle Extension (s)				3.0	3.0	3.0		3.0			3.0	
Lane Grp Cap (vph)				836	725	748		1727	1599		1667	
v/s Ratio Prot				0.16	c0.31			c0.16			0.16	
v/s Ratio Perm						0.30			0.28			
v/c Ratio				0.32	0.63	0.60		0.47	0.28		0.47	
Uniform Delay, d1				7.1	8.7	8.6		12.2	0.0		12.2	
Progression Factor				1.00	1.00	1.00		1.00	1.00		1.00	
Incremental Delay, d2				0.2	1.7	1.4		0.2	0.4		0.2	
Delay (s)				7.4	10.4	10.0		12.4	0.4		12.4	
Level of Service				A	B	A		B	A		B	
Approach Delay (s)		0.0			9.6			8.2			12.4	
Approach LOS		A			A			A			B	

Intersection Summary			
HCM Average Control Delay	9.8	HCM Level of Service	A
HCM Volume to Capacity ratio	0.56		
Actuated Cycle Length (s)	46.7	Sum of lost time (s)	8.0
Intersection Capacity Utilization	57.6%	ICU Level of Service	B
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	390	0	280	0	0	0	0	798	370	0	562	352
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0		4.0					4.0			4.0	4.0
Lane Util. Factor	1.00		1.00					0.91			0.95	1.00
Frpb, ped/bikes	1.00		1.00					0.99			1.00	0.98
Flpb, ped/bikes	1.00		1.00					1.00			1.00	1.00
Frt	1.00		0.85					0.95			1.00	0.85
Flt Protected	0.95		1.00					1.00			1.00	1.00
Satd. Flow (prot)	1770		1583					4806			3539	1549
Flt Permitted	0.95		1.00					1.00			1.00	1.00
Satd. Flow (perm)	1770		1583					4806			3539	1549
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	424	0	304	0	0	0	0	867	402	0	611	383
RTOR Reduction (vph)	0	0	72	0	0	0	0	124	0	0	0	0
Lane Group Flow (vph)	424	0	232	0	0	0	0	1145	0	0	611	383
Confl. Peds. (#/hr)							4		2	2		4
Confl. Bikes (#/hr)									3			
Turn Type	Split		Perm									Free
Protected Phases	8	8						2			6	
Permitted Phases			8									Free
Actuated Green, G (s)	17.1		17.1					19.4			19.4	44.5
Effective Green, g (s)	17.1		17.1					19.4			19.4	44.5
Actuated g/C Ratio	0.38		0.38					0.44			0.44	1.00
Clearance Time (s)	4.0		4.0					4.0			4.0	
Vehicle Extension (s)	3.0		3.0					3.0			3.0	
Lane Grp Cap (vph)	680		608					2095			1543	1549
v/s Ratio Prot	c0.24							c0.24			0.17	
v/s Ratio Perm			0.15									0.25
v/c Ratio	0.62		0.38					0.55			0.40	0.25
Uniform Delay, d1	11.1		9.9					9.3			8.6	0.0
Progression Factor	1.00		1.00					1.00			1.00	1.00
Incremental Delay, d2	1.8		0.4					0.3			0.2	0.4
Delay (s)	12.9		10.3					9.6			8.7	0.4
Level of Service	B		B					A			A	A
Approach Delay (s)		11.8			0.0			9.6			5.5	
Approach LOS		B			A			A			A	

Intersection Summary			
HCM Average Control Delay	8.8	HCM Level of Service	A
HCM Volume to Capacity ratio	0.58		
Actuated Cycle Length (s)	44.5	Sum of lost time (s)	8.0
Intersection Capacity Utilization	52.0%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	200	20	100	20	20	260	30	708	10	20	691	130
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0		4.0	4.0			4.0		4.0	4.0	
Lane Util. Factor		1.00		1.00	1.00			0.95		1.00	0.95	
Frpb, ped/bikes		0.99		1.00	0.99			1.00		1.00	1.00	
Flpb, ped/bikes		1.00		1.00	1.00			1.00		0.96	1.00	
Frt		0.96		1.00	0.86			1.00		1.00	0.98	
Flt Protected		0.97		0.95	1.00			1.00		0.95	1.00	
Satd. Flow (prot)		1695		1751	1568			3489		1681	3411	
Flt Permitted		1.00		0.55	1.00			0.90		0.95	1.00	
Satd. Flow (perm)		1748		1018	1568			3143		1681	3411	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	217	22	109	22	22	283	33	770	11	22	751	141
RTOR Reduction (vph)	0	17	0	0	221	0	0	1	0	0	13	0
Lane Group Flow (vph)	0	331	0	22	84	0	0	813	0	22	879	0
Confl. Peds. (#/hr)	1		3	3		1			5	5		
Confl. Bikes (#/hr)						1			2			1
Heavy Vehicles (%)	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%
Turn Type	Perm			Perm			Perm			Prot		
Protected Phases		3			4			2		1	6	
Permitted Phases	3			4			2					
Actuated Green, G (s)		2.2		11.7	11.7			22.7		0.9	27.6	
Effective Green, g (s)		2.2		11.7	11.7			22.7		0.9	27.6	
Actuated g/C Ratio		0.04		0.22	0.22			0.42		0.02	0.52	
Clearance Time (s)		4.0		4.0	4.0			4.0		4.0	4.0	
Vehicle Extension (s)		3.0		3.0	3.0			3.0		3.0	3.0	
Lane Grp Cap (vph)		72		223	343			1334		28	1760	
v/s Ratio Prot					c0.05					0.01	c0.26	
v/s Ratio Perm		c0.19		0.02				c0.26				
v/c Ratio		4.59		0.10	0.24			0.61		0.79	0.50	
Uniform Delay, d1		25.6		16.7	17.3			12.0		26.2	8.4	
Progression Factor		1.00		1.00	1.00			1.00		1.00	1.00	
Incremental Delay, d2		1648.5		0.2	0.4			0.8		82.7	0.2	
Delay (s)		1674.1		16.9	17.6			12.8		108.9	8.7	
Level of Service		F		B	B			B		F	A	
Approach Delay (s)		1674.1			17.6			12.8			11.1	
Approach LOS		F			B			B			B	

Intersection Summary			
HCM Average Control Delay	253.4	HCM Level of Service	F
HCM Volume to Capacity ratio	0.75		
Actuated Cycle Length (s)	53.5	Sum of lost time (s)	16.0
Intersection Capacity Utilization	88.2%	ICU Level of Service	E
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	190	55	50	84	154	318	50	190	135	81	440	300
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0		4.0	4.0		4.0	4.0	
Lane Util. Factor	1.00	0.95	1.00	1.00	0.95		1.00	0.95		1.00	0.95	
Frpb, ped/bikes	1.00	1.00	1.00	1.00	0.99		1.00	0.99		1.00	0.99	
Flpb, ped/bikes	1.00	1.00	1.00	1.00	1.00		1.00	1.00		1.00	1.00	
Frt	1.00	1.00	0.85	1.00	0.90		1.00	0.94		1.00	0.94	
Flt Protected	0.95	1.00	1.00	0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1770	3539	1583	1770	3153		1770	3300		1770	3293	
Flt Permitted	0.95	1.00	1.00	0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (perm)	1770	3539	1583	1770	3153		1770	3300		1770	3293	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	200	58	53	88	162	335	53	200	142	85	463	316
RTOR Reduction (vph)	0	0	38	0	265	0	0	104	0	0	156	0
Lane Group Flow (vph)	200	58	15	88	232	0	53	238	0	85	623	0
Confl. Peds. (#/hr)							16		1	1		16
Confl. Bikes (#/hr)						1			1			
Turn Type	Prot		Perm	Prot			Prot			Prot		
Protected Phases	7	4		3	8		5	2		1	6	
Permitted Phases			4									
Actuated Green, G (s)	8.6	16.1	16.1	4.4	11.9		3.0	15.2		4.9	17.1	
Effective Green, g (s)	8.6	16.1	16.1	4.4	11.9		3.0	15.2		4.9	17.1	
Actuated g/C Ratio	0.15	0.28	0.28	0.08	0.21		0.05	0.27		0.09	0.30	
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0		4.0	4.0		4.0	4.0	
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	269	1007	450	138	663		94	886		153	995	
v/s Ratio Prot	c0.11	0.02		0.05	c0.07		0.03	0.07		c0.05	c0.19	
v/s Ratio Perm			0.01									
v/c Ratio	0.74	0.06	0.03	0.64	0.35		0.56	0.27		0.56	0.63	
Uniform Delay, d1	22.9	14.7	14.6	25.3	19.1		26.2	16.3		24.8	17.0	
Progression Factor	1.00	1.00	1.00	1.00	1.00		1.00	1.00		1.00	1.00	
Incremental Delay, d2	10.6	0.0	0.0	9.3	0.3		7.5	0.2		4.3	1.2	
Delay (s)	33.5	14.8	14.7	34.6	19.4		33.7	16.5		29.1	18.2	
Level of Service	C	B	B	C	B		C	B		C	B	
Approach Delay (s)		26.8			21.7			18.8			19.3	
Approach LOS		C			C			B			B	

Intersection Summary			
HCM Average Control Delay	20.9	HCM Level of Service	C
HCM Volume to Capacity ratio	0.53		
Actuated Cycle Length (s)	56.6	Sum of lost time (s)	12.0
Intersection Capacity Utilization	64.1%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Volume (veh/h)	133	60	328	361	290	174
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	145	65	357	392	315	189
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)				1133		
pX, platoon unblocked						
vC, conflicting volume			210		1250	145
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			210		1250	145
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			74		0	79
cM capacity (veh/h)			1349		139	897

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	NB 1	NB 2
Volume Total	145	65	357	392	315	189
Volume Left	0	0	357	0	315	0
Volume Right	0	65	0	0	0	189
cSH	1700	1700	1349	1700	139	897
Volume to Capacity	0.09	0.04	0.26	0.23	2.27	0.21
Queue Length 95th (ft)	0	0	27	0	662	20
Control Delay (s)	0.0	0.0	8.6	0.0	644.4	10.1
Lane LOS			A		F	B
Approach Delay (s)	0.0		4.1		406.5	
Approach LOS					F	

Intersection Summary			
Average Delay	142.2		
Intersection Capacity Utilization	51.2%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	120	61	10	10	232	550	20	20	10	217	20	70
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0		4.0	4.0			4.0	
Lane Util. Factor	1.00	1.00		1.00	1.00		1.00	1.00			1.00	
Frt	1.00	0.98		1.00	0.89		1.00	0.95			0.97	
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00			0.97	
Satd. Flow (prot)	1671	1764		1671	1619		1671	1671			1680	
Flt Permitted	0.95	1.00		0.95	1.00		0.65	1.00			0.77	
Satd. Flow (perm)	1671	1764		1671	1619		1152	1671			1338	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	130	66	11	11	252	598	22	22	11	236	22	76
RTOR Reduction (vph)	0	5	0	0	134	0	0	8	0	0	18	0
Lane Group Flow (vph)	130	72	0	11	716	0	22	25	0	0	316	0
Heavy Vehicles (%)	8%	5%	8%	8%	5%	5%	8%	8%	8%	5%	8%	8%
Turn Type	Prot			Prot			Perm			Perm		
Protected Phases	7	4		3	8			2			6	
Permitted Phases							2			6		
Actuated Green, G (s)	5.0	33.8		1.4	30.2		15.6	15.6			15.6	
Effective Green, g (s)	5.0	33.8		1.4	30.2		15.6	15.6			15.6	
Actuated g/C Ratio	0.08	0.54		0.02	0.48		0.25	0.25			0.25	
Clearance Time (s)	4.0	4.0		4.0	4.0		4.0	4.0			4.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0			3.0	
Lane Grp Cap (vph)	133	949		37	779		286	415			332	
v/s Ratio Prot	c0.08	c0.04		0.01	c0.44			0.01				
v/s Ratio Perm							0.02				c0.24	
v/c Ratio	0.98	0.08		0.30	0.92		0.08	0.06			0.95	
Uniform Delay, d1	28.8	7.0		30.2	15.2		18.1	18.0			23.2	
Progression Factor	1.00	1.00		1.00	1.00		1.00	1.00			1.00	
Incremental Delay, d2	70.4	0.0		4.5	15.6		0.1	0.1			36.6	
Delay (s)	99.2	7.0		34.7	30.8		18.2	18.1			59.8	
Level of Service	F	A		C	C		B	B			E	
Approach Delay (s)		64.9			30.8			18.1			59.8	
Approach LOS		E			C			B			E	

Intersection Summary			
HCM Average Control Delay	41.9	HCM Level of Service	D
HCM Volume to Capacity ratio	0.97		
Actuated Cycle Length (s)	62.8	Sum of lost time (s)	16.0
Intersection Capacity Utilization	86.7%	ICU Level of Service	E
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Volume (veh/h)	167	122	87	557	236	103
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	182	133	95	605	257	112
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)	322					
pX, platoon unblocked						
vC, conflicting volume			182		1042	248
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			182		1042	248
tC, single (s)			4.2		6.5	6.3
tC, 2 stage (s)						
tF (s)			2.3		3.6	3.4
p0 queue free %			93		0	86
cM capacity (veh/h)			1358		230	776

Direction, Lane #	EB 1	WB 1	WB 2	NB 1
Volume Total	314	95	605	368
Volume Left	0	95	0	257
Volume Right	133	0	0	112
cSH	1700	1358	1700	293
Volume to Capacity	0.18	0.07	0.36	1.26
Queue Length 95th (ft)	0	6	0	434
Control Delay (s)	0.0	7.8	0.0	176.7
Lane LOS		A		F
Approach Delay (s)	0.0	1.1		176.7
Approach LOS				F

Intersection Summary			
Average Delay	47.6		
Intersection Capacity Utilization	55.4%	ICU Level of Service	B
Analysis Period (min)	15		

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Volume (veh/h)	441	62	89	150	358	559
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	479	67	97	163	389	608
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume			547		870	513
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			547		870	513
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			91		0	0
cM capacity (veh/h)			1023		292	561

Direction, Lane #	EB 1	WB 1	WB 2	NB 1
Volume Total	547	97	163	997
Volume Left	0	97	0	389
Volume Right	67	0	0	608
cSH	1700	1023	1700	412
Volume to Capacity	0.32	0.09	0.10	2.42
Queue Length 95th (ft)	0	8	0	1946
Control Delay (s)	0.0	8.9	0.0	665.9
Lane LOS		A		F
Approach Delay (s)	0.0	3.3		665.9
Approach LOS				F

Intersection Summary			
Average Delay	368.5		
Intersection Capacity Utilization	96.1%	ICU Level of Service	F
Analysis Period (min)	15		

Intersection	
Intersection Delay (sec/veh)	50.2
Intersection LOS	F

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Volume (vph)	10	20	10	510	10	30	10	209	70	525	436	10
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Heavy Vehicles(%)	2	2	2	2	2	2	2	2	2	2	2	2
Movement Flow Rate	11	22	11	554	11	33	11	227	76	571	474	11
Number of Lanes	0	1	0	1	1	0	1	2	0	1	2	0

Approach	EB	WB	NB	SB
Opposing Approach	WB	EB	SB	NB
Opposing Lanes	2	1	3	3
Conflicting Approach Left	SB	NB	EB	WB
Conflicting Lanes Left	3	3	1	2
Conflicting Approach Right	NB	SB	WB	EB
Conflicting Lanes Right	3	3	2	1
HCM Control Delay	14.4	71.2	16.9	49.7
HCM LOS	B	F	C	E

Lane	NBLn1	NBLn2	NBLn3	EBLn1	WBLn1	WBLn2	SBLn1	SBLn2	SBLn3
Volume Left (%)	100%	0%	0%	25%	100%	0%	100%	0%	0%
Volume Thru (%)	0%	100%	50%	50%	0%	25%	0%	100%	94%
Volume Right (%)	0%	0%	50%	25%	0%	75%	0%	0%	6%
Sign Control	Stop	Stop	Stop	Stop	Stop	Stop	Stop	Stop	Stop
Traffic Volume by Lane	10	139	140	40	510	40	525	291	155
Left Turning Volume	0	139	70	20	0	10	0	291	145
Through Volume	0	0	70	10	0	30	0	0	10
Right Turning Volume	10	0	0	10	510	0	525	0	0
Lane Flow Rate	11	151	152	43	554	43	571	316	169
Geometry Group	8	8	8	8	8	8	8	8	8
Degree of Utilization, X	0.029	0.385	0.371	0.123	1	0.097	1	0.692	0.368
Departure Headway, Hd	9.653	9.155	8.805	10.183	9.052	8.036	8.381	7.883	7.838
Convergence(Y/N)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Capacity	371	394	408	352	405	445	434	458	459
Service Time	7.4	6.902	6.552	7.951	6.822	5.806	6.119	5.621	5.576
HCM Lane V/C Ratio	0.03	0.383	0.373	0.122	1.368	0.097	1.316	0.69	0.368
HCM Control Delay	12.7	17.5	16.7	14.4	75.9	11.7	72.7	26.6	15.1
HCM Lane LOS	B	C	C	B	F	B	F	D	C
HCM 95th Percentile Queue	0.1	1.9	1.8	0.4	94.2	0.3	98.1	6.7	1.7

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	0	0	137	10	480	30	926	0	0	142	330
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)				4.0	4.0		4.0	4.0			4.0	
Lane Util. Factor				1.00	1.00		1.00	0.95			0.95	
Frpb, ped/bikes				1.00	1.00		1.00	1.00			0.98	
Flpb, ped/bikes				1.00	1.00		1.00	1.00			1.00	
Frt				1.00	0.85		1.00	1.00			0.90	
Flt Protected				0.95	1.00		0.95	1.00			1.00	
Satd. Flow (prot)				1787	1605		1787	3574			3151	
Flt Permitted				0.95	1.00		0.95	1.00			1.00	
Satd. Flow (perm)				1787	1605		1787	3574			3151	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	0	0	0	144	11	505	32	975	0	0	149	347
RTOR Reduction (vph)	0	0	0	0	72	0	0	0	0	0	232	0
Lane Group Flow (vph)	0	0	0	144	444	0	32	975	0	0	264	0
Confl. Peds. (#/hr)							1		2	2		1
Confl. Bikes (#/hr)			1						1			
Heavy Vehicles (%)	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%
Turn Type				Split			Prot					
Protected Phases				8	8		5	2			6	
Permitted Phases												
Actuated Green, G (s)				19.3	19.3		4.2	25.9			17.7	
Effective Green, g (s)				19.3	19.3		4.2	25.9			17.7	
Actuated g/C Ratio				0.36	0.36		0.08	0.49			0.33	
Clearance Time (s)				4.0	4.0		4.0	4.0			4.0	
Vehicle Extension (s)				3.0	3.0		3.0	3.0			3.0	
Lane Grp Cap (vph)				648	582		141	1740			1048	
v/s Ratio Prot				0.08	c0.28		0.02	c0.27			0.08	
v/s Ratio Perm												
v/c Ratio				0.22	0.76		0.23	0.56			0.25	
Uniform Delay, d1				11.7	14.9		23.0	9.6			12.9	
Progression Factor				1.00	1.00		1.00	1.00			1.00	
Incremental Delay, d2				0.2	5.9		0.8	0.4			0.1	
Delay (s)				11.9	20.8		23.8	10.0			13.1	
Level of Service				B	C		C	B			B	
Approach Delay (s)		0.0			18.9			10.5			13.1	
Approach LOS		A			B			B			B	

Intersection Summary			
HCM Average Control Delay	13.6	HCM Level of Service	B
HCM Volume to Capacity ratio	0.65		
Actuated Cycle Length (s)	53.2	Sum of lost time (s)	8.0
Intersection Capacity Utilization	62.5%	ICU Level of Service	B
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	50	530	90	342	370	60	310	180	916	30	40	50
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0		4.0	4.0	4.0		4.0	
Lane Util. Factor	1.00	0.95		0.91	0.91		0.95	0.95	1.00		1.00	
Frpb, ped/bikes	1.00	1.00		1.00	1.00		1.00	1.00	0.99		1.00	
Flpb, ped/bikes	1.00	1.00		1.00	1.00		1.00	1.00	1.00		1.00	
Frt	1.00	0.98		1.00	0.98		1.00	1.00	0.85		0.94	
Flt Protected	0.95	1.00		0.95	0.99		0.95	0.99	1.00		0.99	
Satd. Flow (prot)	1787	3496		1626	3336		1698	1763	1576		1753	
Flt Permitted	0.95	1.00		0.95	0.99		0.95	0.99	1.00		0.99	
Satd. Flow (perm)	1787	3496		1626	3336		1698	1763	1576		1753	
Peak-hour factor, PHF	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97
Adj. Flow (vph)	52	546	93	353	381	62	320	186	944	31	41	52
RTOR Reduction (vph)	0	14	0	0	10	0	0	0	452	0	29	0
Lane Group Flow (vph)	52	625	0	261	525	0	250	256	492	0	95	0
Confl. Peds. (#/hr)									2	2		
Confl. Bikes (#/hr)									1			
Heavy Vehicles (%)	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%
Turn Type	Split			Split			Split		Perm	Split		
Protected Phases	4	4		8	8		2	2		6	6	
Permitted Phases									2			
Actuated Green, G (s)	16.0	16.0		17.4	17.4		29.1	29.1	29.1		10.0	
Effective Green, g (s)	16.0	16.0		17.4	17.4		29.1	29.1	29.1		10.0	
Actuated g/C Ratio	0.18	0.18		0.20	0.20		0.33	0.33	0.33		0.11	
Clearance Time (s)	4.0	4.0		4.0	4.0		4.0	4.0	4.0		4.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0	3.0		3.0	
Lane Grp Cap (vph)	323	632		320	656		558	580	518		198	
v/s Ratio Prot	0.03	c0.18		c0.16	0.16		0.15	0.15			c0.05	
v/s Ratio Perm									c0.31			
v/c Ratio	0.16	0.99		0.82	0.80		0.45	0.44	0.95		0.48	
Uniform Delay, d1	30.6	36.2		34.0	33.9		23.4	23.3	29.0		36.8	
Progression Factor	1.00	1.00		1.00	1.00		1.00	1.00	1.00		1.00	
Incremental Delay, d2	0.2	32.6		14.7	7.0		0.6	0.5	27.5		1.8	
Delay (s)	30.8	68.8		48.7	40.9		24.0	23.9	56.5		38.6	
Level of Service	C	E		D	D		C	C	E		D	
Approach Delay (s)		66.0			43.4			45.1			38.6	
Approach LOS		E			D			D			D	

Intersection Summary			
HCM Average Control Delay	49.1	HCM Level of Service	D
HCM Volume to Capacity ratio	0.86		
Actuated Cycle Length (s)	88.5	Sum of lost time (s)	16.0
Intersection Capacity Utilization	91.3%	ICU Level of Service	F
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	1056	370	170	465	0	0	0	0	570	20	437
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0			4.0						4.0	
Lane Util. Factor		0.95			0.95						1.00	
Frpb, ped/bikes		0.99			1.00						1.00	
Flpb, ped/bikes		1.00			1.00						1.00	
Frt		0.96			1.00						0.94	
Flt Protected		1.00			0.99						0.97	
Satd. Flow (prot)		3401			3527						1725	
Flt Permitted		1.00			0.54						0.97	
Satd. Flow (perm)		3401			1944						1725	
Peak-hour factor, PHF	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96
Adj. Flow (vph)	0	1100	385	177	484	0	0	0	0	594	21	455
RTOR Reduction (vph)	0	29	0	0	0	0	0	0	0	0	22	0
Lane Group Flow (vph)	0	1456	0	0	661	0	0	0	0	0	1048	0
Confl. Peds. (#/hr)	3		8	8		3						
Confl. Bikes (#/hr)						3						
Heavy Vehicles (%)	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%
Turn Type				Perm						Split		
Protected Phases		4			8					6	6	
Permitted Phases				8								
Actuated Green, G (s)		49.0			49.0						63.0	
Effective Green, g (s)		49.0			49.0						63.0	
Actuated g/C Ratio		0.41			0.41						0.52	
Clearance Time (s)		4.0			4.0						4.0	
Vehicle Extension (s)		3.0			3.0						3.0	
Lane Grp Cap (vph)		1389			794						906	
v/s Ratio Prot		c0.43									c0.61	
v/s Ratio Perm					0.34							
v/c Ratio		1.05			2.81dl						1.16	
Uniform Delay, d1		35.5			31.8						28.5	
Progression Factor		1.00			1.01						1.00	
Incremental Delay, d2		37.9			9.2						82.8	
Delay (s)		73.4			41.3						111.3	
Level of Service		E			D						F	
Approach Delay (s)		73.4			41.3			0.0			111.3	
Approach LOS		E			D			A			F	

Intersection Summary			
HCM Average Control Delay	79.4	HCM Level of Service	E
HCM Volume to Capacity ratio	1.11		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	131.5%	ICU Level of Service	H
Analysis Period (min)	15		

dl Defacto Left Lane. Recode with 1 though lane as a left lane.
c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	612	1014	0	0	535	550	100	140	220	0	0	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0			4.0		4.0	4.0	4.0			
Lane Util. Factor		0.95			0.95		0.95	0.95	1.00			
Frpb, ped/bikes		1.00			0.99		1.00	1.00	1.00			
Flpb, ped/bikes		1.00			1.00		1.00	1.00	1.00			
Frt		1.00			0.92		1.00	1.00	0.85			
Flt Protected		0.98			1.00		0.95	1.00	1.00			
Satd. Flow (prot)		3508			3263		1698	1781	1599			
Flt Permitted		0.52			1.00		0.95	1.00	1.00			
Satd. Flow (perm)		1844			3263		1698	1781	1599			
Peak-hour factor, PHF	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96
Adj. Flow (vph)	638	1056	0	0	557	573	104	146	229	0	0	0
RTOR Reduction (vph)	0	0	0	0	53	0	0	0	164	0	0	0
Lane Group Flow (vph)	0	1694	0	0	1077	0	94	156	65	0	0	0
Confl. Peds. (#/hr)	2		7	7		2						
Confl. Bikes (#/hr)						3						
Heavy Vehicles (%)	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%
Turn Type	Perm						Split		Prot			
Protected Phases		4			8		2	2	2			
Permitted Phases	4											
Actuated Green, G (s)		96.0			96.0		16.0	16.0	16.0			
Effective Green, g (s)		96.0			96.0		16.0	16.0	16.0			
Actuated g/C Ratio		0.80			0.80		0.13	0.13	0.13			
Clearance Time (s)		4.0			4.0		4.0	4.0	4.0			
Vehicle Extension (s)		3.0			3.0		3.0	3.0	3.0			
Lane Grp Cap (vph)		1475			2610		226	237	213			
v/s Ratio Prot					0.33		0.06	c0.09	0.04			
v/s Ratio Perm		c0.92										
v/c Ratio		1.84dl			0.41		0.42	0.66	0.31			
Uniform Delay, d1		12.0			3.6		47.7	49.4	47.0			
Progression Factor		0.80			1.00		1.00	1.00	1.00			
Incremental Delay, d2		67.7			0.5		5.6	13.5	3.7			
Delay (s)		77.3			4.1		53.3	62.9	50.7			
Level of Service		E			A		D	E	D			
Approach Delay (s)		77.3			4.1			55.1			0.0	
Approach LOS		E			A			E			A	

Intersection Summary			
HCM Average Control Delay	49.0	HCM Level of Service	D
HCM Volume to Capacity ratio	1.08		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	106.5%	ICU Level of Service	G
Analysis Period (min)	15		

dl Defacto Left Lane. Recode with 1 though lane as a left lane.
c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	200	20	100	20	20	260	30	708	10	20	691	130
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0			4.0		4.0	4.0	
Lane Util. Factor	1.00	1.00		1.00	1.00			0.95		1.00	0.95	
Frpb, ped/bikes	1.00	0.99		1.00	0.99			1.00		1.00	1.00	
Flpb, ped/bikes	1.00	1.00		0.96	1.00			1.00		0.95	1.00	
Frt	1.00	0.88		1.00	0.86			1.00		1.00	0.98	
Flt Protected	0.95	1.00		0.95	1.00			1.00		0.95	1.00	
Satd. Flow (prot)	1752	1595		1675	1569			3489		1669	3410	
Flt Permitted	0.95	1.00		0.95	1.00			0.89		0.95	1.00	
Satd. Flow (perm)	1752	1595		1675	1569			3124		1669	3410	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	217	22	109	22	22	283	33	770	11	22	751	141
RTOR Reduction (vph)	0	67	0	0	103	0	0	1	0	0	14	0
Lane Group Flow (vph)	217	64	0	22	202	0	0	813	0	22	878	0
Confl. Peds. (#/hr)	1		3	3		1			5	5		
Confl. Bikes (#/hr)						1			2			1
Heavy Vehicles (%)	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%
Turn Type	Prot			Prot			Perm			Prot		
Protected Phases	3	8		7	4			2		1	6	
Permitted Phases							2					
Actuated Green, G (s)	5.5	24.2		0.6	19.3			20.9		0.5	25.4	
Effective Green, g (s)	5.5	24.2		0.6	19.3			20.9		0.5	25.4	
Actuated g/C Ratio	0.09	0.39		0.01	0.31			0.34		0.01	0.41	
Clearance Time (s)	4.0	4.0		4.0	4.0			4.0		4.0	4.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0			3.0		3.0	3.0	
Lane Grp Cap (vph)	155	621		16	487			1050		13	1393	
v/s Ratio Prot	c0.12	0.04		0.01	c0.13					0.01	c0.26	
v/s Ratio Perm								c0.26				
v/c Ratio	1.40	0.10		1.38	0.42			0.77		1.69	0.63	
Uniform Delay, d1	28.4	12.1		30.8	17.0			18.5		30.9	14.7	
Progression Factor	1.00	1.00		1.00	1.00			1.00		1.00	1.00	
Incremental Delay, d2	214.2	0.1		361.4	0.6			3.6		515.9	0.9	
Delay (s)	242.5	12.2		392.2	17.6			22.2		546.8	15.6	
Level of Service	F	B		F	B			C		F	B	
Approach Delay (s)		155.8			42.8			22.2			28.4	
Approach LOS		F			D			C			C	

Intersection Summary			
HCM Average Control Delay	46.7	HCM Level of Service	D
HCM Volume to Capacity ratio	0.72		
Actuated Cycle Length (s)	62.2	Sum of lost time (s)	16.0
Intersection Capacity Utilization	81.0%	ICU Level of Service	D
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Volume (vph)	133	60	328	361	290	174
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00
Frpb, ped/bikes	1.00	0.98	1.00	1.00	1.00	1.00
Flpb, ped/bikes	1.00	1.00	1.00	1.00	1.00	1.00
Frt	1.00	0.85	1.00	1.00	1.00	0.85
Flt Protected	1.00	1.00	0.95	1.00	0.95	1.00
Satd. Flow (prot)	1827	1521	1736	1827	1736	1553
Flt Permitted	1.00	1.00	0.66	1.00	0.95	1.00
Satd. Flow (perm)	1827	1521	1214	1827	1736	1553
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	145	65	357	392	315	189
RTOR Reduction (vph)	0	36	0	0	0	127
Lane Group Flow (vph)	145	29	357	392	315	62
Confl. Bikes (#/hr)		1				
Heavy Vehicles (%)	4%	4%	4%	4%	4%	4%
Turn Type		Perm	Perm			Perm
Protected Phases	4			8	2	
Permitted Phases		4	8			2
Actuated Green, G (s)	15.5	15.5	15.5	15.5	11.6	11.6
Effective Green, g (s)	15.5	15.5	15.5	15.5	11.6	11.6
Actuated g/C Ratio	0.44	0.44	0.44	0.44	0.33	0.33
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	807	672	536	807	574	513
v/s Ratio Prot	0.08			0.21	c0.18	
v/s Ratio Perm		0.02	c0.29			0.04
v/c Ratio	0.18	0.04	0.67	0.49	0.55	0.12
Uniform Delay, d1	5.9	5.6	7.8	7.0	9.6	8.2
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	0.1	0.0	3.1	0.5	1.1	0.1
Delay (s)	6.1	5.6	10.9	7.4	10.7	8.3
Level of Service	A	A	B	A	B	A
Approach Delay (s)	5.9			9.1	9.8	
Approach LOS	A			A	A	

Intersection Summary			
HCM Average Control Delay	8.9	HCM Level of Service	A
HCM Volume to Capacity ratio	0.62		
Actuated Cycle Length (s)	35.1	Sum of lost time (s)	8.0
Intersection Capacity Utilization	51.2%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Volume (vph)	167	122	87	557	236	103
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0		4.0	4.0	4.0	
Lane Util. Factor	1.00		1.00	1.00	1.00	
Frt	0.94		1.00	1.00	0.96	
Flt Protected	1.00		0.95	1.00	0.97	
Satd. Flow (prot)	1686		1671	1810	1630	
Flt Permitted	1.00		0.55	1.00	0.97	
Satd. Flow (perm)	1686		964	1810	1630	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	182	133	95	605	257	112
RTOR Reduction (vph)	37	0	0	0	29	0
Lane Group Flow (vph)	278	0	95	605	340	0
Heavy Vehicles (%)	5%	8%	8%	5%	8%	8%
Turn Type			Perm			
Protected Phases	4			8	2	
Permitted Phases			8			
Actuated Green, G (s)	35.0		35.0	35.0	17.0	
Effective Green, g (s)	35.0		35.0	35.0	17.0	
Actuated g/C Ratio	0.58		0.58	0.58	0.28	
Clearance Time (s)	4.0		4.0	4.0	4.0	
Vehicle Extension (s)	3.0		3.0	3.0	3.0	
Lane Grp Cap (vph)	984		562	1056	462	
v/s Ratio Prot	0.17			c0.33	c0.21	
v/s Ratio Perm			0.10			
v/c Ratio	0.28		0.17	0.57	0.74	
Uniform Delay, d1	6.2		5.8	7.8	19.5	
Progression Factor	1.37		1.00	1.00	1.00	
Incremental Delay, d2	0.5		0.7	2.3	6.0	
Delay (s)	9.1		6.4	10.1	25.5	
Level of Service	A		A	B	C	
Approach Delay (s)	9.1			9.6	25.5	
Approach LOS	A			A	C	

Intersection Summary			
HCM Average Control Delay	13.7	HCM Level of Service	B
HCM Volume to Capacity ratio	0.63		
Actuated Cycle Length (s)	60.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	55.4%	ICU Level of Service	B
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Volume (vph)	441	62	89	150	358	559
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0		4.0	4.0	4.0	4.0
Lane Util. Factor	1.00		1.00	1.00	1.00	1.00
Frt	0.98		1.00	1.00	1.00	0.85
Flt Protected	1.00		0.95	1.00	0.95	1.00
Satd. Flow (prot)	1832		1770	1863	1770	1583
Flt Permitted	1.00		0.18	1.00	0.95	1.00
Satd. Flow (perm)	1832		330	1863	1770	1583
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	479	67	97	163	389	608
RTOR Reduction (vph)	8	0	0	0	0	215
Lane Group Flow (vph)	538	0	97	163	389	393
Turn Type			pm+pt			Perm
Protected Phases	4		3	8	2	
Permitted Phases			8			2
Actuated Green, G (s)	18.6		25.5	25.5	17.4	17.4
Effective Green, g (s)	18.6		25.5	25.5	17.4	17.4
Actuated g/C Ratio	0.37		0.50	0.50	0.34	0.34
Clearance Time (s)	4.0		4.0	4.0	4.0	4.0
Vehicle Extension (s)	3.0		3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	669		247	933	605	541
v/s Ratio Prot	c0.29		c0.02	0.09	0.22	
v/s Ratio Perm			0.17			c0.25
v/c Ratio	0.80		0.39	0.17	0.64	0.73
Uniform Delay, d1	14.5		8.9	6.9	14.1	14.7
Progression Factor	1.00		1.00	1.00	1.00	1.00
Incremental Delay, d2	6.9		1.0	0.1	2.3	4.8
Delay (s)	21.5		9.9	7.0	16.5	19.5
Level of Service	C		A	A	B	B
Approach Delay (s)	21.5			8.1	18.3	
Approach LOS	C			A	B	

Intersection Summary			
HCM Average Control Delay	17.8	HCM Level of Service	B
HCM Volume to Capacity ratio	0.74		
Actuated Cycle Length (s)	50.9	Sum of lost time (s)	12.0
Intersection Capacity Utilization	68.3%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	10	20	10	510	10	30	10	209	70	525	436	10
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Lane Util. Factor		1.00		1.00	1.00		1.00	0.95		0.97	1.00	
Frpb, ped/bikes		1.00		1.00	1.00		1.00	1.00		1.00	1.00	
Flpb, ped/bikes		1.00		1.00	1.00		1.00	1.00		1.00	1.00	
Frt		0.97		1.00	0.89		1.00	0.96		1.00	1.00	
Flt Protected		0.99		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)		1771		1765	1653		1770	3406		3433	1856	
Flt Permitted		0.96		0.73	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (perm)		1720		1353	1653		1770	3406		3433	1856	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	11	22	11	554	11	33	11	227	76	571	474	11
RTOR Reduction (vph)	0	6	0	0	18	0	0	36	0	0	1	0
Lane Group Flow (vph)	0	38	0	554	26	0	11	267	0	571	484	0
Confl. Peds. (#/hr)			2	2								
Confl. Bikes (#/hr)			1									
Turn Type	Perm			Perm			Prot			Prot		
Protected Phases		4			8		5	2		1	6	
Permitted Phases	4			8								
Actuated Green, G (s)		35.8		35.8	35.8		0.7	15.2		16.6	31.1	
Effective Green, g (s)		35.8		35.8	35.8		0.7	15.2		16.6	31.1	
Actuated g/C Ratio		0.45		0.45	0.45		0.01	0.19		0.21	0.39	
Clearance Time (s)		4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Vehicle Extension (s)		3.0		3.0	3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)		774		609	743		16	650		716	725	
v/s Ratio Prot					0.02		0.01	0.08		c0.17	c0.26	
v/s Ratio Perm		0.02		c0.41								
v/c Ratio		0.05		0.91	0.03		0.69	0.41		0.80	0.67	
Uniform Delay, d1		12.3		20.4	12.2		39.3	28.3		29.9	20.0	
Progression Factor		1.00		1.00	1.00		1.00	1.00		1.00	1.00	
Incremental Delay, d2		0.0		17.5	0.0		80.1	0.4		6.2	2.3	
Delay (s)		12.3		37.9	12.3		119.4	28.7		36.1	22.3	
Level of Service		B		D	B		F	C		D	C	
Approach Delay (s)		12.3			36.0			31.9			29.8	
Approach LOS		B			D			C			C	

Intersection Summary			
HCM Average Control Delay	31.6	HCM Level of Service	C
HCM Volume to Capacity ratio	0.81		
Actuated Cycle Length (s)	79.6	Sum of lost time (s)	8.0
Intersection Capacity Utilization	71.8%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	1056	370	170	465	0	0	0	0	570	20	437
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0			4.0						4.0	4.0
Lane Util. Factor		0.95			0.95						1.00	1.00
Frpb, ped/bikes		0.99			1.00						1.00	1.00
Flpb, ped/bikes		1.00			1.00						1.00	1.00
Frt		0.96			1.00						1.00	0.85
Flt Protected		1.00			0.99						0.95	1.00
Satd. Flow (prot)		3401			3527						1795	1599
Flt Permitted		1.00			0.51						0.95	1.00
Satd. Flow (perm)		3401			1819						1795	1599
Peak-hour factor, PHF	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96
Adj. Flow (vph)	0	1100	385	177	484	0	0	0	0	594	21	455
RTOR Reduction (vph)	0	29	0	0	0	0	0	0	0	0	0	111
Lane Group Flow (vph)	0	1456	0	0	661	0	0	0	0	0	615	344
Confl. Peds. (#/hr)	3		8	8		3						
Confl. Bikes (#/hr)						3						
Heavy Vehicles (%)	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%
Turn Type				Perm						Split		Perm
Protected Phases		4			8					6	6	
Permitted Phases				8								6
Actuated Green, G (s)		63.0			63.0						49.0	49.0
Effective Green, g (s)		63.0			63.0						49.0	49.0
Actuated g/C Ratio		0.52			0.52						0.41	0.41
Clearance Time (s)		4.0			4.0						4.0	4.0
Vehicle Extension (s)		3.0			3.0						3.0	3.0
Lane Grp Cap (vph)		1786			955						733	653
v/s Ratio Prot		c0.43									c0.34	
v/s Ratio Perm					0.36							0.21
v/c Ratio		0.82			2.77dl						0.84	0.53
Uniform Delay, d1		23.7			21.3						32.0	26.8
Progression Factor		1.00			0.96						1.00	1.00
Incremental Delay, d2		4.2			3.8						11.1	3.0
Delay (s)		27.9			24.1						43.0	29.8
Level of Service		C			C						D	C
Approach Delay (s)		27.9			24.1			0.0			37.4	
Approach LOS		C			C			A			D	

Intersection Summary			
HCM Average Control Delay	30.3	HCM Level of Service	C
HCM Volume to Capacity ratio	0.83		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	104.7%	ICU Level of Service	G
Analysis Period (min)	15		

dl Defacto Left Lane. Recode with 1 though lane as a left lane.
c Critical Lane Group

Near-Term (2018) Plus Additional Employment Alternative Conditions

FEHR PEERS

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	80	283	86	290	360	131	51	272	150	76	672	50
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	4.0	4.0	3.0	4.0	4.0	3.0	3.0	3.0	3.0	3.0	
Lane Util. Factor	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	
Frpb, ped/bikes	1.00	1.00	0.98	1.00	1.00	0.98	1.00	1.00	0.98	1.00	1.00	
Flpb, ped/bikes	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	0.99	
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	
Satd. Flow (prot)	1736	3471	1518	1736	3471	1516	1736	3471	1530	1736	3432	
Flt Permitted	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	
Satd. Flow (perm)	1736	3471	1518	1736	3471	1516	1736	3471	1530	1736	3432	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	87	308	93	315	391	142	55	296	163	83	730	54
RTOR Reduction (vph)	0	0	62	0	0	92	0	0	119	0	7	0
Lane Group Flow (vph)	87	308	31	315	391	50	55	296	44	83	777	0
Confl. Peds. (#/hr)	14		13	13		14	4		4	4		4
Confl. Bikes (#/hr)						1						1
Heavy Vehicles (%)	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%
Turn Type	Prot		Perm	Prot		Perm	Prot		Perm	Prot		
Protected Phases	5	2		1	6		3	8		7	4	
Permitted Phases			2			6			8			
Actuated Green, G (s)	6.0	15.4	15.4	14.5	21.9	21.9	2.1	17.2	17.2	4.2	19.3	
Effective Green, g (s)	6.0	15.4	15.4	14.5	21.9	21.9	2.1	17.2	17.2	4.2	19.3	
Actuated g/C Ratio	0.09	0.24	0.24	0.23	0.34	0.34	0.03	0.27	0.27	0.07	0.30	
Clearance Time (s)	5.0	4.0	4.0	3.0	4.0	4.0	3.0	3.0	3.0	3.0	3.0	
Vehicle Extension (s)	2.0	4.0	4.0	2.0	4.0	4.0	2.0	2.0	2.0	2.0	2.0	
Lane Grp Cap (vph)	162	831	364	391	1182	516	57	928	409	113	1030	
v/s Ratio Prot	0.05	0.09		c0.18	c0.11		c0.03	0.09		0.05	c0.23	
v/s Ratio Perm			0.02			0.03			0.03			
v/c Ratio	0.54	0.37	0.09	0.81	0.33	0.10	0.96	0.32	0.11	0.73	0.75	
Uniform Delay, d1	27.8	20.4	19.0	23.6	15.8	14.5	31.1	18.9	17.8	29.5	20.4	
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	
Incremental Delay, d2	1.7	0.4	0.1	10.9	0.2	0.1	105.2	0.1	0.0	19.0	2.8	
Delay (s)	29.5	20.8	19.1	34.4	16.0	14.6	136.2	18.9	17.8	48.5	23.2	
Level of Service	C	C	B	C	B	B	F	B	B	D	C	
Approach Delay (s)		22.0			22.6			31.1			25.6	
Approach LOS		C			C			C			C	

Intersection Summary			
HCM Average Control Delay	25.1	HCM Level of Service	C
HCM Volume to Capacity ratio	0.59		
Actuated Cycle Length (s)	64.3	Sum of lost time (s)	6.0
Intersection Capacity Utilization	65.4%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	0	0	330	10	191	0	271	140	0	809	250
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)				4.0	4.0	4.0		4.0	4.0		4.0	
Lane Util. Factor				0.95	0.91	0.95		0.91	1.00		0.91	
Frpb, ped/bikes				1.00	1.00	0.99		1.00	0.98		0.99	
Flpb, ped/bikes				1.00	1.00	1.00		1.00	1.00		1.00	
Frt				1.00	0.98	0.85		1.00	0.85		0.96	
Flt Protected				0.95	0.96	1.00		1.00	1.00		1.00	
Satd. Flow (prot)				1665	1576	1471		5036	1535		4831	
Flt Permitted				0.95	0.96	1.00		1.00	1.00		1.00	
Satd. Flow (perm)				1665	1576	1471		5036	1535		4831	
Peak-hour factor, PHF	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94
Adj. Flow (vph)	0	0	0	351	11	203	0	288	149	0	861	266
RTOR Reduction (vph)	0	0	0	0	13	117	0	0	0	0	75	0
Lane Group Flow (vph)	0	0	0	197	180	58	0	288	149	0	1052	0
Confl. Peds. (#/hr)	1					1	2		1	1		2
Confl. Bikes (#/hr)									2			1
Heavy Vehicles (%)	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%
Turn Type				Split		Perm			Free			
Protected Phases				8	8			2			6	
Permitted Phases						8			Free			
Actuated Green, G (s)				12.9	12.9	12.9		17.9	38.8		17.9	
Effective Green, g (s)				12.9	12.9	12.9		17.9	38.8		17.9	
Actuated g/C Ratio				0.33	0.33	0.33		0.46	1.00		0.46	
Clearance Time (s)				4.0	4.0	4.0		4.0			4.0	
Vehicle Extension (s)				3.0	3.0	3.0		3.0			3.0	
Lane Grp Cap (vph)				554	524	489		2323	1535		2229	
v/s Ratio Prot				c0.12	0.11			0.06			c0.22	
v/s Ratio Perm						0.04			0.10			
v/c Ratio				0.36	0.34	0.12		0.12	0.10		0.47	
Uniform Delay, d1				9.8	9.8	9.0		6.0	0.0		7.2	
Progression Factor				1.00	1.00	1.00		1.00	1.00		1.00	
Incremental Delay, d2				0.4	0.4	0.1		0.0	0.1		0.2	
Delay (s)				10.2	10.2	9.1		6.0	0.1		7.4	
Level of Service				B	B	A		A	A		A	
Approach Delay (s)		0.0			9.8			4.0			7.4	
Approach LOS		A			A			A			A	

Intersection Summary			
HCM Average Control Delay	7.3	HCM Level of Service	A
HCM Volume to Capacity ratio	0.42		
Actuated Cycle Length (s)	38.8	Sum of lost time (s)	8.0
Intersection Capacity Utilization	39.7%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	80	0	130	0	0	0	0	331	330	0	559	579
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0		4.0					4.0			4.0	4.0
Lane Util. Factor	1.00		1.00					0.91			0.95	1.00
Frpb, ped/bikes	1.00		1.00					0.99			1.00	0.98
Flpb, ped/bikes	1.00		1.00					1.00			1.00	1.00
Frt	1.00		0.85					0.93			1.00	0.85
Flt Protected	0.95		1.00					1.00			1.00	1.00
Satd. Flow (prot)	1752		1568					4603			3505	1536
Flt Permitted	0.95		1.00					1.00			1.00	1.00
Satd. Flow (perm)	1752		1568					4603			3505	1536
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	87	0	141	0	0	0	0	360	359	0	608	629
RTOR Reduction (vph)	0	0	88	0	0	0	0	197	0	0	0	0
Lane Group Flow (vph)	87	0	53	0	0	0	0	522	0	0	608	629
Confl. Peds. (#/hr)							1		3	3		1
Confl. Bikes (#/hr)									1			
Heavy Vehicles (%)	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%
Turn Type	Split		Perm									Free
Protected Phases	8	8						2			6	
Permitted Phases			8									Free
Actuated Green, G (s)	7.7		7.7					12.9			12.9	28.6
Effective Green, g (s)	7.7		7.7					12.9			12.9	28.6
Actuated g/C Ratio	0.27		0.27					0.45			0.45	1.00
Clearance Time (s)	4.0		4.0					4.0			4.0	
Vehicle Extension (s)	3.0		3.0					3.0			3.0	
Lane Grp Cap (vph)	472		422					2076			1581	1536
v/s Ratio Prot	0.05							0.11			0.17	
v/s Ratio Perm			0.03									c0.41
v/c Ratio	0.18		0.12					0.25			0.38	0.41
Uniform Delay, d1	8.0		7.9					4.9			5.2	0.0
Progression Factor	1.00		1.00					1.00			1.00	1.00
Incremental Delay, d2	0.2		0.1					0.1			0.2	0.8
Delay (s)	8.2		8.0					4.9			5.4	0.8
Level of Service	A		A					A			A	A
Approach Delay (s)		8.1			0.0			4.9			3.1	
Approach LOS		A			A			A			A	

Intersection Summary			
HCM Average Control Delay	4.2	HCM Level of Service	A
HCM Volume to Capacity ratio	0.41		
Actuated Cycle Length (s)	28.6	Sum of lost time (s)	0.0
Intersection Capacity Utilization	30.2%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	50	20	30	10	10	30	30	581	20	290	289	110
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0		4.0	4.0			4.0		4.0	4.0	
Lane Util. Factor		1.00		1.00	1.00			0.95		1.00	0.95	
Frpb, ped/bikes		1.00		1.00	0.99			1.00		1.00	0.99	
Flpb, ped/bikes		1.00		1.00	1.00			1.00		1.00	1.00	
Frt		0.96		1.00	0.89			1.00		1.00	0.96	
Flt Protected		0.98		0.95	1.00			1.00		0.95	1.00	
Satd. Flow (prot)		1709		1736	1605			3446		1736	3306	
Flt Permitted		1.00		0.69	1.00			0.92		0.95	1.00	
Satd. Flow (perm)		1751		1255	1605			3179		1736	3306	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	54	22	33	11	11	33	33	632	22	315	314	120
RTOR Reduction (vph)	0	16	0	0	28	0	0	2	0	0	25	0
Lane Group Flow (vph)	0	93	0	11	16	0	0	685	0	315	409	0
Confl. Peds. (#/hr)	3					3	2					2
Confl. Bikes (#/hr)												1
Heavy Vehicles (%)	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%
Turn Type	Perm			Perm			Perm			Prot		
Protected Phases		3			4			2		1	6	
Permitted Phases	3			4			2					
Actuated Green, G (s)		2.2		8.4	8.4			21.7		11.9	37.6	
Effective Green, g (s)		2.2		8.4	8.4			21.7		11.9	37.6	
Actuated g/C Ratio		0.04		0.14	0.14			0.36		0.20	0.62	
Clearance Time (s)		4.0		4.0	4.0			4.0		4.0	4.0	
Vehicle Extension (s)		3.0		3.0	3.0			3.0		3.0	3.0	
Lane Grp Cap (vph)		64		175	224			1146		343	2065	
v/s Ratio Prot					c0.01					c0.18	0.12	
v/s Ratio Perm		c0.05		0.01				c0.22				
v/c Ratio		1.45		0.06	0.07			0.60		0.92	0.20	
Uniform Delay, d1		29.0		22.5	22.5			15.7		23.7	4.8	
Progression Factor		1.00		1.00	1.00			1.00		1.00	1.00	
Incremental Delay, d2		269.3		0.2	0.1			0.8		28.5	0.0	
Delay (s)		298.3		22.6	22.6			16.5		52.1	4.9	
Level of Service		F		C	C			B		D	A	
Approach Delay (s)		298.3			22.6			16.5			24.8	
Approach LOS		F			C			B			C	

Intersection Summary			
HCM Average Control Delay	39.8	HCM Level of Service	D
HCM Volume to Capacity ratio	0.63		
Actuated Cycle Length (s)	60.2	Sum of lost time (s)	16.0
Intersection Capacity Utilization	56.3%	ICU Level of Service	B
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	220	46	20	21	11	41	10	370	116	49	100	160
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0		4.0	4.0		4.0	4.0	
Lane Util. Factor	1.00	0.95	1.00	1.00	0.95		1.00	0.95		1.00	0.95	
Frpb, ped/bikes	1.00	1.00	1.00	1.00	0.96		1.00	1.00		1.00	0.99	
Flpb, ped/bikes	1.00	1.00	1.00	1.00	1.00		1.00	1.00		1.00	1.00	
Frt	1.00	1.00	0.85	1.00	0.88		1.00	0.96		1.00	0.91	
Flt Protected	0.95	1.00	1.00	0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1770	3539	1583	1770	2994		1767	3402		1770	3183	
Flt Permitted	0.95	1.00	1.00	0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (perm)	1770	3539	1583	1770	2994		1767	3402		1770	3183	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	239	50	22	23	12	45	11	402	126	53	109	174
RTOR Reduction (vph)	0	0	14	0	40	0	0	37	0	0	117	0
Lane Group Flow (vph)	239	50	8	23	17	0	11	491	0	53	166	0
Confl. Peds. (#/hr)	3					3	4					4
Confl. Bikes (#/hr)						20			1			1
Turn Type	Prot		Perm	Prot			Prot			Prot		
Protected Phases	7	4		3	8		5	2		1	6	
Permitted Phases			4									
Actuated Green, G (s)	13.2	19.0	19.0	0.6	6.4		0.5	15.0		2.9	17.4	
Effective Green, g (s)	13.2	19.0	19.0	0.6	6.4		0.5	15.0		2.9	17.4	
Actuated g/C Ratio	0.25	0.36	0.36	0.01	0.12		0.01	0.28		0.05	0.33	
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0		4.0	4.0		4.0	4.0	
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	437	1257	562	20	358		17	954		96	1035	
v/s Ratio Prot	c0.14	c0.01		0.01	0.01		0.01	c0.14		c0.03	0.05	
v/s Ratio Perm			0.00									
v/c Ratio	0.55	0.04	0.01	1.15	0.05		0.65	0.51		0.55	0.16	
Uniform Delay, d1	17.5	11.3	11.2	26.4	20.9		26.4	16.2		24.7	12.8	
Progression Factor	1.00	1.00	1.00	1.00	1.00		1.00	1.00		1.00	1.00	
Incremental Delay, d2	1.4	0.0	0.0	252.2	0.1		62.0	0.5		6.7	0.1	
Delay (s)	18.9	11.3	11.2	278.6	20.9		88.4	16.7		31.4	12.9	
Level of Service	B	B	B	F	C		F	B		C	B	
Approach Delay (s)		17.2			95.0			18.1			15.8	
Approach LOS		B			F			B			B	

Intersection Summary			
HCM Average Control Delay	22.1	HCM Level of Service	C
HCM Volume to Capacity ratio	0.40		
Actuated Cycle Length (s)	53.5	Sum of lost time (s)	12.0
Intersection Capacity Utilization	46.1%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Volume (veh/h)	237	120	63	116	60	70
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	258	130	68	126	65	76
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)				1133		
pX, platoon unblocked						
vC, conflicting volume			388		521	258
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			388		521	258
tC, single (s)			4.2		6.5	6.3
tC, 2 stage (s)						
tF (s)			2.3		3.6	3.4
p0 queue free %			94		86	90
cM capacity (veh/h)			1128		472	762

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	NB 1	NB 2
Volume Total	258	130	68	126	65	76
Volume Left	0	0	68	0	65	0
Volume Right	0	130	0	0	0	76
cSH	1700	1700	1128	1700	472	762
Volume to Capacity	0.15	0.08	0.06	0.07	0.14	0.10
Queue Length 95th (ft)	0	0	5	0	12	8
Control Delay (s)	0.0	0.0	8.4	0.0	13.9	10.2
Lane LOS			A		B	B
Approach Delay (s)	0.0		3.0		11.9	
Approach LOS					B	

Intersection Summary			
Average Delay	3.1		
Intersection Capacity Utilization	29.3%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	60	120	20	20	50	89	10	20	20	117	30	160
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0		4.0	4.0			4.0	
Lane Util. Factor	1.00	1.00		1.00	1.00		1.00	1.00			1.00	
Frpb, ped/bikes	1.00	1.00		1.00	1.00		1.00	0.99			1.00	
Flpb, ped/bikes	1.00	1.00		1.00	1.00		1.00	1.00			1.00	
Frt	1.00	0.98		1.00	0.90		1.00	0.93			0.93	
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00			0.98	
Satd. Flow (prot)	1556	1602		1556	1480		1556	1497			1493	
Flt Permitted	0.95	1.00		0.95	1.00		0.60	1.00			0.87	
Satd. Flow (perm)	1556	1602		1556	1480		976	1497			1320	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	65	130	22	22	54	97	11	22	22	127	33	174
RTOR Reduction (vph)	0	11	0	0	77	0	0	14	0	0	55	0
Lane Group Flow (vph)	65	141	0	22	74	0	11	30	0	0	279	0
Confl. Peds. (#/hr)									2	2		
Confl. Bikes (#/hr)									2			
Heavy Vehicles (%)	16%	16%	16%	16%	16%	16%	16%	16%	16%	16%	16%	16%
Turn Type	Prot			Prot			Perm			Perm		
Protected Phases	7	4		3	8			2			6	
Permitted Phases							2			6		
Actuated Green, G (s)	2.0	8.3		1.0	7.3		13.4	13.4			13.4	
Effective Green, g (s)	2.0	8.3		1.0	7.3		13.4	13.4			13.4	
Actuated g/C Ratio	0.06	0.24		0.03	0.21		0.39	0.39			0.39	
Clearance Time (s)	4.0	4.0		4.0	4.0		4.0	4.0			4.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0			3.0	
Lane Grp Cap (vph)	90	383		45	311		377	578			510	
v/s Ratio Prot	c0.04	c0.09		0.01	0.05			0.02				
v/s Ratio Perm							0.01				c0.21	
v/c Ratio	0.72	0.37		0.49	0.24		0.03	0.05			0.55	
Uniform Delay, d1	16.1	11.0		16.6	11.4		6.6	6.7			8.3	
Progression Factor	1.00	1.00		1.00	1.00		1.00	1.00			1.00	
Incremental Delay, d2	24.7	0.6		8.1	0.4		0.0	0.0			1.2	
Delay (s)	40.7	11.6		24.7	11.8		6.6	6.7			9.5	
Level of Service	D	B		C	B		A	A			A	
Approach Delay (s)		20.3			13.4			6.7			9.5	
Approach LOS		C			B			A			A	

Intersection Summary			
HCM Average Control Delay	13.2	HCM Level of Service	B
HCM Volume to Capacity ratio	0.44		
Actuated Cycle Length (s)	34.7	Sum of lost time (s)	8.0
Intersection Capacity Utilization	46.0%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Volume (veh/h)	167	100	33	59	100	172
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	182	109	36	64	109	187
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)	322					
pX, platoon unblocked						
vC, conflicting volume			182		372	236
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			182		372	236
tC, single (s)			4.3		6.6	6.4
tC, 2 stage (s)						
tF (s)			2.3		3.6	3.4
p0 queue free %			97		81	76
cM capacity (veh/h)			1314		586	770

Direction, Lane #	EB 1	WB 1	WB 2	NB 1
Volume Total	290	36	64	296
Volume Left	0	36	0	109
Volume Right	109	0	0	187
cSH	1700	1314	1700	690
Volume to Capacity	0.17	0.03	0.04	0.43
Queue Length 95th (ft)	0	2	0	54
Control Delay (s)	0.0	7.8	0.0	14.1
Lane LOS		A		B
Approach Delay (s)	0.0	2.8		14.1
Approach LOS				B

Intersection Summary			
Average Delay	6.5		
Intersection Capacity Utilization	44.3%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Volume (veh/h)	180	159	210	60	32	37
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	196	173	228	65	35	40
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume			368		804	282
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			368		804	282
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			81		88	95
cM capacity (veh/h)			1174		280	750

Direction, Lane #	EB 1	WB 1	WB 2	NB 1
Volume Total	368	228	65	75
Volume Left	0	228	0	35
Volume Right	173	0	0	40
cSH	1700	1174	1700	422
Volume to Capacity	0.22	0.19	0.04	0.18
Queue Length 95th (ft)	0	18	0	16
Control Delay (s)	0.0	8.8	0.0	15.4
Lane LOS		A		C
Approach Delay (s)	0.0	6.8		15.4
Approach LOS				C

Intersection Summary			
Average Delay	4.3		
Intersection Capacity Utilization	44.9%	ICU Level of Service	A
Analysis Period (min)	15		

Intersection	
Intersection Delay, s/veh	34.6
Intersection LOS	D

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Vol, veh/h	10	10	10	420	10	20	30	280	160	127	140	10
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Heavy Vehicles, %	4	4	4	4	4	4	4	4	4	4	4	4
Mvmt Flow	11	11	11	457	11	22	33	304	174	138	152	11
Number of Lanes	0	1	0	1	1	0	1	2	0	1	2	0

Approach	EB	WB	NB	SB
Opposing Approach	WB	EB	SB	NB
Opposing Lanes	2	1	3	3
Conflicting Approach Left	SB	NB	EB	WB
Conflicting Lanes Left	3	3	1	2
Conflicting Approach Right	NB	SB	WB	EB
Conflicting Lanes Right	3	3	2	1
HCM Control Delay	12.5	66.7	17.4	14.1
HCM LOS	B	F	C	B

Lane	NBLn1	NBLn2	NBLn3	EBLn1	WBLn1	WBLn2	SBLn1	SBLn2	SBLn3
Vol Left, %	100%	0%	0%	33%	100%	0%	100%	0%	0%
Vol Thru, %	0%	100%	37%	33%	0%	33%	0%	100%	82%
Vol Right, %	0%	0%	63%	33%	0%	67%	0%	0%	18%
Sign Control	Stop	Stop	Stop	Stop	Stop	Stop	Stop	Stop	Stop
Traffic Vol by Lane	30	187	253	30	420	30	127	93	57
LT Vol	0	187	93	10	0	10	0	93	47
Through Vol	0	0	160	10	0	20	0	0	10
RT Vol	30	0	0	10	420	0	127	0	0
Lane Flow Rate	33	203	275	33	457	33	138	101	62
Geometry Grp	8	8	8	8	8	8	8	8	8
Degree of Util (X)	0.075	0.438	0.56	0.082	1	0.064	0.333	0.231	0.138
Departure Headway (Hd)	8.263	7.765	7.325	9.057	7.996	7.024	8.694	8.196	8.073
Convergence, Y/N	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Cap	437	469	496	401	457	512	417	442	448
Service Time	5.944	5.446	5.006	6.684	5.708	4.736	6.373	5.875	5.752
HCM Lane V/C Ratio	0.076	0.433	0.554	0.082	1	0.064	0.331	0.229	0.138
HCM Control Delay	11.6	16.3	18.9	12.5	70.7	10.2	15.6	13.3	12
HCM Lane LOS	B	C	C	B	F	B	C	B	B
HCM 95th-tile Q	0.2	2.2	3.4	0.3	13	0.2	1.4	0.9	0.5

Notes

~ : Volume Exceeds Capacity; $: Delay Exceeds 300 Seconds; Error : Computation Not Defined

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	0	0	178	10	70	20	550	0	0	282	420
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)				4.0	4.0		4.0	4.0			4.0	
Lane Util. Factor				1.00	1.00		1.00	0.95			0.95	
Frpb, ped/bikes				1.00	1.00		1.00	1.00			0.99	
Flpb, ped/bikes				1.00	1.00		1.00	1.00			1.00	
Frt				1.00	0.87		1.00	1.00			0.91	
Flt Protected				0.95	1.00		0.95	1.00			1.00	
Satd. Flow (prot)				1736	1588		1736	3471			3118	
Flt Permitted				0.95	1.00		0.95	1.00			1.00	
Satd. Flow (perm)				1736	1588		1736	3471			3118	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	0	0	0	193	11	76	22	598	0	0	307	457
RTOR Reduction (vph)	0	0	0	0	60	0	0	0	0	0	278	0
Lane Group Flow (vph)	0	0	0	193	27	0	22	598	0	0	486	0
Confl. Peds. (#/hr)							1					1
Confl. Bikes (#/hr)									2			1
Heavy Vehicles (%)	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%
Turn Type				Split			Prot					
Protected Phases				8	8		5	2			6	
Permitted Phases												
Actuated Green, G (s)				7.5	7.5		2.0	19.8			13.8	
Effective Green, g (s)				7.5	7.5		2.0	19.8			13.8	
Actuated g/C Ratio				0.21	0.21		0.06	0.56			0.39	
Clearance Time (s)				4.0	4.0		4.0	4.0			4.0	
Vehicle Extension (s)				3.0	3.0		3.0	3.0			3.0	
Lane Grp Cap (vph)				369	337		98	1947			1219	
v/s Ratio Prot				c0.11	0.02		0.01	c0.17			c0.16	
v/s Ratio Perm												
v/c Ratio				0.52	0.08		0.22	0.31			0.40	
Uniform Delay, d1				12.3	11.1		15.9	4.1			7.8	
Progression Factor				1.00	1.00		1.00	1.00			1.00	
Incremental Delay, d2				1.3	0.1		1.2	0.1			0.2	
Delay (s)				13.7	11.2		17.1	4.2			8.0	
Level of Service				B	B		B	A			A	
Approach Delay (s)		0.0			12.9			4.7			8.0	
Approach LOS		A			B			A			A	

Intersection Summary			
HCM Average Control Delay	7.6	HCM Level of Service	A
HCM Volume to Capacity ratio	0.45		
Actuated Cycle Length (s)	35.3	Sum of lost time (s)	12.0
Intersection Capacity Utilization	37.9%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	10	390	160	412	100	30	60	70	500	50	140	20
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0		4.0	4.0	4.0		4.0	
Lane Util. Factor	1.00	0.95		0.91	0.91		0.95	0.95	1.00		1.00	
Frpb, ped/bikes	1.00	1.00		1.00	1.00		1.00	1.00	0.99		1.00	
Flpb, ped/bikes	1.00	1.00		1.00	1.00		1.00	1.00	1.00		1.00	
Frt	1.00	0.96		1.00	0.99		1.00	1.00	0.85		0.99	
Flt Protected	0.95	1.00		0.95	0.97		0.95	1.00	1.00		0.99	
Satd. Flow (prot)	1752	3339		1595	3207		1665	1745	1547		1797	
Flt Permitted	0.95	1.00		0.95	0.97		0.95	1.00	1.00		0.99	
Satd. Flow (perm)	1752	3339		1595	3207		1665	1745	1547		1797	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	11	424	174	448	109	33	65	76	543	54	152	22
RTOR Reduction (vph)	0	45	0	0	7	0	0	0	453	0	4	0
Lane Group Flow (vph)	11	553	0	224	359	0	58	83	90	0	224	0
Confl. Peds. (#/hr)	1					1			2	2		
Confl. Bikes (#/hr)			1			1						1
Heavy Vehicles (%)	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%
Turn Type	Split			Split			Split		Perm	Split		
Protected Phases	4	4		8	8		2	2		6	6	
Permitted Phases									2			
Actuated Green, G (s)	16.9	16.9		15.5	15.5		12.4	12.4	12.4		13.8	
Effective Green, g (s)	16.9	16.9		15.5	15.5		12.4	12.4	12.4		13.8	
Actuated g/C Ratio	0.23	0.23		0.21	0.21		0.17	0.17	0.17		0.18	
Clearance Time (s)	4.0	4.0		4.0	4.0		4.0	4.0	4.0		4.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0	3.0		3.0	
Lane Grp Cap (vph)	397	756		331	666		277	290	257		332	
v/s Ratio Prot	0.01	c0.17		c0.14	0.11		0.03	0.05			c0.12	
v/s Ratio Perm									c0.06			
v/c Ratio	0.03	0.73		0.68	0.54		0.21	0.29	0.35		0.67	
Uniform Delay, d1	22.5	26.7		27.2	26.4		26.9	27.2	27.5		28.3	
Progression Factor	1.00	1.00		1.00	1.00		1.00	1.00	1.00		1.00	
Incremental Delay, d2	0.0	3.7		5.4	0.8		0.4	0.5	0.8		5.3	
Delay (s)	22.5	30.4		32.6	27.2		27.2	27.8	28.4		33.6	
Level of Service	C	C		C	C		C	C	C		C	
Approach Delay (s)		30.3			29.3			28.2			33.6	
Approach LOS		C			C			C			C	

Intersection Summary			
HCM Average Control Delay	29.7	HCM Level of Service	C
HCM Volume to Capacity ratio	0.62		
Actuated Cycle Length (s)	74.6	Sum of lost time (s)	16.0
Intersection Capacity Utilization	68.4%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	850	160	100	336	0	0	0	0	420	30	276
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0			4.0						4.0	
Lane Util. Factor		0.95			0.95						1.00	
Frpb, ped/bikes		1.00			1.00						1.00	
Flpb, ped/bikes		1.00			1.00						1.00	
Frt		0.98			1.00						0.95	
Flt Protected		1.00			0.99						0.97	
Satd. Flow (prot)		3438			3498						1718	
Flt Permitted		1.00			0.56						0.97	
Satd. Flow (perm)		3438			1974						1718	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	0	924	174	109	365	0	0	0	0	457	33	300
RTOR Reduction (vph)	0	27	0	0	0	0	0	0	0	0	35	0
Lane Group Flow (vph)	0	1071	0	0	474	0	0	0	0	0	755	0
Confl. Peds. (#/hr)	5		9	9		5						
Confl. Bikes (#/hr)						2						
Turn Type				Perm						Split		
Protected Phases		4			8					6	6	
Permitted Phases				8								
Actuated Green, G (s)		23.7			23.7						28.3	
Effective Green, g (s)		23.7			23.7						28.3	
Actuated g/C Ratio		0.39			0.39						0.47	
Clearance Time (s)		4.0			4.0						4.0	
Vehicle Extension (s)		3.0			3.0						3.0	
Lane Grp Cap (vph)		1358			780						810	
v/s Ratio Prot		c0.31									c0.44	
v/s Ratio Perm					0.24							
v/c Ratio		0.79			0.88dl						0.93	
Uniform Delay, d1		16.0			14.4						14.9	
Progression Factor		1.00			1.00						1.00	
Incremental Delay, d2		3.1			1.3						18.8	
Delay (s)		19.1			15.8						33.7	
Level of Service		B			B						C	
Approach Delay (s)		19.1			15.8			0.0			33.7	
Approach LOS		B			B			A			C	

Intersection Summary			
HCM Average Control Delay	23.3	HCM Level of Service	C
HCM Volume to Capacity ratio	0.87		
Actuated Cycle Length (s)	60.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	94.0%	ICU Level of Service	F
Analysis Period (min)	15		

dl Defacto Left Lane. Recode with 1 though lane as a left lane.
c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	239	1031	0	0	396	410	40	10	80	0	0	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0			4.0		4.0	4.0	4.0			
Lane Util. Factor		0.95			0.95		0.95	0.95	1.00			
Frpb, ped/bikes		1.00			0.99		1.00	1.00	1.00			
Flpb, ped/bikes		1.00			1.00		1.00	1.00	1.00			
Frt		1.00			0.92		1.00	1.00	0.85			
Flt Protected		0.99			1.00		0.95	0.97	1.00			
Satd. Flow (prot)		3505			3227		1681	1719	1583			
Flt Permitted		0.62			1.00		0.95	0.97	1.00			
Satd. Flow (perm)		2189			3227		1681	1719	1583			
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	260	1121	0	0	430	446	43	11	87	0	0	0
RTOR Reduction (vph)	0	0	0	0	135	0	0	0	69	0	0	0
Lane Group Flow (vph)	0	1381	0	0	741	0	27	27	18	0	0	0
Confl. Peds. (#/hr)	5		7	7		5			1	1		
Confl. Bikes (#/hr)						3						
Turn Type	Perm						Split		Prot			
Protected Phases		4			8		2	2	2			
Permitted Phases	4											
Actuated Green, G (s)		55.8			55.8		16.2	16.2	16.2			
Effective Green, g (s)		55.8			55.8		16.2	16.2	16.2			
Actuated g/C Ratio		0.70			0.70		0.20	0.20	0.20			
Clearance Time (s)		4.0			4.0		4.0	4.0	4.0			
Vehicle Extension (s)		3.0			3.0		3.0	3.0	3.0			
Lane Grp Cap (vph)		1527			2251		340	348	321			
v/s Ratio Prot					0.23		c0.02	0.02	0.01			
v/s Ratio Perm		c0.63										
v/c Ratio		0.90			0.33		0.08	0.08	0.05			
Uniform Delay, d1		9.9			4.8		25.9	25.8	25.7			
Progression Factor		1.00			1.00		1.00	1.00	1.00			
Incremental Delay, d2		7.9			0.1		0.5	0.4	0.3			
Delay (s)		17.8			4.8		26.3	26.3	26.1			
Level of Service		B			A		C	C	C			
Approach Delay (s)		17.8			4.8			26.1			0.0	
Approach LOS		B			A			C			A	

Intersection Summary			
HCM Average Control Delay	13.6	HCM Level of Service	B
HCM Volume to Capacity ratio	0.72		
Actuated Cycle Length (s)	80.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	86.1%	ICU Level of Service	E
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	100	410	61	180	363	146	106	812	210	101	322	50
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	4.0	4.0	3.0	4.0	4.0	3.0	3.0	3.0	3.0	3.0	
Lane Util. Factor	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	
Frpb, ped/bikes	1.00	1.00	0.97	1.00	1.00	0.98	1.00	1.00	0.91	1.00	1.00	
Flpb, ped/bikes	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	0.98	
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	
Satd. Flow (prot)	1770	3539	1539	1770	3539	1557	1770	3539	1438	1770	3461	
Flt Permitted	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	
Satd. Flow (perm)	1770	3539	1539	1770	3539	1557	1770	3539	1438	1770	3461	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	109	446	66	196	395	159	115	883	228	110	350	54
RTOR Reduction (vph)	0	0	30	0	0	108	0	0	111	0	16	0
Lane Group Flow (vph)	109	446	36	196	395	51	115	883	117	110	388	0
Confl. Peds. (#/hr)	5		19	19		5	4		14	14		4
Confl. Bikes (#/hr)						1			100			
Turn Type	Prot		Perm	Prot		Perm	Prot		Perm	Prot		
Protected Phases	5	2		1	6		3	8		7	4	
Permitted Phases			2			6			8			
Actuated Green, G (s)	5.4	17.4	17.4	9.9	19.9	19.9	6.1	21.6	21.6	6.1	21.6	
Effective Green, g (s)	5.4	17.4	17.4	9.9	19.9	19.9	6.1	21.6	21.6	6.1	21.6	
Actuated g/C Ratio	0.08	0.26	0.26	0.15	0.29	0.29	0.09	0.32	0.32	0.09	0.32	
Clearance Time (s)	5.0	4.0	4.0	3.0	4.0	4.0	3.0	3.0	3.0	3.0	3.0	
Vehicle Extension (s)	2.0	4.0	4.0	2.0	4.0	4.0	2.0	2.0	2.0	2.0	2.0	
Lane Grp Cap (vph)	141	906	394	258	1036	456	159	1124	457	159	1099	
v/s Ratio Prot	0.06	c0.13		c0.11	0.11		c0.06	c0.25		0.06	0.11	
v/s Ratio Perm			0.02			0.03			0.08			
v/c Ratio	0.77	0.49	0.09	0.76	0.38	0.11	0.72	0.79	0.26	0.69	0.35	
Uniform Delay, d1	30.7	21.5	19.3	27.9	19.1	17.6	30.1	21.1	17.2	30.0	17.8	
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	
Incremental Delay, d2	20.9	0.6	0.1	10.8	0.3	0.1	12.9	3.4	0.1	10.0	0.1	
Delay (s)	51.6	22.1	19.4	38.7	19.5	17.7	43.0	24.5	17.3	40.0	17.9	
Level of Service	D	C	B	D	B	B	D	C	B	D	B	
Approach Delay (s)		27.0			24.1			24.9			22.6	
Approach LOS		C			C			C			C	

Intersection Summary			
HCM Average Control Delay	24.8	HCM Level of Service	C
HCM Volume to Capacity ratio	0.65		
Actuated Cycle Length (s)	68.0	Sum of lost time (s)	13.0
Intersection Capacity Utilization	66.7%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	0	0	300	10	679	0	499	140	0	433	140
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)				4.0	4.0	4.0		4.0	4.0		4.0	
Lane Util. Factor				0.95	0.91	0.95		0.91	1.00		0.91	
Frt				1.00	0.87	0.85		1.00	0.85		0.96	
Flt Protected				0.95	1.00	1.00		1.00	1.00		1.00	
Satd. Flow (prot)				1698	1478	1519		5136	1599		4947	
Flt Permitted				0.95	1.00	1.00		1.00	1.00		1.00	
Satd. Flow (perm)				1698	1478	1519		5136	1599		4947	
Peak-hour factor, PHF	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94
Adj. Flow (vph)	0	0	0	319	11	722	0	531	149	0	461	149
RTOR Reduction (vph)	0	0	0	0	95	95	0	0	0	0	102	0
Lane Group Flow (vph)	0	0	0	287	287	288	0	531	149	0	508	0
Heavy Vehicles (%)	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%
Turn Type				Split		Perm			Free			
Protected Phases				8	8			2			6	
Permitted Phases						8			Free			
Actuated Green, G (s)				16.2	16.2	16.2		10.5	34.7		10.5	
Effective Green, g (s)				16.2	16.2	16.2		10.5	34.7		10.5	
Actuated g/C Ratio				0.47	0.47	0.47		0.30	1.00		0.30	
Clearance Time (s)				4.0	4.0	4.0		4.0			4.0	
Vehicle Extension (s)				3.0	3.0	3.0		3.0			3.0	
Lane Grp Cap (vph)				793	690	709		1554	1599		1497	
v/s Ratio Prot				0.17	c0.19			c0.10			0.10	
v/s Ratio Perm						0.19			0.09			
v/c Ratio				0.36	0.42	0.41		0.34	0.09		0.34	
Uniform Delay, d1				5.9	6.1	6.1		9.4	0.0		9.4	
Progression Factor				1.00	1.00	1.00		1.00	1.00		1.00	
Incremental Delay, d2				0.3	0.4	0.4		0.1	0.1		0.1	
Delay (s)				6.2	6.5	6.5		9.5	0.1		9.5	
Level of Service				A	A	A		A	A		A	
Approach Delay (s)		0.0			6.4			7.5			9.5	
Approach LOS		A			A			A			A	

Intersection Summary			
HCM Average Control Delay	7.5	HCM Level of Service	A
HCM Volume to Capacity ratio	0.39		
Actuated Cycle Length (s)	34.7	Sum of lost time (s)	8.0
Intersection Capacity Utilization	44.3%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	260	0	170	0	0	0	0	379	370	0	481	261
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0		4.0					4.0			4.0	4.0
Lane Util. Factor	1.00		1.00					0.91			0.95	1.00
Frpb, ped/bikes	1.00		1.00					0.99			1.00	0.98
Flpb, ped/bikes	1.00		1.00					1.00			1.00	1.00
Frt	1.00		0.85					0.93			1.00	0.85
Flt Protected	0.95		1.00					1.00			1.00	1.00
Satd. Flow (prot)	1770		1583					4649			3539	1549
Flt Permitted	0.95		1.00					1.00			1.00	1.00
Satd. Flow (perm)	1770		1583					4649			3539	1549
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	283	0	185	0	0	0	0	412	402	0	523	284
RTOR Reduction (vph)	0	0	100	0	0	0	0	254	0	0	0	0
Lane Group Flow (vph)	283	0	85	0	0	0	0	560	0	0	523	284
Confl. Peds. (#/hr)							4		2	2		4
Confl. Bikes (#/hr)									3			
Turn Type	Split		Perm									Free
Protected Phases	8	8						2			6	
Permitted Phases			8									Free
Actuated Green, G (s)	12.4		12.4					11.9			11.9	32.3
Effective Green, g (s)	12.4		12.4					11.9			11.9	32.3
Actuated g/C Ratio	0.38		0.38					0.37			0.37	1.00
Clearance Time (s)	4.0		4.0					4.0			4.0	
Vehicle Extension (s)	3.0		3.0					3.0			3.0	
Lane Grp Cap (vph)	680		608					1713			1304	1549
v/s Ratio Prot	c0.16							0.12			c0.15	
v/s Ratio Perm			0.05									0.18
v/c Ratio	0.42		0.14					0.33			0.40	0.18
Uniform Delay, d1	7.3		6.5					7.3			7.6	0.0
Progression Factor	1.00		1.00					1.00			1.00	1.00
Incremental Delay, d2	0.4		0.1					0.1			0.2	0.3
Delay (s)	7.7		6.6					7.4			7.8	0.3
Level of Service	A		A					A			A	A
Approach Delay (s)		7.3			0.0			7.4			5.1	
Approach LOS		A			A			A			A	

Intersection Summary			
HCM Average Control Delay	6.5	HCM Level of Service	A
HCM Volume to Capacity ratio	0.41		
Actuated Cycle Length (s)	32.3	Sum of lost time (s)	8.0
Intersection Capacity Utilization	36.8%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	170	10	70	20	20	230	30	349	10	20	531	110
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0		4.0	4.0			4.0		4.0	4.0	
Lane Util. Factor		1.00		1.00	1.00			0.95		1.00	0.95	
Frpb, ped/bikes		0.99		1.00	0.99			1.00		1.00	1.00	
Flpb, ped/bikes		1.00		1.00	1.00			1.00		0.94	1.00	
Frt		0.96		1.00	0.86			1.00		1.00	0.97	
Flt Protected		0.97		0.95	1.00			1.00		0.95	1.00	
Satd. Flow (prot)		1703		1751	1571			3475		1646	3402	
Flt Permitted		1.00		0.59	1.00			0.88		0.95	1.00	
Satd. Flow (perm)		1761		1091	1571			3062		1646	3402	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	185	11	76	22	22	250	33	379	11	22	577	120
RTOR Reduction (vph)	0	14	0	0	188	0	0	1	0	0	16	0
Lane Group Flow (vph)	0	258	0	22	84	0	0	422	0	22	681	0
Confl. Peds. (#/hr)	1		3	3		1			5	5		
Confl. Bikes (#/hr)						1			2			1
Heavy Vehicles (%)	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%
Turn Type	Perm			Perm			Perm			Prot		
Protected Phases		3			4			2		1	6	
Permitted Phases	3			4			2					
Actuated Green, G (s)		2.4		11.4	11.4			15.4		0.8	20.2	
Effective Green, g (s)		2.4		11.4	11.4			15.4		0.8	20.2	
Actuated g/C Ratio		0.05		0.25	0.25			0.33		0.02	0.44	
Clearance Time (s)		4.0		4.0	4.0			4.0		4.0	4.0	
Vehicle Extension (s)		3.0		3.0	3.0			3.0		3.0	3.0	
Lane Grp Cap (vph)		92		270	389			1025		29	1494	
v/s Ratio Prot					c0.05					0.01	c0.20	
v/s Ratio Perm		c0.15		0.02				0.14				
v/c Ratio		2.80		0.08	0.22			0.41		0.76	0.46	
Uniform Delay, d1		21.8		13.3	13.7			11.8		22.5	9.0	
Progression Factor		1.00		1.00	1.00			1.00		1.00	1.00	
Incremental Delay, d2		840.3		0.1	0.3			0.3		71.7	0.2	
Delay (s)		862.1		13.4	14.0			12.1		94.2	9.3	
Level of Service		F		B	B			B		F	A	
Approach Delay (s)		862.1			14.0			12.1			11.9	
Approach LOS		F			B			B			B	

Intersection Summary			
HCM Average Control Delay	147.7	HCM Level of Service	F
HCM Volume to Capacity ratio	0.54		
Actuated Cycle Length (s)	46.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	73.2%	ICU Level of Service	D
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	170	21	30	46	46	39	30	160	51	21	350	210
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0		4.0	4.0		4.0	4.0	
Lane Util. Factor	1.00	0.95	1.00	1.00	0.95		1.00	0.95		1.00	0.95	
Frpb, ped/bikes	1.00	1.00	1.00	1.00	0.99		1.00	1.00		1.00	0.99	
Flpb, ped/bikes	1.00	1.00	1.00	1.00	1.00		1.00	1.00		1.00	1.00	
Frt	1.00	1.00	0.85	1.00	0.93		1.00	0.96		1.00	0.94	
Flt Protected	0.95	1.00	1.00	0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1770	3539	1583	1770	3273		1770	3399		1770	3314	
Flt Permitted	0.95	1.00	1.00	0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (perm)	1770	3539	1583	1770	3273		1770	3399		1770	3314	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	179	22	32	48	48	41	32	168	54	22	368	221
RTOR Reduction (vph)	0	0	24	0	37	0	0	33	0	0	117	0
Lane Group Flow (vph)	179	22	8	48	52	0	32	189	0	22	472	0
Confl. Peds. (#/hr)							16		1	1		16
Confl. Bikes (#/hr)						1			1			
Turn Type	Prot		Perm	Prot			Prot			Prot		
Protected Phases	7	4		3	8		5	2		1	6	
Permitted Phases			4									
Actuated Green, G (s)	9.2	11.7	11.7	1.7	4.2		1.4	14.2		1.0	13.8	
Effective Green, g (s)	9.2	11.7	11.7	1.7	4.2		1.4	14.2		1.0	13.8	
Actuated g/C Ratio	0.21	0.26	0.26	0.04	0.09		0.03	0.32		0.02	0.31	
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0		4.0	4.0		4.0	4.0	
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	365	928	415	67	308		56	1082		40	1025	
v/s Ratio Prot	c0.10	0.01		0.03	c0.02		c0.02	0.06		0.01	c0.14	
v/s Ratio Perm			0.01									
v/c Ratio	0.49	0.02	0.02	0.72	0.17		0.57	0.17		0.55	0.46	
Uniform Delay, d1	15.6	12.2	12.2	21.2	18.6		21.3	11.0		21.6	12.4	
Progression Factor	1.00	1.00	1.00	1.00	1.00		1.00	1.00		1.00	1.00	
Incremental Delay, d2	1.0	0.0	0.0	30.4	0.3		13.3	0.1		15.3	0.3	
Delay (s)	16.7	12.2	12.2	51.6	18.9		34.6	11.0		36.9	12.7	
Level of Service	B	B	B	D	B		C	B		D	B	
Approach Delay (s)		15.6			30.3			14.0			13.6	
Approach LOS		B			C			B			B	

Intersection Summary			
HCM Average Control Delay	15.9	HCM Level of Service	B
HCM Volume to Capacity ratio	0.43		
Actuated Cycle Length (s)	44.6	Sum of lost time (s)	16.0
Intersection Capacity Utilization	47.7%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Volume (veh/h)	85	50	106	205	180	70
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	92	54	115	223	196	76
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)				1133		
pX, platoon unblocked						
vC, conflicting volume			147		546	92
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			147		546	92
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			92		57	92
cM capacity (veh/h)			1423		455	959

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	NB 1	NB 2
Volume Total	92	54	115	223	196	76
Volume Left	0	0	115	0	196	0
Volume Right	0	54	0	0	0	76
cSH	1700	1700	1423	1700	455	959
Volume to Capacity	0.05	0.03	0.08	0.13	0.43	0.08
Queue Length 95th (ft)	0	0	7	0	53	6
Control Delay (s)	0.0	0.0	7.8	0.0	18.7	9.1
Lane LOS			A		C	A
Approach Delay (s)	0.0		2.6		16.0	
Approach LOS					C	

Intersection Summary			
Average Delay	6.9		
Intersection Capacity Utilization	29.2%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	110	32	10	10	50	181	20	20	10	85	20	60
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0		4.0	4.0			4.0	
Lane Util. Factor	1.00	1.00		1.00	1.00		1.00	1.00			1.00	
Frt	1.00	0.96		1.00	0.88		1.00	0.95			0.95	
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00			0.97	
Satd. Flow (prot)	1626	1650		1626	1510		1626	1626			1587	
Flt Permitted	0.95	1.00		0.95	1.00		0.77	1.00			0.82	
Satd. Flow (perm)	1626	1650		1626	1510		1322	1626			1336	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	120	35	11	11	54	197	22	22	11	92	22	65
RTOR Reduction (vph)	0	7	0	0	150	0	0	8	0	0	36	0
Lane Group Flow (vph)	120	39	0	11	101	0	22	25	0	0	143	0
Heavy Vehicles (%)	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%
Turn Type	Prot			Prot			Perm			Perm		
Protected Phases	7	4		3	8			2			6	
Permitted Phases							2			6		
Actuated Green, G (s)	4.3	11.0		0.9	7.6		7.7	7.7			7.7	
Effective Green, g (s)	4.3	11.0		0.9	7.6		7.7	7.7			7.7	
Actuated g/C Ratio	0.14	0.35		0.03	0.24		0.24	0.24			0.24	
Clearance Time (s)	4.0	4.0		4.0	4.0		4.0	4.0			4.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0			3.0	
Lane Grp Cap (vph)	221	574		46	363		322	396			326	
v/s Ratio Prot	c0.07	c0.02		0.01	c0.07			0.02				
v/s Ratio Perm							0.02				c0.11	
v/c Ratio	0.54	0.07		0.24	0.28		0.07	0.06			0.44	
Uniform Delay, d1	12.7	6.9		15.0	9.8		9.2	9.2			10.1	
Progression Factor	1.00	1.00		1.00	1.00		1.00	1.00			1.00	
Incremental Delay, d2	2.7	0.1		2.7	0.4		0.1	0.1			1.0	
Delay (s)	15.4	6.9		17.7	10.2		9.3	9.2			11.1	
Level of Service	B	A		B	B		A	A			B	
Approach Delay (s)		13.1			10.5			9.3			11.1	
Approach LOS		B			B			A			B	

Intersection Summary			
HCM Average Control Delay	11.2	HCM Level of Service	B
HCM Volume to Capacity ratio	0.44		
Actuated Cycle Length (s)	31.6	Sum of lost time (s)	16.0
Intersection Capacity Utilization	46.0%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Volume (veh/h)	57	60	71	151	80	63
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	62	65	77	164	87	68
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)	322					
pX, platoon unblocked						
vC, conflicting volume			62		413	95
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			62		413	95
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			95		85	93
cM capacity (veh/h)			1541		566	962

Direction, Lane #	EB 1	WB 1	WB 2	NB 1
Volume Total	127	77	164	155
Volume Left	0	77	0	87
Volume Right	65	0	0	68
cSH	1700	1541	1700	691
Volume to Capacity	0.07	0.05	0.10	0.22
Queue Length 95th (ft)	0	4	0	21
Control Delay (s)	0.0	7.5	0.0	11.7
Lane LOS		A		B
Approach Delay (s)	0.0	2.4		11.7
Approach LOS				B

Intersection Summary			
Average Delay	4.6		
Intersection Capacity Utilization	25.6%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Volume (veh/h)	90	30	35	70	152	201
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	98	33	38	76	165	218
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume			130		266	114
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			130		266	114
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			97		77	77
cM capacity (veh/h)			1455		704	938

Direction, Lane #	EB 1	WB 1	WB 2	NB 1
Volume Total	130	38	76	384
Volume Left	0	38	0	165
Volume Right	33	0	0	218
cSH	1700	1455	1700	821
Volume to Capacity	0.08	0.03	0.04	0.47
Queue Length 95th (ft)	0	2	0	63
Control Delay (s)	0.0	7.5	0.0	13.2
Lane LOS		A		B
Approach Delay (s)	0.0	2.5		13.2
Approach LOS				B

Intersection Summary			
Average Delay	8.5		
Intersection Capacity Utilization	36.0%	ICU Level of Service	A
Analysis Period (min)	15		

Intersection	
Intersection Delay, s/veh	26.5
Intersection LOS	D

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Vol, veh/h	10	20	10	430	10	20	10	75	70	163	139	10
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Heavy Vehicles, %	2	2	2	2	2	2	2	2	2	2	2	2
Mvmt Flow	11	22	11	467	11	22	11	82	76	177	151	11
Number of Lanes	0	1	0	1	1	0	1	2	0	1	2	0

Approach	EB	WB	NB	SB
Opposing Approach	WB	EB	SB	NB
Opposing Lanes	2	1	3	3
Conflicting Approach Left	SB	NB	EB	WB
Conflicting Lanes Left	3	3	1	2
Conflicting Approach Right	NB	SB	WB	EB
Conflicting Lanes Right	3	3	2	1
HCM Control Delay	11.2	41.7	11.6	13.3
HCM LOS	B	E	B	B

Lane	NBLn1	NBLn2	NBLn3	EBLn1	WBLn1	WBLn2	SBLn1	SBLn2	SBLn3
Vol Left, %	100%	0%	0%	25%	100%	0%	100%	0%	0%
Vol Thru, %	0%	100%	26%	50%	0%	33%	0%	100%	82%
Vol Right, %	0%	0%	74%	25%	0%	67%	0%	0%	18%
Sign Control	Stop	Stop	Stop	Stop	Stop	Stop	Stop	Stop	Stop
Traffic Vol by Lane	10	50	95	40	430	30	163	93	56
LT Vol	0	50	25	20	0	10	0	93	46
Through Vol	0	0	70	10	0	20	0	0	10
RT Vol	10	0	0	10	430	0	163	0	0
Lane Flow Rate	11	54	103	43	467	33	177	101	61
Geometry Grp	8	8	8	8	8	8	8	8	8
Degree of Util (X)	0.025	0.116	0.205	0.093	0.894	0.054	0.38	0.202	0.121
Departure Headway (Hd)	8.203	7.687	7.155	7.731	6.985	6.017	7.728	7.215	7.087
Convergence, Y/N	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Cap	438	468	504	465	523	599	468	500	508
Service Time	5.917	5.402	4.87	5.456	4.685	3.717	5.439	4.925	4.798
HCM Lane V/C Ratio	0.025	0.115	0.204	0.092	0.893	0.055	0.378	0.202	0.12
HCM Control Delay	11.1	11.4	11.7	11.2	44	9.1	15.1	11.7	10.8
HCM Lane LOS	B	B	B	B	E	A	C	B	B
HCM 95th-tile Q	0.1	0.4	0.8	0.3	10.2	0.2	1.8	0.7	0.4

Notes

~ : Volume Exceeds Capacity; $: Delay Exceeds 300 Seconds; Error : Computation Not Defined

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	0	0	56	10	450	20	559	0	0	99	300
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)				4.0	4.0		4.0	4.0			4.0	
Lane Util. Factor				1.00	1.00		1.00	0.95			0.95	
Frpb, ped/bikes				1.00	1.00		1.00	1.00			0.98	
Flpb, ped/bikes				1.00	1.00		1.00	1.00			1.00	
Frt				1.00	0.85		1.00	1.00			0.89	
Flt Protected				0.95	1.00		0.95	1.00			1.00	
Satd. Flow (prot)				1787	1605		1787	3574			3119	
Flt Permitted				0.95	1.00		0.95	1.00			1.00	
Satd. Flow (perm)				1787	1605		1787	3574			3119	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	0	0	0	59	11	474	21	588	0	0	104	316
RTOR Reduction (vph)	0	0	0	0	219	0	0	0	0	0	216	0
Lane Group Flow (vph)	0	0	0	59	266	0	21	588	0	0	204	0
Confl. Peds. (#/hr)							1		2	2		1
Confl. Bikes (#/hr)			1						1			
Heavy Vehicles (%)	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%
Turn Type				Split			Prot					
Protected Phases				8	8		5	2			6	
Permitted Phases												
Actuated Green, G (s)				11.2	11.2		2.3	18.1			11.8	
Effective Green, g (s)				11.2	11.2		2.3	18.1			11.8	
Actuated g/C Ratio				0.30	0.30		0.06	0.49			0.32	
Clearance Time (s)				4.0	4.0		4.0	4.0			4.0	
Vehicle Extension (s)				3.0	3.0		3.0	3.0			3.0	
Lane Grp Cap (vph)				537	482		110	1734			987	
v/s Ratio Prot				0.03	c0.17		0.01	c0.16			0.07	
v/s Ratio Perm												
v/c Ratio				0.11	0.55		0.19	0.34			0.21	
Uniform Delay, d1				9.4	10.9		16.6	5.9			9.3	
Progression Factor				1.00	1.00		1.00	1.00			1.00	
Incremental Delay, d2				0.1	1.4		0.8	0.1			0.1	
Delay (s)				9.5	12.3		17.5	6.0			9.4	
Level of Service				A	B		B	A			A	
Approach Delay (s)		0.0			12.0			6.4			9.4	
Approach LOS		A			B			A			A	

Intersection Summary			
HCM Average Control Delay	9.2	HCM Level of Service	A
HCM Volume to Capacity ratio	0.42		
Actuated Cycle Length (s)	37.3	Sum of lost time (s)	8.0
Intersection Capacity Utilization	51.7%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	40	260	70	289	290	50	310	180	519	20	40	50
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0		4.0	4.0	4.0		4.0	
Lane Util. Factor	1.00	0.95		0.91	0.91		0.95	0.95	1.00		1.00	
Frpb, ped/bikes	1.00	1.00		1.00	1.00		1.00	1.00	0.99		1.00	
Flpb, ped/bikes	1.00	1.00		1.00	1.00		1.00	1.00	1.00		1.00	
Frt	1.00	0.97		1.00	0.98		1.00	1.00	0.85		0.94	
Flt Protected	0.95	1.00		0.95	0.99		0.95	0.99	1.00		0.99	
Satd. Flow (prot)	1787	3461		1626	3330		1698	1763	1576		1749	
Flt Permitted	0.95	1.00		0.95	0.99		0.95	0.99	1.00		0.99	
Satd. Flow (perm)	1787	3461		1626	3330		1698	1763	1576		1749	
Peak-hour factor, PHF	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97
Adj. Flow (vph)	41	268	72	298	299	52	320	186	535	21	41	52
RTOR Reduction (vph)	0	26	0	0	11	0	0	0	390	0	34	0
Lane Group Flow (vph)	41	314	0	215	423	0	250	256	145	0	80	0
Confl. Peds. (#/hr)									2	2		
Confl. Bikes (#/hr)									1			
Heavy Vehicles (%)	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%
Turn Type	Split			Split			Split		Perm	Split		
Protected Phases	4	4		8	8		2	2		6	6	
Permitted Phases									2			
Actuated Green, G (s)	12.3	12.3		16.1	16.1		19.2	19.2	19.2		7.2	
Effective Green, g (s)	12.3	12.3		16.1	16.1		19.2	19.2	19.2		7.2	
Actuated g/C Ratio	0.17	0.17		0.23	0.23		0.27	0.27	0.27		0.10	
Clearance Time (s)	4.0	4.0		4.0	4.0		4.0	4.0	4.0		4.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0	3.0		3.0	
Lane Grp Cap (vph)	310	601		370	757		460	478	427		178	
v/s Ratio Prot	0.02	c0.09		c0.13	0.13		c0.15	0.15			c0.05	
v/s Ratio Perm									0.09			
v/c Ratio	0.13	0.52		0.58	0.56		0.54	0.54	0.34		0.45	
Uniform Delay, d1	24.7	26.6		24.3	24.2		22.1	22.0	20.7		29.9	
Progression Factor	1.00	1.00		1.00	1.00		1.00	1.00	1.00		1.00	
Incremental Delay, d2	0.2	0.8		2.3	0.9		1.3	1.2	0.5		1.8	
Delay (s)	24.9	27.4		26.7	25.1		23.4	23.2	21.2		31.7	
Level of Service	C	C		C	C		C	C	C		C	
Approach Delay (s)		27.1			25.6			22.2			31.7	
Approach LOS		C			C			C			C	

Intersection Summary			
HCM Average Control Delay	24.6	HCM Level of Service	C
HCM Volume to Capacity ratio	0.54		
Actuated Cycle Length (s)	70.8	Sum of lost time (s)	16.0
Intersection Capacity Utilization	58.0%	ICU Level of Service	B
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	679	150	90	451	0	0	0	0	360	10	248
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0			4.0						4.0	
Lane Util. Factor		0.95			0.95						1.00	
Frpb, ped/bikes		0.99			1.00						1.00	
Flpb, ped/bikes		1.00			1.00						1.00	
Frt		0.97			1.00						0.95	
Flt Protected		1.00			0.99						0.97	
Satd. Flow (prot)		3459			3543						1729	
Flt Permitted		1.00			0.65						0.97	
Satd. Flow (perm)		3459			2339						1729	
Peak-hour factor, PHF	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96
Adj. Flow (vph)	0	707	156	94	470	0	0	0	0	375	10	258
RTOR Reduction (vph)	0	40	0	0	0	0	0	0	0	0	37	0
Lane Group Flow (vph)	0	823	0	0	564	0	0	0	0	0	606	0
Confl. Peds. (#/hr)	3		8	8		3						
Confl. Bikes (#/hr)						3						
Heavy Vehicles (%)	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%
Turn Type				Perm						Split		
Protected Phases		4			8					6	6	
Permitted Phases				8								
Actuated Green, G (s)		20.1			20.1						26.9	
Effective Green, g (s)		20.1			20.1						26.9	
Actuated g/C Ratio		0.37			0.37						0.49	
Clearance Time (s)		4.0			4.0						4.0	
Vehicle Extension (s)		3.0			3.0						3.0	
Lane Grp Cap (vph)		1264			855						846	
v/s Ratio Prot		0.24									c0.35	
v/s Ratio Perm					c0.24							
v/c Ratio		0.65			0.66						0.72	
Uniform Delay, d1		14.5			14.6						11.0	
Progression Factor		1.00			1.00						1.00	
Incremental Delay, d2		1.2			1.9						5.2	
Delay (s)		15.7			16.4						16.2	
Level of Service		B			B						B	
Approach Delay (s)		15.7			16.4			0.0			16.2	
Approach LOS		B			B			A			B	

Intersection Summary			
HCM Average Control Delay	16.1	HCM Level of Service	B
HCM Volume to Capacity ratio	0.69		
Actuated Cycle Length (s)	55.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	85.0%	ICU Level of Service	E
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	293	746	0	0	471	430	80	180	140	0	0	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0			4.0		4.0	4.0	4.0			
Lane Util. Factor		0.95			0.95		0.95	0.95	1.00			
Frpb, ped/bikes		1.00			0.99		1.00	1.00	1.00			
Flpb, ped/bikes		1.00			1.00		1.00	1.00	1.00			
Frt		1.00			0.93		1.00	1.00	0.85			
Flt Protected		0.99			1.00		0.95	1.00	1.00			
Satd. Flow (prot)		3524			3282		1698	1783	1599			
Flt Permitted		0.56			1.00		0.95	1.00	1.00			
Satd. Flow (perm)		2010			3282		1698	1783	1599			
Peak-hour factor, PHF	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96
Adj. Flow (vph)	305	777	0	0	491	448	83	188	146	0	0	0
RTOR Reduction (vph)	0	0	0	0	107	0	0	0	112	0	0	0
Lane Group Flow (vph)	0	1082	0	0	832	0	75	196	34	0	0	0
Confl. Peds. (#/hr)	2		7	7		2						
Confl. Bikes (#/hr)						3						
Heavy Vehicles (%)	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%
Turn Type	Perm						Split		Prot			
Protected Phases		4			8		2	2	2			
Permitted Phases	4											
Actuated Green, G (s)		53.5			53.5		18.5	18.5	18.5			
Effective Green, g (s)		53.5			53.5		18.5	18.5	18.5			
Actuated g/C Ratio		0.67			0.67		0.23	0.23	0.23			
Clearance Time (s)		4.0			4.0		4.0	4.0	4.0			
Vehicle Extension (s)		3.0			3.0		3.0	3.0	3.0			
Lane Grp Cap (vph)		1344			2195		393	412	370			
v/s Ratio Prot					0.25		0.04	c0.11	0.02			
v/s Ratio Perm		c0.54										
v/c Ratio		0.90dl			0.38		0.19	0.48	0.09			
Uniform Delay, d1		9.5			5.9		24.7	26.6	24.1			
Progression Factor		1.00			1.00		1.00	1.00	1.00			
Incremental Delay, d2		3.6			0.1		1.1	3.9	0.5			
Delay (s)		13.1			6.0		25.8	30.5	24.6			
Level of Service		B			A		C	C	C			
Approach Delay (s)		13.1			6.0			27.6			0.0	
Approach LOS		B			A			C			A	

Intersection Summary			
HCM Average Control Delay	12.8	HCM Level of Service	B
HCM Volume to Capacity ratio	0.72		
Actuated Cycle Length (s)	80.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	76.6%	ICU Level of Service	D
Analysis Period (min)	15		

dl Defacto Left Lane. Recode with 1 though lane as a left lane.
c Critical Lane Group

Appendix C: Freeway LOS Calculations
Richmond Bay Campus

FEHR PEERS

Existing Conditions

FEHR PEERS

HCM 2000
Basic Freeway Segments
Capacity Analysis

Jurisdiction
Analysis Year Existing
Analyst EK

Agency or Company
Date
Project Description

General Information				*Flow Rate Calculation*														*Speed Calculation*		*Results*	
	Freeway/ Direction	From/To	Analysis Time Period	Volume (vph)	PHF	Lanes	HOV Lane?	HOV Lane Volume	Terrain	Truck/ Bus %	RV %	E_T	E_R	f_{HV}	f_P	Flow Rate v_p (pcphpl)	Measured FFS (mph)	S (mph)	Density, D (pcplpm)	Level of Service
R-5	I-580 EB	I-580 between Bayview Avenue and Central Avenue	AM	2,680	0.92	3	No		Level	6%	0%	1.5	1.2	0.971	1.00	1,000	65.0	65.0	**15.4**	**B**
R-6	I-580 EB	I-580 between Central Avenue and I-80	AM	2,730	0.92	2	No		Level	6%	0%	1.5	1.2	0.971	1.00	1,528	65.0	65.0	**23.5**	**C**
R-7	I-80 EB	I-80 between Carlson Boulevard and Potrero Avenue	AM	4,040	0.92	4	Yes	290	Level	4%	0%	1.5	1.2	0.980	1.00	1,386	65.0	65.0	**21.3**	**C**
R-8	I-80 EB	I-80 @ Gilman Overpass	AM	5,840	0.92	5	Yes	780	Level	5%	0%	1.5	1.2	0.976	1.00	1,409	65.0	65.0	**21.7**	**C**
R-5	I-580 WB	I-580 between Bayview Avenue and Central Avenue	AM	2,490	0.92	3	No		Level	6%	0%	1.5	1.2	0.971	1.00	929	65.0	65.0	**14.3**	**B**
R-6	I-580 WB	I-580 between Central Avenue and I-80	AM	2,890	0.92	2	No		Level	6%	0%	1.5	1.2	0.971	1.00	1,618	65.0	64.8	**25.0**	**C**
R-7	I-80 WB	I-80 between Carlson Boulevard and Potrero Avenue	AM	6,010	0.92	4	Yes	960	Level	4%	0%	1.5	1.2	0.980	1.00	1,866	65.0	63.3	**29.5**	**D**
R-8	I-80 WB	I-80 @ Gilman Overpass	AM	8,350	0.92	5	Yes	1410	Level	5%	0%	1.5	1.2	0.976	1.00	1,933	65.0	62.5	**30.9**	**D**
R-5	I-580 EB	I-580 between Bayview Avenue and Central Avenue	PM	2,440	0.92	3	No		Level	6%	0%	1.5	1.2	0.971	1.00	911	65.0	65.0	**14.0**	**B**
R-6	I-580 EB	I-580 between Central Avenue and I-80	PM	3,260	0.92	2	No		Level	6%	0%	1.5	1.2	0.971	1.00	1,825	65.0	63.7	**28.7**	**D**
R-7	I-80 EB	I-80 between Carlson Boulevard and Potrero Avenue	PM	6,000	0.92	4	Yes	1260	Level	4%	0%	1.5	1.2	0.980	1.00	1,752	65.0	64.3	**27.3**	**D**
R-8	I-80 EB	I-80 @ Gilman Overpass	PM	7,310	0.92	5	Yes	1020	Level	5%	0%	1.5	1.2	0.976	1.00	1,752	65.0	64.3	**27.3**	**D**
R-5	I-580 WB	I-580 between Bayview Avenue and Central Avenue	PM	2,940	0.92	3	No		Level	6%	0%	1.5	1.2	0.971	1.00	1,097	65.0	65.0	**16.9**	**B**
R-6	I-580 WB	I-580 between Central Avenue and I-80	PM	2,620	0.92	2	No		Level	6%	0%	1.5	1.2	0.971	1.00	1,467	65.0	65.0	**22.6**	**C**
R-7	I-80 WB	I-80 between Carlson Boulevard and Potrero Avenue	PM	4,550	0.92	4	Yes	330	Level	4%	0%	1.5	1.2	0.980	1.00	1,560	65.0	64.9	**24.0**	**C**
R-8	I-80 WB	I-80 @ Gilman Overpass	PM	6,580	0.92	5	Yes	630	Level	5%	0%	1.5	1.2	0.976	1.00	1,657	65.0	64.7	**25.6**	**C**

Leisch Method for Weaving Analysis

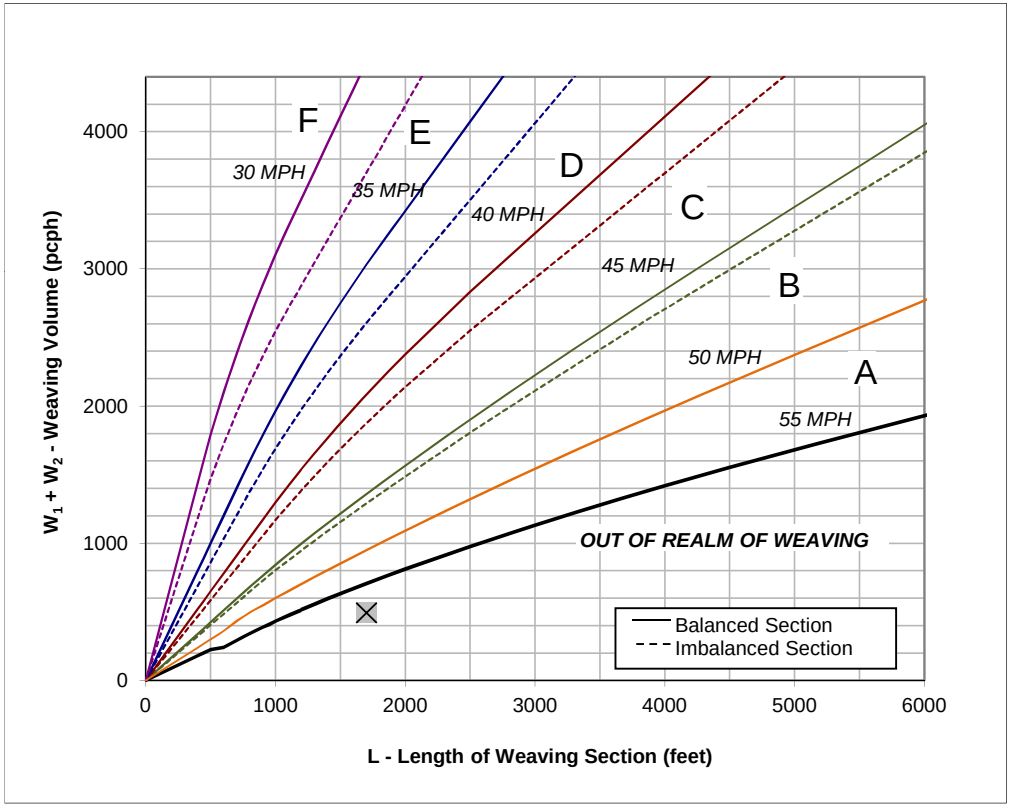
Data Input

Number of Entering Mainline Lanes	N_b	3
Number of Lanes in Weaving Section	N	4
Length of Weaving Section (feet)	L	1,700

Total Weaving Section (V)		On-ramp to Mainline (W_1)		Mainline to Off-ramp (W_2)	
Volume (vph)*	2,220	Volume (vph)*	320	Volume (vph)*	160
Truck Percentage	6%	Truck Percentage	6%	Truck Percentage	6%
PCE for Trucks	1.5	PCE for Trucks	1.5	PCE for Trucks	1.5
Volume (pcph)	2,287	Volume (pcph)	330	Volume (pcph)	165

Project Information

Project	LBNL
Scenario	Existing AM
Freeway	EB I-580
On-ramp	Harbour Way
Off-ramp	Marina Bay Pkwy



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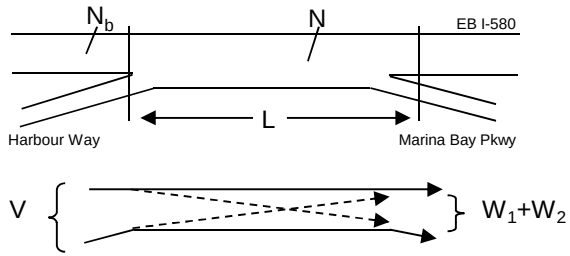


Capacity Analysis

1. Is the weaving section balanced (Y / N)? **N**
   [If optional exit lane, then "Y". Otherwise "N".]
2. In the Weaving Speed Chart to the left, which two speed curves is the black "x" between?
   50 MPH and **55 MPH**
   If below the 55 MPH curve, out of the realm of weaving.
   If left of the 30 MPH curve, LOS is F.
3. Interpolated Weaving Speed (S_w, mph) **59.4**
4. Weaving Intensity Factor (k) **1.00**
5. Service Volume (SV, pcph)
   $SV = (1/N)*[V + (k - 1)*\min(W_1, W_2)]$ **572**
6. Level of Service (LOS) **A**

The LOS in the chart above refers to the capacity of weaving traffic only; through and ramp to ramp traffic is not included.

* Note: **Do not adjust by a Peak Hour Factor (PHF).** The methodology incorporates the PHF in the Service Volume tables.

Sources: *Completion of Procedures for Analysis and Design of Traffic Weaving Sections*, Jack E. Leisch & Associates, September 1983 and *Highway Design Manual*, California Department of Transportation, July 24, 2009

Leisch Method for Weaving Analysis

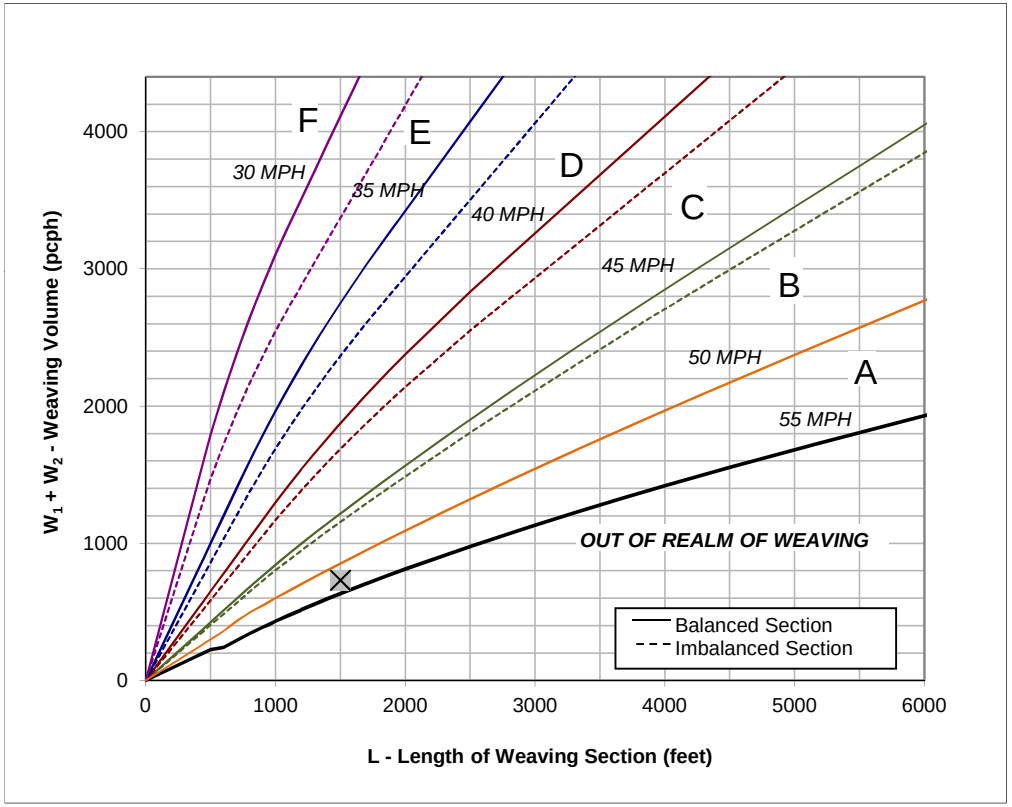
Data Input

Number of Entering Mainline Lanes	N_b	3
Number of Lanes in Weaving Section	N	4
Length of Weaving Section (feet)	L	1,500

Total Weaving Section (V)		On-ramp to Mainline (W_1)		Mainline to Off-ramp (W_2)	
Volume (vph)*	2,220	Volume (vph)*	320	Volume (vph)*	390
Truck Percentage	6%	Truck Percentage	6%	Truck Percentage	6%
PCE for Trucks	1.5	PCE for Trucks	1.5	PCE for Trucks	1.5
Volume (pcph)	2,287	Volume (pcph)	330	Volume (pcph)	402

Project Information

Project	LBNL
Scenario	Existing AM
Freeway	WB I-580
On-ramp	Marina Bay Parkway
Off-ramp	Harbour Way



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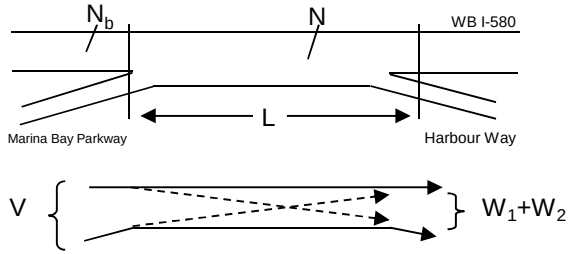


Capacity Analysis

1. Is the weaving section balanced (Y / N)? **N**
   [If optional exit lane, then "Y". Otherwise "N".]
2. In the Weaving Speed Chart to the left, which two speed curves is the black "x" between?
   50 MPH and **55 MPH**
   If below the 55 MPH curve, out of the realm of weaving.
   If left of the 30 MPH curve, LOS is F.
3. Interpolated Weaving Speed (S_w, mph) **52.8**
4. Weaving Intensity Factor (k) **1.00**
5. Service Volume (SV, pcph)
   $SV = (1/N)*[V + (k - 1)*\min(W_1, W_2)]$ **572**
6. Level of Service (LOS) **A**

The LOS in the chart above refers to the capacity of weaving traffic only; through and ramp to ramp traffic is not included.

* Note: **Do not adjust by a Peak Hour Factor (PHF).** The methodology incorporates the PHF in the Service Volume tables.

Sources: *Completion of Procedures for Analysis and Design of Traffic Weaving Sections*, Jack E. Leisch & Associates, September 1983 and *Highway Design Manual*, California Department of Transportation, July 24, 2009

Leisch Method for Weaving Analysis

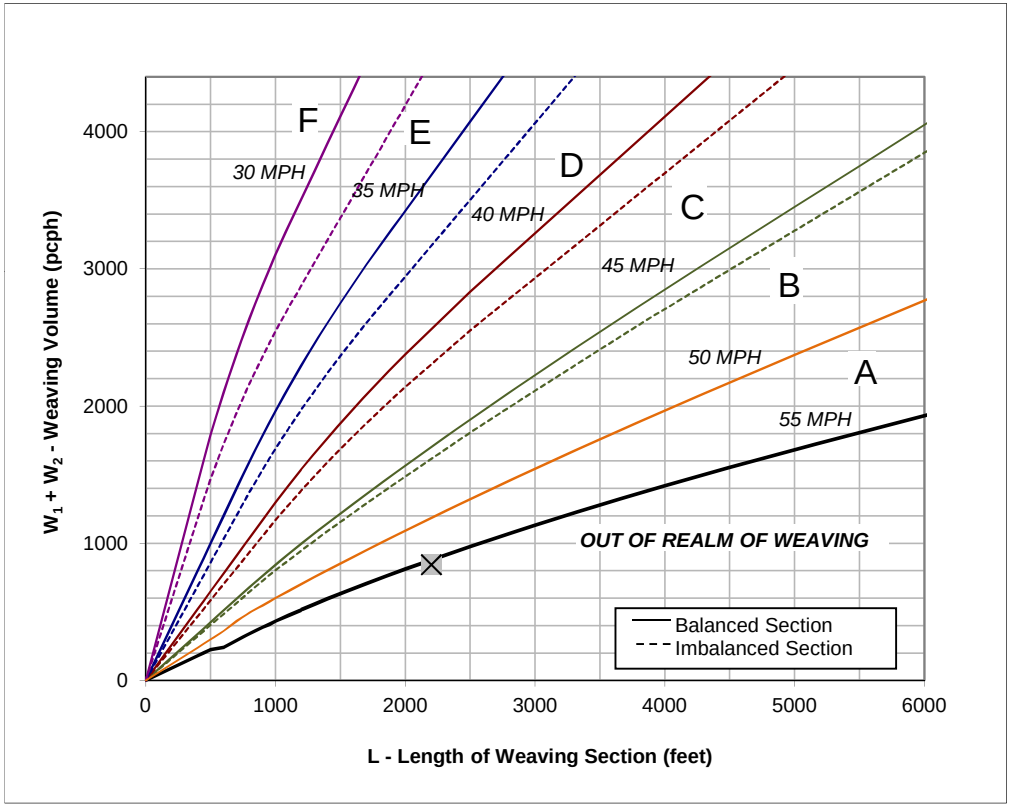
Data Input

Number of Entering Mainline Lanes	N_b	3
Number of Lanes in Weaving Section	N	4
Length of Weaving Section (feet)	L	2,200

Total Weaving Section (V)		On-ramp to Mainline (W_1)		Mainline to Off-ramp (W_2)	
Volume (vph)*	2,800	Volume (vph)*	740	Volume (vph)*	80
Truck Percentage	6%	Truck Percentage	6%	Truck Percentage	6%
PCE for Trucks	1.5	PCE for Trucks	1.5	PCE for Trucks	1.5
Volume (pcph)	2,884	Volume (pcph)	762	Volume (pcph)	82

Project Information

Project	LBNL
Scenario	Existing AM
Freeway	EB I-580
On-ramp	Marina Bay Parkway
Off-ramp	Regatta Blvd



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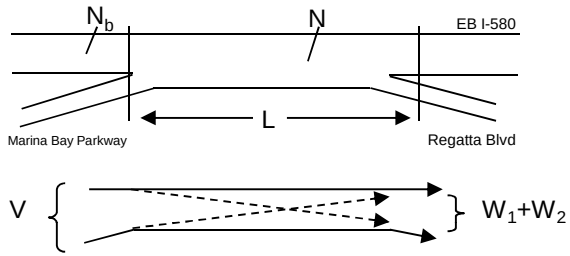


Capacity Analysis

1. Is the weaving section balanced (Y / N)? **N**
   [If optional exit lane, then "Y". Otherwise "N".]
2. In the Weaving Speed Chart to the left, which two speed curves is the black "x" between?
   50 MPH and **55 MPH**
   If below the 55 MPH curve, out of the realm of weaving.
   If left of the 30 MPH curve, LOS is F.
3. Interpolated Weaving Speed (S_w, mph) **55.6**
4. Weaving Intensity Factor (k) **1.00**
5. Service Volume (SV, pcph)
   $SV = (1/N)*[V + (k - 1)*\min(W_1, W_2)]$ **721**
6. Level of Service (LOS) **A**

The LOS in the chart above refers to the capacity of weaving traffic only; through and ramp to ramp traffic is not included.

* Note: **Do not adjust by a Peak Hour Factor (PHF).** The methodology incorporates the PHF in the Service Volume tables.

Sources: *Completion of Procedures for Analysis and Design of Traffic Weaving Sections*, Jack E. Leisch & Associates, September 1983 and *Highway Design Manual*, California Department of Transportation, July 24, 2009

Leisch Method for Weaving Analysis

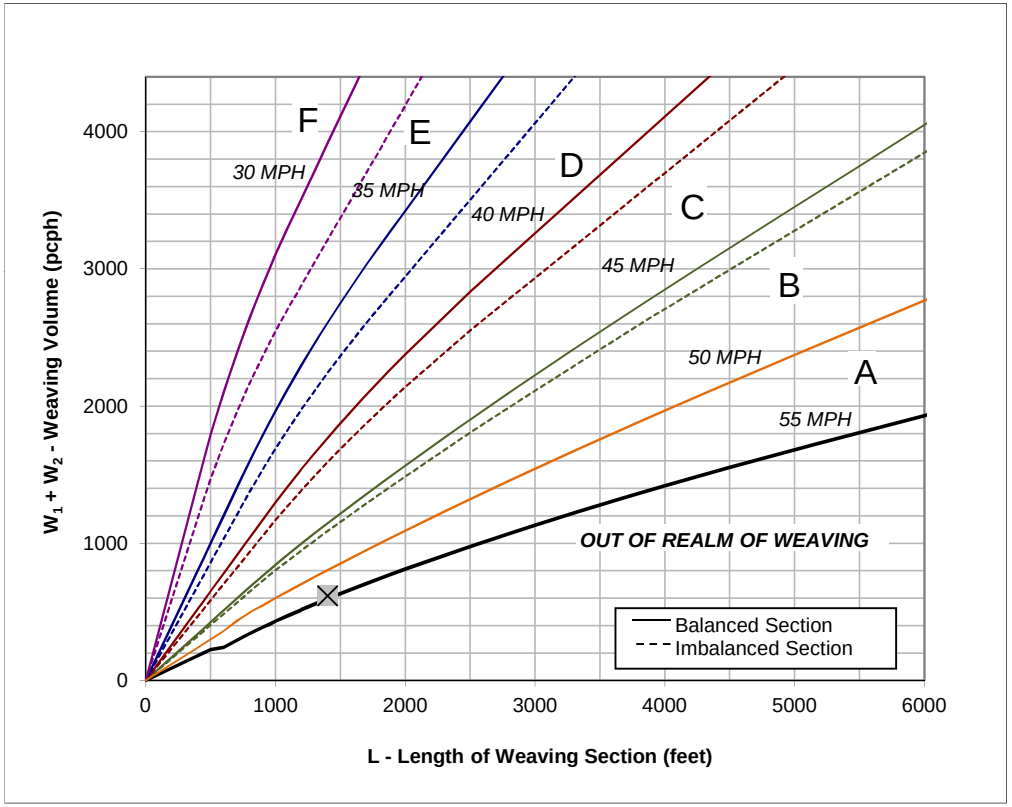
Data Input

Number of Entering Mainline Lanes	N_b	3
Number of Lanes in Weaving Section	N	4
Length of Weaving Section (feet)	L	1,400

Total Weaving Section (V)		On-ramp to Mainline (W_1)		Mainline to Off-ramp (W_2)	
Volume (vph)*	2,790	Volume (vph)*	130	Volume (vph)*	470
Truck Percentage	6%	Truck Percentage	6%	Truck Percentage	6%
PCE for Trucks	1.5	PCE for Trucks	1.5	PCE for Trucks	1.5
Volume (pcph)	2,874	Volume (pcph)	134	Volume (pcph)	484

Project Information

Project	LBNL
Scenario	Existing AM
Freeway	WB I-580
On-ramp	Regatta Blvd
Off-ramp	Marina Bay Parkway



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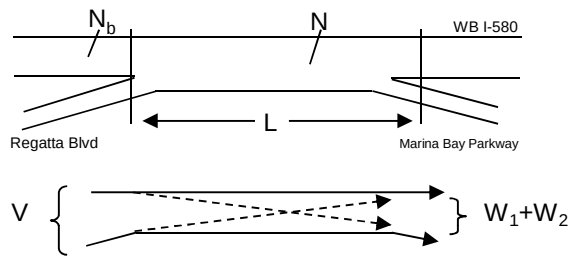


Capacity Analysis

1. Is the weaving section balanced (Y / N)? **N**
   [If optional exit lane, then "Y". Otherwise "N".]
2. In the Weaving Speed Chart to the left, which two speed curves is the black "x" between?
   50 MPH and **55 MPH**
   If below the 55 MPH curve, out of the realm of weaving.
   If left of the 30 MPH curve, LOS is F.
3. Interpolated Weaving Speed (S_w, mph) **54.4**
4. Weaving Intensity Factor (k) **1.00**
5. Service Volume (SV, pcph)
   $SV = (1/N)*[V + (k - 1)*\min(W_1, W_2)]$ **718**
6. Level of Service (LOS) **A**

The LOS in the chart above refers to the capacity of weaving traffic only; through and ramp to ramp traffic is not included.

* Note: **Do not adjust by a Peak Hour Factor (PHF).** The methodology incorporates the PHF in the Service Volume tables.

Sources: *Completion of Procedures for Analysis and Design of Traffic Weaving Sections*, Jack E. Leisch & Associates, September 1983 and *Highway Design Manual*, California Department of Transportation, July 24, 2009

Leisch Method for Weaving Analysis

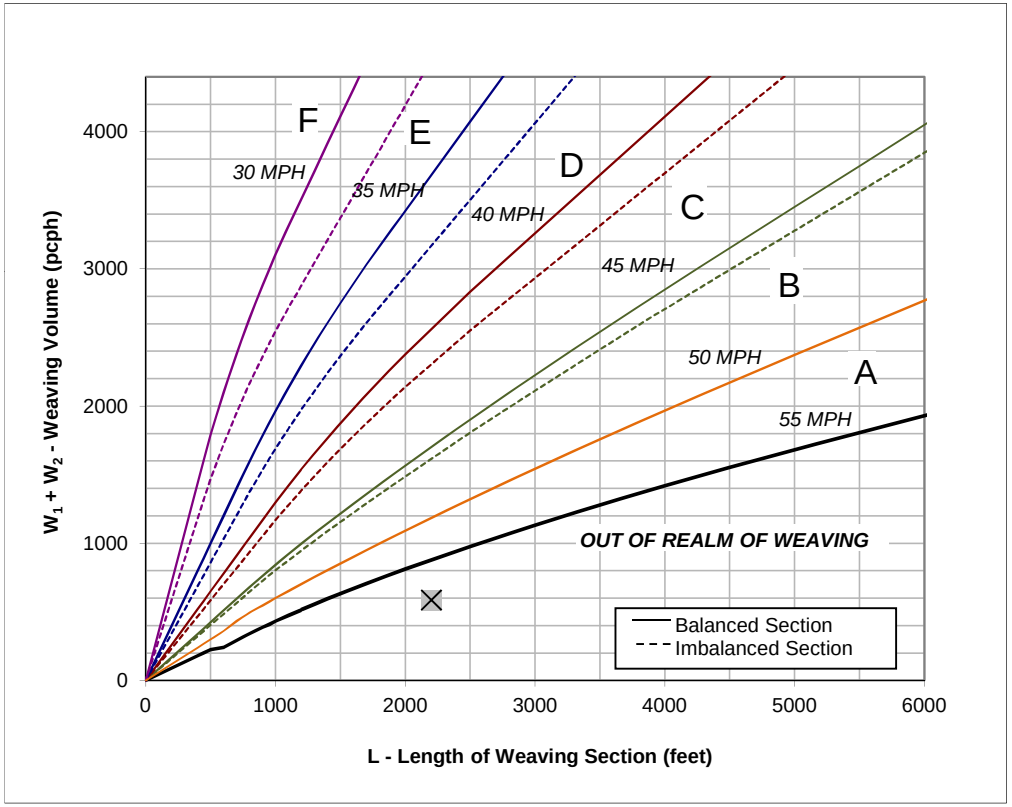
Data Input

Number of Entering Mainline Lanes	N_b	3
Number of Lanes in Weaving Section	N	4
Length of Weaving Section (feet)	L	2,200

Total Weaving Section (V)		On-ramp to Mainline (W_1)		Mainline to Off-ramp (W_2)	
Volume (vph)*	2,870	Volume (vph)*	140	Volume (vph)*	430
Truck Percentage	6%	Truck Percentage	6%	Truck Percentage	6%
PCE for Trucks	1.5	PCE for Trucks	1.5	PCE for Trucks	1.5
Volume (pcph)	2,956	Volume (pcph)	144	Volume (pcph)	443

Project Information

Project	LBNL
Scenario	Existing AM
Freeway	EB I-580
On-ramp	Regatta Blvd
Off-ramp	Bayview Ave



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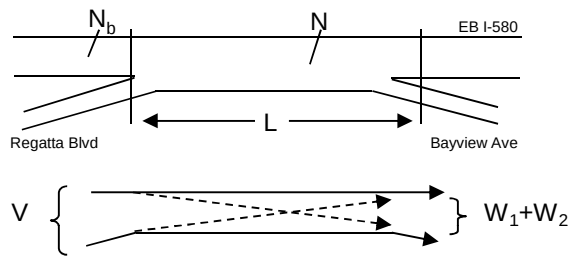


Capacity Analysis

1. Is the weaving section balanced (Y / N)? **N**
   [If optional exit lane, then "Y". Otherwise "N".]
2. In the Weaving Speed Chart to the left, which two speed curves is the black "x" between?
   50 MPH and **55 MPH**
   If below the 55 MPH curve, out of the realm of weaving.
   If left of the 30 MPH curve, LOS is F.
3. Interpolated Weaving Speed (S_w, mph) **59.8**
4. Weaving Intensity Factor (k) **1.00**
5. Service Volume (SV, pcph)
   $SV = (1/N)*[V + (k - 1)*\min(W_1, W_2)]$ **739**
6. Level of Service (LOS) **A**

The LOS in the chart above refers to the capacity of weaving traffic only; through and ramp to ramp traffic is not included.

* Note: **Do not adjust by a Peak Hour Factor (PHF).** The methodology incorporates the PHF in the Service Volume tables.

Sources: *Completion of Procedures for Analysis and Design of Traffic Weaving Sections*, Jack E. Leisch & Associates, September 1983 and *Highway Design Manual*, California Department of Transportation, July 24, 2009

Leisch Method for Weaving Analysis

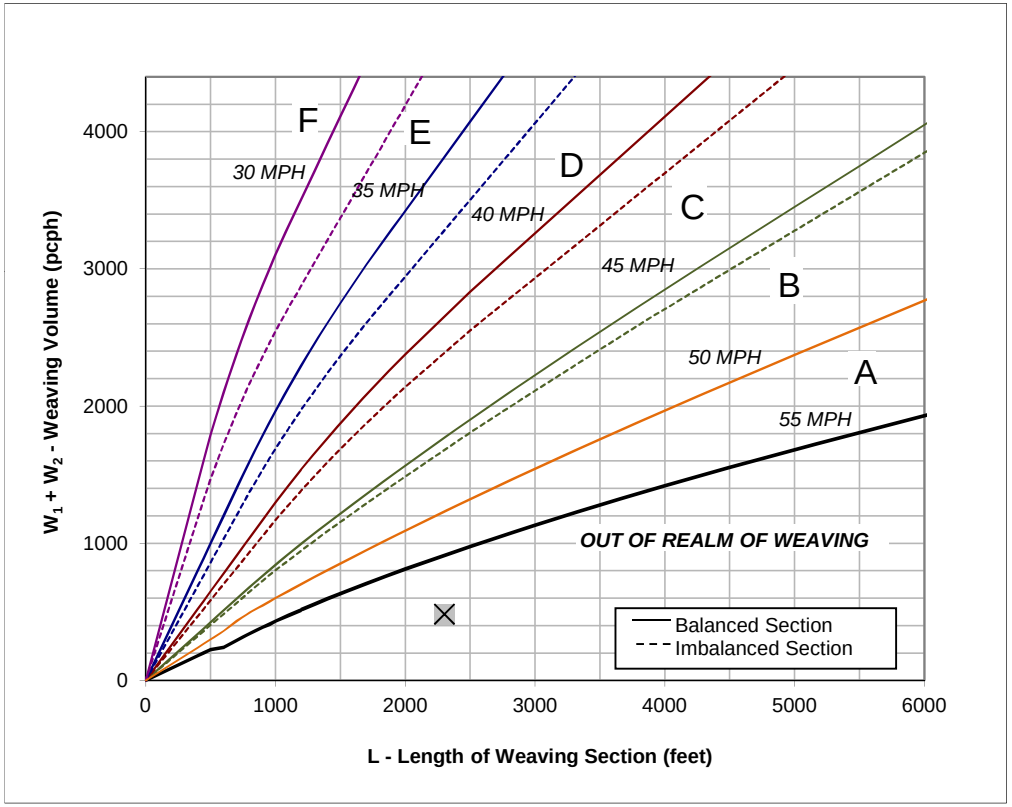
Data Input

Number of Entering Mainline Lanes	N_b	3
Number of Lanes in Weaving Section	N	4
Length of Weaving Section (feet)	L	2,300

Total Weaving Section (V)		On-ramp to Mainline (W_1)		Mainline to Off-ramp (W_2)	
Volume (vph)*	2,750	Volume (vph)*	380	Volume (vph)*	90
Truck Percentage	6%	Truck Percentage	6%	Truck Percentage	6%
PCE for Trucks	1.5	PCE for Trucks	1.5	PCE for Trucks	1.5
Volume (pcph)	2,833	Volume (pcph)	391	Volume (pcph)	93

Project Information

Project	LBNL
Scenario	Existing AM
Freeway	WB I-580
On-ramp	Bayview Ave
Off-ramp	Regatta Blvd



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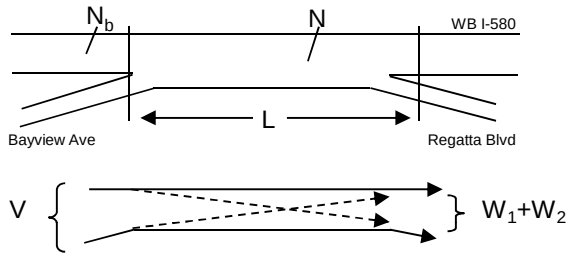


Capacity Analysis

1. Is the weaving section balanced (Y / N)? **N**
   [If optional exit lane, then "Y". Otherwise "N".]
2. In the Weaving Speed Chart to the left, which two speed curves is the black "x" between?
   50 MPH and **55 MPH**
   If below the 55 MPH curve, out of the realm of weaving.
   If left of the 30 MPH curve, LOS is F.
3. Interpolated Weaving Speed (S_w, mph) **61.7**
4. Weaving Intensity Factor (k) **1.00**
5. Service Volume (SV, pcph)
   $SV = (1/N)*[V + (k - 1)*\min(W_1, W_2)]$ **708**
6. Level of Service (LOS) **A**

The LOS in the chart above refers to the capacity of weaving traffic only; through and ramp to ramp traffic is not included.

* Note: **Do not adjust by a Peak Hour Factor (PHF).** The methodology incorporates the PHF in the Service Volume tables.

Sources: *Completion of Procedures for Analysis and Design of Traffic Weaving Sections*, Jack E. Leisch & Associates, September 1983 and *Highway Design Manual*, California Department of Transportation, July 24, 2009

Leisch Method for Weaving Analysis

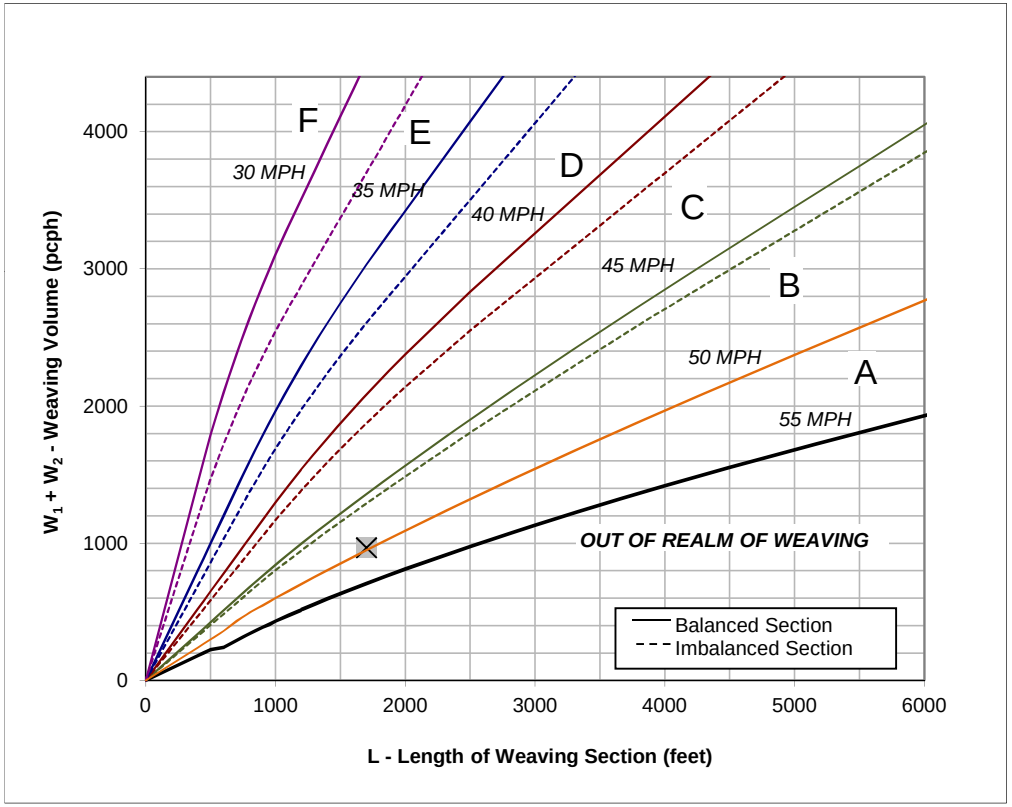
Data Input

Number of Entering Mainline Lanes	N_b	3
Number of Lanes in Weaving Section	N	4
Length of Weaving Section (feet)	L	1,700

Total Weaving Section (V)		On-ramp to Mainline (W_1)		Mainline to Off-ramp (W_2)	
Volume (vph)*	2,530	Volume (vph)*	600	Volume (vph)*	340
Truck Percentage	6%	Truck Percentage	6%	Truck Percentage	6%
PCE for Trucks	1.5	PCE for Trucks	1.5	PCE for Trucks	1.5
Volume (pcph)	2,606	Volume (pcph)	618	Volume (pcph)	350

Project Information

Project	LBNL
Scenario	Existing PM
Freeway	EB I-580
On-ramp	Harbour Way
Off-ramp	Marina Bay Pkwy



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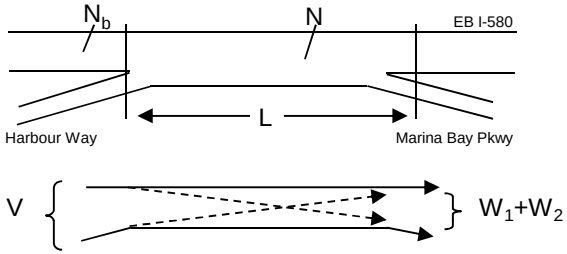


Capacity Analysis

1. Is the weaving section balanced (Y / N)? **N**
   [If optional exit lane, then "Y". Otherwise "N".]
2. In the Weaving Speed Chart to the left, which two speed curves is the black "x" between?
   50 MPH and **55 MPH**
   If below the 55 MPH curve, out of the realm of weaving.
   If left of the 30 MPH curve, LOS is F.
3. Interpolated Weaving Speed (S_w, mph) **49.6**
4. Weaving Intensity Factor (k) **1.25**
5. Service Volume (SV, pcph)
   $SV = (1/N)*[V + (k - 1)*\min(W_1, W_2)]$ **673**
6. Level of Service (LOS) **A**

The LOS in the chart above refers to the capacity of weaving traffic only; through and ramp to ramp traffic is not included.

* Note: **Do not adjust by a Peak Hour Factor (PHF).** The methodology incorporates the PHF in the Service Volume tables.

Sources: *Completion of Procedures for Analysis and Design of Traffic Weaving Sections*, Jack E. Leisch & Associates, September 1983 and *Highway Design Manual*, California Department of Transportation, July 24, 2009

Leisch Method for Weaving Analysis

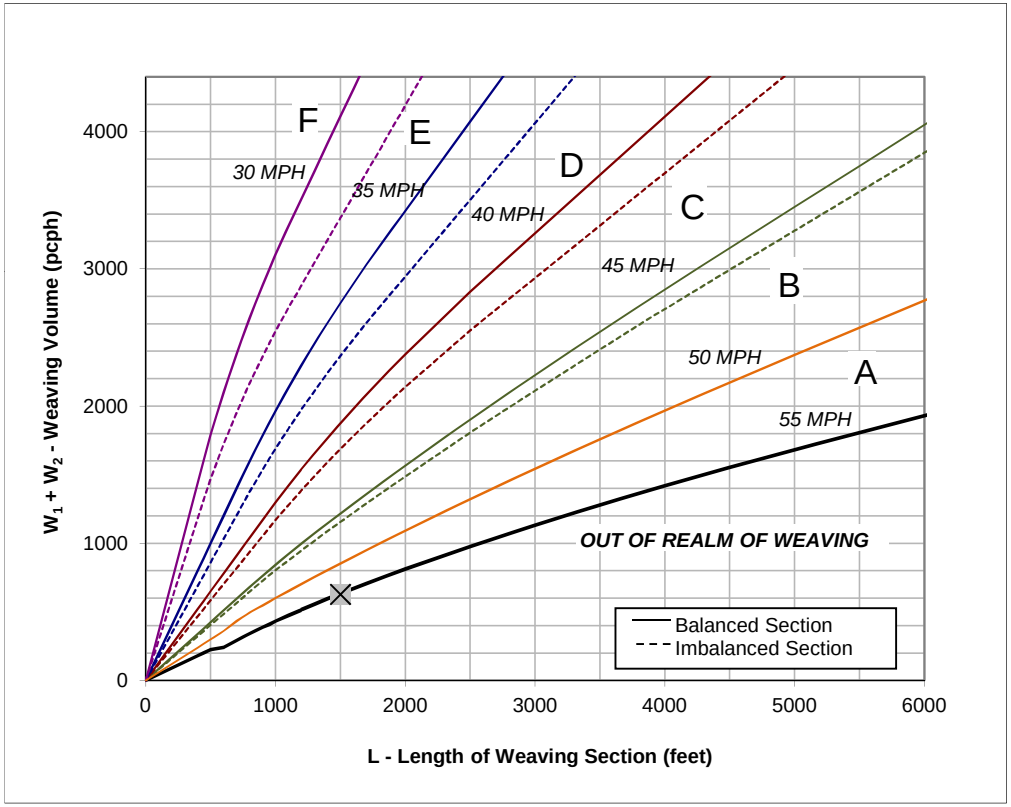
Data Input

Number of Entering Mainline Lanes	N_b	3
Number of Lanes in Weaving Section	N	4
Length of Weaving Section (feet)	L	1,500

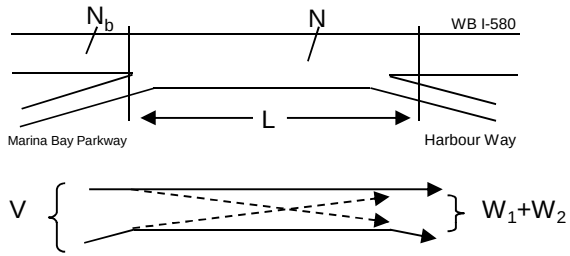
Total Weaving Section (V)		On-ramp to Mainline (W_1)		Mainline to Off-ramp (W_2)	
Volume (vph)*	1,970	Volume (vph)*	220	Volume (vph)*	390
Truck Percentage	6%	Truck Percentage	6%	Truck Percentage	6%
PCE for Trucks	1.5	PCE for Trucks	1.5	PCE for Trucks	1.5
Volume (pcph)	2,029	Volume (pcph)	227	Volume (pcph)	402

Project Information

Project	LBNL
Scenario	Existing PM
Freeway	WB I-580
On-ramp	Marina Bay Parkway
Off-ramp	Harbour Way



Figure



Capacity Analysis

1. Is the weaving section balanced (Y / N)? **N**
   [If optional exit lane, then "Y". Otherwise "N".]
2. In the Weaving Speed Chart to the left, which two speed curves is the black "x" between?
   50 MPH and **55 MPH**
   If below the 55 MPH curve, out of the realm of weaving.
   If left of the 30 MPH curve, LOS is F.
3. Interpolated Weaving Speed (S_w, mph) **55.1**
4. Weaving Intensity Factor (k) **1.00**
5. Service Volume (SV, pcph)
   $SV = (1/N)*[V + (k - 1)*\min(W_1, W_2)]$ **507**
6. Level of Service (LOS) **A**

The LOS in the chart above refers to the capacity of weaving traffic only; through and ramp to ramp traffic is not included.

* Note: **Do not adjust by a Peak Hour Factor (PHF).** The methodology incorporates the PHF in the Service Volume tables.

Sources: *Completion of Procedures for Analysis and Design of Traffic Weaving Sections*, Jack E. Leisch & Associates, September 1983 and *Highway Design Manual*, California Department of Transportation, July 24, 2009

Leisch Method for Weaving Analysis

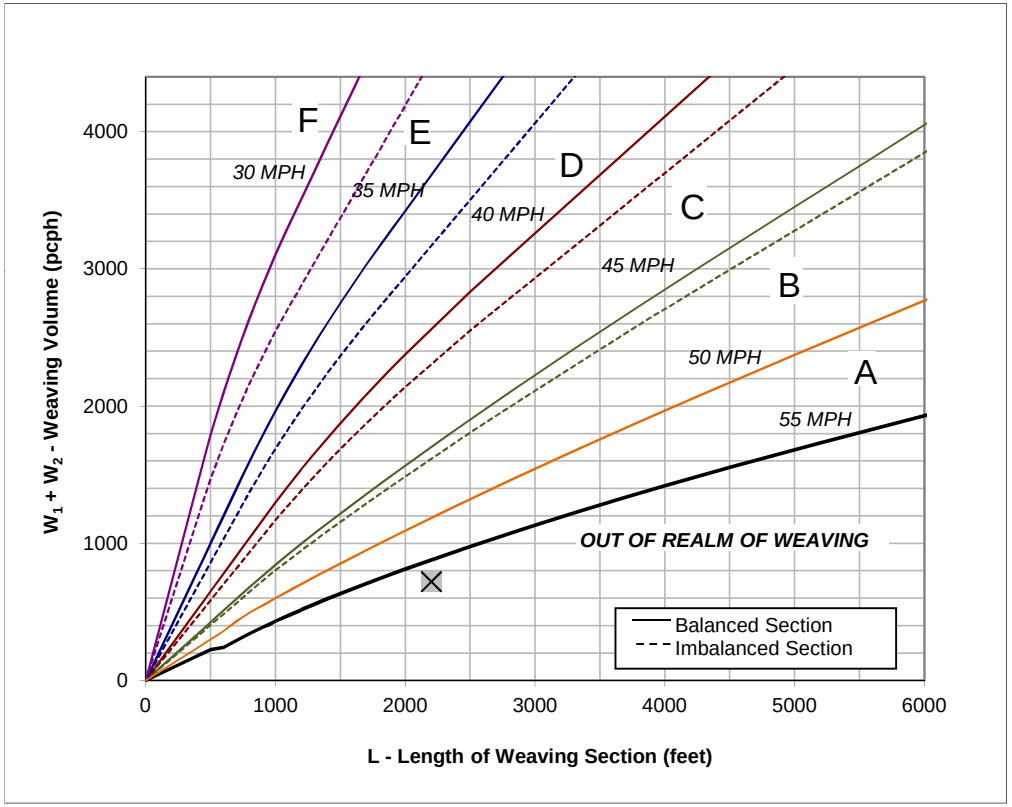
Data Input

Number of Entering Mainline Lanes	N_b	3
Number of Lanes in Weaving Section	N	4
Length of Weaving Section (feet)	L	2,200

Total Weaving Section (V)		On-ramp to Mainline (W_1)		Mainline to Off-ramp (W_2)	
Volume (vph)*	2,770	Volume (vph)*	580	Volume (vph)*	120
Truck Percentage	6%	Truck Percentage	6%	Truck Percentage	6%
PCE for Trucks	1.5	PCE for Trucks	1.5	PCE for Trucks	1.5
Volume (pcph)	2,853	Volume (pcph)	597	Volume (pcph)	124

Project Information

Project	LBNL
Scenario	Existing PM
Freeway	EB I-580
On-ramp	Marina Bay Parkway
Off-ramp	Regatta Blvd



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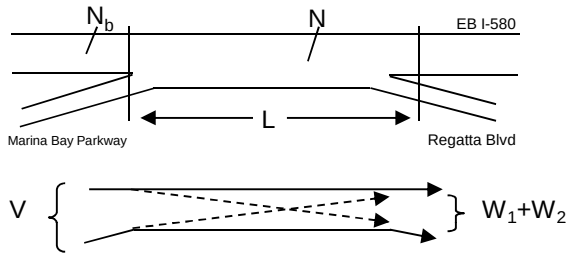


Capacity Analysis

1. Is the weaving section balanced (Y / N)? **N**
   [If optional exit lane, then "Y". Otherwise "N".]
2. In the Weaving Speed Chart to the left, which two speed curves is the black "x" between?
   50 MPH and **55 MPH**
   If below the 55 MPH curve, out of the realm of weaving.
   If left of the 30 MPH curve, LOS is F.
3. Interpolated Weaving Speed (S_w, mph) **57.6**
4. Weaving Intensity Factor (k) **1.00**
5. Service Volume (SV, pcph)
   $SV = (1/N)*[V + (k - 1)*\min(W_1, W_2)]$ **713**
6. Level of Service (LOS) **A**

The LOS in the chart above refers to the capacity of weaving traffic only; through and ramp to ramp traffic is not included.

* Note: **Do not adjust by a Peak Hour Factor (PHF).** The methodology incorporates the PHF in the Service Volume tables.

Sources: *Completion of Procedures for Analysis and Design of Traffic Weaving Sections*, Jack E. Leisch & Associates, September 1983 and *Highway Design Manual*, California Department of Transportation, July 24, 2009

Leisch Method for Weaving Analysis

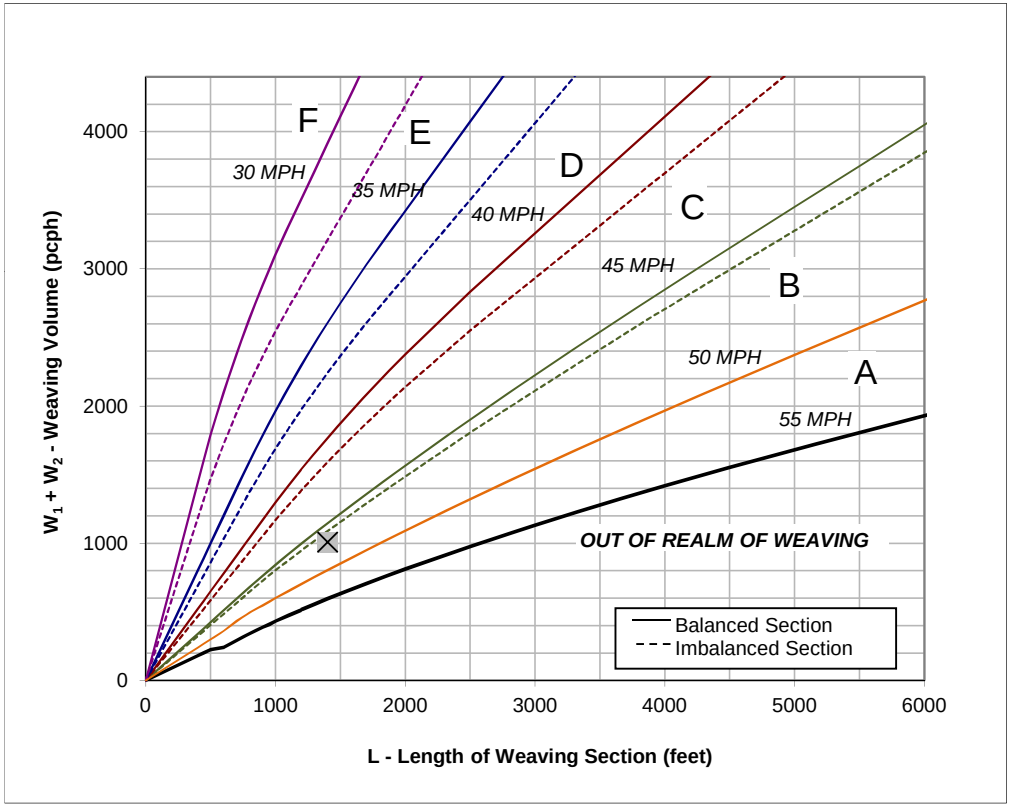
Data Input

Number of Entering Mainline Lanes	N_b	3
Number of Lanes in Weaving Section	N	4
Length of Weaving Section (feet)	L	1,400

Total Weaving Section (V)		On-ramp to Mainline (W_1)		Mainline to Off-ramp (W_2)	
Volume (vph)*	2,670	Volume (vph)*	60	Volume (vph)*	920
Truck Percentage	6%	Truck Percentage	6%	Truck Percentage	6%
PCE for Trucks	1.5	PCE for Trucks	1.5	PCE for Trucks	1.5
Volume (pcph)	2,750	Volume (pcph)	62	Volume (pcph)	948

Project Information

Project	LBNL
Scenario	Existing PM
Freeway	WB I-580
On-ramp	Regatta Blvd
Off-ramp	Marina Bay Parkway



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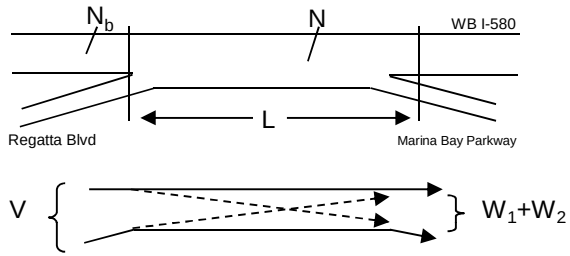


Capacity Analysis

1. Is the weaving section balanced (Y / N)? **N**
   [If optional exit lane, then "Y". Otherwise "N".]
2. In the Weaving Speed Chart to the left, which two speed curves is the black "x" between?
   45 MPH and **50 MPH**
   If below the 55 MPH curve, out of the realm of weaving.
   If left of the 30 MPH curve, LOS is F.
3. Interpolated Weaving Speed (S_w, mph) **46.4**
4. Weaving Intensity Factor (k) **2.30**
5. Service Volume (SV, pcph)
   $SV = (1/N)*[V + (k - 1)*\min(W_1, W_2)]$ **708**
6. Level of Service (LOS) **A**

The LOS in the chart above refers to the capacity of weaving traffic only; through and ramp to ramp traffic is not included.

* Note: **Do not adjust by a Peak Hour Factor (PHF).** The methodology incorporates the PHF in the Service Volume tables.

Sources: *Completion of Procedures for Analysis and Design of Traffic Weaving Sections*, Jack E. Leisch & Associates, September 1983 and *Highway Design Manual*, California Department of Transportation, July 24, 2009

Leisch Method for Weaving Analysis

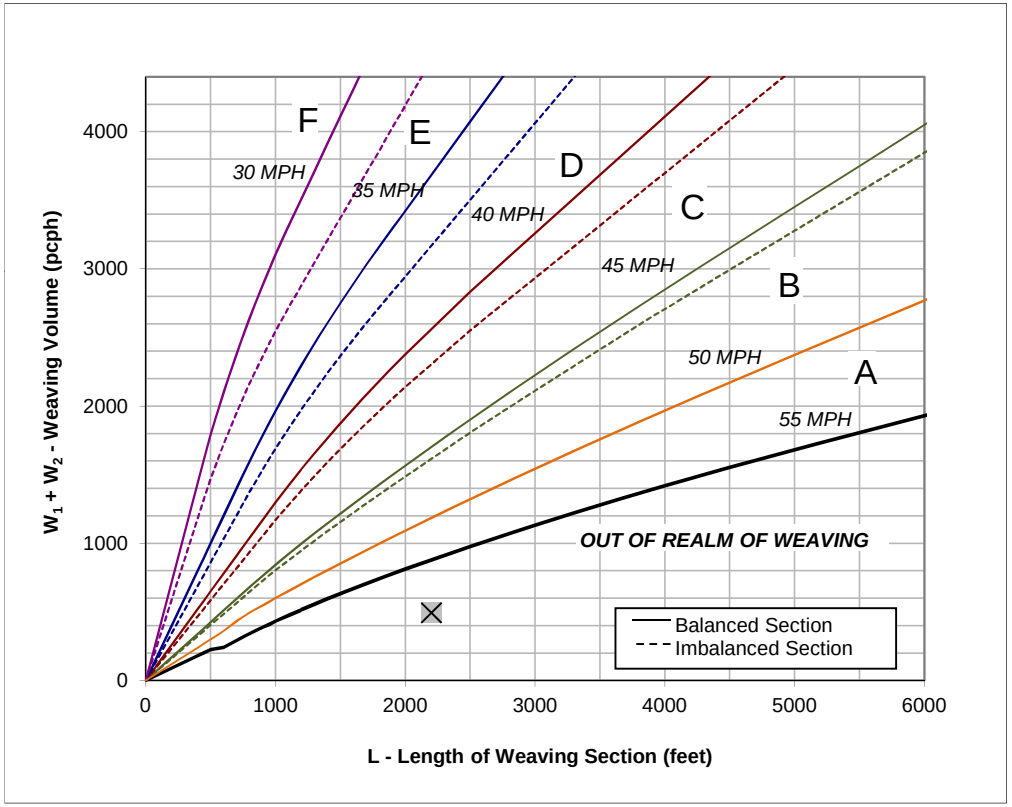
Data Input

Number of Entering Mainline Lanes	N_b	3
Number of Lanes in Weaving Section	N	4
Length of Weaving Section (feet)	L	2,200

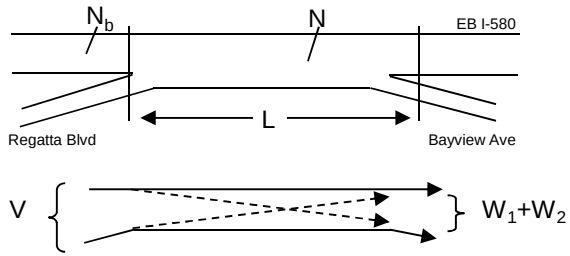
Total Weaving Section (V)		On-ramp to Mainline (W_1)		Mainline to Off-ramp (W_2)	
Volume (vph)*	2,730	Volume (vph)*	400	Volume (vph)*	80
Truck Percentage	6%	Truck Percentage	6%	Truck Percentage	6%
PCE for Trucks	1.5	PCE for Trucks	1.5	PCE for Trucks	1.5
Volume (pcph)	2,812	Volume (pcph)	412	Volume (pcph)	82

Project Information

Project	LBNL
Scenario	Existing PM
Freeway	EB I-580
On-ramp	Regatta Blvd
Off-ramp	Bayview Ave



Figure



Capacity Analysis

1. Is the weaving section balanced (Y / N)? **N**
   [If optional exit lane, then "Y". Otherwise "N".]
2. In the Weaving Speed Chart to the left, which two speed curves is the black "x" between?
   50 MPH and **55 MPH**
   If below the 55 MPH curve, out of the realm of weaving.
   If left of the 30 MPH curve, LOS is F.
3. Interpolated Weaving Speed (S_w, mph) **61.3**
4. Weaving Intensity Factor (k) **1.00**
5. Service Volume (SV, pcph)
   $SV = (1/N)*[V + (k - 1)*\min(W_1, W_2)]$ **703**
6. Level of Service (LOS) **A**

The LOS in the chart above refers to the capacity of weaving traffic only; through and ramp to ramp traffic is not included.

* Note: **Do not adjust by a Peak Hour Factor (PHF).** The methodology incorporates the PHF in the Service Volume tables.

Sources: *Completion of Procedures for Analysis and Design of Traffic Weaving Sections*, Jack E. Leisch & Associates, September 1983 and *Highway Design Manual*, California Department of Transportation, July 24, 2009

Leisch Method for Weaving Analysis

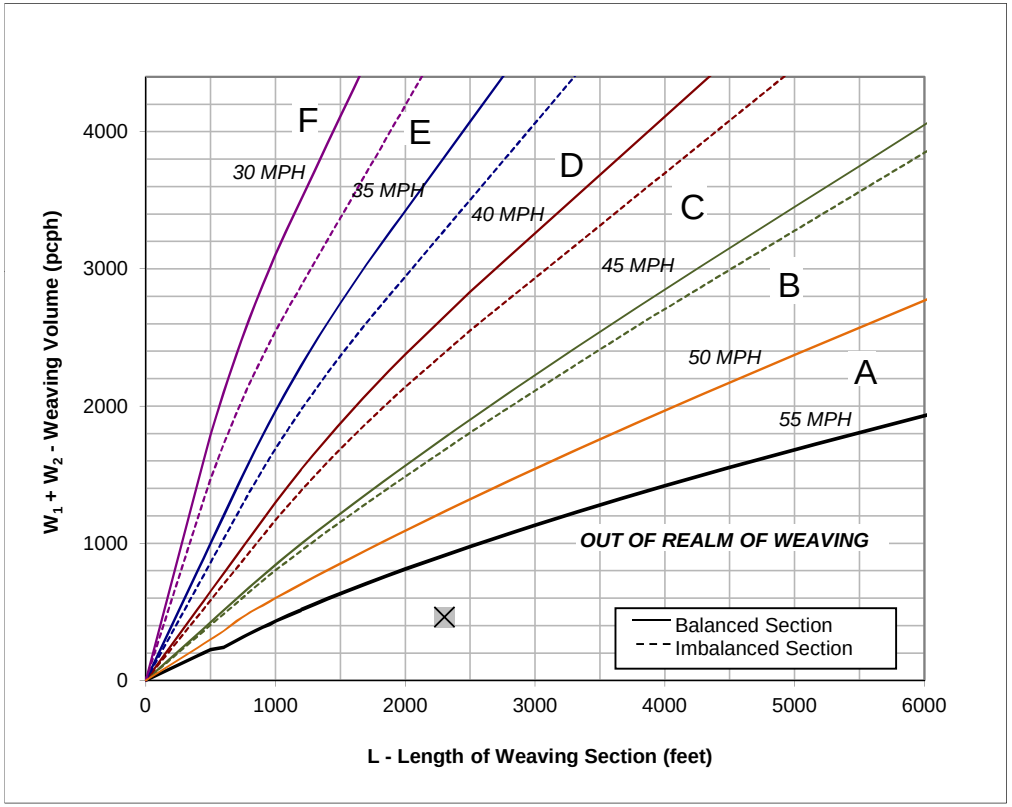
Data Input

Number of Entering Mainline Lanes	N_b	3
Number of Lanes in Weaving Section	N	4
Length of Weaving Section (feet)	L	2,300

Total Weaving Section (V)		On-ramp to Mainline (W_1)		Mainline to Off-ramp (W_2)	
Volume (vph)*	2,780	Volume (vph)*	290	Volume (vph)*	160
Truck Percentage	6%	Truck Percentage	6%	Truck Percentage	6%
PCE for Trucks	1.5	PCE for Trucks	1.5	PCE for Trucks	1.5
Volume (pcph)	2,863	Volume (pcph)	299	Volume (pcph)	165

Project Information

Project	LBNL
Scenario	Existing PM
Freeway	WB I-580
On-ramp	Bayview Ave
Off-ramp	Regatta Blvd



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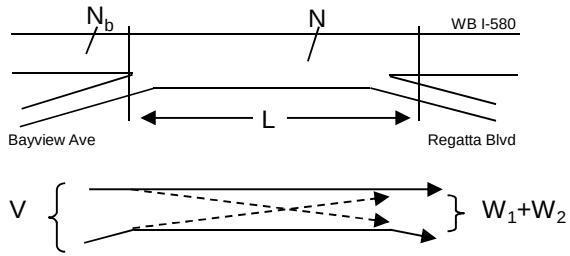


Capacity Analysis

1. Is the weaving section balanced (Y / N)? **N**
   [If optional exit lane, then "Y". Otherwise "N".]
2. In the Weaving Speed Chart to the left, which two speed curves is the black "x" between?
   50 MPH and **55 MPH**
   If below the 55 MPH curve, out of the realm of weaving.
   If left of the 30 MPH curve, LOS is F.
3. Interpolated Weaving Speed (S_w, mph) **62.1**
4. Weaving Intensity Factor (k) **1.00**
5. Service Volume (SV, pcph)
   $SV = (1/N)*[V + (k - 1)*\min(W_1, W_2)]$ **716**
6. Level of Service (LOS) **A**

The LOS in the chart above refers to the capacity of weaving traffic only; through and ramp to ramp traffic is not included.

* Note: **Do not adjust by a Peak Hour Factor (PHF).** The methodology incorporates the PHF in the Service Volume tables.

Sources: *Completion of Procedures for Analysis and Design of Traffic Weaving Sections*, Jack E. Leisch & Associates, September 1983 and *Highway Design Manual*, California Department of Transportation, July 24, 2009

Existing Plus Phase 1 Project Conditions

FEHR PEERS

HCM 2000
Basic Freeway Segments
Capacity Analysis

Jurisdiction
Analysis Year Existing + Project (Phase 1)
Analyst EK

Agency or Company
Date
Project Description

General Information				*Flow Rate Calculation*													*Speed Calculation*		*Results*	
	Freeway/ Direction	From/To	Analysis Time Period	Volume (vph)	PHF	Lanes	HOV Lane?	HOV Lane Volume	Terrain	Truck/ Bus %	RV %	E_T	E_R	f_{HV}	f_P	Flow Rate v_p (pcphpl)	Measured FFS (mph)	S (mph)	Density, D (pcplpm)	Level of Service
R-5	I-580 EB	I-580 between Bayview Avenue and Central Avenue	AM	2,690	0.92	3	No		Level	6%	0%	1.5	1.2	0.971	1.00	1,004	65.0	65.0	**15.4**	**B**
R-6	I-580 EB	I-580 between Central Avenue and I-80	AM	2,740	0.92	2	No		Level	6%	0%	1.5	1.2	0.971	1.00	1,534	65.0	65.0	**23.6**	**C**
R-7	I-80 EB	I-80 between Carlson Boulevard and Potrero Avenue	AM	4,045	0.92	4	Yes	290	Level	4%	0%	1.5	1.2	0.980	1.00	1,388	65.0	65.0	**21.3**	**C**
R-8	I-80 EB	I-80 @ Gilman Overpass	AM	5,904	0.92	5	Yes	780	Level	5%	0%	1.5	1.2	0.976	1.00	1,427	65.0	65.0	**22.0**	**C**
R-5	I-580 WB	I-580 between Bayview Avenue and Central Avenue	AM	2,554	0.92	3	No		Level	6%	0%	1.5	1.2	0.971	1.00	953	65.0	65.0	**14.7**	**B**
R-6	I-580 WB	I-580 between Central Avenue and I-80	AM	2,954	0.92	2	No		Level	6%	0%	1.5	1.2	0.971	1.00	1,654	65.0	64.7	**25.5**	**C**
R-7	I-80 WB	I-80 between Carlson Boulevard and Potrero Avenue	AM	6,043	0.92	4	Yes	960	Level	4%	0%	1.5	1.2	0.980	1.00	1,879	65.0	63.1	**29.7**	**D**
R-8	I-80 WB	I-80 @ Gilman Overpass	AM	8,360	0.92	5	Yes	1410	Level	5%	0%	1.5	1.2	0.976	1.00	1,936	65.0	62.4	**31.0**	**D**
R-5	I-580 EB	I-580 between Bayview Avenue and Central Avenue	PM	2,500	0.92	3	No		Level	6%	0%	1.5	1.2	0.971	1.00	933	65.0	65.0	**14.4**	**B**
R-6	I-580 EB	I-580 between Central Avenue and I-80	PM	3,320	0.92	2	No		Level	6%	0%	1.5	1.2	0.971	1.00	1,858	65.0	63.4	**29.3**	**D**
R-7	I-80 EB	I-80 between Carlson Boulevard and Potrero Avenue	PM	6,031	0.92	4	Yes	1260	Level	4%	0%	1.5	1.2	0.980	1.00	1,763	65.0	64.2	**27.5**	**D**
R-8	I-80 EB	I-80 @ Gilman Overpass	PM	7,319	0.92	5	Yes	1020	Level	5%	0%	1.5	1.2	0.976	1.00	1,754	65.0	64.2	**27.3**	**D**
R-5	I-580 WB	I-580 between Bayview Avenue and Central Avenue	PM	2,949	0.92	3	No		Level	6%	0%	1.5	1.2	0.971	1.00	1,101	65.0	65.0	**16.9**	**B**
R-6	I-580 WB	I-580 between Central Avenue and I-80	PM	2,629	0.92	2	No		Level	6%	0%	1.5	1.2	0.971	1.00	1,472	65.0	65.0	**22.6**	**C**
R-7	I-80 WB	I-80 between Carlson Boulevard and Potrero Avenue	PM	4,555	0.92	4	Yes	330	Level	4%	0%	1.5	1.2	0.980	1.00	1,561	65.0	64.9	**24.0**	**C**
R-8	I-80 WB	I-80 @ Gilman Overpass	PM	6,640	0.92	5	Yes	630	Level	5%	0%	1.5	1.2	0.976	1.00	1,674	65.0	64.7	**25.9**	**C**

Leisch Method for Weaving Analysis

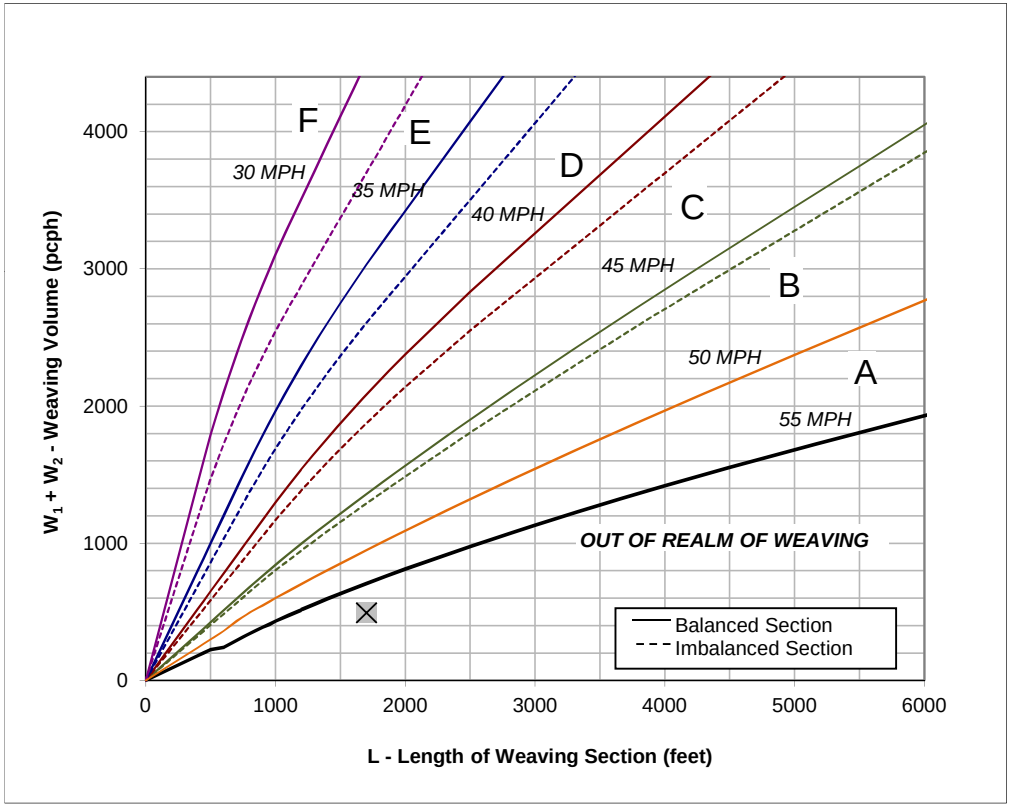
Data Input

Number of Entering Mainline Lanes	N_b	3
Number of Lanes in Weaving Section	N	4
Length of Weaving Section (feet)	L	1,700

Total Weaving Section (V)		On-ramp to Mainline (W_1)		Mainline to Off-ramp (W_2)	
Volume (vph)*	2,262	Volume (vph)*	320	Volume (vph)*	160
Truck Percentage	6%	Truck Percentage	6%	Truck Percentage	6%
PCE for Trucks	1.5	PCE for Trucks	1.5	PCE for Trucks	1.5
Volume (pcph)	2,330	Volume (pcph)	330	Volume (pcph)	165

Project Information

Project	LBNL
Scenario	Existing + Project (Phase 1) AM
Freeway	EB I-580
On-ramp	Harbour Way
Off-ramp	Marina Bay Pkwy



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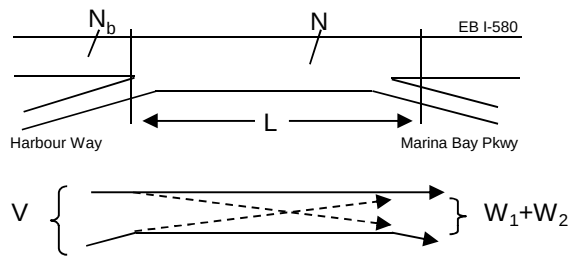


Capacity Analysis

1. Is the weaving section balanced (Y / N)? **N**
   [If optional exit lane, then "Y". Otherwise "N".]
2. In the Weaving Speed Chart to the left, which two speed curves is the black "x" between?
   50 MPH and **55 MPH**
   If below the 55 MPH curve, out of the realm of weaving.
   If left of the 30 MPH curve, LOS is F.
3. Interpolated Weaving Speed (S_w, mph) **59.4**
4. Weaving Intensity Factor (k) **1.00**
5. Service Volume (SV, pcph)
   $SV = (1/N)*[V + (k - 1)*\min(W_1, W_2)]$ **582**
6. Level of Service (LOS) **A**

The LOS in the chart above refers to the capacity of weaving traffic only; through and ramp to ramp traffic is not included.

* Note: **Do not adjust by a Peak Hour Factor (PHF).** The methodology incorporates the PHF in the Service Volume tables.

Sources: *Completion of Procedures for Analysis and Design of Traffic Weaving Sections*, Jack E. Leisch & Associates, September 1983 and *Highway Design Manual*, California Department of Transportation, July 24, 2009

Leisch Method for Weaving Analysis

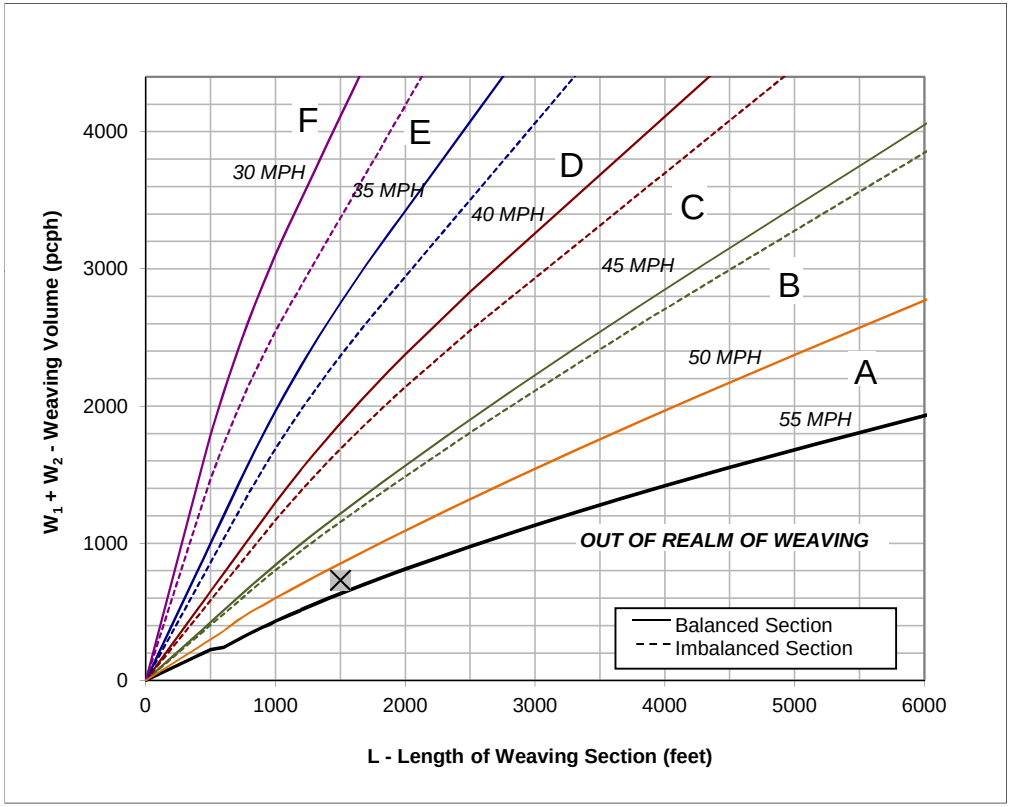
Data Input

Number of Entering Mainline Lanes	N_b	3
Number of Lanes in Weaving Section	N	4
Length of Weaving Section (feet)	L	1,500

Total Weaving Section (V)		On-ramp to Mainline (W_1)		Mainline to Off-ramp (W_2)	
Volume (vph)*	2,227	Volume (vph)*	320	Volume (vph)*	390
Truck Percentage	6%	Truck Percentage	6%	Truck Percentage	6%
PCE for Trucks	1.5	PCE for Trucks	1.5	PCE for Trucks	1.5
Volume (pcph)	2,294	Volume (pcph)	330	Volume (pcph)	402

Project Information

Project	LBNL
Scenario	Existing + Project (Phase 1) AM
Freeway	WB I-580
On-ramp	Marina Bay Parkway
Off-ramp	Harbour Way



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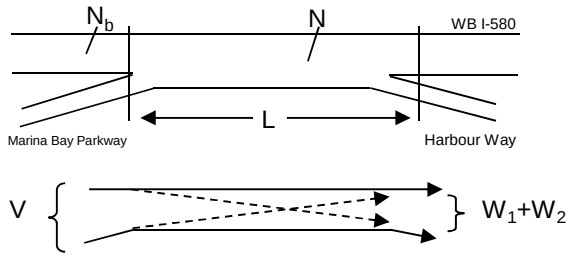


Capacity Analysis

1. Is the weaving section balanced (Y / N)? **N**
   [If optional exit lane, then "Y". Otherwise "N".]
2. In the Weaving Speed Chart to the left, which two speed curves is the black "x" between?
   50 MPH and **55 MPH**
   If below the 55 MPH curve, out of the realm of weaving.
   If left of the 30 MPH curve, LOS is F.
3. Interpolated Weaving Speed (S_w, mph) **52.8**
4. Weaving Intensity Factor (k) **1.00**
5. Service Volume (SV, pcph)
   $SV = (1/N)*[V + (k - 1)*\min(W_1, W_2)]$ **573**
6. Level of Service (LOS) **A**

The LOS in the chart above refers to the capacity of weaving traffic only; through and ramp to ramp traffic is not included.

* Note: **Do not adjust by a Peak Hour Factor (PHF).** The methodology incorporates the PHF in the Service Volume tables.

Sources: *Completion of Procedures for Analysis and Design of Traffic Weaving Sections*, Jack E. Leisch & Associates, September 1983 and *Highway Design Manual*, California Department of Transportation, July 24, 2009

Leisch Method for Weaving Analysis

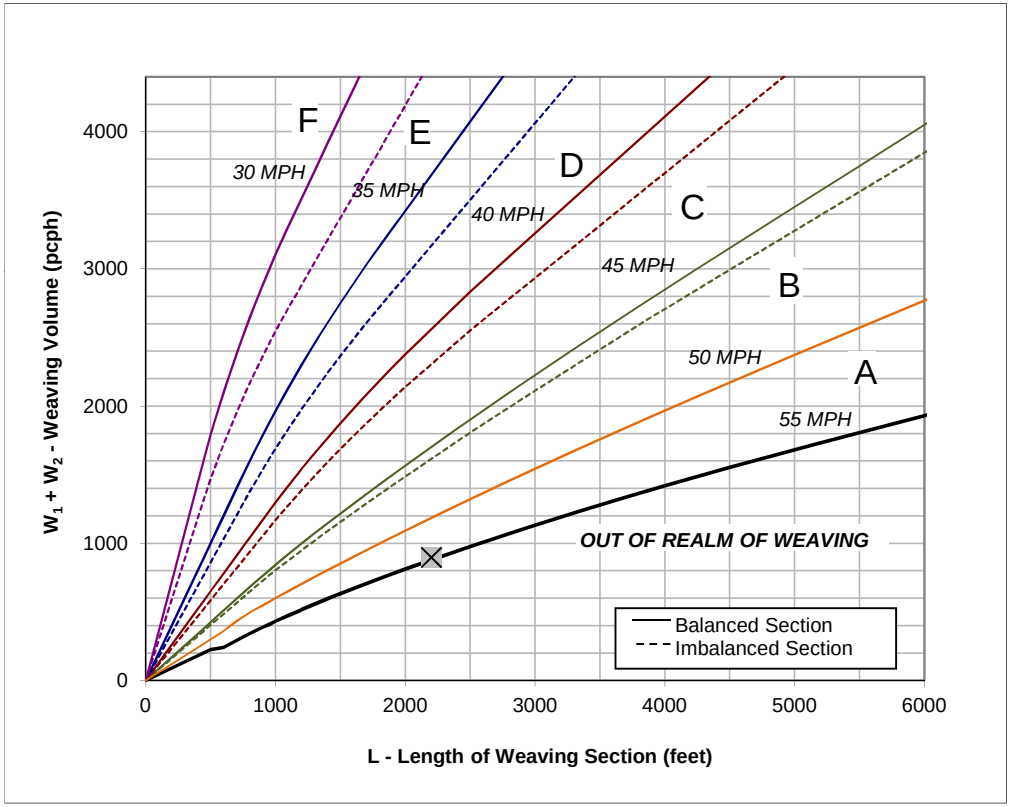
Data Input

Number of Entering Mainline Lanes	N_b	3
Number of Lanes in Weaving Section	N	4
Length of Weaving Section (feet)	L	2,200

Total Weaving Section (V)		On-ramp to Mainline (W_1)		Mainline to Off-ramp (W_2)	
Volume (vph)*	2,847	Volume (vph)*	745	Volume (vph)*	127
Truck Percentage	6%	Truck Percentage	6%	Truck Percentage	6%
PCE for Trucks	1.5	PCE for Trucks	1.5	PCE for Trucks	1.5
Volume (pcph)	2,932	Volume (pcph)	767	Volume (pcph)	131

Project Information

Project	LBNL
Scenario	Existing + Project (Phase 1) AM
Freeway	EB I-580
On-ramp	Marina Bay Parkway
Off-ramp	Regatta Blvd



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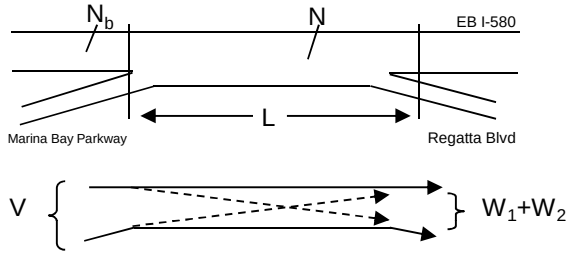


Capacity Analysis

1. Is the weaving section balanced (Y / N)? **N**
   [If optional exit lane, then "Y". Otherwise "N".]
2. In the Weaving Speed Chart to the left, which two speed curves is the black "x" between?
   50 MPH and **55 MPH**
   If below the 55 MPH curve, out of the realm of weaving.
   If left of the 30 MPH curve, LOS is F.
3. Interpolated Weaving Speed (S_w, mph) **54.7**
4. Weaving Intensity Factor (k) **1.00**
5. Service Volume (SV, pcph)
   $SV = (1/N)*[V + (k - 1)*\min(W_1, W_2)]$ **733**
6. Level of Service (LOS) **A**

The LOS in the chart above refers to the capacity of weaving traffic only; through and ramp to ramp traffic is not included.

* Note: **Do not adjust by a Peak Hour Factor (PHF).** The methodology incorporates the PHF in the Service Volume tables.

Sources: *Completion of Procedures for Analysis and Design of Traffic Weaving Sections*, Jack E. Leisch & Associates, September 1983 and *Highway Design Manual*, California Department of Transportation, July 24, 2009

Leisch Method for Weaving Analysis

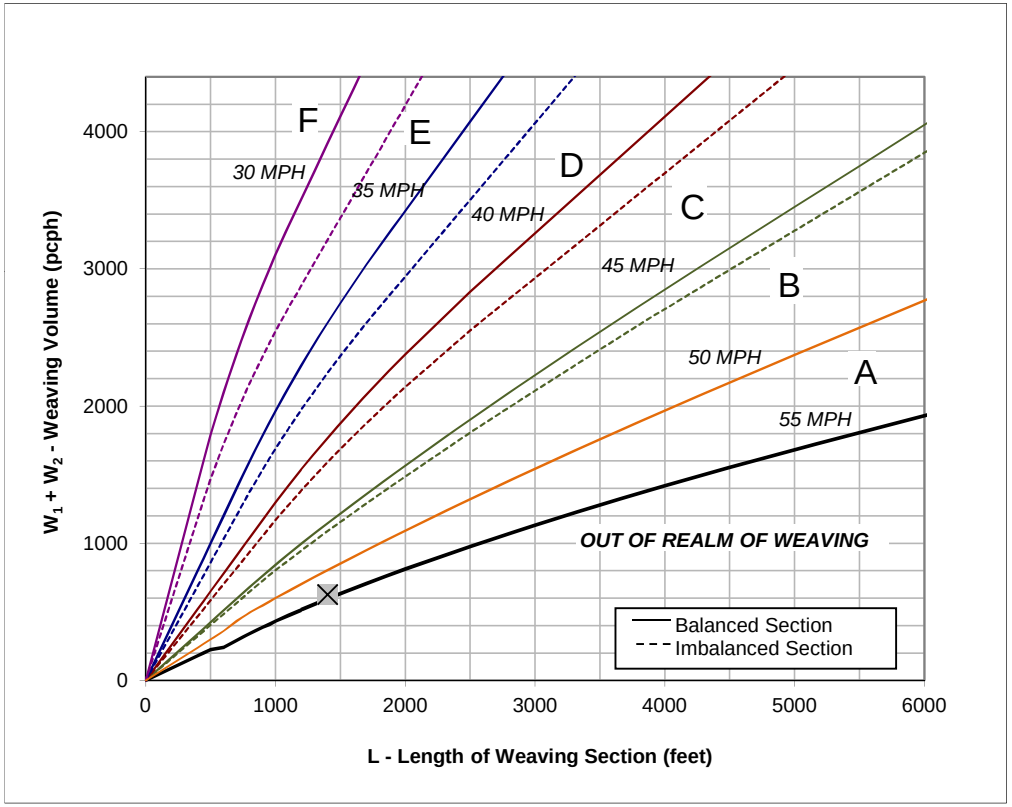
Data Input

Number of Entering Mainline Lanes	N_b	3
Number of Lanes in Weaving Section	N	4
Length of Weaving Section (feet)	L	1,400

Total Weaving Section (V)		On-ramp to Mainline (W_1)		Mainline to Off-ramp (W_2)	
Volume (vph)*	2,798	Volume (vph)*	138	Volume (vph)*	471
Truck Percentage	6%	Truck Percentage	6%	Truck Percentage	6%
PCE for Trucks	1.5	PCE for Trucks	1.5	PCE for Trucks	1.5
Volume (pcph)	2,882	Volume (pcph)	142	Volume (pcph)	485

Project Information

Project	LBNL
Scenario	Existing + Project (Phase 1) AM
Freeway	WB I-580
On-ramp	Regatta Blvd
Off-ramp	Marina Bay Parkway



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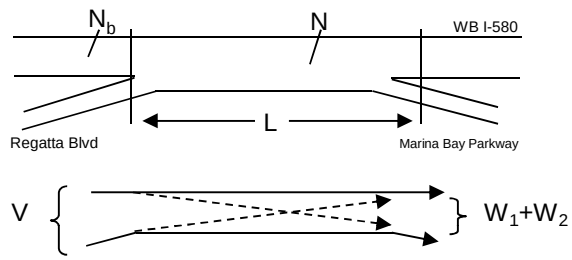


Capacity Analysis

1. Is the weaving section balanced (Y / N)? **N**
   [If optional exit lane, then "Y". Otherwise "N".]
2. In the Weaving Speed Chart to the left, which two speed curves is the black "x" between?
   50 MPH and **55 MPH**
   If below the 55 MPH curve, out of the realm of weaving.
   If left of the 30 MPH curve, LOS is F.
3. Interpolated Weaving Speed (S_w, mph) **54.2**
4. Weaving Intensity Factor (k) **1.00**
5. Service Volume (SV, pcph)
   $SV = (1/N)*[V + (k - 1)*\min(W_1, W_2)]$ **720**
6. Level of Service (LOS) **A**

The LOS in the chart above refers to the capacity of weaving traffic only; through and ramp to ramp traffic is not included.

* Note: **Do not adjust by a Peak Hour Factor (PHF).** The methodology incorporates the PHF in the Service Volume tables.

Sources: *Completion of Procedures for Analysis and Design of Traffic Weaving Sections*, Jack E. Leisch & Associates, September 1983 and *Highway Design Manual*, California Department of Transportation, July 24, 2009

Leisch Method for Weaving Analysis

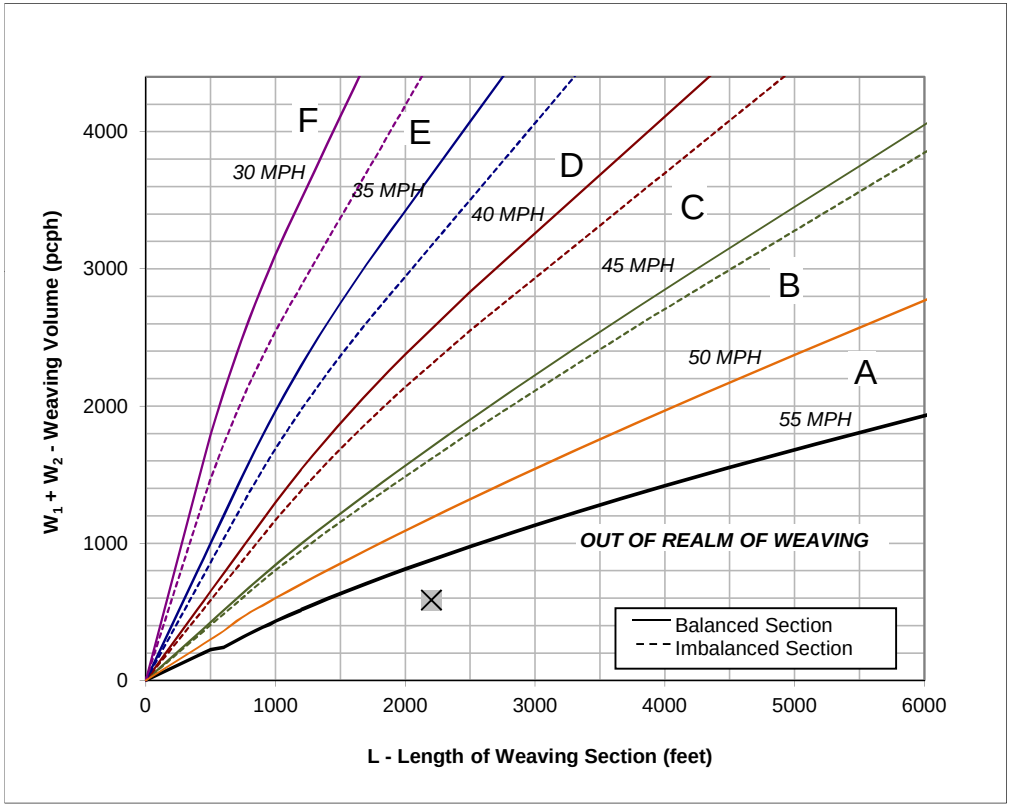
Data Input

Number of Entering Mainline Lanes	N_b	3
Number of Lanes in Weaving Section	N	4
Length of Weaving Section (feet)	L	2,200

Total Weaving Section (V)		On-ramp to Mainline (W_1)		Mainline to Off-ramp (W_2)	
Volume (vph)*	2,870	Volume (vph)*	140	Volume (vph)*	430
Truck Percentage	6%	Truck Percentage	6%	Truck Percentage	6%
PCE for Trucks	1.5	PCE for Trucks	1.5	PCE for Trucks	1.5
Volume (pcph)	2,956	Volume (pcph)	144	Volume (pcph)	443

Project Information

Project	LBNL
Scenario	Existing + Project (Phase 1) AM
Freeway	EB I-580
On-ramp	Regatta Blvd
Off-ramp	Bayview Ave



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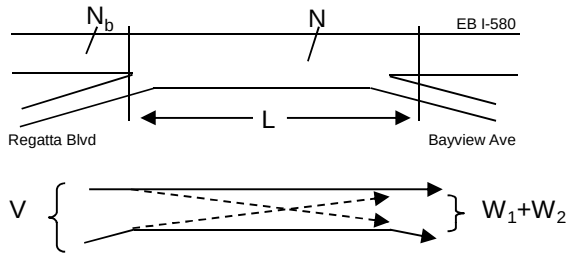


Capacity Analysis

1. Is the weaving section balanced (Y / N)? **N**
   [If optional exit lane, then "Y". Otherwise "N".]
2. In the Weaving Speed Chart to the left, which two speed curves is the black "x" between?
   50 MPH and **55 MPH**
   If below the 55 MPH curve, out of the realm of weaving.
   If left of the 30 MPH curve, LOS is F.
3. Interpolated Weaving Speed (S_w, mph) **59.8**
4. Weaving Intensity Factor (k) **1.00**
5. Service Volume (SV, pcph)
   $SV = (1/N)*[V + (k - 1)*\min(W_1, W_2)]$ **739**
6. Level of Service (LOS) **A**

The LOS in the chart above refers to the capacity of weaving traffic only; through and ramp to ramp traffic is not included.

* Note: **Do not adjust by a Peak Hour Factor (PHF).** The methodology incorporates the PHF in the Service Volume tables.

Sources: *Completion of Procedures for Analysis and Design of Traffic Weaving Sections*, Jack E. Leisch & Associates, September 1983 and *Highway Design Manual*, California Department of Transportation, July 24, 2009

Leisch Method for Weaving Analysis

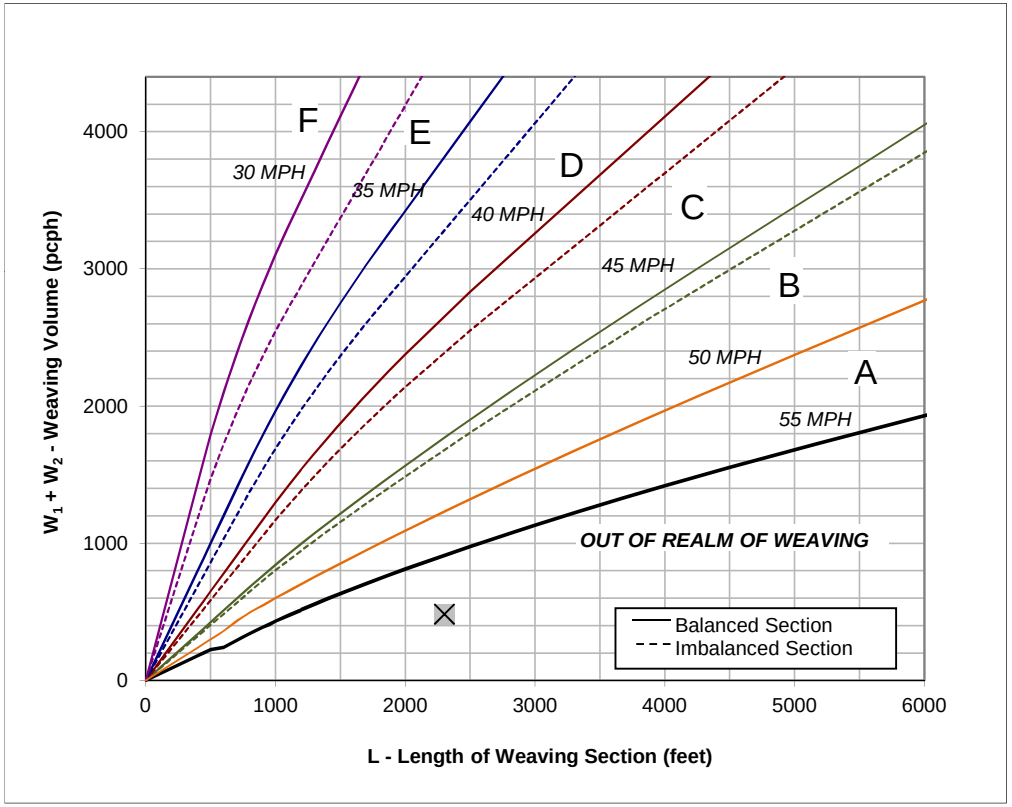
Data Input

Number of Entering Mainline Lanes	N_b	3
Number of Lanes in Weaving Section	N	4
Length of Weaving Section (feet)	L	2,300

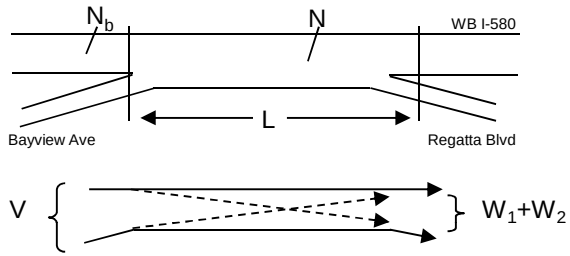
Total Weaving Section (V)		On-ramp to Mainline (W_1)		Mainline to Off-ramp (W_2)	
Volume (vph)*	2,750	Volume (vph)*	380	Volume (vph)*	90
Truck Percentage	6%	Truck Percentage	6%	Truck Percentage	6%
PCE for Trucks	1.5	PCE for Trucks	1.5	PCE for Trucks	1.5
Volume (pcph)	2,833	Volume (pcph)	391	Volume (pcph)	93

Project Information

Project	LBNL
Scenario	Existing + Project (Phase 1) AM
Freeway	WB I-580
On-ramp	Bayview Ave
Off-ramp	Regatta Blvd



Figure



Capacity Analysis

1. Is the weaving section balanced (Y / N)? **N**
   [If optional exit lane, then "Y". Otherwise "N".]
2. In the Weaving Speed Chart to the left, which two speed curves is the black "x" between?
   50 MPH and **55 MPH**
   If below the 55 MPH curve, out of the realm of weaving.
   If left of the 30 MPH curve, LOS is F.
3. Interpolated Weaving Speed (S_w, mph) **61.7**
4. Weaving Intensity Factor (k) **1.00**
5. Service Volume (SV, pcph)
   $SV = (1/N)*[V + (k - 1)*\min(W_1, W_2)]$ **708**
6. Level of Service (LOS) **A**

The LOS in the chart above refers to the capacity of weaving traffic only; through and ramp to ramp traffic is not included.

* Note: **Do not adjust by a Peak Hour Factor (PHF).** The methodology incorporates the PHF in the Service Volume tables.

Sources: *Completion of Procedures for Analysis and Design of Traffic Weaving Sections*, Jack E. Leisch & Associates, September 1983 and *Highway Design Manual*, California Department of Transportation, July 24, 2009

Leisch Method for Weaving Analysis

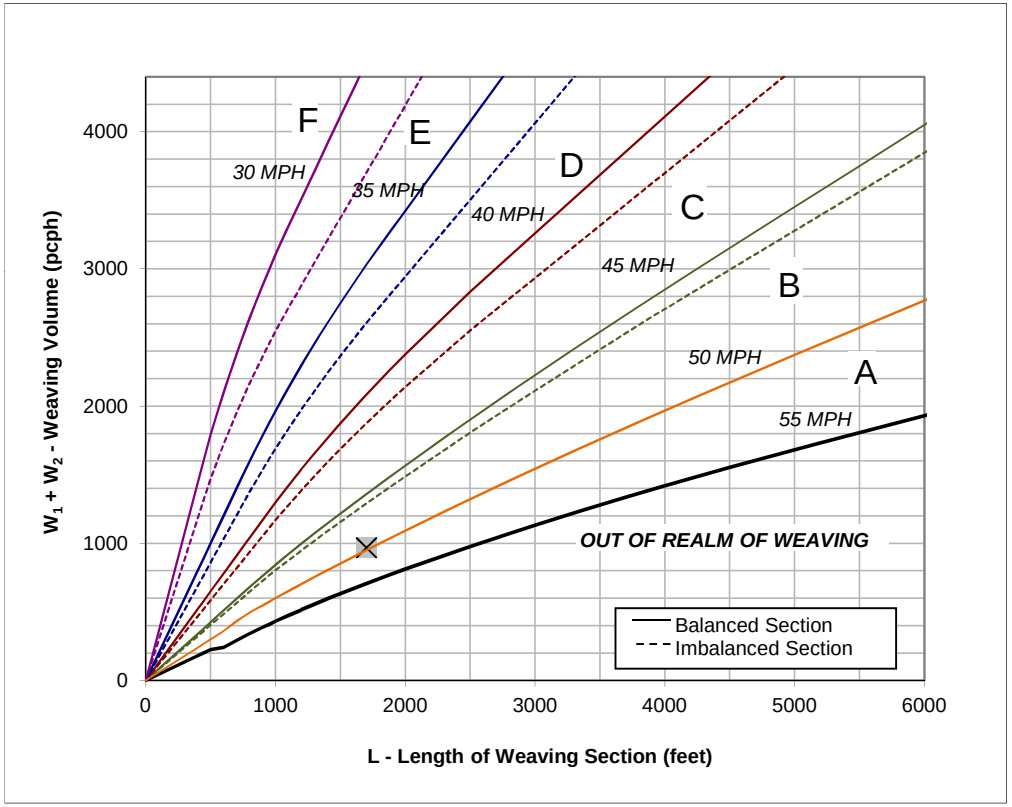
Data Input

Number of Entering Mainline Lanes	N_b	3
Number of Lanes in Weaving Section	N	4
Length of Weaving Section (feet)	L	1,700

Total Weaving Section (V)		On-ramp to Mainline (W_1)		Mainline to Off-ramp (W_2)	
Volume (vph)*	2,536	Volume (vph)*	600	Volume (vph)*	340
Truck Percentage	6%	Truck Percentage	6%	Truck Percentage	6%
PCE for Trucks	1.5	PCE for Trucks	1.5	PCE for Trucks	1.5
Volume (pcph)	2,612	Volume (pcph)	618	Volume (pcph)	350

Project Information

Project	LBNL
Scenario	Existing + Project (Phase 1) PM
Freeway	EB I-580
On-ramp	Harbour Way
Off-ramp	Marina Bay Pkwy



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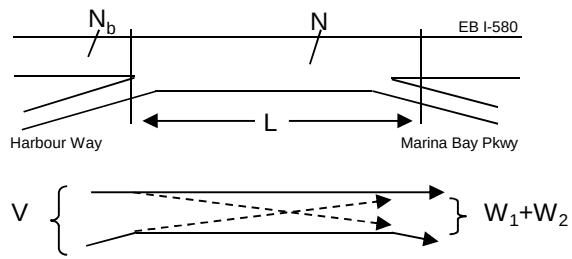


Capacity Analysis

1. Is the weaving section balanced (Y / N)? **N**
   [If optional exit lane, then "Y". Otherwise "N".]
2. In the Weaving Speed Chart to the left, which two speed curves is the black "x" between?
   50 MPH and **55 MPH**
   If below the 55 MPH curve, out of the realm of weaving.
   If left of the 30 MPH curve, LOS is F.
3. Interpolated Weaving Speed (S_w, mph) **49.6**
4. Weaving Intensity Factor (k) **1.25**
5. Service Volume (SV, pcph)
   $SV = (1/N)*[V + (k - 1)*\min(W_1, W_2)]$ **675**
6. Level of Service (LOS) **A**

The LOS in the chart above refers to the capacity of weaving traffic only; through and ramp to ramp traffic is not included.

* Note: **Do not adjust by a Peak Hour Factor (PHF).** The methodology incorporates the PHF in the Service Volume tables.

Sources: *Completion of Procedures for Analysis and Design of Traffic Weaving Sections*, Jack E. Leisch & Associates, September 1983 and *Highway Design Manual*, California Department of Transportation, July 24, 2009

Leisch Method for Weaving Analysis

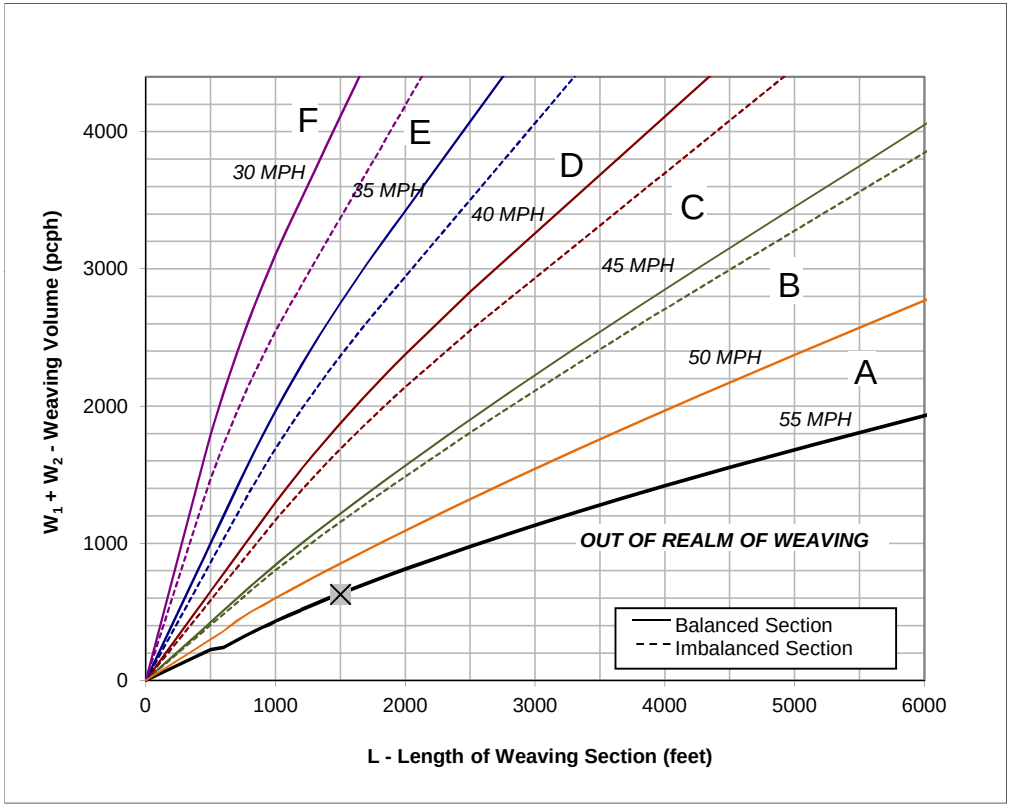
Data Input

Number of Entering Mainline Lanes	N_b	3
Number of Lanes in Weaving Section	N	4
Length of Weaving Section (feet)	L	1,500

Total Weaving Section (V)		On-ramp to Mainline (W_1)		Mainline to Off-ramp (W_2)	
Volume (vph)*	2,010	Volume (vph)*	220	Volume (vph)*	390
Truck Percentage	6%	Truck Percentage	6%	Truck Percentage	6%
PCE for Trucks	1.5	PCE for Trucks	1.5	PCE for Trucks	1.5
Volume (pcph)	2,070	Volume (pcph)	227	Volume (pcph)	402

Project Information

Project	LBNL
Scenario	Existing + Project (Phase 1) PM
Freeway	WB I-580
On-ramp	Marina Bay Parkway
Off-ramp	Harbour Way



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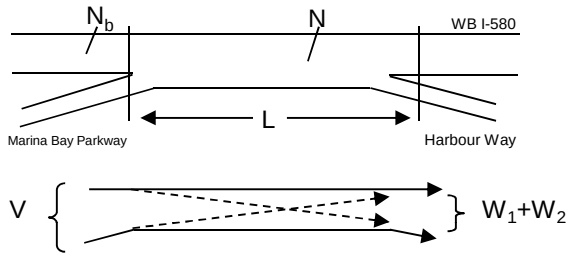


Capacity Analysis

1. Is the weaving section balanced (Y / N)? **N**
   [If optional exit lane, then "Y". Otherwise "N".]
2. In the Weaving Speed Chart to the left, which two speed curves is the black "x" between?
   50 MPH and **55 MPH**
   If below the 55 MPH curve, out of the realm of weaving.
   If left of the 30 MPH curve, LOS is F.
3. Interpolated Weaving Speed (S_w, mph) **55.1**
4. Weaving Intensity Factor (k) **1.00**
5. Service Volume (SV, pcph)
   $SV = (1/N)*[V + (k - 1)*\min(W_1, W_2)]$ **518**
6. Level of Service (LOS) **A**

The LOS in the chart above refers to the capacity of weaving traffic only; through and ramp to ramp traffic is not included.

* Note: **Do not adjust by a Peak Hour Factor (PHF).** The methodology incorporates the PHF in the Service Volume tables.

Sources: *Completion of Procedures for Analysis and Design of Traffic Weaving Sections*, Jack E. Leisch & Associates, September 1983 and *Highway Design Manual*, California Department of Transportation, July 24, 2009

Leisch Method for Weaving Analysis

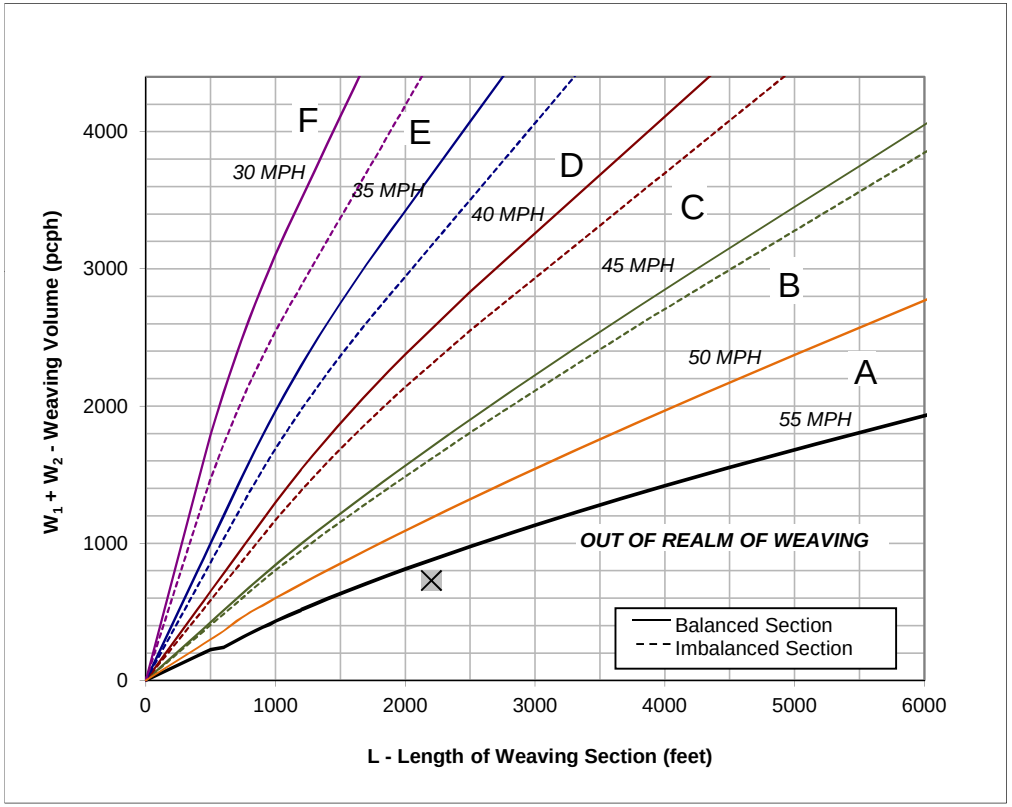
Data Input

Number of Entering Mainline Lanes	N_b	3
Number of Lanes in Weaving Section	N	4
Length of Weaving Section (feet)	L	2,200

Total Weaving Section (V)		On-ramp to Mainline (W_1)		Mainline to Off-ramp (W_2)	
Volume (vph)*	2,777	Volume (vph)*	581	Volume (vph)*	127
Truck Percentage	6%	Truck Percentage	6%	Truck Percentage	6%
PCE for Trucks	1.5	PCE for Trucks	1.5	PCE for Trucks	1.5
Volume (pcph)	2,860	Volume (pcph)	598	Volume (pcph)	131

Project Information

Project	LBNL
Scenario	Existing + Project (Phase 1) PM
Freeway	EB I-580
On-ramp	Marina Bay Parkway
Off-ramp	Regatta Blvd



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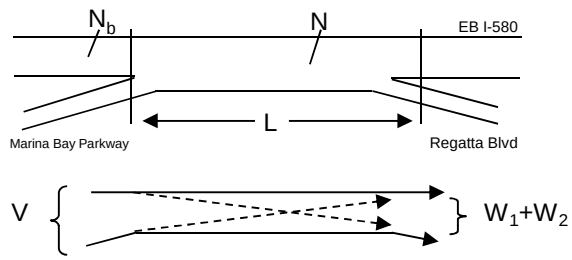


Capacity Analysis

1. Is the weaving section balanced (Y / N)? **N**
   [If optional exit lane, then "Y". Otherwise "N".]
2. In the Weaving Speed Chart to the left, which two speed curves is the black "x" between?
   50 MPH and **55 MPH**
   If below the 55 MPH curve, out of the realm of weaving.
   If left of the 30 MPH curve, LOS is F.
3. Interpolated Weaving Speed (S_w, mph) **57.5**
4. Weaving Intensity Factor (k) **1.00**
5. Service Volume (SV, pcph)
   $SV = (1/N)*[V + (k - 1)*\min(W_1, W_2)]$ **715**
6. Level of Service (LOS) **A**

The LOS in the chart above refers to the capacity of weaving traffic only; through and ramp to ramp traffic is not included.

* Note: **Do not adjust by a Peak Hour Factor (PHF).** The methodology incorporates the PHF in the Service Volume tables.

Sources: *Completion of Procedures for Analysis and Design of Traffic Weaving Sections*, Jack E. Leisch & Associates, September 1983 and *Highway Design Manual*, California Department of Transportation, July 24, 2009

Leisch Method for Weaving Analysis

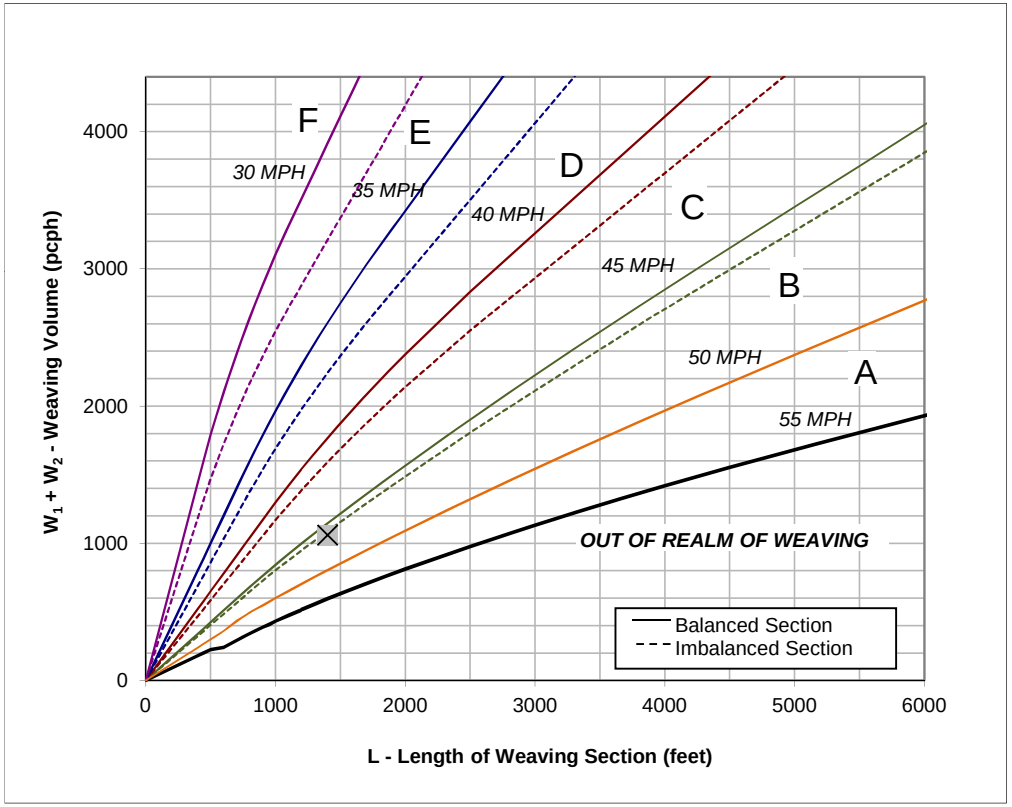
Data Input

Number of Entering Mainline Lanes	N_b	3
Number of Lanes in Weaving Section	N	4
Length of Weaving Section (feet)	L	1,400

Total Weaving Section (V)		On-ramp to Mainline (W_1)		Mainline to Off-ramp (W_2)	
Volume (vph)*	2,715	Volume (vph)*	105	Volume (vph)*	925
Truck Percentage	6%	Truck Percentage	6%	Truck Percentage	6%
PCE for Trucks	1.5	PCE for Trucks	1.5	PCE for Trucks	1.5
Volume (pcph)	2,796	Volume (pcph)	108	Volume (pcph)	953

Project Information

Project	LBNL
Scenario	Existing + Project (Phase 1) PM
Freeway	WB I-580
On-ramp	Regatta Blvd
Off-ramp	Marina Bay Parkway



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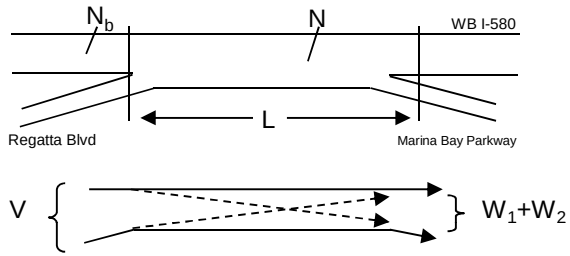


Capacity Analysis

1. Is the weaving section balanced (Y / N)? **N**
   [If optional exit lane, then "Y". Otherwise "N".]
2. In the Weaving Speed Chart to the left, which two speed curves is the black "x" between?
   45 MPH and **50 MPH**
   If below the 55 MPH curve, out of the realm of weaving.
   If left of the 30 MPH curve, LOS is F.
3. Interpolated Weaving Speed (S_w, mph) **45.5**
4. Weaving Intensity Factor (k) **2.53**
5. Service Volume (SV, pcph)
   $SV = (1/N)*[V + (k - 1)*\min(W_1, W_2)]$ **741**
6. Level of Service (LOS) **A**

The LOS in the chart above refers to the capacity of weaving traffic only; through and ramp to ramp traffic is not included.

* Note: **Do not adjust by a Peak Hour Factor (PHF).** The methodology incorporates the PHF in the Service Volume tables.

Sources: *Completion of Procedures for Analysis and Design of Traffic Weaving Sections*, Jack E. Leisch & Associates, September 1983 and *Highway Design Manual*, California Department of Transportation, July 24, 2009

Leisch Method for Weaving Analysis

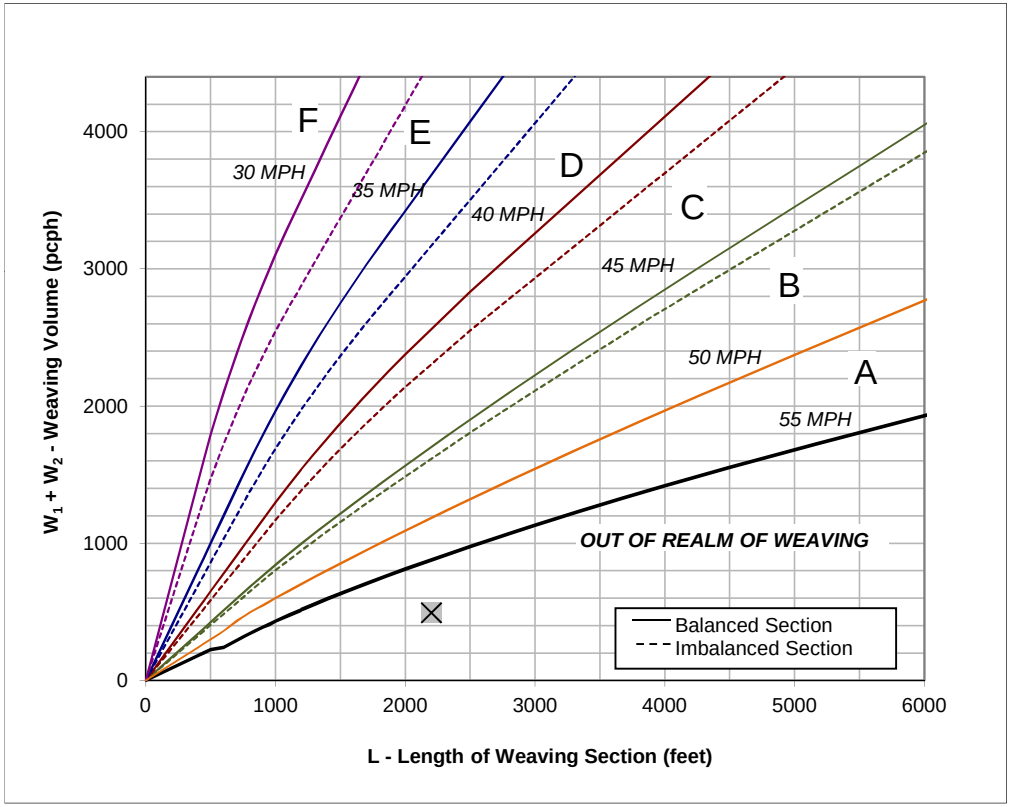
Data Input

Number of Entering Mainline Lanes	N_b	3
Number of Lanes in Weaving Section	N	4
Length of Weaving Section (feet)	L	2,200

Total Weaving Section (V)		On-ramp to Mainline (W_1)		Mainline to Off-ramp (W_2)	
Volume (vph)*	2,730	Volume (vph)*	400	Volume (vph)*	80
Truck Percentage	6%	Truck Percentage	6%	Truck Percentage	6%
PCE for Trucks	1.5	PCE for Trucks	1.5	PCE for Trucks	1.5
Volume (pcph)	2,812	Volume (pcph)	412	Volume (pcph)	82

Project Information

Project	LBNL
Scenario	Existing + Project (Phase 1) PM
Freeway	EB I-580
On-ramp	Regatta Blvd
Off-ramp	Bayview Ave



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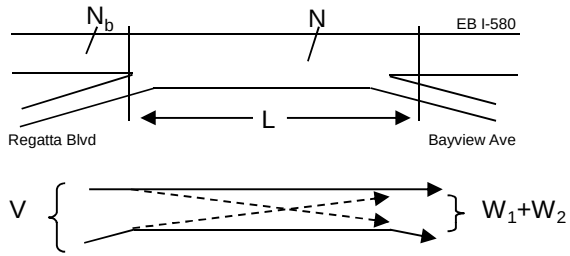


Capacity Analysis

1. Is the weaving section balanced (Y / N)? **N**
   [If optional exit lane, then "Y". Otherwise "N".]
2. In the Weaving Speed Chart to the left, which two speed curves is the black "x" between?
   50 MPH and **55 MPH**
   If below the 55 MPH curve, out of the realm of weaving.
   If left of the 30 MPH curve, LOS is F.
3. Interpolated Weaving Speed (S_w, mph) **61.3**
4. Weaving Intensity Factor (k) **1.00**
5. Service Volume (SV, pcph)
   $SV = (1/N)*[V + (k - 1)*\min(W_1, W_2)]$ **703**
6. Level of Service (LOS) **A**

The LOS in the chart above refers to the capacity of weaving traffic only; through and ramp to ramp traffic is not included.

* Note: **Do not adjust by a Peak Hour Factor (PHF).** The methodology incorporates the PHF in the Service Volume tables.

Sources: *Completion of Procedures for Analysis and Design of Traffic Weaving Sections*, Jack E. Leisch & Associates, September 1983 and *Highway Design Manual*, California Department of Transportation, July 24, 2009

Leisch Method for Weaving Analysis

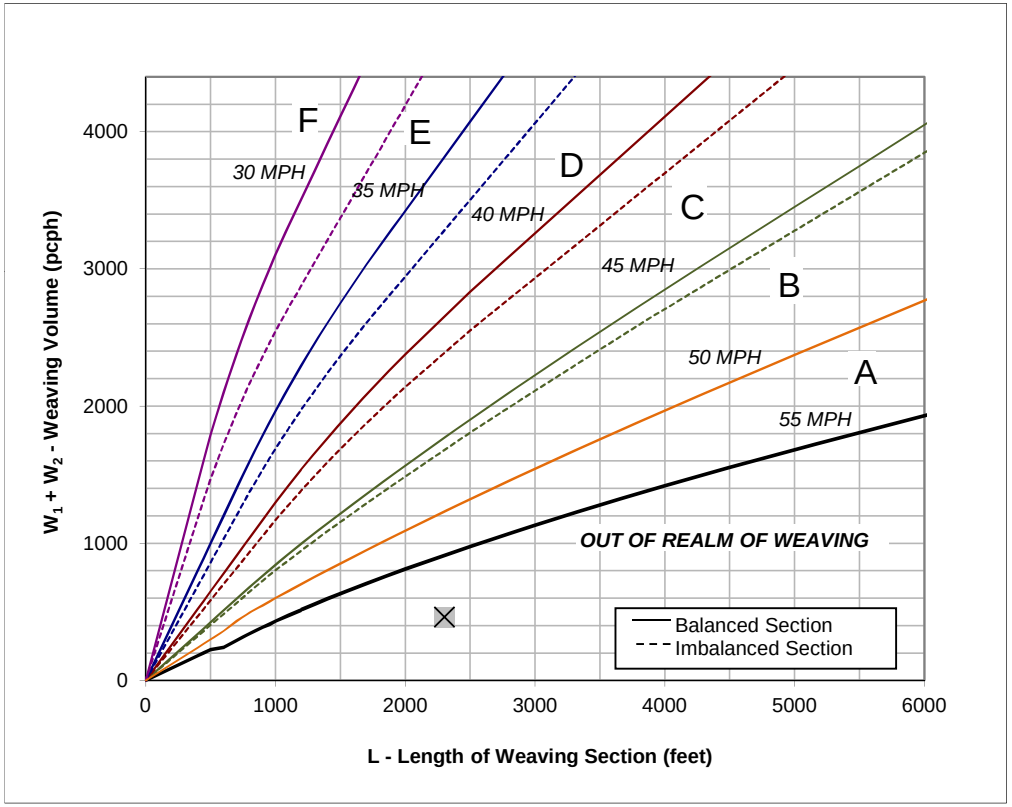
Data Input

Number of Entering Mainline Lanes	N_b	3
Number of Lanes in Weaving Section	N	4
Length of Weaving Section (feet)	L	2,300

Total Weaving Section (V)		On-ramp to Mainline (W_1)		Mainline to Off-ramp (W_2)	
Volume (vph)*	2,780	Volume (vph)*	290	Volume (vph)*	160
Truck Percentage	6%	Truck Percentage	6%	Truck Percentage	6%
PCE for Trucks	1.5	PCE for Trucks	1.5	PCE for Trucks	1.5
Volume (pcph)	2,863	Volume (pcph)	299	Volume (pcph)	165

Project Information

Project	LBNL
Scenario	Existing + Project (Phase 1) PM
Freeway	WB I-580
On-ramp	Bayview Ave
Off-ramp	Regatta Blvd



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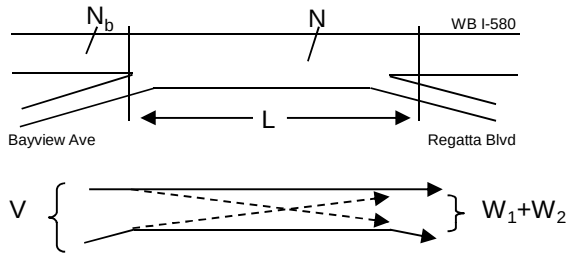


Capacity Analysis

1. Is the weaving section balanced (Y / N)? **N**
   [If optional exit lane, then "Y". Otherwise "N".]
2. In the Weaving Speed Chart to the left, which two speed curves is the black "x" between?
   50 MPH and **55 MPH**
   If below the 55 MPH curve, out of the realm of weaving.
   If left of the 30 MPH curve, LOS is F.
3. Interpolated Weaving Speed (S_w, mph) **62.1**
4. Weaving Intensity Factor (k) **1.00**
5. Service Volume (SV, pcph)
   $SV = (1/N)*[V + (k - 1)*\min(W_1, W_2)]$ **716**
6. Level of Service (LOS) **A**

The LOS in the chart above refers to the capacity of weaving traffic only; through and ramp to ramp traffic is not included.

* Note: **Do not adjust by a Peak Hour Factor (PHF).** The methodology incorporates the PHF in the Service Volume tables.

Sources: *Completion of Procedures for Analysis and Design of Traffic Weaving Sections*, Jack E. Leisch & Associates, September 1983 and *Highway Design Manual*, California Department of Transportation, July 24, 2009

Existing Plus Project Buildout Conditions

FEHR PEERS

HCM 2000
Basic Freeway Segments
Capacity Analysis

Jurisdiction
Analysis Year Existing + Project (Buildout)
Analyst EK

Agency or Company
Date
Project Description

General Information				*Flow Rate Calculation*														*Speed Calculation*		*Results*	
	Freeway/ Direction	From/To	Analysis Time Period	Volume (vph)	PHF	Lanes	HOV Lane?	HOV Lane Volume	Terrain	Truck/ Bus %	RV %	E_T	E_R	f_{HV}	f_P	Flow Rate v_p (pcphpl)	Measured FFS (mph)	S (mph)	Density, D (pcplpm)	Level of Service
R-5	I-580 EB	I-580 between Bayview Avenue and Central Avenue	AM	2,779	0.92	3	No		Level	6%	0%	1.5	1.2	0.971	1.00	1,037	65.0	65.0	**16.0**	**B**
R-6	I-580 EB	I-580 between Central Avenue and I-80	AM	2,829	0.92	2	No		Level	6%	0%	1.5	1.2	0.971	1.00	1,584	65.0	64.9	**24.4**	**C**
R-7	I-80 EB	I-80 between Carlson Boulevard and Potrero Avenue	AM	4,091	0.92	4	Yes	290	Level	4%	0%	1.5	1.2	0.980	1.00	1,405	65.0	65.0	**21.6**	**C**
R-8	I-80 EB	I-80 @ Gilman Overpass	AM	6,460	0.92	5	Yes	780	Level	5%	0%	1.5	1.2	0.976	1.00	1,582	65.0	64.9	**24.4**	**C**
R-5	I-580 WB	I-580 between Bayview Avenue and Central Avenue	AM	3,110	0.92	3	No		Level	6%	0%	1.5	1.2	0.971	1.00	1,161	65.0	65.0	**17.9**	**B**
R-6	I-580 WB	I-580 between Central Avenue and I-80	AM	3,510	0.92	2	No		Level	6%	0%	1.5	1.2	0.971	1.00	1,965	65.0	62.0	**31.7**	**D**
R-7	I-80 WB	I-80 between Carlson Boulevard and Potrero Avenue	AM	6,329	0.92	4	Yes	960	Level	4%	0%	1.5	1.2	0.980	1.00	1,984	65.0	61.7	**32.2**	**D**
R-8	I-80 WB	I-80 @ Gilman Overpass	AM	8,449	0.92	5	Yes	1410	Level	5%	0%	1.5	1.2	0.976	1.00	1,961	65.0	62.1	**31.6**	**D**
R-5	I-580 EB	I-580 between Bayview Avenue and Central Avenue	PM	3,027	0.92	3	No		Level	6%	0%	1.5	1.2	0.971	1.00	1,130	65.0	65.0	**17.4**	**B**
R-6	I-580 EB	I-580 between Central Avenue and I-80	PM	3,847	0.92	2	No		Level	6%	0%	1.5	1.2	0.971	1.00	2,153	65.0	58.3	**37.0**	**E**
R-7	I-80 EB	I-80 between Carlson Boulevard and Potrero Avenue	PM	6,302	0.92	4	Yes	1260	Level	4%	0%	1.5	1.2	0.980	1.00	1,863	65.0	63.3	**29.4**	**D**
R-8	I-80 EB	I-80 @ Gilman Overpass	PM	7,401	0.92	5	Yes	1020	Level	5%	0%	1.5	1.2	0.976	1.00	1,777	65.0	64.1	**27.7**	**D**
R-5	I-580 WB	I-580 between Bayview Avenue and Central Avenue	PM	3,031	0.92	3	No		Level	6%	0%	1.5	1.2	0.971	1.00	1,131	65.0	65.0	**17.4**	**B**
R-6	I-580 WB	I-580 between Central Avenue and I-80	PM	2,711	0.92	2	No		Level	6%	0%	1.5	1.2	0.971	1.00	1,518	65.0	65.0	**23.4**	**C**
R-7	I-80 WB	I-80 between Carlson Boulevard and Potrero Avenue	PM	4,597	0.92	4	Yes	330	Level	4%	0%	1.5	1.2	0.980	1.00	1,577	65.0	64.9	**24.3**	**C**
R-8	I-80 WB	I-80 @ Gilman Overpass	PM	7,167	0.92	5	Yes	630	Level	5%	0%	1.5	1.2	0.976	1.00	1,821	65.0	63.7	**28.6**	**D**

Leisch Method for Weaving Analysis

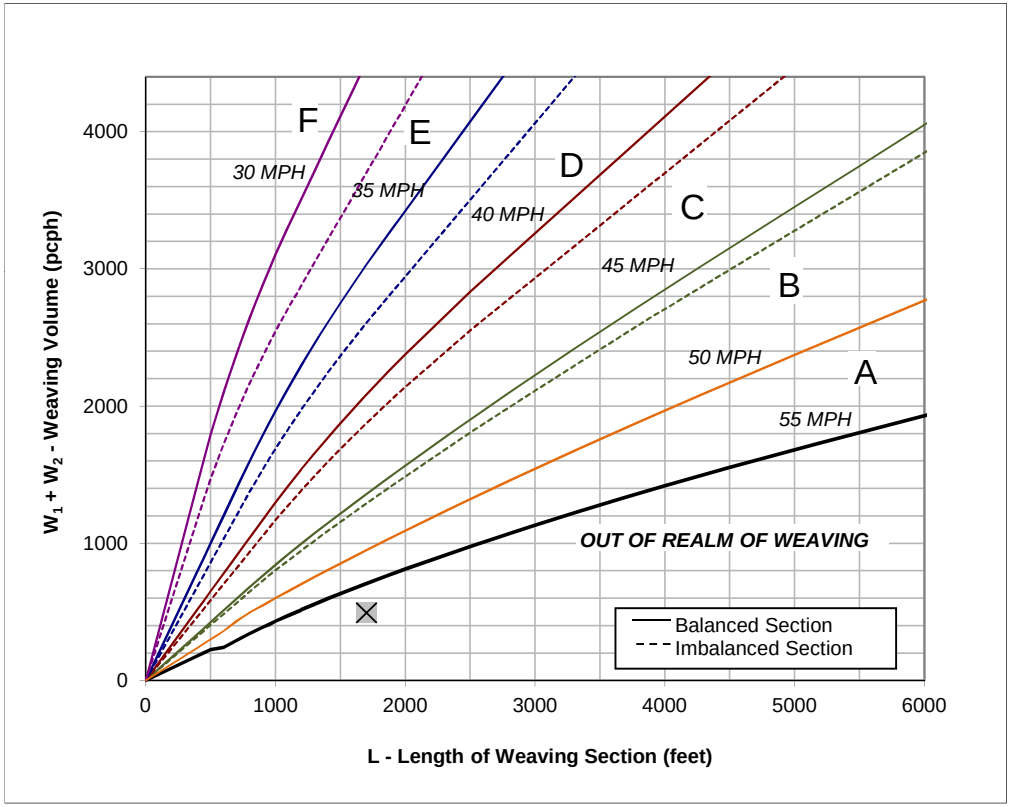
Data Input

Number of Entering Mainline Lanes	N_b	3
Number of Lanes in Weaving Section	N	4
Length of Weaving Section (feet)	L	1,700

Total Weaving Section (V)		On-ramp to Mainline (W_1)		Mainline to Off-ramp (W_2)	
Volume (vph)*	2,423	Volume (vph)*	320	Volume (vph)*	160
Truck Percentage	6%	Truck Percentage	6%	Truck Percentage	6%
PCE for Trucks	1.5	PCE for Trucks	1.5	PCE for Trucks	1.5
Volume (pcph)	2,496	Volume (pcph)	330	Volume (pcph)	165

Project Information

Project	LBNL
Scenario	Existing + Project (Buildout) AM
Freeway	EB I-580
On-ramp	Harbour Way
Off-ramp	Marina Bay Pkwy



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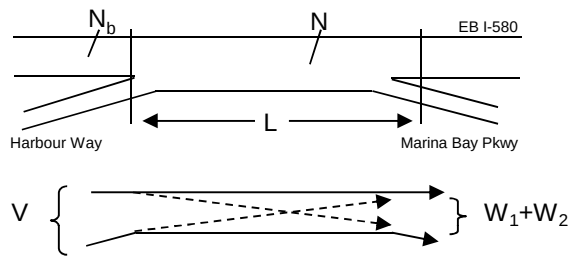


Capacity Analysis

1. Is the weaving section balanced (Y / N)? **N**
   [If optional exit lane, then "Y". Otherwise "N".]
2. In the Weaving Speed Chart to the left, which two speed curves is the black "x" between?
   50 MPH and **55 MPH**
   If below the 55 MPH curve, out of the realm of weaving.
   If left of the 30 MPH curve, LOS is F.
3. Interpolated Weaving Speed (S_w, mph) **59.4**
4. Weaving Intensity Factor (k) **1.00**
5. Service Volume (SV, pcph)
   $SV = (1/N)*[V + (k - 1)*\min(W_1, W_2)]$ **624**
6. Level of Service (LOS) **A**

The LOS in the chart above refers to the capacity of weaving traffic only; through and ramp to ramp traffic is not included.

* Note: **Do not adjust by a Peak Hour Factor (PHF).** The methodology incorporates the PHF in the Service Volume tables.

Sources: *Completion of Procedures for Analysis and Design of Traffic Weaving Sections*, Jack E. Leisch & Associates, September 1983 and *Highway Design Manual*, California Department of Transportation, July 24, 2009

Leisch Method for Weaving Analysis

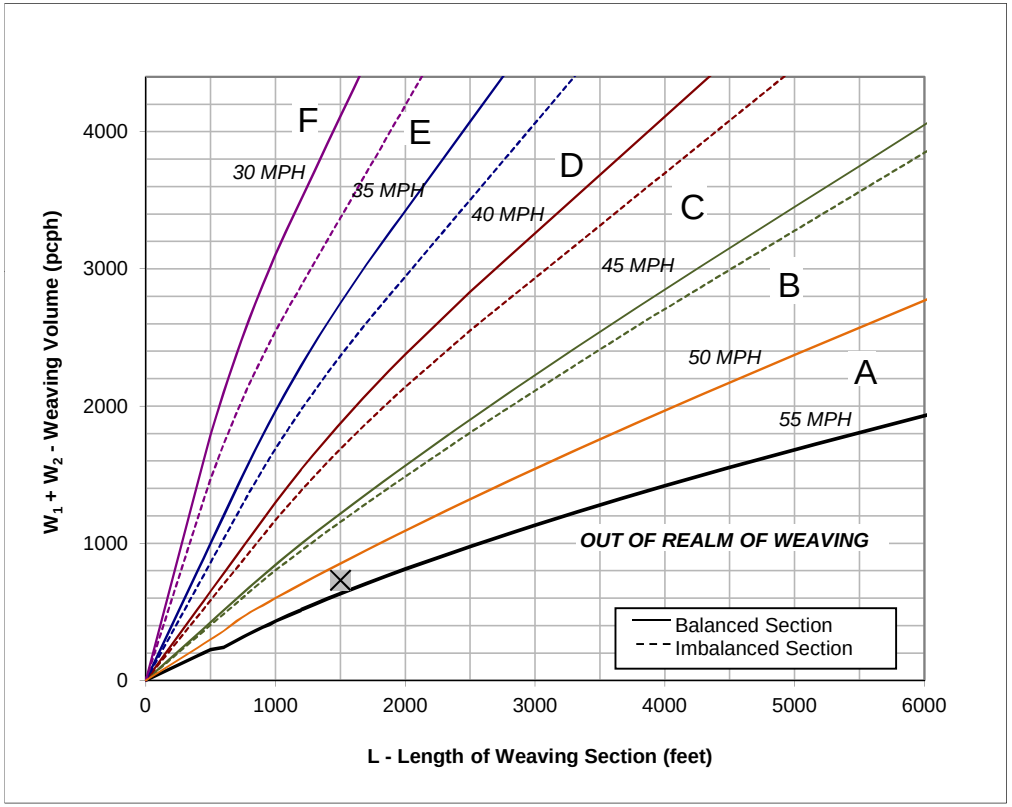
Data Input

Number of Entering Mainline Lanes	N_b	3
Number of Lanes in Weaving Section	N	4
Length of Weaving Section (feet)	L	1,500

Total Weaving Section (V)		On-ramp to Mainline (W_1)		Mainline to Off-ramp (W_2)	
Volume (vph)*	2,252	Volume (vph)*	320	Volume (vph)*	390
Truck Percentage	6%	Truck Percentage	6%	Truck Percentage	6%
PCE for Trucks	1.5	PCE for Trucks	1.5	PCE for Trucks	1.5
Volume (pcph)	2,320	Volume (pcph)	330	Volume (pcph)	402

Project Information

Project	LBNL
Scenario	Existing + Project (Buildout) AM
Freeway	WB I-580
On-ramp	Marina Bay Parkway
Off-ramp	Harbour Way



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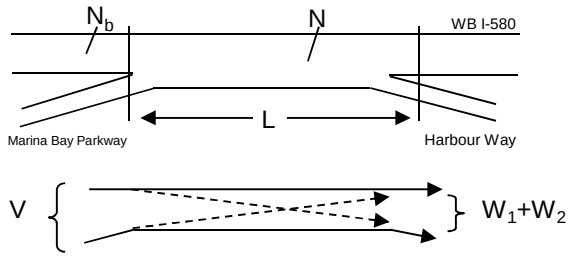


Capacity Analysis

1. Is the weaving section balanced (Y / N)? **N**
   [If optional exit lane, then "Y". Otherwise "N".]
2. In the Weaving Speed Chart to the left, which two speed curves is the black "x" between?
   50 MPH and **55 MPH**
   If below the 55 MPH curve, out of the realm of weaving.
   If left of the 30 MPH curve, LOS is F.
3. Interpolated Weaving Speed (S_w, mph) **52.8**
4. Weaving Intensity Factor (k) **1.00**
5. Service Volume (SV, pcph)
   $SV = (1/N)*[V + (k - 1)*\min(W_1, W_2)]$ **580**
6. Level of Service (LOS) **A**

The LOS in the chart above refers to the capacity of weaving traffic only; through and ramp to ramp traffic is not included.

* Note: **Do not adjust by a Peak Hour Factor (PHF).** The methodology incorporates the PHF in the Service Volume tables.

Sources: *Completion of Procedures for Analysis and Design of Traffic Weaving Sections*, Jack E. Leisch & Associates, September 1983 and *Highway Design Manual*, California Department of Transportation, July 24, 2009

Leisch Method for Weaving Analysis

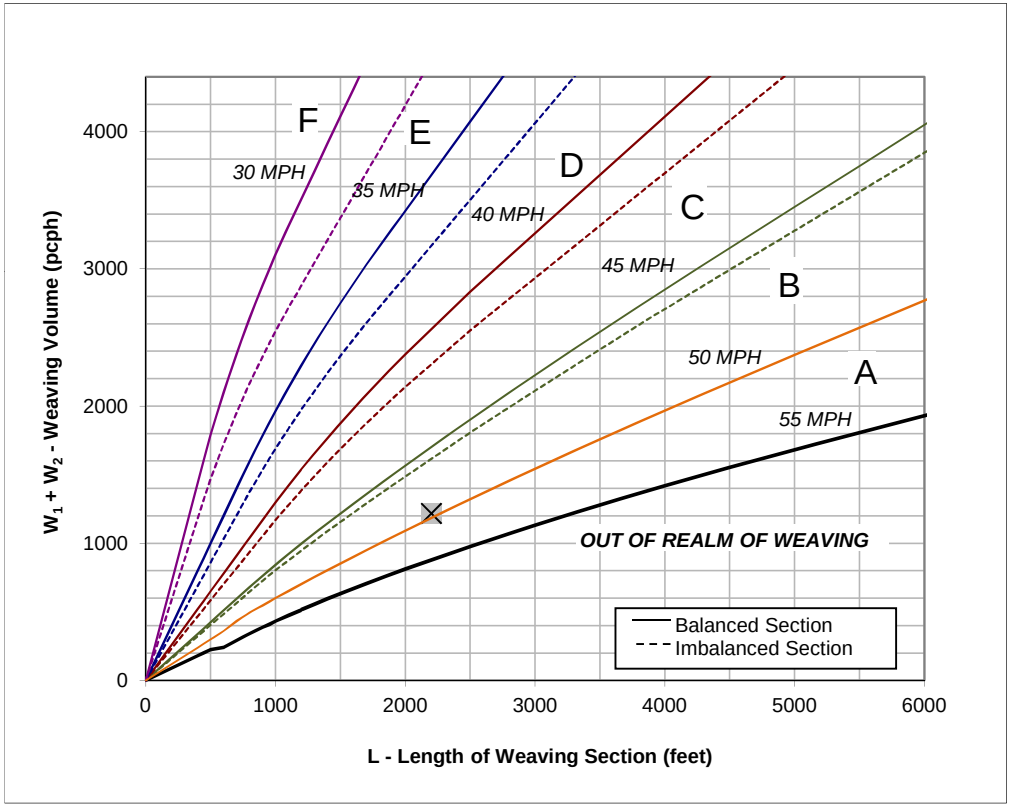
Data Input

Number of Entering Mainline Lanes	N_b	3
Number of Lanes in Weaving Section	N	4
Length of Weaving Section (feet)	L	2,200

Total Weaving Section (V)		On-ramp to Mainline (W_1)		Mainline to Off-ramp (W_2)	
Volume (vph)*	3,083	Volume (vph)*	820	Volume (vph)*	363
Truck Percentage	6%	Truck Percentage	6%	Truck Percentage	6%
PCE for Trucks	1.5	PCE for Trucks	1.5	PCE for Trucks	1.5
Volume (pcph)	3,175	Volume (pcph)	845	Volume (pcph)	374

Project Information

Project	LBNL
Scenario	Existing + Project (Buildout) AM
Freeway	EB I-580
On-ramp	Marina Bay Parkway
Off-ramp	Regatta Blvd



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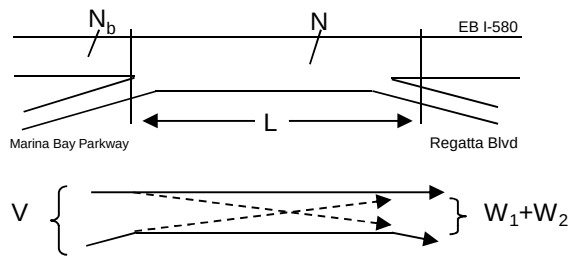


Capacity Analysis

1. Is the weaving section balanced (Y / N)? **N**
   [If optional exit lane, then "Y". Otherwise "N".]
2. In the Weaving Speed Chart to the left, which two speed curves is the black "x" between?
   50 MPH and **55 MPH**
   If below the 55 MPH curve, out of the realm of weaving.
   If left of the 30 MPH curve, LOS is F.
3. Interpolated Weaving Speed (S_w, mph) **49.4**
4. Weaving Intensity Factor (k) **1.28**
5. Service Volume (SV, pcph)
   $SV = (1/N)*[V + (k - 1)*\min(W_1, W_2)]$ **820**
6. Level of Service (LOS) **B**

The LOS in the chart above refers to the capacity of weaving traffic only; through and ramp to ramp traffic is not included.

* Note: **Do not adjust by a Peak Hour Factor (PHF).** The methodology incorporates the PHF in the Service Volume tables.

Sources: *Completion of Procedures for Analysis and Design of Traffic Weaving Sections*, Jack E. Leisch & Associates, September 1983 and *Highway Design Manual*, California Department of Transportation, July 24, 2009

Leisch Method for Weaving Analysis

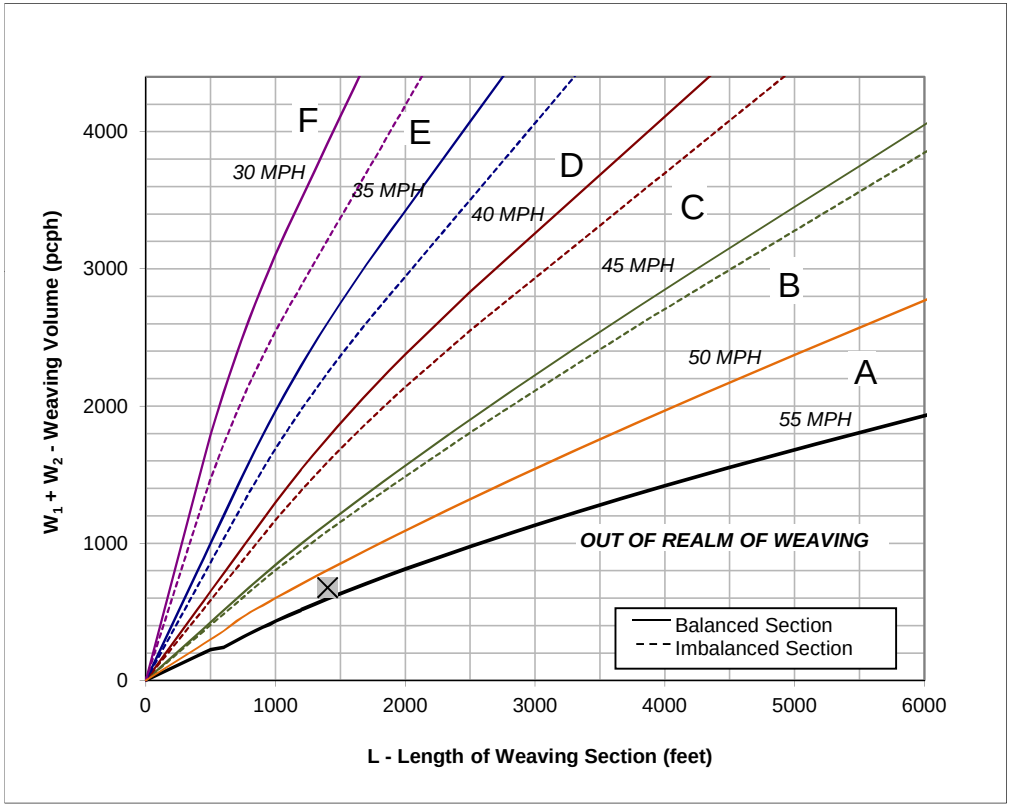
Data Input

Number of Entering Mainline Lanes	N_b	3
Number of Lanes in Weaving Section	N	4
Length of Weaving Section (feet)	L	1,400

Total Weaving Section (V)		On-ramp to Mainline (W_1)		Mainline to Off-ramp (W_2)	
Volume (vph)*	2,835	Volume (vph)*	175	Volume (vph)*	483
Truck Percentage	6%	Truck Percentage	6%	Truck Percentage	6%
PCE for Trucks	1.5	PCE for Trucks	1.5	PCE for Trucks	1.5
Volume (pcph)	2,920	Volume (pcph)	180	Volume (pcph)	497

Project Information

Project	LBNL
Scenario	Existing + Project (Buildout) AM
Freeway	WB I-580
On-ramp	Regatta Blvd
Off-ramp	Marina Bay Parkway



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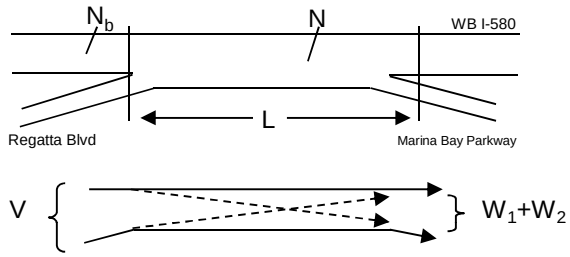


Capacity Analysis

1. Is the weaving section balanced (Y / N)? **N**
   [If optional exit lane, then "Y". Otherwise "N".]
2. In the Weaving Speed Chart to the left, which two speed curves is the black "x" between?
   50 MPH and **55 MPH**
   If below the 55 MPH curve, out of the realm of weaving.
   If left of the 30 MPH curve, LOS is F.
3. Interpolated Weaving Speed (S_w, mph) **53.0**
4. Weaving Intensity Factor (k) **1.00**
5. Service Volume (SV, pcph)
   $SV = (1/N)*[V + (k - 1)*\min(W_1, W_2)]$ **730**
6. Level of Service (LOS) **A**

The LOS in the chart above refers to the capacity of weaving traffic only; through and ramp to ramp traffic is not included.

* Note: **Do not adjust by a Peak Hour Factor (PHF).** The methodology incorporates the PHF in the Service Volume tables.

Sources: *Completion of Procedures for Analysis and Design of Traffic Weaving Sections*, Jack E. Leisch & Associates, September 1983 and *Highway Design Manual*, California Department of Transportation, July 24, 2009

Leisch Method for Weaving Analysis

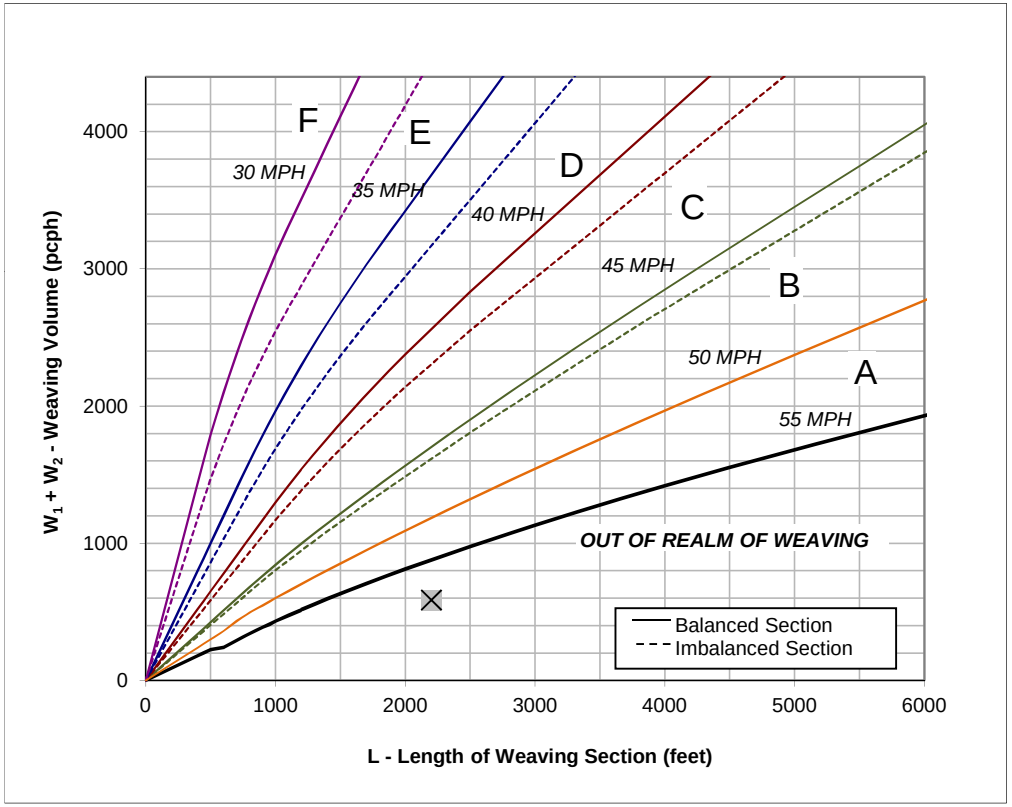
Data Input

Number of Entering Mainline Lanes	N_b	3
Number of Lanes in Weaving Section	N	4
Length of Weaving Section (feet)	L	2,200

Total Weaving Section (V)		On-ramp to Mainline (W_1)		Mainline to Off-ramp (W_2)	
Volume (vph)*	2,870	Volume (vph)*	140	Volume (vph)*	430
Truck Percentage	6%	Truck Percentage	6%	Truck Percentage	6%
PCE for Trucks	1.5	PCE for Trucks	1.5	PCE for Trucks	1.5
Volume (pcph)	2,956	Volume (pcph)	144	Volume (pcph)	443

Project Information

Project	LBNL
Scenario	Existing + Project (Buildout) AM
Freeway	EB I-580
On-ramp	Regatta Blvd
Off-ramp	Bayview Ave



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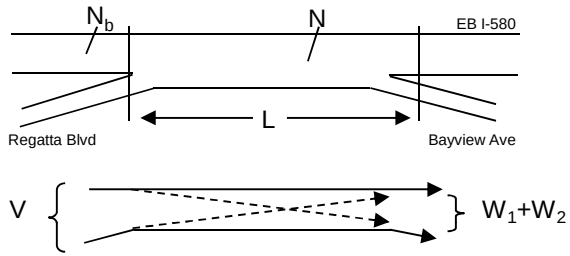


Capacity Analysis

1. Is the weaving section balanced (Y / N)? **N**
   [If optional exit lane, then "Y". Otherwise "N".]
2. In the Weaving Speed Chart to the left, which two speed curves is the black "x" between?
   50 MPH and **55 MPH**
   If below the 55 MPH curve, out of the realm of weaving.
   If left of the 30 MPH curve, LOS is F.
3. Interpolated Weaving Speed (S_w, mph) **59.8**
4. Weaving Intensity Factor (k) **1.00**
5. Service Volume (SV, pcph)
   $SV = (1/N)*[V + (k - 1)*\min(W_1, W_2)]$ **739**
6. Level of Service (LOS) **A**

The LOS in the chart above refers to the capacity of weaving traffic only; through and ramp to ramp traffic is not included.

* Note: **Do not adjust by a Peak Hour Factor (PHF).** The methodology incorporates the PHF in the Service Volume tables.

Sources: *Completion of Procedures for Analysis and Design of Traffic Weaving Sections*, Jack E. Leisch & Associates, September 1983 and *Highway Design Manual*, California Department of Transportation, July 24, 2009

Leisch Method for Weaving Analysis

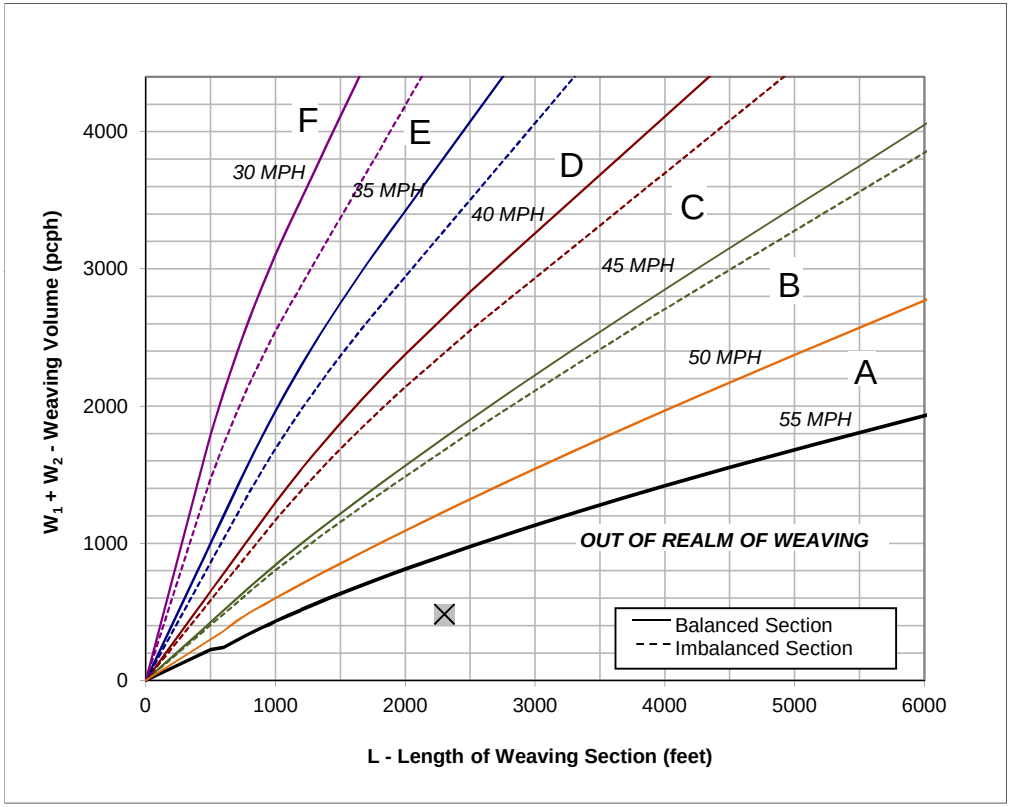
Data Input

Number of Entering Mainline Lanes	N_b	3
Number of Lanes in Weaving Section	N	4
Length of Weaving Section (feet)	L	2,300

Total Weaving Section (V)		On-ramp to Mainline (W_1)		Mainline to Off-ramp (W_2)	
Volume (vph)*	2,750	Volume (vph)*	380	Volume (vph)*	90
Truck Percentage	6%	Truck Percentage	6%	Truck Percentage	6%
PCE for Trucks	1.5	PCE for Trucks	1.5	PCE for Trucks	1.5
Volume (pcph)	2,833	Volume (pcph)	391	Volume (pcph)	93

Project Information

Project	LBNL
Scenario	Existing + Project (Buildout) AM
Freeway	WB I-580
On-ramp	Bayview Ave
Off-ramp	Regatta Blvd



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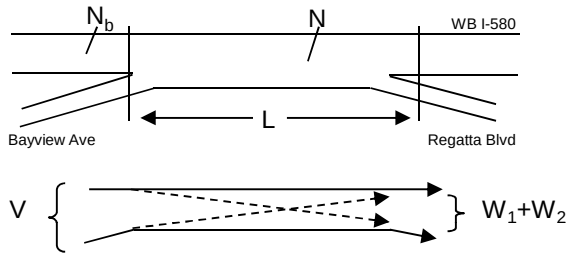


Capacity Analysis

1. Is the weaving section balanced (Y / N)? **N**
   [If optional exit lane, then "Y". Otherwise "N".]
2. In the Weaving Speed Chart to the left, which two speed curves is the black "x" between?
   50 MPH and **55 MPH**
   If below the 55 MPH curve, out of the realm of weaving.
   If left of the 30 MPH curve, LOS is F.
3. Interpolated Weaving Speed (S_w, mph) **61.7**
4. Weaving Intensity Factor (k) **1.00**
5. Service Volume (SV, pcph)
   $SV = (1/N)*[V + (k - 1)*\min(W_1, W_2)]$ **708**
6. Level of Service (LOS) **A**

The LOS in the chart above refers to the capacity of weaving traffic only; through and ramp to ramp traffic is not included.

* Note: **Do not adjust by a Peak Hour Factor (PHF).** The methodology incorporates the PHF in the Service Volume tables.

Sources: *Completion of Procedures for Analysis and Design of Traffic Weaving Sections*, Jack E. Leisch & Associates, September 1983 and *Highway Design Manual*, California Department of Transportation, July 24, 2009

Leisch Method for Weaving Analysis

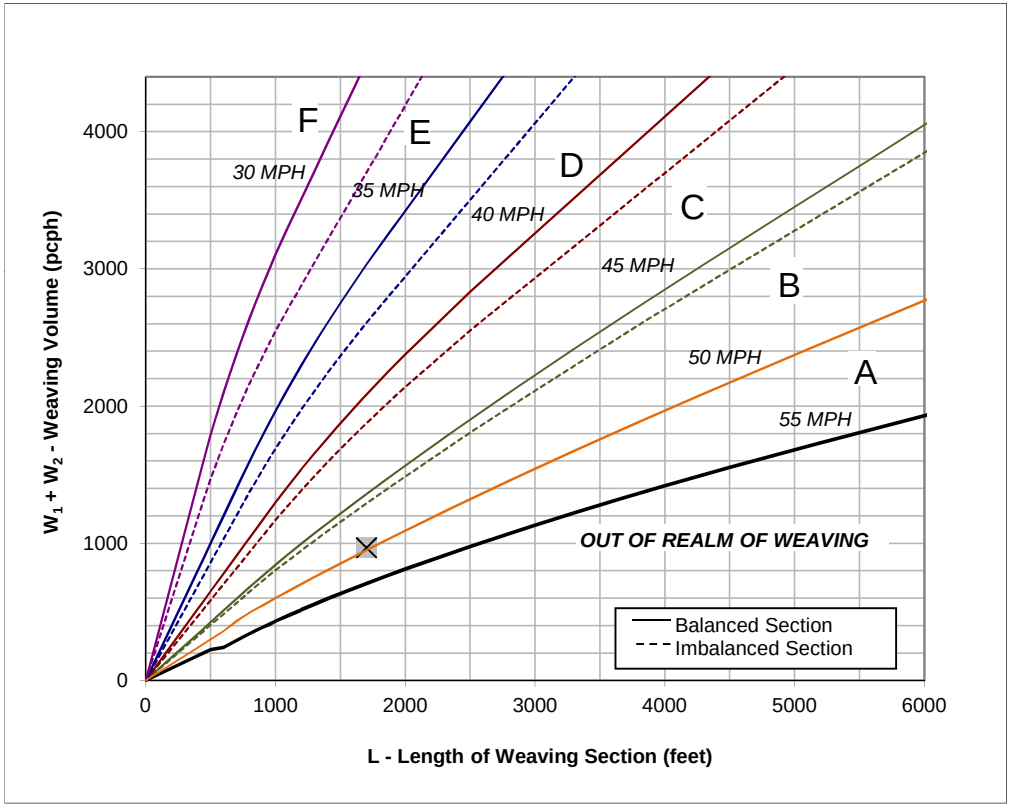
Data Input

Number of Entering Mainline Lanes	N_b	3
Number of Lanes in Weaving Section	N	4
Length of Weaving Section (feet)	L	1,700

Total Weaving Section (V)		On-ramp to Mainline (W_1)		Mainline to Off-ramp (W_2)	
Volume (vph)*	2,559	Volume (vph)*	600	Volume (vph)*	340
Truck Percentage	6%	Truck Percentage	6%	Truck Percentage	6%
PCE for Trucks	1.5	PCE for Trucks	1.5	PCE for Trucks	1.5
Volume (pcph)	2,636	Volume (pcph)	618	Volume (pcph)	350

Project Information

Project	LBNL
Scenario	Existing + Project (Buildout) PM
Freeway	EB I-580
On-ramp	Harbour Way
Off-ramp	Marina Bay Pkwy



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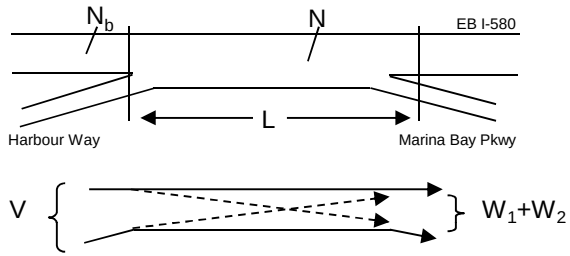


Capacity Analysis

1. Is the weaving section balanced (Y / N)? **N**
   [If optional exit lane, then "Y". Otherwise "N".]
2. In the Weaving Speed Chart to the left, which two speed curves is the black "x" between?
   50 MPH and **55 MPH**
   If below the 55 MPH curve, out of the realm of weaving.
   If left of the 30 MPH curve, LOS is F.
3. Interpolated Weaving Speed (S_w, mph) **49.6**
4. Weaving Intensity Factor (k) **1.25**
5. Service Volume (SV, pcph)
   $SV = (1/N)*[V + (k - 1)*\min(W_1, W_2)]$ **681**
6. Level of Service (LOS) **A**

The LOS in the chart above refers to the capacity of weaving traffic only; through and ramp to ramp traffic is not included.

* Note: **Do not adjust by a Peak Hour Factor (PHF).** The methodology incorporates the PHF in the Service Volume tables.

Sources: *Completion of Procedures for Analysis and Design of Traffic Weaving Sections*, Jack E. Leisch & Associates, September 1983 and *Highway Design Manual*, California Department of Transportation, July 24, 2009

Leisch Method for Weaving Analysis

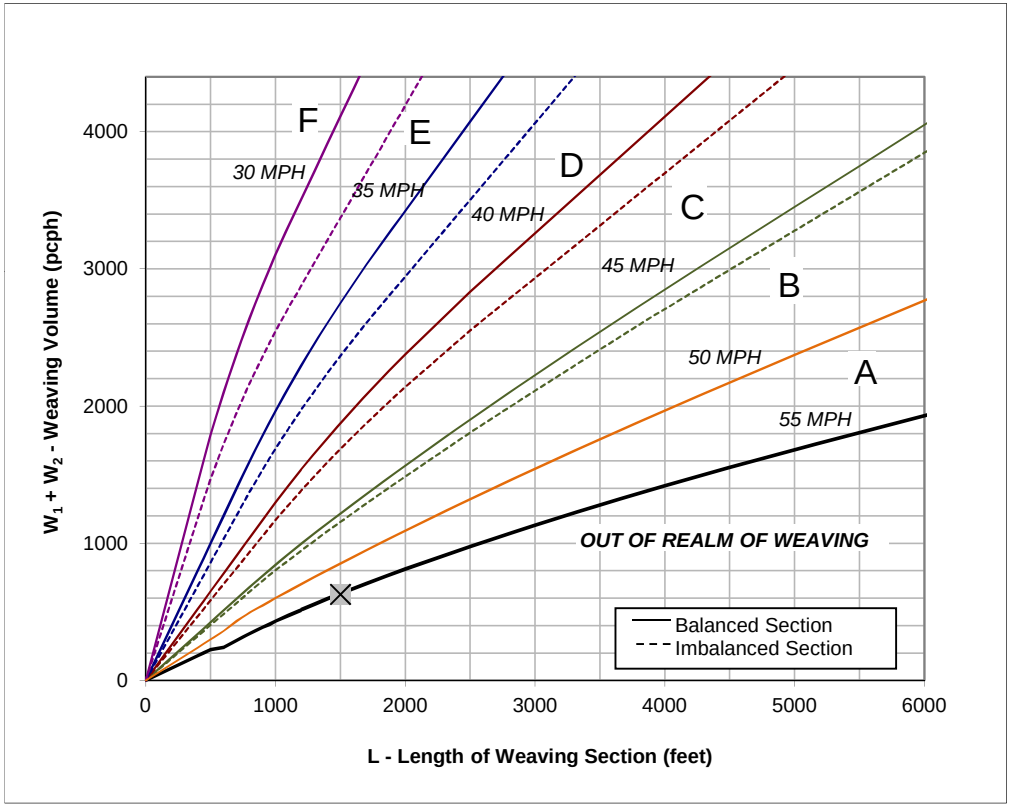
Data Input

Number of Entering Mainline Lanes	N_b	3
Number of Lanes in Weaving Section	N	4
Length of Weaving Section (feet)	L	1,500

Total Weaving Section (V)		On-ramp to Mainline (W_1)		Mainline to Off-ramp (W_2)	
Volume (vph)*	2,162	Volume (vph)*	220	Volume (vph)*	390
Truck Percentage	6%	Truck Percentage	6%	Truck Percentage	6%
PCE for Trucks	1.5	PCE for Trucks	1.5	PCE for Trucks	1.5
Volume (pcph)	2,227	Volume (pcph)	227	Volume (pcph)	402

Project Information

Project	LBNL
Scenario	Existing + Project (Buildout) PM
Freeway	WB I-580
On-ramp	Marina Bay Parkway
Off-ramp	Harbour Way



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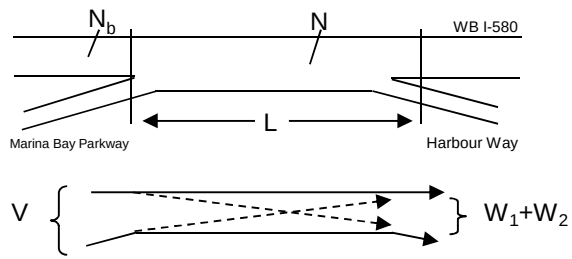


Capacity Analysis

1. Is the weaving section balanced (Y / N)? **N**
   [If optional exit lane, then "Y". Otherwise "N".]
2. In the Weaving Speed Chart to the left, which two speed curves is the black "x" between?
   50 MPH and **55 MPH**
   If below the 55 MPH curve, out of the realm of weaving.
   If left of the 30 MPH curve, LOS is F.
3. Interpolated Weaving Speed (S_w, mph) **55.1**
4. Weaving Intensity Factor (k) **1.00**
5. Service Volume (SV, pcph)
   $SV = (1/N)*[V + (k - 1)*\min(W_1, W_2)]$ **557**
6. Level of Service (LOS) **A**

The LOS in the chart above refers to the capacity of weaving traffic only; through and ramp to ramp traffic is not included.

* Note: **Do not adjust by a Peak Hour Factor (PHF).** The methodology incorporates the PHF in the Service Volume tables.

Sources: *Completion of Procedures for Analysis and Design of Traffic Weaving Sections*, Jack E. Leisch & Associates, September 1983 and *Highway Design Manual*, California Department of Transportation, July 24, 2009

Leisch Method for Weaving Analysis

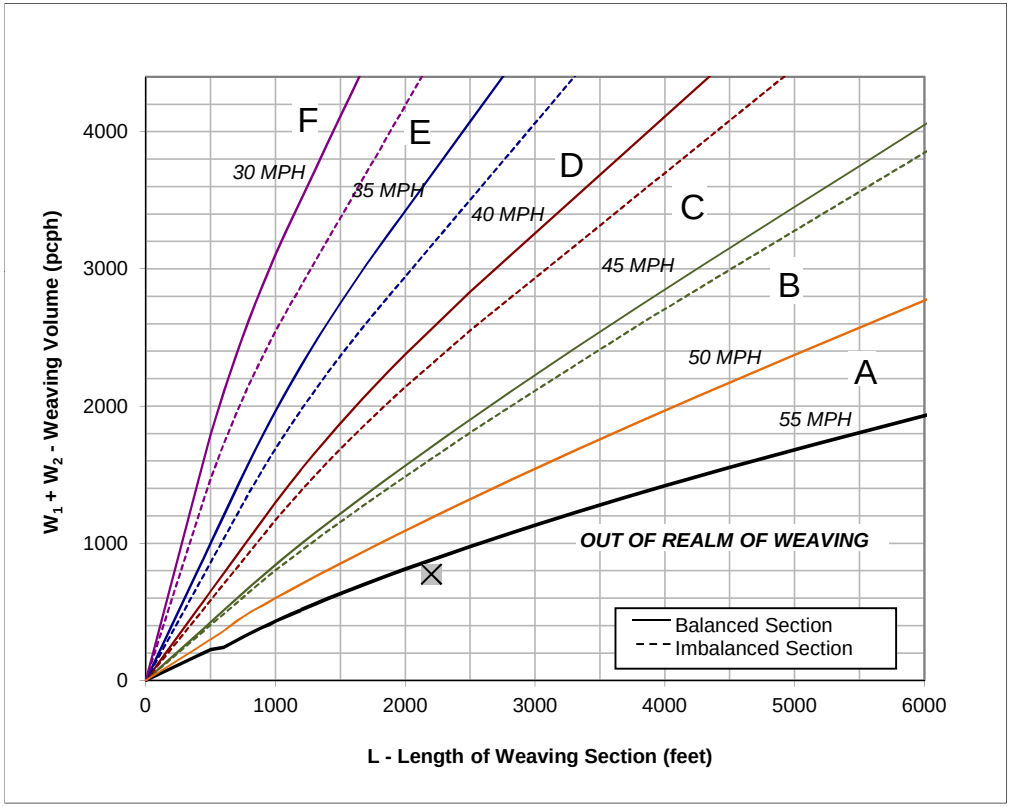
Data Input

Number of Entering Mainline Lanes	N_b	3
Number of Lanes in Weaving Section	N	4
Length of Weaving Section (feet)	L	2,200

Total Weaving Section (V)		On-ramp to Mainline (W_1)		Mainline to Off-ramp (W_2)	
Volume (vph)*	2,811	Volume (vph)*	592	Volume (vph)*	161
Truck Percentage	6%	Truck Percentage	6%	Truck Percentage	6%
PCE for Trucks	1.5	PCE for Trucks	1.5	PCE for Trucks	1.5
Volume (pcph)	2,895	Volume (pcph)	610	Volume (pcph)	166

Project Information

Project	LBNL
Scenario	Existing + Project (Buildout) PM
Freeway	EB I-580
On-ramp	Marina Bay Parkway
Off-ramp	Regatta Blvd



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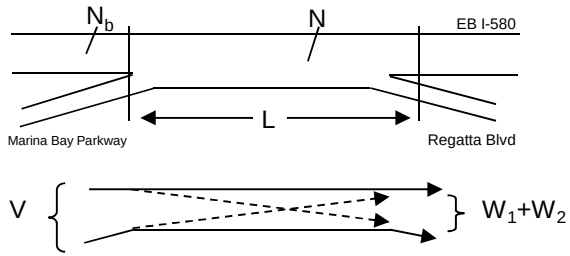


Capacity Analysis

1. Is the weaving section balanced (Y / N)? **N**
   [If optional exit lane, then "Y". Otherwise "N".]
2. In the Weaving Speed Chart to the left, which two speed curves is the black "x" between?
   50 MPH and **55 MPH**
   If below the 55 MPH curve, out of the realm of weaving.
   If left of the 30 MPH curve, LOS is F.
3. Interpolated Weaving Speed (S_w, mph) **56.7**
4. Weaving Intensity Factor (k) **1.00**
5. Service Volume (SV, pcph)
   $SV = (1/N)*[V + (k - 1)*\min(W_1, W_2)]$ **724**
6. Level of Service (LOS) **A**

The LOS in the chart above refers to the capacity of weaving traffic only; through and ramp to ramp traffic is not included.

* Note: **Do not adjust by a Peak Hour Factor (PHF).** The methodology incorporates the PHF in the Service Volume tables.

Sources: *Completion of Procedures for Analysis and Design of Traffic Weaving Sections*, Jack E. Leisch & Associates, September 1983 and *Highway Design Manual*, California Department of Transportation, July 24, 2009

Leisch Method for Weaving Analysis

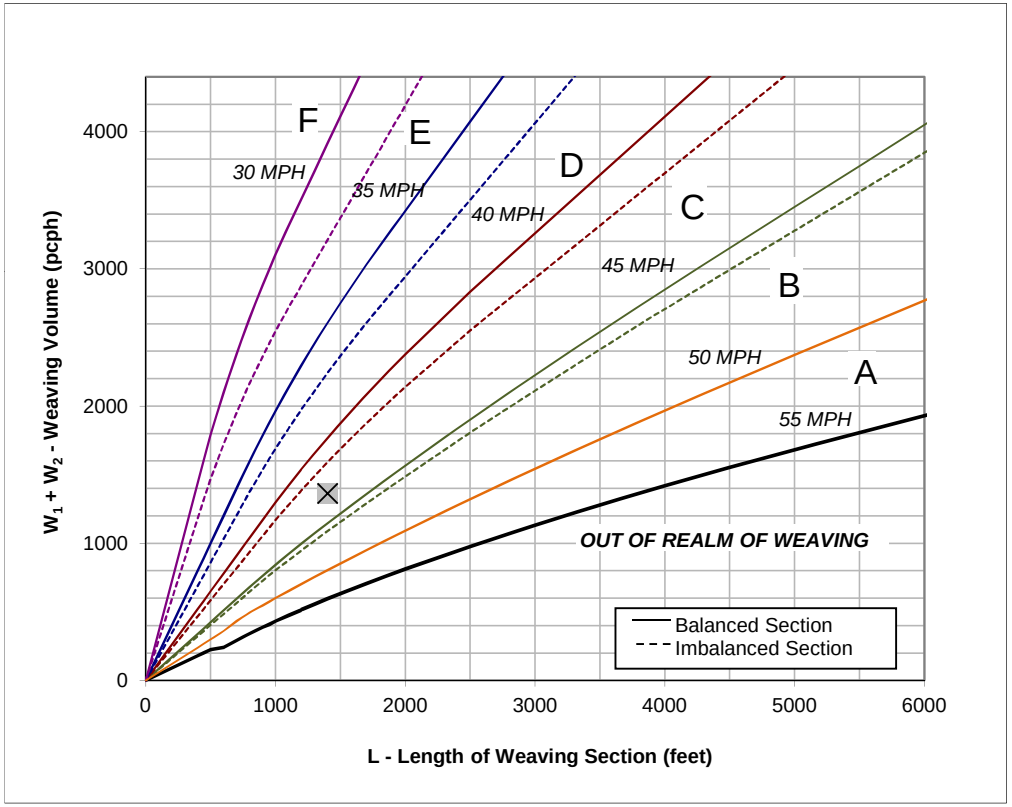
Data Input

Number of Entering Mainline Lanes	N_b	3
Number of Lanes in Weaving Section	N	4
Length of Weaving Section (feet)	L	1,400

Total Weaving Section (V)		On-ramp to Mainline (W_1)		Mainline to Off-ramp (W_2)	
Volume (vph)*	2,938	Volume (vph)*	328	Volume (vph)*	996
Truck Percentage	6%	Truck Percentage	6%	Truck Percentage	6%
PCE for Trucks	1.5	PCE for Trucks	1.5	PCE for Trucks	1.5
Volume (pcph)	3,026	Volume (pcph)	338	Volume (pcph)	1,026

Project Information

Project	LBNL
Scenario	Existing + Project (Buildout) PM
Freeway	WB I-580
On-ramp	Regatta Blvd
Off-ramp	Marina Bay Parkway



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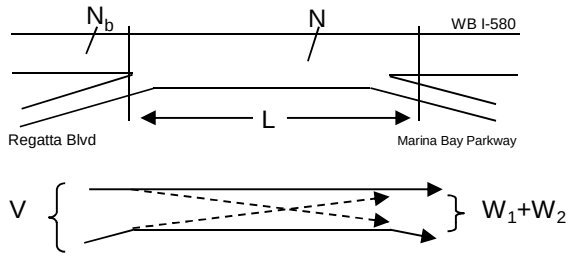


Capacity Analysis

1. Is the weaving section balanced (Y / N)? **N**
   [If optional exit lane, then "Y". Otherwise "N".]
2. In the Weaving Speed Chart to the left, which two speed curves is the black "x" between?
   40 MPH and **45 MPH**
   If below the 55 MPH curve, out of the realm of weaving.
   If left of the 30 MPH curve, LOS is F.
3. Interpolated Weaving Speed (S_w, mph) **42.3**
4. Weaving Intensity Factor (k) **3.05**
5. Service Volume (SV, pcph)
   $SV = (1/N)*[V + (k - 1)*\min(W_1, W_2)]$ **930**
6. Level of Service (LOS) **B**

The LOS in the chart above refers to the capacity of weaving traffic only; through and ramp to ramp traffic is not included.

* Note: **Do not adjust by a Peak Hour Factor (PHF).** The methodology incorporates the PHF in the Service Volume tables.

Sources: *Completion of Procedures for Analysis and Design of Traffic Weaving Sections*, Jack E. Leisch & Associates, September 1983 and *Highway Design Manual*, California Department of Transportation, July 24, 2009

Leisch Method for Weaving Analysis

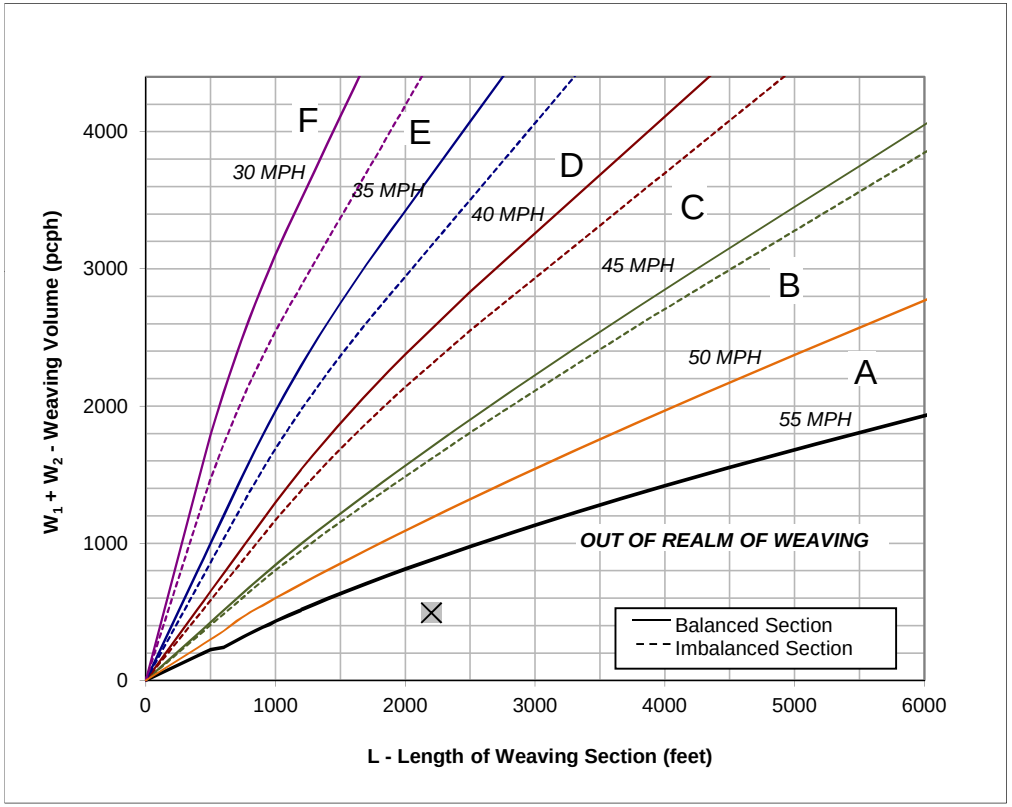
Data Input

Number of Entering Mainline Lanes	N_b	3
Number of Lanes in Weaving Section	N	4
Length of Weaving Section (feet)	L	2,200

Total Weaving Section (V)		On-ramp to Mainline (W_1)		Mainline to Off-ramp (W_2)	
Volume (vph)*	2,730	Volume (vph)*	400	Volume (vph)*	80
Truck Percentage	6%	Truck Percentage	6%	Truck Percentage	6%
PCE for Trucks	1.5	PCE for Trucks	1.5	PCE for Trucks	1.5
Volume (pcph)	2,812	Volume (pcph)	412	Volume (pcph)	82

Project Information

Project	LBNL
Scenario	Existing + Project (Buildout) PM
Freeway	EB I-580
On-ramp	Regatta Blvd
Off-ramp	Bayview Ave



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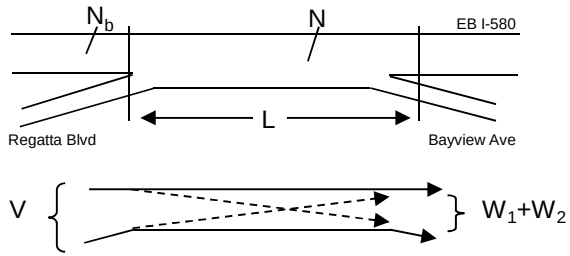


Capacity Analysis

1. Is the weaving section balanced (Y / N)? **N**
   [If optional exit lane, then "Y". Otherwise "N".]
2. In the Weaving Speed Chart to the left, which two speed curves is the black "x" between?
   50 MPH and **55 MPH**
   If below the 55 MPH curve, out of the realm of weaving.
   If left of the 30 MPH curve, LOS is F.
3. Interpolated Weaving Speed (S_w, mph) **61.3**
4. Weaving Intensity Factor (k) **1.00**
5. Service Volume (SV, pcph)
   $SV = (1/N)*[V + (k - 1)*\min(W_1, W_2)]$ **703**
6. Level of Service (LOS) **A**

The LOS in the chart above refers to the capacity of weaving traffic only; through and ramp to ramp traffic is not included.

* Note: **Do not adjust by a Peak Hour Factor (PHF).** The methodology incorporates the PHF in the Service Volume tables.

Sources: *Completion of Procedures for Analysis and Design of Traffic Weaving Sections*, Jack E. Leisch & Associates, September 1983 and *Highway Design Manual*, California Department of Transportation, July 24, 2009

Leisch Method for Weaving Analysis

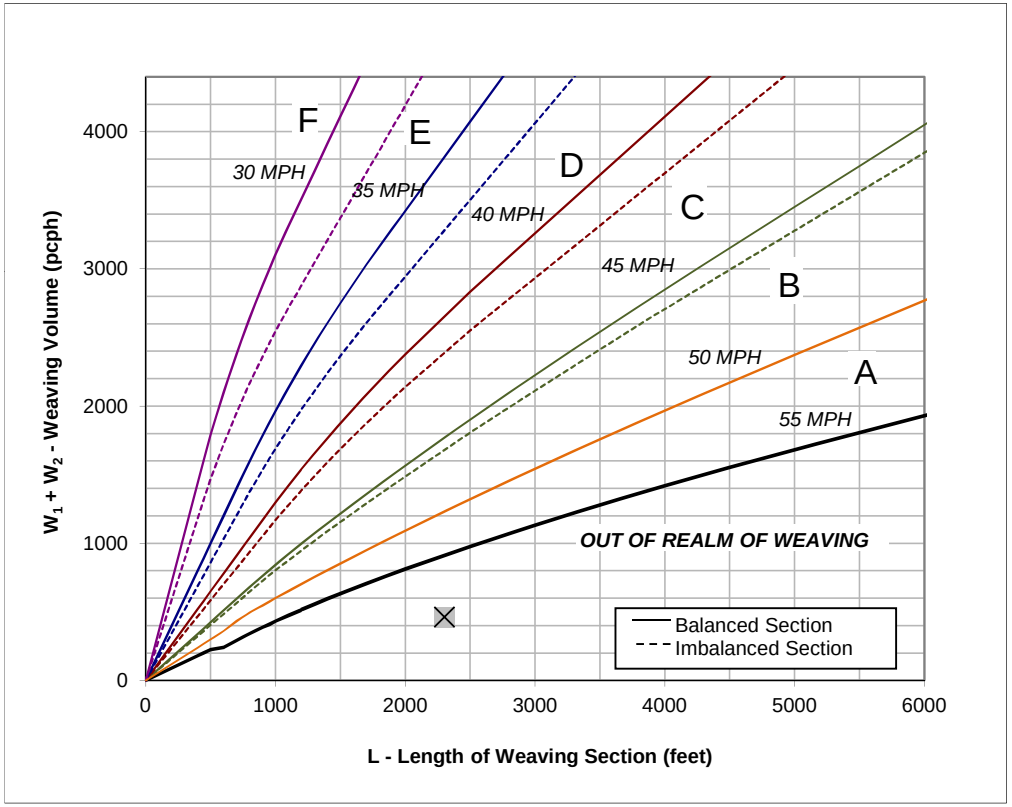
Data Input

Number of Entering Mainline Lanes	N_b	3
Number of Lanes in Weaving Section	N	4
Length of Weaving Section (feet)	L	2,300

Total Weaving Section (V)		On-ramp to Mainline (W_1)		Mainline to Off-ramp (W_2)	
Volume (vph)*	2,780	Volume (vph)*	290	Volume (vph)*	160
Truck Percentage	6%	Truck Percentage	6%	Truck Percentage	6%
PCE for Trucks	1.5	PCE for Trucks	1.5	PCE for Trucks	1.5
Volume (pcph)	2,863	Volume (pcph)	299	Volume (pcph)	165

Project Information

Project	LBNL
Scenario	Existing + Project (Buildout) PM
Freeway	WB I-580
On-ramp	Bayview Ave
Off-ramp	Regatta Blvd



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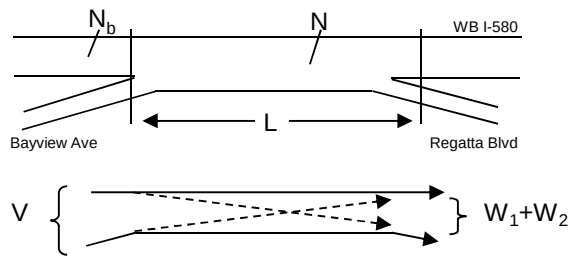


Capacity Analysis

1. Is the weaving section balanced (Y / N)? **N**
   [If optional exit lane, then "Y". Otherwise "N".]
2. In the Weaving Speed Chart to the left, which two speed curves is the black "x" between?
   50 MPH and **55 MPH**
   If below the 55 MPH curve, out of the realm of weaving.
   If left of the 30 MPH curve, LOS is F.
3. Interpolated Weaving Speed (S_w, mph) **62.1**
4. Weaving Intensity Factor (k) **1.00**
5. Service Volume (SV, pcph)
   $SV = (1/N)*[V + (k - 1)*\min(W_1, W_2)]$ **716**
6. Level of Service (LOS) **A**

The LOS in the chart above refers to the capacity of weaving traffic only; through and ramp to ramp traffic is not included.

* Note: **Do not adjust by a Peak Hour Factor (PHF).** The methodology incorporates the PHF in the Service Volume tables.

Sources: *Completion of Procedures for Analysis and Design of Traffic Weaving Sections*, Jack E. Leisch & Associates, September 1983 and *Highway Design Manual*, California Department of Transportation, July 24, 2009

Near-Term (2018) No Project Conditions

FEHR PEERS

HCM 2000
Basic Freeway Segments
Capacity Analysis

Jurisdiction
Analysis Year Near-Term
Analyst TL

Agency or Company
Date
Project Description

General Information				*Flow Rate Calculation*													*Speed Calculation*		*Results*	
	Freeway/ Direction	From/To	Analysis Time Period	Volume (vph)	PHF	Lanes	HOV Lane?	HOV Lane Volume	Terrain	Truck/ Bus %	RV %	E_T	E_R	f_{HV}	f_P	Flow Rate v_p (pcphpl)	Measured FFS (mph)	S (mph)	Density, D (pcplpm)	Level of Service
R-5	I-580 EB	I-580 between Bayview Avenue and Central Avenue	AM	3,100	0.92	3	No		Level	6%	0%	1.5	1.2	0.971	1.00	1,157	65.0	65.0	**17.8**	**B**
R-6	I-580 EB	I-580 between Central Avenue and I-80	AM	3,010	0.92	2	No		Level	6%	0%	1.5	1.2	0.971	1.00	1,685	65.0	64.6	**26.1**	**D**
R-7	I-80 EB	I-80 between Carlson Boulevard and Potrero Avenue	AM	4,320	0.92	4	Yes	290	Level	4%	0%	1.5	1.2	0.980	1.00	1,489	65.0	65.0	**22.9**	**C**
R-8	I-80 EB	I-80 @ Gilman Overpass	AM	6,140	0.92	5	Yes	780	Level	5%	0%	1.5	1.2	0.976	1.00	1,493	65.0	65.0	**23.0**	**C**
R-5	I-580 WB	I-580 between Bayview Avenue and Central Avenue	AM	3,010	0.92	3	No		Level	6%	0%	1.5	1.2	0.971	1.00	1,123	65.0	65.0	**17.3**	**B**
R-6	I-580 WB	I-580 between Central Avenue and I-80	AM	3,300	0.92	2	No		Level	6%	0%	1.5	1.2	0.971	1.00	1,847	65.0	63.5	**29.1**	**D**
R-7	I-80 WB	I-80 between Carlson Boulevard and Potrero Avenue	AM	6,280	0.92	4	Yes	1000	Level	4%	0%	1.5	1.2	0.980	1.00	1,951	65.0	62.2	**31.4**	**D**
R-8	I-80 WB	I-80 @ Gilman Overpass	AM	8,530	0.92	5	Yes	1410	Level	5%	0%	1.5	1.2	0.976	1.00	1,983	65.0	61.7	**32.1**	**D**
R-5	I-580 EB	I-580 between Bayview Avenue and Central Avenue	PM	2,970	0.92	3	No		Level	6%	0%	1.5	1.2	0.971	1.00	1,108	65.0	65.0	**17.1**	**B**
R-6	I-580 EB	I-580 between Central Avenue and I-80	PM	3,590	0.92	2	No		Level	6%	0%	1.5	1.2	0.971	1.00	2,010	65.0	61.3	**32.8**	**D**
R-7	I-80 EB	I-80 between Carlson Boulevard and Potrero Avenue	PM	6,180	0.92	4	Yes	1300	Level	4%	0%	1.5	1.2	0.980	1.00	1,803	65.0	63.9	**28.2**	**D**
R-8	I-80 EB	I-80 @ Gilman Overpass	PM	7,570	0.92	5	Yes	1070	Level	5%	0%	1.5	1.2	0.976	1.00	1,810	65.0	63.8	**28.4**	**D**
R-5	I-580 WB	I-580 between Bayview Avenue and Central Avenue	PM	3,240	0.92	3	No		Level	6%	0%	1.5	1.2	0.971	1.00	1,209	65.0	65.0	**18.6**	**C**
R-6	I-580 WB	I-580 between Central Avenue and I-80	PM	2,790	0.92	2	No		Level	6%	0%	1.5	1.2	0.971	1.00	1,562	65.0	64.9	**24.0**	**C**
R-7	I-80 WB	I-80 between Carlson Boulevard and Potrero Avenue	PM	4,770	0.92	4	Yes	330	Level	4%	0%	1.5	1.2	0.980	1.00	1,641	65.0	64.8	**25.3**	**C**
R-8	I-80 WB	I-80 @ Gilman Overpass	PM	6,740	0.92	5	Yes	650	Level	5%	0%	1.5	1.2	0.976	1.00	1,696	65.0	64.6	**26.3**	**D**

Leisch Method for Weaving Analysis

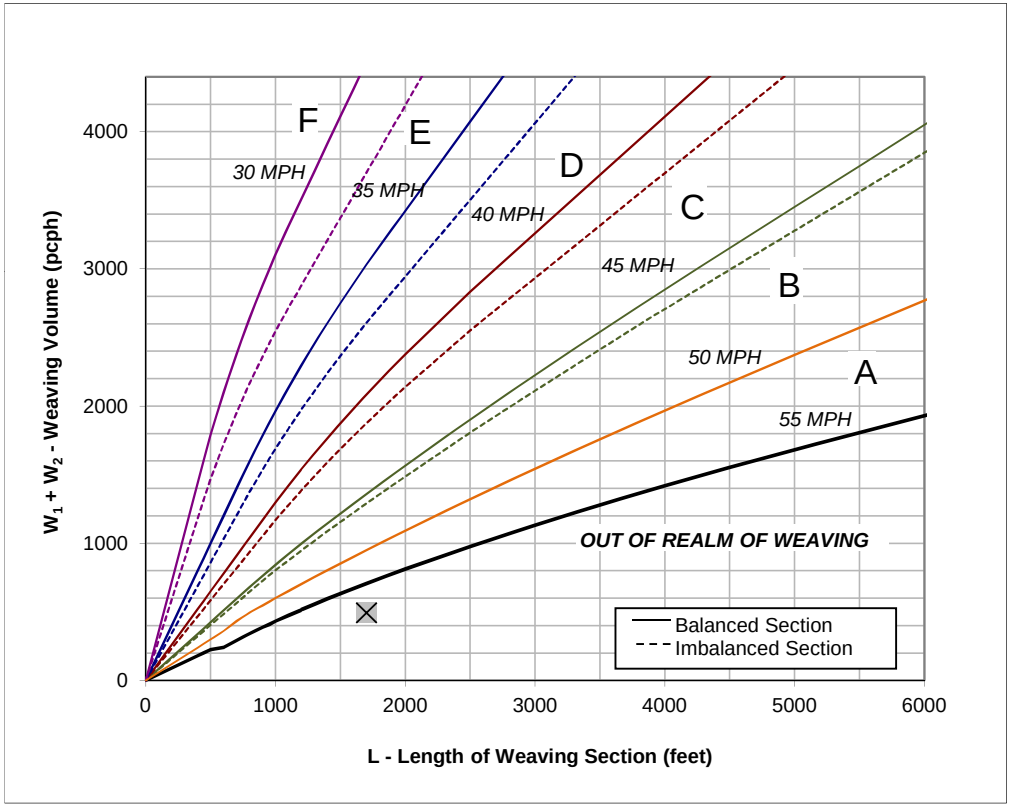
Data Input

Number of Entering Mainline Lanes	N_b	3
Number of Lanes in Weaving Section	N	4
Length of Weaving Section (feet)	L	1,700

Total Weaving Section (V)		On-ramp to Mainline (W_1)		Mainline to Off-ramp (W_2)	
Volume (vph)*	2,410	Volume (vph)*	320	Volume (vph)*	160
Truck Percentage	6%	Truck Percentage	6%	Truck Percentage	6%
PCE for Trucks	1.5	PCE for Trucks	1.5	PCE for Trucks	1.5
Volume (pcph)	2,482	Volume (pcph)	330	Volume (pcph)	165

Project Information

Project	LBNL
Scenario	Near-Term AM
Freeway	EB I-580
On-ramp	Harbour Way
Off-ramp	Marina Bay Pkwy



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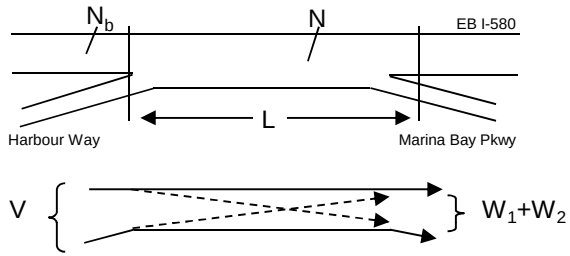


Capacity Analysis

1. Is the weaving section balanced (Y / N)? **N**
   [If optional exit lane, then "Y". Otherwise "N".]
2. In the Weaving Speed Chart to the left, which two speed curves is the black "x" between?
   50 MPH and **55 MPH**
   If below the 55 MPH curve, out of the realm of weaving.
   If left of the 30 MPH curve, LOS is F.
3. Interpolated Weaving Speed (S_w, mph) **59.4**
4. Weaving Intensity Factor (k) **1.00**
5. Service Volume (SV, pcph)
   $SV = (1/N)*[V + (k - 1)*\min(W_1, W_2)]$ **621**
6. Level of Service (LOS) **A**

The LOS in the chart above refers to the capacity of weaving traffic only; through and ramp to ramp traffic is not included.

* Note: **Do not adjust by a Peak Hour Factor (PHF).** The methodology incorporates the PHF in the Service Volume tables.

Sources: *Completion of Procedures for Analysis and Design of Traffic Weaving Sections*, Jack E. Leisch & Associates, September 1983 and *Highway Design Manual*, California Department of Transportation, July 24, 2009

Leisch Method for Weaving Analysis

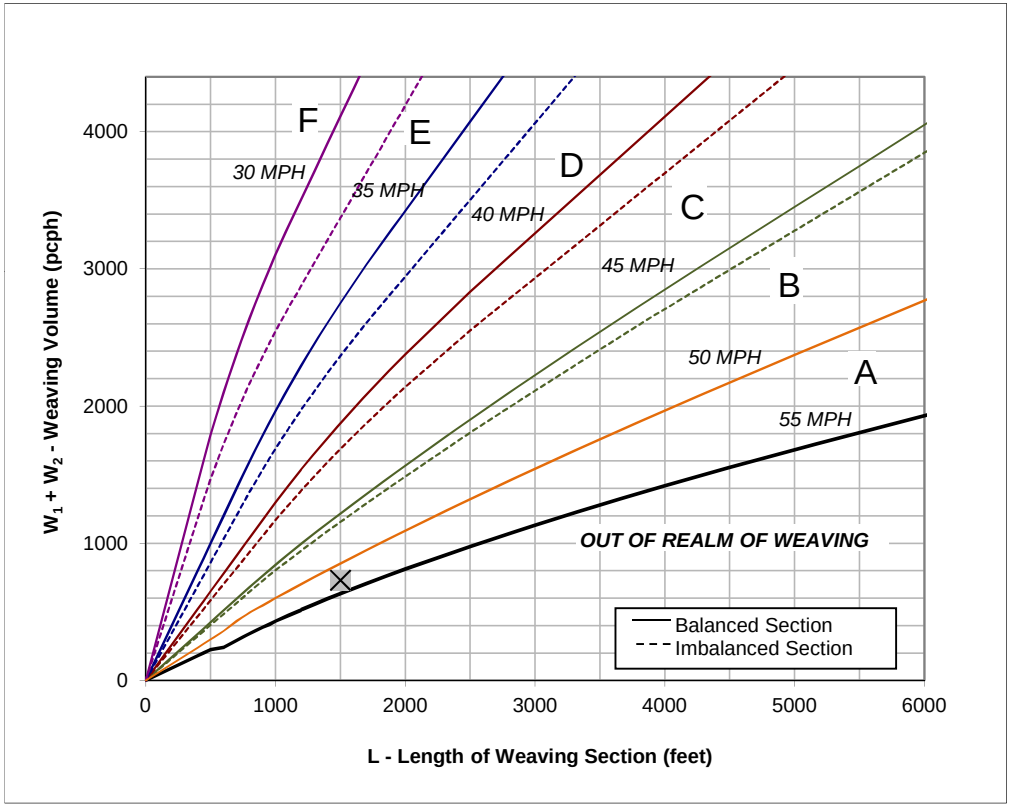
Data Input

Number of Entering Mainline Lanes	N_b	3
Number of Lanes in Weaving Section	N	4
Length of Weaving Section (feet)	L	1,500

Total Weaving Section (V)		On-ramp to Mainline (W_1)		Mainline to Off-ramp (W_2)	
Volume (vph)*	2,780	Volume (vph)*	320	Volume (vph)*	390
Truck Percentage	6%	Truck Percentage	6%	Truck Percentage	6%
PCE for Trucks	1.5	PCE for Trucks	1.5	PCE for Trucks	1.5
Volume (pcph)	2,863	Volume (pcph)	330	Volume (pcph)	402

Project Information

Project	LBNL
Scenario	Near-Term AM
Freeway	WB I-580
On-ramp	Marina Bay Parkway
Off-ramp	Harbour Way



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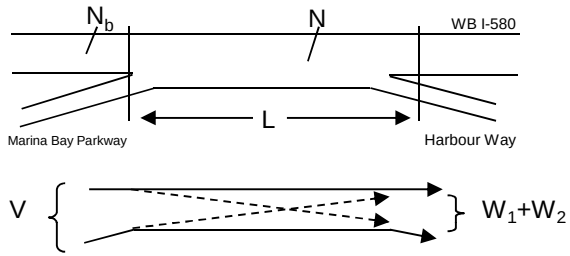


Capacity Analysis

1. Is the weaving section balanced (Y / N)? **N**
   [If optional exit lane, then "Y". Otherwise "N".]
2. In the Weaving Speed Chart to the left, which two speed curves is the black "x" between?
   50 MPH and **55 MPH**
   If below the 55 MPH curve, out of the realm of weaving.
   If left of the 30 MPH curve, LOS is F.
3. Interpolated Weaving Speed (S_w, mph) **52.8**
4. Weaving Intensity Factor (k) **1.00**
5. Service Volume (SV, pcph)
   $SV = (1/N)*[V + (k - 1)*\min(W_1, W_2)]$ **716**
6. Level of Service (LOS) **A**

The LOS in the chart above refers to the capacity of weaving traffic only; through and ramp to ramp traffic is not included.

* Note: **Do not adjust by a Peak Hour Factor (PHF).** The methodology incorporates the PHF in the Service Volume tables.

Sources: *Completion of Procedures for Analysis and Design of Traffic Weaving Sections*, Jack E. Leisch & Associates, September 1983 and *Highway Design Manual*, California Department of Transportation, July 24, 2009

Leisch Method for Weaving Analysis

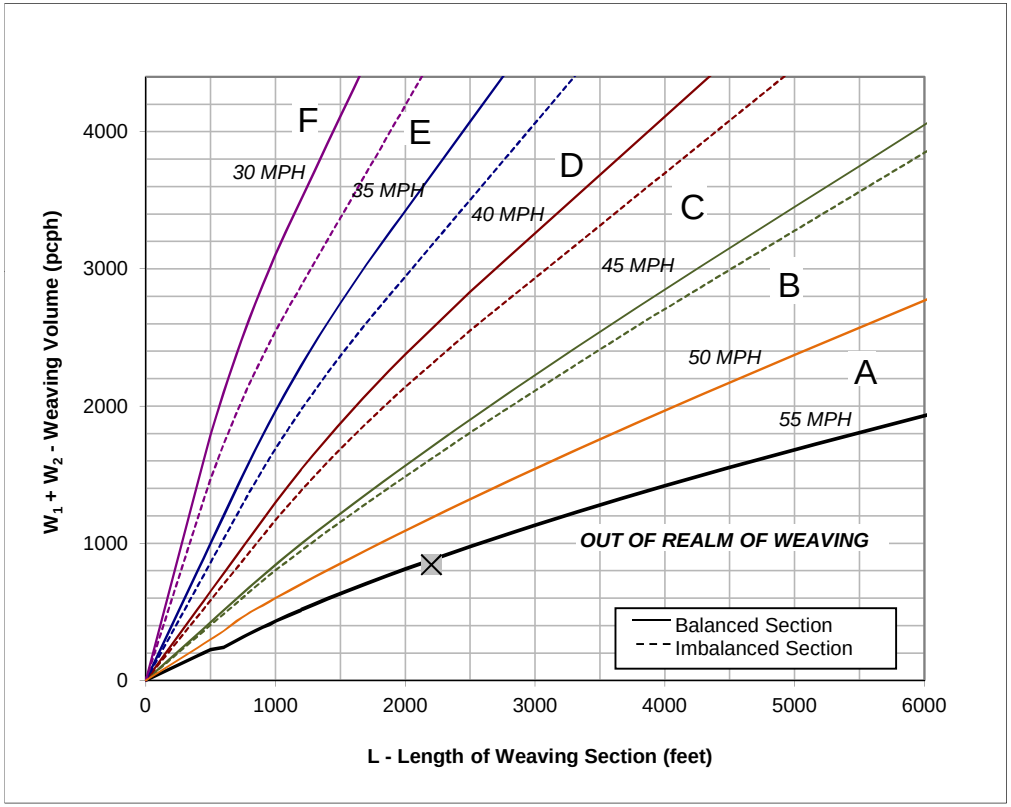
Data Input

Number of Entering Mainline Lanes	N_b	3
Number of Lanes in Weaving Section	N	4
Length of Weaving Section (feet)	L	2,200

Total Weaving Section (V)		On-ramp to Mainline (W_1)		Mainline to Off-ramp (W_2)	
Volume (vph)*	3,080	Volume (vph)*	740	Volume (vph)*	80
Truck Percentage	6%	Truck Percentage	6%	Truck Percentage	6%
PCE for Trucks	1.5	PCE for Trucks	1.5	PCE for Trucks	1.5
Volume (pcph)	3,172	Volume (pcph)	762	Volume (pcph)	82

Project Information

Project	LBNL
Scenario	Near-Term AM
Freeway	EB I-580
On-ramp	Marina Bay Parkway
Off-ramp	Regatta Blvd



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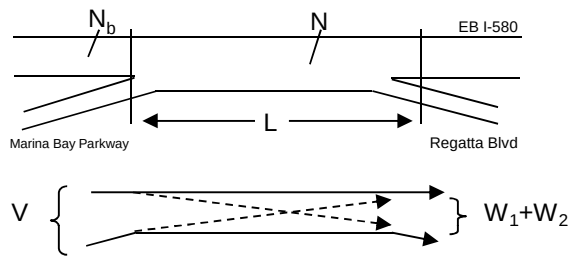


Capacity Analysis

1. Is the weaving section balanced (Y / N)? **N**
   [If optional exit lane, then "Y". Otherwise "N".]
2. In the Weaving Speed Chart to the left, which two speed curves is the black "x" between?
   50 MPH and **55 MPH**
   If below the 55 MPH curve, out of the realm of weaving.
   If left of the 30 MPH curve, LOS is F.
3. Interpolated Weaving Speed (S_w, mph) **55.6**
4. Weaving Intensity Factor (k) **1.00**
5. Service Volume (SV, pcph)
   $SV = (1/N)*[V + (k - 1)*\min(W_1, W_2)]$ **793**
6. Level of Service (LOS) **A**

The LOS in the chart above refers to the capacity of weaving traffic only; through and ramp to ramp traffic is not included.

* Note: **Do not adjust by a Peak Hour Factor (PHF).** The methodology incorporates the PHF in the Service Volume tables.

Sources: *Completion of Procedures for Analysis and Design of Traffic Weaving Sections*, Jack E. Leisch & Associates, September 1983 and *Highway Design Manual*, California Department of Transportation, July 24, 2009

Leisch Method for Weaving Analysis

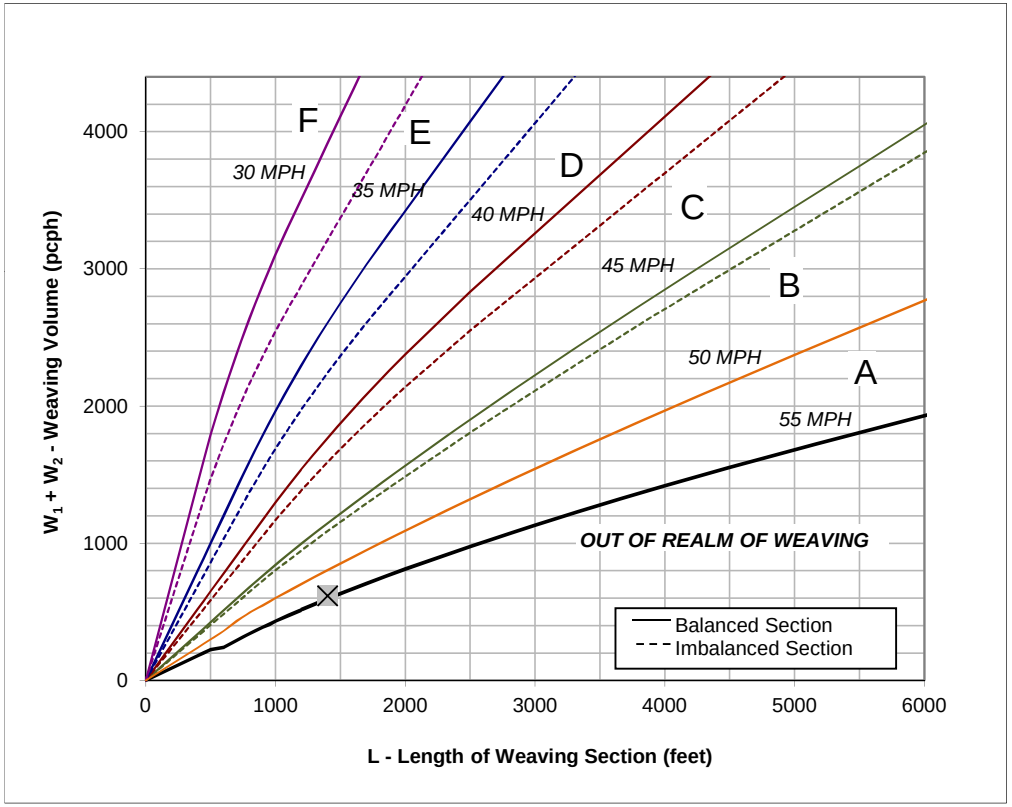
Data Input

Number of Entering Mainline Lanes	N_b	3
Number of Lanes in Weaving Section	N	4
Length of Weaving Section (feet)	L	1,400

Total Weaving Section (V)		On-ramp to Mainline (W_1)		Mainline to Off-ramp (W_2)	
Volume (vph)*	3,350	Volume (vph)*	130	Volume (vph)*	470
Truck Percentage	6%	Truck Percentage	6%	Truck Percentage	6%
PCE for Trucks	1.5	PCE for Trucks	1.5	PCE for Trucks	1.5
Volume (pcph)	3,451	Volume (pcph)	134	Volume (pcph)	484

Project Information

Project	LBNL
Scenario	Near-Term AM
Freeway	WB I-580
On-ramp	Regatta Blvd
Off-ramp	Marina Bay Parkway



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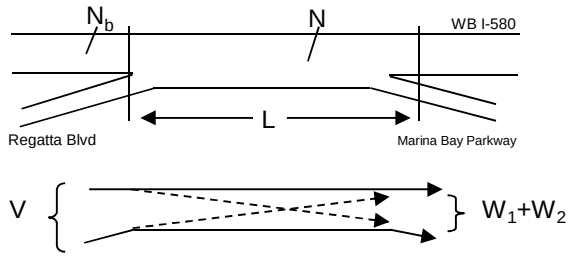


Capacity Analysis

1. Is the weaving section balanced (Y / N)? **N**
   [If optional exit lane, then "Y". Otherwise "N".]
2. In the Weaving Speed Chart to the left, which two speed curves is the black "x" between?
   50 MPH and **55 MPH**
   If below the 55 MPH curve, out of the realm of weaving.
   If left of the 30 MPH curve, LOS is F.
3. Interpolated Weaving Speed (S_w, mph) **54.4**
4. Weaving Intensity Factor (k) **1.00**
5. Service Volume (SV, pcph)
   $SV = (1/N)*[V + (k - 1)*\min(W_1, W_2)]$ **863**
6. Level of Service (LOS) **B**

The LOS in the chart above refers to the capacity of weaving traffic only; through and ramp to ramp traffic is not included.

* Note: **Do not adjust by a Peak Hour Factor (PHF).** The methodology incorporates the PHF in the Service Volume tables.

Sources: *Completion of Procedures for Analysis and Design of Traffic Weaving Sections*, Jack E. Leisch & Associates, September 1983 and *Highway Design Manual*, California Department of Transportation, July 24, 2009

Leisch Method for Weaving Analysis

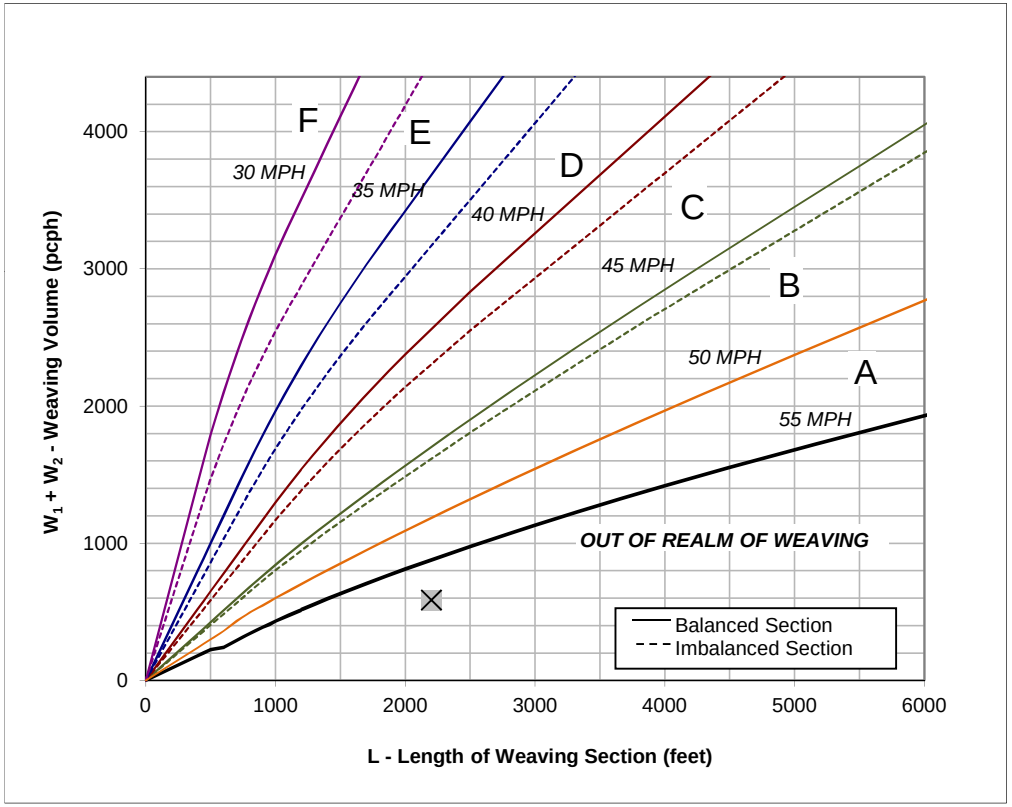
Data Input

Number of Entering Mainline Lanes	N_b	3
Number of Lanes in Weaving Section	N	4
Length of Weaving Section (feet)	L	2,200

Total Weaving Section (V)		On-ramp to Mainline (W_1)		Mainline to Off-ramp (W_2)	
Volume (vph)*	3,270	Volume (vph)*	140	Volume (vph)*	430
Truck Percentage	6%	Truck Percentage	6%	Truck Percentage	6%
PCE for Trucks	1.5	PCE for Trucks	1.5	PCE for Trucks	1.5
Volume (pcph)	3,368	Volume (pcph)	144	Volume (pcph)	443

Project Information

Project	LBNL
Scenario	Near-Term AM
Freeway	EB I-580
On-ramp	Regatta Blvd
Off-ramp	Bayview Ave



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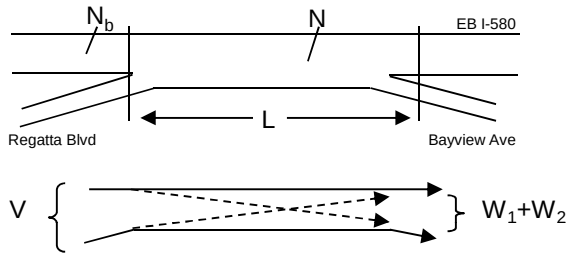


Capacity Analysis

1. Is the weaving section balanced (Y / N)? **N**
   [If optional exit lane, then "Y". Otherwise "N".]
2. In the Weaving Speed Chart to the left, which two speed curves is the black "x" between?
   50 MPH and **55 MPH**
   If below the 55 MPH curve, out of the realm of weaving.
   If left of the 30 MPH curve, LOS is F.
3. Interpolated Weaving Speed (S_w, mph) **59.8**
4. Weaving Intensity Factor (k) **1.00**
5. Service Volume (SV, pcph)
   $SV = (1/N)*[V + (k - 1)*\min(W_1, W_2)]$ **842**
6. Level of Service (LOS) **B**

The LOS in the chart above refers to the capacity of weaving traffic only; through and ramp to ramp traffic is not included.

* Note: **Do not adjust by a Peak Hour Factor (PHF).** The methodology incorporates the PHF in the Service Volume tables.

Sources: *Completion of Procedures for Analysis and Design of Traffic Weaving Sections*, Jack E. Leisch & Associates, September 1983 and *Highway Design Manual*, California Department of Transportation, July 24, 2009

Leisch Method for Weaving Analysis

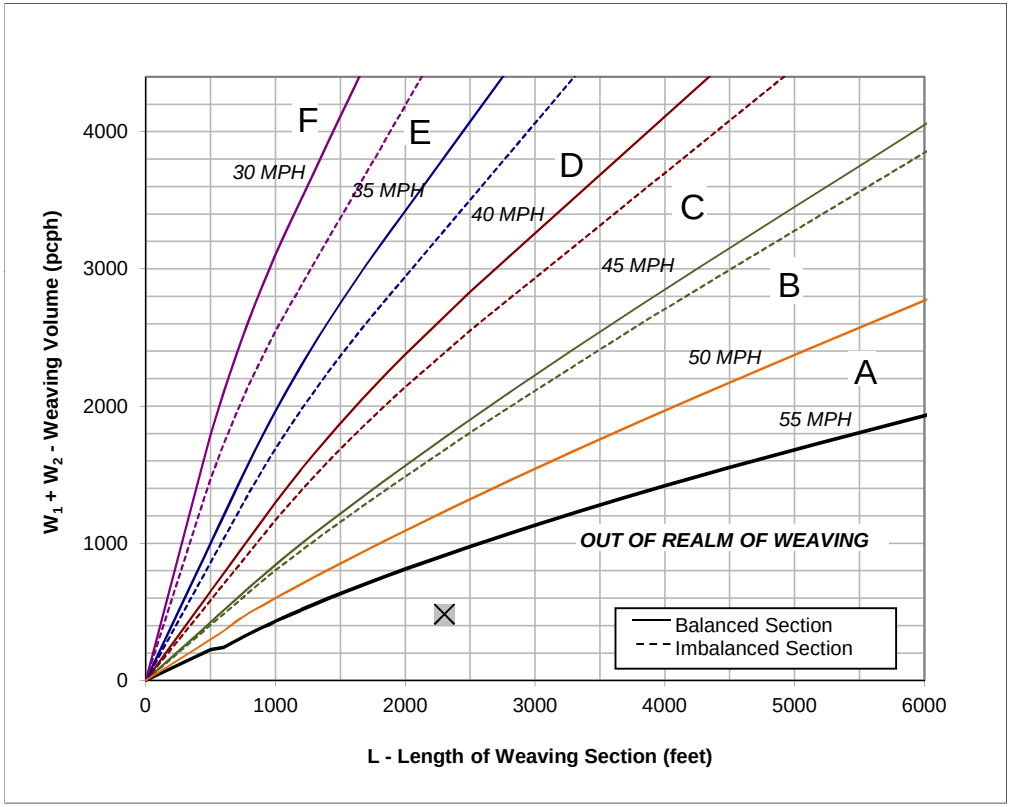
Data Input

Number of Entering Mainline Lanes	N_b	3
Number of Lanes in Weaving Section	N	4
Length of Weaving Section (feet)	L	2,300

Total Weaving Section (V)		On-ramp to Mainline (W_1)		Mainline to Off-ramp (W_2)	
Volume (vph)*	3,310	Volume (vph)*	380	Volume (vph)*	90
Truck Percentage	6%	Truck Percentage	6%	Truck Percentage	6%
PCE for Trucks	1.5	PCE for Trucks	1.5	PCE for Trucks	1.5
Volume (pcph)	3,409	Volume (pcph)	391	Volume (pcph)	93

Project Information

Project	LBNL
Scenario	Near-Term AM
Freeway	WB I-580
On-ramp	Bayview Ave
Off-ramp	Regatta Blvd



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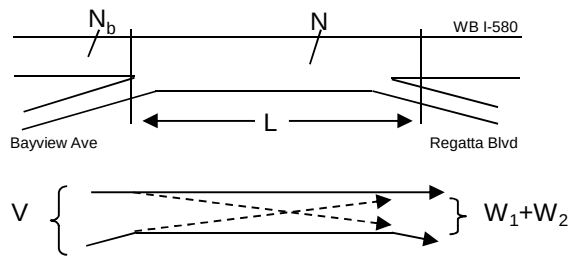


Capacity Analysis

1. Is the weaving section balanced (Y / N)? **N**
   [If optional exit lane, then "Y". Otherwise "N".]
2. In the Weaving Speed Chart to the left, which two speed curves is the black "x" between?
   50 MPH and **55 MPH**
   If below the 55 MPH curve, out of the realm of weaving.
   If left of the 30 MPH curve, LOS is F.
3. Interpolated Weaving Speed (S_w, mph) **61.7**
4. Weaving Intensity Factor (k) **1.00**
5. Service Volume (SV, pcph)
   $SV = (1/N)*[V + (k - 1)*\min(W_1, W_2)]$ **852**
6. Level of Service (LOS) **B**

The LOS in the chart above refers to the capacity of weaving traffic only; through and ramp to ramp traffic is not included.

* Note: **Do not adjust by a Peak Hour Factor (PHF).** The methodology incorporates the PHF in the Service Volume tables.

Sources: *Completion of Procedures for Analysis and Design of Traffic Weaving Sections*, Jack E. Leisch & Associates, September 1983 and *Highway Design Manual*, California Department of Transportation, July 24, 2009

Leisch Method for Weaving Analysis

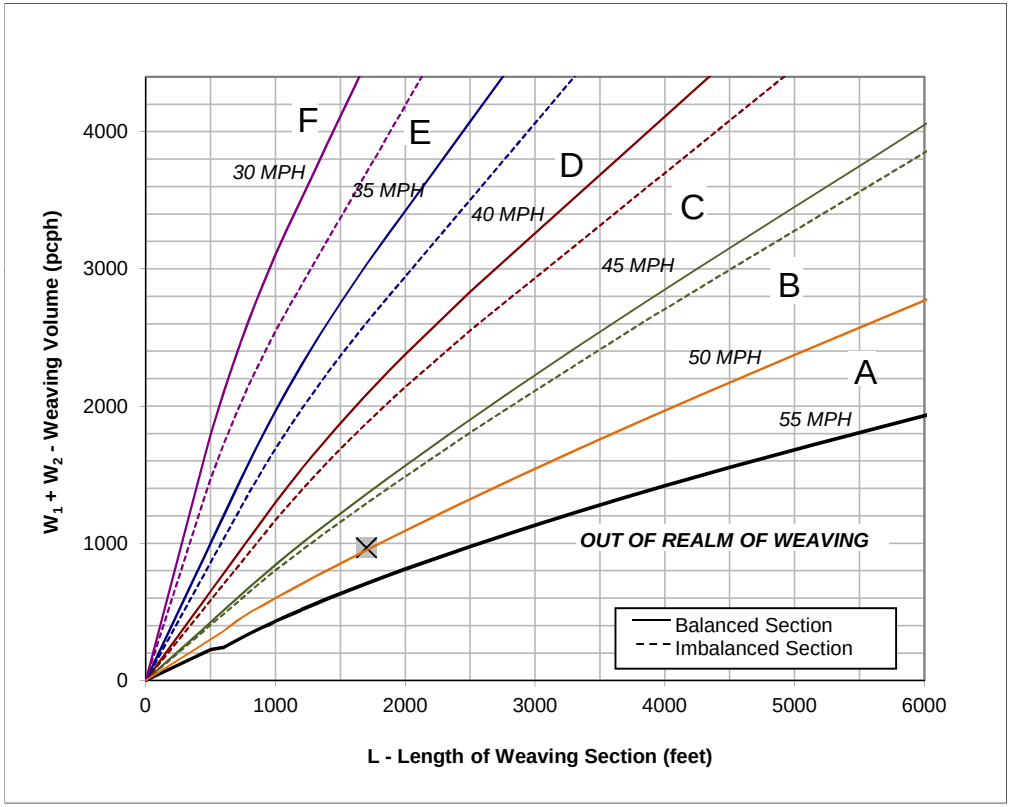
Data Input

Number of Entering Mainline Lanes	N_b	3
Number of Lanes in Weaving Section	N	4
Length of Weaving Section (feet)	L	1,700

Total Weaving Section (V)		On-ramp to Mainline (W_1)		Mainline to Off-ramp (W_2)	
Volume (vph)*	3,100	Volume (vph)*	600	Volume (vph)*	340
Truck Percentage	6%	Truck Percentage	6%	Truck Percentage	6%
PCE for Trucks	1.5	PCE for Trucks	1.5	PCE for Trucks	1.5
Volume (pcph)	3,193	Volume (pcph)	618	Volume (pcph)	350

Project Information

Project	LBNL
Scenario	Near-Term PM
Freeway	EB I-580
On-ramp	Harbour Way
Off-ramp	Marina Bay Pkwy



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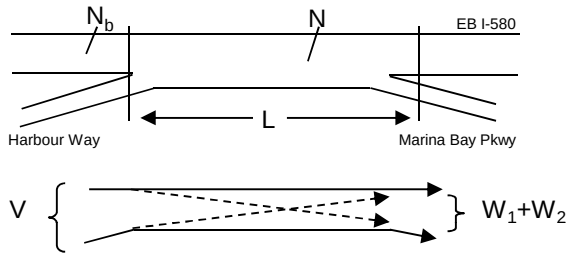


Capacity Analysis

1. Is the weaving section balanced (Y / N)? **N**
   [If optional exit lane, then "Y". Otherwise "N".]
2. In the Weaving Speed Chart to the left, which two speed curves is the black "x" between?
   50 MPH and **55 MPH**
   If below the 55 MPH curve, out of the realm of weaving.
   If left of the 30 MPH curve, LOS is F.
3. Interpolated Weaving Speed (S_w, mph) **49.6**
4. Weaving Intensity Factor (k) **1.25**
5. Service Volume (SV, pcph)
   $SV = (1/N)*[V + (k - 1)*\min(W_1, W_2)]$ **820**
6. Level of Service (LOS) **B**

The LOS in the chart above refers to the capacity of weaving traffic only; through and ramp to ramp traffic is not included.

* Note: **Do not adjust by a Peak Hour Factor (PHF).** The methodology incorporates the PHF in the Service Volume tables.

Sources: *Completion of Procedures for Analysis and Design of Traffic Weaving Sections*, Jack E. Leisch & Associates, September 1983 and *Highway Design Manual*, California Department of Transportation, July 24, 2009

Leisch Method for Weaving Analysis

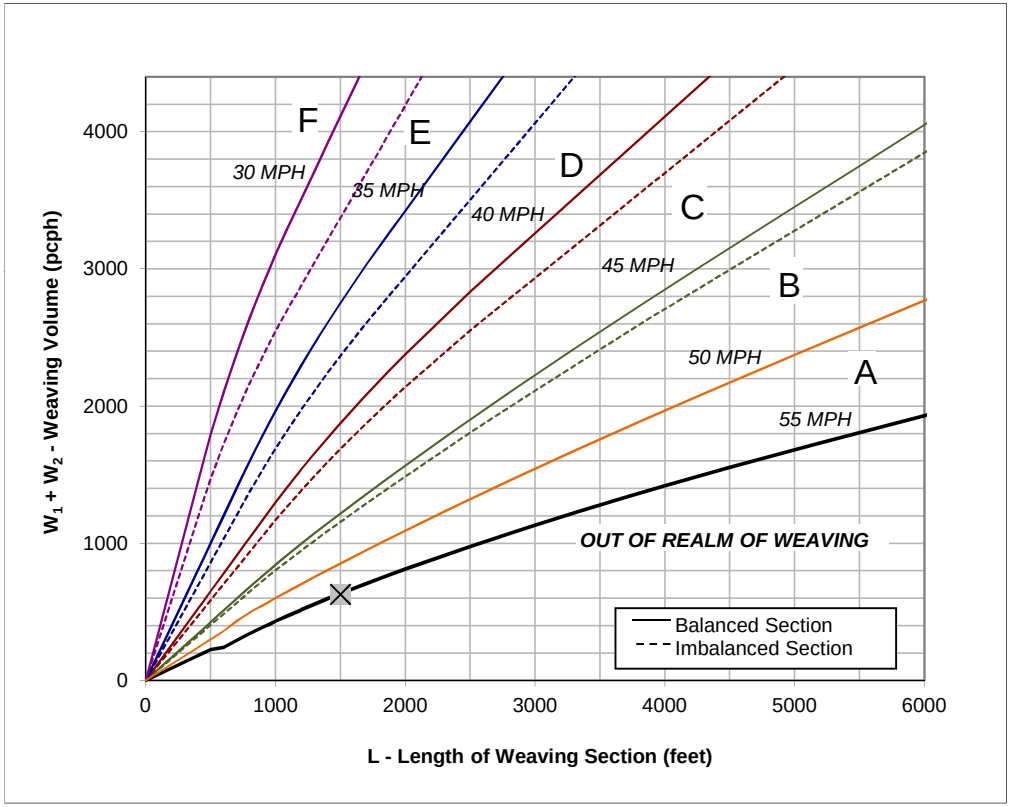
Data Input

Number of Entering Mainline Lanes	N_b	3
Number of Lanes in Weaving Section	N	4
Length of Weaving Section (feet)	L	1,500

Total Weaving Section (V)		On-ramp to Mainline (W_1)		Mainline to Off-ramp (W_2)	
Volume (vph)*	2,170	Volume (vph)*	220	Volume (vph)*	390
Truck Percentage	6%	Truck Percentage	6%	Truck Percentage	6%
PCE for Trucks	1.5	PCE for Trucks	1.5	PCE for Trucks	1.5
Volume (pcph)	2,235	Volume (pcph)	227	Volume (pcph)	402

Project Information

Project	LBNL
Scenario	Near-Term PM
Freeway	WB I-580
On-ramp	Marina Bay Parkway
Off-ramp	Harbour Way



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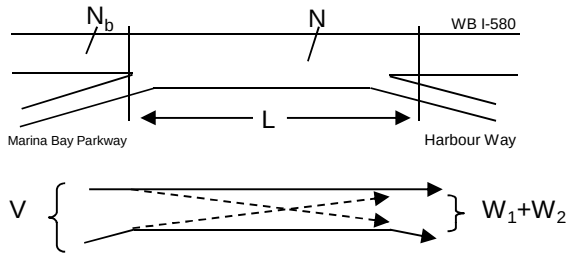


Capacity Analysis

1. Is the weaving section balanced (Y / N)? **N**
   [If optional exit lane, then "Y". Otherwise "N".]
2. In the Weaving Speed Chart to the left, which two speed curves is the black "x" between?
   50 MPH and **55 MPH**
   If below the 55 MPH curve, out of the realm of weaving.
   If left of the 30 MPH curve, LOS is F.
3. Interpolated Weaving Speed (S_w, mph) **55.1**
4. Weaving Intensity Factor (k) **1.00**
5. Service Volume (SV, pcph)
   $SV = (1/N)*[V + (k - 1)*\min(W_1, W_2)]$ **559**
6. Level of Service (LOS) **A**

The LOS in the chart above refers to the capacity of weaving traffic only; through and ramp to ramp traffic is not included.

* Note: **Do not adjust by a Peak Hour Factor (PHF).** The methodology incorporates the PHF in the Service Volume tables.

Sources: *Completion of Procedures for Analysis and Design of Traffic Weaving Sections*, Jack E. Leisch & Associates, September 1983 and *Highway Design Manual*, California Department of Transportation, July 24, 2009

Leisch Method for Weaving Analysis

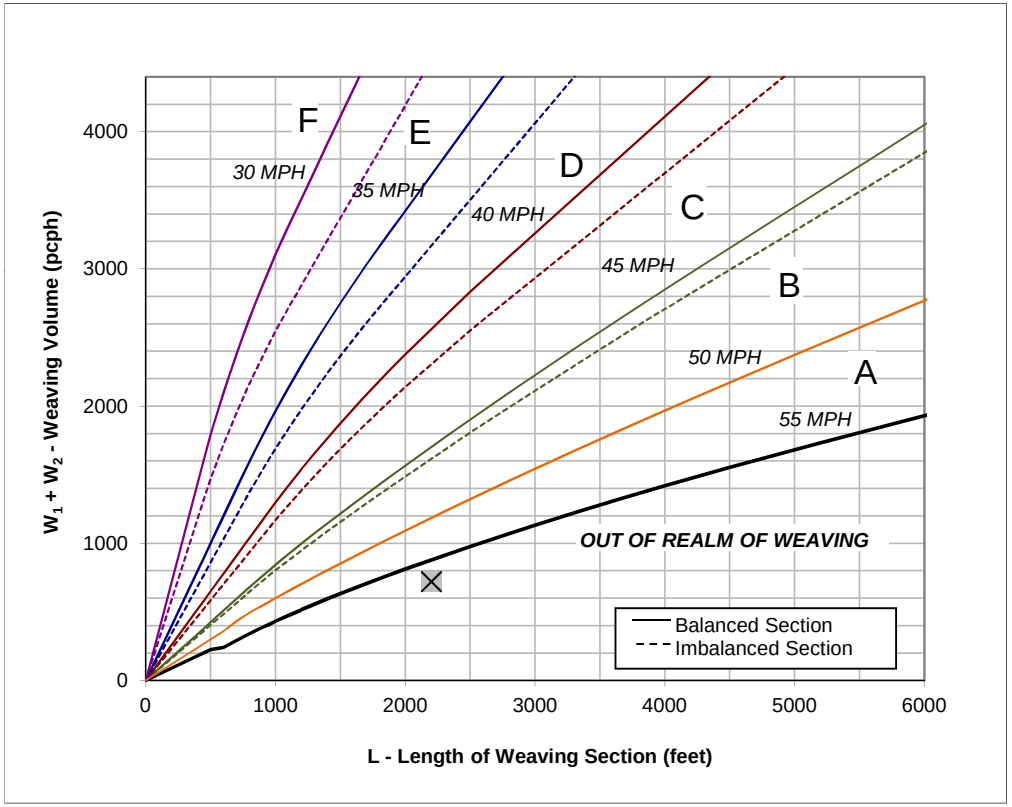
Data Input

Number of Entering Mainline Lanes	N_b	3
Number of Lanes in Weaving Section	N	4
Length of Weaving Section (feet)	L	2,200

Total Weaving Section (V)		On-ramp to Mainline (W_1)		Mainline to Off-ramp (W_2)	
Volume (vph)*	3,250	Volume (vph)*	580	Volume (vph)*	120
Truck Percentage	6%	Truck Percentage	6%	Truck Percentage	6%
PCE for Trucks	1.5	PCE for Trucks	1.5	PCE for Trucks	1.5
Volume (pcph)	3,348	Volume (pcph)	597	Volume (pcph)	124

Project Information

Project	LBNL
Scenario	Near-Term PM
Freeway	EB I-580
On-ramp	Marina Bay Parkway
Off-ramp	Regatta Blvd



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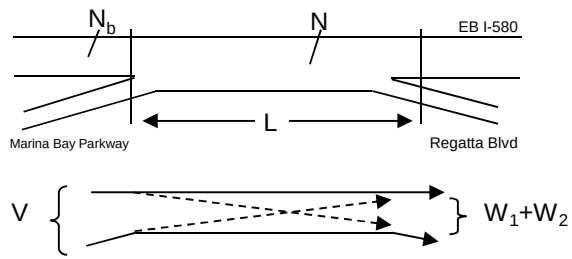


Capacity Analysis

1. Is the weaving section balanced (Y / N)? **N**
   [If optional exit lane, then "Y". Otherwise "N".]
2. In the Weaving Speed Chart to the left, which two speed curves is the black "x" between?
   50 MPH and **55 MPH**
   If below the 55 MPH curve, out of the realm of weaving.
   If left of the 30 MPH curve, LOS is F.
3. Interpolated Weaving Speed (S_w, mph) **57.6**
4. Weaving Intensity Factor (k) **1.00**
5. Service Volume (SV, pcph)
   $SV = (1/N)*[V + (k - 1)*\min(W_1, W_2)]$ **837**
6. Level of Service (LOS) **B**

The LOS in the chart above refers to the capacity of weaving traffic only; through and ramp to ramp traffic is not included.

* Note: **Do not adjust by a Peak Hour Factor (PHF).** The methodology incorporates the PHF in the Service Volume tables.

Sources: *Completion of Procedures for Analysis and Design of Traffic Weaving Sections*, Jack E. Leisch & Associates, September 1983 and *Highway Design Manual*, California Department of Transportation, July 24, 2009

Leisch Method for Weaving Analysis

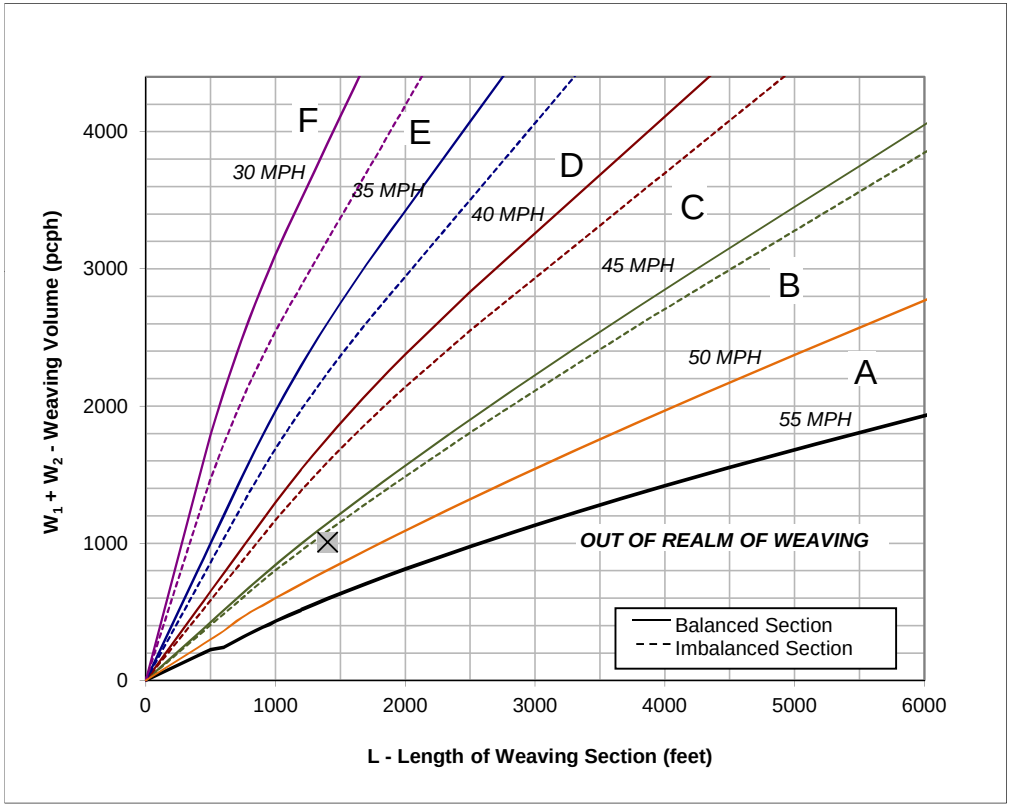
Data Input

Number of Entering Mainline Lanes	N_b	3
Number of Lanes in Weaving Section	N	4
Length of Weaving Section (feet)	L	1,400

Total Weaving Section (V)		On-ramp to Mainline (W_1)		Mainline to Off-ramp (W_2)	
Volume (vph)*	2,850	Volume (vph)*	60	Volume (vph)*	920
Truck Percentage	6%	Truck Percentage	6%	Truck Percentage	6%
PCE for Trucks	1.5	PCE for Trucks	1.5	PCE for Trucks	1.5
Volume (pcph)	2,936	Volume (pcph)	62	Volume (pcph)	948

Project Information

Project	LBNL
Scenario	Near-Term PM
Freeway	WB I-580
On-ramp	Regatta Blvd
Off-ramp	Marina Bay Parkway



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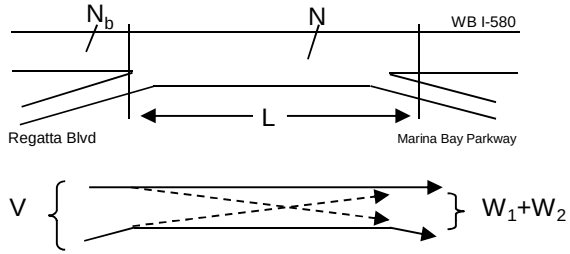


Capacity Analysis

1. Is the weaving section balanced (Y / N)? **N**
   [If optional exit lane, then "Y". Otherwise "N".]
2. In the Weaving Speed Chart to the left, which two speed curves is the black "x" between?
   45 MPH and **50 MPH**
   If below the 55 MPH curve, out of the realm of weaving.
   If left of the 30 MPH curve, LOS is F.
3. Interpolated Weaving Speed (S_w, mph) **46.4**
4. Weaving Intensity Factor (k) **2.30**
5. Service Volume (SV, pcph)
   $SV = (1/N)*[V + (k - 1)*\min(W_1, W_2)]$ **754**
6. Level of Service (LOS) **A**

The LOS in the chart above refers to the capacity of weaving traffic only; through and ramp to ramp traffic is not included.

* Note: **Do not adjust by a Peak Hour Factor (PHF).** The methodology incorporates the PHF in the Service Volume tables.

Sources: *Completion of Procedures for Analysis and Design of Traffic Weaving Sections*, Jack E. Leisch & Associates, September 1983 and *Highway Design Manual*, California Department of Transportation, July 24, 2009

Leisch Method for Weaving Analysis

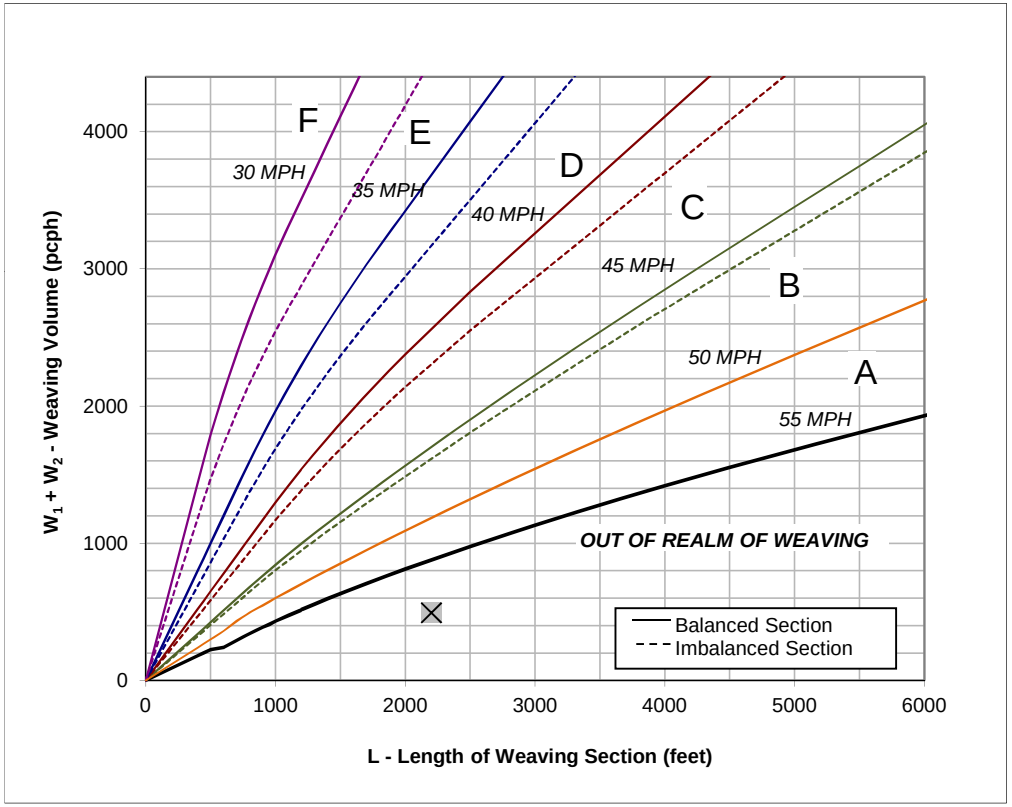
Data Input

Number of Entering Mainline Lanes	N_b	3
Number of Lanes in Weaving Section	N	4
Length of Weaving Section (feet)	L	2,200

Total Weaving Section (V)		On-ramp to Mainline (W_1)		Mainline to Off-ramp (W_2)	
Volume (vph)*	3,260	Volume (vph)*	400	Volume (vph)*	80
Truck Percentage	6%	Truck Percentage	6%	Truck Percentage	6%
PCE for Trucks	1.5	PCE for Trucks	1.5	PCE for Trucks	1.5
Volume (pcph)	3,358	Volume (pcph)	412	Volume (pcph)	82

Project Information

Project	LBNL
Scenario	Near-Term PM
Freeway	EB I-580
On-ramp	Regatta Blvd
Off-ramp	Bayview Ave



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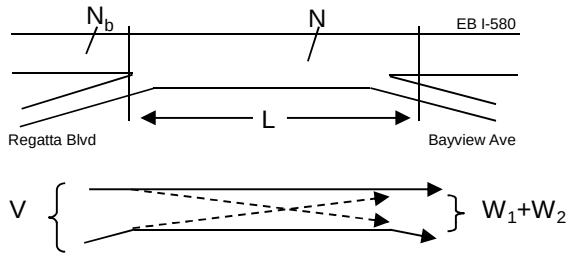


Capacity Analysis

1. Is the weaving section balanced (Y / N)? **N**
   [If optional exit lane, then "Y". Otherwise "N".]
2. In the Weaving Speed Chart to the left, which two speed curves is the black "x" between?
   50 MPH and **55 MPH**
   If below the 55 MPH curve, out of the realm of weaving.
   If left of the 30 MPH curve, LOS is F.
3. Interpolated Weaving Speed (S_w, mph) **61.3**
4. Weaving Intensity Factor (k) **1.00**
5. Service Volume (SV, pcph)
   $SV = (1/N)*[V + (k - 1)*\min(W_1, W_2)]$ **839**
6. Level of Service (LOS) **B**

The LOS in the chart above refers to the capacity of weaving traffic only; through and ramp to ramp traffic is not included.

* Note: **Do not adjust by a Peak Hour Factor (PHF).** The methodology incorporates the PHF in the Service Volume tables.

Sources: *Completion of Procedures for Analysis and Design of Traffic Weaving Sections*, Jack E. Leisch & Associates, September 1983 and *Highway Design Manual*, California Department of Transportation, July 24, 2009

Leisch Method for Weaving Analysis

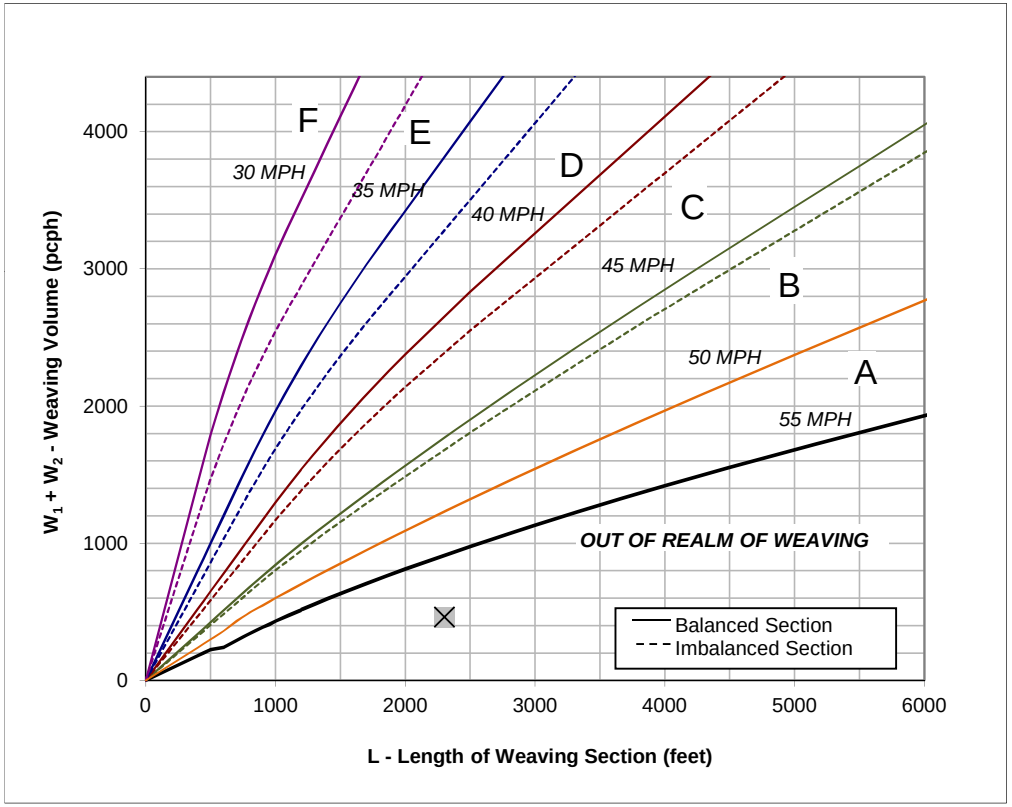
Data Input

Number of Entering Mainline Lanes	N_b	3
Number of Lanes in Weaving Section	N	4
Length of Weaving Section (feet)	L	2,300

Total Weaving Section (V)		On-ramp to Mainline (W_1)		Mainline to Off-ramp (W_2)	
Volume (vph)*	3,080	Volume (vph)*	290	Volume (vph)*	160
Truck Percentage	6%	Truck Percentage	6%	Truck Percentage	6%
PCE for Trucks	1.5	PCE for Trucks	1.5	PCE for Trucks	1.5
Volume (pcph)	3,172	Volume (pcph)	299	Volume (pcph)	165

Project Information

Project	LBNL
Scenario	Near-Term PM
Freeway	WB I-580
On-ramp	Bayview Ave
Off-ramp	Regatta Blvd



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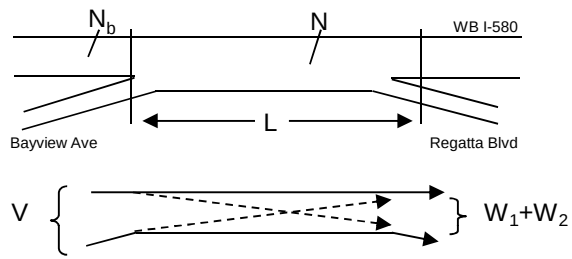


Capacity Analysis

1. Is the weaving section balanced (Y / N)? **N**
   [If optional exit lane, then "Y". Otherwise "N".]
2. In the Weaving Speed Chart to the left, which two speed curves is the black "x" between?
   50 MPH and **55 MPH**
   If below the 55 MPH curve, out of the realm of weaving.
   If left of the 30 MPH curve, LOS is F.
3. Interpolated Weaving Speed (S_w, mph) **62.1**
4. Weaving Intensity Factor (k) **1.00**
5. Service Volume (SV, pcph)
   $SV = (1/N)*[V + (k - 1)*\min(W_1, W_2)]$ **793**
6. Level of Service (LOS) **A**

The LOS in the chart above refers to the capacity of weaving traffic only; through and ramp to ramp traffic is not included.

* Note: **Do not adjust by a Peak Hour Factor (PHF).** The methodology incorporates the PHF in the Service Volume tables.

Sources: *Completion of Procedures for Analysis and Design of Traffic Weaving Sections*, Jack E. Leisch & Associates, September 1983 and *Highway Design Manual*, California Department of Transportation, July 24, 2009

Near-Term (2018) Plus Phase 1 Project Conditions

FEHR PEERS

HCM 2000
Basic Freeway Segments
Capacity Analysis

Jurisdiction
Analysis Year Near-Term + Project (Phase 1)
Analyst TL

Agency or Company
Date
Project Description

General Information				*Flow Rate Calculation*													*Speed Calculation*		*Results*	
	Freeway/ Direction	From/To	Analysis Time Period	Volume (vph)	PHF	Lanes	HOV Lane?	HOV Lane Volume	Terrain	Truck/ Bus %	RV %	E_T	E_R	f_{HV}	f_P	Flow Rate v_p (pcphpl)	Measured FFS (mph)	S (mph)	Density, D (pcplpm)	Level of Service
R-5	I-580 EB	I-580 between Bayview Avenue and Central Avenue	AM	3,110	0.92	3	No		Level	6%	0%	1.5	1.2	0.971	1.00	1,161	65.0	65.0	**17.9**	**B**
R-6	I-580 EB	I-580 between Central Avenue and I-80	AM	3,020	0.92	2	No		Level	6%	0%	1.5	1.2	0.971	1.00	1,691	65.0	64.6	**26.2**	**D**
R-7	I-80 EB	I-80 between Carlson Boulevard and Potrero Avenue	AM	4,325	0.92	4	Yes	290	Level	4%	0%	1.5	1.2	0.980	1.00	1,491	65.0	65.0	**22.9**	**C**
R-8	I-80 EB	I-80 @ Gilman Overpass	AM	6,204	0.92	5	Yes	780	Level	5%	0%	1.5	1.2	0.976	1.00	1,511	65.0	65.0	**23.2**	**C**
R-5	I-580 WB	I-580 between Bayview Avenue and Central Avenue	AM	3,074	0.92	3	No		Level	6%	0%	1.5	1.2	0.971	1.00	1,147	65.0	65.0	**17.6**	**B**
R-6	I-580 WB	I-580 between Central Avenue and I-80	AM	3,364	0.92	2	No		Level	6%	0%	1.5	1.2	0.971	1.00	1,883	65.0	63.1	**29.8**	**D**
R-7	I-80 WB	I-80 between Carlson Boulevard and Potrero Avenue	AM	6,313	0.92	4	Yes	1000	Level	4%	0%	1.5	1.2	0.980	1.00	1,964	65.0	62.0	**31.7**	**D**
R-8	I-80 WB	I-80 @ Gilman Overpass	AM	8,540	0.92	5	Yes	1410	Level	5%	0%	1.5	1.2	0.976	1.00	1,986	65.0	61.7	**32.2**	**D**
R-5	I-580 EB	I-580 between Bayview Avenue and Central Avenue	PM	3,030	0.92	3	No		Level	6%	0%	1.5	1.2	0.971	1.00	1,131	65.0	65.0	**17.4**	**B**
R-6	I-580 EB	I-580 between Central Avenue and I-80	PM	3,650	0.92	2	No		Level	6%	0%	1.5	1.2	0.971	1.00	2,043	65.0	60.7	**33.7**	**D**
R-7	I-80 EB	I-80 between Carlson Boulevard and Potrero Avenue	PM	6,211	0.92	4	Yes	1300	Level	4%	0%	1.5	1.2	0.980	1.00	1,815	65.0	63.8	**28.5**	**D**
R-8	I-80 EB	I-80 @ Gilman Overpass	PM	7,579	0.92	5	Yes	1070	Level	5%	0%	1.5	1.2	0.976	1.00	1,813	65.0	63.8	**28.4**	**D**
R-5	I-580 WB	I-580 between Bayview Avenue and Central Avenue	PM	3,249	0.92	3	No		Level	6%	0%	1.5	1.2	0.971	1.00	1,212	65.0	65.0	**18.7**	**C**
R-6	I-580 WB	I-580 between Central Avenue and I-80	PM	2,799	0.92	2	No		Level	6%	0%	1.5	1.2	0.971	1.00	1,567	65.0	64.9	**24.1**	**C**
R-7	I-80 WB	I-80 between Carlson Boulevard and Potrero Avenue	PM	4,775	0.92	4	Yes	330	Level	4%	0%	1.5	1.2	0.980	1.00	1,643	65.0	64.8	**25.4**	**C**
R-8	I-80 WB	I-80 @ Gilman Overpass	PM	6,800	0.92	5	Yes	650	Level	5%	0%	1.5	1.2	0.976	1.00	1,713	65.0	64.5	**26.6**	**D**

Leisch Method for Weaving Analysis

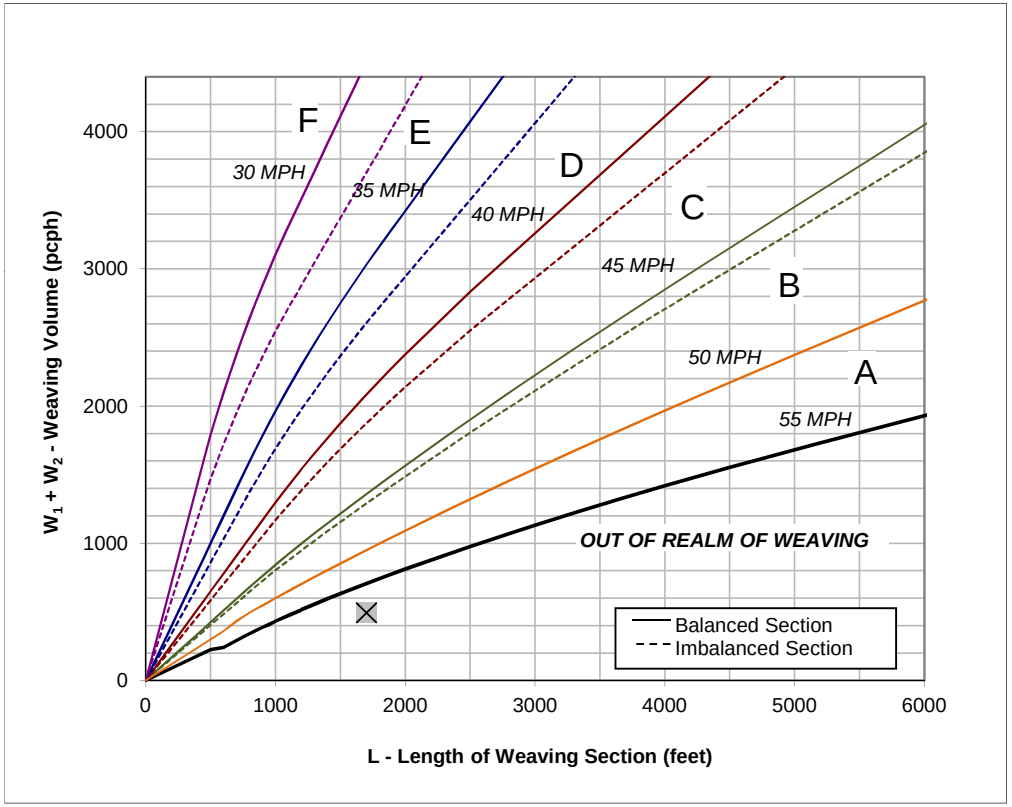
Data Input

Number of Entering Mainline Lanes	N_b	3
Number of Lanes in Weaving Section	N	4
Length of Weaving Section (feet)	L	1,700

Total Weaving Section (V)		On-ramp to Mainline (W_1)		Mainline to Off-ramp (W_2)	
Volume (vph)*	2,452	Volume (vph)*	320	Volume (vph)*	160
Truck Percentage	6%	Truck Percentage	6%	Truck Percentage	6%
PCE for Trucks	1.5	PCE for Trucks	1.5	PCE for Trucks	1.5
Volume (pcph)	2,526	Volume (pcph)	330	Volume (pcph)	165

Project Information

Project	LBNL
Scenario	Near-Term Plus Phase 1 AM
Freeway	EB I-580
On-ramp	Harbour Way
Off-ramp	Marina Bay Pkwy



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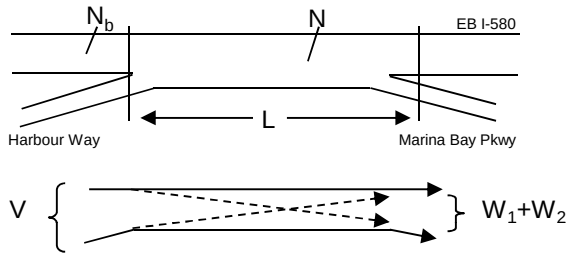


Capacity Analysis

1. Is the weaving section balanced (Y / N)? **N**
   [If optional exit lane, then "Y". Otherwise "N".]
2. In the Weaving Speed Chart to the left, which two speed curves is the black "x" between?
   50 MPH and **55 MPH**
   If below the 55 MPH curve, out of the realm of weaving.
   If left of the 30 MPH curve, LOS is F.
3. Interpolated Weaving Speed (S_w, mph) **59.4**
4. Weaving Intensity Factor (k) **1.00**
5. Service Volume (SV, pcph)
   $SV = (1/N)*[V + (k - 1)*\min(W_1, W_2)]$ **631**
6. Level of Service (LOS) **A**

The LOS in the chart above refers to the capacity of weaving traffic only; through and ramp to ramp traffic is not included.

* Note: **Do not adjust by a Peak Hour Factor (PHF).** The methodology incorporates the PHF in the Service Volume tables.

Sources: *Completion of Procedures for Analysis and Design of Traffic Weaving Sections*, Jack E. Leisch & Associates, September 1983 and *Highway Design Manual*, California Department of Transportation, July 24, 2009

Leisch Method for Weaving Analysis

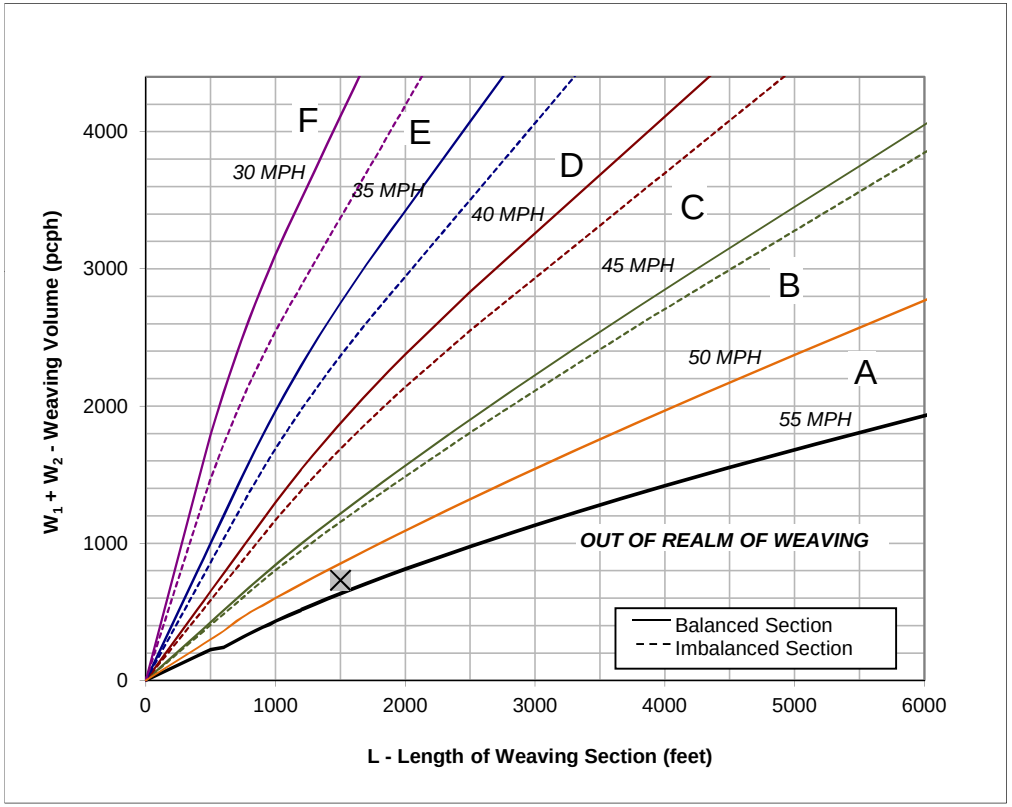
Data Input

Number of Entering Mainline Lanes	N_b	3
Number of Lanes in Weaving Section	N	4
Length of Weaving Section (feet)	L	1,500

Total Weaving Section (V)		On-ramp to Mainline (W_1)		Mainline to Off-ramp (W_2)	
Volume (vph)*	2,787	Volume (vph)*	320	Volume (vph)*	390
Truck Percentage	6%	Truck Percentage	6%	Truck Percentage	6%
PCE for Trucks	1.5	PCE for Trucks	1.5	PCE for Trucks	1.5
Volume (pcph)	2,871	Volume (pcph)	330	Volume (pcph)	402

Project Information

Project	LBNL
Scenario	Near-Term Plus Phase 1 AM
Freeway	WB I-580
On-ramp	Marina Bay Parkway
Off-ramp	Harbour Way



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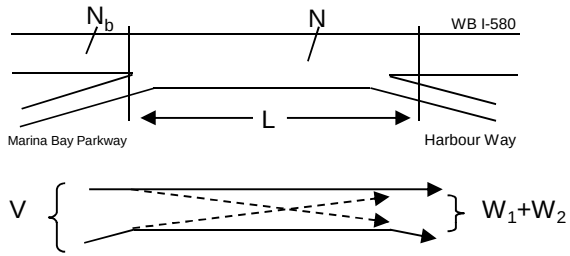


Capacity Analysis

1. Is the weaving section balanced (Y / N)? **N**
   [If optional exit lane, then "Y". Otherwise "N".]
2. In the Weaving Speed Chart to the left, which two speed curves is the black "x" between?
   50 MPH and **55 MPH**
   If below the 55 MPH curve, out of the realm of weaving.
   If left of the 30 MPH curve, LOS is F.
3. Interpolated Weaving Speed (S_w, mph) **52.8**
4. Weaving Intensity Factor (k) **1.00**
5. Service Volume (SV, pcph)
   $SV = (1/N)*[V + (k - 1)*\min(W_1, W_2)]$ **718**
6. Level of Service (LOS) **A**

The LOS in the chart above refers to the capacity of weaving traffic only; through and ramp to ramp traffic is not included.

* Note: **Do not adjust by a Peak Hour Factor (PHF).** The methodology incorporates the PHF in the Service Volume tables.

Sources: *Completion of Procedures for Analysis and Design of Traffic Weaving Sections*, Jack E. Leisch & Associates, September 1983 and *Highway Design Manual*, California Department of Transportation, July 24, 2009

Leisch Method for Weaving Analysis

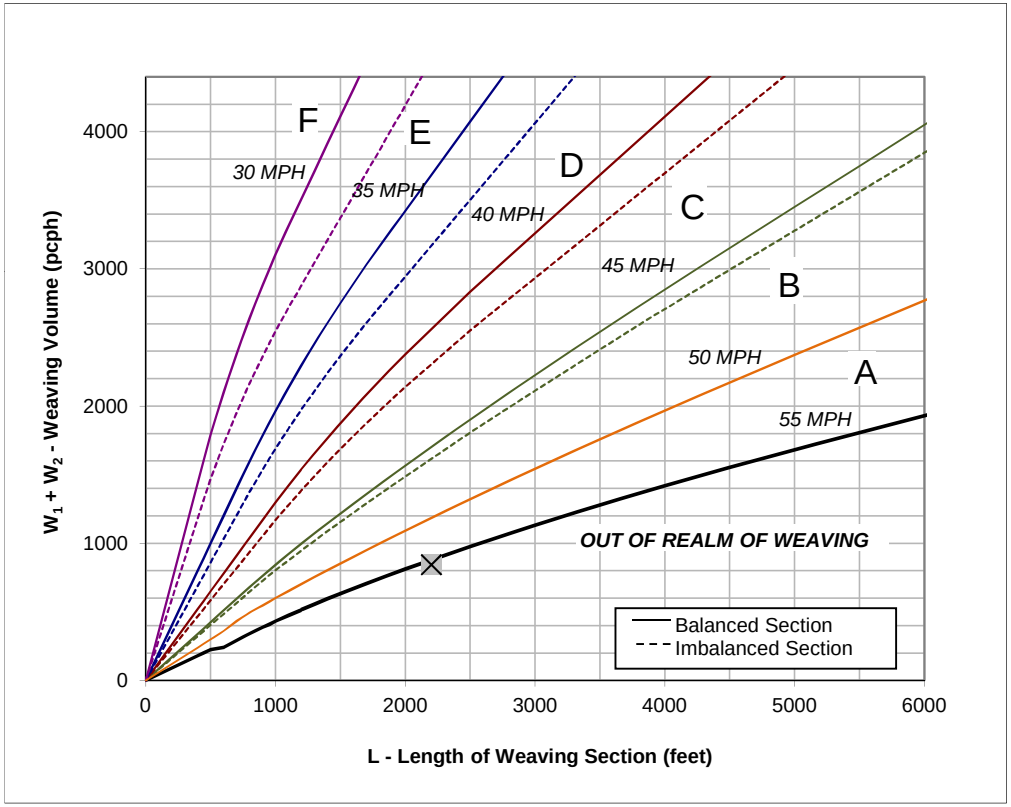
Data Input

Number of Entering Mainline Lanes	N_b	3
Number of Lanes in Weaving Section	N	4
Length of Weaving Section (feet)	L	2,200

Total Weaving Section (V)		On-ramp to Mainline (W_1)		Mainline to Off-ramp (W_2)	
Volume (vph)*	3,127	Volume (vph)*	740	Volume (vph)*	80
Truck Percentage	6%	Truck Percentage	6%	Truck Percentage	6%
PCE for Trucks	1.5	PCE for Trucks	1.5	PCE for Trucks	1.5
Volume (pcph)	3,221	Volume (pcph)	762	Volume (pcph)	82

Project Information

Project	LBNL
Scenario	Near-Term Plus Phase 1 AM
Freeway	EB I-580
On-ramp	Marina Bay Parkway
Off-ramp	Regatta Blvd



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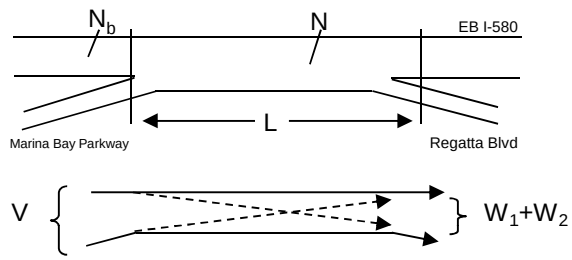


Capacity Analysis

1. Is the weaving section balanced (Y / N)? **N**
   [If optional exit lane, then "Y". Otherwise "N".]
2. In the Weaving Speed Chart to the left, which two speed curves is the black "x" between?
   50 MPH and **55 MPH**
   If below the 55 MPH curve, out of the realm of weaving.
   If left of the 30 MPH curve, LOS is F.
3. Interpolated Weaving Speed (S_w, mph) **55.6**
4. Weaving Intensity Factor (k) **1.00**
5. Service Volume (SV, pcph)
   $SV = (1/N)*[V + (k - 1)*\min(W_1, W_2)]$ **805**
6. Level of Service (LOS) **B**

The LOS in the chart above refers to the capacity of weaving traffic only; through and ramp to ramp traffic is not included.

* Note: **Do not adjust by a Peak Hour Factor (PHF).** The methodology incorporates the PHF in the Service Volume tables.

Sources: *Completion of Procedures for Analysis and Design of Traffic Weaving Sections*, Jack E. Leisch & Associates, September 1983 and *Highway Design Manual*, California Department of Transportation, July 24, 2009

Leisch Method for Weaving Analysis

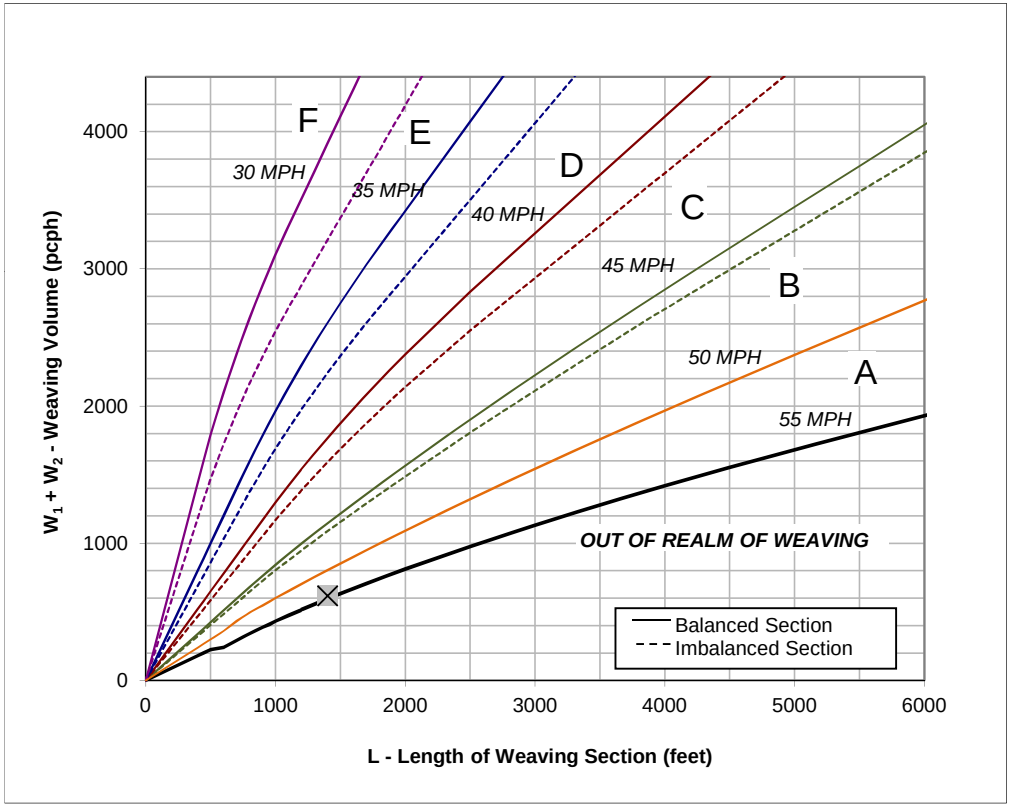
Data Input

Number of Entering Mainline Lanes	N_b	3
Number of Lanes in Weaving Section	N	4
Length of Weaving Section (feet)	L	1,400

Total Weaving Section (V)		On-ramp to Mainline (W_1)		Mainline to Off-ramp (W_2)	
Volume (vph)*	3,358	Volume (vph)*	130	Volume (vph)*	470
Truck Percentage	6%	Truck Percentage	6%	Truck Percentage	6%
PCE for Trucks	1.5	PCE for Trucks	1.5	PCE for Trucks	1.5
Volume (pcph)	3,459	Volume (pcph)	134	Volume (pcph)	484

Project Information

Project	LBNL
Scenario	Near-Term Plus Phase 1 AM
Freeway	WB I-580
On-ramp	Regatta Blvd
Off-ramp	Marina Bay Parkway



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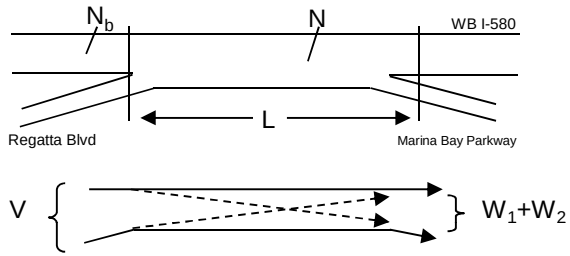


Capacity Analysis

1. Is the weaving section balanced (Y / N)? **N**
   [If optional exit lane, then "Y". Otherwise "N".]
2. In the Weaving Speed Chart to the left, which two speed curves is the black "x" between?
   50 MPH and **55 MPH**
   If below the 55 MPH curve, out of the realm of weaving.
   If left of the 30 MPH curve, LOS is F.
3. Interpolated Weaving Speed (S_w, mph) **54.4**
4. Weaving Intensity Factor (k) **1.00**
5. Service Volume (SV, pcph)
   $SV = (1/N)*[V + (k - 1)*\min(W_1, W_2)]$ **865**
6. Level of Service (LOS) **B**

The LOS in the chart above refers to the capacity of weaving traffic only; through and ramp to ramp traffic is not included.

* Note: **Do not adjust by a Peak Hour Factor (PHF).** The methodology incorporates the PHF in the Service Volume tables.

Sources: *Completion of Procedures for Analysis and Design of Traffic Weaving Sections*, Jack E. Leisch & Associates, September 1983 and *Highway Design Manual*, California Department of Transportation, July 24, 2009

Leisch Method for Weaving Analysis

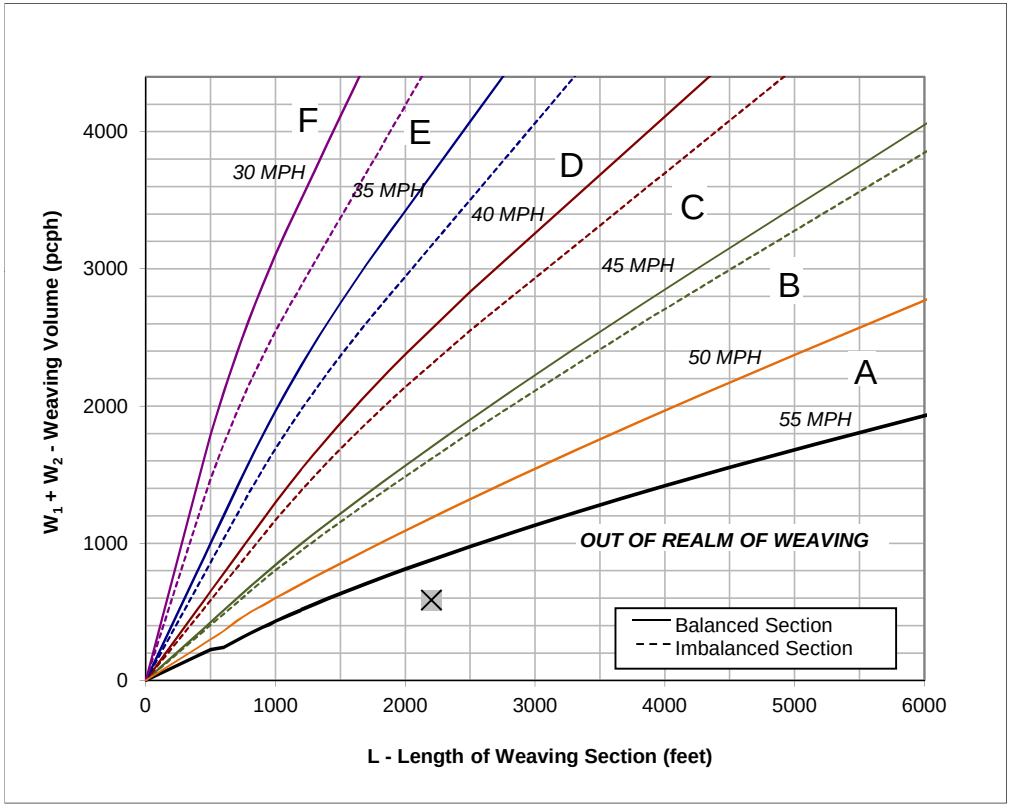
Data Input

Number of Entering Mainline Lanes	N_b	3
Number of Lanes in Weaving Section	N	4
Length of Weaving Section (feet)	L	2,200

Total Weaving Section (V)		On-ramp to Mainline (W_1)		Mainline to Off-ramp (W_2)	
Volume (vph)*	3,270	Volume (vph)*	140	Volume (vph)*	430
Truck Percentage	6%	Truck Percentage	6%	Truck Percentage	6%
PCE for Trucks	1.5	PCE for Trucks	1.5	PCE for Trucks	1.5
Volume (pcph)	3,368	Volume (pcph)	144	Volume (pcph)	443

Project Information

Project	LBNL
Scenario	Near-Term Plus Phase 1 AM
Freeway	EB I-580
On-ramp	Regatta Blvd
Off-ramp	Bayview Ave



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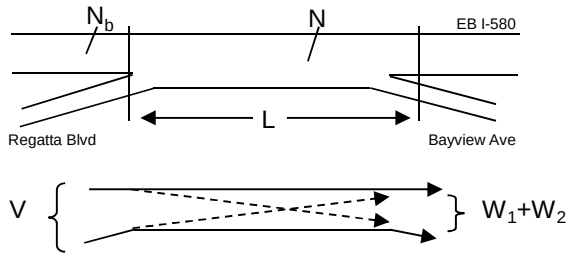


Capacity Analysis

1. Is the weaving section balanced (Y / N)? **N**
   [If optional exit lane, then "Y". Otherwise "N".]
2. In the Weaving Speed Chart to the left, which two speed curves is the black "x" between?
   50 MPH and **55 MPH**
   If below the 55 MPH curve, out of the realm of weaving.
   If left of the 30 MPH curve, LOS is F.
3. Interpolated Weaving Speed (S_w, mph) **59.8**
4. Weaving Intensity Factor (k) **1.00**
5. Service Volume (SV, pcph)
   $SV = (1/N)*[V + (k - 1)*\min(W_1, W_2)]$ **842**
6. Level of Service (LOS) **B**

The LOS in the chart above refers to the capacity of weaving traffic only; through and ramp to ramp traffic is not included.

* Note: **Do not adjust by a Peak Hour Factor (PHF).** The methodology incorporates the PHF in the Service Volume tables.

Sources: *Completion of Procedures for Analysis and Design of Traffic Weaving Sections*, Jack E. Leisch & Associates, September 1983 and *Highway Design Manual*, California Department of Transportation, July 24, 2009

Leisch Method for Weaving Analysis

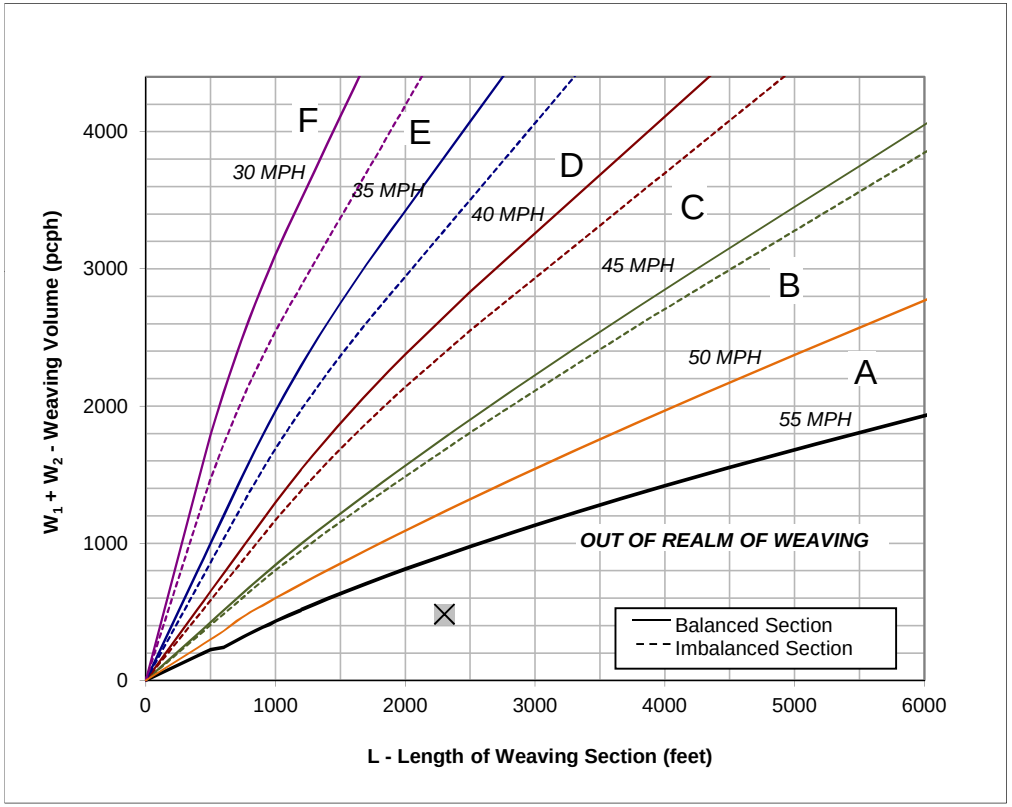
Data Input

Number of Entering Mainline Lanes	N_b	3
Number of Lanes in Weaving Section	N	4
Length of Weaving Section (feet)	L	2,300

Total Weaving Section (V)		On-ramp to Mainline (W_1)		Mainline to Off-ramp (W_2)	
Volume (vph)*	3,310	Volume (vph)*	380	Volume (vph)*	90
Truck Percentage	6%	Truck Percentage	6%	Truck Percentage	6%
PCE for Trucks	1.5	PCE for Trucks	1.5	PCE for Trucks	1.5
Volume (pcph)	3,409	Volume (pcph)	391	Volume (pcph)	93

Project Information

Project	LBNL
Scenario	Near-Term Plus Phase 1 AM
Freeway	WB I-580
On-ramp	Bayview Ave
Off-ramp	Regatta Blvd



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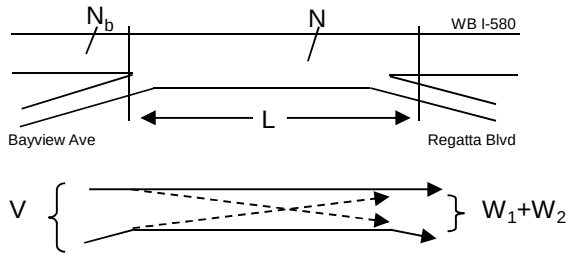


Capacity Analysis

1. Is the weaving section balanced (Y / N)? **N**
   [If optional exit lane, then "Y". Otherwise "N".]
2. In the Weaving Speed Chart to the left, which two speed curves is the black "x" between?
   50 MPH and **55 MPH**
   If below the 55 MPH curve, out of the realm of weaving.
   If left of the 30 MPH curve, LOS is F.
3. Interpolated Weaving Speed (S_w, mph) **61.7**
4. Weaving Intensity Factor (k) **1.00**
5. Service Volume (SV, pcph)
   $SV = (1/N)*[V + (k - 1)*\min(W_1, W_2)]$ **852**
6. Level of Service (LOS) **B**

The LOS in the chart above refers to the capacity of weaving traffic only; through and ramp to ramp traffic is not included.

* Note: **Do not adjust by a Peak Hour Factor (PHF).** The methodology incorporates the PHF in the Service Volume tables.

Sources: *Completion of Procedures for Analysis and Design of Traffic Weaving Sections*, Jack E. Leisch & Associates, September 1983 and *Highway Design Manual*, California Department of Transportation, July 24, 2009

Leisch Method for Weaving Analysis

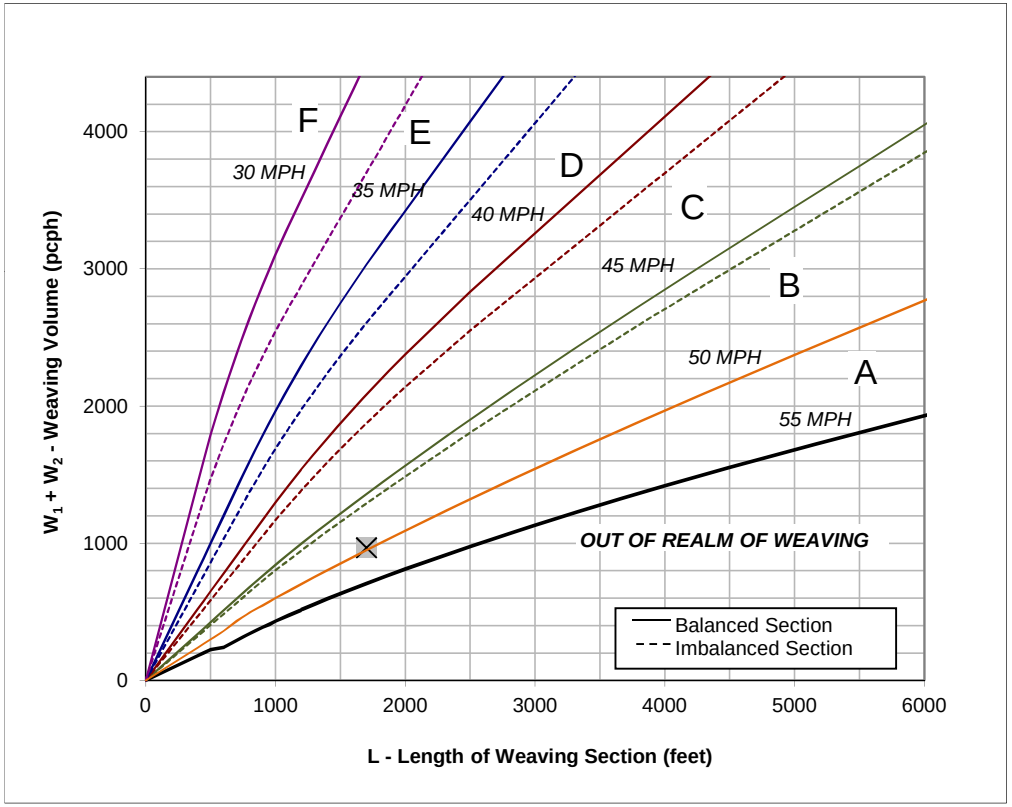
Data Input

Number of Entering Mainline Lanes	N_b	3
Number of Lanes in Weaving Section	N	4
Length of Weaving Section (feet)	L	1,700

Total Weaving Section (V)		On-ramp to Mainline (W_1)		Mainline to Off-ramp (W_2)	
Volume (vph)*	3,106	Volume (vph)*	600	Volume (vph)*	340
Truck Percentage	6%	Truck Percentage	6%	Truck Percentage	6%
PCE for Trucks	1.5	PCE for Trucks	1.5	PCE for Trucks	1.5
Volume (pcph)	3,199	Volume (pcph)	618	Volume (pcph)	350

Project Information

Project	LBNL
Scenario	Near-Term Plus Phase 1 PM
Freeway	EB I-580
On-ramp	Harbour Way
Off-ramp	Marina Bay Pkwy



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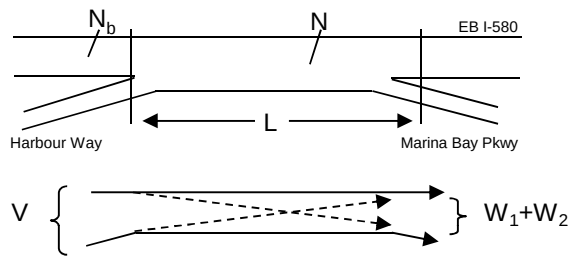


Capacity Analysis

1. Is the weaving section balanced (Y / N)? **N**
   [If optional exit lane, then "Y". Otherwise "N".]
2. In the Weaving Speed Chart to the left, which two speed curves is the black "x" between?
   50 MPH and **55 MPH**
   If below the 55 MPH curve, out of the realm of weaving.
   If left of the 30 MPH curve, LOS is F.
3. Interpolated Weaving Speed (S_w, mph) **49.6**
4. Weaving Intensity Factor (k) **1.25**
5. Service Volume (SV, pcph)
   $SV = (1/N)*[V + (k - 1)*\min(W_1, W_2)]$ **822**
6. Level of Service (LOS) **B**

The LOS in the chart above refers to the capacity of weaving traffic only; through and ramp to ramp traffic is not included.

* Note: **Do not adjust by a Peak Hour Factor (PHF).** The methodology incorporates the PHF in the Service Volume tables.

Sources: *Completion of Procedures for Analysis and Design of Traffic Weaving Sections*, Jack E. Leisch & Associates, September 1983 and *Highway Design Manual*, California Department of Transportation, July 24, 2009

Leisch Method for Weaving Analysis

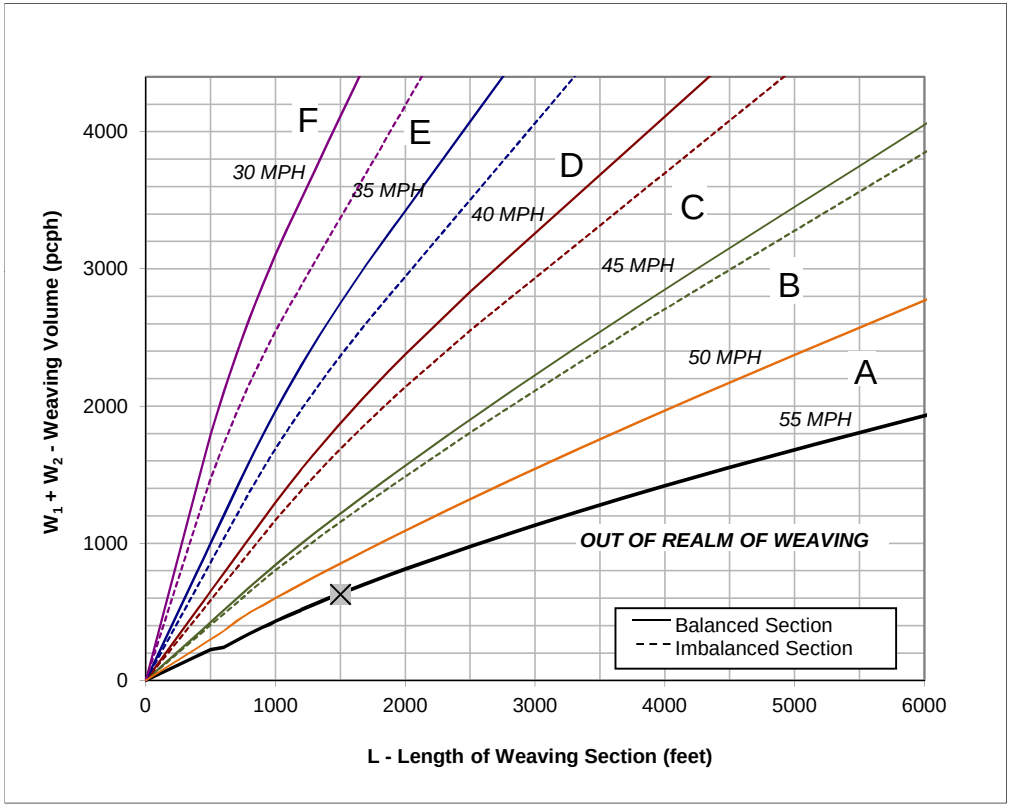
Data Input

Number of Entering Mainline Lanes	N_b	3
Number of Lanes in Weaving Section	N	4
Length of Weaving Section (feet)	L	1,500

Total Weaving Section (V)		On-ramp to Mainline (W_1)		Mainline to Off-ramp (W_2)	
Volume (vph)*	2,210	Volume (vph)*	220	Volume (vph)*	390
Truck Percentage	6%	Truck Percentage	6%	Truck Percentage	6%
PCE for Trucks	1.5	PCE for Trucks	1.5	PCE for Trucks	1.5
Volume (pcph)	2,276	Volume (pcph)	227	Volume (pcph)	402

Project Information

Project	LBNL
Scenario	Near-Term Plus Phase 1 PM
Freeway	WB I-580
On-ramp	Marina Bay Parkway
Off-ramp	Harbour Way



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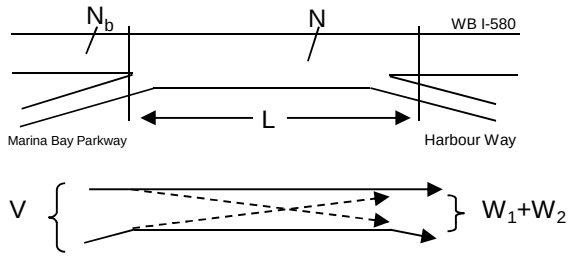


Capacity Analysis

1. Is the weaving section balanced (Y / N)? **N**
   [If optional exit lane, then "Y". Otherwise "N".]
2. In the Weaving Speed Chart to the left, which two speed curves is the black "x" between?
   50 MPH and **55 MPH**
   If below the 55 MPH curve, out of the realm of weaving.
   If left of the 30 MPH curve, LOS is F.
3. Interpolated Weaving Speed (S_w, mph) **55.1**
4. Weaving Intensity Factor (k) **1.00**
5. Service Volume (SV, pcph)
   $SV = (1/N)*[V + (k - 1)*\min(W_1, W_2)]$ **569**
6. Level of Service (LOS) **A**

The LOS in the chart above refers to the capacity of weaving traffic only; through and ramp to ramp traffic is not included.

* Note: **Do not adjust by a Peak Hour Factor (PHF).** The methodology incorporates the PHF in the Service Volume tables.

Sources: *Completion of Procedures for Analysis and Design of Traffic Weaving Sections*, Jack E. Leisch & Associates, September 1983 and *Highway Design Manual*, California Department of Transportation, July 24, 2009

Leisch Method for Weaving Analysis

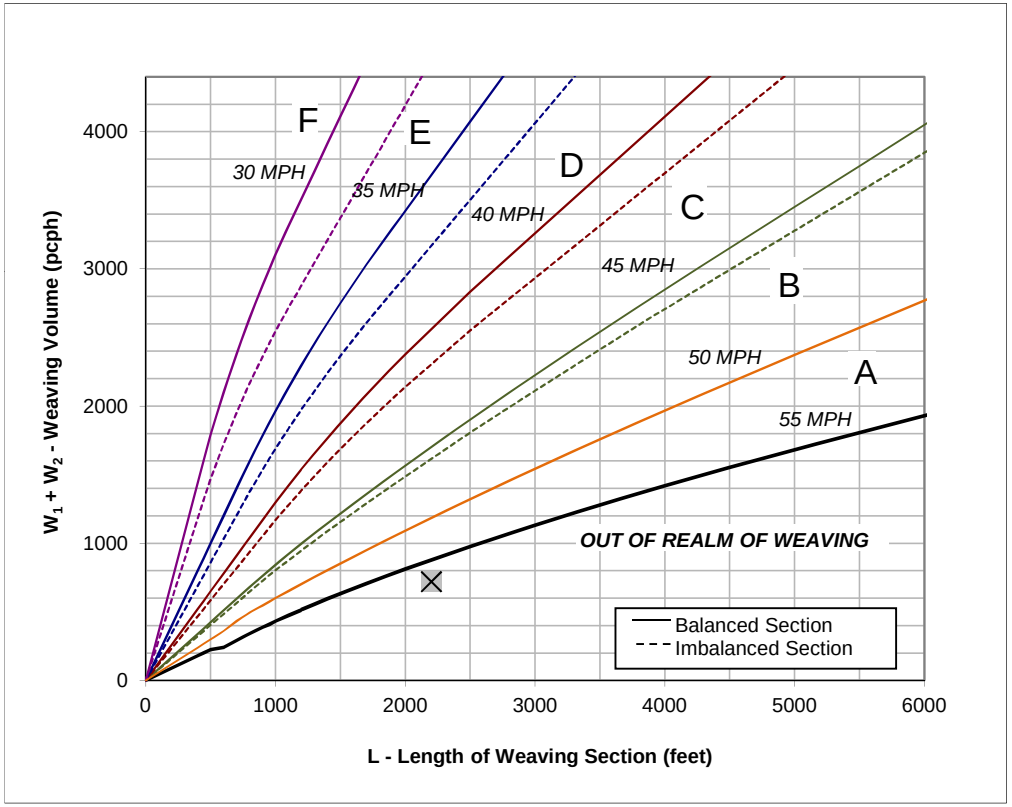
Data Input

Number of Entering Mainline Lanes	N_b	3
Number of Lanes in Weaving Section	N	4
Length of Weaving Section (feet)	L	2,200

Total Weaving Section (V)		On-ramp to Mainline (W_1)		Mainline to Off-ramp (W_2)	
Volume (vph)*	3,257	Volume (vph)*	580	Volume (vph)*	120
Truck Percentage	6%	Truck Percentage	6%	Truck Percentage	6%
PCE for Trucks	1.5	PCE for Trucks	1.5	PCE for Trucks	1.5
Volume (pcph)	3,355	Volume (pcph)	597	Volume (pcph)	124

Project Information

Project	LBNL
Scenario	Near-Term Plus Phase 1 PM
Freeway	EB I-580
On-ramp	Marina Bay Parkway
Off-ramp	Regatta Blvd



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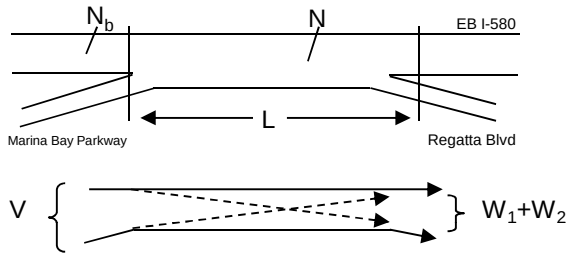


Capacity Analysis

1. Is the weaving section balanced (Y / N)? **N**
   [If optional exit lane, then "Y". Otherwise "N".]
2. In the Weaving Speed Chart to the left, which two speed curves is the black "x" between?
   50 MPH and **55 MPH**
   If below the 55 MPH curve, out of the realm of weaving.
   If left of the 30 MPH curve, LOS is F.
3. Interpolated Weaving Speed (S_w, mph) **57.6**
4. Weaving Intensity Factor (k) **1.00**
5. Service Volume (SV, pcph)
   $SV = (1/N)*[V + (k - 1)*\min(W_1, W_2)]$ **839**
6. Level of Service (LOS) **B**

The LOS in the chart above refers to the capacity of weaving traffic only; through and ramp to ramp traffic is not included.

* Note: **Do not adjust by a Peak Hour Factor (PHF).** The methodology incorporates the PHF in the Service Volume tables.

Sources: *Completion of Procedures for Analysis and Design of Traffic Weaving Sections*, Jack E. Leisch & Associates, September 1983 and *Highway Design Manual*, California Department of Transportation, July 24, 2009

Leisch Method for Weaving Analysis

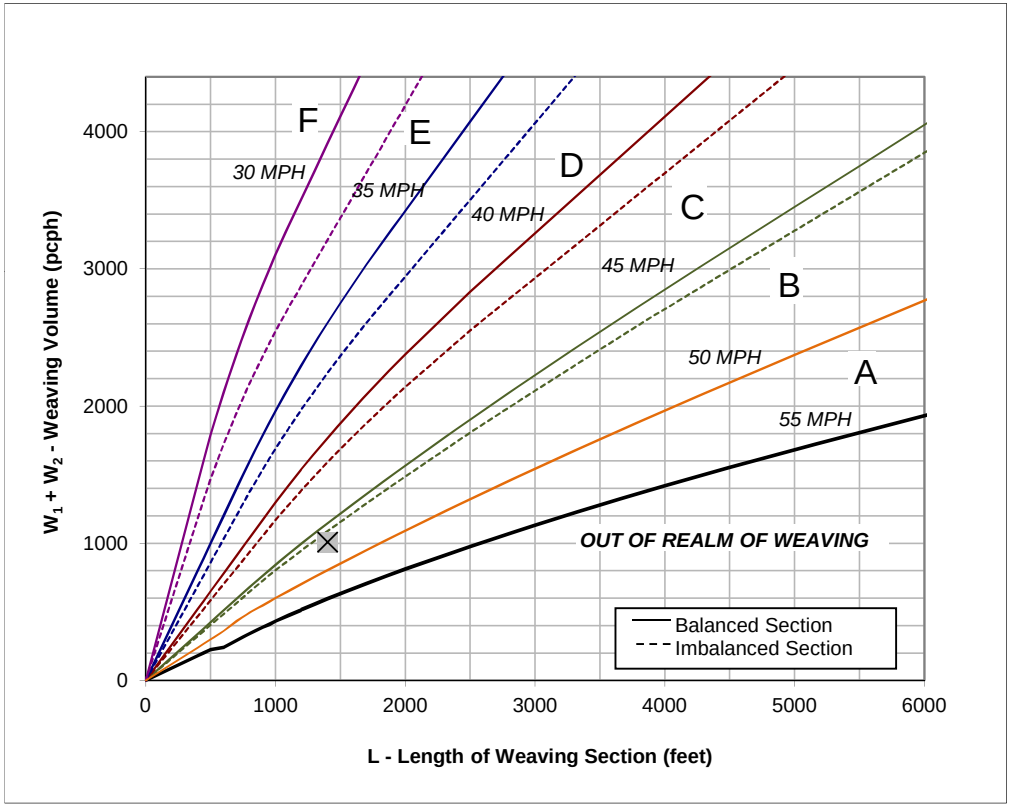
Data Input

Number of Entering Mainline Lanes	N_b	3
Number of Lanes in Weaving Section	N	4
Length of Weaving Section (feet)	L	1,400

Total Weaving Section (V)		On-ramp to Mainline (W_1)		Mainline to Off-ramp (W_2)	
Volume (vph)*	2,895	Volume (vph)*	60	Volume (vph)*	920
Truck Percentage	6%	Truck Percentage	6%	Truck Percentage	6%
PCE for Trucks	1.5	PCE for Trucks	1.5	PCE for Trucks	1.5
Volume (pcph)	2,982	Volume (pcph)	62	Volume (pcph)	948

Project Information

Project	LBNL
Scenario	Near-Term Plus Phase 1 PM
Freeway	WB I-580
On-ramp	Regatta Blvd
Off-ramp	Marina Bay Parkway



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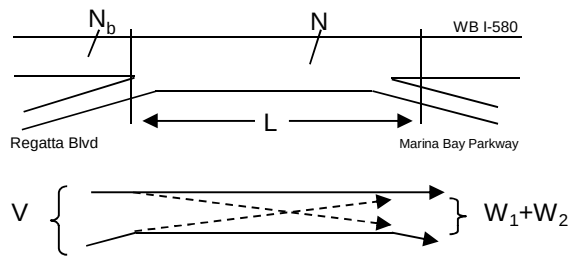


Capacity Analysis

1. Is the weaving section balanced (Y / N)? **N**
   [If optional exit lane, then "Y". Otherwise "N".]
2. In the Weaving Speed Chart to the left, which two speed curves is the black "x" between?
   45 MPH and **50 MPH**
   If below the 55 MPH curve, out of the realm of weaving.
   If left of the 30 MPH curve, LOS is F.
3. Interpolated Weaving Speed (S_w, mph) **46.4**
4. Weaving Intensity Factor (k) **2.30**
5. Service Volume (SV, pcph)
   $SV = (1/N)*[V + (k - 1)*\min(W_1, W_2)]$ **766**
6. Level of Service (LOS) **A**

The LOS in the chart above refers to the capacity of weaving traffic only; through and ramp to ramp traffic is not included.

* Note: **Do not adjust by a Peak Hour Factor (PHF).** The methodology incorporates the PHF in the Service Volume tables.

Sources: *Completion of Procedures for Analysis and Design of Traffic Weaving Sections*, Jack E. Leisch & Associates, September 1983 and *Highway Design Manual*, California Department of Transportation, July 24, 2009

Leisch Method for Weaving Analysis

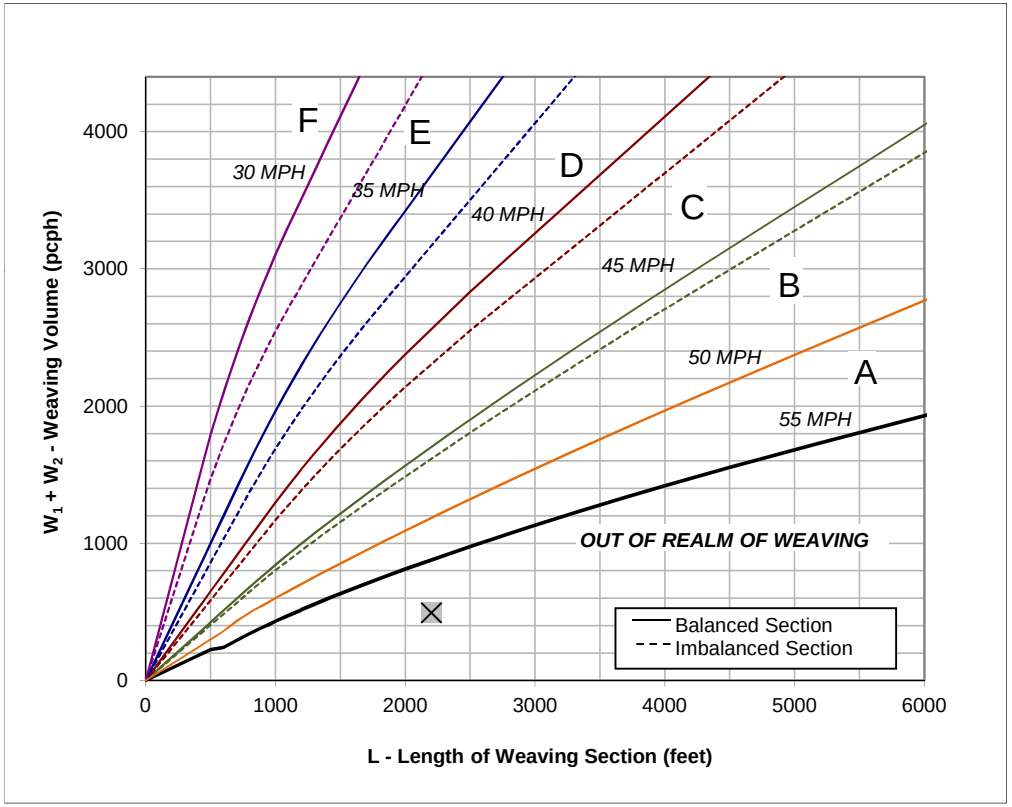
Data Input

Number of Entering Mainline Lanes	N_b	3
Number of Lanes in Weaving Section	N	4
Length of Weaving Section (feet)	L	2,200

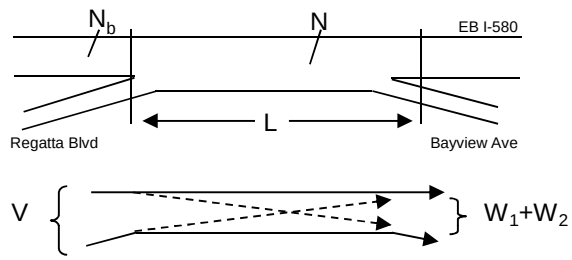
Total Weaving Section (V)		On-ramp to Mainline (W_1)		Mainline to Off-ramp (W_2)	
Volume (vph)*	3,260	Volume (vph)*	400	Volume (vph)*	80
Truck Percentage	6%	Truck Percentage	6%	Truck Percentage	6%
PCE for Trucks	1.5	PCE for Trucks	1.5	PCE for Trucks	1.5
Volume (pcph)	3,358	Volume (pcph)	412	Volume (pcph)	82

Project Information

Project	LBNL
Scenario	Near-Term Plus Phase 1 PM
Freeway	EB I-580
On-ramp	Regatta Blvd
Off-ramp	Bayview Ave



Figure



Capacity Analysis

1. Is the weaving section balanced (Y / N)? **N**
   [If optional exit lane, then "Y". Otherwise "N".]
2. In the Weaving Speed Chart to the left, which two speed curves is the black "x" between?
   50 MPH and **55 MPH**
   If below the 55 MPH curve, out of the realm of weaving.
   If left of the 30 MPH curve, LOS is F.
3. Interpolated Weaving Speed (S_w, mph) **61.3**
4. Weaving Intensity Factor (k) **1.00**
5. Service Volume (SV, pcph)
   $SV = (1/N)*[V + (k - 1)*\min(W_1, W_2)]$ **839**
6. Level of Service (LOS) **B**

The LOS in the chart above refers to the capacity of weaving traffic only; through and ramp to ramp traffic is not included.

* Note: **Do not adjust by a Peak Hour Factor (PHF).** The methodology incorporates the PHF in the Service Volume tables.

Sources: *Completion of Procedures for Analysis and Design of Traffic Weaving Sections*, Jack E. Leisch & Associates, September 1983 and *Highway Design Manual*, California Department of Transportation, July 24, 2009

Leisch Method for Weaving Analysis

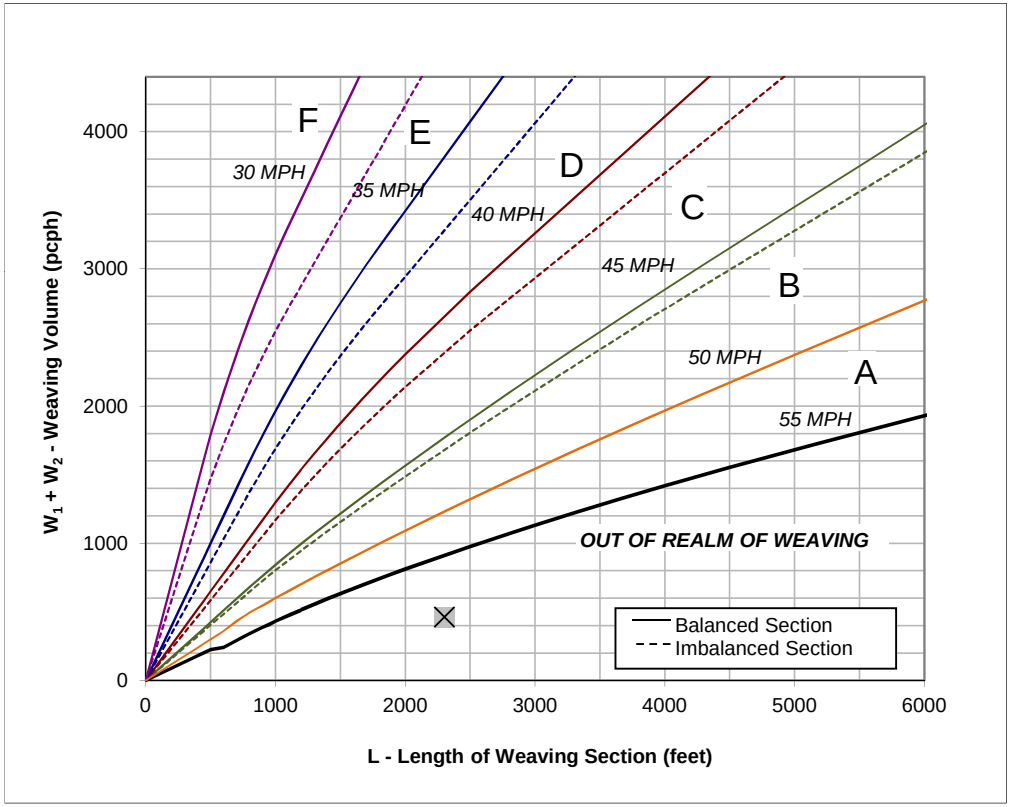
Data Input

Number of Entering Mainline Lanes	N_b	3
Number of Lanes in Weaving Section	N	4
Length of Weaving Section (feet)	L	2,300

Total Weaving Section (V)		On-ramp to Mainline (W_1)		Mainline to Off-ramp (W_2)	
Volume (vph)*	3,080	Volume (vph)*	290	Volume (vph)*	160
Truck Percentage	6%	Truck Percentage	6%	Truck Percentage	6%
PCE for Trucks	1.5	PCE for Trucks	1.5	PCE for Trucks	1.5
Volume (pcph)	3,172	Volume (pcph)	299	Volume (pcph)	165

Project Information

Project	LBNL
Scenario	Near-Term Plus Phase 1 PM
Freeway	WB I-580
On-ramp	Bayview Ave
Off-ramp	Regatta Blvd



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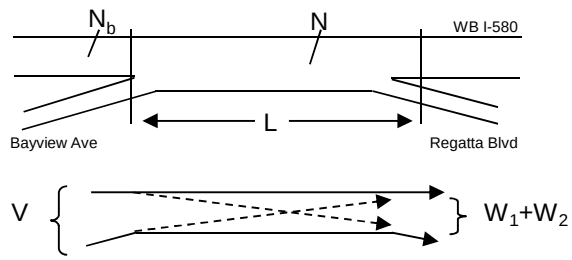


Capacity Analysis

1. Is the weaving section balanced (Y / N)? **N**
   [If optional exit lane, then "Y". Otherwise "N".]
2. In the Weaving Speed Chart to the left, which two speed curves is the black "x" between?
   50 MPH and **55 MPH**
   If below the 55 MPH curve, out of the realm of weaving.
   If left of the 30 MPH curve, LOS is F.
3. Interpolated Weaving Speed (S_w, mph) **62.1**
4. Weaving Intensity Factor (k) **1.00**
5. Service Volume (SV, pcph)
   $SV = (1/N)*[V + (k - 1)*\min(W_1, W_2)]$ **793**
6. Level of Service (LOS) **A**

The LOS in the chart above refers to the capacity of weaving traffic only; through and ramp to ramp traffic is not included.

* Note: **Do not adjust by a Peak Hour Factor (PHF).** The methodology incorporates the PHF in the Service Volume tables.

Sources: *Completion of Procedures for Analysis and Design of Traffic Weaving Sections*, Jack E. Leisch & Associates, September 1983 and *Highway Design Manual*, California Department of Transportation, July 24, 2009

Cumulative (2035) No Project Conditions

FEHR PEERS

HCM 2000
Basic Freeway Segments
Capacity Analysis

Jurisdiction
Analysis Year Cumulative
Analyst TL

Agency or Company
Date
Project Description

General Information				*Flow Rate Calculation*													*Speed Calculation*		*Results*	
	Freeway/ Direction	From/To	Analysis Time Period	Volume (vph)	PHF	Lanes	HOV Lane?	HOV Lane Volume	Terrain	Truck/ Bus %	RV %	E_T	E_R	f_{HV}	f_P	Flow Rate v_p (pcphpl)	Measured FFS (mph)	S (mph)	Density, D (pcplpm)	Level of Service
R-5	I-580 EB	I-580 between Bayview Avenue and Central Avenue	AM	4,260	0.92	3	No		Level	6%	0%	1.5	1.2	0.971	1.00	1,590	65.0	64.9	**24.5**	**C**
R-6	I-580 EB	I-580 between Central Avenue and I-80	AM	3,800	0.92	2	No		Level	6%	0%	1.5	1.2	0.971	1.00	2,127	65.0	58.9	**36.1**	**E**
R-7	I-80 EB	I-80 between Carlson Boulevard and Potrero Avenue	AM	5,080	0.92	4	Yes	350	Level	4%	0%	1.5	1.2	0.980	1.00	1,748	65.0	64.3	**27.2**	**D**
R-8	I-80 EB	I-80 @ Gilman Overpass	AM	6,980	0.92	5	Yes	900	Level	5%	0%	1.5	1.2	0.976	1.00	1,693	65.0	64.6	**26.2**	**D**
R-5	I-580 WB	I-580 between Bayview Avenue and Central Avenue	AM	4,480	0.92	3	No		Level	6%	0%	1.5	1.2	0.971	1.00	1,672	65.0	64.7	**25.9**	**C**
R-6	I-580 WB	I-580 between Central Avenue and I-80	AM	4,430	0.92	2	No		Level	6%	0%	1.5	1.2	0.971	1.00	2,480	65.0	-	**-**	**F**
R-7	I-80 WB	I-80 between Carlson Boulevard and Potrero Avenue	AM	7,030	0.92	4	Yes	1150	Level	4%	0%	1.5	1.2	0.980	1.00	2,173	65.0	57.8	**37.6**	**E**
R-8	I-80 WB	I-80 @ Gilman Overpass	AM	9,020	0.92	5	Yes	1500	Level	5%	0%	1.5	1.2	0.976	1.00	2,095	65.0	59.6	**35.1**	**E**
R-5	I-580 EB	I-580 between Bayview Avenue and Central Avenue	PM	4,470	0.92	3	No		Level	6%	0%	1.5	1.2	0.971	1.00	1,668	65.0	64.7	**25.8**	**C**
R-6	I-580 EB	I-580 between Central Avenue and I-80	PM	4,500	0.92	2	No		Level	6%	0%	1.5	1.2	0.971	1.00	2,519	65.0	-	**-**	**F**
R-7	I-80 EB	I-80 between Carlson Boulevard and Potrero Avenue	PM	6,690	0.92	4	Yes	1400	Level	4%	0%	1.5	1.2	0.980	1.00	1,955	65.0	62.2	**31.5**	**D**
R-8	I-80 EB	I-80 @ Gilman Overpass	PM	8,280	0.92	5	Yes	1150	Level	5%	0%	1.5	1.2	0.976	1.00	1,986	65.0	61.7	**32.2**	**D**
R-5	I-580 WB	I-580 between Bayview Avenue and Central Avenue	PM	4,090	0.92	3	No		Level	6%	0%	1.5	1.2	0.971	1.00	1,526	65.0	65.0	**23.5**	**C**
R-6	I-580 WB	I-580 between Central Avenue and I-80	PM	3,270	0.92	2	No		Level	6%	0%	1.5	1.2	0.971	1.00	1,830	65.0	63.6	**28.8**	**D**
R-7	I-80 WB	I-80 between Carlson Boulevard and Potrero Avenue	PM	5,360	0.92	4	Yes	400	Level	4%	0%	1.5	1.2	0.980	1.00	1,833	65.0	63.6	**28.8**	**D**
R-8	I-80 WB	I-80 @ Gilman Overpass	PM	7,190	0.92	5	Yes	700	Level	5%	0%	1.5	1.2	0.976	1.00	1,808	65.0	63.8	**28.3**	**D**

Leisch Method for Weaving Analysis

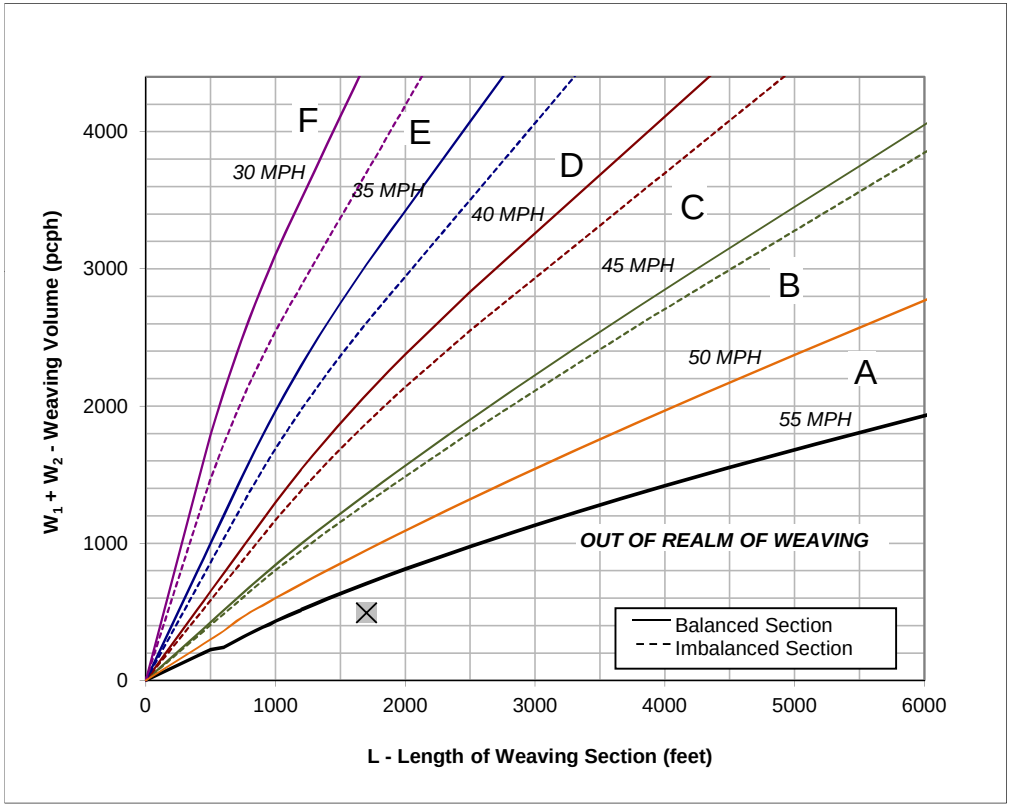
Data Input

Number of Entering Mainline Lanes	N_b	3
Number of Lanes in Weaving Section	N	4
Length of Weaving Section (feet)	L	1,700

Total Weaving Section (V)		On-ramp to Mainline (W_1)		Mainline to Off-ramp (W_2)	
Volume (vph)*	2,930	Volume (vph)*	320	Volume (vph)*	160
Truck Percentage	6%	Truck Percentage	6%	Truck Percentage	6%
PCE for Trucks	1.5	PCE for Trucks	1.5	PCE for Trucks	1.5
Volume (pcph)	3,018	Volume (pcph)	330	Volume (pcph)	165

Project Information

Project	LBNL
Scenario	Cumulative AM
Freeway	EB I-580
On-ramp	Harbour Way
Off-ramp	Marina Bay Pkwy



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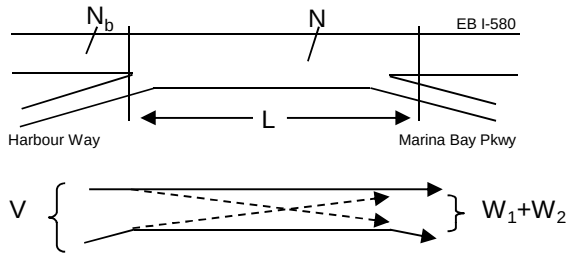


Capacity Analysis

1. Is the weaving section balanced (Y / N)? **N**
   [If optional exit lane, then "Y". Otherwise "N".]
2. In the Weaving Speed Chart to the left, which two speed curves is the black "x" between?
   50 MPH and **55 MPH**
   If below the 55 MPH curve, out of the realm of weaving.
   If left of the 30 MPH curve, LOS is F.
3. Interpolated Weaving Speed (S_w, mph) **59.4**
4. Weaving Intensity Factor (k) **1.00**
5. Service Volume (SV, pcph)
   $SV = (1/N)*[V + (k - 1)*\min(W_1, W_2)]$ **754**
6. Level of Service (LOS) **A**

The LOS in the chart above refers to the capacity of weaving traffic only; through and ramp to ramp traffic is not included.

* Note: **Do not adjust by a Peak Hour Factor (PHF).** The methodology incorporates the PHF in the Service Volume tables.

Sources: *Completion of Procedures for Analysis and Design of Traffic Weaving Sections*, Jack E. Leisch & Associates, September 1983 and *Highway Design Manual*, California Department of Transportation, July 24, 2009

Leisch Method for Weaving Analysis

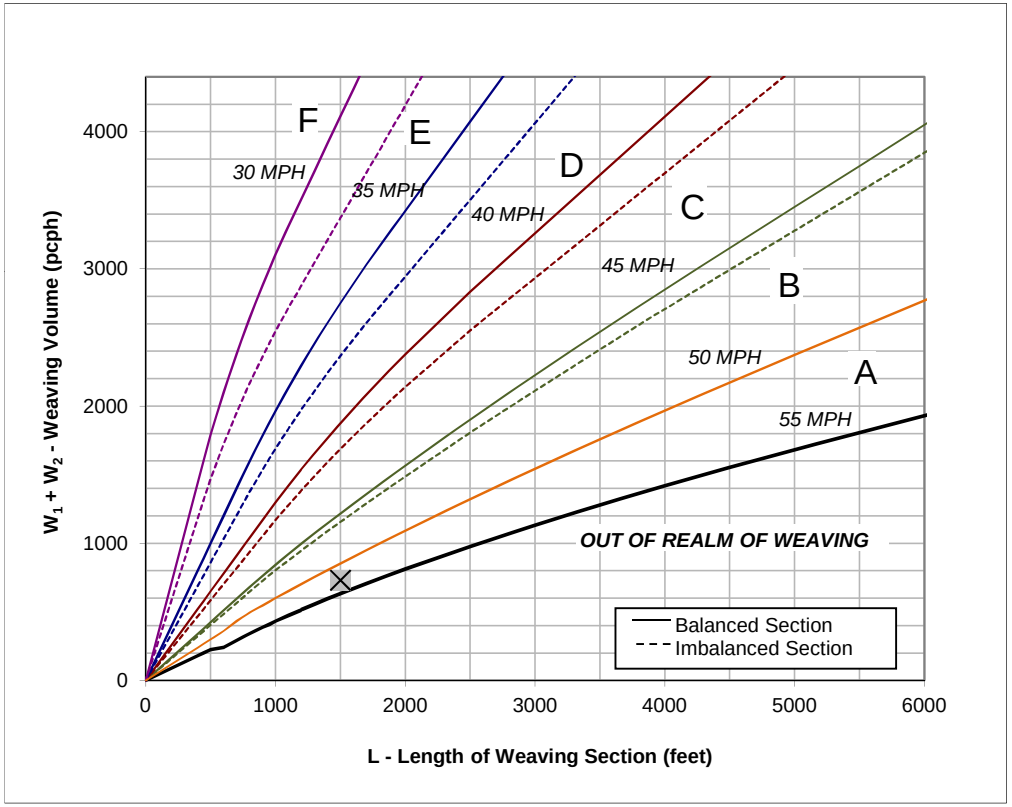
Data Input

Number of Entering Mainline Lanes	N_b	3
Number of Lanes in Weaving Section	N	4
Length of Weaving Section (feet)	L	1,500

Total Weaving Section (V)		On-ramp to Mainline (W_1)		Mainline to Off-ramp (W_2)	
Volume (vph)*	4,350	Volume (vph)*	320	Volume (vph)*	390
Truck Percentage	6%	Truck Percentage	6%	Truck Percentage	6%
PCE for Trucks	1.5	PCE for Trucks	1.5	PCE for Trucks	1.5
Volume (pcph)	4,481	Volume (pcph)	330	Volume (pcph)	402

Project Information

Project	LBNL
Scenario	Cumulative AM
Freeway	WB I-580
On-ramp	Marina Bay Parkway
Off-ramp	Harbour Way



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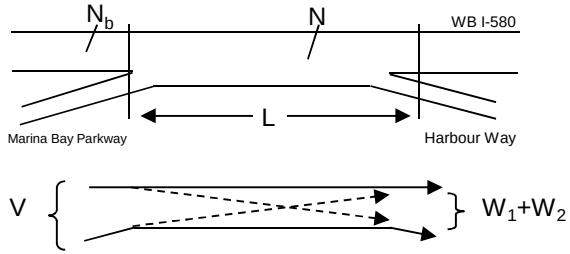


Capacity Analysis

1. Is the weaving section balanced (Y / N)? **N**
   [If optional exit lane, then "Y". Otherwise "N".]
2. In the Weaving Speed Chart to the left, which two speed curves is the black "x" between?
   50 MPH and **55 MPH**
   If below the 55 MPH curve, out of the realm of weaving.
   If left of the 30 MPH curve, LOS is F.
3. Interpolated Weaving Speed (S_w, mph) **52.8**
4. Weaving Intensity Factor (k) **1.00**
5. Service Volume (SV, pcph)
   $SV = (1/N)*[V + (k - 1)*\min(W_1, W_2)]$ **1,120**
6. Level of Service (LOS) **C**

The LOS in the chart above refers to the capacity of weaving traffic only; through and ramp to ramp traffic is not included.

* Note: **Do not adjust by a Peak Hour Factor (PHF).** The methodology incorporates the PHF in the Service Volume tables.

Sources: *Completion of Procedures for Analysis and Design of Traffic Weaving Sections*, Jack E. Leisch & Associates, September 1983 and *Highway Design Manual*, California Department of Transportation, July 24, 2009

Leisch Method for Weaving Analysis

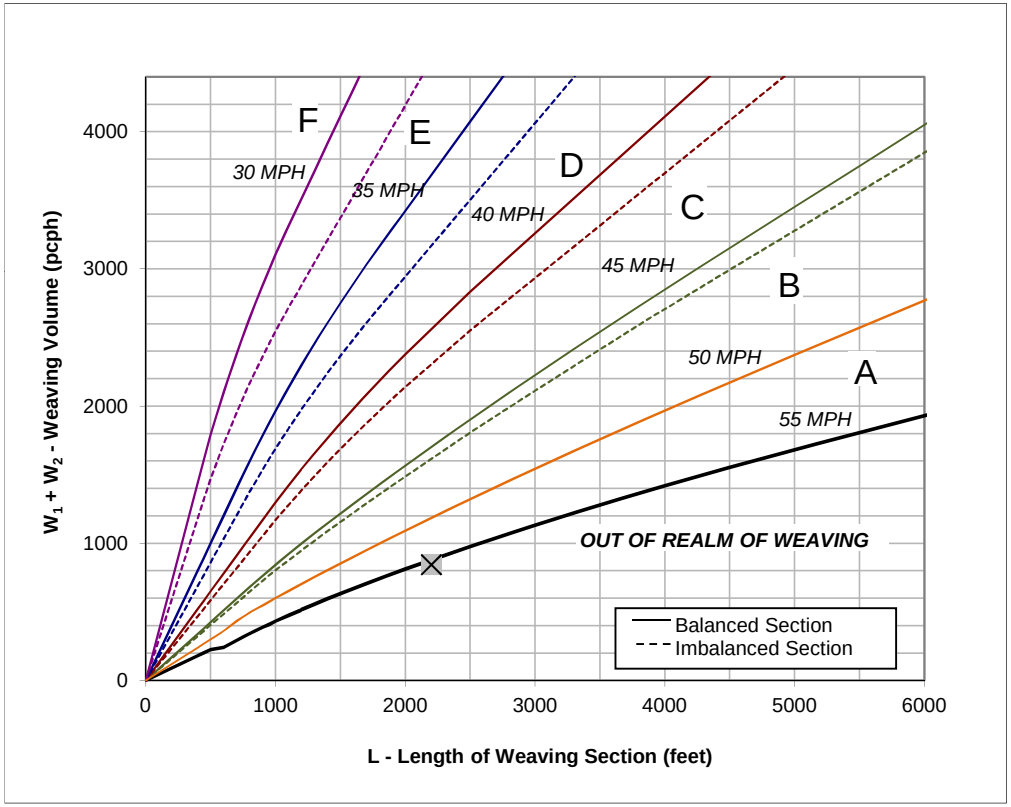
Data Input

Number of Entering Mainline Lanes	N_b	3
Number of Lanes in Weaving Section	N	4
Length of Weaving Section (feet)	L	2,200

Total Weaving Section (V)		On-ramp to Mainline (W_1)		Mainline to Off-ramp (W_2)	
Volume (vph)*	3,840	Volume (vph)*	740	Volume (vph)*	80
Truck Percentage	6%	Truck Percentage	6%	Truck Percentage	6%
PCE for Trucks	1.5	PCE for Trucks	1.5	PCE for Trucks	1.5
Volume (pcph)	3,955	Volume (pcph)	762	Volume (pcph)	82

Project Information

Project	LBNL
Scenario	Cumulative AM
Freeway	EB I-580
On-ramp	Marina Bay Parkway
Off-ramp	Regatta Blvd



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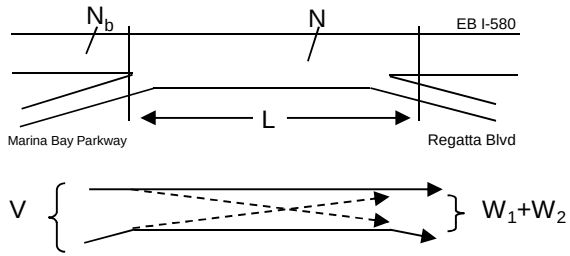


Capacity Analysis

1. Is the weaving section balanced (Y / N)? **N**
   [If optional exit lane, then "Y". Otherwise "N".]
2. In the Weaving Speed Chart to the left, which two speed curves is the black "x" between?
   50 MPH and **55 MPH**
   If below the 55 MPH curve, out of the realm of weaving.
   If left of the 30 MPH curve, LOS is F.
3. Interpolated Weaving Speed (S_w, mph) **55.6**
4. Weaving Intensity Factor (k) **1.00**
5. Service Volume (SV, pcph)
   $SV = (1/N)*[V + (k - 1)*\min(W_1, W_2)]$ **989**
6. Level of Service (LOS) **B**

The LOS in the chart above refers to the capacity of weaving traffic only; through and ramp to ramp traffic is not included.

* Note: **Do not adjust by a Peak Hour Factor (PHF).** The methodology incorporates the PHF in the Service Volume tables.

Sources: *Completion of Procedures for Analysis and Design of Traffic Weaving Sections*, Jack E. Leisch & Associates, September 1983 and *Highway Design Manual*, California Department of Transportation, July 24, 2009

Leisch Method for Weaving Analysis

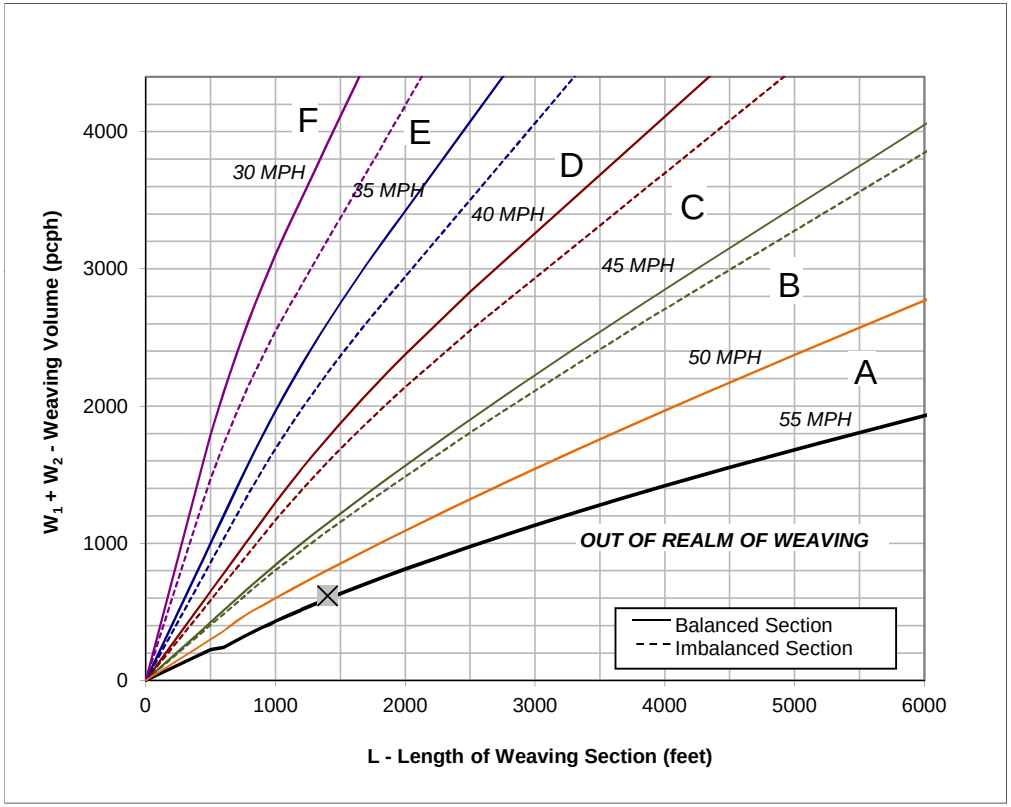
Data Input

Number of Entering Mainline Lanes	N_b	3
Number of Lanes in Weaving Section	N	4
Length of Weaving Section (feet)	L	1,400

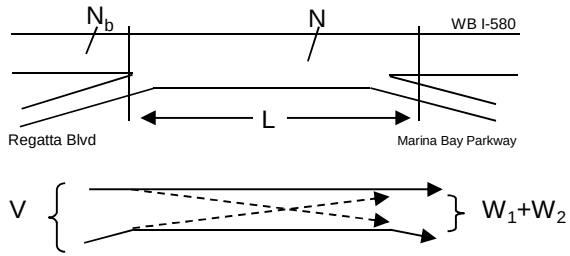
Total Weaving Section (V)		On-ramp to Mainline (W_1)		Mainline to Off-ramp (W_2)	
Volume (vph)*	4,920	Volume (vph)*	130	Volume (vph)*	470
Truck Percentage	6%	Truck Percentage	6%	Truck Percentage	6%
PCE for Trucks	1.5	PCE for Trucks	1.5	PCE for Trucks	1.5
Volume (pcph)	5,068	Volume (pcph)	134	Volume (pcph)	484

Project Information

Project	LBNL
Scenario	Cumulative AM
Freeway	WB I-580
On-ramp	Regatta Blvd
Off-ramp	Marina Bay Parkway



Figure



Capacity Analysis

1. Is the weaving section balanced (Y / N)? **N**
   [If optional exit lane, then "Y". Otherwise "N".]
2. In the Weaving Speed Chart to the left, which two speed curves is the black "x" between?
   50 MPH and **55 MPH**
   If below the 55 MPH curve, out of the realm of weaving.
   If left of the 30 MPH curve, LOS is F.
3. Interpolated Weaving Speed (S_w, mph) **54.4**
4. Weaving Intensity Factor (k) **1.00**
5. Service Volume (SV, pcph)
   $SV = (1/N)*[V + (k - 1)*\min(W_1, W_2)]$ **1,267**
6. Level of Service (LOS) **C**

The LOS in the chart above refers to the capacity of weaving traffic only; through and ramp to ramp traffic is not included.

* Note: **Do not adjust by a Peak Hour Factor (PHF).** The methodology incorporates the PHF in the Service Volume tables.

Sources: *Completion of Procedures for Analysis and Design of Traffic Weaving Sections*, Jack E. Leisch & Associates, September 1983 and *Highway Design Manual*, California Department of Transportation, July 24, 2009

Leisch Method for Weaving Analysis

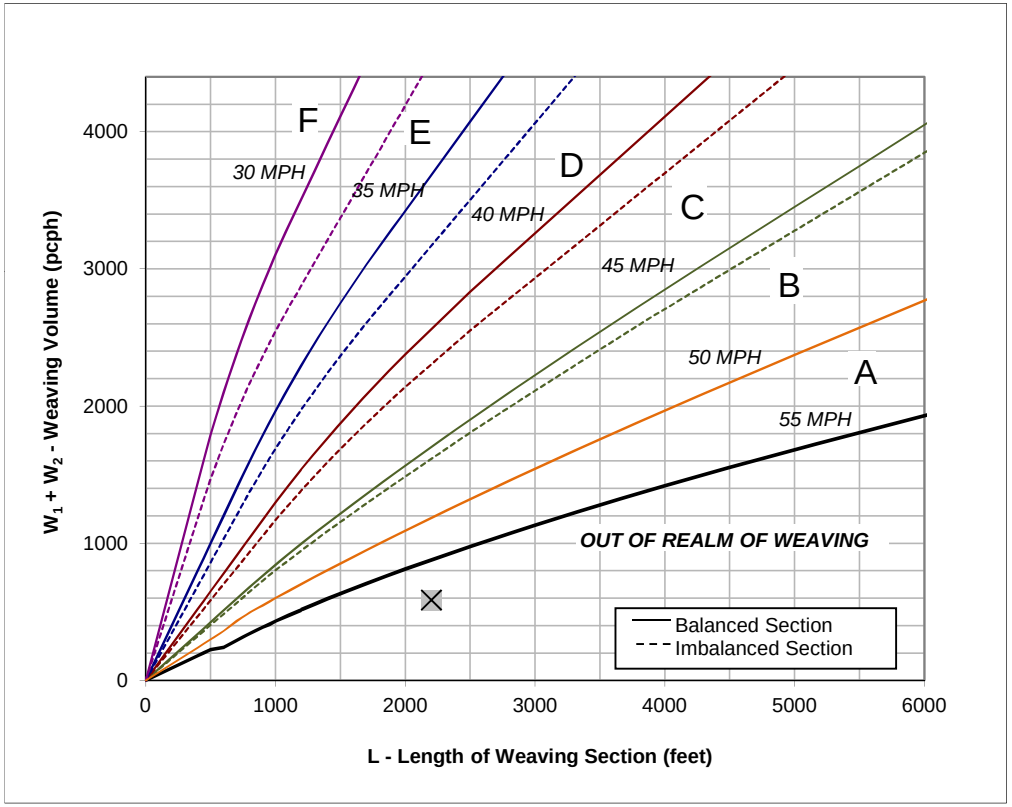
Data Input

Number of Entering Mainline Lanes	N_b	3
Number of Lanes in Weaving Section	N	4
Length of Weaving Section (feet)	L	2,200

Total Weaving Section (V)		On-ramp to Mainline (W_1)		Mainline to Off-ramp (W_2)	
Volume (vph)*	4,390	Volume (vph)*	140	Volume (vph)*	430
Truck Percentage	6%	Truck Percentage	6%	Truck Percentage	6%
PCE for Trucks	1.5	PCE for Trucks	1.5	PCE for Trucks	1.5
Volume (pcph)	4,522	Volume (pcph)	144	Volume (pcph)	443

Project Information

Project	LBNL
Scenario	Cumulative AM
Freeway	EB I-580
On-ramp	Regatta Blvd
Off-ramp	Bayview Ave



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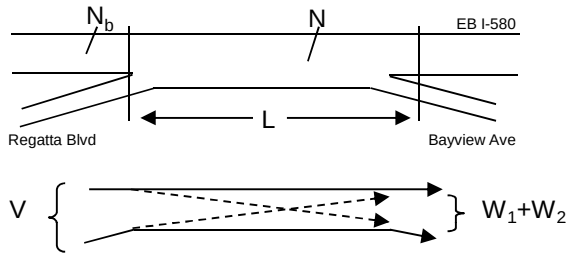


Capacity Analysis

1. Is the weaving section balanced (Y / N)? **N**
   [If optional exit lane, then "Y". Otherwise "N".]
2. In the Weaving Speed Chart to the left, which two speed curves is the black "x" between?
   50 MPH and **55 MPH**
   If below the 55 MPH curve, out of the realm of weaving.
   If left of the 30 MPH curve, LOS is F.
3. Interpolated Weaving Speed (S_w, mph) **59.8**
4. Weaving Intensity Factor (k) **1.00**
5. Service Volume (SV, pcph)
   $SV = (1/N)*[V + (k - 1)*\min(W_1, W_2)]$ **1,130**
6. Level of Service (LOS) **C**

The LOS in the chart above refers to the capacity of weaving traffic only; through and ramp to ramp traffic is not included.

* Note: **Do not adjust by a Peak Hour Factor (PHF).** The methodology incorporates the PHF in the Service Volume tables.

Sources: *Completion of Procedures for Analysis and Design of Traffic Weaving Sections*, Jack E. Leisch & Associates, September 1983 and *Highway Design Manual*, California Department of Transportation, July 24, 2009

Leisch Method for Weaving Analysis

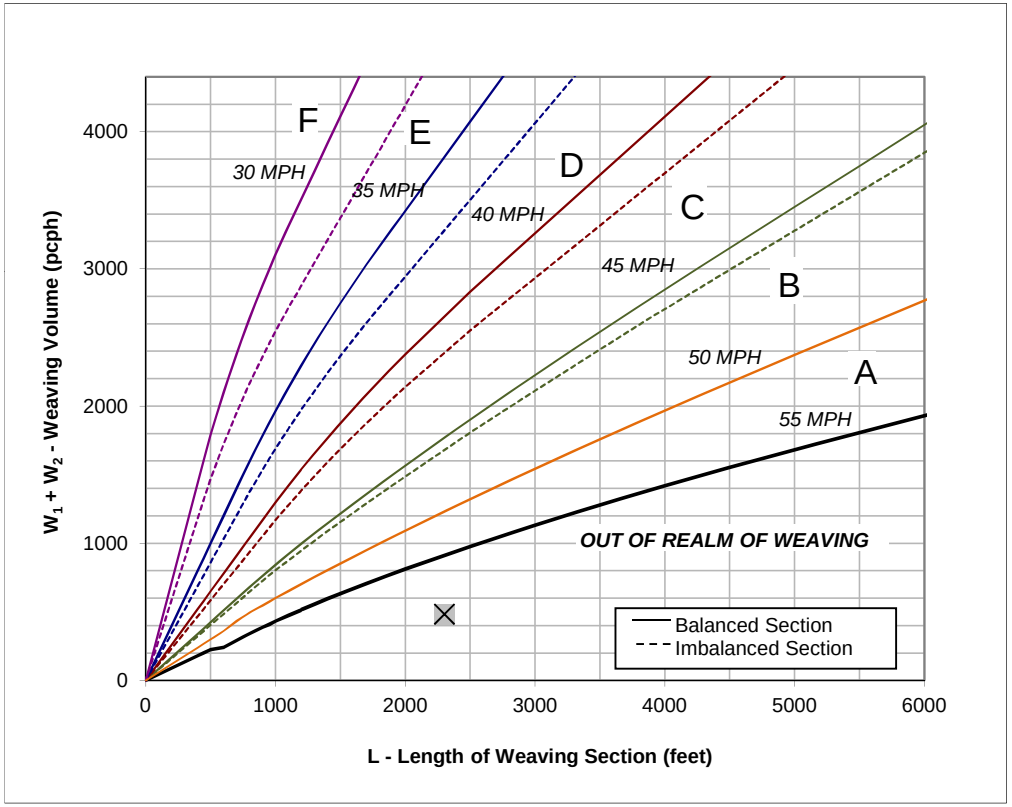
Data Input

Number of Entering Mainline Lanes	N_b	3
Number of Lanes in Weaving Section	N	4
Length of Weaving Section (feet)	L	2,300

Total Weaving Section (V)		On-ramp to Mainline (W_1)		Mainline to Off-ramp (W_2)	
Volume (vph)*	4,890	Volume (vph)*	380	Volume (vph)*	90
Truck Percentage	6%	Truck Percentage	6%	Truck Percentage	6%
PCE for Trucks	1.5	PCE for Trucks	1.5	PCE for Trucks	1.5
Volume (pcph)	5,037	Volume (pcph)	391	Volume (pcph)	93

Project Information

Project	LBNL
Scenario	Cumulative AM
Freeway	WB I-580
On-ramp	Bayview Ave
Off-ramp	Regatta Blvd



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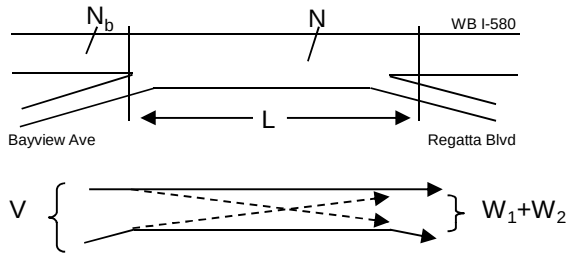


Capacity Analysis

1. Is the weaving section balanced (Y / N)? **N**
   [If optional exit lane, then "Y". Otherwise "N".]
2. In the Weaving Speed Chart to the left, which two speed curves is the black "x" between?
   50 MPH and **55 MPH**
   If below the 55 MPH curve, out of the realm of weaving.
   If left of the 30 MPH curve, LOS is F.
3. Interpolated Weaving Speed (S_w, mph) **61.7**
4. Weaving Intensity Factor (k) **1.00**
5. Service Volume (SV, pcph)
   $SV = (1/N)*[V + (k - 1)*\min(W_1, W_2)]$ **1,259**
6. Level of Service (LOS) **C**

The LOS in the chart above refers to the capacity of weaving traffic only; through and ramp to ramp traffic is not included.

* Note: **Do not adjust by a Peak Hour Factor (PHF).** The methodology incorporates the PHF in the Service Volume tables.

Sources: *Completion of Procedures for Analysis and Design of Traffic Weaving Sections*, Jack E. Leisch & Associates, September 1983 and *Highway Design Manual*, California Department of Transportation, July 24, 2009

Leisch Method for Weaving Analysis

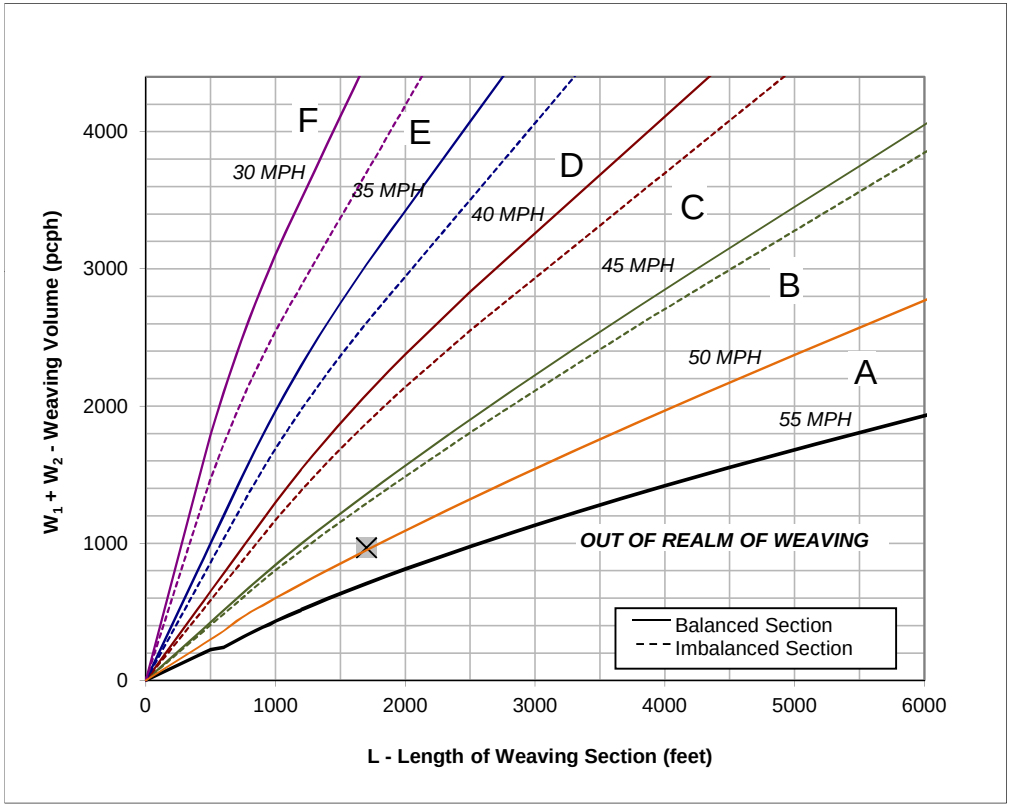
Data Input

Number of Entering Mainline Lanes	N_b	3
Number of Lanes in Weaving Section	N	4
Length of Weaving Section (feet)	L	1,700

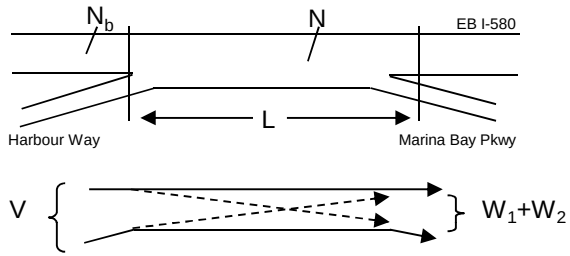
Total Weaving Section (V)		On-ramp to Mainline (W_1)		Mainline to Off-ramp (W_2)	
Volume (vph)*	4,710	Volume (vph)*	600	Volume (vph)*	340
Truck Percentage	6%	Truck Percentage	6%	Truck Percentage	6%
PCE for Trucks	1.5	PCE for Trucks	1.5	PCE for Trucks	1.5
Volume (pcph)	4,851	Volume (pcph)	618	Volume (pcph)	350

Project Information

Project	LBNL
Scenario	Cumulative PM
Freeway	EB I-580
On-ramp	Harbour Way
Off-ramp	Marina Bay Pkwy



Figure



Capacity Analysis

1. Is the weaving section balanced (Y / N)? **N**
   [If optional exit lane, then "Y". Otherwise "N".]
2. In the Weaving Speed Chart to the left, which two speed curves is the black "x" between?
   50 MPH and **55 MPH**
   If below the 55 MPH curve, out of the realm of weaving.
   If left of the 30 MPH curve, LOS is F.
3. Interpolated Weaving Speed (S_w, mph) **49.6**
4. Weaving Intensity Factor (k) **1.25**
5. Service Volume (SV, pcph)
   $SV = (1/N)*[V + (k - 1)*\min(W_1, W_2)]$ **1,235**
6. Level of Service (LOS) **C**

The LOS in the chart above refers to the capacity of weaving traffic only; through and ramp to ramp traffic is not included.

* Note: **Do not adjust by a Peak Hour Factor (PHF).** The methodology incorporates the PHF in the Service Volume tables.

Sources: *Completion of Procedures for Analysis and Design of Traffic Weaving Sections*, Jack E. Leisch & Associates, September 1983 and *Highway Design Manual*, California Department of Transportation, July 24, 2009

Leisch Method for Weaving Analysis

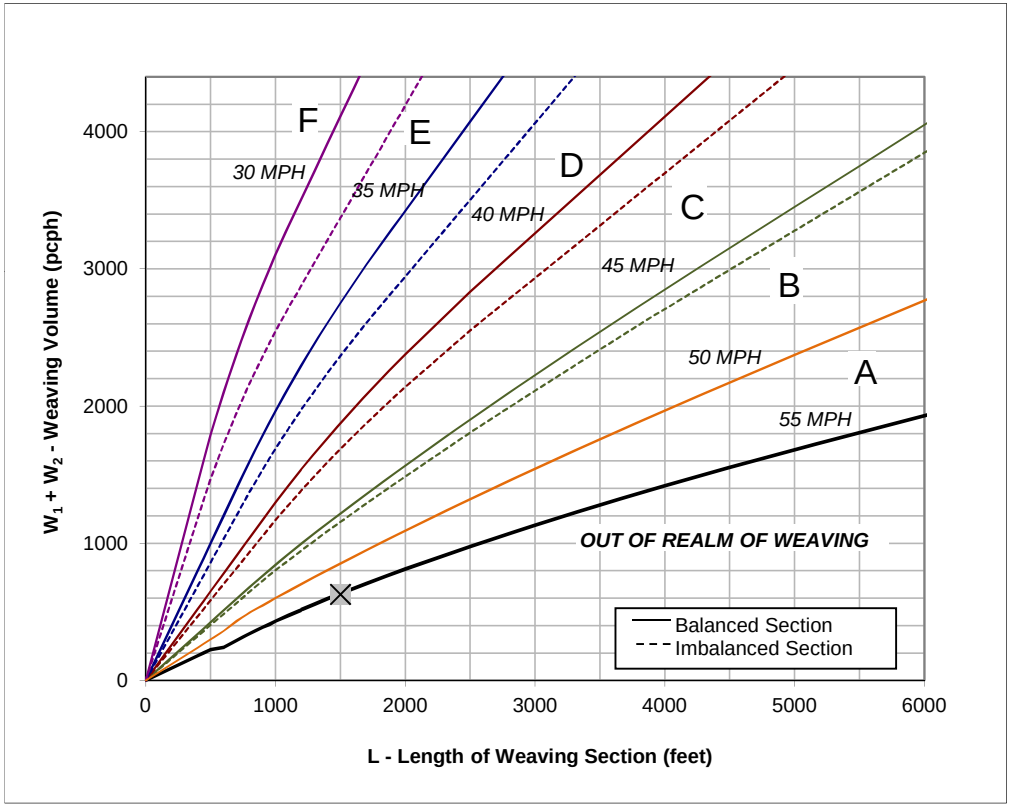
Data Input

Number of Entering Mainline Lanes	N_b	3
Number of Lanes in Weaving Section	N	4
Length of Weaving Section (feet)	L	1,500

Total Weaving Section (V)		On-ramp to Mainline (W_1)		Mainline to Off-ramp (W_2)	
Volume (vph)*	2,710	Volume (vph)*	220	Volume (vph)*	390
Truck Percentage	6%	Truck Percentage	6%	Truck Percentage	6%
PCE for Trucks	1.5	PCE for Trucks	1.5	PCE for Trucks	1.5
Volume (pcph)	2,791	Volume (pcph)	227	Volume (pcph)	402

Project Information

Project	LBNL
Scenario	Cumulative PM
Freeway	WB I-580
On-ramp	Marina Bay Parkway
Off-ramp	Harbour Way



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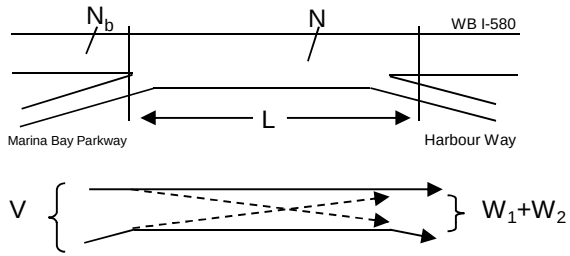


Capacity Analysis

1. Is the weaving section balanced (Y / N)? **N**
   [If optional exit lane, then "Y". Otherwise "N".]
2. In the Weaving Speed Chart to the left, which two speed curves is the black "x" between?
   50 MPH and **55 MPH**
   If below the 55 MPH curve, out of the realm of weaving.
   If left of the 30 MPH curve, LOS is F.
3. Interpolated Weaving Speed (S_w, mph) **55.1**
4. Weaving Intensity Factor (k) **1.00**
5. Service Volume (SV, pcph)
   $SV = (1/N)*[V + (k - 1)*\min(W_1, W_2)]$ **698**
6. Level of Service (LOS) **A**

The LOS in the chart above refers to the capacity of weaving traffic only; through and ramp to ramp traffic is not included.

* Note: **Do not adjust by a Peak Hour Factor (PHF).** The methodology incorporates the PHF in the Service Volume tables.

Sources: *Completion of Procedures for Analysis and Design of Traffic Weaving Sections*, Jack E. Leisch & Associates, September 1983 and *Highway Design Manual*, California Department of Transportation, July 24, 2009

Leisch Method for Weaving Analysis

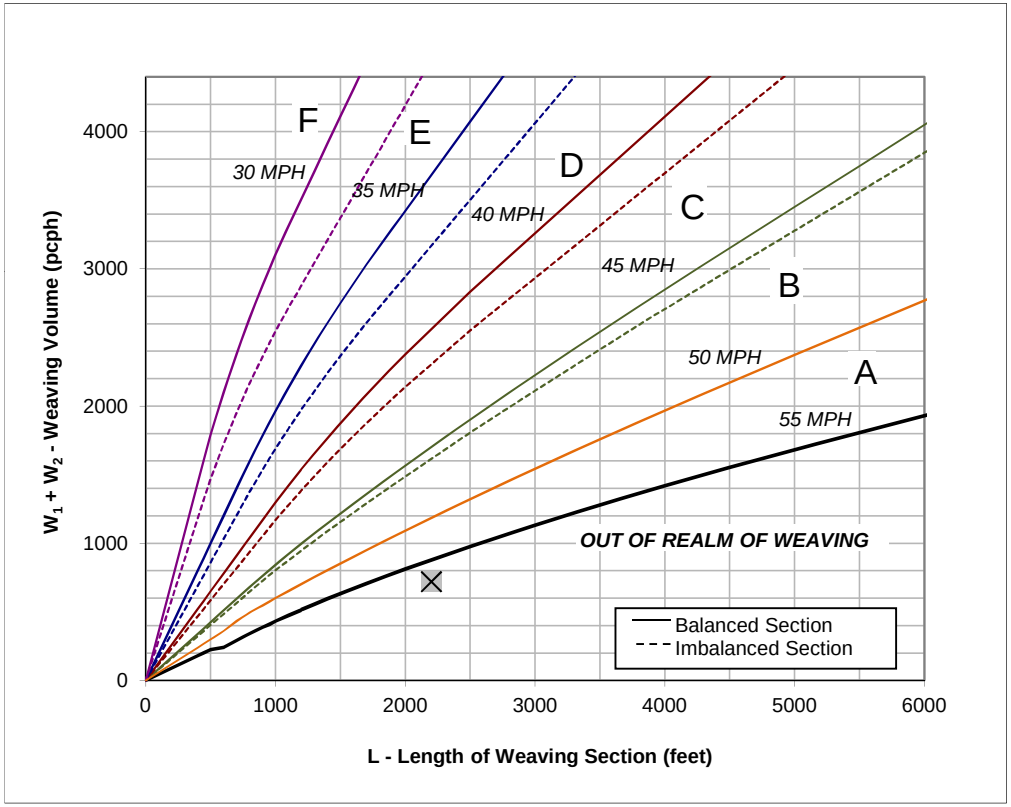
Data Input

Number of Entering Mainline Lanes	N_b	3
Number of Lanes in Weaving Section	N	4
Length of Weaving Section (feet)	L	2,200

Total Weaving Section (V)		On-ramp to Mainline (W_1)		Mainline to Off-ramp (W_2)	
Volume (vph)*	4,600	Volume (vph)*	580	Volume (vph)*	120
Truck Percentage	6%	Truck Percentage	6%	Truck Percentage	6%
PCE for Trucks	1.5	PCE for Trucks	1.5	PCE for Trucks	1.5
Volume (pcph)	4,738	Volume (pcph)	597	Volume (pcph)	124

Project Information

Project	LBNL
Scenario	Cumulative PM
Freeway	EB I-580
On-ramp	Marina Bay Parkway
Off-ramp	Regatta Blvd



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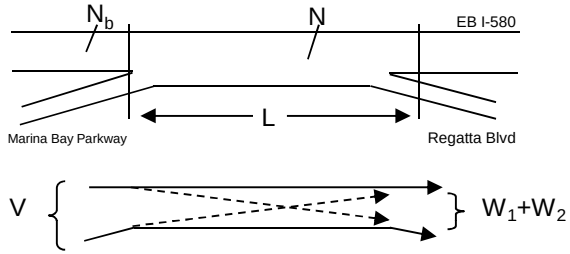


Capacity Analysis

1. Is the weaving section balanced (Y / N)? **N**
   [If optional exit lane, then "Y". Otherwise "N".]
2. In the Weaving Speed Chart to the left, which two speed curves is the black "x" between?
   50 MPH and **55 MPH**
   If below the 55 MPH curve, out of the realm of weaving.
   If left of the 30 MPH curve, LOS is F.
3. Interpolated Weaving Speed (S_w, mph) **57.6**
4. Weaving Intensity Factor (k) **1.00**
5. Service Volume (SV, pcph)
   $SV = (1/N)*[V + (k - 1)*\min(W_1, W_2)]$ **1,185**
6. Level of Service (LOS) **C**

The LOS in the chart above refers to the capacity of weaving traffic only; through and ramp to ramp traffic is not included.

* Note: **Do not adjust by a Peak Hour Factor (PHF).** The methodology incorporates the PHF in the Service Volume tables.

Sources: *Completion of Procedures for Analysis and Design of Traffic Weaving Sections*, Jack E. Leisch & Associates, September 1983 and *Highway Design Manual*, California Department of Transportation, July 24, 2009

Leisch Method for Weaving Analysis

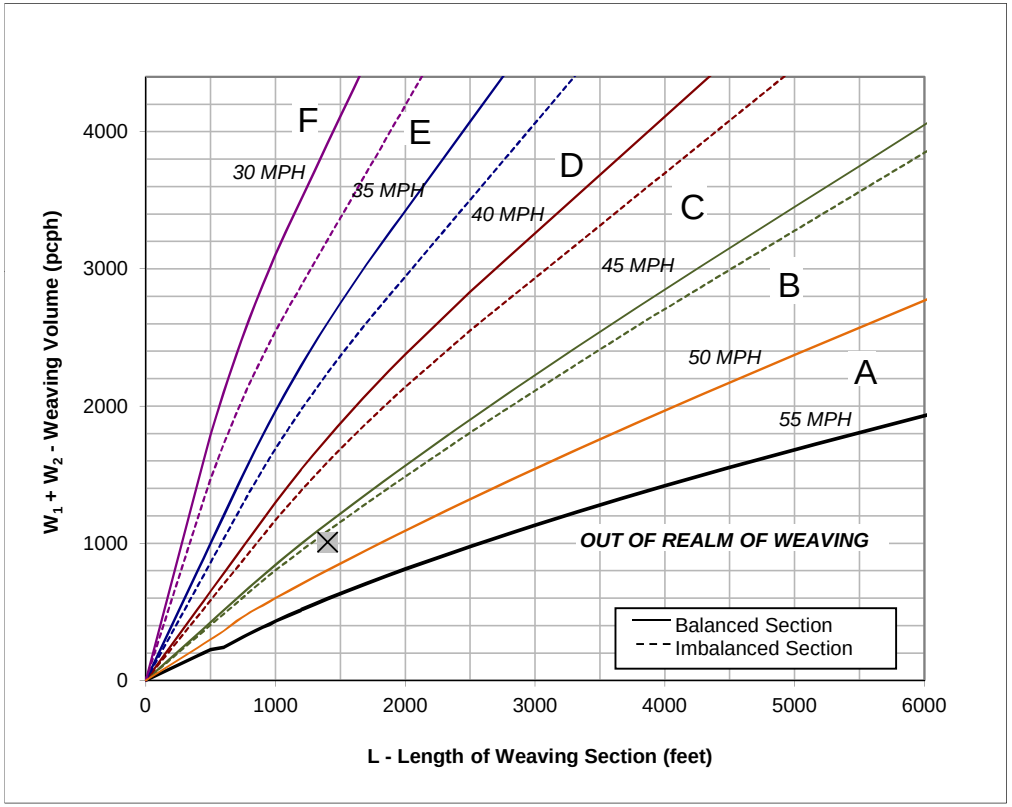
Data Input

Number of Entering Mainline Lanes	N_b	3
Number of Lanes in Weaving Section	N	4
Length of Weaving Section (feet)	L	1,400

Total Weaving Section (V)		On-ramp to Mainline (W_1)		Mainline to Off-ramp (W_2)	
Volume (vph)*	3,360	Volume (vph)*	60	Volume (vph)*	920
Truck Percentage	6%	Truck Percentage	6%	Truck Percentage	6%
PCE for Trucks	1.5	PCE for Trucks	1.5	PCE for Trucks	1.5
Volume (pcph)	3,461	Volume (pcph)	62	Volume (pcph)	948

Project Information

Project	LBNL
Scenario	Cumulative PM
Freeway	WB I-580
On-ramp	Regatta Blvd
Off-ramp	Marina Bay Parkway



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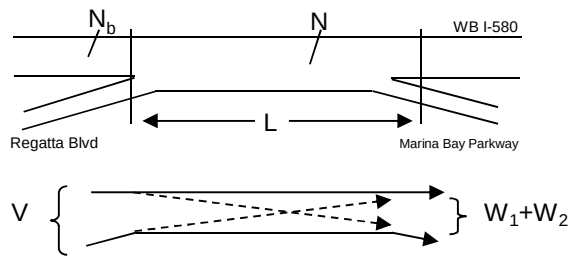


Capacity Analysis

1. Is the weaving section balanced (Y / N)? **N**
   [If optional exit lane, then "Y". Otherwise "N".]
2. In the Weaving Speed Chart to the left, which two speed curves is the black "x" between?
   45 MPH and **50 MPH**
   If below the 55 MPH curve, out of the realm of weaving.
   If left of the 30 MPH curve, LOS is F.
3. Interpolated Weaving Speed (S_w, mph) **46.4**
4. Weaving Intensity Factor (k) **2.30**
5. Service Volume (SV, pcph)
   $SV = (1/N)*[V + (k - 1)*\min(W_1, W_2)]$ **885**
6. Level of Service (LOS) **B**

The LOS in the chart above refers to the capacity of weaving traffic only; through and ramp to ramp traffic is not included.

* Note: **Do not adjust by a Peak Hour Factor (PHF).** The methodology incorporates the PHF in the Service Volume tables.

Sources: *Completion of Procedures for Analysis and Design of Traffic Weaving Sections*, Jack E. Leisch & Associates, September 1983 and *Highway Design Manual*, California Department of Transportation, July 24, 2009

Leisch Method for Weaving Analysis

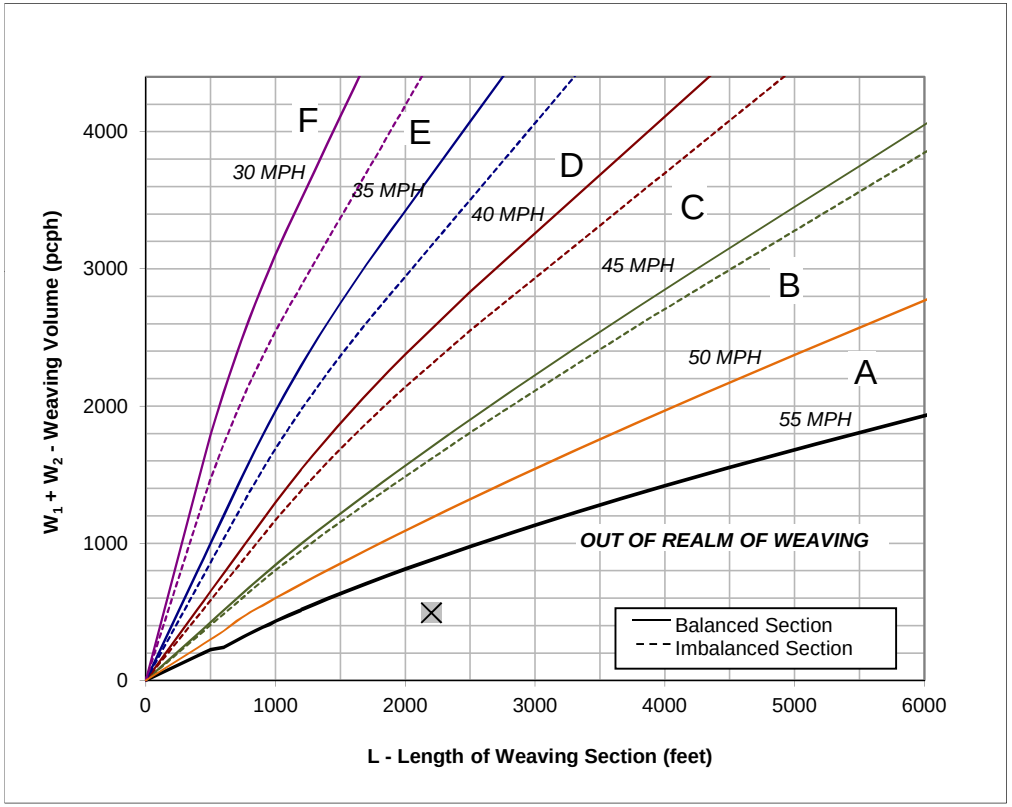
Data Input

Number of Entering Mainline Lanes	N_b	3
Number of Lanes in Weaving Section	N	4
Length of Weaving Section (feet)	L	2,200

Total Weaving Section (V)		On-ramp to Mainline (W_1)		Mainline to Off-ramp (W_2)	
Volume (vph)*	4,760	Volume (vph)*	400	Volume (vph)*	80
Truck Percentage	6%	Truck Percentage	6%	Truck Percentage	6%
PCE for Trucks	1.5	PCE for Trucks	1.5	PCE for Trucks	1.5
Volume (pcph)	4,903	Volume (pcph)	412	Volume (pcph)	82

Project Information

Project	LBNL
Scenario	Cumulative PM
Freeway	EB I-580
On-ramp	Regatta Blvd
Off-ramp	Bayview Ave



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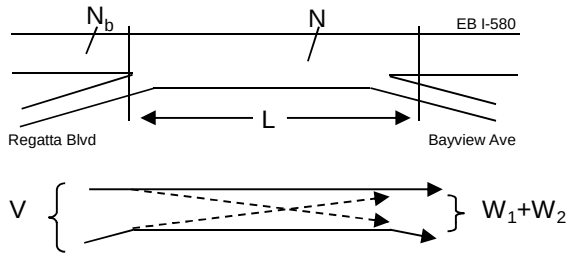


Capacity Analysis

1. Is the weaving section balanced (Y / N)? **N**
   [If optional exit lane, then "Y". Otherwise "N".]
2. In the Weaving Speed Chart to the left, which two speed curves is the black "x" between?
   50 MPH and **55 MPH**
   If below the 55 MPH curve, out of the realm of weaving.
   If left of the 30 MPH curve, LOS is F.
3. Interpolated Weaving Speed (S_w, mph) **61.3**
4. Weaving Intensity Factor (k) **1.00**
5. Service Volume (SV, pcph)
   $SV = (1/N)*[V + (k - 1)*\min(W_1, W_2)]$ **1,226**
6. Level of Service (LOS) **C**

The LOS in the chart above refers to the capacity of weaving traffic only; through and ramp to ramp traffic is not included.

* Note: **Do not adjust by a Peak Hour Factor (PHF).** The methodology incorporates the PHF in the Service Volume tables.

Sources: *Completion of Procedures for Analysis and Design of Traffic Weaving Sections*, Jack E. Leisch & Associates, September 1983 and *Highway Design Manual*, California Department of Transportation, July 24, 2009

Leisch Method for Weaving Analysis

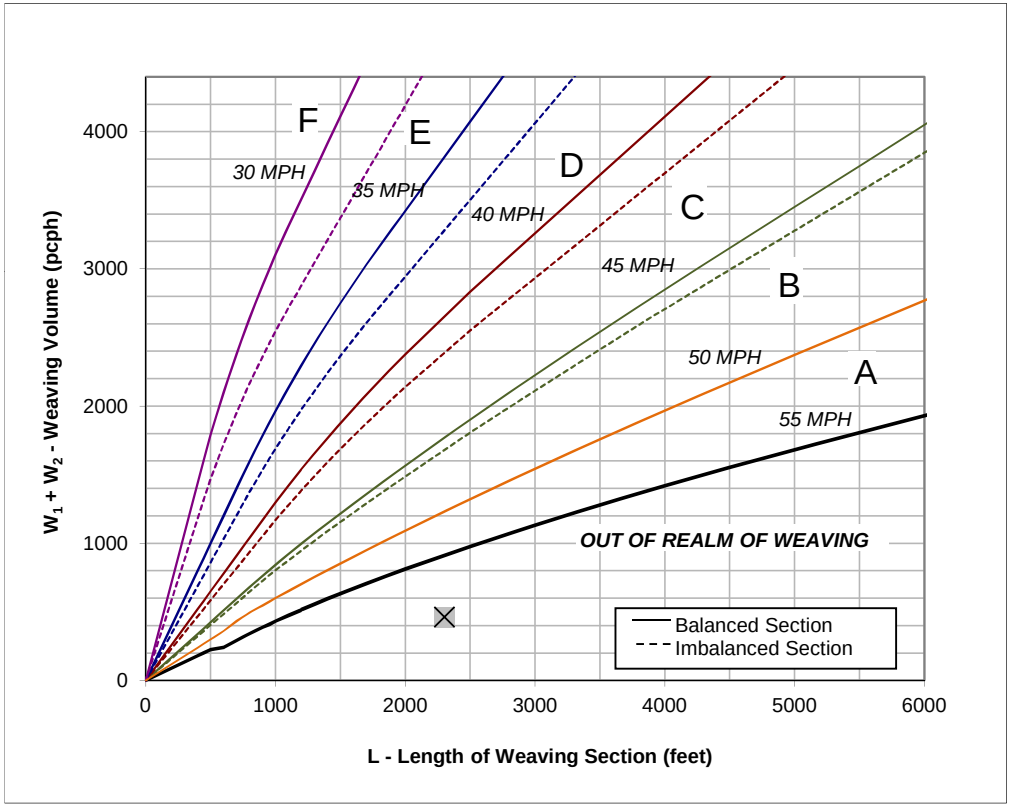
Data Input

Number of Entering Mainline Lanes	N_b	3
Number of Lanes in Weaving Section	N	4
Length of Weaving Section (feet)	L	2,300

Total Weaving Section (V)		On-ramp to Mainline (W_1)		Mainline to Off-ramp (W_2)	
Volume (vph)*	3,900	Volume (vph)*	290	Volume (vph)*	160
Truck Percentage	6%	Truck Percentage	6%	Truck Percentage	6%
PCE for Trucks	1.5	PCE for Trucks	1.5	PCE for Trucks	1.5
Volume (pcph)	4,017	Volume (pcph)	299	Volume (pcph)	165

Project Information

Project	LBNL
Scenario	Cumulative PM
Freeway	WB I-580
On-ramp	Bayview Ave
Off-ramp	Regatta Blvd



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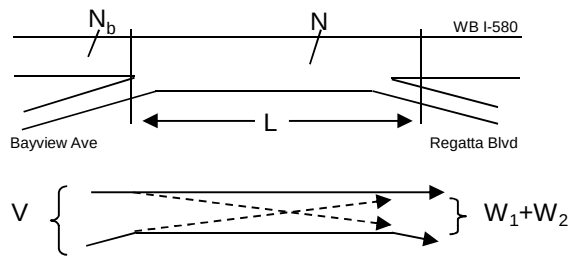


Capacity Analysis

1. Is the weaving section balanced (Y / N)? **N**
   [If optional exit lane, then "Y". Otherwise "N".]
2. In the Weaving Speed Chart to the left, which two speed curves is the black "x" between?
   50 MPH and **55 MPH**
   If below the 55 MPH curve, out of the realm of weaving.
   If left of the 30 MPH curve, LOS is F.
3. Interpolated Weaving Speed (S_w, mph) **62.1**
4. Weaving Intensity Factor (k) **1.00**
5. Service Volume (SV, pcph)
   $SV = (1/N)*[V + (k - 1)*\min(W_1, W_2)]$ **1,004**
6. Level of Service (LOS) **B**

The LOS in the chart above refers to the capacity of weaving traffic only; through and ramp to ramp traffic is not included.

* Note: **Do not adjust by a Peak Hour Factor (PHF).** The methodology incorporates the PHF in the Service Volume tables.

Sources: *Completion of Procedures for Analysis and Design of Traffic Weaving Sections*, Jack E. Leisch & Associates, September 1983 and *Highway Design Manual*, California Department of Transportation, July 24, 2009

Cumulative (2035) Plus Project Buildout Conditions

FEHR PEERS

HCM 2000
Basic Freeway Segments
Capacity Analysis

Jurisdiction
Analysis Year Cumulative
Analyst TL

Agency or Company
Date
Project Description

General Information				*Flow Rate Calculation*													*Speed Calculation*		*Results*	
	Freeway/ Direction	From/To	Analysis Time Period	Volume (vph)	PHF	Lanes	HOV Lane?	HOV Lane Volume	Terrain	Truck/ Bus %	RV %	E_T	E_R	f_{HV}	f_P	Flow Rate v_p (pcphpl)	Measured FFS (mph)	S (mph)	Density, D (pcplpm)	Level of Service
R-5	I-580 EB	I-580 between Bayview Avenue and Central Avenue	AM	4,359	0.92	3	No		Level	6%	0%	1.5	1.2	0.971	1.00	1,627	65.0	64.8	**25.1**	**C**
R-6	I-580 EB	I-580 between Central Avenue and I-80	AM	3,899	0.92	2	No		Level	6%	0%	1.5	1.2	0.971	1.00	2,183	65.0	57.5	**37.9**	**E**
R-7	I-80 EB	I-80 between Carlson Boulevard and Potrero Avenue	AM	5,131	0.92	4	Yes	350	Level	4%	0%	1.5	1.2	0.980	1.00	1,767	65.0	64.2	**27.5**	**D**
R-8	I-80 EB	I-80 @ Gilman Overpass	AM	7,600	0.92	5	Yes	900	Level	5%	0%	1.5	1.2	0.976	1.00	1,866	65.0	63.3	**29.5**	**D**
R-5	I-580 WB	I-580 between Bayview Avenue and Central Avenue	AM	5,100	0.92	3	No		Level	6%	0%	1.5	1.2	0.971	1.00	1,903	65.0	62.9	**30.3**	**D**
R-6	I-580 WB	I-580 between Central Avenue and I-80	AM	5,050	0.92	2	No		Level	6%	0%	1.5	1.2	0.971	1.00	2,827	65.0	-	**-**	**F**
R-7	I-80 WB	I-80 between Carlson Boulevard and Potrero Avenue	AM	7,349	0.92	4	Yes	1150	Level	4%	0%	1.5	1.2	0.980	1.00	2,291	65.0	54.3	**42.2**	**E**
R-8	I-80 WB	I-80 @ Gilman Overpass	AM	9,119	0.92	5	Yes	1500	Level	5%	0%	1.5	1.2	0.976	1.00	2,122	65.0	59.0	**36.0**	**E**
R-5	I-580 EB	I-580 between Bayview Avenue and Central Avenue	PM	5,057	0.92	3	No		Level	6%	0%	1.5	1.2	0.971	1.00	1,887	65.0	63.0	**29.9**	**D**
R-6	I-580 EB	I-580 between Central Avenue and I-80	PM	5,087	0.92	2	No		Level	6%	0%	1.5	1.2	0.971	1.00	2,848	65.0	-	**-**	**F**
R-7	I-80 EB	I-80 between Carlson Boulevard and Potrero Avenue	PM	6,992	0.92	4	Yes	1400	Level	4%	0%	1.5	1.2	0.980	1.00	2,067	65.0	60.2	**34.3**	**D**
R-8	I-80 EB	I-80 @ Gilman Overpass	PM	8,371	0.92	5	Yes	1150	Level	5%	0%	1.5	1.2	0.976	1.00	2,011	65.0	61.3	**32.8**	**D**
R-5	I-580 WB	I-580 between Bayview Avenue and Central Avenue	PM	4,181	0.92	3	No		Level	6%	0%	1.5	1.2	0.971	1.00	1,560	65.0	64.9	**24.0**	**C**
R-6	I-580 WB	I-580 between Central Avenue and I-80	PM	3,361	0.92	2	No		Level	6%	0%	1.5	1.2	0.971	1.00	1,881	65.0	63.1	**29.8**	**D**
R-7	I-80 WB	I-80 between Carlson Boulevard and Potrero Avenue	PM	5,407	0.92	4	Yes	400	Level	4%	0%	1.5	1.2	0.980	1.00	1,850	65.0	63.4	**29.2**	**D**
R-8	I-80 WB	I-80 @ Gilman Overpass	PM	7,777	0.92	5	Yes	700	Level	5%	0%	1.5	1.2	0.976	1.00	1,971	65.0	61.9	**31.8**	**D**

Leisch Method for Weaving Analysis

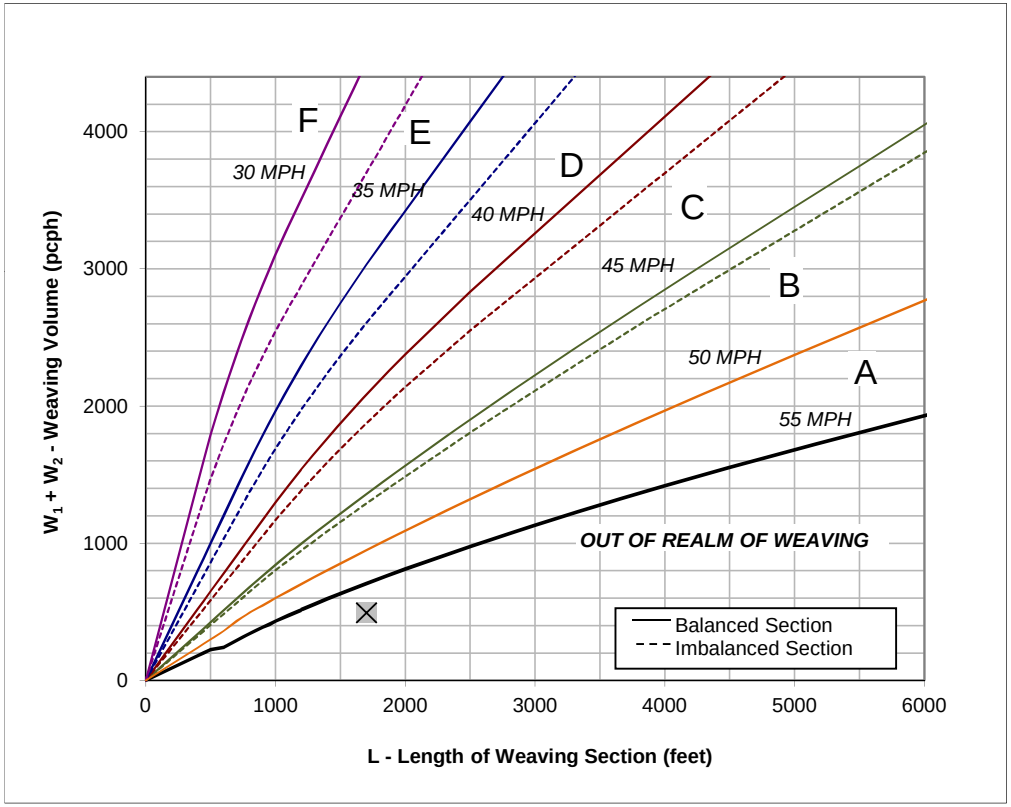
Data Input

Number of Entering Mainline Lanes	N_b	3
Number of Lanes in Weaving Section	N	4
Length of Weaving Section (feet)	L	1,700

Total Weaving Section (V)		On-ramp to Mainline (W_1)		Mainline to Off-ramp (W_2)	
Volume (vph)*	3,133	Volume (vph)*	320	Volume (vph)*	160
Truck Percentage	6%	Truck Percentage	6%	Truck Percentage	6%
PCE for Trucks	1.5	PCE for Trucks	1.5	PCE for Trucks	1.5
Volume (pcph)	3,227	Volume (pcph)	330	Volume (pcph)	165

Project Information

Project	LBNL
Scenario	Cumulative Plus Buildout AM
Freeway	EB I-580
On-ramp	Harbour Way
Off-ramp	Marina Bay Pkwy



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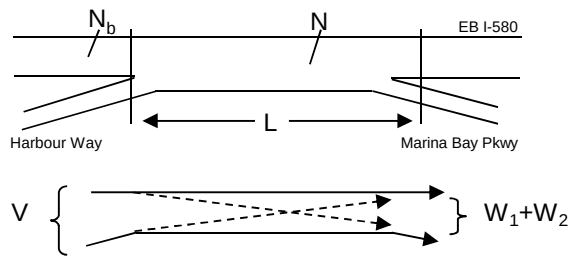


Capacity Analysis

1. Is the weaving section balanced (Y / N)? **N**
   [If optional exit lane, then "Y". Otherwise "N".]
2. In the Weaving Speed Chart to the left, which two speed curves is the black "x" between?
   50 MPH and **55 MPH**
   If below the 55 MPH curve, out of the realm of weaving.
   If left of the 30 MPH curve, LOS is F.
3. Interpolated Weaving Speed (S_w, mph) **59.4**
4. Weaving Intensity Factor (k) **1.00**
5. Service Volume (SV, pcph)
   $SV = (1/N)*[V + (k - 1)*\min(W_1, W_2)]$ **807**
6. Level of Service (LOS) **B**

The LOS in the chart above refers to the capacity of weaving traffic only; through and ramp to ramp traffic is not included.

* Note: **Do not adjust by a Peak Hour Factor (PHF).** The methodology incorporates the PHF in the Service Volume tables.

Sources: *Completion of Procedures for Analysis and Design of Traffic Weaving Sections*, Jack E. Leisch & Associates, September 1983 and *Highway Design Manual*, California Department of Transportation, July 24, 2009

Leisch Method for Weaving Analysis

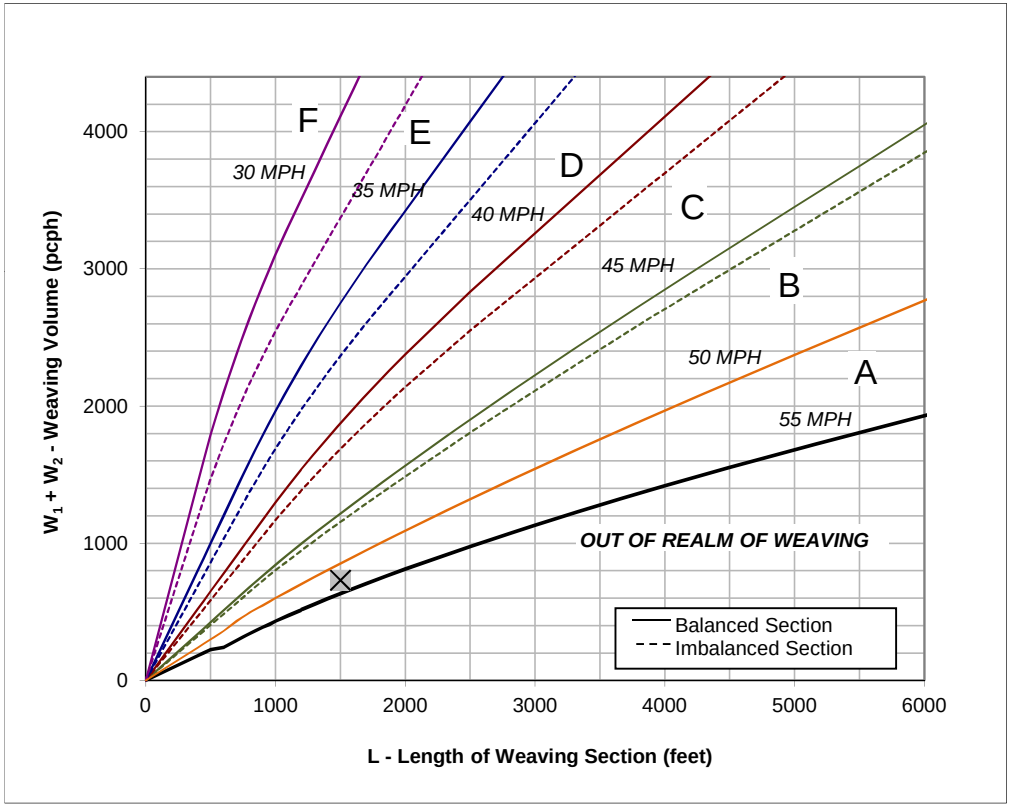
Data Input

Number of Entering Mainline Lanes	N_b	3
Number of Lanes in Weaving Section	N	4
Length of Weaving Section (feet)	L	1,500

Total Weaving Section (V)		On-ramp to Mainline (W_1)		Mainline to Off-ramp (W_2)	
Volume (vph)*	4,382	Volume (vph)*	320	Volume (vph)*	390
Truck Percentage	6%	Truck Percentage	6%	Truck Percentage	6%
PCE for Trucks	1.5	PCE for Trucks	1.5	PCE for Trucks	1.5
Volume (pcph)	4,513	Volume (pcph)	330	Volume (pcph)	402

Project Information

Project	LBNL
Scenario	Cumulative Plus Buildout AM
Freeway	WB I-580
On-ramp	Marina Bay Parkway
Off-ramp	Harbour Way



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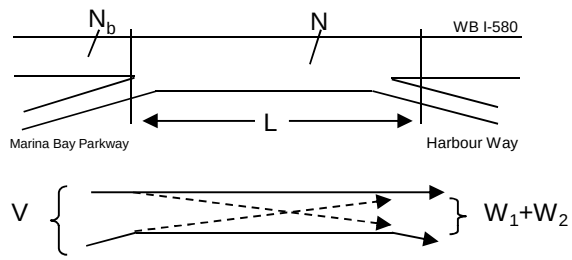


Capacity Analysis

1. Is the weaving section balanced (Y / N)? **N**
   [If optional exit lane, then "Y". Otherwise "N".]
2. In the Weaving Speed Chart to the left, which two speed curves is the black "x" between?
   50 MPH and **55 MPH**
   If below the 55 MPH curve, out of the realm of weaving.
   If left of the 30 MPH curve, LOS is F.
3. Interpolated Weaving Speed (S_w, mph) **52.8**
4. Weaving Intensity Factor (k) **1.00**
5. Service Volume (SV, pcph)
   $SV = (1/N)*[V + (k - 1)*\min(W_1, W_2)]$ **1,128**
6. Level of Service (LOS) **C**

The LOS in the chart above refers to the capacity of weaving traffic only; through and ramp to ramp traffic is not included.

* Note: **Do not adjust by a Peak Hour Factor (PHF).** The methodology incorporates the PHF in the Service Volume tables.

Sources: *Completion of Procedures for Analysis and Design of Traffic Weaving Sections*, Jack E. Leisch & Associates, September 1983 and *Highway Design Manual*, California Department of Transportation, July 24, 2009

Leisch Method for Weaving Analysis

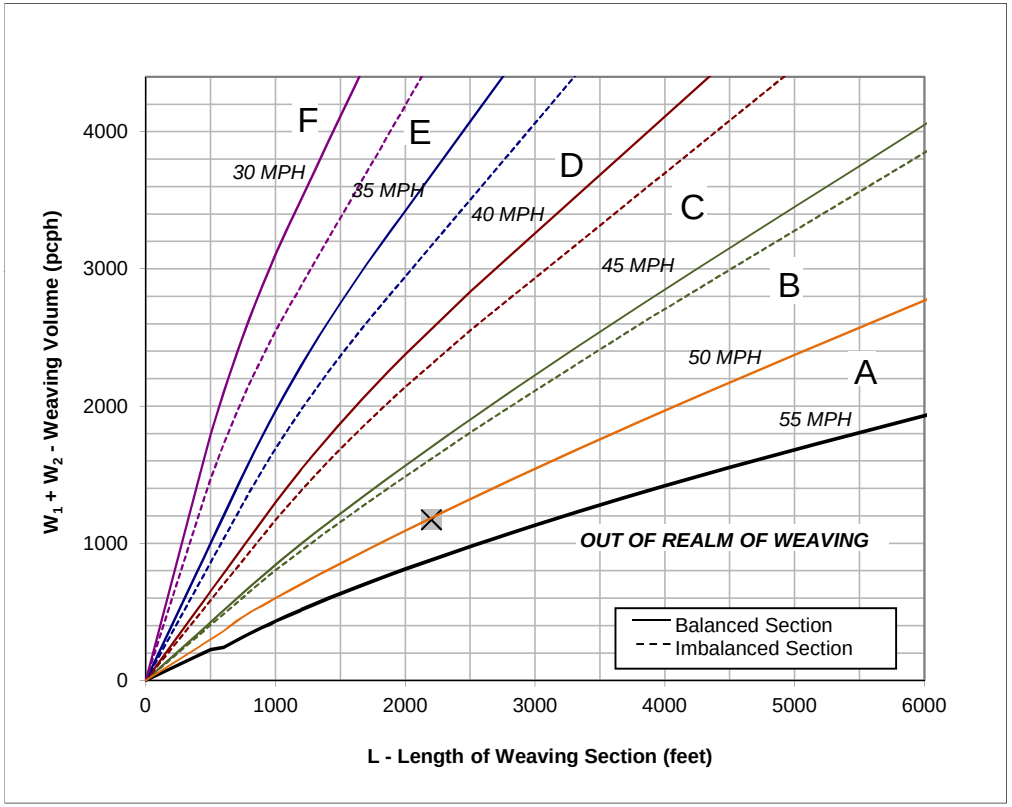
Data Input

Number of Entering Mainline Lanes	N_b	3
Number of Lanes in Weaving Section	N	4
Length of Weaving Section (feet)	L	2,200

Total Weaving Section (V)		On-ramp to Mainline (W_1)		Mainline to Off-ramp (W_2)	
Volume (vph)*	4,123	Volume (vph)*	820	Volume (vph)*	318
Truck Percentage	6%	Truck Percentage	6%	Truck Percentage	6%
PCE for Trucks	1.5	PCE for Trucks	1.5	PCE for Trucks	1.5
Volume (pcph)	4,247	Volume (pcph)	845	Volume (pcph)	328

Project Information

Project	LBNL
Scenario	Cumulative Plus Buildout AM
Freeway	EB I-580
On-ramp	Marina Bay Parkway
Off-ramp	Regatta Blvd



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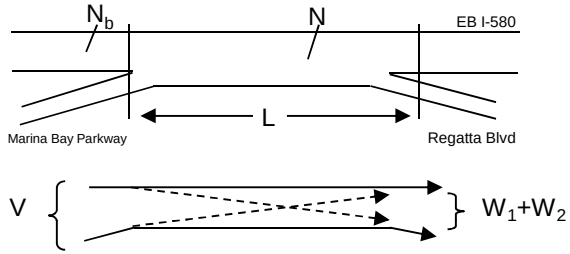


Capacity Analysis

1. Is the weaving section balanced (Y / N)? **N**
   [If optional exit lane, then "Y". Otherwise "N".]
2. In the Weaving Speed Chart to the left, which two speed curves is the black "x" between?
   50 MPH and **55 MPH**
   If below the 55 MPH curve, out of the realm of weaving.
   If left of the 30 MPH curve, LOS is F.
3. Interpolated Weaving Speed (S_w, mph) **50.2**
4. Weaving Intensity Factor (k) **1.00**
5. Service Volume (SV, pcph)
   $SV = (1/N)*[V + (k - 1)*\min(W_1, W_2)]$ **1,062**
6. Level of Service (LOS) **B**

The LOS in the chart above refers to the capacity of weaving traffic only; through and ramp to ramp traffic is not included.

* Note: **Do not adjust by a Peak Hour Factor (PHF).** The methodology incorporates the PHF in the Service Volume tables.

Sources: *Completion of Procedures for Analysis and Design of Traffic Weaving Sections*, Jack E. Leisch & Associates, September 1983 and *Highway Design Manual*, California Department of Transportation, July 24, 2009

Leisch Method for Weaving Analysis

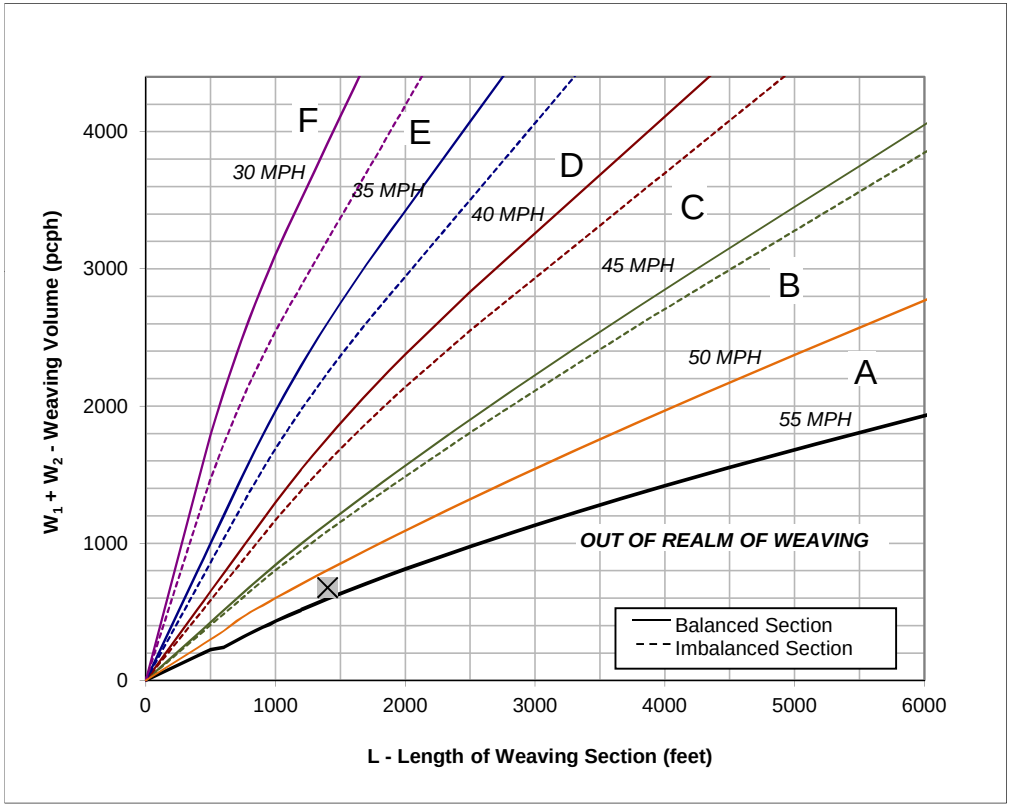
Data Input

Number of Entering Mainline Lanes	N_b	3
Number of Lanes in Weaving Section	N	4
Length of Weaving Section (feet)	L	1,400

Total Weaving Section (V)		On-ramp to Mainline (W_1)		Mainline to Off-ramp (W_2)	
Volume (vph)*	4,965	Volume (vph)*	175	Volume (vph)*	483
Truck Percentage	6%	Truck Percentage	6%	Truck Percentage	6%
PCE for Trucks	1.5	PCE for Trucks	1.5	PCE for Trucks	1.5
Volume (pcph)	5,114	Volume (pcph)	180	Volume (pcph)	497

Project Information

Project	LBNL
Scenario	Cumulative Plus Buildout AM
Freeway	WB I-580
On-ramp	Regatta Blvd
Off-ramp	Marina Bay Parkway



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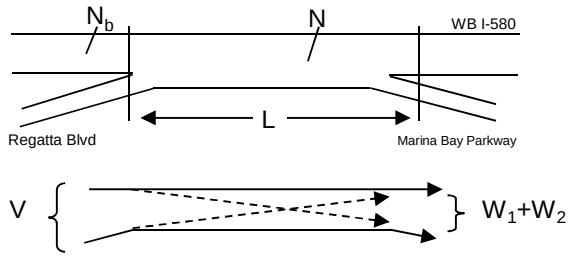


Capacity Analysis

1. Is the weaving section balanced (Y / N)? **N**
   [If optional exit lane, then "Y". Otherwise "N".]
2. In the Weaving Speed Chart to the left, which two speed curves is the black "x" between?
   50 MPH and **55 MPH**
   If below the 55 MPH curve, out of the realm of weaving.
   If left of the 30 MPH curve, LOS is F.
3. Interpolated Weaving Speed (S_w, mph) **53.0**
4. Weaving Intensity Factor (k) **1.00**
5. Service Volume (SV, pcph)
   $SV = (1/N)*[V + (k - 1)*\min(W_1, W_2)]$ **1,278**
6. Level of Service (LOS) **C**

The LOS in the chart above refers to the capacity of weaving traffic only; through and ramp to ramp traffic is not included.

* Note: **Do not adjust by a Peak Hour Factor (PHF).** The methodology incorporates the PHF in the Service Volume tables.

Sources: *Completion of Procedures for Analysis and Design of Traffic Weaving Sections*, Jack E. Leisch & Associates, September 1983 and *Highway Design Manual*, California Department of Transportation, July 24, 2009

Leisch Method for Weaving Analysis

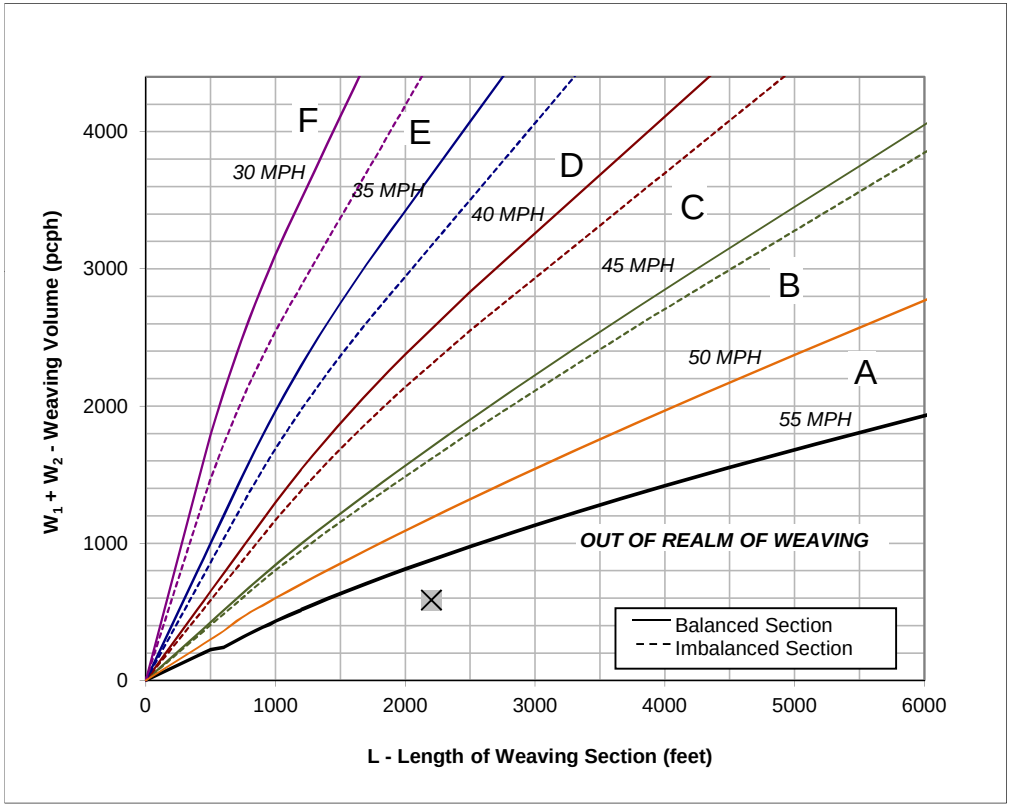
Data Input

Number of Entering Mainline Lanes	N_b	3
Number of Lanes in Weaving Section	N	4
Length of Weaving Section (feet)	L	2,200

Total Weaving Section (V)		On-ramp to Mainline (W_1)		Mainline to Off-ramp (W_2)	
Volume (vph)*	4,390	Volume (vph)*	140	Volume (vph)*	430
Truck Percentage	6%	Truck Percentage	6%	Truck Percentage	6%
PCE for Trucks	1.5	PCE for Trucks	1.5	PCE for Trucks	1.5
Volume (pcph)	4,522	Volume (pcph)	144	Volume (pcph)	443

Project Information

Project	LBNL
Scenario	Cumulative Plus Buildout AM
Freeway	EB I-580
On-ramp	Regatta Blvd
Off-ramp	Bayview Ave



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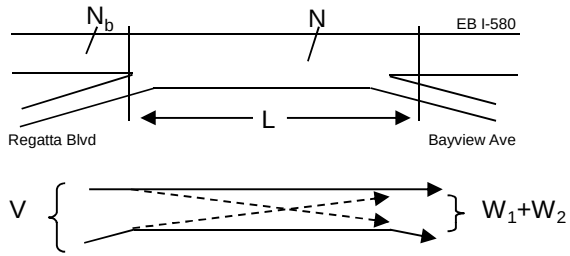


Capacity Analysis

1. Is the weaving section balanced (Y / N)? **N**
   [If optional exit lane, then "Y". Otherwise "N".]
2. In the Weaving Speed Chart to the left, which two speed curves is the black "x" between?
   50 MPH and **55 MPH**
   If below the 55 MPH curve, out of the realm of weaving.
   If left of the 30 MPH curve, LOS is F.
3. Interpolated Weaving Speed (S_w, mph) **59.8**
4. Weaving Intensity Factor (k) **1.00**
5. Service Volume (SV, pcph)
   $SV = (1/N)*[V + (k - 1)*\min(W_1, W_2)]$ **1,130**
6. Level of Service (LOS) **C**

The LOS in the chart above refers to the capacity of weaving traffic only; through and ramp to ramp traffic is not included.

* Note: **Do not adjust by a Peak Hour Factor (PHF).** The methodology incorporates the PHF in the Service Volume tables.

Sources: *Completion of Procedures for Analysis and Design of Traffic Weaving Sections*, Jack E. Leisch & Associates, September 1983 and *Highway Design Manual*, California Department of Transportation, July 24, 2009

Leisch Method for Weaving Analysis

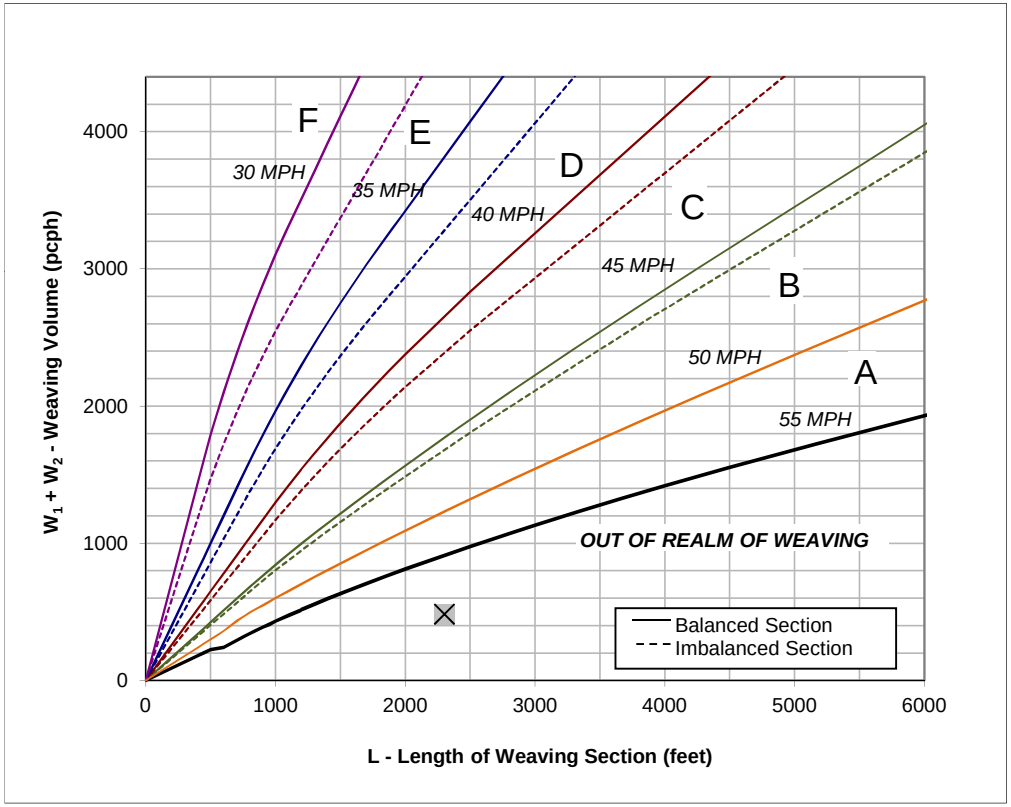
Data Input

Number of Entering Mainline Lanes	N_b	3
Number of Lanes in Weaving Section	N	4
Length of Weaving Section (feet)	L	2,300

Total Weaving Section (V)		On-ramp to Mainline (W_1)		Mainline to Off-ramp (W_2)	
Volume (vph)*	4,890	Volume (vph)*	380	Volume (vph)*	90
Truck Percentage	6%	Truck Percentage	6%	Truck Percentage	6%
PCE for Trucks	1.5	PCE for Trucks	1.5	PCE for Trucks	1.5
Volume (pcph)	5,037	Volume (pcph)	391	Volume (pcph)	93

Project Information

Project	LBNL
Scenario	Cumulative Plus Buildout AM
Freeway	WB I-580
On-ramp	Bayview Ave
Off-ramp	Regatta Blvd



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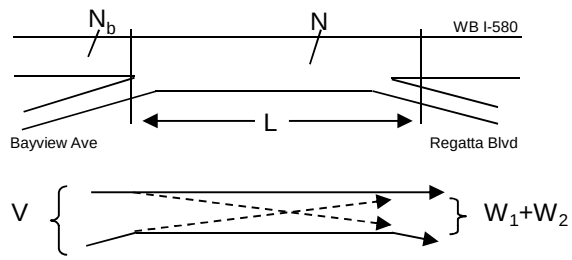


Capacity Analysis

1. Is the weaving section balanced (Y / N)? **N**
   [If optional exit lane, then "Y". Otherwise "N".]
2. In the Weaving Speed Chart to the left, which two speed curves is the black "x" between?
   50 MPH and **55 MPH**
   If below the 55 MPH curve, out of the realm of weaving.
   If left of the 30 MPH curve, LOS is F.
3. Interpolated Weaving Speed (S_w, mph) **61.7**
4. Weaving Intensity Factor (k) **1.00**
5. Service Volume (SV, pcph)
   $SV = (1/N)*[V + (k - 1)*\min(W_1, W_2)]$ **1,259**
6. Level of Service (LOS) **C**

The LOS in the chart above refers to the capacity of weaving traffic only; through and ramp to ramp traffic is not included.

* Note: **Do not adjust by a Peak Hour Factor (PHF).** The methodology incorporates the PHF in the Service Volume tables.

Sources: *Completion of Procedures for Analysis and Design of Traffic Weaving Sections*, Jack E. Leisch & Associates, September 1983 and *Highway Design Manual*, California Department of Transportation, July 24, 2009

Leisch Method for Weaving Analysis

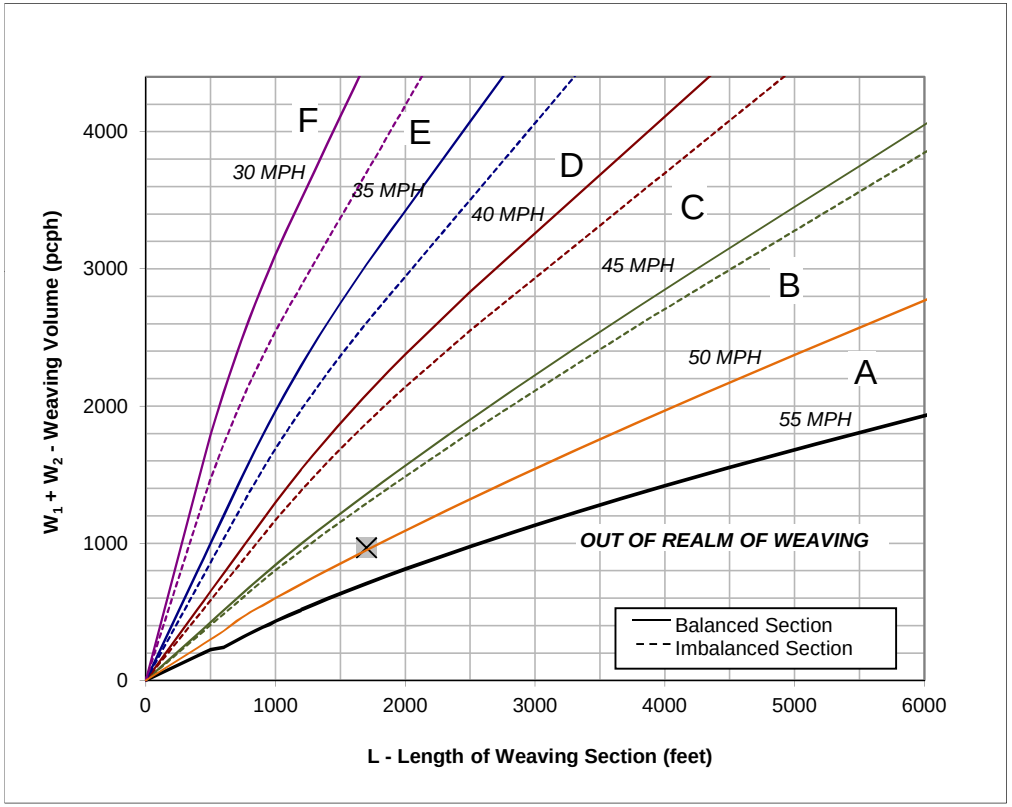
Data Input

Number of Entering Mainline Lanes	N_b	3
Number of Lanes in Weaving Section	N	4
Length of Weaving Section (feet)	L	1,700

Total Weaving Section (V)		On-ramp to Mainline (W_1)		Mainline to Off-ramp (W_2)	
Volume (vph)*	4,739	Volume (vph)*	600	Volume (vph)*	340
Truck Percentage	6%	Truck Percentage	6%	Truck Percentage	6%
PCE for Trucks	1.5	PCE for Trucks	1.5	PCE for Trucks	1.5
Volume (pcph)	4,881	Volume (pcph)	618	Volume (pcph)	350

Project Information

Project	LBNL
Scenario	Cumulative Plus Buildout PM
Freeway	EB I-580
On-ramp	Harbour Way
Off-ramp	Marina Bay Pkwy



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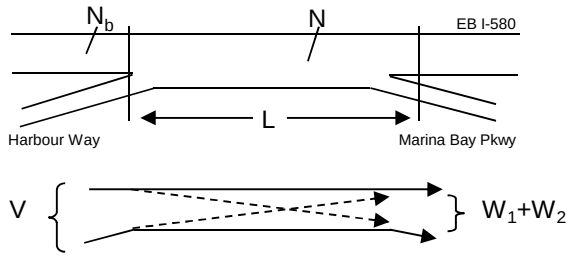


Capacity Analysis

1. Is the weaving section balanced (Y / N)? **N**
   [If optional exit lane, then "Y". Otherwise "N".]
2. In the Weaving Speed Chart to the left, which two speed curves is the black "x" between?
   50 MPH and **55 MPH**
   If below the 55 MPH curve, out of the realm of weaving.
   If left of the 30 MPH curve, LOS is F.
3. Interpolated Weaving Speed (S_w, mph) **49.6**
4. Weaving Intensity Factor (k) **1.25**
5. Service Volume (SV, pcph)
   $SV = (1/N)*[V + (k - 1)*\min(W_1, W_2)]$ **1,242**
6. Level of Service (LOS) **C**

The LOS in the chart above refers to the capacity of weaving traffic only; through and ramp to ramp traffic is not included.

* Note: **Do not adjust by a Peak Hour Factor (PHF).** The methodology incorporates the PHF in the Service Volume tables.

Sources: *Completion of Procedures for Analysis and Design of Traffic Weaving Sections*, Jack E. Leisch & Associates, September 1983 and *Highway Design Manual*, California Department of Transportation, July 24, 2009

Leisch Method for Weaving Analysis

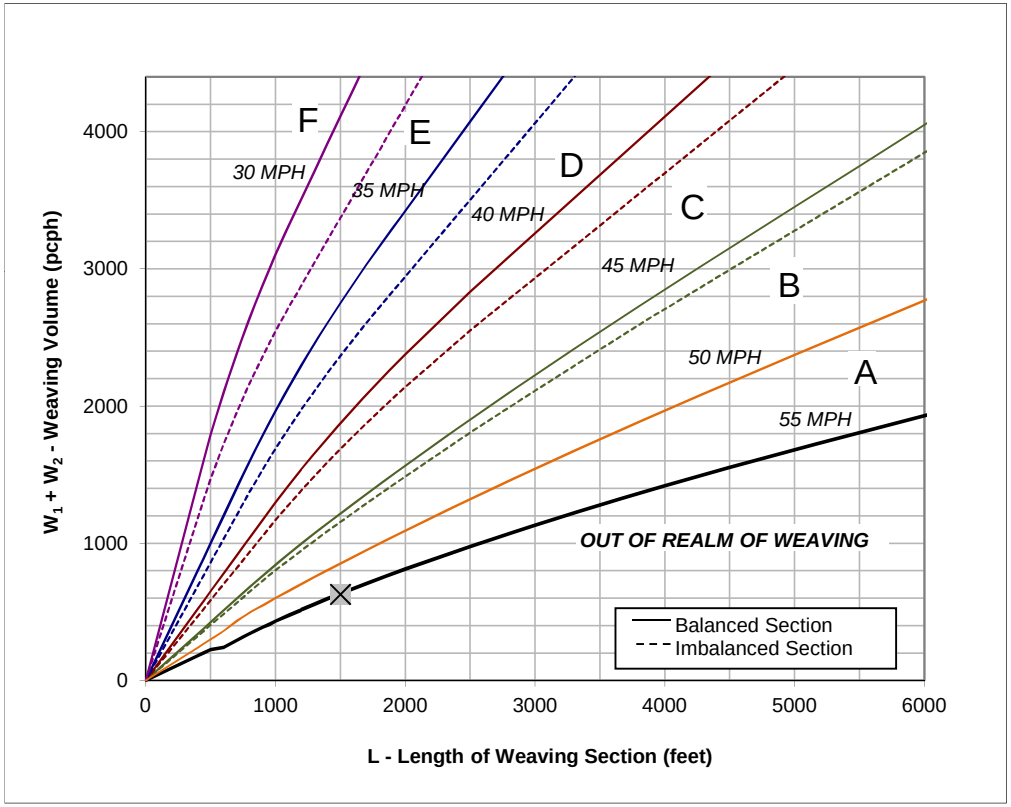
Data Input

Number of Entering Mainline Lanes	N_b	3
Number of Lanes in Weaving Section	N	4
Length of Weaving Section (feet)	L	1,500

Total Weaving Section (V)		On-ramp to Mainline (W_1)		Mainline to Off-ramp (W_2)	
Volume (vph)*	2,902	Volume (vph)*	220	Volume (vph)*	390
Truck Percentage	6%	Truck Percentage	6%	Truck Percentage	6%
PCE for Trucks	1.5	PCE for Trucks	1.5	PCE for Trucks	1.5
Volume (pcph)	2,989	Volume (pcph)	227	Volume (pcph)	402

Project Information

Project	LBNL
Scenario	Cumulative Plus Buildout PM
Freeway	WB I-580
On-ramp	Marina Bay Parkway
Off-ramp	Harbour Way



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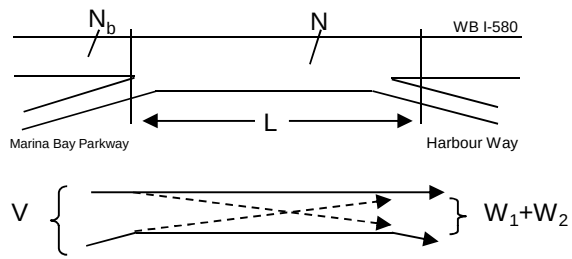


Capacity Analysis

1. Is the weaving section balanced (Y / N)? **N**
   [If optional exit lane, then "Y". Otherwise "N".]
2. In the Weaving Speed Chart to the left, which two speed curves is the black "x" between?
   50 MPH and **55 MPH**
   If below the 55 MPH curve, out of the realm of weaving.
   If left of the 30 MPH curve, LOS is F.
3. Interpolated Weaving Speed (S_w, mph) **55.1**
4. Weaving Intensity Factor (k) **1.00**
5. Service Volume (SV, pcph)
   $SV = (1/N)*[V + (k - 1)*\min(W_1, W_2)]$ **747**
6. Level of Service (LOS) **A**

The LOS in the chart above refers to the capacity of weaving traffic only; through and ramp to ramp traffic is not included.

* Note: **Do not adjust by a Peak Hour Factor (PHF).** The methodology incorporates the PHF in the Service Volume tables.

Sources: *Completion of Procedures for Analysis and Design of Traffic Weaving Sections*, Jack E. Leisch & Associates, September 1983 and *Highway Design Manual*, California Department of Transportation, July 24, 2009

Leisch Method for Weaving Analysis

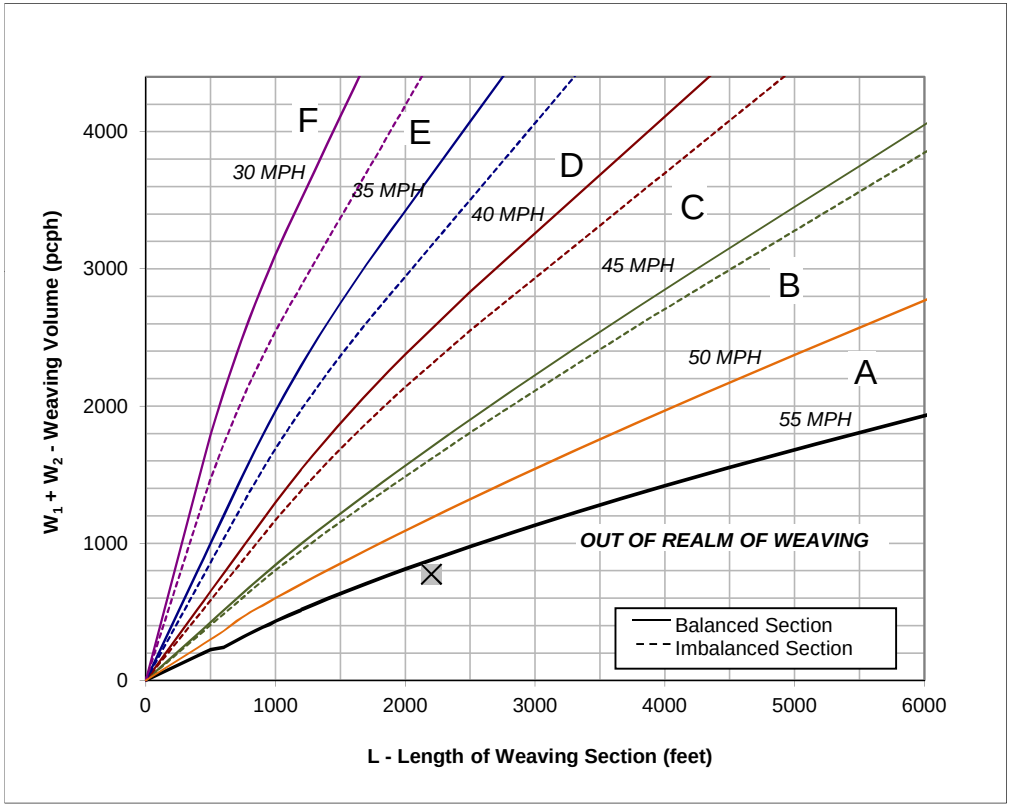
Data Input

Number of Entering Mainline Lanes	N_b	3
Number of Lanes in Weaving Section	N	4
Length of Weaving Section (feet)	L	2,200

Total Weaving Section (V)		On-ramp to Mainline (W_1)		Mainline to Off-ramp (W_2)	
Volume (vph)*	4,641	Volume (vph)*	592	Volume (vph)*	161
Truck Percentage	6%	Truck Percentage	6%	Truck Percentage	6%
PCE for Trucks	1.5	PCE for Trucks	1.5	PCE for Trucks	1.5
Volume (pcph)	4,780	Volume (pcph)	610	Volume (pcph)	166

Project Information

Project	LBNL
Scenario	Cumulative Plus Buildout PM
Freeway	EB I-580
On-ramp	Marina Bay Parkway
Off-ramp	Regatta Blvd



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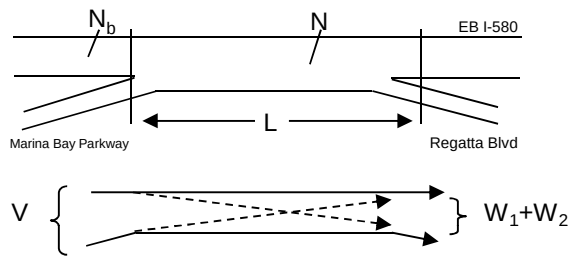


Capacity Analysis

1. Is the weaving section balanced (Y / N)? **N**
   [If optional exit lane, then "Y". Otherwise "N".]
2. In the Weaving Speed Chart to the left, which two speed curves is the black "x" between?
   50 MPH and **55 MPH**
   If below the 55 MPH curve, out of the realm of weaving.
   If left of the 30 MPH curve, LOS is F.
3. Interpolated Weaving Speed (S_w, mph) **56.7**
4. Weaving Intensity Factor (k) **1.00**
5. Service Volume (SV, pcph)
   $SV = (1/N)*[V + (k - 1)*\min(W_1, W_2)]$ **1,195**
6. Level of Service (LOS) **C**

The LOS in the chart above refers to the capacity of weaving traffic only; through and ramp to ramp traffic is not included.

* Note: **Do not adjust by a Peak Hour Factor (PHF).** The methodology incorporates the PHF in the Service Volume tables.

Sources: *Completion of Procedures for Analysis and Design of Traffic Weaving Sections*, Jack E. Leisch & Associates, September 1983 and *Highway Design Manual*, California Department of Transportation, July 24, 2009

Leisch Method for Weaving Analysis

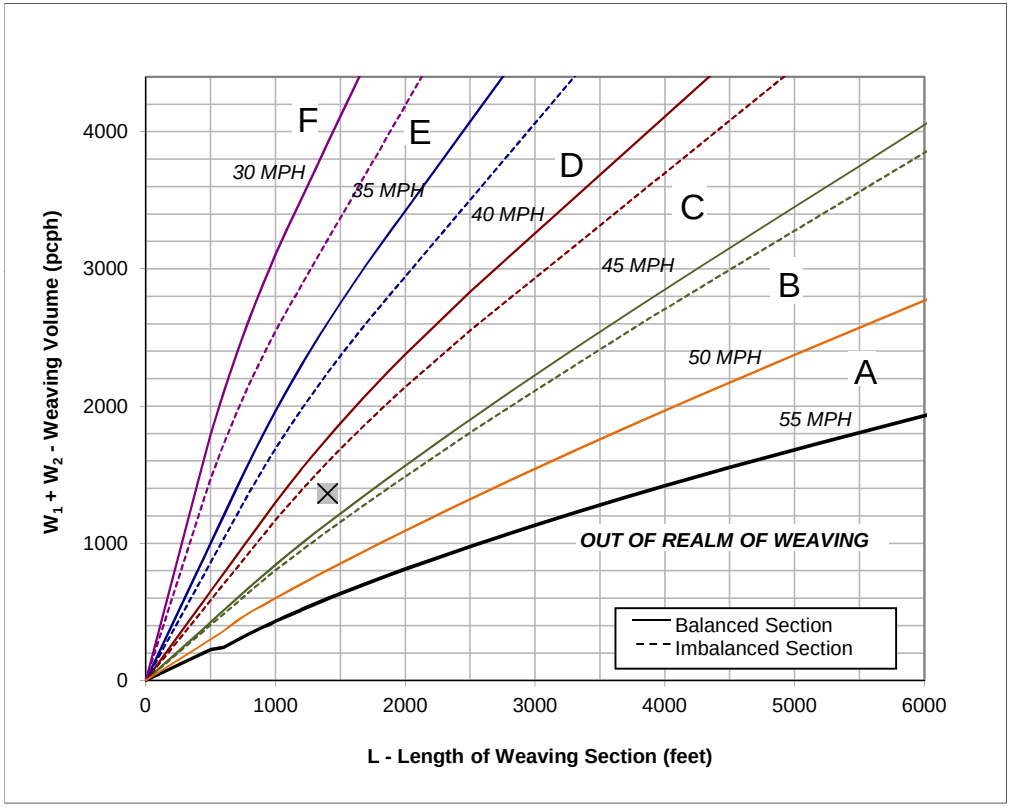
Data Input

Number of Entering Mainline Lanes	N_b	3
Number of Lanes in Weaving Section	N	4
Length of Weaving Section (feet)	L	1,400

Total Weaving Section (V)		On-ramp to Mainline (W_1)		Mainline to Off-ramp (W_2)	
Volume (vph)*	3,628	Volume (vph)*	328	Volume (vph)*	996
Truck Percentage	6%	Truck Percentage	6%	Truck Percentage	6%
PCE for Trucks	1.5	PCE for Trucks	1.5	PCE for Trucks	1.5
Volume (pcph)	3,737	Volume (pcph)	338	Volume (pcph)	1,026

Project Information

Project	LBNL
Scenario	Cumulative Plus Buildout PM
Freeway	WB I-580
On-ramp	Regatta Blvd
Off-ramp	Marina Bay Parkway



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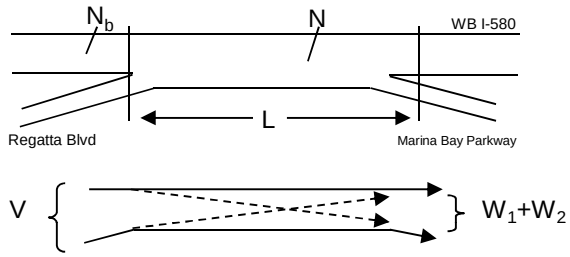


Capacity Analysis

1. Is the weaving section balanced (Y / N)? **N**
   [If optional exit lane, then "Y". Otherwise "N".]
2. In the Weaving Speed Chart to the left, which two speed curves is the black "x" between?
   45 MPH and **50 MPH**
   If below the 55 MPH curve, out of the realm of weaving.
   If left of the 30 MPH curve, LOS is F.
3. Interpolated Weaving Speed (S_w, mph) **40.1**
4. Weaving Intensity Factor (k) **2.98**
5. Service Volume (SV, pcph)
   $SV = (1/N)*[V + (k - 1)*\min(W_1, W_2)]$ **1,101**
6. Level of Service (LOS) **C**

The LOS in the chart above refers to the capacity of weaving traffic only; through and ramp to ramp traffic is not included.

* Note: **Do not adjust by a Peak Hour Factor (PHF).** The methodology incorporates the PHF in the Service Volume tables.

Sources: *Completion of Procedures for Analysis and Design of Traffic Weaving Sections*, Jack E. Leisch & Associates, September 1983 and *Highway Design Manual*, California Department of Transportation, July 24, 2009

Leisch Method for Weaving Analysis

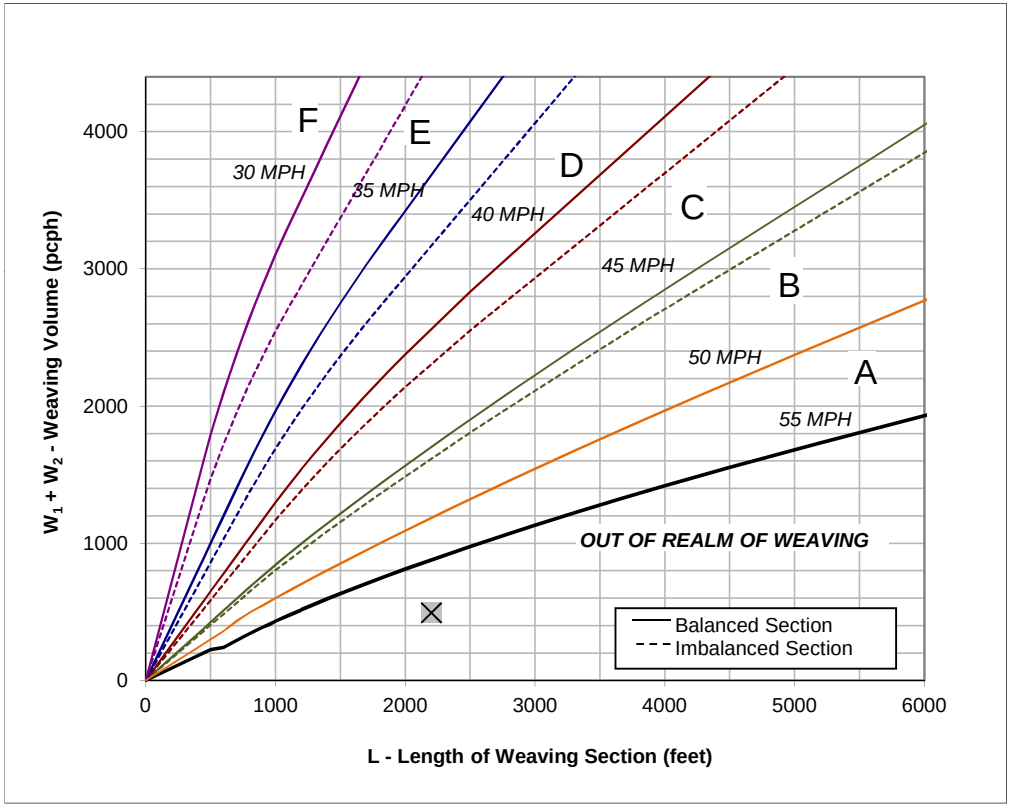
Data Input

Number of Entering Mainline Lanes	N_b	3
Number of Lanes in Weaving Section	N	4
Length of Weaving Section (feet)	L	2,200

Total Weaving Section (V)		On-ramp to Mainline (W_1)		Mainline to Off-ramp (W_2)	
Volume (vph)*	4,760	Volume (vph)*	400	Volume (vph)*	80
Truck Percentage	6%	Truck Percentage	6%	Truck Percentage	6%
PCE for Trucks	1.5	PCE for Trucks	1.5	PCE for Trucks	1.5
Volume (pcph)	4,903	Volume (pcph)	412	Volume (pcph)	82

Project Information

Project	LBNL
Scenario	Cumulative Plus Buildout PM
Freeway	EB I-580
On-ramp	Regatta Blvd
Off-ramp	Bayview Ave



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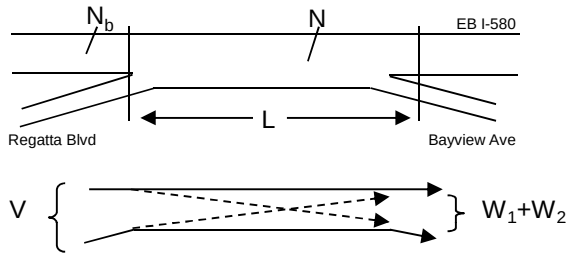


Capacity Analysis

1. Is the weaving section balanced (Y / N)? **N**
   [If optional exit lane, then "Y". Otherwise "N".]
2. In the Weaving Speed Chart to the left, which two speed curves is the black "x" between?
   50 MPH and **55 MPH**
   If below the 55 MPH curve, out of the realm of weaving.
   If left of the 30 MPH curve, LOS is F.
3. Interpolated Weaving Speed (S_w, mph) **61.3**
4. Weaving Intensity Factor (k) **1.00**
5. Service Volume (SV, pcph)
   $SV = (1/N)*[V + (k - 1)*\min(W_1, W_2)]$ **1,226**
6. Level of Service (LOS) **C**

The LOS in the chart above refers to the capacity of weaving traffic only; through and ramp to ramp traffic is not included.

* Note: **Do not adjust by a Peak Hour Factor (PHF).** The methodology incorporates the PHF in the Service Volume tables.

Sources: *Completion of Procedures for Analysis and Design of Traffic Weaving Sections*, Jack E. Leisch & Associates, September 1983 and *Highway Design Manual*, California Department of Transportation, July 24, 2009

Leisch Method for Weaving Analysis

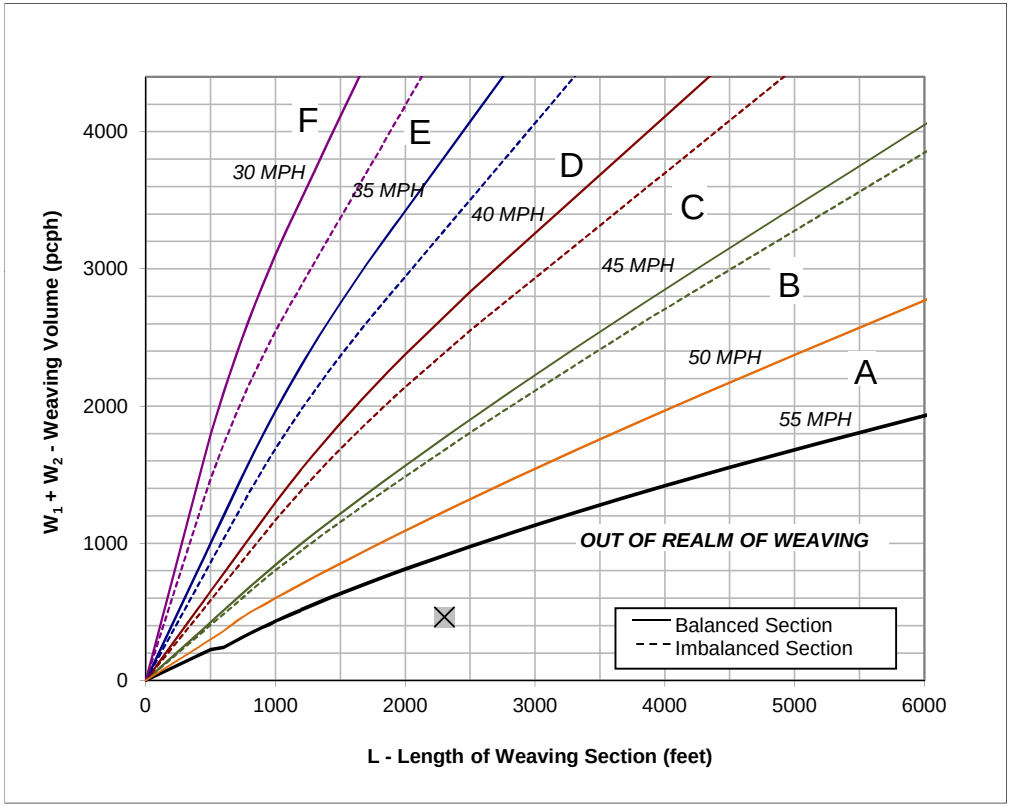
Data Input

Number of Entering Mainline Lanes	N_b	3
Number of Lanes in Weaving Section	N	4
Length of Weaving Section (feet)	L	2,300

Total Weaving Section (V)		On-ramp to Mainline (W_1)		Mainline to Off-ramp (W_2)	
Volume (vph)*	3,900	Volume (vph)*	290	Volume (vph)*	160
Truck Percentage	6%	Truck Percentage	6%	Truck Percentage	6%
PCE for Trucks	1.5	PCE for Trucks	1.5	PCE for Trucks	1.5
Volume (pcph)	4,017	Volume (pcph)	299	Volume (pcph)	165

Project Information

Project	LBNL
Scenario	Cumulative Plus Buildout PM
Freeway	WB I-580
On-ramp	Bayview Ave
Off-ramp	Regatta Blvd



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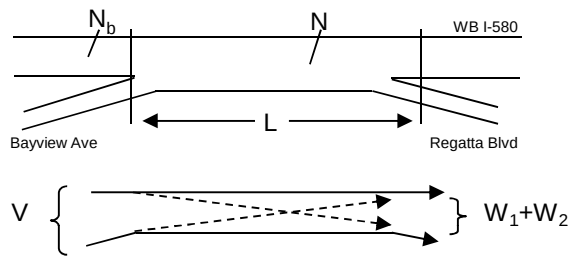


Capacity Analysis

1. Is the weaving section balanced (Y / N)? **N**
   [If optional exit lane, then "Y". Otherwise "N".]
2. In the Weaving Speed Chart to the left, which two speed curves is the black "x" between?
   50 MPH and **55 MPH**
   If below the 55 MPH curve, out of the realm of weaving.
   If left of the 30 MPH curve, LOS is F.
3. Interpolated Weaving Speed (S_w, mph) **62.1**
4. Weaving Intensity Factor (k) **1.00**
5. Service Volume (SV, pcph)
   $SV = (1/N)*[V + (k - 1)*\min(W_1, W_2)]$ **1,004**
6. Level of Service (LOS) **B**

The LOS in the chart above refers to the capacity of weaving traffic only; through and ramp to ramp traffic is not included.

* Note: **Do not adjust by a Peak Hour Factor (PHF).** The methodology incorporates the PHF in the Service Volume tables.

Sources: *Completion of Procedures for Analysis and Design of Traffic Weaving Sections*, Jack E. Leisch & Associates, September 1983 and *Highway Design Manual*, California Department of Transportation, July 24, 2009

Near-Term (2018) Plus Additional Employment Alternative Conditions

FEHR PEERS

HCM 2000
Basic Freeway Segments
Capacity Analysis

Jurisdiction
Analysis Year Near-Term + Phase 1 Alternative
Analyst SN

Agency or Company
Date
Project Description

General Information				*Flow Rate Calculation*													*Speed Calculation*		*Results*	
	Freeway/ Direction	From/To	Analysis Time Period	Volume (vph)	PHF	Lanes	HOV Lane?	HOV Lane Volume	Terrain	Truck/ Bus %	RV %	E_T	E_R	f_{HV}	f_P	Flow Rate v_p (pcphpl)	Measured FFS (mph)	S (mph)	Density, D (pcplpm)	Level of Service
R-5	I-580 EB	I-580 between Bayview Avenue and Central Avenue	AM	3,117	0.92	3	No		Level	6%	0%	1.5	1.2	0.971	1.00	1,163	65.0	65.0	**17.9**	**B**
R-6	I-580 EB	I-580 between Central Avenue and I-80	AM	3,027	0.92	2	No		Level	6%	0%	1.5	1.2	0.971	1.00	1,694	65.0	64.6	**26.2**	**D**
R-7	I-80 EB	I-80 between Carlson Boulevard and Potrero Avenue	AM	4,329	0.92	4	Yes	290	Level	4%	0%	1.5	1.2	0.980	1.00	1,493	65.0	65.0	**23.0**	**C**
R-8	I-80 EB	I-80 @ Gilman Overpass	AM	6,248	0.92	5	Yes	780	Level	5%	0%	1.5	1.2	0.976	1.00	1,523	65.0	65.0	**23.4**	**C**
R-5	I-580 WB	I-580 between Bayview Avenue and Central Avenue	AM	3,118	0.92	3	No		Level	6%	0%	1.5	1.2	0.971	1.00	1,164	65.0	65.0	**17.9**	**B**
R-6	I-580 WB	I-580 between Central Avenue and I-80	AM	3,408	0.92	2	No		Level	6%	0%	1.5	1.2	0.971	1.00	1,908	65.0	62.8	**30.4**	**D**
R-7	I-80 WB	I-80 between Carlson Boulevard and Potrero Avenue	AM	6,336	0.92	4	Yes	1000	Level	4%	0%	1.5	1.2	0.980	1.00	1,972	65.0	61.9	**31.9**	**D**
R-8	I-80 WB	I-80 @ Gilman Overpass	AM	8,547	0.92	5	Yes	1410	Level	5%	0%	1.5	1.2	0.976	1.00	1,988	65.0	61.6	**32.2**	**D**
R-5	I-580 EB	I-580 between Bayview Avenue and Central Avenue	PM	3,073	0.92	3	No		Level	6%	0%	1.5	1.2	0.971	1.00	1,147	65.0	65.0	**17.6**	**B**
R-6	I-580 EB	I-580 between Central Avenue and I-80	PM	3,693	0.92	2	No		Level	6%	0%	1.5	1.2	0.971	1.00	2,067	65.0	60.2	**34.3**	**D**
R-7	I-80 EB	I-80 between Carlson Boulevard and Potrero Avenue	PM	6,233	0.92	4	Yes	1300	Level	4%	0%	1.5	1.2	0.980	1.00	1,823	65.0	63.7	**28.6**	**D**
R-8	I-80 EB	I-80 @ Gilman Overpass	PM	7,586	0.92	5	Yes	1070	Level	5%	0%	1.5	1.2	0.976	1.00	1,815	65.0	63.8	**28.5**	**D**
R-5	I-580 WB	I-580 between Bayview Avenue and Central Avenue	PM	3,256	0.92	3	No		Level	6%	0%	1.5	1.2	0.971	1.00	1,215	65.0	65.0	**18.7**	**C**
R-6	I-580 WB	I-580 between Central Avenue and I-80	PM	2,806	0.92	2	No		Level	6%	0%	1.5	1.2	0.971	1.00	1,571	65.0	64.9	**24.2**	**C**
R-7	I-80 WB	I-80 between Carlson Boulevard and Potrero Avenue	PM	4,778	0.92	4	Yes	330	Level	4%	0%	1.5	1.2	0.980	1.00	1,644	65.0	64.8	**25.4**	**C**
R-8	I-80 WB	I-80 @ Gilman Overpass	PM	6,843	0.92	5	Yes	650	Level	5%	0%	1.5	1.2	0.976	1.00	1,725	65.0	64.4	**26.8**	**D**

Leisch Method for Weaving Analysis

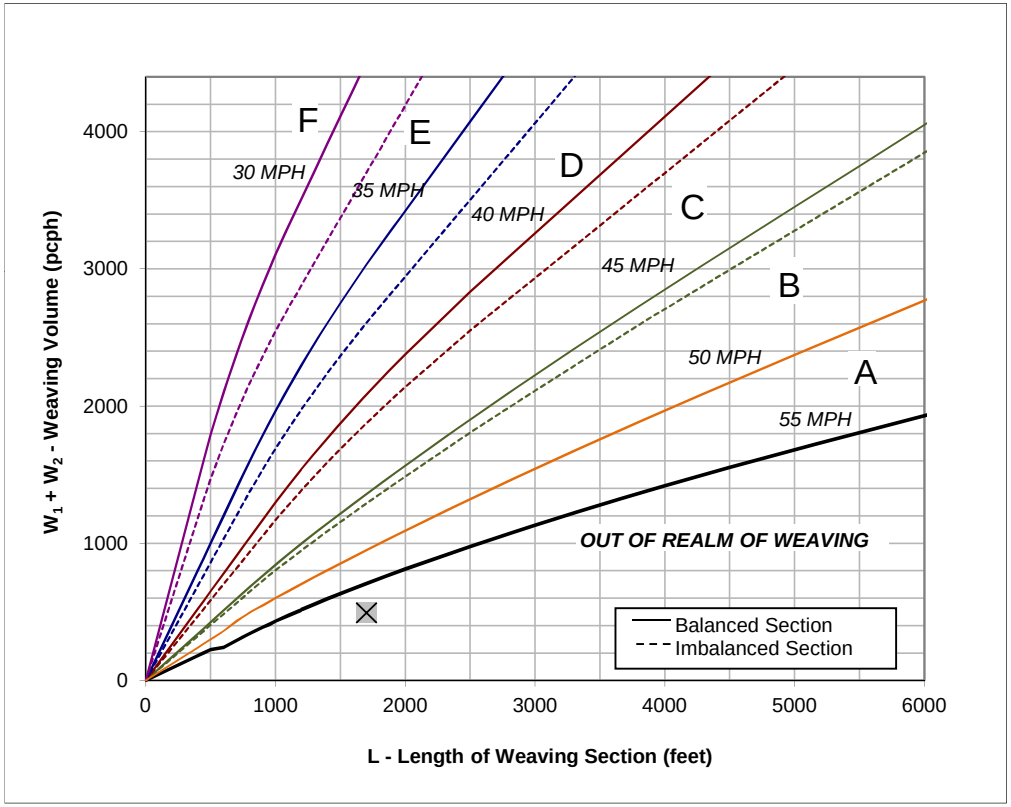
Data Input

Number of Entering Mainline Lanes	N_b	3
Number of Lanes in Weaving Section	N	4
Length of Weaving Section (feet)	L	1,700

Total Weaving Section (V)		On-ramp to Mainline (W_1)		Mainline to Off-ramp (W_2)	
Volume (vph)*	2,481	Volume (vph)*	320	Volume (vph)*	160
Truck Percentage	6%	Truck Percentage	6%	Truck Percentage	6%
PCE for Trucks	1.5	PCE for Trucks	1.5	PCE for Trucks	1.5
Volume (pcph)	2,555	Volume (pcph)	330	Volume (pcph)	165

Project Information

Project	LBNL
Scenario	Near-Term + Project Alt AM
Freeway	EB I-580
On-ramp	Harbour Way
Off-ramp	Marina Bay Pkwy



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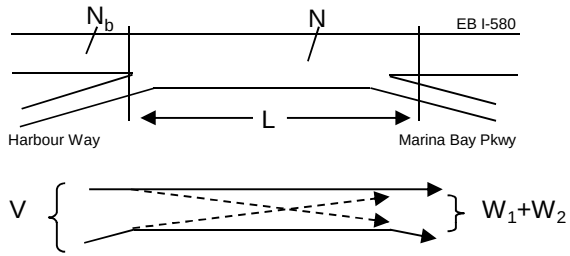


Capacity Analysis

1. Is the weaving section balanced (Y / N)? **N**
   [If optional exit lane, then "Y". Otherwise "N".]
2. In the Weaving Speed Chart to the left, which two speed curves is the black "x" between?
   50 MPH and **55 MPH**
   If below the 55 MPH curve, out of the realm of weaving.
   If left of the 30 MPH curve, LOS is F.
3. Interpolated Weaving Speed (S_w, mph) **59.4**
4. Weaving Intensity Factor (k) **1.00**
5. Service Volume (SV, pcph)
   $SV = (1/N)*[V + (k - 1)*\min(W_1, W_2)]$ **639**
6. Level of Service (LOS) **A**

The LOS in the chart above refers to the capacity of weaving traffic only; through and ramp to ramp traffic is not included.

* Note: **Do not adjust by a Peak Hour Factor (PHF).** The methodology incorporates the PHF in the Service Volume tables.

Sources: *Completion of Procedures for Analysis and Design of Traffic Weaving Sections*, Jack E. Leisch & Associates, September 1983 and *Highway Design Manual*, California Department of Transportation, July 24, 2009

Leisch Method for Weaving Analysis

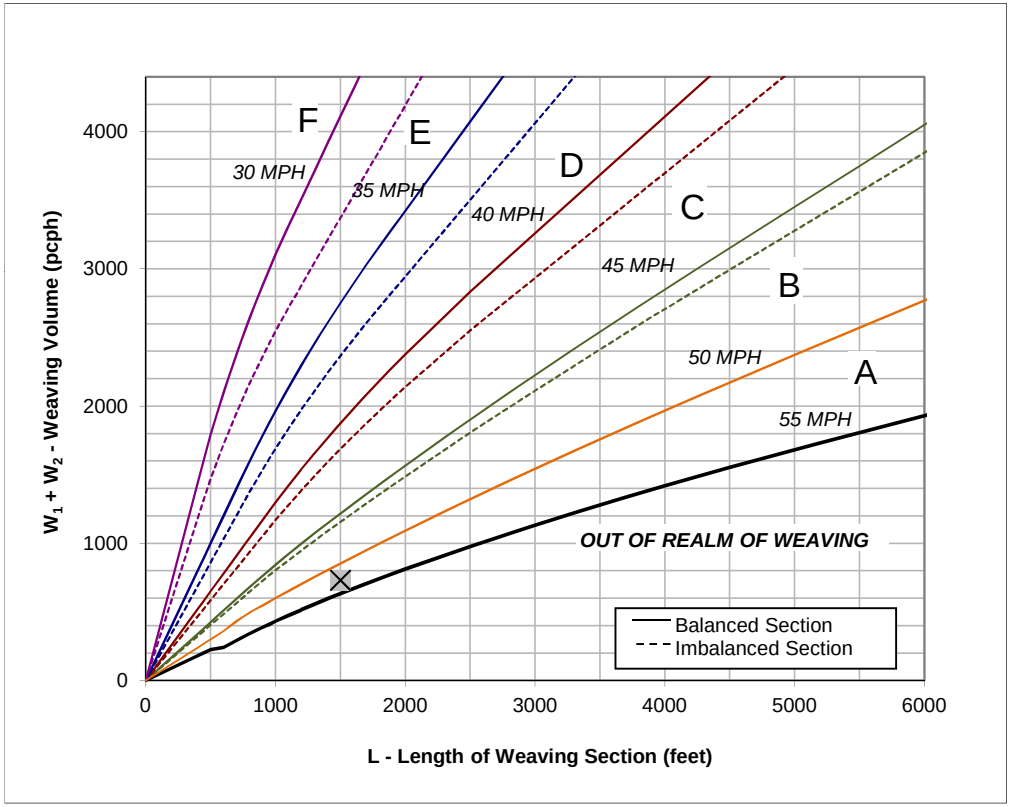
Data Input

Number of Entering Mainline Lanes	N_b	3
Number of Lanes in Weaving Section	N	4
Length of Weaving Section (feet)	L	1,500

Total Weaving Section (V)		On-ramp to Mainline (W_1)		Mainline to Off-ramp (W_2)	
Volume (vph)*	2,791	Volume (vph)*	320	Volume (vph)*	390
Truck Percentage	6%	Truck Percentage	6%	Truck Percentage	6%
PCE for Trucks	1.5	PCE for Trucks	1.5	PCE for Trucks	1.5
Volume (pcph)	2,875	Volume (pcph)	330	Volume (pcph)	402

Project Information

Project	LBNL
Scenario	Near-Term + Project Alt AM
Freeway	WB I-580
On-ramp	Marina Bay Parkway
Off-ramp	Harbour Way



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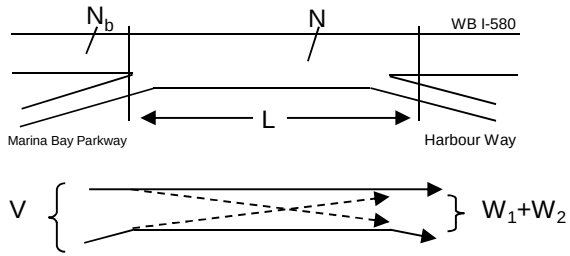


Capacity Analysis

1. Is the weaving section balanced (Y / N)? **N**
   [If optional exit lane, then "Y". Otherwise "N".]
2. In the Weaving Speed Chart to the left, which two speed curves is the black "x" between?
   50 MPH and **55 MPH**
   If below the 55 MPH curve, out of the realm of weaving.
   If left of the 30 MPH curve, LOS is F.
3. Interpolated Weaving Speed (S_w, mph) **52.8**
4. Weaving Intensity Factor (k) **1.00**
5. Service Volume (SV, pcph)
   $SV = (1/N)*[V + (k - 1)*\min(W_1, W_2)]$ **719**
6. Level of Service (LOS) **A**

The LOS in the chart above refers to the capacity of weaving traffic only; through and ramp to ramp traffic is not included.

* Note: **Do not adjust by a Peak Hour Factor (PHF).** The methodology incorporates the PHF in the Service Volume tables.

Sources: *Completion of Procedures for Analysis and Design of Traffic Weaving Sections*, Jack E. Leisch & Associates, September 1983 and *Highway Design Manual*, California Department of Transportation, July 24, 2009

Leisch Method for Weaving Analysis

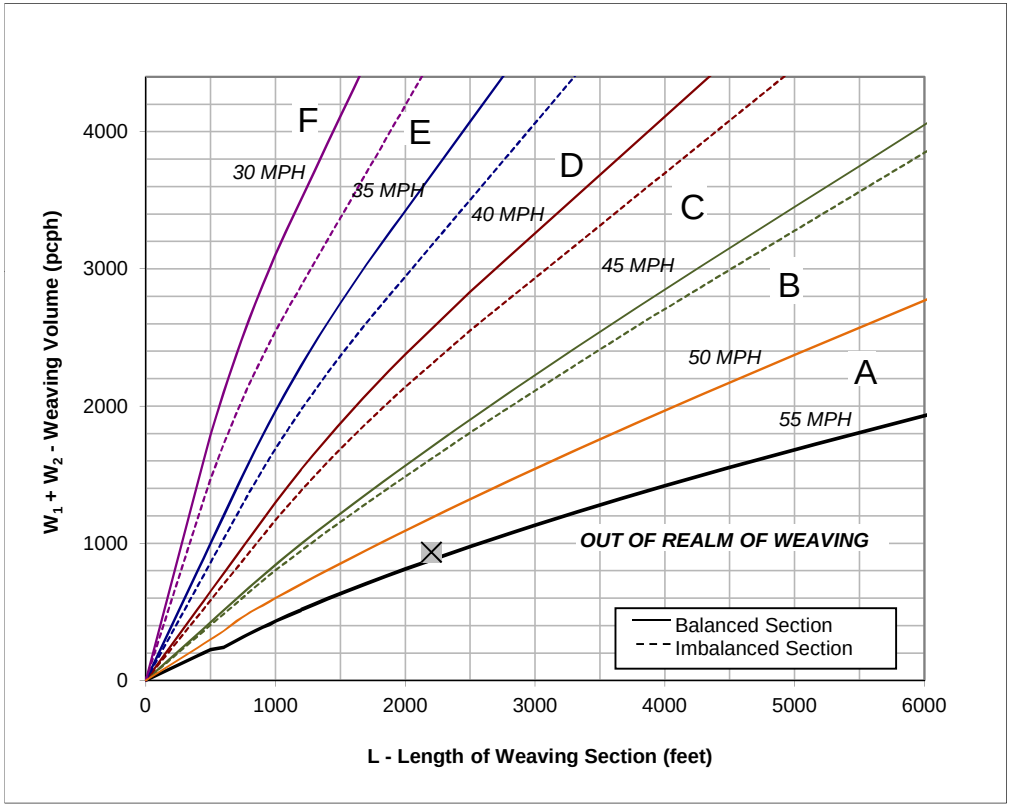
Data Input

Number of Entering Mainline Lanes	N_b	3
Number of Lanes in Weaving Section	N	4
Length of Weaving Section (feet)	L	2,200

Total Weaving Section (V)		On-ramp to Mainline (W_1)		Mainline to Off-ramp (W_2)	
Volume (vph)*	3,160	Volume (vph)*	749	Volume (vph)*	160
Truck Percentage	6%	Truck Percentage	6%	Truck Percentage	6%
PCE for Trucks	1.5	PCE for Trucks	1.5	PCE for Trucks	1.5
Volume (pcph)	3,255	Volume (pcph)	771	Volume (pcph)	165

Project Information

Project	LBNL
Scenario	Near-Term + Project Alt AM
Freeway	EB I-580
On-ramp	Marina Bay Parkway
Off-ramp	Regatta Blvd



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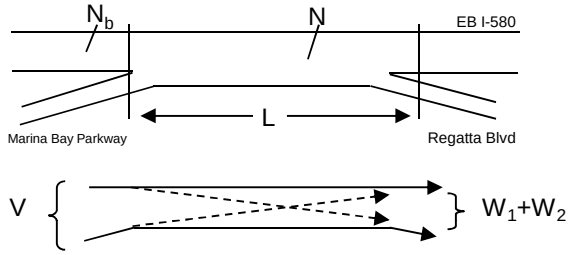


Capacity Analysis

1. Is the weaving section balanced (Y / N)? **N**
   [If optional exit lane, then "Y". Otherwise "N".]
2. In the Weaving Speed Chart to the left, which two speed curves is the black "x" between?
   50 MPH and **55 MPH**
   If below the 55 MPH curve, out of the realm of weaving.
   If left of the 30 MPH curve, LOS is F.
3. Interpolated Weaving Speed (S_w, mph) **54.1**
4. Weaving Intensity Factor (k) **1.00**
5. Service Volume (SV, pcph)
   $SV = (1/N)*[V + (k - 1)*\min(W_1, W_2)]$ **814**
6. Level of Service (LOS) **B**

The LOS in the chart above refers to the capacity of weaving traffic only; through and ramp to ramp traffic is not included.

* Note: **Do not adjust by a Peak Hour Factor (PHF).** The methodology incorporates the PHF in the Service Volume tables.

Sources: *Completion of Procedures for Analysis and Design of Traffic Weaving Sections*, Jack E. Leisch & Associates, September 1983 and *Highway Design Manual*, California Department of Transportation, July 24, 2009

Leisch Method for Weaving Analysis

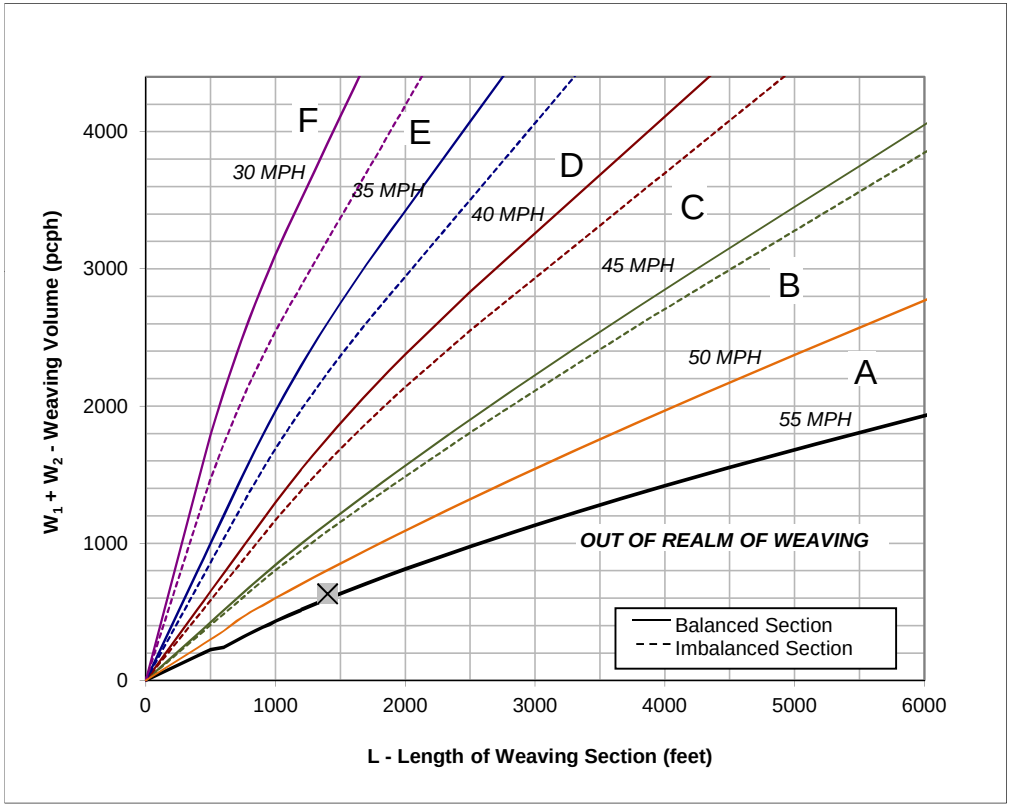
Data Input

Number of Entering Mainline Lanes	N_b	3
Number of Lanes in Weaving Section	N	4
Length of Weaving Section (feet)	L	1,400

Total Weaving Section (V)		On-ramp to Mainline (W_1)		Mainline to Off-ramp (W_2)	
Volume (vph)*	3,363	Volume (vph)*	143	Volume (vph)*	471
Truck Percentage	6%	Truck Percentage	6%	Truck Percentage	6%
PCE for Trucks	1.5	PCE for Trucks	1.5	PCE for Trucks	1.5
Volume (pcph)	3,464	Volume (pcph)	147	Volume (pcph)	485

Project Information

Project	LBNL
Scenario	Near-Term + Project Alt AM
Freeway	WB I-580
On-ramp	Regatta Blvd
Off-ramp	Marina Bay Parkway



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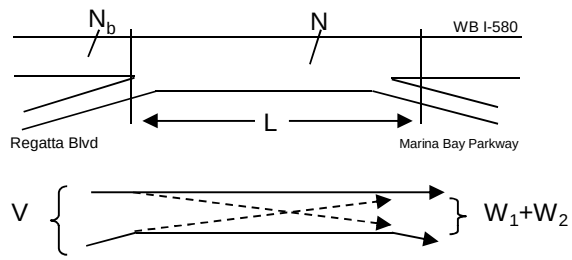


Capacity Analysis

1. Is the weaving section balanced (Y / N)? **N**
   [If optional exit lane, then "Y". Otherwise "N".]
2. In the Weaving Speed Chart to the left, which two speed curves is the black "x" between?
   50 MPH and **55 MPH**
   If below the 55 MPH curve, out of the realm of weaving.
   If left of the 30 MPH curve, LOS is F.
3. Interpolated Weaving Speed (S_w, mph) **54.1**
4. Weaving Intensity Factor (k) **1.00**
5. Service Volume (SV, pcph)
   $SV = (1/N)*[V + (k - 1)*\min(W_1, W_2)]$ **866**
6. Level of Service (LOS) **B**

The LOS in the chart above refers to the capacity of weaving traffic only; through and ramp to ramp traffic is not included.

* Note: **Do not adjust by a Peak Hour Factor (PHF).** The methodology incorporates the PHF in the Service Volume tables.

Sources: *Completion of Procedures for Analysis and Design of Traffic Weaving Sections*, Jack E. Leisch & Associates, September 1983 and *Highway Design Manual*, California Department of Transportation, July 24, 2009

Leisch Method for Weaving Analysis

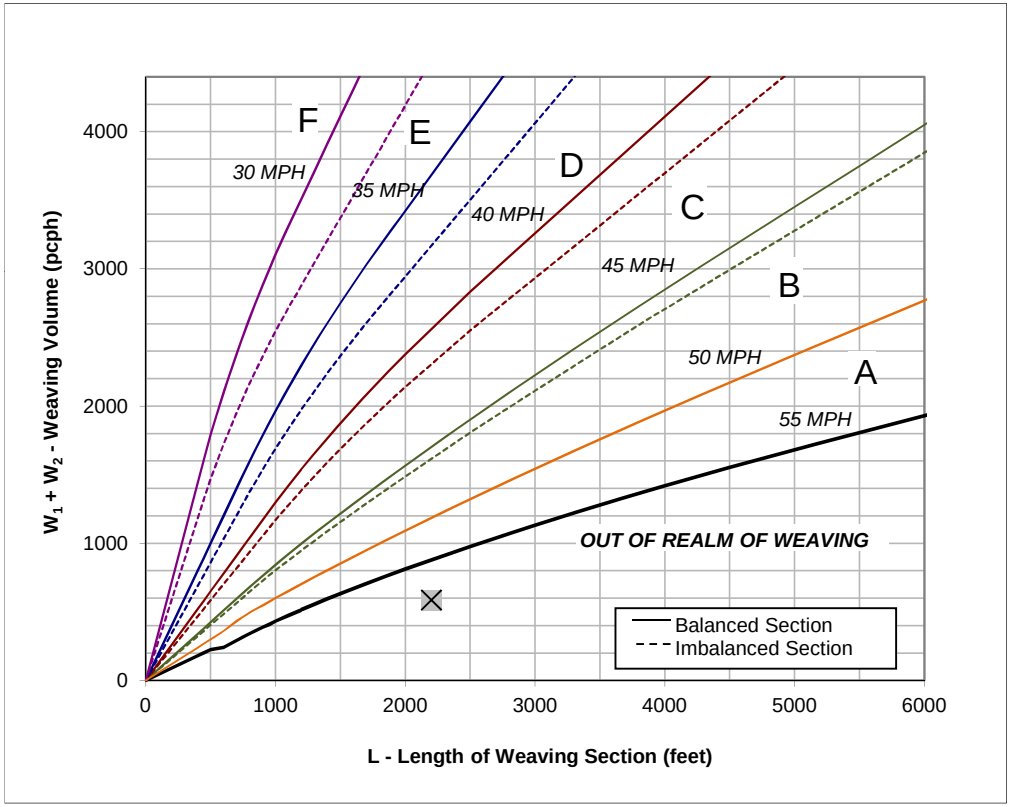
Data Input

Number of Entering Mainline Lanes	N_b	3
Number of Lanes in Weaving Section	N	4
Length of Weaving Section (feet)	L	2,200

Total Weaving Section (V)		On-ramp to Mainline (W_1)		Mainline to Off-ramp (W_2)	
Volume (vph)*	3,270	Volume (vph)*	140	Volume (vph)*	430
Truck Percentage	6%	Truck Percentage	6%	Truck Percentage	6%
PCE for Trucks	1.5	PCE for Trucks	1.5	PCE for Trucks	1.5
Volume (pcph)	3,368	Volume (pcph)	144	Volume (pcph)	443

Project Information

Project	LBNL
Scenario	Near-Term + Project Alt AM
Freeway	EB I-580
On-ramp	Regatta Blvd
Off-ramp	Bayview Ave



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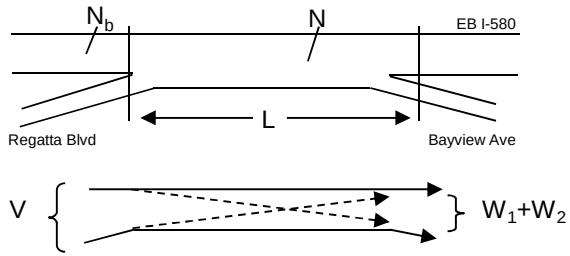


Capacity Analysis

1. Is the weaving section balanced (Y / N)? **N**
   [If optional exit lane, then "Y". Otherwise "N".]
2. In the Weaving Speed Chart to the left, which two speed curves is the black "x" between?
   50 MPH and **55 MPH**
   If below the 55 MPH curve, out of the realm of weaving.
   If left of the 30 MPH curve, LOS is F.
3. Interpolated Weaving Speed (S_w, mph) **59.8**
4. Weaving Intensity Factor (k) **1.00**
5. Service Volume (SV, pcph)
   $SV = (1/N)*[V + (k - 1)*\min(W_1, W_2)]$ **842**
6. Level of Service (LOS) **B**

The LOS in the chart above refers to the capacity of weaving traffic only; through and ramp to ramp traffic is not included.

* Note: **Do not adjust by a Peak Hour Factor (PHF).** The methodology incorporates the PHF in the Service Volume tables.

Sources: *Completion of Procedures for Analysis and Design of Traffic Weaving Sections*, Jack E. Leisch & Associates, September 1983 and *Highway Design Manual*, California Department of Transportation, July 24, 2009

Leisch Method for Weaving Analysis

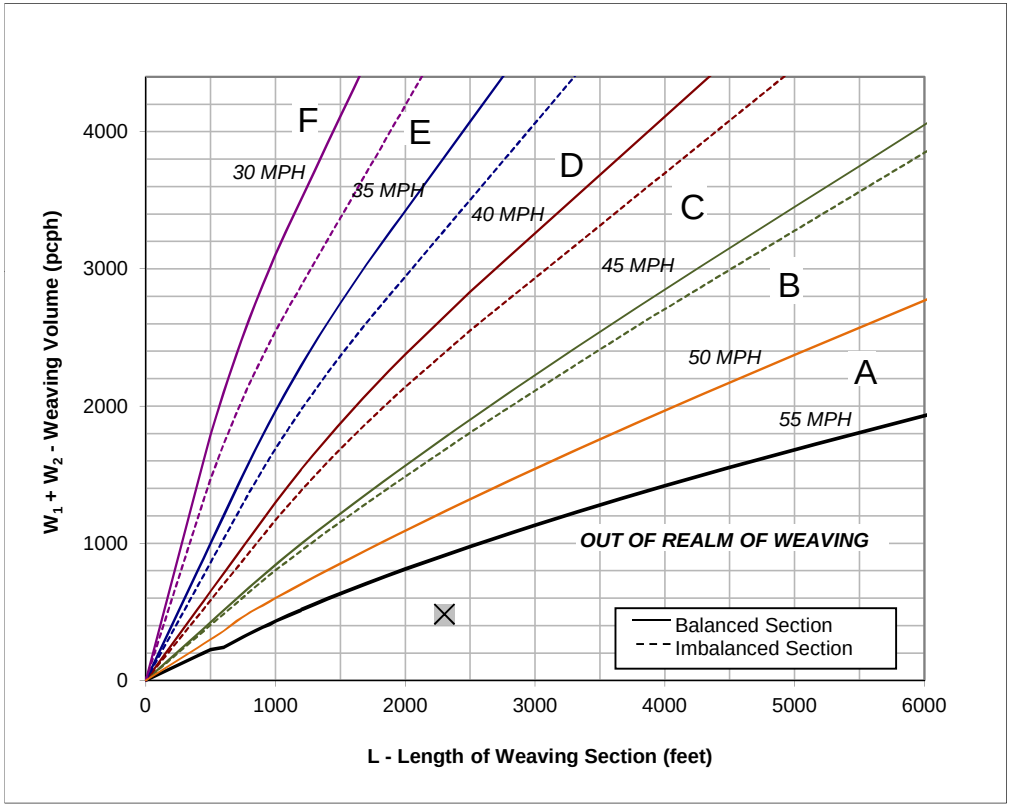
Data Input

Number of Entering Mainline Lanes	N_b	3
Number of Lanes in Weaving Section	N	4
Length of Weaving Section (feet)	L	2,300

Total Weaving Section (V)		On-ramp to Mainline (W_1)		Mainline to Off-ramp (W_2)	
Volume (vph)*	3,310	Volume (vph)*	380	Volume (vph)*	90
Truck Percentage	6%	Truck Percentage	6%	Truck Percentage	6%
PCE for Trucks	1.5	PCE for Trucks	1.5	PCE for Trucks	1.5
Volume (pcph)	3,409	Volume (pcph)	391	Volume (pcph)	93

Project Information

Project	LBNL
Scenario	Near-Term + Project Alt AM
Freeway	WB I-580
On-ramp	Bayview Ave
Off-ramp	Regatta Blvd



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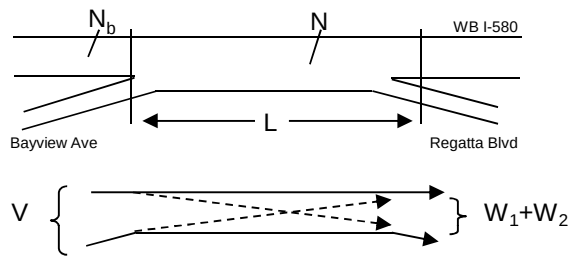


Capacity Analysis

1. Is the weaving section balanced (Y / N)? **N**
   [If optional exit lane, then "Y". Otherwise "N".]
2. In the Weaving Speed Chart to the left, which two speed curves is the black "x" between?
   50 MPH and **55 MPH**
   If below the 55 MPH curve, out of the realm of weaving.
   If left of the 30 MPH curve, LOS is F.
3. Interpolated Weaving Speed (S_w, mph) **61.7**
4. Weaving Intensity Factor (k) **1.00**
5. Service Volume (SV, pcph)
   $SV = (1/N)*[V + (k - 1)*\min(W_1, W_2)]$ **852**
6. Level of Service (LOS) **B**

The LOS in the chart above refers to the capacity of weaving traffic only; through and ramp to ramp traffic is not included.

* Note: **Do not adjust by a Peak Hour Factor (PHF).** The methodology incorporates the PHF in the Service Volume tables.

Sources: *Completion of Procedures for Analysis and Design of Traffic Weaving Sections*, Jack E. Leisch & Associates, September 1983 and *Highway Design Manual*, California Department of Transportation, July 24, 2009

Leisch Method for Weaving Analysis

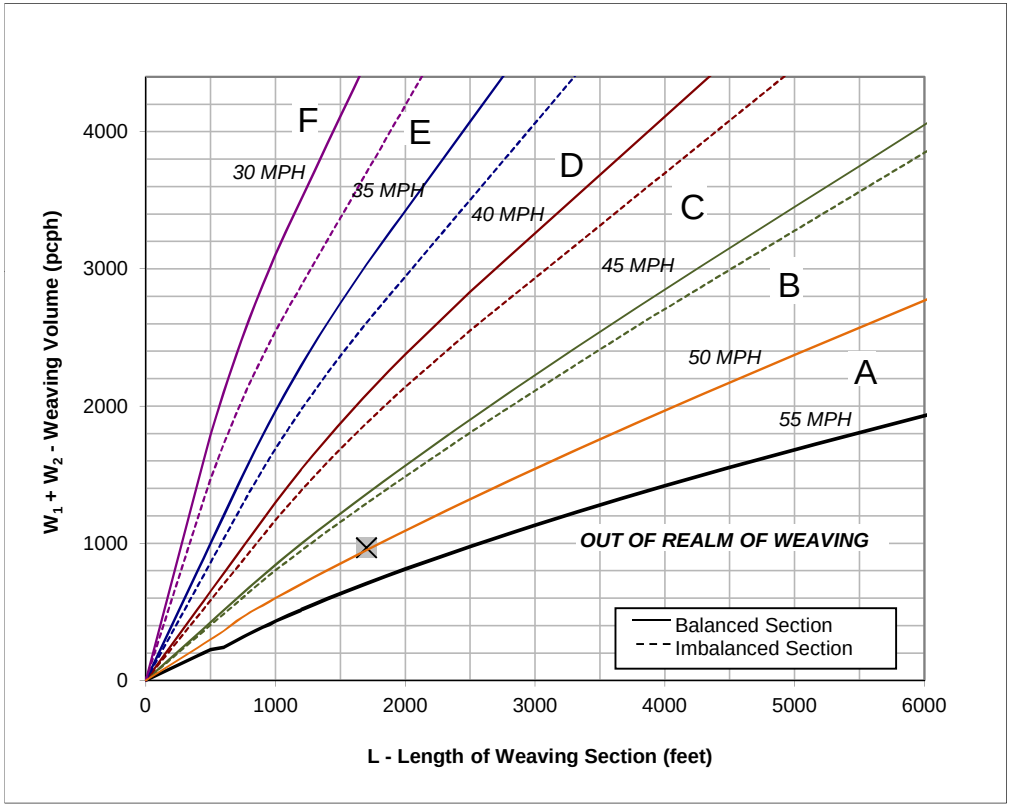
Data Input

Number of Entering Mainline Lanes	N_b	3
Number of Lanes in Weaving Section	N	4
Length of Weaving Section (feet)	L	1,700

Total Weaving Section (V)		On-ramp to Mainline (W_1)		Mainline to Off-ramp (W_2)	
Volume (vph)*	3,110	Volume (vph)*	600	Volume (vph)*	340
Truck Percentage	6%	Truck Percentage	6%	Truck Percentage	6%
PCE for Trucks	1.5	PCE for Trucks	1.5	PCE for Trucks	1.5
Volume (pcph)	3,203	Volume (pcph)	618	Volume (pcph)	350

Project Information

Project	LBNL
Scenario	Near-Term PM
Freeway	EB I-580
On-ramp	Harbour Way
Off-ramp	Marina Bay Pkwy



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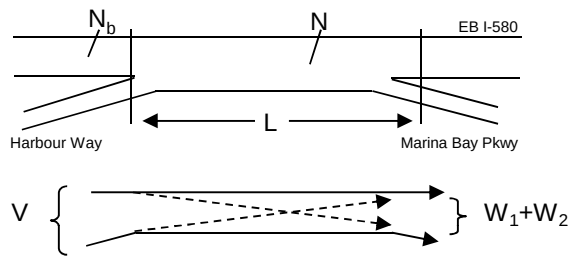


Capacity Analysis

1. Is the weaving section balanced (Y / N)? **N**
   [If optional exit lane, then "Y". Otherwise "N".]
2. In the Weaving Speed Chart to the left, which two speed curves is the black "x" between?
   50 MPH and **55 MPH**
   If below the 55 MPH curve, out of the realm of weaving.
   If left of the 30 MPH curve, LOS is F.
3. Interpolated Weaving Speed (S_w, mph) **49.6**
4. Weaving Intensity Factor (k) **1.25**
5. Service Volume (SV, pcph)
   $SV = (1/N)*[V + (k - 1)*\min(W_1, W_2)]$ **823**
6. Level of Service (LOS) **B**

The LOS in the chart above refers to the capacity of weaving traffic only; through and ramp to ramp traffic is not included.

* Note: **Do not adjust by a Peak Hour Factor (PHF).** The methodology incorporates the PHF in the Service Volume tables.

Sources: *Completion of Procedures for Analysis and Design of Traffic Weaving Sections*, Jack E. Leisch & Associates, September 1983 and *Highway Design Manual*, California Department of Transportation, July 24, 2009

Leisch Method for Weaving Analysis

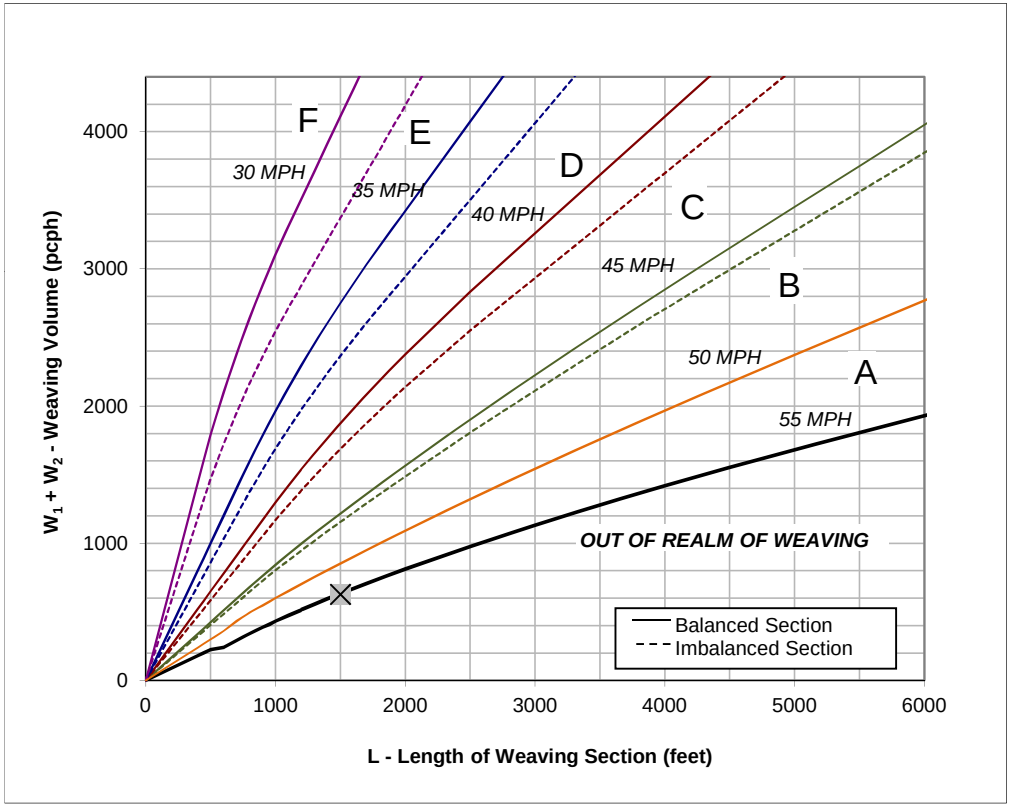
Data Input

Number of Entering Mainline Lanes	N_b	3
Number of Lanes in Weaving Section	N	4
Length of Weaving Section (feet)	L	1,500

Total Weaving Section (V)		On-ramp to Mainline (W_1)		Mainline to Off-ramp (W_2)	
Volume (vph)*	2,237	Volume (vph)*	220	Volume (vph)*	390
Truck Percentage	6%	Truck Percentage	6%	Truck Percentage	6%
PCE for Trucks	1.5	PCE for Trucks	1.5	PCE for Trucks	1.5
Volume (pcph)	2,304	Volume (pcph)	227	Volume (pcph)	402

Project Information

Project	LBNL
Scenario	Near-Term PM
Freeway	WB I-580
On-ramp	Marina Bay Parkway
Off-ramp	Harbour Way



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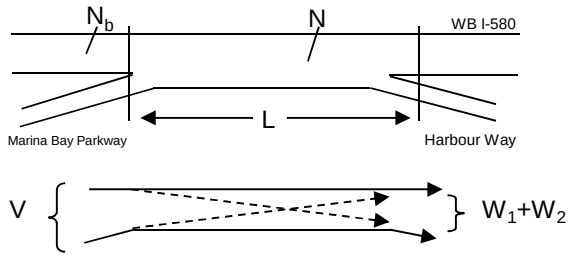


Capacity Analysis

1. Is the weaving section balanced (Y / N)? **N**
   [If optional exit lane, then "Y". Otherwise "N".]
2. In the Weaving Speed Chart to the left, which two speed curves is the black "x" between?
   50 MPH and **55 MPH**
   If below the 55 MPH curve, out of the realm of weaving.
   If left of the 30 MPH curve, LOS is F.
3. Interpolated Weaving Speed (S_w, mph) **55.1**
4. Weaving Intensity Factor (k) **1.00**
5. Service Volume (SV, pcph)
   $SV = (1/N)*[V + (k - 1)*\min(W_1, W_2)]$ **576**
6. Level of Service (LOS) **A**

The LOS in the chart above refers to the capacity of weaving traffic only; through and ramp to ramp traffic is not included.

* Note: **Do not adjust by a Peak Hour Factor (PHF).** The methodology incorporates the PHF in the Service Volume tables.

Sources: *Completion of Procedures for Analysis and Design of Traffic Weaving Sections*, Jack E. Leisch & Associates, September 1983 and *Highway Design Manual*, California Department of Transportation, July 24, 2009

Leisch Method for Weaving Analysis

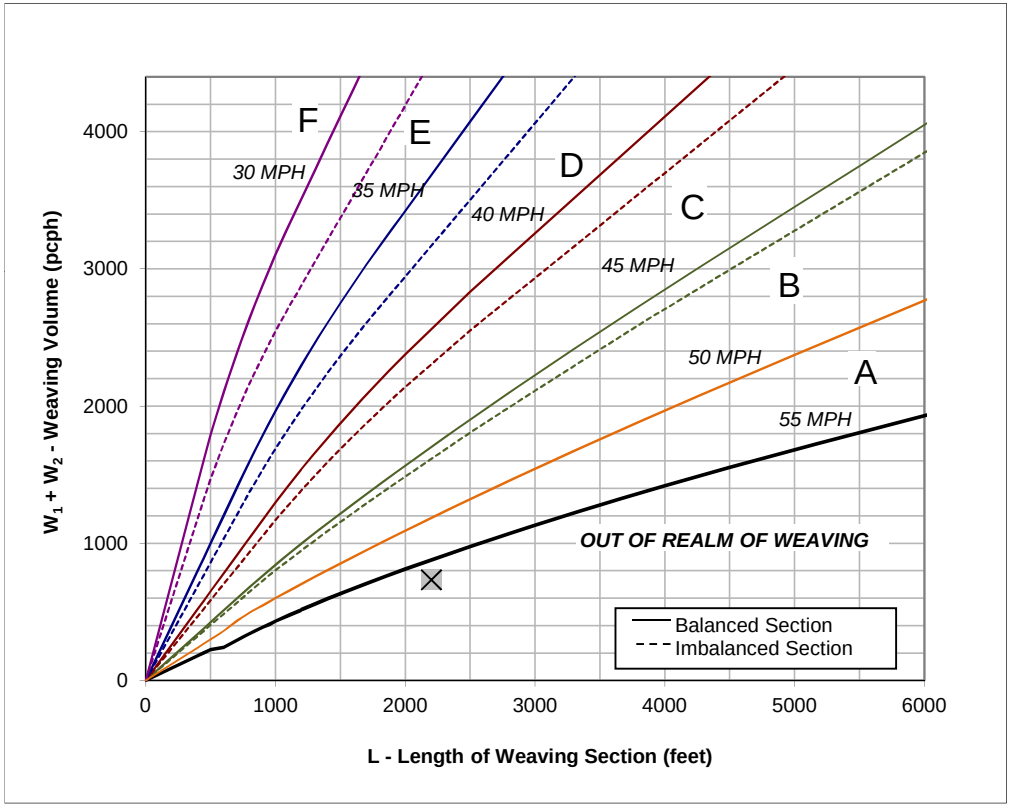
Data Input

Number of Entering Mainline Lanes	N_b	3
Number of Lanes in Weaving Section	N	4
Length of Weaving Section (feet)	L	2,200

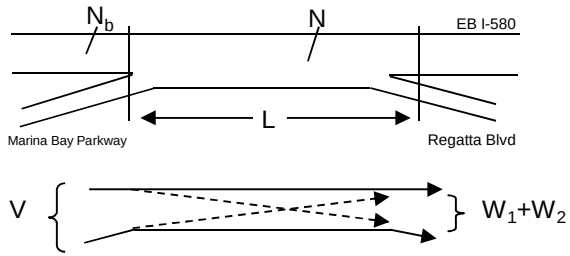
Total Weaving Section (V)		On-ramp to Mainline (W_1)		Mainline to Off-ramp (W_2)	
Volume (vph)*	3,262	Volume (vph)*	581	Volume (vph)*	132
Truck Percentage	6%	Truck Percentage	6%	Truck Percentage	6%
PCE for Trucks	1.5	PCE for Trucks	1.5	PCE for Trucks	1.5
Volume (pcph)	3,360	Volume (pcph)	598	Volume (pcph)	136

Project Information

Project	LBNL
Scenario	Near-Term PM
Freeway	EB I-580
On-ramp	Marina Bay Parkway
Off-ramp	Regatta Blvd



Figure



Capacity Analysis

1. Is the weaving section balanced (Y / N)? **N**
   [If optional exit lane, then "Y". Otherwise "N".]
2. In the Weaving Speed Chart to the left, which two speed curves is the black "x" between?
   50 MPH and **55 MPH**
   If below the 55 MPH curve, out of the realm of weaving.
   If left of the 30 MPH curve, LOS is F.
3. Interpolated Weaving Speed (S_w, mph) **57.4**
4. Weaving Intensity Factor (k) **1.00**
5. Service Volume (SV, pcph)
   $SV = (1/N)*[V + (k - 1)*\min(W_1, W_2)]$ **840**
6. Level of Service (LOS) **B**

The LOS in the chart above refers to the capacity of weaving traffic only; through and ramp to ramp traffic is not included.

* Note: **Do not adjust by a Peak Hour Factor (PHF).** The methodology incorporates the PHF in the Service Volume tables.

Sources: *Completion of Procedures for Analysis and Design of Traffic Weaving Sections*, Jack E. Leisch & Associates, September 1983 and *Highway Design Manual*, California Department of Transportation, July 24, 2009

Leisch Method for Weaving Analysis

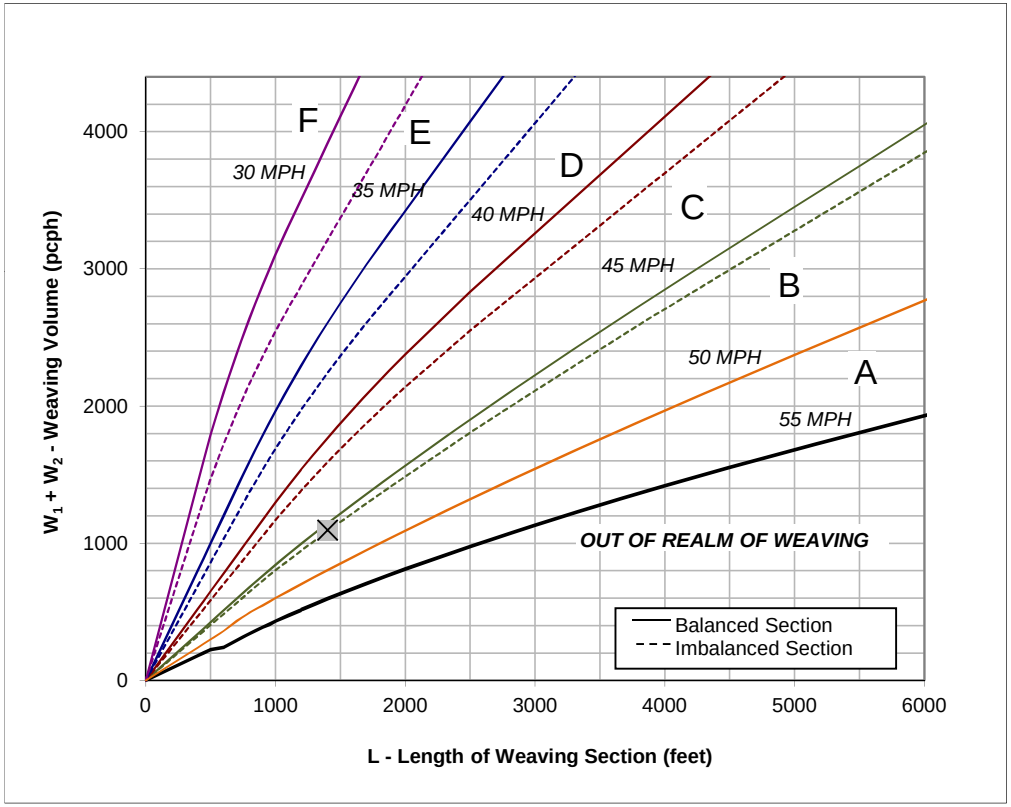
Data Input

Number of Entering Mainline Lanes	N_b	3
Number of Lanes in Weaving Section	N	4
Length of Weaving Section (feet)	L	1,400

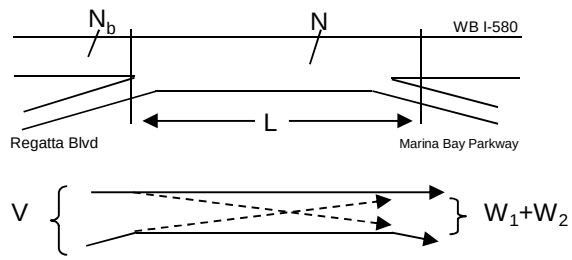
Total Weaving Section (V)		On-ramp to Mainline (W_1)		Mainline to Off-ramp (W_2)	
Volume (vph)*	2,926	Volume (vph)*	136	Volume (vph)*	929
Truck Percentage	6%	Truck Percentage	6%	Truck Percentage	6%
PCE for Trucks	1.5	PCE for Trucks	1.5	PCE for Trucks	1.5
Volume (pcph)	3,014	Volume (pcph)	140	Volume (pcph)	957

Project Information

Project	LBNL
Scenario	Near-Term PM
Freeway	WB I-580
On-ramp	Regatta Blvd
Off-ramp	Marina Bay Parkway



Figure



Capacity Analysis

1. Is the weaving section balanced (Y / N)? **N**
   [If optional exit lane, then "Y". Otherwise "N".]
2. In the Weaving Speed Chart to the left, which two speed curves is the black "x" between?
   45 MPH and **50 MPH**
   If below the 55 MPH curve, out of the realm of weaving.
   If left of the 30 MPH curve, LOS is F.
3. Interpolated Weaving Speed (S_w, mph) **44.8**
4. Weaving Intensity Factor (k) **2.69**
5. Service Volume (SV, pcph)
   $SV = (1/N)*[V + (k - 1)*\min(W_1, W_2)]$ **813**
6. Level of Service (LOS) **B**

The LOS in the chart above refers to the capacity of weaving traffic only; through and ramp to ramp traffic is not included.

* Note: **Do not adjust by a Peak Hour Factor (PHF).** The methodology incorporates the PHF in the Service Volume tables.

Sources: *Completion of Procedures for Analysis and Design of Traffic Weaving Sections*, Jack E. Leisch & Associates, September 1983 and *Highway Design Manual*, California Department of Transportation, July 24, 2009

Leisch Method for Weaving Analysis

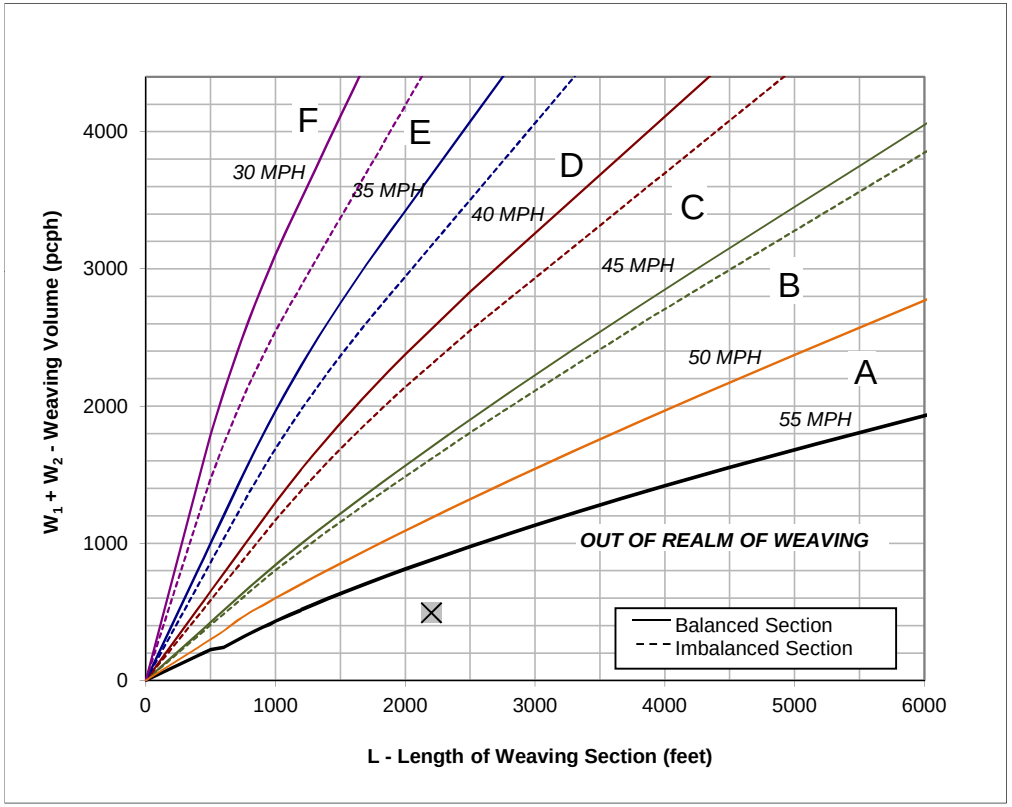
Data Input

Number of Entering Mainline Lanes	N_b	3
Number of Lanes in Weaving Section	N	4
Length of Weaving Section (feet)	L	2,200

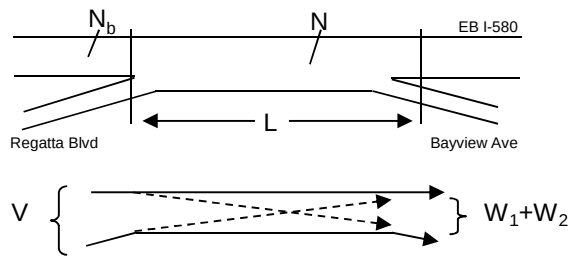
Total Weaving Section (V)		On-ramp to Mainline (W_1)		Mainline to Off-ramp (W_2)	
Volume (vph)*	3,260	Volume (vph)*	400	Volume (vph)*	80
Truck Percentage	6%	Truck Percentage	6%	Truck Percentage	6%
PCE for Trucks	1.5	PCE for Trucks	1.5	PCE for Trucks	1.5
Volume (pcph)	3,358	Volume (pcph)	412	Volume (pcph)	82

Project Information

Project	LBNL
Scenario	Near-Term PM
Freeway	EB I-580
On-ramp	Regatta Blvd
Off-ramp	Bayview Ave



Figure



Capacity Analysis

1. Is the weaving section balanced (Y / N)? **N**
   [If optional exit lane, then "Y". Otherwise "N".]
2. In the Weaving Speed Chart to the left, which two speed curves is the black "x" between?
   50 MPH and **55 MPH**
   If below the 55 MPH curve, out of the realm of weaving.
   If left of the 30 MPH curve, LOS is F.
3. Interpolated Weaving Speed (S_w, mph) **61.3**
4. Weaving Intensity Factor (k) **1.00**
5. Service Volume (SV, pcph)
   $SV = (1/N)*[V + (k - 1)*\min(W_1, W_2)]$ **839**
6. Level of Service (LOS) **B**

The LOS in the chart above refers to the capacity of weaving traffic only; through and ramp to ramp traffic is not included.

* Note: **Do not adjust by a Peak Hour Factor (PHF).** The methodology incorporates the PHF in the Service Volume tables.

Sources: *Completion of Procedures for Analysis and Design of Traffic Weaving Sections*, Jack E. Leisch & Associates, September 1983 and *Highway Design Manual*, California Department of Transportation, July 24, 2009

Leisch Method for Weaving Analysis

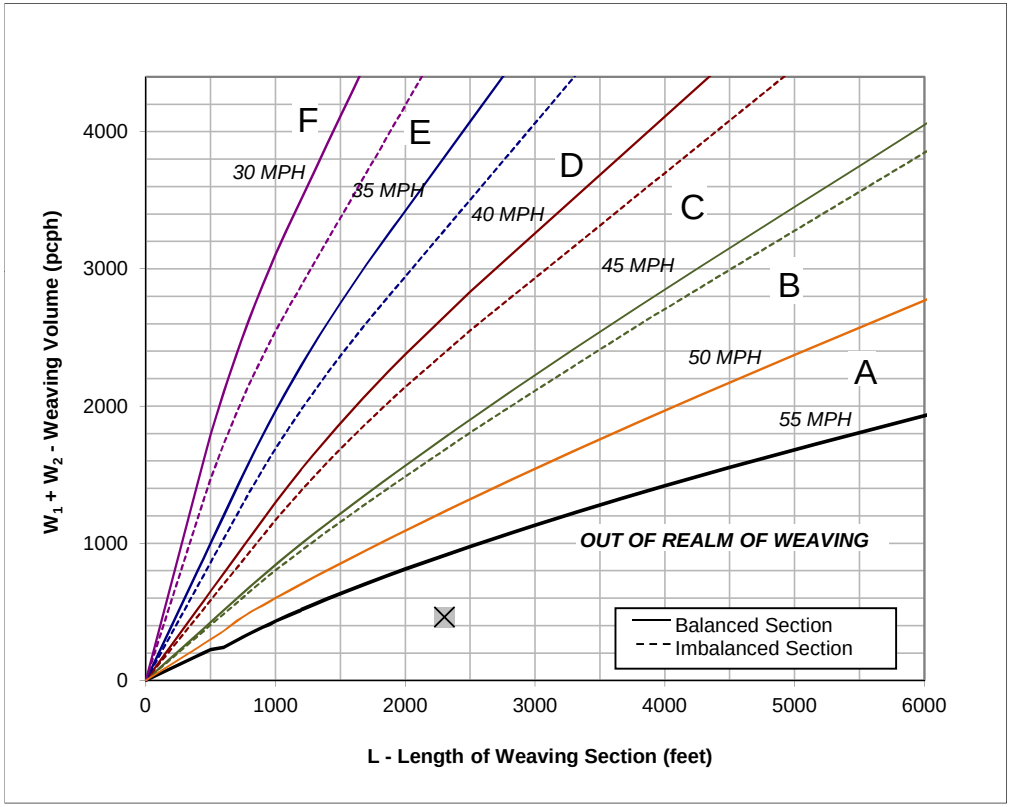
Data Input

Number of Entering Mainline Lanes	N_b	3
Number of Lanes in Weaving Section	N	4
Length of Weaving Section (feet)	L	2,300

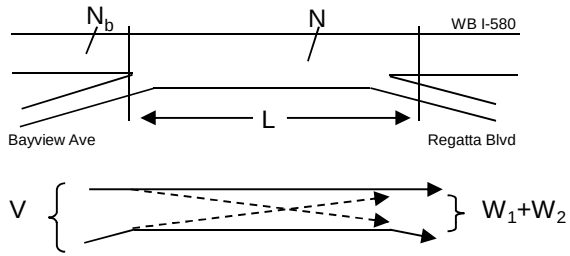
Total Weaving Section (V)		On-ramp to Mainline (W_1)		Mainline to Off-ramp (W_2)	
Volume (vph)*	3,080	Volume (vph)*	290	Volume (vph)*	160
Truck Percentage	6%	Truck Percentage	6%	Truck Percentage	6%
PCE for Trucks	1.5	PCE for Trucks	1.5	PCE for Trucks	1.5
Volume (pcph)	3,172	Volume (pcph)	299	Volume (pcph)	165

Project Information

Project	LBNL
Scenario	Near-Term PM
Freeway	WB I-580
On-ramp	Bayview Ave
Off-ramp	Regatta Blvd



Figure



Capacity Analysis

1. Is the weaving section balanced (Y / N)? **N**
   [If optional exit lane, then "Y". Otherwise "N".]
2. In the Weaving Speed Chart to the left, which two speed curves is the black "x" between?
   50 MPH and **55 MPH**
   If below the 55 MPH curve, out of the realm of weaving.
   If left of the 30 MPH curve, LOS is F.
3. Interpolated Weaving Speed (S_w, mph) **62.1**
4. Weaving Intensity Factor (k) **1.00**
5. Service Volume (SV, pcph)
   $SV = (1/N)*[V + (k - 1)*\min(W_1, W_2)]$ **793**
6. Level of Service (LOS) **A**

The LOS in the chart above refers to the capacity of weaving traffic only; through and ramp to ramp traffic is not included.

* Note: **Do not adjust by a Peak Hour Factor (PHF).** The methodology incorporates the PHF in the Service Volume tables.

Sources: *Completion of Procedures for Analysis and Design of Traffic Weaving Sections*, Jack E. Leisch & Associates, September 1983 and *Highway Design Manual*, California Department of Transportation, July 24, 2009

Appendix D: Intersection Count Data Sheets
Alameda Point

FEHR PEERS

Study Name WC12-2953_A1 1. Willie Stargell Avenue (sometimes called Tinker Ave)/We
Start Date 12/12/2012
Start Time 4:00 PM
Site Code

	Southbound Street Southbound			Northbound Street Northbound			Eastbound Street Eastbound		
Start Time	Right	Thru	U-Turn	Thru	Left	U-Turn	Right	Left	U-Turn
4:00 PM	0	1	0	2	0	0	1	0	0
4:15 PM	0	1	0	1	0	0	0	0	0
4:30 PM	0	0	0	0	0	0	0	0	0
4:45 PM	0	1	0	1	0	0	0	0	0
5:00 PM	0	0	0	0	0	0	0	0	0
5:15 PM	0	0	0	0	0	0	0	1	0
5:30 PM	0	0	0	0	0	0	0	0	0
5:45 PM	0	0	0	1	0	0	0	0	0
7:00 AM	0	0	0	0	0	0	0	0	0
7:15 AM	0	0	0	0	0	0	0	0	0
7:30 AM	0	0	0	0	0	0	0	0	0
7:45 AM	0	0	0	0	0	0	0	0	0
8:00 AM	0	0	0	0	0	0	0	0	0
8:15 AM	0	0	0	0	0	0	0	0	0
8:30 AM	0	0	0	0	0	0	0	0	0
8:45 AM	0	0	0	0	0	0	0	0	0

Study Name WC12-2953_A1 1. Willie Stargell Avenue (sometimes called Tink
Start Date 12/12/2012
Start Time 4:00 PM
Site Code

	Southbound Street Southbound		Westbound Street Westbound		Northbound Street Northbound		Eastbound Street Eastbound	
Start Time	Peds CCW	Peds CW	Peds CCW	Peds CW	Peds CCW	Peds CW	Peds CCW	Peds CW
4:00 PM	0	0	2	1	2	0	0	2
4:15 PM	0	0	0	0	2	3	0	0
4:30 PM	0	0	0	1	0	0	0	0
4:45 PM	0	0	1	1	1	2	0	0
5:00 PM	0	0	3	1	5	1	0	0
5:15 PM	0	0	1	0	2	0	0	0
5:30 PM	1	0	0	1	5	2	1	0
5:45 PM	1	0	1	0	2	0	1	0
7:00 AM	0	0	0	0	1	0	0	0
7:15 AM	0	0	1	0	1	1	0	0
7:30 AM	0	0	1	0	3	3	0	0
7:45 AM	0	1	3	1	3	0	0	1
8:00 AM	0	0	1	1	1	0	0	0
8:15 AM	0	2	2	0	2	3	0	2
8:30 AM	0	1	1	2	2	0	0	1
8:45 AM	0	1	1	1	2	0	0	2

Study Name WC12-2953_A1 1. Willie Stargell Avenue (sometimes called Tinker Ave)/We
Start Date 12/12/2012
Start Time 4:00 PM
Site Code

	Southbound Street Southbound			Northbound Street Northbound			Eastbound Street Eastbound		
Start Time	Right	Thru	U-Turn	Thru	Left	U-Turn	Right	Left	U-Turn
4:00 PM	67	188	0	187	5	0	18	72	0
4:15 PM	60	220	0	149	9	1	15	78	0
4:30 PM	78	205	0	166	3	0	19	66	0
4:45 PM	104	261	0	165	16	0	14	62	0
5:00 PM	87	238	0	181	16	1	16	87	0
5:15 PM	108	318	0	167	16	0	20	60	0
5:30 PM	145	308	0	183	17	0	19	62	0
5:45 PM	137	310	0	191	12	0	25	75	0
7:00 AM	53	90	0	197	2	2	2	46	0
7:15 AM	81	128	0	222	7	0	10	40	0
7:30 AM	107	166	0	283	2	1	4	57	0
7:45 AM	118	242	0	307	5	0	10	82	0
8:00 AM	100	176	0	359	5	0	7	107	0
8:15 AM	84	134	0	247	4	0	7	94	0
8:30 AM	76	113	0	254	14	1	9	68	0
8:45 AM	74	141	0	222	8	0	4	62	0

Totals

Study Name WC12-2953_A2 Main Street/Atlantic Avenue (also called Ralph Appezzato Memorial Pkwy)
Start Date 12/12/2012
Start Time 7:00 AM
Site Code

	Southbound Street Southbound				Westbound Street Westbound				Northbound Street Northbound				Eastbound Street Eastbound			
Start Time	Right	Thru	Left	U-Turn	Right	Thru	Left	U-Turn	Right	Thru	Left	U-Turn	Right	Thru	Left	U-Turn
7:00 AM	0	0	0	0	0	1	0	0	1	1	0	0	1	0	0	0
7:15 AM	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0
7:30 AM	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
7:45 AM	0	1	1	0	0	3	0	0	0	0	2	0	0	0	0	0
8:00 AM	0	0	0	0	0	0	0	0	0	3	1	0	0	0	0	0
8:15 AM	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0
8:30 AM	0	1	0	0	0	0	0	0	0	1	1	0	0	0	0	0
8:45 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4:00 PM	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
4:15 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4:30 PM	0	3	1	0	0	0	0	0	0	0	0	0	0	0	0	0
4:45 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5:00 PM	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0
5:15 PM	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0
5:30 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5:45 PM	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0

Study Name WC12-2953_A2 Main Street/Atlantic Avenue (also called Ralph Ap
Start Date 12/12/2012
Start Time 7:00 AM
Site Code

	Southbound Street Southbound		Westbound Street Westbound		Northbound Street Northbound		Eastbound Street Eastbound	
Start Time	Peds CCW	Peds CW	Peds CCW	Peds CW	Peds CCW	Peds CW	Peds CCW	Peds CW
7:00 AM	0	0	2	0	0	0	0	0
7:15 AM	0	0	0	0	1	0	0	1
7:30 AM	0	1	1	1	0	1	0	1
7:45 AM	0	0	0	1	2	0	5	3
8:00 AM	2	0	2	1	0	0	0	0
8:15 AM	0	0	1	1	2	0	0	0
8:30 AM	0	0	0	1	1	1	1	0
8:45 AM	1	0	1	4	1	0	2	0
4:00 PM	0	0	0	4	0	1	0	0
4:15 PM	1	0	0	0	0	0	0	0
4:30 PM	0	0	0	1	0	1	0	0
4:45 PM	0	0	0	1	0	3	0	2
5:00 PM	0	0	1	0	1	0	1	0
5:15 PM	0	0	0	0	0	0	0	0
5:30 PM	1	0	1	0	0	0	0	0
5:45 PM	0	0	0	0	0	1	0	1

Study Name WC12-2953_A2 Main Street/Atlantic Avenue (also called Ralph Appezzato Memorial Pkwy)
Start Date 12/12/2012
Start Time 7:00 AM
Site Code

	Southbound Street Southbound				Westbound Street Westbound				Northbound Street Northbound				Eastbound Street Eastbound			
Start Time	Right	Thru	Left	U-Turn	Right	Thru	Left	U-Turn	Right	Thru	Left	U-Turn	Right	Thru	Left	U-Turn
7:00 AM	5	10	6	0	25	28	8	0	10	68	4	0	6	9	0	0
7:15 AM	2	8	3	0	6	16	3	1	4	9	3	0	1	8	0	0
7:30 AM	7	11	5	0	2	22	15	0	8	9	4	0	3	6	0	0
7:45 AM	5	34	7	0	17	17	28	0	21	29	15	0	3	5	0	0
8:00 AM	1	18	5	0	34	14	16	0	15	89	12	0	3	7	1	0
8:15 AM	3	15	3	0	17	21	4	0	5	33	13	0	3	12	3	0
8:30 AM	1	12	8	0	15	30	10	0	8	26	11	0	6	10	0	0
8:45 AM	2	17	12	0	8	35	18	0	12	22	9	0	4	10	1	0
4:00 PM	3	14	14	0	5	23	6	0	5	17	10	0	10	21	3	1
4:15 PM	1	25	16	0	14	19	10	1	7	16	6	0	9	23	4	0
4:30 PM	1	44	24	0	15	12	6	0	9	10	8	0	11	26	4	0
4:45 PM	2	17	5	0	11	19	13	0	7	14	11	0	16	34	5	0
5:00 PM	2	21	11	0	10	15	6	0	8	14	8	0	20	36	3	0
5:15 PM	0	28	18	0	5	36	8	0	5	16	22	0	8	25	0	0
5:30 PM	1	40	23	0	11	20	12	0	10	14	9	0	17	39	8	0
5:45 PM	1	51	27	0	18	21	11	0	8	28	9	0	2	28	0	0

Totals

Study Name WC12-2953_A3 Third Street/Atlantic Avenue
Start Date 12/12/2012
Start Time 7:00 AM
Site Code

	Southbound Street Southbound				Westbound Street Westbound				Northbound Street Northbound				Eastbound Street Eastbound			
Start Time	Right	Thru	Left	U-Turn	Right	Thru	Left	U-Turn	Right	Thru	Left	U-Turn	Right	Thru	Left	U-Turn
7:00 AM	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0
7:15 AM	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
7:30 AM	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0
7:45 AM	0	0	0	0	0	2	0	0	0	0	0	0	0	1	0	0
8:00 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8:15 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8:30 AM	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
8:45 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4:00 PM	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4:15 PM	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
4:30 PM	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4:45 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5:00 PM	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
5:15 PM	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
5:30 PM	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
5:45 PM	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0

Study Name WC12-2953_A3 Third Street/Atlantic Avenue
Start Date 12/12/2012
Start Time 7:00 AM
Site Code

	Southbound Street Southbound		Westbound Street Westbound		Northbound Street Northbound		Eastbound Street Eastbound	
Start Time	Peds CCW	Peds CW	Peds CCW	Peds CW	Peds CCW	Peds CW	Peds CCW	Peds CW
7:00 AM	1	0	0	0	0	0	0	0
7:15 AM	2	0	2	0	0	0	1	0
7:30 AM	0	0	1	0	2	2	1	7
7:45 AM	2	0	1	13	2	3	7	8
8:00 AM	0	0	0	0	2	3	2	10
8:15 AM	0	3	0	3	2	0	4	11
8:30 AM	0	4	0	4	0	0	2	4
8:45 AM	1	1	0	8	0	0	3	1
4:00 PM	3	1	0	0	3	1	5	3
4:15 PM	1	1	1	0	0	0	0	0
4:30 PM	0	0	1	1	0	0	2	0
4:45 PM	0	0	2	0	0	0	0	0
5:00 PM	0	0	0	0	0	0	0	0
5:15 PM	1	0	0	0	0	0	6	0
5:30 PM	0	0	0	0	0	0	0	6
5:45 PM	0	0	0	0	0	0	11	0

Study Name WC12-2953_A3 Third Street/Atlantic Avenue
Start Date 12/12/2012
Start Time 7:00 AM
Site Code

	Southbound Street Southbound				Westbound Street Westbound				Northbound Street Northbound				Eastbound Street Eastbound			
Start Time	Right	Thru	Left	U-Turn	Right	Thru	Left	U-Turn	Right	Thru	Left	U-Turn	Right	Thru	Left	U-Turn
7:00 AM	0	3	5	0	2	60	13	0	27	4	0	0	1	22	1	1
7:15 AM	0	0	1	0	3	27	14	1	42	2	0	0	2	15	0	0
7:30 AM	2	11	6	0	1	34	17	0	44	10	0	0	1	16	2	1
7:45 AM	5	18	8	0	3	53	26	0	62	19	2	0	2	28	1	0
8:00 AM	4	25	8	0	4	58	28	0	51	29	2	0	1	21	2	0
8:15 AM	0	24	4	0	3	39	25	0	47	22	1	0	0	20	0	0
8:30 AM	3	8	5	0	5	49	22	0	32	8	1	0	1	23	1	1
8:45 AM	0	11	3	0	0	62	51	0	45	15	1	0	3	30	0	1
4:00 PM	1	8	2	0	4	31	23	0	34	6	2	0	2	43	0	0
4:15 PM	0	4	6	0	4	38	37	0	15	7	1	0	0	39	0	3
4:30 PM	0	6	4	0	2	33	33	0	23	5	1	0	3	59	1	0
4:45 PM	2	5	3	0	6	40	36	1	21	6	1	0	3	44	0	1
5:00 PM	1	5	2	0	10	32	31	0	35	6	0	0	2	45	1	1
5:15 PM	1	7	7	0	4	47	42	0	24	8	1	0	3	51	0	0
5:30 PM	2	8	7	0	8	43	42	0	27	8	1	0	1	63	1	0
5:45 PM	1	14	9	0	7	50	61	0	25	6	0	0	0	67	3	0

Totals

Study Name WC12-2953_A4 Webster Street/Atlantic Avenue
Start Date 12/12/2012
Start Time 4:00 PM
Site Code

	Southbound Street Southbound				Westbound Street Westbound				Northbound Street Northbound				Eastbound Street Eastbound			
Start Time	Right	Thru	Left	U-Turn	Right	Thru	Left	U-Turn	Right	Thru	Left	U-Turn	Right	Thru	Left	U-Turn
4:00 PM	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0
4:15 PM	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0
4:30 PM	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0
4:45 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5:00 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5:15 PM	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0
5:30 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5:45 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7:00 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7:15 AM	0	0	0	0	0	0	1	0	0	0	0	0	0	2	0	0
7:30 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7:45 AM	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
8:00 AM	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
8:15 AM	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
8:30 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8:45 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Study Name WC12-2953_A4 Webster Street/Atlantic Avenue
Start Date 12/12/2012
Start Time 4:00 PM
Site Code

	Southbound Street Southbound		Westbound Street Westbound		Northbound Street Northbound		Eastbound Street Eastbound	
Start Time	Peds CCW	Peds CW	Peds CCW	Peds CW	Peds CCW	Peds CW	Peds CCW	Peds CW
4:00 PM	5	7	4	2	4	3	8	8
4:15 PM	4	4	6	1	3	2	11	2
4:30 PM	2	4	3	8	3	3	2	3
4:45 PM	3	7	4	8	3	2	1	4
5:00 PM	3	3	4	1	1	1	2	3
5:15 PM	7	3	1	1	7	3	8	3
5:30 PM	5	5	2	3	2	1	8	7
5:45 PM	10	4	3	5	4	2	2	10
7:00 AM	0	0	1	0	0	0	0	0
7:15 AM	1	0	2	0	0	0	1	8
7:30 AM	1	0	0	0	0	0	0	6
7:45 AM	0	0	3	1	0	0	0	11
8:00 AM	0	0	1	1	0	0	0	1
8:15 AM	6	0	6	2	0	0	0	10
8:30 AM	0	1	1	5	0	0	0	2
8:45 AM	2	0	5	5	0	0	4	6

Study Name WC12-2953_A4 Webster Street/Atlantic Avenue
Start Date 12/12/2012
Start Time 4:00 PM
Site Code

	Southbound Street Southbound				Westbound Street Westbound				Northbound Street Northbound				Eastbound Street Eastbound			
Start Time	Right	Thru	Left	U-Turn	Right	Thru	Left	U-Turn	Right	Thru	Left	U-Turn	Right	Thru	Left	U-Turn
4:00 PM	41	147	24	0	11	42	8	0	15	123	18	0	13	35	56	1
4:15 PM	55	156	17	0	12	33	12	0	22	108	14	0	20	28	40	0
4:30 PM	48	160	28	0	11	44	14	0	20	114	12	0	18	52	53	0
4:45 PM	54	201	22	0	21	48	11	0	18	117	23	0	21	44	43	0
5:00 PM	53	179	30	0	21	51	18	0	20	138	21	0	11	37	54	0
5:15 PM	80	223	25	0	8	47	14	0	19	126	20	0	13	40	47	0
5:30 PM	86	196	24	0	10	76	16	0	21	112	20	0	21	66	58	0
5:45 PM	97	213	27	0	12	76	20	0	17	127	29	0	21	56	64	0
7:00 AM	36	44	8	0	7	18	1	0	6	130	6	0	1	8	47	0
7:15 AM	37	74	19	0	9	17	7	0	3	175	7	0	4	17	52	0
7:30 AM	60	92	21	0	6	38	6	0	3	188	11	0	9	37	74	0
7:45 AM	101	126	15	0	15	72	15	0	7	239	20	0	16	88	89	0
8:00 AM	66	102	9	0	11	67	3	0	12	245	24	0	27	60	83	0
8:15 AM	45	91	10	0	16	39	5	0	19	191	25	0	19	48	56	0
8:30 AM	39	57	15	0	15	46	4	0	13	186	31	0	12	28	39	0
8:45 AM	56	73	9	0	9	34	7	0	4	148	20	0	22	30	53	0

Totals

Study Name WC12-2953_A5 Constitution Way/Atlantic Street
Start Date 12/13/2012
Start Time 7:00 AM
Site Code

	Southbound Street Southbound				Westbound Street Westbound				Northbound Street Northbound				Eastbound Street Eastbound			
Start Time	Right	Thru	Left	U-Turn	Right	Thru	Left	U-Turn	Right	Thru	Left	U-Turn	Right	Thru	Left	U-Turn
7:00 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7:15 AM	0	0	0	0	0	1	0	0	1	0	0	0	0	2	0	0
7:30 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7:45 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8:00 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8:15 AM	0	0	0	0	0	2	0	0	1	0	0	0	0	0	0	0
8:30 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8:45 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Peak Hour Bike Counts																
AM	0	0	0	0	0	2	0	0	1	0	0	0	0	0	0	0

Study Name WC12-2953_A5 Constitution Way/Atlantic Street
Start Date 12/13/2012
Start Time 7:00 AM
Site Code

	Southbound Street Southbound		Westbound Street Westbound		Northbound Street Northbound		Eastbound Street Eastbound	
Start Time	Peds CCW	Peds CW	Peds CCW	Peds CW	Peds CCW	Peds CW	Peds CCW	Peds CW
7:00 AM	2	1	0	1	0	1	0	1
7:15 AM	1	2	0	0	0	2	1	3
7:30 AM	1	0	2	0	1	1	0	0
7:45 AM	0	0	0	1	0	5	0	3
8:00 AM	0	2	2	0	0	0	2	1
8:15 AM	3	3	3	0	0	0	1	4
8:30 AM	2	1	0	0	0	2	0	0
8:45 AM	0	2	1	0	0	0	0	1

Study Name WC12-2953_A5 Constitution Way/Atlantic Street
Start Date 12/13/2012
Start Time 7:00 AM
Site Code

	Southbound Street Southbound				Westbound Street Westbound				Northbound Street Northbound				Eastbound Street Eastbound			
Start Time	Right	Thru	Left	U-Turn	Right	Thru	Left	U-Turn	Right	Thru	Left	U-Turn	Right	Thru	Left	U-Turn
7:00 AM	8	43	10	0	21	15	3	0	3	126	7	0	5	9	10	0
7:15 AM	6	61	11	0	19	12	3	0	2	163	11	0	4	15	15	0
7:30 AM	13	52	10	0	23	20	4	0	6	188	15	0	15	17	14	0
7:45 AM	10	84	12	0	21	45	12	0	8	203	37	0	17	38	11	0
8:00 AM	8	72	14	0	18	28	6	0	14	192	30	0	27	49	12	0
8:15 AM	6	68	22	0	23	26	9	0	9	199	15	0	19	31	28	0
8:30 AM	13	64	21	0	29	25	7	0	10	171	29	0	8	35	11	0
8:45 AM	9	86	25	0	19	26	4	0	9	164	13	0	6	37	13	0

Totals

Study Name WC12-2953_A5 Constitution Way/Atlantic Street - PM
Start Date 12/12/2012
Start Time 4:00 PM
Site Code

	Southbound Street Southbound				Westbound Street Westbound				Northbound Street Northbound				Eastbound Street Eastbound			
Start Time	Right	Thru	Left	U-Turn	Right	Thru	Left	U-Turn	Right	Thru	Left	U-Turn	Right	Thru	Left	U-Turn
4:00 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
4:15 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4:30 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4:45 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5:00 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5:15 PM	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
5:30 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5:45 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6:00 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Peak Hour Bike Counts																
AM	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0

Study Name WC12-2953_A5 Constitution Way/Atlantic Street - PM
Start Date 12/12/2012
Start Time 4:00 PM
Site Code

	Southbound Street Southbound		Westbound Street Westbound		Northbound Street Northbound		Eastbound Street Eastbound	
Start Time	Peds CCW	Peds CW	Peds CCW	Peds CW	Peds CCW	Peds CW	Peds CCW	Peds CW
4:00 PM	0	0	0	2	0	1	0	2
4:15 PM	0	0	1	1	2	0	0	0
4:30 PM	2	0	0	1	0	0	0	0
4:45 PM	1	0	2	0	4	0	2	1
5:00 PM	3	1	2	3	1	1	2	0
5:15 PM	3	2	2	1	0	2	0	0
5:30 PM	1	1	0	0	0	1	0	1
5:45 PM	1	1	0	0	0	2	0	0
6:00 PM	0	0	0	0	0	0	0	0

Study Name WC12-2953_A5 Constitution Way/Atlantic Street - PM
Start Date 12/12/2012
Start Time 4:00 PM
Site Code

	Southbound Street Southbound				Westbound Street Westbound				Northbound Street Northbound				Eastbound Street Eastbound			
Start Time	Right	Thru	Left	U-Turn	Right	Thru	Left	U-Turn	Right	Thru	Left	U-Turn	Right	Thru	Left	U-Turn
4:00 PM	19	188	11	0	28	24	8	0	11	94	17	0	17	24	22	0
4:15 PM	23	207	22	0	23	11	6	0	3	123	14	0	20	27	18	0
4:30 PM	22	248	28	0	22	21	8	0	5	114	14	0	12	48	27	0
4:45 PM	25	257	29	0	21	20	11	0	5	105	23	0	14	31	24	0
5:00 PM	32	290	38	0	25	23	12	0	9	111	20	0	18	36	22	0
5:15 PM	17	296	30	0	32	25	10	0	4	118	18	0	27	27	33	0
5:30 PM	24	292	28	0	28	27	10	0	5	112	23	0	28	34	20	0
5:45 PM	38	279	33	0	22	36	8	0	14	118	34	0	22	52	23	0
6:00 PM	1	15	3	0	1	1	0	0	0	4	0	0	1	1	1	0

Totals

Study Name WC12-2953_A6 Main Street/Pacific Avenue
Start Date 12/13/2012
Start Time 7:00 AM
Site Code

	Southbound Street Southbound					Westbound Street Westbound					Northbound Street Northbound					Eastbound Street Eastbound				
Start Time	Right	Thru	Left	Hard Left	U-Turn	Hard Right	Right	Thru	Left	U-Turn	Right	Bear Right	Thru	Left	U-Turn	Right	Thru	Bear Left	Left	U-Turn
7:00 AM	0	0	0	0	0	0	3	0	0	0	0	0	1	0	0	0	0	0	0	0
7:15 AM	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0
7:30 AM	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
7:45 AM	0	0	0	0	0	1	1	0	0	0	0	0	2	0	0	0	0	0	0	0
8:00 AM	0	0	0	0	0	0	5	1	0	0	0	0	2	0	0	0	0	0	0	0
8:15 AM	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
8:30 AM	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
8:45 AM	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0

Study Name WC12-2953_A6 Main Street/Pacific Avenue
Start Date 12/13/2012
Start Time 7:00 AM
Site Code

	Southbound Street Southbound		Westbound Street Westbound		Northbound Street Northbound		Eastbound Street Eastbound	
Start Time	Peds CCW	Peds CW	Peds CCW	Peds CW	Peds CCW	Peds CW	Peds CCW	Peds CW
7:00 AM	1	0	0	1	1	0	1	0
7:15 AM	0	1	0	1	0	1	0	0
7:30 AM	0	0	0	1	0	0	1	1
7:45 AM	0	0	0	2	0	0	5	5
8:00 AM	0	0	1	7	0	1	1	2
8:15 AM	0	0	0	1	0	0	0	0
8:30 AM	0	1	0	4	0	0	0	0
8:45 AM	0	0	0	2	0	0	0	0

Study Name WC12-2953_A6 Main Street/Pacific Avenue
Start Date 12/13/2012
Start Time 7:00 AM
Site Code

	Southbound Street Southbound					Westbound Street Westbound					Northbound Street Northbound					Eastbound Street Eastbound				
Start Time	Right	Thru	Left	Hard Left	U-Turn	Hard Right	Right	Thru	Left	U-Turn	Right	Bear Right	Thru	Left	U-Turn	Right	Thru	Bear Left	Left	U-Turn
7:00 AM	1	14	3	0	0	0	19	2	3	0	1	0	60	0	1	0	0	0	0	0
7:15 AM	0	12	5	0	0	0	6	0	5	0	4	1	11	1	0	0	0	0	0	0
7:30 AM	1	31	5	0	0	0	8	0	8	0	3	0	22	0	0	0	1	0	0	0
7:45 AM	0	85	18	0	0	1	22	3	41	0	19	0	56	0	0	0	0	0	0	0
8:00 AM	0	32	10	0	0	1	40	6	17	0	7	1	90	0	0	0	1	0	0	0
8:15 AM	1	27	8	0	0	0	20	3	3	0	1	2	35	0	0	3	0	0	1	0
8:30 AM	0	13	4	0	0	0	15	2	3	0	5	1	21	0	0	0	2	0	0	0
8:45 AM	2	4	5	1	0	0	16	5	1	0	1	0	16	0	0	1	0	0	2	0

Totals

Study Name WC12-2953_A6 Main Street/Pacific Avenue - PM
Start Date 12/13/2012
Start Time 4:00 PM
Site Code

	Southbound Street Southbound					Westbound Street Westbound					Northbound Street Northbound					Eastbound Street Eastbound					South-Eastbound Street Southeastbound				
Start Time	Hard Right	Right	Thru	Left	U-Turn	Right	Bear Right	Thru	Left	U-Turn	Right	Thru	Bear Left	Left	U-Turn	Right	Thru	Left	Hard Left	U-Turn	Hard Right	Bear Right	Bear Left	Hard Left	U-Turn
4:00 PM	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0
4:15 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4:30 PM	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0
4:45 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0
5:00 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
5:15 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5:30 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0
5:45 PM	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0

Study Name WC12-2953_A6 Main Street/Pacific Avenue - PM
Start Date 12/13/2012
Start Time 4:00 PM
Site Code

	Southbound Street Southbound		Westbound Street Westbound		Northbound Street Northbound		Eastbound Street Eastbound		South-Eastbound Stree Southeastbound	
Start Time	Peds CCW	Peds CW	Peds CCW	Peds CW	Peds CCW	Peds CW	Peds CCW	Peds CW	Peds CCW	Peds CW
4:00 PM	0	0	0	0	0	0	0	1	0	0
4:15 PM	0	0	0	0	0	0	0	1	0	0
4:30 PM	0	0	2	0	0	0	2	0	0	0
4:45 PM	1	0	1	2	0	0	1	0	0	0
5:00 PM	0	0	0	0	0	0	0	1	0	0
5:15 PM	0	0	0	0	0	0	0	0	0	0
5:30 PM	0	0	0	0	0	0	0	0	0	0
5:45 PM	0	0	1	1	0	0	1	0	0	0

Study Name WC12-2953_A6 Main Street/Pacific Avenue - PM
Start Date 12/13/2012
Start Time 4:00 PM
Site Code

	Southbound Street Southbound					Westbound Street Westbound					Northbound Street Northbound					Eastbound Street Eastbound					South-Eastbound Street Southeastbound				
Start Time	Hard Right	Right	Thru	Left	U-Turn	Right	Bear Right	Thru	Left	U-Turn	Right	Thru	Bear Left	Left	U-Turn	Right	Thru	Left	Hard Left	U-Turn	Hard Right	Bear Right	Bear Left	Hard Left	U-Turn
4:00 PM	0	0	0	0	0	2	3	0	3	0	5	1	18	1	0	0	3	0	1	0	3	30	8	0	0
4:15 PM	0	0	0	0	0	1	8	5	1	0	5	0	30	1	0	0	0	0	1	0	1	24	7	0	0
4:30 PM	0	0	0	0	0	1	5	1	2	0	3	0	18	0	0	0	0	0	0	0	0	41	23	0	0
4:45 PM	0	0	0	0	0	0	5	3	1	0	4	1	26	4	0	0	1	0	0	0	1	23	5	0	0
5:00 PM	0	0	0	0	0	0	4	1	3	0	10	0	25	0	0	1	1	0	1	0	0	42	14	0	0
5:15 PM	0	0	0	0	0	0	12	0	5	0	10	2	29	0	0	0	2	0	0	0	2	37	10	0	0
5:30 PM	0	0	0	0	0	0	7	1	1	0	4	1	18	0	0	0	2	0	2	0	0	54	26	0	0
5:45 PM	0	0	0	0	0	0	5	3	1	0	0	0	26	1	0	1	0	0	1	0	1	40	15	0	0

Totals

Study Name WC12-2953_A7 Webster Street/Lincoln Avenue
Start Date 12/12/2012
Start Time 4:00 PM
Site Code

	Southbound Street Southbound				Westbound Street Westbound				Northbound Street Northbound				Eastbound Street Eastbound			
Start Time	Right	Thru	Left	U-Turn	Right	Thru	Left	U-Turn	Right	Thru	Left	U-Turn	Right	Thru	Left	U-Turn
4:00 PM	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0
4:15 PM	0	1	0	0	0	0	0	0	0	1	0	0	0	1	0	0
4:30 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
4:45 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5:00 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5:15 PM	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0
5:30 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5:45 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6:00 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7:00 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7:15 AM	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
7:30 AM	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0
7:45 AM	0	0	0	0	0	0	0	0	0	2	0	0	0	0	1	0
8:00 AM	1	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0
8:15 AM	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0
8:30 AM	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0

Study Name WC12-2953_A7 Webster Street/Lincoln Avenue
Start Date 12/12/2012
Start Time 4:00 PM
Site Code

	Southbound Street Southbound		Westbound Street Westbound		Northbound Street Northbound		Eastbound Street Eastbound	
Start Time	Peds CCW	Peds CW	Peds CCW	Peds CW	Peds CCW	Peds CW	Peds CCW	Peds CW
4:00 PM	1	5	6	4	4	4	10	8
4:15 PM	2	3	8	2	5	0	4	4
4:30 PM	2	6	4	2	7	4	4	5
4:45 PM	5	1	3	9	4	1	6	9
5:00 PM	1	0	3	4	5	3	10	9
5:15 PM	5	0	5	2	8	2	5	13
5:30 PM	0	0	2	5	5	2	3	9
5:45 PM	3	1	9	3	3	1	3	11
6:00 PM	0	0	0	0	0	0	0	0
7:00 AM	1	2	3	4	2	3	1	0
7:15 AM	3	2	3	2	1	4	4	2
7:30 AM	6	2	6	4	2	11	3	6
7:45 AM	19	4	9	5	1	2	3	3
8:00 AM	8	1	1	5	8	3	8	4
8:15 AM	12	5	3	1	0	4	3	4
8:30 AM	4	1	6	6	2	1	4	1

Study Name WC12-2953_A7 Webster Street/Lincoln Avenue
Start Date 12/12/2012
Start Time 4:00 PM
Site Code

	Southbound Street Southbound				Westbound Street Westbound				Northbound Street Northbound				Eastbound Street Eastbound			
Start Time	Right	Thru	Left	U-Turn	Right	Thru	Left	U-Turn	Right	Thru	Left	U-Turn	Right	Thru	Left	U-Turn
4:00 PM	17	105	6	0	6	27	7	0	4	92	9	0	7	37	37	0
4:15 PM	23	132	6	0	10	15	1	0	5	89	2	0	9	29	18	0
4:30 PM	18	104	12	0	9	22	8	0	8	87	1	0	12	32	27	0
4:45 PM	19	148	8	0	8	25	3	0	3	85	4	0	8	33	22	0
5:00 PM	22	138	10	0	4	28	11	0	6	102	2	0	10	32	36	0
5:15 PM	22	169	5	0	8	35	10	0	8	88	3	0	7	34	41	0
5:30 PM	19	141	10	0	9	37	12	0	12	100	3	0	11	21	34	0
5:45 PM	22	159	12	0	9	29	16	0	5	114	0	0	7	32	31	0
6:00 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7:00 AM	8	32	1	0	5	15	4	0	1	73	1	0	5	10	39	0
7:15 AM	4	52	0	0	5	12	3	0	2	92	3	0	4	8	45	0
7:30 AM	20	59	2	0	5	32	5	0	7	102	5	0	12	22	54	0
7:45 AM	30	73	4	0	7	122	11	0	5	120	21	0	10	47	61	0
8:00 AM	20	101	3	0	6	82	14	0	5	162	14	0	20	95	69	0
8:15 AM	13	66	4	0	10	31	5	0	7	152	8	0	9	33	55	0
8:30 AM	13	58	6	0	7	24	11	0	4	154	5	0	7	34	45	0

Totals

Study Name WC12-2953_A8 Constitution Way/Lincoln Avenue
Start Date 12/12/2012
Start Time 4:00 PM
Site Code

	Southbound Street Southbound				Westbound Street Westbound				Northbound Street Northbound				Eastbound Street Eastbound			
Start Time	Right	Thru	Left	U-Turn	Right	Thru	Left	U-Turn	Right	Thru	Left	U-Turn	Right	Thru	Left	U-Turn
4:00 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4:15 PM	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0
4:30 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4:45 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0
5:00 PM	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
5:15 PM	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5:30 PM	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
5:45 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6:00 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7:00 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7:15 AM	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0
7:30 AM	0	0	0	0	0	2	0	0	0	0	1	0	0	0	0	0
7:45 AM	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
8:00 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
8:15 AM	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
8:30 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Study Name WC12-2953_A8 Constitution Way/Lincoln Avenue
Start Date 12/12/2012
Start Time 4:00 PM
Site Code

	Southbound Street Southbound		Westbound Street Westbound		Northbound Street Northbound		Eastbound Street Eastbound	
Start Time	Peds CCW	Peds CW	Peds CCW	Peds CW	Peds CCW	Peds CW	Peds CCW	Peds CW
4:00 PM	0	0	1	1	1	1	4	2
4:15 PM	0	0	5	3	4	0	0	0
4:30 PM	1	0	6	4	5	1	7	0
4:45 PM	0	0	3	1	2	0	1	0
5:00 PM	0	0	3	1	0	4	0	3
5:15 PM	0	0	2	3	1	0	0	0
5:30 PM	0	0	0	1	1	0	1	2
5:45 PM	0	0	0	0	0	0	4	0
6:00 PM	0	0	0	0	0	0	0	0
7:00 AM	0	0	2	0	0	2	0	0
7:15 AM	0	0	0	0	1	0	1	1
7:30 AM	1	0	1	5	0	6	3	1
7:45 AM	0	0	1	4	0	4	2	1
8:00 AM	0	0	3	5	0	0	4	2
8:15 AM	0	0	4	5	1	3	0	2
8:30 AM	0	0	1	2	0	2	2	1

Study Name WC12-2953_A8 Constitution Way/Lincoln Avenue
Start Date 12/12/2012
Start Time 4:00 PM
Site Code

	Southbound Street Southbound				Westbound Street Westbound				Northbound Street Northbound				Eastbound Street Eastbound			
Start Time	Right	Thru	Left	U-Turn	Right	Thru	Left	U-Turn	Right	Thru	Left	U-Turn	Right	Thru	Left	U-Turn
4:00 PM	5	109	88	0	30	29	6	0	11	82	4	0	2	40	0	0
4:15 PM	2	120	71	0	35	23	6	0	3	98	7	0	0	36	0	0
4:30 PM	6	130	79	0	33	27	4	0	4	85	1	0	3	37	0	0
4:45 PM	6	118	122	0	25	23	5	0	7	98	8	0	0	47	1	1
5:00 PM	6	121	120	0	38	36	4	0	10	91	3	0	8	37	2	0
5:15 PM	6	146	141	0	24	39	0	0	7	92	3	0	5	43	1	1
5:30 PM	6	137	136	0	39	46	3	0	13	108	5	0	5	31	4	0
5:45 PM	10	127	125	0	25	33	5	0	6	104	2	0	4	44	3	0
6:00 PM	0	0	0	0	0	1	0	0	0	2	0	0	0	0	0	0
7:00 AM	1	28	11	0	34	18	1	0	1	102	4	0	2	10	1	0
7:15 AM	1	26	22	0	39	15	1	1	1	119	3	0	2	7	1	0
7:30 AM	2	49	25	1	47	39	2	0	2	121	7	0	4	19	6	0
7:45 AM	6	64	27	0	57	128	1	0	1	133	9	0	9	40	2	0
8:00 AM	2	75	36	0	71	66	1	0	5	126	5	0	11	79	5	0
8:15 AM	4	55	32	0	48	33	4	0	5	151	2	0	6	42	2	0
8:30 AM	2	48	28	0	46	38	6	0	4	131	6	0	4	33	2	0

Totals

Study Name WC12-2953_A9 8th Street/Central Avenue
Start Date 12/12/2012
Start Time 7:00 AM
Site Code

	Southbound Street Southbound				Westbound Street Westbound				Northbound Street Northbound				Eastbound Street Eastbound			
Start Time	Right	Thru	Left	U-Turn	Right	Thru	Left	U-Turn	Right	Thru	Left	U-Turn	Right	Thru	Left	U-Turn
7:00 AM	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
7:15 AM	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
7:30 AM	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0
7:45 AM	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
8:00 AM	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
8:15 AM	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0
8:30 AM	0	0	0	0	1	0	0	0	0	0	0	0	1	1	0	0
8:45 AM	0	1	0	0	0	2	0	0	0	0	0	0	0	0	0	0
9:00 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4:00 PM	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0
4:15 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4:30 PM	0	0	0	0	0	1	0	0	0	1	0	0	0	1	0	0
4:45 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
5:00 PM	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
5:15 PM	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0
5:30 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Study Name WC12-2953_A9 8th Street/Central Avenue
Start Date 12/12/2012
Start Time 7:00 AM
Site Code

	Southbound Street Southbound		Westbound Street Westbound		Northbound Street Northbound		Eastbound Street Eastbound	
Start Time	Peds CCW	Peds CW	Peds CCW	Peds CW	Peds CCW	Peds CW	Peds CCW	Peds CW
7:00 AM	3	1	1	0	0	3	0	0
7:15 AM	3	1	2	0	2	3	3	1
7:30 AM	4	1	1	2	0	6	5	0
7:45 AM	3	1	1	0	1	3	7	2
8:00 AM	2	1	6	0	1	4	4	0
8:15 AM	1	0	2	0	3	2	1	2
8:30 AM	5	0	2	3	2	4	4	0
8:45 AM	5	5	1	2	1	3	4	3
9:00 AM	0	0	0	0	0	0	0	0
4:00 PM	0	6	4	1	0	0	2	5
4:15 PM	1	1	1	2	1	1	0	2
4:30 PM	0	1	2	1	1	1	4	5
4:45 PM	1	1	0	1	1	1	2	3
5:00 PM	3	2	2	2	4	0	3	4
5:15 PM	0	3	2	5	4	1	8	5
5:30 PM	0	2	0	1	1	3	0	4

Study Name WC12-2953_A9 8th Street/Central Avenue
Start Date 12/12/2012
Start Time 7:00 AM
Site Code

	Southbound Street Southbound				Westbound Street Westbound				Northbound Street Northbound				Eastbound Street Eastbound			
Start Time	Right	Thru	Left	U-Turn	Right	Thru	Left	U-Turn	Right	Thru	Left	U-Turn	Right	Thru	Left	U-Turn
7:00 AM	2	15	7	0	18	43	1	0	1	61	50	0	30	23	2	0
7:15 AM	2	23	6	0	31	37	2	0	2	63	37	0	35	36	1	0
7:30 AM	9	26	18	0	32	73	1	0	4	88	61	0	51	57	2	0
7:45 AM	3	31	18	0	51	105	4	0	2	86	101	0	86	64	0	0
8:00 AM	5	76	20	0	48	106	2	0	5	79	101	0	127	71	4	0
8:15 AM	2	48	20	0	32	79	3	0	1	78	82	0	52	46	2	0
8:30 AM	2	41	15	0	33	75	1	0	5	80	90	0	48	48	2	0
8:45 AM	6	40	10	0	28	88	2	0	5	90	91	0	58	57	3	0
9:00 AM	0	0	0	0	0	0	0	0	0	1	2	0	2	0	0	0
4:00 PM	5	76	18	0	17	73	6	0	5	68	70	0	77	53	1	0
4:15 PM	7	101	16	0	18	48	6	0	4	56	71	0	81	63	2	0
4:30 PM	2	95	17	0	26	52	3	0	3	50	77	0	88	76	2	0
4:45 PM	4	81	23	0	24	79	3	0	5	76	78	0	88	75	1	0
5:00 PM	6	93	19	0	27	72	3	0	2	54	80	0	91	73	3	0
5:15 PM	1	95	35	0	26	72	1	0	9	70	78	0	80	90	4	0
5:30 PM	4	93	19	0	29	76	7	0	4	65	86	0	88	66	4	0

Totals

Study Name 4 TMC
Start Date 01/31/2013
Start Time 7:00 AM
Site Code WC12-2953_#4

	Southbound Street Southbound				Westbound Street Westbound				Northbound Street Northbound				Eastbound Street Eastbound			
Start Time	Right	Thru	Left	U-Turn	Right	Thru	Left	U-Turn	Right	Thru	Left	U-Turn	Right	Thru	Left	U-Turn
7:00 AM	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
7:15 AM	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
7:30 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7:45 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8:00 AM	2	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
8:15 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8:30 AM	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8:45 AM	1	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0
4:00 PM	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0
4:15 PM	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0
4:30 PM	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
4:45 PM	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
5:00 PM	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0
5:15 PM	0	0	0	0	0	1	1	0	0	0	0	0	0	0	1	0
5:30 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
5:45 PM	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0

Study Name 4 TMC
Start Date 01/31/2013
Start Time 7:00 AM
Site Code WC12-2953_#4

	Southbound Street Southbound		Westbound Street Westbound		Northbound Street Northbound		Eastbound Street Eastbound	
Start Time	Peds CCW	Peds CW	Peds CCW	Peds CW	Peds CCW	Peds CW	Peds CCW	Peds CW
7:00 AM	0	2	1	2	0	1	0	0
7:15 AM	2	9	0	0	0	0	0	0
7:30 AM	9	3	1	2	1	2	0	3
7:45 AM	24	0	1	1	0	0	0	1
8:00 AM	15	4	6	5	0	3	5	12
8:15 AM	18	3	3	2	2	3	1	8
8:30 AM	16	5	5	2	7	1	3	7
8:45 AM	45	8	18	6	3	7	4	17
4:00 PM	4	18	7	5	11	9	24	3
4:15 PM	6	14	7	5	8	4	14	7
4:30 PM	1	15	4	8	9	5	19	5
4:45 PM	2	13	2	7	4	6	4	3
5:00 PM	5	9	6	2	4	12	13	8
5:15 PM	6	5	9	0	4	4	8	5
5:30 PM	10	7	4	7	5	9	8	19
5:45 PM	10	8	3	11	3	6	4	10

Study Name Atlantic/Webster TMC
Start Date 01/31/2013
Start Time 7:00 AM
Site Code WC12-2953_#4

	Southbound Street Southbound				Westbound Street Westbound				Northbound Street Northbound				Eastbound Street Eastbound			
Start Time	Right	Thru	Left	U-Turn	Right	Thru	Left	U-Turn	Right	Thru	Left	U-Turn	Right	Thru	Left	U-Turn
7:00 AM	46	33	8	0	10	22	3	0	4	142	3	0	1	12	50	0
7:15 AM	49	72	12	0	8	16	3	0	7	173	8	0	7	10	59	0
7:30 AM	58	89	13	0	7	24	5	0	10	185	9	0	20	20	59	0
7:45 AM	99	137	24	0	7	75	10	0	8	240	31	0	26	47	65	0
8:00 AM	89	119	16	0	15	79	6	0	6	208	33	0	34	82	114	0
8:15 AM	72	88	13	0	15	52	4	0	25	214	24	0	25	55	62	0
8:30 AM	50	75	10	0	11	57	3	0	21	164	34	0	26	46	50	0
8:45 AM	75	69	14	0	13	65	10	0	16	173	36	0	23	50	52	0
4:00 PM	59	142	17	0	12	34	10	0	18	122	18	0	22	45	62	0
4:15 PM	59	153	31	0	10	27	20	0	14	147	21	0	17	33	65	0
4:30 PM	59	146	30	0	11	30	13	0	18	128	12	0	22	39	56	0
4:45 PM	54	171	19	0	21	38	16	0	12	112	14	0	19	37	48	1
5:00 PM	63	184	30	0	21	43	18	0	13	128	31	0	20	37	47	0
5:15 PM	83	222	25	0	15	27	16	0	20	135	27	0	25	42	71	0
5:30 PM	92	202	23	1	19	53	18	0	10	110	25	0	14	41	45	0
5:45 PM	101	208	37	0	17	85	17	0	16	123	30	0	27	63	40	0

Totals

Study Name 9 TMC
Start Date 01/31/2013
Start Time 7:00 AM
Site Code WC12-2953_#9

	Southbound Street Southbound				Westbound Street Westbound				Northbound Street Northbound				Eastbound Street Eastbound			
Start Time	Right	Thru	Left	U-Turn	Right	Thru	Left	U-Turn	Right	Thru	Left	U-Turn	Right	Thru	Left	U-Turn
7:00 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7:15 AM	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
7:30 AM	0	0	0	0	0	6	0	0	0	0	1	0	0	0	0	0
7:45 AM	0	0	0	0	0	1	0	0	0	0	1	0	1	0	0	0
8:00 AM	0	1	0	0	0	1	1	0	0	0	0	0	0	0	0	0
8:15 AM	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0
8:30 AM	0	0	0	0	0	0	0	0	0	3	2	0	0	1	0	0
8:45 AM	0	0	0	0	0	0	0	0	0	1	1	0	1	0	0	0
4:00 PM	0	3	0	0	0	2	0	0	0	0	1	0	0	0	0	0
4:15 PM	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0
4:30 PM	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4:45 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
5:00 PM	0	2	0	0	0	1	0	0	0	0	0	0	0	2	0	0
5:15 PM	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0
5:30 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5:45 PM	0	1	0	0	1	2	0	0	0	0	2	0	0	0	0	0

Study Name 9 TMC
Start Date 01/31/2013
Start Time 7:00 AM
Site Code WC12-2953_#9

	Southbound Street Southbound		Westbound Street Westbound		Northbound Street Northbound		Eastbound Street Eastbound	
Start Time	Peds CCW	Peds CW	Peds CCW	Peds CW	Peds CCW	Peds CW	Peds CCW	Peds CW
7:00 AM	1	1	0	0	0	0	1	2
7:15 AM	2	2	3	1	2	5	0	1
7:30 AM	9	2	3	1	2	13	3	5
7:45 AM	3	0	3	0	1	2	4	2
8:00 AM	6	1	5	2	0	3	1	1
8:15 AM	4	0	3	2	0	0	3	0
8:30 AM	1	2	1	2	0	2	1	1
8:45 AM	0	2	0	0	2	0	5	0
4:00 PM	0	1	1	1	3	3	5	0
4:15 PM	0	3	1	7	3	5	2	2
4:30 PM	3	1	1	0	3	2	2	2
4:45 PM	2	2	3	3	7	3	1	2
5:00 PM	3	2	1	3	4	3	3	0
5:15 PM	3	2	1	6	7	3	3	6
5:30 PM	2	2	2	1	9	2	4	5
5:45 PM	3	0	3	5	4	5	3	6

Study Name Central/8th TMC
Start Date 01/31/2013
Start Time 7:00 AM
Site Code WC12-2953_#9

	Southbound Street Southbound				Westbound Street Westbound				Northbound Street Northbound				Eastbound Street Eastbound			
Start Time	Right	Thru	Left	U-Turn	Right	Thru	Left	U-Turn	Right	Thru	Left	U-Turn	Right	Thru	Left	U-Turn
7:00 AM	3	18	7	0	26	32	3	0	1	67	42	0	37	23	2	0
7:15 AM	3	23	9	0	29	41	4	0	1	79	47	0	25	41	1	0
7:30 AM	6	28	9	0	31	73	3	0	5	86	78	0	63	68	1	0
7:45 AM	5	37	17	0	35	136	3	0	2	73	115	0	91	86	4	0
8:00 AM	4	65	17	0	53	112	5	0	4	72	101	0	105	90	4	0
8:15 AM	3	45	21	0	28	87	3	0	6	92	99	0	62	45	2	0
8:30 AM	2	34	9	0	20	58	1	0	5	82	93	0	51	42	2	0
8:45 AM	3	33	14	0	23	74	1	0	1	73	72	0	63	43	4	0
4:00 PM	3	81	25	0	13	69	4	0	7	68	70	0	81	62	3	0
4:15 PM	3	98	13	0	23	62	7	0	6	58	80	0	73	71	6	0
4:30 PM	3	80	24	0	15	53	6	0	5	50	65	0	83	59	3	0
4:45 PM	7	84	22	0	26	69	6	0	8	71	87	0	81	64	2	0
5:00 PM	9	88	21	0	26	75	5	0	7	73	92	0	98	85	3	0
5:15 PM	6	102	19	0	31	65	6	0	5	53	73	0	104	78	2	0
5:30 PM	5	98	27	0	28	65	2	0	7	79	77	0	92	70	5	0
5:45 PM	6	87	23	0	20	77	3	0	8	68	95	0	101	76	2	0

Totals

Appendix E: Intersection LOS Calculation
Alameda Point

FEHR PEERS

Existing Conditions

FEHR PEERS

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Volume (vph)	347	39	29	1178	775	437
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	0.97	1.00	1.00	0.95	0.91	0.88
Frpb, ped/bikes	1.00	0.98	1.00	1.00	1.00	1.00
Flpb, ped/bikes	1.00	1.00	1.00	1.00	1.00	1.00
Frt	1.00	0.85	1.00	1.00	1.00	0.85
Flt Protected	0.95	1.00	0.95	1.00	1.00	1.00
Satd. Flow (prot)	3400	1535	1752	3505	5036	2760
Flt Permitted	0.95	1.00	0.95	1.00	1.00	1.00
Satd. Flow (perm)	3400	1535	1752	3505	5036	2760
Peak-hour factor, PHF	0.85	0.85	0.85	0.85	0.85	0.85
Adj. Flow (vph)	408	46	34	1386	912	514
RTOR Reduction (vph)	0	0	0	0	0	360
Lane Group Flow (vph)	408	46	34	1386	912	154
Confl. Peds. (#/hr)	3	11	4			4
Confl. Bikes (#/hr)		5				5
Heavy Vehicles (%)	3%	3%	3%	3%	3%	3%
Turn Type		Perm	Prot			Prot
Protected Phases	4		5	2	6	6
Permitted Phases		4				
Actuated Green, G (s)	26.0	26.0	4.0	26.0	18.0	18.0
Effective Green, g (s)	26.0	26.0	4.0	26.0	18.0	18.0
Actuated g/C Ratio	0.43	0.43	0.07	0.43	0.30	0.30
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Lane Grp Cap (vph)	1473	665	117	1519	1511	828
v/s Ratio Prot	c0.12		0.02	c0.40	0.18	0.06
v/s Ratio Perm		0.03				
v/c Ratio	0.28	0.07	0.29	0.91	0.60	0.19
Uniform Delay, d1	10.9	9.9	26.6	15.9	18.0	15.6
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	0.5	0.2	6.2	9.9	1.8	0.5
Delay (s)	11.4	10.1	32.8	25.8	19.7	16.1
Level of Service	B	B	C	C	B	B
Approach Delay (s)	11.3			26.0	18.4	
Approach LOS	B			C	B	

Intersection Summary			
HCM Average Control Delay	20.7	HCM Level of Service	C
HCM Volume to Capacity ratio	0.59		
Actuated Cycle Length (s)	60.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	65.1%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	3	35	15	63	87	91	47	172	51	23	77	10
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0			4.0	4.0	4.0	4.0		4.0	4.0	
Lane Util. Factor		0.95			0.95	1.00	1.00	0.95		0.91	0.91	
Frpb, ped/bikes		0.99			1.00	0.98	1.00	0.99		1.00	1.00	
Flpb, ped/bikes		1.00			1.00	1.00	1.00	1.00		1.00	1.00	
Frt		0.96			1.00	0.85	1.00	0.97		1.00	0.98	
Flt Protected		1.00			0.98	1.00	0.95	1.00		0.95	1.00	
Satd. Flow (prot)		3226			3324	1500	1703	3268		1550	3195	
Flt Permitted		0.94			0.82	1.00	0.95	1.00		0.95	1.00	
Satd. Flow (perm)		3042			2790	1500	1703	3268		1550	3195	
Peak-hour factor, PHF	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77
Adj. Flow (vph)	4	45	19	82	113	118	61	223	66	30	100	13
RTOR Reduction (vph)	0	13	0	0	0	0	0	37	0	0	11	0
Lane Group Flow (vph)	0	55	0	0	195	118	61	252	0	27	105	0
Confl. Peds. (#/hr)	9		8	8		9	12		17	17		12
Confl. Bikes (#/hr)						3			5			2
Heavy Vehicles (%)	6%	6%	6%	6%	6%	6%	6%	6%	6%	6%	6%	6%
Turn Type	Perm			Perm		Free	Split			Split		
Protected Phases		2			6		3	3		4	4	
Permitted Phases	2			6		Free						
Actuated Green, G (s)		12.4			11.4	41.9	9.7	9.7		6.8	6.8	
Effective Green, g (s)		12.4			12.4	41.9	9.7	9.7		7.8	7.8	
Actuated g/C Ratio		0.30			0.30	1.00	0.23	0.23		0.19	0.19	
Clearance Time (s)		4.0			5.0		4.0	4.0		5.0	5.0	
Vehicle Extension (s)		3.0			3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)		900			826	1500	394	757		289	595	
v/s Ratio Prot							0.04	c0.08		0.02	c0.03	
v/s Ratio Perm		0.02			c0.07	0.08						
v/c Ratio		0.06			0.24	0.08	0.15	0.33		0.09	0.18	
Uniform Delay, d1		10.6			11.2	0.0	12.8	13.4		14.1	14.3	
Progression Factor		1.00			1.00	1.00	1.00	1.00		1.00	1.00	
Incremental Delay, d2		0.0			0.1	0.1	0.2	0.3		0.1	0.1	
Delay (s)		10.6			11.3	0.1	13.0	13.7		14.3	14.5	
Level of Service		B			B	A	B	B		B	B	
Approach Delay (s)		10.6			7.1			13.6			14.4	
Approach LOS		B			A			B			B	

Intersection Summary			
HCM Average Control Delay	11.2	HCM Level of Service	B
HCM Volume to Capacity ratio	0.25		
Actuated Cycle Length (s)	41.9	Sum of lost time (s)	12.0
Intersection Capacity Utilization	32.3%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	5	100	4	115	223	15	6	77	210	27	75	12
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0			4.0			4.0	
Lane Util. Factor	1.00	0.95		1.00	0.95			1.00			1.00	
Frpb, ped/bikes	1.00	1.00		1.00	1.00			0.97			1.00	
Flpb, ped/bikes	1.00	1.00		1.00	1.00			1.00			1.00	
Frt	1.00	0.99		1.00	0.99			0.90			0.99	
Flt Protected	0.95	1.00		0.95	1.00			1.00			0.99	
Satd. Flow (prot)	1736	3443		1736	3430			1598			1768	
Flt Permitted	0.95	1.00		0.95	1.00			1.00			0.89	
Satd. Flow (perm)	1736	3443		1736	3430			1593			1595	
Peak-hour factor, PHF	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86
Adj. Flow (vph)	6	116	5	134	259	17	7	90	244	31	87	14
RTOR Reduction (vph)	0	4	0	0	8	0	0	138	0	0	7	0
Lane Group Flow (vph)	6	117	0	134	268	0	0	203	0	0	125	0
Confl. Peds. (#/hr)	11		13	13		11	22		48	48		22
Confl. Bikes (#/hr)			1			2			1			
Heavy Vehicles (%)	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%
Turn Type	Prot			Prot			Perm			Perm		
Protected Phases	7	4		3	8			2			6	
Permitted Phases							2			6		
Actuated Green, G (s)	6.0	16.0		6.0	16.0			26.0			26.0	
Effective Green, g (s)	6.0	16.0		6.0	16.0			26.0			26.0	
Actuated g/C Ratio	0.10	0.27		0.10	0.27			0.43			0.43	
Clearance Time (s)	4.0	4.0		4.0	4.0			4.0			4.0	
Lane Grp Cap (vph)	174	918		174	915			690			691	
v/s Ratio Prot	0.00	0.03		c0.08	c0.08							
v/s Ratio Perm								c0.13			0.08	
v/c Ratio	0.03	0.13		0.77	0.29			0.29			0.18	
Uniform Delay, d1	24.4	16.7		26.3	17.5			11.0			10.5	
Progression Factor	1.00	1.00		1.00	1.00			1.00			1.00	
Incremental Delay, d2	0.4	0.3		27.4	0.8			1.1			0.6	
Delay (s)	24.8	17.0		53.7	18.3			12.1			11.0	
Level of Service	C	B		D	B			B			B	
Approach Delay (s)		17.4			29.9			12.1			11.0	
Approach LOS		B			C			B			B	

Intersection Summary			
HCM Average Control Delay	19.8	HCM Level of Service	B
HCM Volume to Capacity ratio	0.35		
Actuated Cycle Length (s)	60.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	43.3%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	291	224	111	27	263	56	122	860	51	64	431	319
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width	10	11	12	11	11	12	12	12	12	12	12	12
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0		4.0	4.0		4.0	4.0	4.0
Lane Util. Factor	0.97	0.95	1.00	1.00	0.95		1.00	0.95		1.00	0.95	1.00
Frpb, ped/bikes	1.00	1.00	0.97	1.00	0.98		1.00	1.00		1.00	1.00	0.95
Flpb, ped/bikes	1.00	1.00	1.00	1.00	1.00		1.00	1.00		1.00	1.00	1.00
Frt	1.00	1.00	0.85	1.00	0.97		1.00	0.99		1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00		0.95	1.00		0.95	1.00	1.00
Satd. Flow (prot)	2828	3020	1357	1510	2888		1562	3091		1562	3124	1283
Flt Permitted	0.95	1.00	1.00	0.95	1.00		0.95	1.00		0.95	1.00	1.00
Satd. Flow (perm)	2828	3020	1357	1510	2888		1562	3091		1562	3124	1283
Peak-hour factor, PHF	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86
Adj. Flow (vph)	338	260	129	31	306	65	142	1000	59	74	501	371
RTOR Reduction (vph)	0	0	104	0	16	0	0	3	0	0	0	256
Lane Group Flow (vph)	338	260	25	31	355	0	142	1056	0	74	501	115
Confl. Peds. (#/hr)			16			85			25			37
Confl. Bikes (#/hr)						1			1			1
Heavy Vehicles (%)	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%
Bus Blockages (#/hr)	0	0	0	0	0	2	0	0	0	0	0	8
Turn Type	Split		Perm	Split			Prot			Prot		Perm
Protected Phases	4	4		8	8		5	2		1	6	
Permitted Phases			4									6
Actuated Green, G (s)	17.1	17.1	17.1	16.6	16.6		11.9	31.0		7.7	26.8	26.8
Effective Green, g (s)	17.1	17.1	17.1	16.6	16.6		11.9	32.0		7.7	27.8	27.8
Actuated g/C Ratio	0.19	0.19	0.19	0.19	0.19		0.13	0.36		0.09	0.31	0.31
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0		4.0	5.0		4.0	5.0	5.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0		3.0	3.0		3.0	3.0	3.0
Lane Grp Cap (vph)	541	578	260	280	536		208	1106		135	971	399
v/s Ratio Prot	c0.12	0.09		0.02	c0.12		c0.09	c0.34		0.05	0.16	
v/s Ratio Perm			0.02									0.09
v/c Ratio	0.62	0.45	0.09	0.11	0.66		0.68	0.95		0.55	0.52	0.29
Uniform Delay, d1	33.2	32.0	29.8	30.3	33.8		36.9	28.0		39.2	25.3	23.3
Progression Factor	1.00	1.00	1.00	1.00	1.00		1.00	1.00		1.00	1.00	1.00
Incremental Delay, d2	2.3	0.6	0.2	0.2	3.1		8.9	17.1		4.5	0.5	0.4
Delay (s)	35.5	32.5	29.9	30.4	36.9		45.9	45.1		43.7	25.7	23.7
Level of Service	D	C	C	C	D		D	D		D	C	C
Approach Delay (s)		33.4			36.4			45.2			26.4	
Approach LOS		C			D			D			C	

Intersection Summary			
HCM Average Control Delay	36.1	HCM Level of Service	D
HCM Volume to Capacity ratio	0.76		
Actuated Cycle Length (s)	89.4	Sum of lost time (s)	12.0
Intersection Capacity Utilization	75.1%	ICU Level of Service	D
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	62	153	71	34	140	91	127	765	40	69	288	42
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.9	4.9		4.9	4.9		4.3	4.8	4.8	4.3	4.8	4.8
Lane Util. Factor	1.00	0.95		1.00	0.95		0.97	0.95	1.00	0.97	0.95	1.00
Frpb, ped/bikes	1.00	0.99		1.00	0.99		1.00	1.00	0.98	1.00	1.00	0.98
Flpb, ped/bikes	1.00	1.00		1.00	1.00		1.00	1.00	1.00	1.00	1.00	1.00
Frt	1.00	0.95		1.00	0.94		1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	1770	3354		1770	3300		3433	3539	1559	3433	3539	1552
Flt Permitted	0.95	1.00		0.95	1.00		0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)	1770	3354		1770	3300		3433	3539	1559	3433	3539	1552
Peak-hour factor, PHF	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93
Adj. Flow (vph)	67	165	76	37	151	98	137	823	43	74	310	45
RTOR Reduction (vph)	0	56	0	0	83	0	0	0	29	0	0	23
Lane Group Flow (vph)	67	185	0	37	166	0	137	823	14	74	310	22
Confl. Peds. (#/hr)			7			13			6			11
Confl. Bikes (#/hr)						2						
Turn Type	Split			Split			Prot		Perm	Prot		Perm
Protected Phases	4	4		8	8		5	2		1	6	
Permitted Phases									2			6
Actuated Green, G (s)	10.3	10.3		10.0	10.0		5.3	19.2	19.2	3.2	17.1	17.1
Effective Green, g (s)	9.4	9.4		9.1	9.1		5.0	19.4	19.4	2.9	17.3	17.3
Actuated g/C Ratio	0.16	0.16		0.15	0.15		0.08	0.32	0.32	0.05	0.29	0.29
Clearance Time (s)	4.0	4.0		4.0	4.0		4.0	5.0	5.0	4.0	5.0	5.0
Vehicle Extension (s)	2.0	2.0		2.0	2.0		2.0	2.0	2.0	2.0	2.0	2.0
Lane Grp Cap (vph)	279	528		270	503		288	1150	507	167	1026	450
v/s Ratio Prot	0.04	c0.06		0.02	c0.05		c0.04	c0.23		0.02	0.09	
v/s Ratio Perm									0.01			0.01
v/c Ratio	0.24	0.35		0.14	0.33		0.48	0.72	0.03	0.44	0.30	0.05
Uniform Delay, d1	22.0	22.4		21.9	22.6		26.1	17.7	13.7	27.6	16.5	15.3
Progression Factor	1.00	1.00		1.00	1.00		1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	0.2	0.1		0.1	0.1		0.5	1.8	0.0	0.7	0.1	0.0
Delay (s)	22.2	22.6		22.0	22.7		26.6	19.5	13.7	28.3	16.6	15.3
Level of Service	C	C		C	C		C	B	B	C	B	B
Approach Delay (s)		22.5			22.6			20.2			18.5	
Approach LOS		C			C			C			B	

Intersection Summary			
HCM Average Control Delay	20.5	HCM Level of Service	C
HCM Volume to Capacity ratio	0.49		
Actuated Cycle Length (s)	59.7	Sum of lost time (s)	14.1
Intersection Capacity Utilization	57.3%	ICU Level of Service	B
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	1	3	3	64	13	91	0	201	32	40	157	1
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0			4.0	4.0		4.0		4.0	4.0	
Lane Util. Factor		1.00			1.00	1.00		1.00		1.00	1.00	
Frpb, ped/bikes		0.99			1.00	0.98		0.99		1.00	1.00	
Flpb, ped/bikes		1.00			1.00	1.00		1.00		1.00	1.00	
Frt		0.94			1.00	0.85		0.98		1.00	1.00	
Flt Protected		0.99			0.96	1.00		1.00		0.95	1.00	
Satd. Flow (prot)		1728			1789	1556		1811		1770	1860	
Flt Permitted		0.99			0.96	1.00		1.00		0.95	1.00	
Satd. Flow (perm)		1728			1789	1556		1811		1770	1860	
Peak-hour factor, PHF	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63
Adj. Flow (vph)	2	5	5	102	21	144	0	319	51	63	249	2
RTOR Reduction (vph)	0	5	0	0	0	121	0	6	0	0	0	0
Lane Group Flow (vph)	0	7	0	0	123	23	0	364	0	63	251	0
Confl. Peds. (#/hr)	2		1	1		2	13		20	20		13
Confl. Bikes (#/hr)						1			5			
Turn Type	Split			Split		Perm	Split			Split		
Protected Phases	2	2		1	1		4	4		3	3	
Permitted Phases						1						
Actuated Green, G (s)		3.2			9.6	9.6		17.9		14.4	14.4	
Effective Green, g (s)		3.2			9.6	9.6		17.9		14.4	14.4	
Actuated g/C Ratio		0.05			0.16	0.16		0.29		0.24	0.24	
Clearance Time (s)		4.0			4.0	4.0		4.0		4.0	4.0	
Vehicle Extension (s)		3.0			3.0	3.0		3.0		3.0	3.0	
Lane Grp Cap (vph)		91			281	244		531		417	438	
v/s Ratio Prot		c0.00			c0.07			c0.20		0.04	c0.13	
v/s Ratio Perm						0.01						
v/c Ratio		0.08			0.44	0.09		0.69		0.15	0.57	
Uniform Delay, d1		27.5			23.3	22.0		19.1		18.5	20.6	
Progression Factor		1.00			1.00	1.00		1.00		1.00	1.00	
Incremental Delay, d2		0.4			1.1	0.2		3.7		0.2	1.8	
Delay (s)		27.9			24.4	22.2		22.8		18.7	22.4	
Level of Service		C			C	C		C		B	C	
Approach Delay (s)		27.9			23.2			22.8			21.7	
Approach LOS		C			C			C			C	

Intersection Summary			
HCM Average Control Delay	22.6	HCM Level of Service	C
HCM Volume to Capacity ratio	0.55		
Actuated Cycle Length (s)	61.1	Sum of lost time (s)	16.0
Intersection Capacity Utilization	40.7%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	229	209	46	41	257	30	48	583	21	17	297	75
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0			4.0			4.0	
Lane Util. Factor	1.00	0.95		1.00	0.95			0.95			0.95	
Frpb, ped/bikes	1.00	1.00		1.00	0.99			1.00			0.99	
Flpb, ped/bikes	0.98	1.00		0.99	1.00			1.00			1.00	
Frt	1.00	0.97		1.00	0.98			1.00			0.97	
Flt Protected	0.95	1.00		0.95	1.00			1.00			1.00	
Satd. Flow (prot)	1540	3054		1562	3088			3120			3035	
Flt Permitted	0.52	1.00		0.55	1.00			0.88			0.91	
Satd. Flow (perm)	849	3054		912	3088			2768			2767	
Peak-hour factor, PHF	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79
Adj. Flow (vph)	290	265	58	52	325	38	61	738	27	22	376	95
RTOR Reduction (vph)	0	28	0	0	13	0	0	3	0	0	30	0
Lane Group Flow (vph)	290	295	0	52	350	0	0	823	0	0	463	0
Confl. Peds. (#/hr)	56		22	22		56	31		42	42		31
Confl. Bikes (#/hr)						2			5			1
Heavy Vehicles (%)	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%
Turn Type	Perm			Perm			Perm			Perm		
Protected Phases		4			4			2			2	
Permitted Phases	4			4			2			2		
Actuated Green, G (s)	30.0	30.0		30.0	30.0			32.0			32.0	
Effective Green, g (s)	29.0	29.0		29.0	29.0			31.0			31.0	
Actuated g/C Ratio	0.43	0.43		0.43	0.43			0.46			0.46	
Clearance Time (s)	3.0	3.0		3.0	3.0			3.0			3.0	
Lane Grp Cap (vph)	362	1302		389	1317			1262			1261	
v/s Ratio Prot		0.10			0.11							
v/s Ratio Perm	c0.34			0.06				c0.30			0.17	
v/c Ratio	0.80	0.23		0.13	0.27			0.65			0.37	
Uniform Delay, d1	17.0	12.4		11.9	12.6			14.3			12.1	
Progression Factor	1.00	1.00		1.00	1.00			1.00			1.00	
Incremental Delay, d2	16.9	0.4		0.7	0.5			2.6			0.8	
Delay (s)	33.8	12.8		12.6	13.1			17.0			12.9	
Level of Service	C	B		B	B			B			B	
Approach Delay (s)		22.7			13.0			17.0			12.9	
Approach LOS		C			B			B			B	

Intersection Summary			
HCM Average Control Delay	16.9	HCM Level of Service	B
HCM Volume to Capacity ratio	0.72		
Actuated Cycle Length (s)	68.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	99.9%	ICU Level of Service	F
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	11	193	30	12	263	222	22	541	15	123	242	14
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0			5.0			5.0		5.0	5.0	
Lane Util. Factor		0.95			0.95			0.95		0.97	1.00	
Frpb, ped/bikes		1.00			0.99			1.00		1.00	1.00	
Flpb, ped/bikes		1.00			1.00			1.00		1.00	1.00	
Frt		0.98			0.93			1.00		1.00	0.99	
Flt Protected		1.00			1.00			1.00		0.95	1.00	
Satd. Flow (prot)		3482			3307			3551		3467	1864	
Flt Permitted		0.92			0.94			1.00		0.95	1.00	
Satd. Flow (perm)		3211			3124			3551		3467	1864	
Peak-hour factor, PHF	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88
Adj. Flow (vph)	12	219	34	14	299	252	25	615	17	140	275	16
RTOR Reduction (vph)	0	16	0	0	194	0	0	2	0	0	3	0
Lane Group Flow (vph)	0	249	0	0	371	0	0	655	0	140	288	0
Confl. Peds. (#/hr)	2		11	11		2	14		25	25		14
Confl. Bikes (#/hr)			1			2						
Heavy Vehicles (%)	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%
Turn Type	Perm			Perm			Split			Split		
Protected Phases		4			4		2	2		3	3	
Permitted Phases	4			4								
Actuated Green, G (s)		13.4			13.4			16.1		15.1	15.1	
Effective Green, g (s)		12.4			12.4			15.1		14.1	14.1	
Actuated g/C Ratio		0.22			0.22			0.27		0.25	0.25	
Clearance Time (s)		4.0			4.0			4.0		4.0	4.0	
Vehicle Extension (s)		3.0			3.0			3.0		3.0	3.0	
Lane Grp Cap (vph)		703			684			947		864	464	
v/s Ratio Prot								c0.18		0.04	c0.15	
v/s Ratio Perm		0.08			c0.12							
v/c Ratio		0.35			0.54			0.69		0.16	0.62	
Uniform Delay, d1		18.7			19.6			18.7		16.6	18.9	
Progression Factor		1.00			1.00			1.00		1.00	1.00	
Incremental Delay, d2		0.3			0.9			2.2		0.1	2.6	
Delay (s)		19.0			20.5			20.9		16.7	21.5	
Level of Service		B			C			C		B	C	
Approach Delay (s)		19.0			20.5			20.9			19.9	
Approach LOS		B			C			C			B	

Intersection Summary			
HCM Average Control Delay	20.3	HCM Level of Service	C
HCM Volume to Capacity ratio	0.62		
Actuated Cycle Length (s)	56.6	Sum of lost time (s)	15.0
Intersection Capacity Utilization	69.3%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	12	263	309	12	393	136	408	319	17	64	181	14
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0	4.0		4.0		4.0	4.0			4.0	
Lane Util. Factor		0.91	0.91		0.95		1.00	1.00			1.00	
Frpb, ped/bikes		0.99	0.96		0.99		1.00	1.00			1.00	
Flpb, ped/bikes		1.00	1.00		1.00		1.00	1.00			1.00	
Frt		0.95	0.85		0.96		1.00	0.99			0.99	
Flt Protected		1.00	1.00		1.00		0.95	1.00			0.99	
Satd. Flow (prot)		2965	1385		3137		1770	1588			1568	
Flt Permitted		0.90	1.00		0.94		0.95	1.00			0.99	
Satd. Flow (perm)		2685	1385		2951		1770	1588			1568	
Peak-hour factor, PHF	0.84	0.84	0.84	0.84	0.84	0.84	0.84	0.84	0.84	0.84	0.84	0.84
Adj. Flow (vph)	14	313	368	14	468	162	486	380	20	76	215	17
RTOR Reduction (vph)	0	56	168	0	39	0	0	2	0	0	3	0
Lane Group Flow (vph)	0	418	53	0	605	0	486	398	0	0	305	0
Confl. Peds. (#/hr)	16		21	21		16	20		16	16		20
Confl. Bikes (#/hr)			1			2			1			
Parking (#/hr)		8			8			8			8	
Turn Type	Perm		Perm	Perm			Split			Split		
Protected Phases		2			2		4	4		8	8	
Permitted Phases	2		2	2								
Actuated Green, G (s)		20.0	20.0		20.0		25.0	25.0			26.0	
Effective Green, g (s)		20.0	20.0		20.0		25.0	25.0			26.0	
Actuated g/C Ratio		0.24	0.24		0.24		0.30	0.30			0.31	
Clearance Time (s)		4.0	4.0		4.0		4.0	4.0			4.0	
Lane Grp Cap (vph)		647	334		711		533	478			491	
v/s Ratio Prot							c0.27	0.25			c0.19	
v/s Ratio Perm		0.16	0.04		c0.20							
v/c Ratio		0.65	0.16		0.85		0.91	0.83			0.62	
Uniform Delay, d1		28.3	24.9		30.1		27.9	27.0			24.3	
Progression Factor		1.00	1.00		1.00		1.00	1.00			1.00	
Incremental Delay, d2		4.9	1.0		12.2		22.3	15.5			5.8	
Delay (s)		33.2	25.9		42.2		50.3	42.6			30.1	
Level of Service		C	C		D		D	D			C	
Approach Delay (s)		30.9			42.2			46.8			30.1	
Approach LOS		C			D			D			C	

Intersection Summary			
HCM Average Control Delay	39.3	HCM Level of Service	D
HCM Volume to Capacity ratio	0.79		
Actuated Cycle Length (s)	83.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	78.8%	ICU Level of Service	D
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL2	EBL	EBT	EBR	NBT	NBR	NBR2	SBL2	SBL	SBT
Lane Configurations										
Volume (vph)	43	595	141	82	131	155	57	326	130	295
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0	4.0	4.5	4.0	4.0		4.0	4.0	4.0
Lane Util. Factor		0.91	0.91	1.00	0.95	1.00		1.00	1.00	1.00
Frpb, ped/bikes		1.00	1.00	0.86	1.00	0.93		1.00	1.00	1.00
Flpb, ped/bikes		1.00	1.00	1.00	1.00	1.00		1.00	1.00	1.00
Frt		1.00	1.00	0.85	1.00	0.85		1.00	1.00	1.00
Flt Protected		0.95	0.97	1.00	1.00	1.00		0.95	0.95	1.00
Satd. Flow (prot)		1610	3276	1369	3539	1478		1770	1770	1863
Flt Permitted		0.95	0.97	1.00	1.00	1.00		0.95	0.95	1.00
Satd. Flow (perm)		1610	3276	1369	3539	1478		1770	1770	1863
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	45	626	148	86	138	163	60	343	137	311
RTOR Reduction (vph)	0	0	0	65	0	20	0	0	0	0
Lane Group Flow (vph)	0	333	486	21	138	203	0	343	137	311
Confl. Peds. (#/hr)				50			50		50	
Confl. Bikes (#/hr)				10			10			
Turn Type	Perm	Perm		Perm		Perm		Prot	Prot	
Protected Phases			4		2			1	1	6
Permitted Phases	4	4		4		2				
Actuated Green, G (s)		17.4	17.4	17.4	18.3	18.3		25.8	25.8	47.6
Effective Green, g (s)		18.9	18.9	18.4	17.8	17.8		26.3	26.3	48.1
Actuated g/C Ratio		0.25	0.25	0.25	0.24	0.24		0.35	0.35	0.64
Clearance Time (s)		5.5	5.5	5.5	3.5	3.5		4.5	4.5	4.5
Vehicle Extension (s)		2.0	2.0	2.0	2.0	2.0		2.0	2.0	2.0
Lane Grp Cap (vph)		406	826	336	840	351		621	621	1195
v/s Ratio Prot					0.04			c0.19	0.08	0.17
v/s Ratio Perm		c0.21	0.15	0.02		c0.14				
v/c Ratio		0.82	0.59	0.06	0.16	0.58		0.55	0.22	0.26
Uniform Delay, d1		26.4	24.6	21.7	22.7	25.3		19.6	17.1	5.8
Progression Factor		1.00	1.00	1.00	1.00	1.00		1.00	1.00	1.00
Incremental Delay, d2		11.9	0.7	0.0	0.0	1.4		3.5	0.8	0.5
Delay (s)		38.4	25.3	21.7	22.7	26.7		23.1	18.0	6.3
Level of Service		D	C	C	C	C		C	B	A
Approach Delay (s)			29.8		25.2					15.6
Approach LOS			C		C					B

Intersection Summary			
HCM Average Control Delay	23.5	HCM Level of Service	C
HCM Volume to Capacity ratio	0.64		
Actuated Cycle Length (s)	75.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	63.2%	ICU Level of Service	B
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	0	0	252	559	0	0	0	0	0	423	219
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)				4.0	4.0						4.0	4.0
Lane Util. Factor				0.86	0.86						0.86	0.86
Frpb, ped/bikes				1.00	1.00						1.00	1.00
Flpb, ped/bikes				1.00	1.00						1.00	1.00
Frt				1.00	1.00						0.98	0.85
Flt Protected				0.95	1.00						1.00	1.00
Satd. Flow (prot)				1522	4784						4685	1362
Flt Permitted				0.95	1.00						1.00	1.00
Satd. Flow (perm)				1522	4784						4685	1362
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	0	0	0	265	588	0	0	0	0	0	445	231
RTOR Reduction (vph)	0	0	0	155	14	0	0	0	0	0	29	92
Lane Group Flow (vph)	0	0	0	52	632	0	0	0	0	0	495	60
Confl. Bikes (#/hr)						9						10
Turn Type				Prot								Prot
Protected Phases				7	3						2	2
Permitted Phases												
Actuated Green, G (s)				20.0	40.0						31.0	31.0
Effective Green, g (s)				20.0	40.0						31.0	31.0
Actuated g/C Ratio				0.25	0.51						0.39	0.39
Clearance Time (s)				4.0	4.0						4.0	4.0
Lane Grp Cap (vph)				385	2422						1838	534
v/s Ratio Prot				0.03	c0.07						c0.11	0.04
v/s Ratio Perm					0.07							
v/c Ratio				0.14	0.26						0.27	0.11
Uniform Delay, d1				22.8	11.1						16.3	15.3
Progression Factor				1.00	1.00						1.00	1.00
Incremental Delay, d2				0.7	0.3						0.4	0.4
Delay (s)				23.6	11.4						16.7	15.7
Level of Service				C	B						B	B
Approach Delay (s)		0.0			14.3			0.0			16.4	
Approach LOS		A			B			A			B	

Intersection Summary			
HCM Average Control Delay	15.3	HCM Level of Service	B
HCM Volume to Capacity ratio	0.26		
Actuated Cycle Length (s)	79.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	28.4%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	63	279	0	0	0	0	0	941	1712	0	0	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0						4.0	4.0			
Lane Util. Factor		0.91						0.91	0.88			
Frpb, ped/bikes		1.00						1.00	1.00			
Flpb, ped/bikes		1.00						1.00	1.00			
Frt		1.00						1.00	0.85			
Flt Protected		0.99						1.00	1.00			
Satd. Flow (prot)		5032						5085	2787			
Flt Permitted		0.99						1.00	1.00			
Satd. Flow (perm)		5032						5085	2787			
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	66	294	0	0	0	0	0	991	1802	0	0	0
RTOR Reduction (vph)	0	15	0	0	0	0	0	0	440	0	0	0
Lane Group Flow (vph)	0	345	0	0	0	0	0	991	1362	0	0	0
Confl. Peds. (#/hr)	12		21	21		12	42		29	29		42
Confl. Bikes (#/hr)			2			1						
Turn Type	Perm								custom			
Protected Phases		4						2	2			
Permitted Phases	4								7			
Actuated Green, G (s)		27.0						23.0	23.0			
Effective Green, g (s)		27.0						24.0	24.0			
Actuated g/C Ratio		0.45						0.40	0.40			
Clearance Time (s)		5.0						5.0	5.0			
Vehicle Extension (s)		3.0						3.0	3.0			
Lane Grp Cap (vph)		2264						2034	1115			
v/s Ratio Prot								0.19	c0.49			
v/s Ratio Perm		0.07										
v/c Ratio		0.15						0.49	1.22			
Uniform Delay, d1		9.7						13.4	18.0			
Progression Factor		1.00						1.00	1.00			
Incremental Delay, d2		0.1						0.2	108.0			
Delay (s)		9.9						13.6	126.0			
Level of Service		A						B	F			
Approach Delay (s)		9.9			0.0			86.1			0.0	
Approach LOS		A			A			F			A	

Intersection Summary			
HCM Average Control Delay	77.4	HCM Level of Service	E
HCM Volume to Capacity ratio	0.66		
Actuated Cycle Length (s)	60.0	Sum of lost time (s)	9.0
Intersection Capacity Utilization	92.5%	ICU Level of Service	F
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	42	683	1234	0	0	0	0	253	89	36	309	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0	4.0					4.0			4.0	
Lane Util. Factor		0.86	0.86					1.00			1.00	
Frpb, ped/bikes		0.96	0.97					0.98			1.00	
Flpb, ped/bikes		1.00	1.00					1.00			1.00	
Frt		0.93	0.85					0.96			1.00	
Flt Protected		1.00	1.00					1.00			0.99	
Satd. Flow (prot)		4271	1315					1755			1846	
Flt Permitted		1.00	1.00					1.00			0.79	
Satd. Flow (perm)		4271	1315					1755			1464	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	44	719	1299	0	0	0	0	266	94	38	325	0
RTOR Reduction (vph)	0	82	0	0	0	0	0	22	0	0	0	0
Lane Group Flow (vph)	0	1331	649	0	0	0	0	338	0	0	363	0
Confl. Peds. (#/hr)	51		75	75		51	29		79	79		29
Confl. Bikes (#/hr)												3
Turn Type	Perm		Free							Perm		
Protected Phases		2						4			8	
Permitted Phases	2		Free							8		
Actuated Green, G (s)		34.9	60.0					16.1			16.1	
Effective Green, g (s)		35.9	60.0					16.1			16.1	
Actuated g/C Ratio		0.60	1.00					0.27			0.27	
Clearance Time (s)		5.0						4.0			4.0	
Vehicle Extension (s)		2.0						2.0			2.0	
Lane Grp Cap (vph)		2555	1315					471			393	
v/s Ratio Prot								0.19				
v/s Ratio Perm		0.31	c0.49								c0.25	
v/c Ratio		0.52	0.49					0.72			0.92	
Uniform Delay, d1		7.0	0.0					19.9			21.4	
Progression Factor		0.70	1.00					1.00			1.00	
Incremental Delay, d2		0.1	0.1					4.3			26.7	
Delay (s)		5.0	0.1					24.2			48.0	
Level of Service		A	A					C			D	
Approach Delay (s)		3.5			0.0			24.2			48.0	
Approach LOS		A			A			C			D	

Intersection Summary			
HCM Average Control Delay	12.0	HCM Level of Service	B
HCM Volume to Capacity ratio	0.62		
Actuated Cycle Length (s)	60.0	Sum of lost time (s)	4.0
Intersection Capacity Utilization	75.7%	ICU Level of Service	D
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Volume (vph)	283	80	61	716	1177	477
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	0.97	1.00	1.00	0.95	0.91	0.88
Frpb, ped/bikes	1.00	0.98	1.00	1.00	1.00	1.00
Flpb, ped/bikes	1.00	1.00	1.00	1.00	1.00	1.00
Frt	1.00	0.85	1.00	1.00	1.00	0.85
Flt Protected	0.95	1.00	0.95	1.00	1.00	1.00
Satd. Flow (prot)	3433	1550	1770	3539	5085	2787
Flt Permitted	0.95	1.00	0.95	1.00	1.00	1.00
Satd. Flow (perm)	3433	1550	1770	3539	5085	2787
Peak-hour factor, PHF	0.94	0.94	0.94	0.94	0.94	0.94
Adj. Flow (vph)	301	85	65	762	1252	507
RTOR Reduction (vph)	0	0	0	0	0	355
Lane Group Flow (vph)	301	85	65	762	1252	152
Confl. Peds. (#/hr)	2	16	2			2
Turn Type		Perm	Prot			Prot
Protected Phases	4		5	2	6	6
Permitted Phases		4				
Actuated Green, G (s)	26.0	26.0	4.0	26.0	18.0	18.0
Effective Green, g (s)	26.0	26.0	4.0	26.0	18.0	18.0
Actuated g/C Ratio	0.43	0.43	0.07	0.43	0.30	0.30
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Lane Grp Cap (vph)	1488	672	118	1534	1526	836
v/s Ratio Prot	c0.09		0.04	c0.22	c0.25	0.05
v/s Ratio Perm		0.05				
v/c Ratio	0.20	0.13	0.55	0.50	0.82	0.18
Uniform Delay, d1	10.6	10.2	27.1	12.3	19.5	15.5
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	0.3	0.4	17.2	1.2	5.1	0.5
Delay (s)	10.9	10.6	44.4	13.4	24.6	16.0
Level of Service	B	B	D	B	C	B
Approach Delay (s)	10.8			15.9	22.1	
Approach LOS	B			B	C	

Intersection Summary			
HCM Average Control Delay	18.9	HCM Level of Service	B
HCM Volume to Capacity ratio	0.47		
Actuated Cycle Length (s)	60.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	62.0%	ICU Level of Service	B
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	11	127	47	38	94	45	48	72	31	80	138	4
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0			4.0	4.0	4.0	4.0		4.0	4.0	
Lane Util. Factor		0.95			0.95	1.00	1.00	0.95		0.91	0.91	
Frpb, ped/bikes		0.99			1.00	0.99	1.00	1.00		1.00	1.00	
Flpb, ped/bikes		1.00			1.00	1.00	1.00	1.00		1.00	1.00	
Frt		0.96			1.00	0.85	1.00	0.95		1.00	1.00	
Flt Protected		1.00			0.99	1.00	0.95	1.00		0.95	1.00	
Satd. Flow (prot)		3371			3486	1563	1770	3365		1610	3368	
Flt Permitted		0.94			0.85	1.00	0.95	1.00		0.95	1.00	
Satd. Flow (perm)		3179			2994	1563	1770	3365		1610	3368	
Peak-hour factor, PHF	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89
Adj. Flow (vph)	12	143	53	43	106	51	54	81	35	90	155	4
RTOR Reduction (vph)	0	34	0	0	0	0	0	29	0	0	2	0
Lane Group Flow (vph)	0	174	0	0	149	51	54	87	0	81	166	0
Confl. Peds. (#/hr)	2		4	4		2	4		2	2		4
Confl. Bikes (#/hr)			2			1						2
Turn Type	Perm			Perm		Free	Split			Split		
Protected Phases		2			6		3	3		4	4	
Permitted Phases	2			6		Free						
Actuated Green, G (s)		14.8			13.8	41.7	6.7	6.7		7.2	7.2	
Effective Green, g (s)		14.8			14.8	41.7	6.7	6.7		8.2	8.2	
Actuated g/C Ratio		0.35			0.35	1.00	0.16	0.16		0.20	0.20	
Clearance Time (s)		4.0			5.0		4.0	4.0		5.0	5.0	
Vehicle Extension (s)		3.0			3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)		1128			1063	1563	284	541		317	662	
v/s Ratio Prot							c0.03	0.03		c0.05	0.05	
v/s Ratio Perm		c0.05			0.05	0.03						
v/c Ratio		0.15			0.14	0.03	0.19	0.16		0.26	0.25	
Uniform Delay, d1		9.2			9.1	0.0	15.2	15.1		14.2	14.2	
Progression Factor		1.00			1.00	1.00	1.00	1.00		1.00	1.00	
Incremental Delay, d2		0.1			0.1	0.0	0.3	0.1		0.4	0.2	
Delay (s)		9.2			9.2	0.0	15.5	15.2		14.6	14.4	
Level of Service		A			A	A	B	B		B	B	
Approach Delay (s)		9.2			6.9			15.3			14.4	
Approach LOS		A			A			B			B	

Intersection Summary			
HCM Average Control Delay	11.5	HCM Level of Service	B
HCM Volume to Capacity ratio	0.19		
Actuated Cycle Length (s)	41.7	Sum of lost time (s)	12.0
Intersection Capacity Utilization	34.3%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	6	226	6	175	170	29	2	27	111	25	34	5
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0			4.0			4.0	
Lane Util. Factor	1.00	0.95		1.00	0.95			1.00			1.00	
Frpb, ped/bikes	1.00	1.00		1.00	1.00			0.98			1.00	
Flpb, ped/bikes	1.00	1.00		1.00	1.00			1.00			1.00	
Frt	1.00	1.00		1.00	0.98			0.89			0.99	
Flt Protected	0.95	1.00		0.95	1.00			1.00			0.98	
Satd. Flow (prot)	1787	3561		1787	3480			1641			1815	
Flt Permitted	0.95	1.00		0.95	1.00			1.00			0.88	
Satd. Flow (perm)	1787	3561		1787	3480			1640			1634	
Peak-hour factor, PHF	0.84	0.84	0.84	0.84	0.84	0.84	0.84	0.84	0.84	0.84	0.84	0.84
Adj. Flow (vph)	7	269	7	208	202	35	2	32	132	30	40	6
RTOR Reduction (vph)	0	3	0	0	23	0	0	75	0	0	3	0
Lane Group Flow (vph)	7	273	0	208	214	0	0	91	0	0	73	0
Confl. Peds. (#/hr)	4					4	1		24	24		1
Confl. Bikes (#/hr)						2			1			
Heavy Vehicles (%)	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%
Turn Type	Prot			Prot			Perm			Perm		
Protected Phases	7	4		3	8			2			6	
Permitted Phases							2			6		
Actuated Green, G (s)	6.0	16.0		6.0	16.0			26.0			26.0	
Effective Green, g (s)	6.0	16.0		6.0	16.0			26.0			26.0	
Actuated g/C Ratio	0.10	0.27		0.10	0.27			0.43			0.43	
Clearance Time (s)	4.0	4.0		4.0	4.0			4.0			4.0	
Lane Grp Cap (vph)	179	950		179	928			711			708	
v/s Ratio Prot	0.00	c0.08		c0.12	0.06							
v/s Ratio Perm								c0.06			0.04	
v/c Ratio	0.04	0.29		1.16	0.23			0.13			0.10	
Uniform Delay, d1	24.4	17.5		27.0	17.2			10.2			10.1	
Progression Factor	1.00	1.00		1.00	1.00			1.00			1.00	
Incremental Delay, d2	0.4	0.8		117.6	0.6			0.4			0.3	
Delay (s)	24.8	18.2		144.6	17.8			10.6			10.4	
Level of Service	C	B		F	B			B			B	
Approach Delay (s)		18.4			77.1			10.6			10.4	
Approach LOS		B			E			B			B	

Intersection Summary			
HCM Average Control Delay	43.3	HCM Level of Service	D
HCM Volume to Capacity ratio	0.31		
Actuated Cycle Length (s)	60.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	50.0%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	223	199	66	68	249	51	89	503	77	108	827	322
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width	10	11	12	11	11	12	12	12	12	12	12	12
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0		4.0	4.0		4.0	4.0	4.0
Lane Util. Factor	0.97	0.95	1.00	1.00	0.95		1.00	0.95		1.00	0.95	1.00
Frpb, ped/bikes	1.00	1.00	0.94	1.00	0.99		1.00	0.99		1.00	1.00	0.91
Flpb, ped/bikes	1.00	1.00	1.00	1.00	1.00		1.00	1.00		1.00	1.00	1.00
Frt	1.00	1.00	0.85	1.00	0.97		1.00	0.98		1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00		0.95	1.00		0.95	1.00	1.00
Satd. Flow (prot)	2884	3079	1340	1540	2963		1593	3099		1593	3185	1259
Flt Permitted	0.95	1.00	1.00	0.95	1.00		0.95	1.00		0.95	1.00	1.00
Satd. Flow (perm)	2884	3079	1340	1540	2963		1593	3099		1593	3185	1259
Peak-hour factor, PHF	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91
Adj. Flow (vph)	245	219	73	75	274	56	98	553	85	119	909	354
RTOR Reduction (vph)	0	0	61	0	16	0	0	9	0	0	0	216
Lane Group Flow (vph)	245	219	12	75	314	0	98	629	0	119	909	138
Confl. Peds. (#/hr)			47			60			42			75
Confl. Bikes (#/hr)						1						
Bus Blockages (#/hr)	0	0	0	0	0	2	0	0	0	0	0	8
Turn Type	Split		Perm	Split			Prot			Prot		Perm
Protected Phases	4	4		8	8		5	2		1	6	
Permitted Phases			4									6
Actuated Green, G (s)	14.2	14.2	14.2	15.2	15.2		8.2	28.4		10.9	31.1	31.1
Effective Green, g (s)	14.2	14.2	14.2	15.2	15.2		8.2	29.4		10.9	32.1	32.1
Actuated g/C Ratio	0.17	0.17	0.17	0.18	0.18		0.10	0.34		0.13	0.37	0.37
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0		4.0	5.0		4.0	5.0	5.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0		3.0	3.0		3.0	3.0	3.0
Lane Grp Cap (vph)	478	510	222	273	526		152	1063		203	1193	472
v/s Ratio Prot	c0.08	0.07		0.05	c0.11		0.06	0.20		c0.07	c0.29	
v/s Ratio Perm			0.01									0.11
v/c Ratio	0.51	0.43	0.05	0.27	0.60		0.64	0.59		0.59	0.76	0.29
Uniform Delay, d1	32.6	32.1	30.1	30.5	32.4		37.3	23.2		35.3	23.5	18.8
Progression Factor	1.00	1.00	1.00	1.00	1.00		1.00	1.00		1.00	1.00	1.00
Incremental Delay, d2	0.9	0.6	0.1	0.5	1.8		9.0	0.9		4.3	2.9	0.3
Delay (s)	33.5	32.7	30.2	31.0	34.3		46.4	24.1		39.5	26.4	19.2
Level of Service	C	C	C	C	C		D	C		D	C	B
Approach Delay (s)		32.7			33.7			27.1			25.7	
Approach LOS		C			C			C			C	

Intersection Summary			
HCM Average Control Delay	28.3	HCM Level of Service	C
HCM Volume to Capacity ratio	0.67		
Actuated Cycle Length (s)	85.7	Sum of lost time (s)	16.0
Intersection Capacity Utilization	70.7%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	98	149	95	40	110	107	95	459	32	129	1157	111
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.9	4.9		4.9	4.9		4.3	4.8	4.8	4.3	4.8	4.8
Lane Util. Factor	1.00	0.95		1.00	0.95		0.97	0.95	1.00	0.97	0.95	1.00
Frpb, ped/bikes	1.00	0.99		1.00	0.99		1.00	1.00	0.98	1.00	1.00	0.99
Flpb, ped/bikes	1.00	1.00		1.00	1.00		1.00	1.00	1.00	1.00	1.00	1.00
Frt	1.00	0.94		1.00	0.93		1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	1787	3343		1787	3270		3467	3574	1571	3467	3574	1576
Flt Permitted	0.95	1.00		0.95	1.00		0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)	1787	3343		1787	3270		3467	3574	1571	3467	3574	1576
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	103	157	100	42	116	113	100	483	34	136	1218	117
RTOR Reduction (vph)	0	86	0	0	99	0	0	0	20	0	0	12
Lane Group Flow (vph)	103	171	0	42	130	0	100	483	14	136	1218	105
Confl. Peds. (#/hr)			7			14			8			3
Confl. Bikes (#/hr)						1						
Heavy Vehicles (%)	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%
Turn Type	Split			Split			Prot		Perm	Prot		Perm
Protected Phases	4	4		8	8		5	2		1	6	
Permitted Phases									2			6
Actuated Green, G (s)	10.5	10.5		9.4	9.4		5.0	29.4	29.4	4.3	28.7	28.7
Effective Green, g (s)	9.6	9.6		8.5	8.5		4.7	29.6	29.6	4.0	28.9	28.9
Actuated g/C Ratio	0.14	0.14		0.12	0.12		0.07	0.42	0.42	0.06	0.41	0.41
Clearance Time (s)	4.0	4.0		4.0	4.0		4.0	5.0	5.0	4.0	5.0	5.0
Vehicle Extension (s)	2.0	2.0		2.0	2.0		2.0	2.0	2.0	2.0	2.0	2.0
Lane Grp Cap (vph)	243	455		215	394		231	1498	659	196	1463	645
v/s Ratio Prot	c0.06	0.05		0.02	c0.04		0.03	0.14		c0.04	c0.34	
v/s Ratio Perm									0.01			0.07
v/c Ratio	0.42	0.37		0.20	0.33		0.43	0.32	0.02	0.69	0.83	0.16
Uniform Delay, d1	28.0	27.8		28.0	28.4		31.7	13.8	12.0	32.7	18.7	13.2
Progression Factor	1.00	1.00		1.00	1.00		1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	0.4	0.2		0.2	0.2		0.5	0.0	0.0	8.3	4.0	0.0
Delay (s)	28.4	28.0		28.1	28.6		32.1	13.8	12.0	41.0	22.7	13.2
Level of Service	C	C		C	C		C	B	B	D	C	B
Approach Delay (s)		28.1			28.5			16.7			23.6	
Approach LOS		C			C			B			C	

Intersection Summary			
HCM Average Control Delay	23.1	HCM Level of Service	C
HCM Volume to Capacity ratio	0.65		
Actuated Cycle Length (s)	70.6	Sum of lost time (s)	18.9
Intersection Capacity Utilization	69.7%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	4	5	2	10	4	28	1	101	24	59	173	3
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0			4.0	4.0	4.0	4.0		4.0	4.0	
Lane Util. Factor		1.00			1.00	1.00	1.00	1.00		1.00	1.00	
Frpb, ped/bikes		1.00			1.00	0.97	1.00	1.00		1.00	1.00	
Flpb, ped/bikes		1.00			1.00	1.00	1.00	1.00		1.00	1.00	
Frt		0.98			1.00	0.85	1.00	0.97		1.00	1.00	
Flt Protected		0.98			0.96	1.00	0.95	1.00		0.95	1.00	
Satd. Flow (prot)		1776			1797	1536	1770	1802		1770	1858	
Flt Permitted		0.98			0.96	1.00	0.95	1.00		0.95	1.00	
Satd. Flow (perm)		1776			1797	1536	1770	1802		1770	1858	
Peak-hour factor, PHF	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91
Adj. Flow (vph)	4	5	2	11	4	31	1	111	26	65	190	3
RTOR Reduction (vph)	0	2	0	0	0	30	0	9	0	0	1	0
Lane Group Flow (vph)	0	9	0	0	15	1	1	128	0	65	192	0
Confl. Peds. (#/hr)	2		6	6		2	8		2	2		8
Confl. Bikes (#/hr)						1						
Turn Type	Split			Split		Perm	Split			Split		
Protected Phases	2	2		1	1		4	4		3	3	
Permitted Phases						1						
Actuated Green, G (s)		1.5			1.9	1.9	11.2	11.2		12.0	12.0	
Effective Green, g (s)		1.5			1.9	1.9	11.2	11.2		12.0	12.0	
Actuated g/C Ratio		0.04			0.04	0.04	0.26	0.26		0.28	0.28	
Clearance Time (s)		4.0			4.0	4.0	4.0	4.0		4.0	4.0	
Vehicle Extension (s)		3.0			3.0	3.0	3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)		63			80	69	465	474		499	523	
v/s Ratio Prot		c0.01			c0.01		0.00	c0.07		0.04	c0.10	
v/s Ratio Perm						0.00						
v/c Ratio		0.14			0.19	0.02	0.00	0.27		0.13	0.37	
Uniform Delay, d1		19.9			19.6	19.5	11.6	12.5		11.4	12.3	
Progression Factor		1.00			1.00	1.00	1.00	1.00		1.00	1.00	
Incremental Delay, d2		1.1			1.1	0.1	0.0	0.3		0.1	0.4	
Delay (s)		21.0			20.7	19.6	11.6	12.8		11.5	12.7	
Level of Service		C			C	B	B	B		B	B	
Approach Delay (s)		21.0			20.0			12.8			12.4	
Approach LOS		C			B			B			B	

Intersection Summary			
HCM Average Control Delay	13.5	HCM Level of Service	B
HCM Volume to Capacity ratio	0.30		
Actuated Cycle Length (s)	42.6	Sum of lost time (s)	16.0
Intersection Capacity Utilization	30.7%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	142	119	34	49	129	30	8	403	31	37	607	85
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0			4.0			4.0	
Lane Util. Factor	1.00	0.95		1.00	0.95			0.95			0.95	
Frpb, ped/bikes	1.00	0.99		1.00	1.00			1.00			0.99	
Flpb, ped/bikes	0.99	1.00		0.98	1.00			1.00			1.00	
Frt	1.00	0.97		1.00	0.97			0.99			0.98	
Flt Protected	0.95	1.00		0.95	1.00			1.00			1.00	
Satd. Flow (prot)	1584	3058		1567	3085			3141			3099	
Flt Permitted	0.65	1.00		0.65	1.00			0.94			0.92	
Satd. Flow (perm)	1079	3058		1074	3085			2968			2844	
Peak-hour factor, PHF	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96
Adj. Flow (vph)	148	124	35	51	134	31	8	420	32	39	632	89
RTOR Reduction (vph)	0	20	0	0	18	0	0	8	0	0	15	0
Lane Group Flow (vph)	148	139	0	51	147	0	0	452	0	0	745	0
Confl. Peds. (#/hr)	10		29	29		10	63		34	34		63
Confl. Bikes (#/hr)									1			
Parking (#/hr)							0					
Turn Type	Perm			Perm			Perm			Perm		
Protected Phases		4			4			2			2	
Permitted Phases	4			4			2			2		
Actuated Green, G (s)	30.0	30.0		30.0	30.0			32.0			32.0	
Effective Green, g (s)	29.0	29.0		29.0	29.0			31.0			31.0	
Actuated g/C Ratio	0.43	0.43		0.43	0.43			0.46			0.46	
Clearance Time (s)	3.0	3.0		3.0	3.0			3.0			3.0	
Lane Grp Cap (vph)	460	1304		458	1316			1353			1297	
v/s Ratio Prot		0.05			0.05							
v/s Ratio Perm	c0.14			0.05				0.15			c0.26	
v/c Ratio	0.32	0.11		0.11	0.11			0.33			0.57	
Uniform Delay, d1	13.0	11.7		11.7	11.7			11.9			13.6	
Progression Factor	1.00	1.00		1.00	1.00			1.00			1.00	
Incremental Delay, d2	1.8	0.2		0.5	0.2			0.7			1.9	
Delay (s)	14.8	11.9		12.2	11.9			12.5			15.5	
Level of Service	B	B		B	B			B			B	
Approach Delay (s)		13.3			12.0			12.5			15.5	
Approach LOS		B			B			B			B	

Intersection Summary			
HCM Average Control Delay	13.9	HCM Level of Service	B
HCM Volume to Capacity ratio	0.45		
Actuated Cycle Length (s)	68.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	94.6%	ICU Level of Service	F
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	11	155	22	12	152	126	13	395	36	522	530	28
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0			5.0			5.0		5.0	5.0	
Lane Util. Factor		0.95			0.95			0.95		0.97	1.00	
Frpb, ped/bikes		1.00			0.99			1.00		1.00	1.00	
Flpb, ped/bikes		1.00			1.00			1.00		1.00	1.00	
Frt		0.98			0.93			0.99		1.00	0.99	
Flt Protected		1.00			1.00			1.00		0.95	1.00	
Satd. Flow (prot)		3491			3310			3520		3467	1865	
Flt Permitted		0.92			0.94			1.00		0.95	1.00	
Satd. Flow (perm)		3230			3106			3520		3467	1865	
Peak-hour factor, PHF	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94
Adj. Flow (vph)	12	165	23	13	162	134	14	420	38	555	564	30
RTOR Reduction (vph)	0	14	0	0	113	0	0	9	0	0	2	0
Lane Group Flow (vph)	0	186	0	0	196	0	0	463	0	555	592	0
Confl. Peds. (#/hr)	2		6	6		2	11		10	10		11
Confl. Bikes (#/hr)						2						1
Heavy Vehicles (%)	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%
Turn Type	Perm			Perm			Split			Split		
Protected Phases		4			4		2	2		3	3	
Permitted Phases	4			4								
Actuated Green, G (s)		11.0			11.0			13.6		26.5	26.5	
Effective Green, g (s)		10.0			10.0			12.6		25.5	25.5	
Actuated g/C Ratio		0.16			0.16			0.20		0.40	0.40	
Clearance Time (s)		4.0			4.0			4.0		4.0	4.0	
Vehicle Extension (s)		3.0			3.0			3.0		3.0	3.0	
Lane Grp Cap (vph)		512			492			703		1401	754	
v/s Ratio Prot								c0.13		0.16	c0.32	
v/s Ratio Perm		0.06			c0.06							
v/c Ratio		0.36			0.40			0.66		0.40	0.79	
Uniform Delay, d1		23.7			23.8			23.3		13.3	16.4	
Progression Factor		1.00			1.00			1.00		1.00	1.00	
Incremental Delay, d2		0.4			0.5			2.2		0.2	5.4	
Delay (s)		24.1			24.4			25.5		13.5	21.8	
Level of Service		C			C			C		B	C	
Approach Delay (s)		24.1			24.4			25.5			17.8	
Approach LOS		C			C			C			B	

Intersection Summary			
HCM Average Control Delay	21.1	HCM Level of Service	C
HCM Volume to Capacity ratio	0.67		
Actuated Cycle Length (s)	63.1	Sum of lost time (s)	15.0
Intersection Capacity Utilization	73.7%	ICU Level of Service	D
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	12	309	395	16	282	105	337	273	27	90	375	26
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0	4.0		4.0		4.0	4.0			4.0	
Lane Util. Factor		0.91	0.91		0.95		1.00	1.00			1.00	
Frpb, ped/bikes		0.99	0.96		0.99		1.00	1.00			1.00	
Flpb, ped/bikes		1.00	1.00		1.00		1.00	1.00			1.00	
Frt		0.95	0.85		0.96		1.00	0.99			0.99	
Flt Protected		1.00	1.00		1.00		0.95	1.00			0.99	
Satd. Flow (prot)		2974	1399		3159		1787	1592			1588	
Flt Permitted		0.94	1.00		0.93		0.95	1.00			0.99	
Satd. Flow (perm)		2804	1399		2931		1787	1592			1588	
Peak-hour factor, PHF	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97
Adj. Flow (vph)	12	319	407	16	291	108	347	281	28	93	387	27
RTOR Reduction (vph)	0	74	176	0	43	0	0	4	0	0	3	0
Lane Group Flow (vph)	0	432	56	0	372	0	347	305	0	0	504	0
Confl. Peds. (#/hr)	17		21	21		17	30		15	15		30
Confl. Bikes (#/hr)			1			1						
Heavy Vehicles (%)	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%
Parking (#/hr)		8			8			8			8	
Turn Type	Perm		Perm	Perm			Split			Split		
Protected Phases		2			2		4	4		8	8	
Permitted Phases	2		2	2								
Actuated Green, G (s)		20.0	20.0		20.0		25.0	25.0			26.0	
Effective Green, g (s)		20.0	20.0		20.0		25.0	25.0			26.0	
Actuated g/C Ratio		0.24	0.24		0.24		0.30	0.30			0.31	
Clearance Time (s)		4.0	4.0		4.0		4.0	4.0			4.0	
Lane Grp Cap (vph)		676	337		706		538	480			497	
v/s Ratio Prot							c0.19	0.19			c0.32	
v/s Ratio Perm		c0.15	0.04		0.13							
v/c Ratio		0.64	0.17		0.53		0.64	0.64			1.01	
Uniform Delay, d1		28.3	24.9		27.4		25.2	25.1			28.5	
Progression Factor		1.00	1.00		1.00		1.00	1.00			1.00	
Incremental Delay, d2		4.6	1.1		2.8		5.9	6.3			44.1	
Delay (s)		32.9	26.0		30.2		31.0	31.3			72.6	
Level of Service		C	C		C		C	C			E	
Approach Delay (s)		30.7			30.2			31.2			72.6	
Approach LOS		C			C			C			E	

Intersection Summary			
HCM Average Control Delay	39.9	HCM Level of Service	D
HCM Volume to Capacity ratio	0.78		
Actuated Cycle Length (s)	83.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	79.4%	ICU Level of Service	D
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL2	EBL	EBT	EBR	NBT	NBR	NBR2	SBL2	SBL	SBT
Lane Configurations										
Volume (vph)	28	896	268	71	293	232	56	308	243	262
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0	4.0	4.5	4.0	4.0		4.0	4.0	4.0
Lane Util. Factor		0.91	0.91	1.00	0.95	1.00		1.00	1.00	1.00
Frpb, ped/bikes		1.00	1.00	0.85	1.00	0.92		1.00	1.00	1.00
Flpb, ped/bikes		1.00	1.00	1.00	1.00	1.00		1.00	1.00	1.00
Frt		1.00	1.00	0.85	1.00	0.85		1.00	1.00	1.00
Flt Protected		0.95	0.97	1.00	1.00	1.00		0.95	0.95	1.00
Satd. Flow (prot)		1610	3286	1343	3539	1451		1770	1770	1863
Flt Permitted		0.95	0.97	1.00	1.00	1.00		0.95	0.95	1.00
Satd. Flow (perm)		1610	3286	1343	3539	1451		1770	1770	1863
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	29	943	282	75	308	244	59	324	256	276
RTOR Reduction (vph)	0	0	0	49	0	10	0	0	0	0
Lane Group Flow (vph)	0	482	772	26	308	293	0	324	256	276
Confl. Peds. (#/hr)				50			50		50	
Confl. Bikes (#/hr)				10			10			
Turn Type	Perm	Perm		Perm		Perm		Prot	Prot	
Protected Phases			4		2			1	1	6
Permitted Phases	4	4		4		2				
Actuated Green, G (s)		30.0	30.0	30.0	20.6	20.6		26.4	26.4	50.0
Effective Green, g (s)		31.5	31.5	31.0	20.1	20.1		26.4	26.4	50.5
Actuated g/C Ratio		0.35	0.35	0.34	0.22	0.22		0.29	0.29	0.56
Clearance Time (s)		5.5	5.5	5.5	3.5	3.5		4.0	4.0	4.5
Vehicle Extension (s)		2.0	2.0	2.0	2.0	2.0		2.0	2.0	2.0
Lane Grp Cap (vph)		564	1150	463	790	324		519	519	1045
v/s Ratio Prot					0.09			c0.18	0.14	0.15
v/s Ratio Perm		c0.30	0.23	0.02		c0.20				
v/c Ratio		0.85	0.67	0.06	0.39	0.90		0.62	0.49	0.26
Uniform Delay, d1		27.1	24.9	19.7	29.7	34.0		27.5	26.3	10.2
Progression Factor		1.00	1.00	1.00	1.00	1.00		1.00	1.00	1.00
Incremental Delay, d2		11.6	1.2	0.0	0.1	26.6		5.6	3.3	0.6
Delay (s)		38.8	26.1	19.7	29.8	60.6		33.1	29.6	10.8
Level of Service		D	C	B	C	E		C	C	B
Approach Delay (s)			30.3		45.1					24.9
Approach LOS			C		D					C

Intersection Summary			
HCM Average Control Delay	31.9	HCM Level of Service	C
HCM Volume to Capacity ratio	0.79		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	69.7%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	0	0	315	439	0	0	0	0	0	860	259
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)				4.0	4.0						4.0	4.0
Lane Util. Factor				0.86	0.86						0.86	0.86
Frpb, ped/bikes				1.00	1.00						1.00	1.00
Flpb, ped/bikes				1.00	1.00						1.00	1.00
Frt				1.00	1.00						1.00	0.85
Flt Protected				0.95	0.99						1.00	1.00
Satd. Flow (prot)				1522	4751						4783	1362
Flt Permitted				0.95	0.99						1.00	1.00
Satd. Flow (perm)				1522	4751						4783	1362
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	0	0	0	332	462	0	0	0	0	0	905	273
RTOR Reduction (vph)	0	0	0	144	24	0	0	0	0	0	4	149
Lane Group Flow (vph)	0	0	0	49	577	0	0	0	0	0	928	97
Confl. Bikes (#/hr)						5						9
Turn Type				Prot								Prot
Protected Phases				7	3						2	2
Permitted Phases												
Actuated Green, G (s)				20.0	40.0						31.0	31.0
Effective Green, g (s)				20.0	40.0						31.0	31.0
Actuated g/C Ratio				0.25	0.51						0.39	0.39
Clearance Time (s)				4.0	4.0						4.0	4.0
Lane Grp Cap (vph)				385	2406						1877	534
v/s Ratio Prot				0.03	c0.06						c0.19	0.07
v/s Ratio Perm					0.06							
v/c Ratio				0.13	0.24						0.49	0.18
Uniform Delay, d1				22.8	11.0						18.1	15.7
Progression Factor				1.00	1.00						1.00	1.00
Incremental Delay, d2				0.7	0.2						0.9	0.7
Delay (s)				23.4	11.2						19.0	16.4
Level of Service				C	B						B	B
Approach Delay (s)		0.0			14.2			0.0			18.5	
Approach LOS		A			B			A			B	

Intersection Summary			
HCM Average Control Delay	16.7	HCM Level of Service	B
HCM Volume to Capacity ratio	0.35		
Actuated Cycle Length (s)	79.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	36.4%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	148	611	0	0	0	0	0	685	1561	0	0	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0						4.0	4.0			
Lane Util. Factor		0.91						0.91	0.88			
Frpb, ped/bikes		1.00						1.00	1.00			
Flpb, ped/bikes		1.00						1.00	1.00			
Frt		1.00						1.00	0.85			
Flt Protected		0.99						1.00	1.00			
Satd. Flow (prot)		5022						5085	2787			
Flt Permitted		0.99						1.00	1.00			
Satd. Flow (perm)		5022						5085	2787			
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	156	643	0	0	0	0	0	721	1643	0	0	0
RTOR Reduction (vph)	0	5	0	0	0	0	0	0	317	0	0	0
Lane Group Flow (vph)	0	794	0	0	0	0	0	721	1326	0	0	0
Confl. Peds. (#/hr)	28		7	7		28	99		3	3		99
Confl. Bikes (#/hr)			1			2			1			
Turn Type	Perm								custom			
Protected Phases		4						2	2			
Permitted Phases	4								7			
Actuated Green, G (s)		34.0						16.0	16.0			
Effective Green, g (s)		35.0						17.0	17.0			
Actuated g/C Ratio		0.58						0.28	0.28			
Clearance Time (s)		5.0						5.0	5.0			
Vehicle Extension (s)		3.0						3.0	3.0			
Lane Grp Cap (vph)		2930						1441	790			
v/s Ratio Prot								0.14	c0.48			
v/s Ratio Perm		0.16										
v/c Ratio		0.27						0.50	1.68			
Uniform Delay, d1		6.2						18.0	21.5			
Progression Factor		1.00						1.00	1.00			
Incremental Delay, d2		0.2						0.3	310.6			
Delay (s)		6.4						18.2	332.1			
Level of Service		A						B	F			
Approach Delay (s)		6.4			0.0			236.4			0.0	
Approach LOS		A			A			F			A	

Intersection Summary			
HCM Average Control Delay	178.3	HCM Level of Service	F
HCM Volume to Capacity ratio	0.73		
Actuated Cycle Length (s)	60.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	89.9%	ICU Level of Service	E
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	33	1021	1127	0	0	0	0	168	170	57	322	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0	4.0					4.0			4.0	
Lane Util. Factor		0.86	0.86					1.00			1.00	
Frpb, ped/bikes		0.98	0.97					0.98			1.00	
Flpb, ped/bikes		1.00	1.00					1.00			1.00	
Frt		0.95	0.85					0.93			1.00	
Flt Protected		1.00	1.00					1.00			0.99	
Satd. Flow (prot)		4432	1323					1703			1845	
Flt Permitted		1.00	1.00					1.00			0.76	
Satd. Flow (perm)		4432	1323					1703			1405	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	35	1075	1186	0	0	0	0	177	179	60	339	0
RTOR Reduction (vph)	0	76	0	0	0	0	0	46	0	0	0	0
Lane Group Flow (vph)	0	1627	593	0	0	0	0	310	0	0	399	0
Confl. Peds. (#/hr)	52		55	55		52	39		25	25		39
Confl. Bikes (#/hr)			1						2			2
Turn Type	Perm		Free							Perm		
Protected Phases		2						4			8	
Permitted Phases	2		Free							8		
Actuated Green, G (s)		33.2	60.0					17.8			17.8	
Effective Green, g (s)		34.2	60.0					17.8			17.8	
Actuated g/C Ratio		0.57	1.00					0.30			0.30	
Clearance Time (s)		5.0						4.0			4.0	
Vehicle Extension (s)		2.0						2.0			2.0	
Lane Grp Cap (vph)		2526	1323					505			417	
v/s Ratio Prot								0.18				
v/s Ratio Perm		0.37	0.45								c0.28	
v/c Ratio		0.64	0.45					0.61			0.96	
Uniform Delay, d1		8.8	0.0					18.1			20.7	
Progression Factor		0.58	1.00					1.00			1.00	
Incremental Delay, d2		0.1	0.1					1.6			32.5	
Delay (s)		5.2	0.1					19.7			53.3	
Level of Service		A	A					B			D	
Approach Delay (s)		3.9			0.0			19.7			53.3	
Approach LOS		A			A			B			D	

Intersection Summary			
HCM Average Control Delay	12.2	HCM Level of Service	B
HCM Volume to Capacity ratio	0.75		
Actuated Cycle Length (s)	60.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	82.6%	ICU Level of Service	E
Analysis Period (min)	15		
c Critical Lane Group			

Near-Term (2018) No Project Conditions

FEHR PEERS

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Volume (vph)	410	60	40	1210	850	530
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	0.97	1.00	1.00	0.95	0.91	0.88
Frpb, ped/bikes	1.00	0.98	1.00	1.00	1.00	1.00
Flpb, ped/bikes	1.00	1.00	1.00	1.00	1.00	1.00
Frt	1.00	0.85	1.00	1.00	1.00	0.85
Flt Protected	0.95	1.00	0.95	1.00	1.00	1.00
Satd. Flow (prot)	3400	1535	1752	3505	5036	2760
Flt Permitted	0.95	1.00	0.95	1.00	1.00	1.00
Satd. Flow (perm)	3400	1535	1752	3505	5036	2760
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	446	65	43	1315	924	576
RTOR Reduction (vph)	0	0	0	0	0	403
Lane Group Flow (vph)	446	65	43	1315	924	173
Confl. Peds. (#/hr)	3	11	4			4
Confl. Bikes (#/hr)		5				5
Heavy Vehicles (%)	3%	3%	3%	3%	3%	3%
Turn Type		Perm	Prot			Prot
Protected Phases	4		5	2	6	6
Permitted Phases		4				
Actuated Green, G (s)	26.0	26.0	4.0	26.0	18.0	18.0
Effective Green, g (s)	26.0	26.0	4.0	26.0	18.0	18.0
Actuated g/C Ratio	0.43	0.43	0.07	0.43	0.30	0.30
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Lane Grp Cap (vph)	1473	665	117	1519	1511	828
v/s Ratio Prot	c0.13		0.02	c0.38	0.18	0.06
v/s Ratio Perm		0.04				
v/c Ratio	0.30	0.10	0.37	0.87	0.61	0.21
Uniform Delay, d1	11.1	10.1	26.8	15.4	18.0	15.7
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	0.5	0.3	8.7	6.9	1.9	0.6
Delay (s)	11.6	10.4	35.5	22.3	19.9	16.3
Level of Service	B	B	D	C	B	B
Approach Delay (s)	11.5			22.7	18.5	
Approach LOS	B			C	B	

Intersection Summary			
HCM Average Control Delay	19.1	HCM Level of Service	B
HCM Volume to Capacity ratio	0.58		
Actuated Cycle Length (s)	60.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	65.9%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	10	50	30	100	100	110	60	190	70	40	90	20
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0			4.0	4.0	4.0	4.0		4.0	4.0	
Lane Util. Factor		0.95			0.95	1.00	1.00	0.95		0.91	0.91	
Frpb, ped/bikes		0.99			1.00	0.98	1.00	0.99		1.00	1.00	
Flpb, ped/bikes		1.00			1.00	1.00	1.00	1.00		1.00	1.00	
Frt		0.95			1.00	0.85	1.00	0.96		1.00	0.97	
Flt Protected		0.99			0.98	1.00	0.95	1.00		0.95	1.00	
Satd. Flow (prot)		3183			3310	1500	1703	3244		1550	3158	
Flt Permitted		0.92			0.78	1.00	0.95	1.00		0.95	1.00	
Satd. Flow (perm)		2947			2652	1500	1703	3244		1550	3158	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	11	54	33	109	109	120	65	207	76	43	98	22
RTOR Reduction (vph)	0	23	0	0	0	0	0	51	0	0	18	0
Lane Group Flow (vph)	0	75	0	0	218	120	65	232	0	39	106	0
Confl. Peds. (#/hr)	9		8	8		9	12		17	17		12
Confl. Bikes (#/hr)						3			5			2
Heavy Vehicles (%)	6%	6%	6%	6%	6%	6%	6%	6%	6%	6%	6%	6%
Turn Type	Perm			Perm		Free	Split			Split		
Protected Phases		2			6		3	3		4	4	
Permitted Phases	2			6		Free						
Actuated Green, G (s)		12.7			11.7	41.9	9.5	9.5		6.7	6.7	
Effective Green, g (s)		12.7			12.7	41.9	9.5	9.5		7.7	7.7	
Actuated g/C Ratio		0.30			0.30	1.00	0.23	0.23		0.18	0.18	
Clearance Time (s)		4.0			5.0		4.0	4.0		5.0	5.0	
Vehicle Extension (s)		3.0			3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)		893			804	1500	386	736		285	580	
v/s Ratio Prot							0.04	c0.07		0.03	c0.03	
v/s Ratio Perm		0.03			c0.08	0.08						
v/c Ratio		0.08			0.27	0.08	0.17	0.32		0.14	0.18	
Uniform Delay, d1		10.4			11.1	0.0	13.0	13.5		14.3	14.4	
Progression Factor		1.00			1.00	1.00	1.00	1.00		1.00	1.00	
Incremental Delay, d2		0.0			0.2	0.1	0.2	0.2		0.2	0.2	
Delay (s)		10.5			11.3	0.1	13.2	13.7		14.5	14.6	
Level of Service		B			B	A	B	B		B	B	
Approach Delay (s)		10.5			7.3			13.6			14.6	
Approach LOS		B			A			B			B	

Intersection Summary			
HCM Average Control Delay	11.2	HCM Level of Service	B
HCM Volume to Capacity ratio	0.26		
Actuated Cycle Length (s)	41.9	Sum of lost time (s)	12.0
Intersection Capacity Utilization	42.0%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	10	130	10	140	270	30	20	90	230	40	80	20
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0			4.0			4.0	
Lane Util. Factor	1.00	0.95		1.00	0.95			1.00			1.00	
Frpb, ped/bikes	1.00	1.00		1.00	1.00			0.97			1.00	
Flpb, ped/bikes	1.00	1.00		1.00	1.00			1.00			1.00	
Frt	1.00	0.99		1.00	0.98			0.91			0.98	
Flt Protected	0.95	1.00		0.95	1.00			1.00			0.99	
Satd. Flow (prot)	1736	3422		1736	3404			1607			1752	
Flt Permitted	0.95	1.00		0.95	1.00			0.98			0.85	
Satd. Flow (perm)	1736	3422		1736	3404			1582			1515	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	11	141	11	152	293	33	22	98	250	43	87	22
RTOR Reduction (vph)	0	8	0	0	14	0	0	125	0	0	10	0
Lane Group Flow (vph)	11	144	0	152	312	0	0	245	0	0	142	0
Confl. Peds. (#/hr)	11		13	13		11	22		48	48		22
Confl. Bikes (#/hr)			1			2			1			
Heavy Vehicles (%)	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%
Turn Type	Prot			Prot			Perm			Perm		
Protected Phases	7	4		3	8			2			6	
Permitted Phases							2			6		
Actuated Green, G (s)	6.0	16.0		6.0	16.0			26.0			26.0	
Effective Green, g (s)	6.0	16.0		6.0	16.0			26.0			26.0	
Actuated g/C Ratio	0.10	0.27		0.10	0.27			0.43			0.43	
Clearance Time (s)	4.0	4.0		4.0	4.0			4.0			4.0	
Lane Grp Cap (vph)	174	913		174	908			686			657	
v/s Ratio Prot	0.01	0.04		c0.09	c0.09							
v/s Ratio Perm								c0.15			0.09	
v/c Ratio	0.06	0.16		0.87	0.34			0.36			0.22	
Uniform Delay, d1	24.5	16.8		26.6	17.8			11.4			10.6	
Progression Factor	1.00	1.00		1.00	1.00			1.00			1.00	
Incremental Delay, d2	0.7	0.4		41.4	1.0			1.4			0.8	
Delay (s)	25.2	17.2		68.0	18.8			12.8			11.4	
Level of Service	C	B		E	B			B			B	
Approach Delay (s)		17.7			34.4			12.8			11.4	
Approach LOS		B			C			B			B	

Intersection Summary			
HCM Average Control Delay	22.2	HCM Level of Service	C
HCM Volume to Capacity ratio	0.42		
Actuated Cycle Length (s)	60.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	54.5%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	310	260	120	40	320	70	140	890	70	100	480	340
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width	10	11	12	11	11	12	12	12	12	12	12	12
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0		4.0	4.0		4.0	4.0	4.0
Lane Util. Factor	0.97	0.95	1.00	1.00	0.95		1.00	0.95		1.00	0.95	1.00
Frpb, ped/bikes	1.00	1.00	0.97	1.00	0.98		1.00	1.00		1.00	1.00	0.95
Flpb, ped/bikes	1.00	1.00	1.00	1.00	1.00		1.00	1.00		1.00	1.00	1.00
Frt	1.00	1.00	0.85	1.00	0.97		1.00	0.99		1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00		0.95	1.00		0.95	1.00	1.00
Satd. Flow (prot)	2828	3020	1356	1510	2882		1562	3081		1562	3124	1280
Flt Permitted	0.95	1.00	1.00	0.95	1.00		0.95	1.00		0.95	1.00	1.00
Satd. Flow (perm)	2828	3020	1356	1510	2882		1562	3081		1562	3124	1280
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	337	283	130	43	348	76	152	967	76	109	522	370
RTOR Reduction (vph)	0	0	105	0	16	0	0	5	0	0	0	252
Lane Group Flow (vph)	337	283	25	43	408	0	152	1038	0	109	522	118
Confl. Peds. (#/hr)			16			85			25			37
Confl. Bikes (#/hr)						1			1			1
Heavy Vehicles (%)	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%
Bus Blockages (#/hr)	0	0	0	0	0	2	0	0	0	0	0	8
Turn Type	Split		Perm	Split			Prot			Prot		Perm
Protected Phases	4	4		8	8		5	2		1	6	
Permitted Phases			4									6
Actuated Green, G (s)	17.8	17.8	17.8	18.4	18.4		12.2	30.5		10.7	29.0	29.0
Effective Green, g (s)	17.8	17.8	17.8	18.4	18.4		12.2	31.5		10.7	30.0	30.0
Actuated g/C Ratio	0.19	0.19	0.19	0.19	0.19		0.13	0.33		0.11	0.32	0.32
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0		4.0	5.0		4.0	5.0	5.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0		3.0	3.0		3.0	3.0	3.0
Lane Grp Cap (vph)	533	569	256	294	562		202	1028		177	993	407
v/s Ratio Prot	c0.12	0.09		0.03	c0.14		c0.10	c0.34		0.07	0.17	
v/s Ratio Perm			0.02									0.09
v/c Ratio	0.63	0.50	0.10	0.15	0.73		0.75	1.01		0.62	0.53	0.29
Uniform Delay, d1	35.3	34.3	31.6	31.5	35.6		39.6	31.5		39.9	26.4	24.2
Progression Factor	1.00	1.00	1.00	1.00	1.00		1.00	1.00		1.00	1.00	1.00
Incremental Delay, d2	2.4	0.7	0.2	0.2	4.6		14.6	30.6		6.2	0.5	0.4
Delay (s)	37.7	35.0	31.8	31.7	40.3		54.3	62.0		46.1	26.9	24.6
Level of Service	D	C	C	C	D		D	E		D	C	C
Approach Delay (s)		35.7			39.5			61.0			28.1	
Approach LOS		D			D			E			C	

Intersection Summary			
HCM Average Control Delay	42.9	HCM Level of Service	D
HCM Volume to Capacity ratio	0.80		
Actuated Cycle Length (s)	94.4	Sum of lost time (s)	12.0
Intersection Capacity Utilization	79.7%	ICU Level of Service	D
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	80	200	90	50	180	100	140	790	50	90	350	70
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.9	4.9		4.9	4.9		4.3	4.8	4.8	4.3	4.8	4.8
Lane Util. Factor	1.00	0.95		1.00	0.95		0.97	0.95	1.00	0.97	0.95	1.00
Frpb, ped/bikes	1.00	0.99		1.00	0.99		1.00	1.00	0.98	1.00	1.00	0.98
Flpb, ped/bikes	1.00	1.00		1.00	1.00		1.00	1.00	1.00	1.00	1.00	1.00
Frt	1.00	0.95		1.00	0.95		1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	1770	3357		1770	3321		3433	3539	1558	3433	3539	1550
Flt Permitted	0.95	1.00		0.95	1.00		0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)	1770	3357		1770	3321		3433	3539	1558	3433	3539	1550
Peak-hour factor, PHF	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93
Adj. Flow (vph)	86	215	97	54	194	108	151	849	54	97	376	75
RTOR Reduction (vph)	0	54	0	0	80	0	0	0	37	0	0	32
Lane Group Flow (vph)	86	258	0	54	222	0	151	849	17	97	376	43
Confl. Peds. (#/hr)			7			13			6			11
Confl. Bikes (#/hr)						2						
Turn Type	Split			Split			Prot		Perm	Prot		Perm
Protected Phases	4	4		8	8		5	2		1	6	
Permitted Phases									2			6
Actuated Green, G (s)	11.7	11.7		11.1	11.1		7.1	20.8	20.8	4.3	18.0	18.0
Effective Green, g (s)	10.8	10.8		10.2	10.2		6.8	21.0	21.0	4.0	18.2	18.2
Actuated g/C Ratio	0.17	0.17		0.16	0.16		0.10	0.32	0.32	0.06	0.28	0.28
Clearance Time (s)	4.0	4.0		4.0	4.0		4.0	5.0	5.0	4.0	5.0	5.0
Vehicle Extension (s)	2.0	2.0		2.0	2.0		2.0	2.0	2.0	2.0	2.0	2.0
Lane Grp Cap (vph)	295	559		278	522		360	1145	504	212	992	435
v/s Ratio Prot	0.05	c0.08		0.03	c0.07		c0.04	c0.24		0.03	0.11	
v/s Ratio Perm									0.01			0.03
v/c Ratio	0.29	0.46		0.19	0.43		0.42	0.74	0.03	0.46	0.38	0.10
Uniform Delay, d1	23.7	24.4		23.8	24.7		27.2	19.5	15.0	29.4	18.8	17.3
Progression Factor	1.00	1.00		1.00	1.00		1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	0.2	0.2		0.1	0.2		0.3	2.3	0.0	0.6	0.1	0.0
Delay (s)	23.9	24.6		23.9	24.9		27.5	21.8	15.0	30.0	18.9	17.3
Level of Service	C	C		C	C		C	C	B	C	B	B
Approach Delay (s)		24.5			24.8			22.3			20.6	
Approach LOS		C			C			C			C	

Intersection Summary			
HCM Average Control Delay	22.7	HCM Level of Service	C
HCM Volume to Capacity ratio	0.59		
Actuated Cycle Length (s)	64.9	Sum of lost time (s)	18.9
Intersection Capacity Utilization	59.7%	ICU Level of Service	B
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	10	10	10	80	20	110	10	220	40	50	190	10
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0			4.0	4.0	4.0	4.0		4.0	4.0	
Lane Util. Factor		1.00			1.00	1.00	1.00	1.00		1.00	1.00	
Frpb, ped/bikes		0.99			1.00	0.98	1.00	0.99		1.00	1.00	
Flpb, ped/bikes		1.00			1.00	1.00	1.00	1.00		1.00	1.00	
Frt		0.95			1.00	0.85	1.00	0.98		1.00	0.99	
Flt Protected		0.98			0.96	1.00	0.95	1.00		0.95	1.00	
Satd. Flow (prot)		1737			1791	1554	1770	1806		1770	1845	
Flt Permitted		0.98			0.96	1.00	0.95	1.00		0.95	1.00	
Satd. Flow (perm)		1737			1791	1554	1770	1806		1770	1845	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	11	11	11	87	22	120	11	239	43	54	207	11
RTOR Reduction (vph)	0	10	0	0	0	105	0	7	0	0	2	0
Lane Group Flow (vph)	0	23	0	0	109	15	11	275	0	54	216	0
Confl. Peds. (#/hr)	2		1	1		2	13		20	20		13
Confl. Bikes (#/hr)						1			5			
Turn Type	Split			Split		Perm	Split			Split		
Protected Phases	2	2		1	1		4	4		3	3	
Permitted Phases						1						
Actuated Green, G (s)		4.5			7.0	7.0	15.5	15.5		13.8	13.8	
Effective Green, g (s)		4.5			7.0	7.0	15.5	15.5		13.8	13.8	
Actuated g/C Ratio		0.08			0.12	0.12	0.27	0.27		0.24	0.24	
Clearance Time (s)		4.0			4.0	4.0	4.0	4.0		4.0	4.0	
Vehicle Extension (s)		3.0			3.0	3.0	3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)		138			221	192	483	493		430	448	
v/s Ratio Prot		c0.01			c0.06		0.01	c0.15		0.03	c0.12	
v/s Ratio Perm						0.01						
v/c Ratio		0.17			0.49	0.08	0.02	0.56		0.13	0.48	
Uniform Delay, d1		24.4			23.2	22.0	15.1	17.7		16.8	18.4	
Progression Factor		1.00			1.00	1.00	1.00	1.00		1.00	1.00	
Incremental Delay, d2		0.6			1.7	0.2	0.0	1.4		0.1	0.8	
Delay (s)		25.0			25.0	22.2	15.1	19.1		16.9	19.3	
Level of Service		C			C	C	B	B		B	B	
Approach Delay (s)		25.0			23.5			18.9			18.8	
Approach LOS		C			C			B			B	

Intersection Summary			
HCM Average Control Delay	20.4	HCM Level of Service	C
HCM Volume to Capacity ratio	0.48		
Actuated Cycle Length (s)	56.8	Sum of lost time (s)	16.0
Intersection Capacity Utilization	42.2%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	250	220	50	50	280	50	60	610	30	30	330	90
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0			4.0			4.0	
Lane Util. Factor	1.00	0.95		1.00	0.95			0.95			0.95	
Frpb, ped/bikes	1.00	0.99		1.00	0.99			1.00			0.99	
Flpb, ped/bikes	0.98	1.00		0.99	1.00			1.00			1.00	
Frt	1.00	0.97		1.00	0.98			0.99			0.97	
Flt Protected	0.95	1.00		0.95	1.00			1.00			1.00	
Satd. Flow (prot)	1540	3052		1561	3059			3112			3027	
Flt Permitted	0.53	1.00		0.57	1.00			0.87			0.88	
Satd. Flow (perm)	855	3052		941	3059			2728			2683	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	272	239	54	54	304	54	65	663	33	33	359	98
RTOR Reduction (vph)	0	29	0	0	21	0	0	5	0	0	33	0
Lane Group Flow (vph)	272	264	0	54	337	0	0	756	0	0	457	0
Confl. Peds. (#/hr)	56		22	22		56	31		42	42		31
Confl. Bikes (#/hr)						2			5			1
Heavy Vehicles (%)	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%
Turn Type	Perm			Perm			Perm			Perm		
Protected Phases		4			4			2			2	
Permitted Phases	4			4			2			2		
Actuated Green, G (s)	30.0	30.0		30.0	30.0			32.0			32.0	
Effective Green, g (s)	29.0	29.0		29.0	29.0			31.0			31.0	
Actuated g/C Ratio	0.43	0.43		0.43	0.43			0.46			0.46	
Clearance Time (s)	3.0	3.0		3.0	3.0			3.0			3.0	
Lane Grp Cap (vph)	365	1302		401	1305			1244			1223	
v/s Ratio Prot		0.09			0.11							
v/s Ratio Perm	c0.32			0.06				c0.28			0.17	
v/c Ratio	0.75	0.20		0.13	0.26			0.61			0.37	
Uniform Delay, d1	16.4	12.2		11.9	12.6			13.9			12.1	
Progression Factor	1.00	1.00		1.00	1.00			1.00			1.00	
Incremental Delay, d2	13.0	0.4		0.7	0.5			2.2			0.9	
Delay (s)	29.4	12.6		12.6	13.0			16.1			13.0	
Level of Service	C	B		B	B			B			B	
Approach Delay (s)		20.7			13.0			16.1			13.0	
Approach LOS		C			B			B			B	

Intersection Summary			
HCM Average Control Delay	16.0	HCM Level of Service	B
HCM Volume to Capacity ratio	0.67		
Actuated Cycle Length (s)	68.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	101.2%	ICU Level of Service	G
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	20	220	40	20	290	250	30	560	20	170	290	20
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0			5.0			5.0		5.0	5.0	
Lane Util. Factor		0.95			0.95			0.95		0.97	1.00	
Frpb, ped/bikes		0.99			0.99			1.00		1.00	1.00	
Flpb, ped/bikes		1.00			1.00			1.00		1.00	1.00	
Frt		0.98			0.93			1.00		1.00	0.99	
Flt Protected		1.00			1.00			1.00		0.95	1.00	
Satd. Flow (prot)		3468			3305			3544		3467	1860	
Flt Permitted		0.88			0.93			1.00		0.95	1.00	
Satd. Flow (perm)		3047			3093			3544		3467	1860	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	22	239	43	22	315	272	33	609	22	185	315	22
RTOR Reduction (vph)	0	17	0	0	191	0	0	3	0	0	3	0
Lane Group Flow (vph)	0	287	0	0	418	0	0	661	0	185	334	0
Confl. Peds. (#/hr)	2		11	11		2	14		25	25		14
Confl. Bikes (#/hr)			1			2						
Heavy Vehicles (%)	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%
Turn Type	Perm			Perm			Split			Split		
Protected Phases		4			4		2	2		3	3	
Permitted Phases	4			4								
Actuated Green, G (s)		14.8			14.8			16.6		16.8	16.8	
Effective Green, g (s)		13.8			13.8			15.6		15.8	15.8	
Actuated g/C Ratio		0.23			0.23			0.26		0.26	0.26	
Clearance Time (s)		4.0			4.0			4.0		4.0	4.0	
Vehicle Extension (s)		3.0			3.0			3.0		3.0	3.0	
Lane Grp Cap (vph)		698			709			918		910	488	
v/s Ratio Prot								c0.19		0.05	c0.18	
v/s Ratio Perm		0.09			c0.14							
v/c Ratio		0.41			0.59			0.72		0.20	0.68	
Uniform Delay, d1		19.7			20.7			20.3		17.3	20.0	
Progression Factor		1.00			1.00			1.00		1.00	1.00	
Incremental Delay, d2		0.4			1.3			2.8		0.1	4.0	
Delay (s)		20.1			21.9			23.1		17.4	23.9	
Level of Service		C			C			C		B	C	
Approach Delay (s)		20.1			21.9			23.1			21.6	
Approach LOS		C			C			C			C	

Intersection Summary			
HCM Average Control Delay	22.0	HCM Level of Service	C
HCM Volume to Capacity ratio	0.67		
Actuated Cycle Length (s)	60.2	Sum of lost time (s)	15.0
Intersection Capacity Utilization	79.7%	ICU Level of Service	D
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	20	280	330	20	410	150	420	330	30	80	210	20
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0	4.0		4.0		4.0	4.0			4.0	
Lane Util. Factor		0.91	0.91		0.95		1.00	1.00			1.00	
Frpb, ped/bikes		0.99	0.96		0.99		1.00	1.00			1.00	
Flpb, ped/bikes		1.00	1.00		1.00		1.00	1.00			1.00	
Frt		0.95	0.85		0.96		1.00	0.99			0.99	
Flt Protected		1.00	1.00		1.00		0.95	1.00			0.99	
Satd. Flow (prot)		2968	1385		3130		1770	1578			1564	
Flt Permitted		0.85	1.00		0.93		0.95	1.00			0.99	
Satd. Flow (perm)		2533	1385		2906		1770	1578			1564	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	22	304	359	22	446	163	457	359	33	87	228	22
RTOR Reduction (vph)	0	52	166	0	42	0	0	4	0	0	3	0
Lane Group Flow (vph)	0	414	53	0	589	0	457	388	0	0	334	0
Confl. Peds. (#/hr)	16		21	21		16	20		16	16		20
Confl. Bikes (#/hr)			1			2			1			
Parking (#/hr)		8			8			8			8	
Turn Type	Perm		Perm	Perm			Split			Split		
Protected Phases		2			2		4	4		8	8	
Permitted Phases	2		2	2								
Actuated Green, G (s)		20.0	20.0		20.0		25.0	25.0			26.0	
Effective Green, g (s)		20.0	20.0		20.0		25.0	25.0			26.0	
Actuated g/C Ratio		0.24	0.24		0.24		0.30	0.30			0.31	
Clearance Time (s)		4.0	4.0		4.0		4.0	4.0			4.0	
Lane Grp Cap (vph)		610	334		700		533	475			490	
v/s Ratio Prot							c0.26	0.25			c0.21	
v/s Ratio Perm		0.16	0.04		c0.20							
v/c Ratio		0.68	0.16		0.84		0.86	0.82			0.68	
Uniform Delay, d1		28.6	24.9		30.0		27.3	26.9			24.9	
Progression Factor		1.00	1.00		1.00		1.00	1.00			1.00	
Incremental Delay, d2		6.0	1.0		11.7		16.2	14.4			7.5	
Delay (s)		34.5	25.9		41.7		43.5	41.2			32.4	
Level of Service		C	C		D		D	D			C	
Approach Delay (s)		31.8			41.7			42.5			32.4	
Approach LOS		C			D			D			C	

Intersection Summary			
HCM Average Control Delay	38.0	HCM Level of Service	D
HCM Volume to Capacity ratio	0.79		
Actuated Cycle Length (s)	83.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	86.6%	ICU Level of Service	E
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL2	EBL	EBT	EBR	NBT	NBR	NBR2	SBL2	SBL	SBT
Lane Configurations										
Volume (vph)	70	660	150	100	200	190	70	360	150	330
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0	4.0	4.5	4.0	4.0		4.0	4.0	4.0
Lane Util. Factor		0.91	0.91	1.00	0.95	1.00		1.00	1.00	1.00
Frpb, ped/bikes		1.00	1.00	0.87	1.00	0.93		1.00	1.00	1.00
Flpb, ped/bikes		1.00	1.00	1.00	1.00	1.00		1.00	1.00	1.00
Frt		1.00	1.00	0.85	1.00	0.85		1.00	1.00	1.00
Flt Protected		0.95	0.97	1.00	1.00	1.00		0.95	0.95	1.00
Satd. Flow (prot)		1610	3274	1370	3539	1479		1770	1770	1863
Flt Permitted		0.95	0.97	1.00	1.00	1.00		0.95	0.95	1.00
Satd. Flow (perm)		1610	3274	1370	3539	1479		1770	1770	1863
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	74	695	158	105	211	200	74	379	158	347
RTOR Reduction (vph)	0	0	0	78	0	20	0	0	0	0
Lane Group Flow (vph)	0	387	540	27	211	254	0	379	158	347
Confl. Peds. (#/hr)				50			50		50	
Confl. Bikes (#/hr)				10			10			
Turn Type	Perm	Perm		Perm		Perm		Prot	Prot	
Protected Phases			4		2			1	1	6
Permitted Phases	4	4		4		2				
Actuated Green, G (s)		18.5	18.5	18.5	19.1	19.1		23.9	23.9	46.5
Effective Green, g (s)		20.0	20.0	19.5	18.6	18.6		24.4	24.4	47.0
Actuated g/C Ratio		0.27	0.27	0.26	0.25	0.25		0.33	0.33	0.63
Clearance Time (s)		5.5	5.5	5.5	3.5	3.5		4.5	4.5	4.5
Vehicle Extension (s)		2.0	2.0	2.0	2.0	2.0		2.0	2.0	2.0
Lane Grp Cap (vph)		429	873	356	878	367		576	576	1167
v/s Ratio Prot					0.06			c0.21	0.09	0.19
v/s Ratio Perm		c0.24	0.16	0.02		c0.17				
v/c Ratio		0.90	0.85dl	0.08	0.24	0.69		0.66	0.27	0.30
Uniform Delay, d1		26.6	24.2	21.0	22.6	25.6		21.7	18.7	6.4
Progression Factor		1.00	1.00	1.00	1.00	1.00		1.00	1.00	1.00
Incremental Delay, d2		21.4	0.9	0.0	0.1	4.5		5.8	1.2	0.7
Delay (s)		47.9	25.1	21.0	22.6	30.1		27.5	19.9	7.1
Level of Service		D	C	C	C	C		C	B	A
Approach Delay (s)			33.2		26.9					18.1
Approach LOS			C		C					B

Intersection Summary			
HCM Average Control Delay	26.4	HCM Level of Service	C
HCM Volume to Capacity ratio	0.75		
Actuated Cycle Length (s)	75.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	67.5%	ICU Level of Service	C
Analysis Period (min)	15		

dl Defacto Left Lane. Recode with 1 though lane as a left lane.
c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	0	0	330	790	0	0	0	0	0	480	320
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)				4.0	4.0						4.0	4.0
Lane Util. Factor				0.86	0.86						0.86	0.86
Frpb, ped/bikes				1.00	1.00						1.00	1.00
Flpb, ped/bikes				1.00	1.00						1.00	1.00
Frt				1.00	1.00						0.97	0.85
Flt Protected				0.95	1.00						1.00	1.00
Satd. Flow (prot)				1522	4789						4627	1362
Flt Permitted				0.95	1.00						1.00	1.00
Satd. Flow (perm)				1522	4789						4627	1362
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	0	0	0	347	832	0	0	0	0	0	505	337
RTOR Reduction (vph)	0	0	0	213	10	0	0	0	0	0	62	81
Lane Group Flow (vph)	0	0	0	72	884	0	0	0	0	0	588	111
Confl. Bikes (#/hr)						9						10
Turn Type				Prot								Prot
Protected Phases				7	3						2	2
Permitted Phases												
Actuated Green, G (s)				20.0	40.0						31.0	31.0
Effective Green, g (s)				20.0	40.0						31.0	31.0
Actuated g/C Ratio				0.25	0.51						0.39	0.39
Clearance Time (s)				4.0	4.0						4.0	4.0
Lane Grp Cap (vph)				385	2425						1816	534
v/s Ratio Prot				0.05	c0.09						c0.13	0.08
v/s Ratio Perm					0.09							
v/c Ratio				0.19	0.36						0.32	0.21
Uniform Delay, d1				23.1	11.8						16.7	15.9
Progression Factor				1.00	1.00						1.00	1.00
Incremental Delay, d2				1.1	0.4						0.5	0.9
Delay (s)				24.2	12.2						17.2	16.8
Level of Service				C	B						B	B
Approach Delay (s)		0.0			15.1			0.0			17.1	
Approach LOS		A			B			A			B	

Intersection Summary			
HCM Average Control Delay	15.9	HCM Level of Service	B
HCM Volume to Capacity ratio	0.35		
Actuated Cycle Length (s)	79.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	36.3%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	130	330	0	0	0	0	0	1030	1770	0	0	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0						4.0	4.0			
Lane Util. Factor		0.91						0.91	0.88			
Frpb, ped/bikes		1.00						1.00	1.00			
Flpb, ped/bikes		1.00						1.00	1.00			
Frt		1.00						1.00	0.85			
Flt Protected		0.99						1.00	1.00			
Satd. Flow (prot)		5003						5085	2787			
Flt Permitted		0.99						1.00	1.00			
Satd. Flow (perm)		5003						5085	2787			
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	137	347	0	0	0	0	0	1084	1863	0	0	0
RTOR Reduction (vph)	0	11	0	0	0	0	0	0	376	0	0	0
Lane Group Flow (vph)	0	473	0	0	0	0	0	1084	1487	0	0	0
Confl. Peds. (#/hr)	12		21	21		12	42		29	29		42
Confl. Bikes (#/hr)			2			1						1
Turn Type	Perm								custom			
Protected Phases		4						2	2			
Permitted Phases	4								7			
Actuated Green, G (s)		27.0						23.0	23.0			
Effective Green, g (s)		27.0						24.0	24.0			
Actuated g/C Ratio		0.45						0.40	0.40			
Clearance Time (s)		5.0						5.0	5.0			
Vehicle Extension (s)		3.0						3.0	3.0			
Lane Grp Cap (vph)		2251						2034	1115			
v/s Ratio Prot								0.21	c0.53			
v/s Ratio Perm		0.09										
v/c Ratio		0.21						0.53	1.33			
Uniform Delay, d1		10.0						13.7	18.0			
Progression Factor		1.00						1.00	1.00			
Incremental Delay, d2		0.2						0.3	156.3			
Delay (s)		10.2						14.0	174.3			
Level of Service		B						B	F			
Approach Delay (s)		10.2			0.0			115.3			0.0	
Approach LOS		B			A			F			A	

Intersection Summary			
HCM Average Control Delay	100.5	HCM Level of Service	F
HCM Volume to Capacity ratio	0.74		
Actuated Cycle Length (s)	60.0	Sum of lost time (s)	9.0
Intersection Capacity Utilization	94.6%	ICU Level of Service	F
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	50	730	1310	0	0	0	0	270	100	60	320	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0	4.0					4.0			4.0	
Lane Util. Factor		0.86	0.86					1.00			1.00	
Frpb, ped/bikes		0.96	0.97					0.98			1.00	
Flpb, ped/bikes		1.00	1.00					1.00			0.99	
Frt		0.93	0.85					0.96			1.00	
Flt Protected		1.00	1.00					1.00			0.99	
Satd. Flow (prot)		4272	1315					1752			1838	
Flt Permitted		1.00	1.00					1.00			0.69	
Satd. Flow (perm)		4272	1315					1752			1270	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	53	768	1379	0	0	0	0	284	105	63	337	0
RTOR Reduction (vph)	0	84	0	0	0	0	0	22	0	0	0	0
Lane Group Flow (vph)	0	1427	689	0	0	0	0	367	0	0	400	0
Confl. Peds. (#/hr)	51		75	75		51	29		79	79		29
Confl. Bikes (#/hr)											1	1
Turn Type	Perm		Free							Perm		
Protected Phases		2						4			8	
Permitted Phases	2		Free							8		
Actuated Green, G (s)		33.0	60.0					18.0			18.0	
Effective Green, g (s)		34.0	60.0					18.0			18.0	
Actuated g/C Ratio		0.57	1.00					0.30			0.30	
Clearance Time (s)		5.0						4.0			4.0	
Vehicle Extension (s)		2.0						2.0			2.0	
Lane Grp Cap (vph)		2421	1315					526			381	
v/s Ratio Prot								0.21				
v/s Ratio Perm		0.33	0.52								c0.31	
v/c Ratio		0.59	0.52					0.70			1.05	
Uniform Delay, d1		8.5	0.0					18.6			21.0	
Progression Factor		0.71	1.00					1.00			1.00	
Incremental Delay, d2		0.1	0.1					3.2			59.8	
Delay (s)		6.1	0.1					21.8			80.8	
Level of Service		A	A					C			F	
Approach Delay (s)		4.3			0.0			21.8			80.8	
Approach LOS		A			A			C			F	

Intersection Summary			
HCM Average Control Delay	16.8	HCM Level of Service	B
HCM Volume to Capacity ratio	0.75		
Actuated Cycle Length (s)	60.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	80.8%	ICU Level of Service	D
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Volume (vph)	390	100	70	780	1210	580
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	0.97	1.00	1.00	0.95	0.91	0.88
Frpb, ped/bikes	1.00	0.98	1.00	1.00	1.00	1.00
Flpb, ped/bikes	1.00	1.00	1.00	1.00	1.00	1.00
Frt	1.00	0.85	1.00	1.00	1.00	0.85
Flt Protected	0.95	1.00	0.95	1.00	1.00	1.00
Satd. Flow (prot)	3433	1550	1770	3539	5085	2787
Flt Permitted	0.95	1.00	0.95	1.00	1.00	1.00
Satd. Flow (perm)	3433	1550	1770	3539	5085	2787
Peak-hour factor, PHF	0.94	0.94	0.94	0.94	0.94	0.94
Adj. Flow (vph)	415	106	74	830	1287	617
RTOR Reduction (vph)	0	0	0	0	0	432
Lane Group Flow (vph)	415	106	74	830	1287	185
Confl. Peds. (#/hr)	2	16	2			2
Turn Type		Perm	Prot			Prot
Protected Phases	4		5	2	6	6
Permitted Phases		4				
Actuated Green, G (s)	26.0	26.0	4.0	26.0	18.0	18.0
Effective Green, g (s)	26.0	26.0	4.0	26.0	18.0	18.0
Actuated g/C Ratio	0.43	0.43	0.07	0.43	0.30	0.30
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Lane Grp Cap (vph)	1488	672	118	1534	1526	836
v/s Ratio Prot	c0.12		0.04	c0.23	c0.25	0.07
v/s Ratio Perm		0.07				
v/c Ratio	0.28	0.16	0.63	0.54	0.84	0.22
Uniform Delay, d1	11.0	10.3	27.3	12.6	19.7	15.7
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	0.5	0.5	22.6	1.4	5.9	0.6
Delay (s)	11.4	10.8	49.9	14.0	25.5	16.4
Level of Service	B	B	D	B	C	B
Approach Delay (s)	11.3			16.9	22.6	
Approach LOS	B			B	C	

Intersection Summary			
HCM Average Control Delay	19.3	HCM Level of Service	B
HCM Volume to Capacity ratio	0.53		
Actuated Cycle Length (s)	60.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	63.1%	ICU Level of Service	B
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	20	150	60	50	100	60	60	90	50	90	150	10
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0			4.0	4.0	4.0	4.0		4.0	4.0	
Lane Util. Factor		0.95			0.95	1.00	1.00	0.95		0.91	0.91	
Frpb, ped/bikes		0.99			1.00	0.99	1.00	1.00		1.00	1.00	
Flpb, ped/bikes		1.00			1.00	1.00	1.00	1.00		1.00	1.00	
Frt		0.96			1.00	0.85	1.00	0.95		1.00	0.99	
Flt Protected		1.00			0.98	1.00	0.95	1.00		0.95	1.00	
Satd. Flow (prot)		3363			3478	1563	1770	3335		1610	3347	
Flt Permitted		0.93			0.82	1.00	0.95	1.00		0.95	1.00	
Satd. Flow (perm)		3133			2889	1563	1770	3335		1610	3347	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	22	163	65	54	109	65	65	98	54	98	163	11
RTOR Reduction (vph)	0	42	0	0	0	0	0	45	0	0	6	0
Lane Group Flow (vph)	0	208	0	0	163	65	65	107	0	88	178	0
Confl. Peds. (#/hr)	2		4	4		2	4		2	2		4
Confl. Bikes (#/hr)			2			1						2
Turn Type	Perm			Perm		Free	Split			Split		
Protected Phases		2			6		3	3		4	4	
Permitted Phases	2			6		Free						
Actuated Green, G (s)		15.1			14.1	42.2	6.8	6.8		7.3	7.3	
Effective Green, g (s)		15.1			15.1	42.2	6.8	6.8		8.3	8.3	
Actuated g/C Ratio		0.36			0.36	1.00	0.16	0.16		0.20	0.20	
Clearance Time (s)		4.0			5.0		4.0	4.0		5.0	5.0	
Vehicle Extension (s)		3.0			3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)		1121			1034	1563	285	537		317	658	
v/s Ratio Prot							c0.04	0.03		c0.05	0.05	
v/s Ratio Perm		c0.07			0.06	0.04						
v/c Ratio		0.19			0.16	0.04	0.23	0.20		0.28	0.27	
Uniform Delay, d1		9.3			9.2	0.0	15.4	15.3		14.4	14.4	
Progression Factor		1.00			1.00	1.00	1.00	1.00		1.00	1.00	
Incremental Delay, d2		0.1			0.1	0.0	0.4	0.2		0.5	0.2	
Delay (s)		9.4			9.3	0.0	15.8	15.5		14.9	14.6	
Level of Service		A			A	A	B	B		B	B	
Approach Delay (s)		9.4			6.7			15.6			14.7	
Approach LOS		A			A			B			B	

Intersection Summary			
HCM Average Control Delay	11.6	HCM Level of Service	B
HCM Volume to Capacity ratio	0.22		
Actuated Cycle Length (s)	42.2	Sum of lost time (s)	12.0
Intersection Capacity Utilization	37.2%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	10	260	10	190	200	40	10	40	130	30	40	10
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0			4.0			4.0	
Lane Util. Factor	1.00	0.95		1.00	0.95			1.00			1.00	
Frpb, ped/bikes	1.00	1.00		1.00	1.00			0.98			1.00	
Flpb, ped/bikes	1.00	1.00		1.00	1.00			1.00			1.00	
Frt	1.00	0.99		1.00	0.98			0.90			0.98	
Flt Protected	0.95	1.00		0.95	1.00			1.00			0.98	
Satd. Flow (prot)	1787	3554		1787	3468			1659			1804	
Flt Permitted	0.95	1.00		0.95	1.00			0.99			0.88	
Satd. Flow (perm)	1787	3554		1787	3468			1645			1610	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	11	283	11	207	217	43	11	43	141	33	43	11
RTOR Reduction (vph)	0	4	0	0	27	0	0	80	0	0	6	0
Lane Group Flow (vph)	11	290	0	207	233	0	0	115	0	0	81	0
Confl. Peds. (#/hr)	4					4	1		24	24		1
Confl. Bikes (#/hr)						2			1			
Heavy Vehicles (%)	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%
Turn Type	Prot			Prot			Perm			Perm		
Protected Phases	7	4		3	8			2			6	
Permitted Phases							2			6		
Actuated Green, G (s)	6.0	16.0		6.0	16.0			26.0			26.0	
Effective Green, g (s)	6.0	16.0		6.0	16.0			26.0			26.0	
Actuated g/C Ratio	0.10	0.27		0.10	0.27			0.43			0.43	
Clearance Time (s)	4.0	4.0		4.0	4.0			4.0			4.0	
Lane Grp Cap (vph)	179	948		179	925			713			698	
v/s Ratio Prot	0.01	c0.08		c0.12	0.07							
v/s Ratio Perm								c0.07			0.05	
v/c Ratio	0.06	0.31		1.16	0.25			0.16			0.12	
Uniform Delay, d1	24.5	17.6		27.0	17.3			10.4			10.1	
Progression Factor	1.00	1.00		1.00	1.00			1.00			1.00	
Incremental Delay, d2	0.7	0.8		115.6	0.7			0.5			0.3	
Delay (s)	25.1	18.4		142.6	17.9			10.8			10.5	
Level of Service	C	B		F	B			B			B	
Approach Delay (s)		18.6			73.2			10.8			10.5	
Approach LOS		B			E			B			B	

Intersection Summary			
HCM Average Control Delay	40.7	HCM Level of Service	D
HCM Volume to Capacity ratio	0.33		
Actuated Cycle Length (s)	60.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	51.4%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	260	220	80	90	280	70	100	530	100	120	840	350
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width	10	11	12	11	11	12	12	12	12	12	12	12
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0		4.0	4.0		4.0	4.0	4.0
Lane Util. Factor	0.97	0.95	1.00	1.00	0.95		1.00	0.95		1.00	0.95	1.00
Frpb, ped/bikes	1.00	1.00	0.94	1.00	0.98		1.00	0.99		1.00	1.00	0.91
Flpb, ped/bikes	1.00	1.00	1.00	1.00	1.00		1.00	1.00		1.00	1.00	1.00
Frt	1.00	1.00	0.85	1.00	0.97		1.00	0.98		1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00		0.95	1.00		0.95	1.00	1.00
Satd. Flow (prot)	2884	3079	1337	1540	2941		1593	3081		1593	3185	1253
Flt Permitted	0.95	1.00	1.00	0.95	1.00		0.95	1.00		0.95	1.00	1.00
Satd. Flow (perm)	2884	3079	1337	1540	2941		1593	3081		1593	3185	1253
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	283	239	87	98	304	76	109	576	109	130	913	380
RTOR Reduction (vph)	0	0	72	0	20	0	0	12	0	0	0	239
Lane Group Flow (vph)	283	239	15	98	360	0	109	673	0	130	913	141
Confl. Peds. (#/hr)			47			60			42			75
Confl. Bikes (#/hr)						1						
Bus Blockages (#/hr)	0	0	0	0	0	2	0	0	0	0	0	8
Turn Type	Split		Perm	Split			Prot			Prot		Perm
Protected Phases	4	4		8	8		5	2		1	6	
Permitted Phases			4									6
Actuated Green, G (s)	15.5	15.5	15.5	16.6	16.6		10.6	29.7		11.4	30.5	30.5
Effective Green, g (s)	15.5	15.5	15.5	16.6	16.6		10.6	30.7		11.4	31.5	31.5
Actuated g/C Ratio	0.17	0.17	0.17	0.18	0.18		0.12	0.34		0.13	0.35	0.35
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0		4.0	5.0		4.0	5.0	5.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0		3.0	3.0		3.0	3.0	3.0
Lane Grp Cap (vph)	496	529	230	283	541		187	1049		201	1112	438
v/s Ratio Prot	c0.10	0.08		0.06	c0.12		0.07	0.22		c0.08	c0.29	
v/s Ratio Perm			0.01									0.11
v/c Ratio	0.57	0.45	0.07	0.35	0.67		0.58	0.64		0.65	0.82	0.32
Uniform Delay, d1	34.3	33.5	31.3	32.1	34.2		37.7	25.1		37.5	26.8	21.5
Progression Factor	1.00	1.00	1.00	1.00	1.00		1.00	1.00		1.00	1.00	1.00
Incremental Delay, d2	1.6	0.6	0.1	0.7	3.1		4.6	1.4		7.0	5.0	0.4
Delay (s)	35.9	34.2	31.4	32.8	37.3		42.3	26.5		44.5	31.8	21.9
Level of Service	D	C	C	C	D		D	C		D	C	C
Approach Delay (s)		34.6			36.4			28.6			30.3	
Approach LOS		C			D			C			C	

Intersection Summary			
HCM Average Control Delay	31.6	HCM Level of Service	C
HCM Volume to Capacity ratio	0.68		
Actuated Cycle Length (s)	90.2	Sum of lost time (s)	12.0
Intersection Capacity Utilization	73.2%	ICU Level of Service	D
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	120	180	110	50	140	120	110	480	40	140	1200	140
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.9	4.9		4.9	4.9		4.3	4.8	4.8	4.3	4.8	4.8
Lane Util. Factor	1.00	0.95		1.00	0.95		0.97	0.95	1.00	0.97	0.95	1.00
Frpb, ped/bikes	1.00	0.99		1.00	0.99		1.00	1.00	0.98	1.00	1.00	0.99
Flpb, ped/bikes	1.00	1.00		1.00	1.00		1.00	1.00	1.00	1.00	1.00	1.00
Frt	1.00	0.94		1.00	0.93		1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	1787	3348		1787	3289		3467	3574	1571	3467	3574	1576
Flt Permitted	0.95	1.00		0.95	1.00		0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)	1787	3348		1787	3289		3467	3574	1571	3467	3574	1576
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	126	189	116	53	147	126	116	505	42	147	1263	147
RTOR Reduction (vph)	0	99	0	0	110	0	0	0	25	0	0	16
Lane Group Flow (vph)	126	206	0	53	163	0	116	505	17	147	1263	131
Confl. Peds. (#/hr)			7			14			8			3
Confl. Bikes (#/hr)						1						
Heavy Vehicles (%)	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%
Turn Type	Split			Split			Prot		Perm	Prot		Perm
Protected Phases	4	4		8	8		5	2		1	6	
Permitted Phases									2			6
Actuated Green, G (s)	11.3	11.3		10.0	10.0		5.1	29.5	29.5	4.2	28.6	28.6
Effective Green, g (s)	10.4	10.4		9.1	9.1		4.8	29.7	29.7	3.9	28.8	28.8
Actuated g/C Ratio	0.14	0.14		0.13	0.13		0.07	0.41	0.41	0.05	0.40	0.40
Clearance Time (s)	4.0	4.0		4.0	4.0		4.0	5.0	5.0	4.0	5.0	5.0
Vehicle Extension (s)	2.0	2.0		2.0	2.0		2.0	2.0	2.0	2.0	2.0	2.0
Lane Grp Cap (vph)	258	484		226	416		231	1474	648	188	1430	630
v/s Ratio Prot	c0.07	0.06		0.03	c0.05		0.03	0.14		c0.04	c0.35	
v/s Ratio Perm									0.01			0.08
v/c Ratio	0.49	0.43		0.23	0.39		0.50	0.34	0.03	0.78	0.88	0.21
Uniform Delay, d1	28.4	28.1		28.3	28.9		32.4	14.5	12.6	33.6	20.0	14.1
Progression Factor	1.00	1.00		1.00	1.00		1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	0.5	0.2		0.2	0.2		0.6	0.1	0.0	17.5	6.6	0.1
Delay (s)	28.9	28.3		28.5	29.1		33.1	14.5	12.6	51.1	26.7	14.2
Level of Service	C	C		C	C		C	B	B	D	C	B
Approach Delay (s)		28.5			29.0			17.6			27.8	
Approach LOS		C			C			B			C	

Intersection Summary			
HCM Average Control Delay	25.8	HCM Level of Service	C
HCM Volume to Capacity ratio	0.70		
Actuated Cycle Length (s)	72.0	Sum of lost time (s)	18.9
Intersection Capacity Utilization	72.9%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	10	10	10	20	10	40	10	130	30	70	200	10
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0			4.0	4.0	4.0	4.0		4.0	4.0	
Lane Util. Factor		1.00			1.00	1.00	1.00	1.00		1.00	1.00	
Frpb, ped/bikes		0.99			1.00	0.98	1.00	1.00		1.00	1.00	
Flpb, ped/bikes		1.00			1.00	1.00	1.00	1.00		1.00	1.00	
Frt		0.95			1.00	0.85	1.00	0.97		1.00	0.99	
Flt Protected		0.98			0.97	1.00	0.95	1.00		0.95	1.00	
Satd. Flow (prot)		1733			1803	1547	1770	1802		1770	1847	
Flt Permitted		0.98			0.97	1.00	0.95	1.00		0.95	1.00	
Satd. Flow (perm)		1733			1803	1547	1770	1802		1770	1847	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	11	11	11	22	11	43	11	141	33	76	217	11
RTOR Reduction (vph)	0	10	0	0	0	40	0	9	0	0	2	0
Lane Group Flow (vph)	0	23	0	0	33	3	11	165	0	76	226	0
Confl. Peds. (#/hr)	2		6	6		2	8		2	2		8
Confl. Bikes (#/hr)						1						
Turn Type	Split			Split		Perm	Split			Split		
Protected Phases	2	2		1	1		4	4		3	3	
Permitted Phases						1						
Actuated Green, G (s)		2.9			3.6	3.6	12.4	12.4		13.5	13.5	
Effective Green, g (s)		2.9			3.6	3.6	12.4	12.4		13.5	13.5	
Actuated g/C Ratio		0.06			0.07	0.07	0.26	0.26		0.28	0.28	
Clearance Time (s)		4.0			4.0	4.0	4.0	4.0		4.0	4.0	
Vehicle Extension (s)		3.0			3.0	3.0	3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)		104			134	115	453	462		494	515	
v/s Ratio Prot		c0.01			c0.02		0.01	c0.09		0.04	c0.12	
v/s Ratio Perm						0.00						
v/c Ratio		0.22			0.25	0.03	0.02	0.36		0.15	0.44	
Uniform Delay, d1		21.7			21.1	20.8	13.5	14.7		13.1	14.3	
Progression Factor		1.00			1.00	1.00	1.00	1.00		1.00	1.00	
Incremental Delay, d2		1.1			1.0	0.1	0.0	0.5		0.1	0.6	
Delay (s)		22.7			22.1	20.9	13.5	15.2		13.3	14.9	
Level of Service		C			C	C	B	B		B	B	
Approach Delay (s)		22.7			21.4			15.1			14.5	
Approach LOS		C			C			B			B	

Intersection Summary			
HCM Average Control Delay	16.0	HCM Level of Service	B
HCM Volume to Capacity ratio	0.37		
Actuated Cycle Length (s)	48.4	Sum of lost time (s)	16.0
Intersection Capacity Utilization	35.8%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	160	140	40	60	150	40	20	430	40	50	630	100
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0			4.0			4.0	
Lane Util. Factor	1.00	0.95		1.00	0.95			0.95			0.95	
Frpb, ped/bikes	1.00	0.99		1.00	1.00			1.00			0.99	
Flpb, ped/bikes	0.99	1.00		0.98	1.00			1.00			1.00	
Frt	1.00	0.97		1.00	0.97			0.99			0.98	
Flt Protected	0.95	1.00		0.95	1.00			1.00			1.00	
Satd. Flow (prot)	1584	3057		1568	3072			3129			3090	
Flt Permitted	0.63	1.00		0.63	1.00			0.91			0.89	
Satd. Flow (perm)	1046	3057		1045	3072			2867			2773	
Peak-hour factor, PHF	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96
Adj. Flow (vph)	167	146	42	62	156	42	21	448	42	52	656	104
RTOR Reduction (vph)	0	24	0	0	24	0	0	10	0	0	17	0
Lane Group Flow (vph)	167	164	0	62	174	0	0	501	0	0	795	0
Confl. Peds. (#/hr)	10		29	29		10	63		34	34		63
Confl. Bikes (#/hr)									1			
Parking (#/hr)							0					
Turn Type	Perm			Perm			Perm			Perm		
Protected Phases		4			4			2			2	
Permitted Phases	4			4			2			2		
Actuated Green, G (s)	30.0	30.0		30.0	30.0			32.0			32.0	
Effective Green, g (s)	29.0	29.0		29.0	29.0			31.0			31.0	
Actuated g/C Ratio	0.43	0.43		0.43	0.43			0.46			0.46	
Clearance Time (s)	3.0	3.0		3.0	3.0			3.0			3.0	
Lane Grp Cap (vph)	446	1304		446	1310			1307			1264	
v/s Ratio Prot		0.05			0.06							
v/s Ratio Perm	c0.16			0.06				0.17			c0.29	
v/c Ratio	0.37	0.13		0.14	0.13			0.38			0.63	
Uniform Delay, d1	13.3	11.8		11.9	11.9			12.2			14.1	
Progression Factor	1.00	1.00		1.00	1.00			1.00			1.00	
Incremental Delay, d2	2.4	0.2		0.7	0.2			0.9			2.4	
Delay (s)	15.7	12.0		12.5	12.1			13.1			16.5	
Level of Service	B	B		B	B			B			B	
Approach Delay (s)		13.8			12.2			13.1			16.5	
Approach LOS		B			B			B			B	

Intersection Summary			
HCM Average Control Delay	14.5	HCM Level of Service	B
HCM Volume to Capacity ratio	0.51		
Actuated Cycle Length (s)	68.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	96.6%	ICU Level of Service	F
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	20	170	30	20	170	140	20	420	40	550	550	40
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0			5.0			5.0		5.0	5.0	
Lane Util. Factor		0.95			0.95			0.95		0.97	1.00	
Frpb, ped/bikes		1.00			0.99			1.00		1.00	1.00	
Flpb, ped/bikes		1.00			1.00			1.00		1.00	1.00	
Frt		0.98			0.94			0.99		1.00	0.99	
Flt Protected		1.00			1.00			1.00		0.95	1.00	
Satd. Flow (prot)		3472			3312			3516		3467	1859	
Flt Permitted		0.90			0.92			1.00		0.95	1.00	
Satd. Flow (perm)		3125			3067			3516		3467	1859	
Peak-hour factor, PHF	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94
Adj. Flow (vph)	21	181	32	21	181	149	21	447	43	585	585	43
RTOR Reduction (vph)	0	18	0	0	125	0	0	9	0	0	3	0
Lane Group Flow (vph)	0	216	0	0	226	0	0	502	0	585	625	0
Confl. Peds. (#/hr)	2		6	6		2	11		10	10		11
Confl. Bikes (#/hr)						2						1
Heavy Vehicles (%)	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%
Turn Type	Perm			Perm			Split			Split		
Protected Phases		4			4		2	2		3	3	
Permitted Phases	4			4								
Actuated Green, G (s)		11.5			11.5			14.2		26.5	26.5	
Effective Green, g (s)		10.5			10.5			13.2		25.5	25.5	
Actuated g/C Ratio		0.16			0.16			0.21		0.40	0.40	
Clearance Time (s)		4.0			4.0			4.0		4.0	4.0	
Vehicle Extension (s)		3.0			3.0			3.0		3.0	3.0	
Lane Grp Cap (vph)		511			502			723		1377	738	
v/s Ratio Prot								c0.14		0.17	c0.34	
v/s Ratio Perm		0.07			c0.07							
v/c Ratio		0.42			0.45			0.69		0.42	0.85	
Uniform Delay, d1		24.1			24.2			23.6		14.0	17.6	
Progression Factor		1.00			1.00			1.00		1.00	1.00	
Incremental Delay, d2		0.6			0.6			2.9		0.2	8.9	
Delay (s)		24.7			24.9			26.5		14.2	26.5	
Level of Service		C			C			C		B	C	
Approach Delay (s)		24.7			24.9			26.5			20.6	
Approach LOS		C			C			C			C	

Intersection Summary			
HCM Average Control Delay	23.0	HCM Level of Service	C
HCM Volume to Capacity ratio	0.72		
Actuated Cycle Length (s)	64.2	Sum of lost time (s)	15.0
Intersection Capacity Utilization	81.7%	ICU Level of Service	D
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	20	330	410	20	300	120	350	290	40	100	390	30
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0	4.0		4.0		4.0	4.0			4.0	
Lane Util. Factor		0.91	0.91		0.95		1.00	1.00			1.00	
Frpb, ped/bikes		0.99	0.96		0.99		1.00	1.00			1.00	
Flpb, ped/bikes		1.00	1.00		1.00		1.00	1.00			1.00	
Frt		0.95	0.85		0.96		1.00	0.98			0.99	
Flt Protected		1.00	1.00		1.00		0.95	1.00			0.99	
Satd. Flow (prot)		2981	1399		3150		1787	1583			1586	
Flt Permitted		0.93	1.00		0.90		0.95	1.00			0.99	
Satd. Flow (perm)		2767	1399		2848		1787	1583			1586	
Peak-hour factor, PHF	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97
Adj. Flow (vph)	21	340	423	21	309	124	361	299	41	103	402	31
RTOR Reduction (vph)	0	65	186	0	47	0	0	6	0	0	3	0
Lane Group Flow (vph)	0	474	59	0	407	0	361	334	0	0	533	0
Confl. Peds. (#/hr)	17		21	21		17	30		15	15		30
Confl. Bikes (#/hr)			1			1						
Heavy Vehicles (%)	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%
Parking (#/hr)		8			8			8			8	
Turn Type	Perm		Perm	Perm			Split			Split		
Protected Phases		2			2		4	4		8	8	
Permitted Phases	2		2	2								
Actuated Green, G (s)		20.0	20.0		20.0		25.0	25.0			26.0	
Effective Green, g (s)		20.0	20.0		20.0		25.0	25.0			26.0	
Actuated g/C Ratio		0.24	0.24		0.24		0.30	0.30			0.31	
Clearance Time (s)		4.0	4.0		4.0		4.0	4.0			4.0	
Lane Grp Cap (vph)		667	337		686		538	477			497	
v/s Ratio Prot							0.20	c0.21			c0.34	
v/s Ratio Perm		c0.17	0.04		0.14							
v/c Ratio		0.71	0.18		0.59		0.67	0.70			1.07	
Uniform Delay, d1		28.8	25.0		27.9		25.4	25.7			28.5	
Progression Factor		1.00	1.00		1.00		1.00	1.00			1.00	
Incremental Delay, d2		6.3	1.1		3.7		6.5	8.3			61.3	
Delay (s)		35.2	26.1		31.6		31.9	34.0			89.8	
Level of Service		D	C		C		C	C			F	
Approach Delay (s)		32.3			31.6			32.9			89.8	
Approach LOS		C			C			C			F	

Intersection Summary			
HCM Average Control Delay	44.8	HCM Level of Service	D
HCM Volume to Capacity ratio	0.84		
Actuated Cycle Length (s)	83.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	86.8%	ICU Level of Service	E
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL2	EBL	EBT	EBR	NBT	NBR	NBR2	SBL2	SBL	SBT
Lane Configurations										
Volume (vph)	30	950	310	100	380	270	70	330	270	340
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0	4.0	4.5	4.0	4.0		4.0	4.0	4.0
Lane Util. Factor		0.91	0.91	1.00	0.95	1.00		1.00	1.00	1.00
Frpb, ped/bikes		1.00	1.00	0.85	1.00	0.92		1.00	1.00	1.00
Flpb, ped/bikes		1.00	1.00	1.00	1.00	1.00		1.00	1.00	1.00
Frt		1.00	1.00	0.85	1.00	0.85		1.00	1.00	1.00
Flt Protected		0.95	0.97	1.00	1.00	1.00		0.95	0.95	1.00
Satd. Flow (prot)		1610	3289	1343	3539	1452		1770	1770	1863
Flt Permitted		0.95	0.97	1.00	1.00	1.00		0.95	0.95	1.00
Satd. Flow (perm)		1610	3289	1343	3539	1452		1770	1770	1863
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	32	1000	326	105	400	284	74	347	284	358
RTOR Reduction (vph)	0	0	0	68	0	11	0	0	0	0
Lane Group Flow (vph)	0	512	846	37	400	347	0	347	284	358
Confl. Peds. (#/hr)				50			50		50	
Confl. Bikes (#/hr)				10			10			
Turn Type	Perm	Perm		Perm		Perm		Prot	Prot	
Protected Phases			4		2			1	1	6
Permitted Phases	4	4		4		2				
Actuated Green, G (s)		30.7	30.7	30.7	22.5	22.5		23.8	23.8	49.3
Effective Green, g (s)		32.2	32.2	31.7	22.0	22.0		23.8	23.8	49.8
Actuated g/C Ratio		0.36	0.36	0.35	0.24	0.24		0.26	0.26	0.55
Clearance Time (s)		5.5	5.5	5.5	3.5	3.5		4.0	4.0	4.5
Vehicle Extension (s)		2.0	2.0	2.0	2.0	2.0		2.0	2.0	2.0
Lane Grp Cap (vph)		576	1177	473	865	355		468	468	1031
v/s Ratio Prot					0.11			c0.20	0.16	0.19
v/s Ratio Perm		c0.32	0.26	0.03		c0.24				
v/c Ratio		0.89	0.86dl	0.08	0.46	0.98		0.74	0.61	0.35
Uniform Delay, d1		27.2	25.0	19.4	29.0	33.8		30.3	29.0	11.1
Progression Factor		1.00	1.00	1.00	1.00	1.00		1.00	1.00	1.00
Incremental Delay, d2		15.1	1.8	0.0	0.1	41.4		10.1	5.7	0.9
Delay (s)		42.3	26.8	19.4	29.1	75.2		40.4	34.8	12.0
Level of Service		D	C	B	C	E		D	C	B
Approach Delay (s)			31.7		50.9					28.5
Approach LOS			C		D					C

Intersection Summary			
HCM Average Control Delay	35.2	HCM Level of Service	D
HCM Volume to Capacity ratio	0.87		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	75.7%	ICU Level of Service	D
Analysis Period (min)	15		

dl Defacto Left Lane. Recode with 1 though lane as a left lane.
c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	0	0	360	660	0	0	0	0	0	890	350
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)				4.0	4.0						4.0	4.0
Lane Util. Factor				0.86	0.86						0.86	0.86
Frpb, ped/bikes				1.00	1.00						1.00	1.00
Flpb, ped/bikes				1.00	1.00						1.00	1.00
Frt				1.00	1.00						0.99	0.85
Flt Protected				0.95	0.99						1.00	1.00
Satd. Flow (prot)				1522	4772						4745	1362
Flt Permitted				0.95	0.99						1.00	1.00
Satd. Flow (perm)				1522	4772						4745	1362
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	0	0	0	379	695	0	0	0	0	0	937	368
RTOR Reduction (vph)	0	0	0	196	22	0	0	0	0	0	11	114
Lane Group Flow (vph)	0	0	0	66	790	0	0	0	0	0	1003	177
Confl. Bikes (#/hr)						5						9
Turn Type				Prot								Prot
Protected Phases				7	3						2	2
Permitted Phases												
Actuated Green, G (s)				20.0	40.0						31.0	31.0
Effective Green, g (s)				20.0	40.0						31.0	31.0
Actuated g/C Ratio				0.25	0.51						0.39	0.39
Clearance Time (s)				4.0	4.0						4.0	4.0
Lane Grp Cap (vph)				385	2416						1862	534
v/s Ratio Prot				0.04	c0.08						c0.21	0.13
v/s Ratio Perm					0.08							
v/c Ratio				0.17	0.33						0.54	0.33
Uniform Delay, d1				23.0	11.5						18.5	16.8
Progression Factor				1.00	1.00						1.00	1.00
Incremental Delay, d2				1.0	0.4						1.1	1.7
Delay (s)				24.0	11.9						19.6	18.4
Level of Service				C	B						B	B
Approach Delay (s)		0.0			14.9			0.0			19.3	
Approach LOS		A			B			A			B	

Intersection Summary			
HCM Average Control Delay	17.3	HCM Level of Service	B
HCM Volume to Capacity ratio	0.42		
Actuated Cycle Length (s)	79.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	41.5%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	210	740	0	0	0	0	0	800	1670	0	0	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0						4.0	4.0			
Lane Util. Factor		0.91						0.91	0.88			
Frpb, ped/bikes		1.00						1.00	1.00			
Flpb, ped/bikes		1.00						1.00	1.00			
Frt		1.00						1.00	0.85			
Flt Protected		0.99						1.00	1.00			
Satd. Flow (prot)		5013						5085	2787			
Flt Permitted		0.99						1.00	1.00			
Satd. Flow (perm)		5013						5085	2787			
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	221	779	0	0	0	0	0	842	1758	0	0	0
RTOR Reduction (vph)	0	3	0	0	0	0	0	0	231	0	0	0
Lane Group Flow (vph)	0	998	0	0	0	0	0	842	1527	0	0	0
Confl. Peds. (#/hr)	28		7	7		28	99		3	3		99
Confl. Bikes (#/hr)			1			2			1			
Turn Type	Perm								custom			
Protected Phases		4						2	2			
Permitted Phases	4								7			
Actuated Green, G (s)		34.0						16.0	16.0			
Effective Green, g (s)		35.0						17.0	17.0			
Actuated g/C Ratio		0.58						0.28	0.28			
Clearance Time (s)		5.0						5.0	5.0			
Vehicle Extension (s)		3.0						3.0	3.0			
Lane Grp Cap (vph)		2924						1441	790			
v/s Ratio Prot								0.17	c0.55			
v/s Ratio Perm		0.20										
v/c Ratio		0.34						0.58	1.93			
Uniform Delay, d1		6.5						18.5	21.5			
Progression Factor		1.00						1.00	1.00			
Incremental Delay, d2		0.3						0.6	424.2			
Delay (s)		6.8						19.1	445.7			
Level of Service		A						B	F			
Approach Delay (s)		6.8			0.0			307.5			0.0	
Approach LOS		A			A			F			A	

Intersection Summary			
HCM Average Control Delay	224.0	HCM Level of Service	F
HCM Volume to Capacity ratio	0.86		
Actuated Cycle Length (s)	60.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	93.7%	ICU Level of Service	F
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	50	1150	1230	0	0	0	0	230	240	80	340	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0	4.0					4.0			4.0	
Lane Util. Factor		0.86	0.86					1.00			1.00	
Frpb, ped/bikes		0.98	0.97					0.98			1.00	
Flpb, ped/bikes		1.00	1.00					1.00			1.00	
Frt		0.95	0.85					0.93			1.00	
Flt Protected		1.00	1.00					1.00			0.99	
Satd. Flow (prot)		4437	1323					1701			1842	
Flt Permitted		1.00	1.00					1.00			0.39	
Satd. Flow (perm)		4437	1323					1701			733	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	53	1211	1295	0	0	0	0	242	253	84	358	0
RTOR Reduction (vph)	0	70	0	0	0	0	0	33	0	0	0	0
Lane Group Flow (vph)	0	1842	647	0	0	0	0	462	0	0	442	0
Confl. Peds. (#/hr)	52		55	55		52	39		25	25		39
Confl. Bikes (#/hr)			1						2		1	2
Turn Type	Perm		Free							Perm		
Protected Phases		2						4			8	
Permitted Phases	2		Free							8		
Actuated Green, G (s)		33.0	60.0					18.0			18.0	
Effective Green, g (s)		34.0	60.0					18.0			18.0	
Actuated g/C Ratio		0.57	1.00					0.30			0.30	
Clearance Time (s)		5.0						4.0			4.0	
Vehicle Extension (s)		2.0						2.0			2.0	
Lane Grp Cap (vph)		2514	1323					510			220	
v/s Ratio Prot								0.27				
v/s Ratio Perm		0.42	0.49								c0.60	
v/c Ratio		0.73	0.49					0.91			2.01	
Uniform Delay, d1		9.6	0.0					20.2			21.0	
Progression Factor		0.59	1.00					1.00			1.00	
Incremental Delay, d2		0.2	0.1					19.2			469.8	
Delay (s)		5.9	0.1					39.4			490.8	
Level of Service		A	A					D			F	
Approach Delay (s)		4.4			0.0			39.4			490.8	
Approach LOS		A			A			D			F	

Intersection Summary			
HCM Average Control Delay	70.9	HCM Level of Service	E
HCM Volume to Capacity ratio	1.17		
Actuated Cycle Length (s)	60.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	96.0%	ICU Level of Service	F
Analysis Period (min)	15		
c Critical Lane Group			

Near-Term (2018) Plus Phase 1 Project Conditions

FEHR PEERS

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Volume (vph)	410	60	40	1227	954	530
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	0.97	1.00	1.00	0.95	0.91	0.88
Frpb, ped/bikes	1.00	0.98	1.00	1.00	1.00	1.00
Flpb, ped/bikes	1.00	1.00	1.00	1.00	1.00	1.00
Frt	1.00	0.85	1.00	1.00	1.00	0.85
Flt Protected	0.95	1.00	0.95	1.00	1.00	1.00
Satd. Flow (prot)	3400	1535	1752	3505	5036	2760
Flt Permitted	0.95	1.00	0.95	1.00	1.00	1.00
Satd. Flow (perm)	3400	1535	1752	3505	5036	2760
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	446	65	43	1334	1037	576
RTOR Reduction (vph)	0	0	0	0	0	403
Lane Group Flow (vph)	446	65	43	1334	1037	173
Confl. Peds. (#/hr)	3	11	4			4
Confl. Bikes (#/hr)		5				5
Heavy Vehicles (%)	3%	3%	3%	3%	3%	3%
Turn Type		Perm	Prot			Prot
Protected Phases	4		5	2	6	6
Permitted Phases		4				
Actuated Green, G (s)	26.0	26.0	4.0	26.0	18.0	18.0
Effective Green, g (s)	26.0	26.0	4.0	26.0	18.0	18.0
Actuated g/C Ratio	0.43	0.43	0.07	0.43	0.30	0.30
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Lane Grp Cap (vph)	1473	665	117	1519	1511	828
v/s Ratio Prot	c0.13		0.02	c0.38	0.21	0.06
v/s Ratio Perm		0.04				
v/c Ratio	0.30	0.10	0.37	0.88	0.69	0.21
Uniform Delay, d1	11.1	10.1	26.8	15.6	18.5	15.7
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	0.5	0.3	8.7	7.5	2.6	0.6
Delay (s)	11.6	10.4	35.5	23.1	21.1	16.3
Level of Service	B	B	D	C	C	B
Approach Delay (s)	11.5			23.5	19.4	
Approach LOS	B			C	B	

Intersection Summary			
HCM Average Control Delay	19.8	HCM Level of Service	B
HCM Volume to Capacity ratio	0.59		
Actuated Cycle Length (s)	60.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	66.4%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	10	62	32	160	175	110	75	190	80	40	92	22
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0			4.0	4.0	4.0	4.0		4.0	4.0	
Lane Util. Factor		0.95			0.95	1.00	1.00	0.95		0.91	0.91	
Frpb, ped/bikes		0.99			1.00	0.98	1.00	0.99		1.00	1.00	
Flpb, ped/bikes		1.00			1.00	1.00	1.00	1.00		1.00	1.00	
Frt		0.95			1.00	0.85	1.00	0.96		1.00	0.97	
Flt Protected		1.00			0.98	1.00	0.95	1.00		0.95	1.00	
Satd. Flow (prot)		3201			3314	1500	1703	3227		1550	3152	
Flt Permitted		0.92			0.78	1.00	0.95	1.00		0.95	1.00	
Satd. Flow (perm)		2948			2635	1500	1703	3227		1550	3152	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	11	67	35	174	190	120	82	207	87	43	100	24
RTOR Reduction (vph)	0	24	0	0	0	0	0	63	0	0	20	0
Lane Group Flow (vph)	0	89	0	0	364	120	82	231	0	39	108	0
Confl. Peds. (#/hr)	9		8	8		9	12		17	17		12
Confl. Bikes (#/hr)						3			5			2
Heavy Vehicles (%)	6%	6%	6%	6%	6%	6%	6%	6%	6%	6%	6%	6%
Turn Type	Perm			Perm		Free	Split			Split		
Protected Phases		2			6		3	3		4	4	
Permitted Phases	2			6		Free						
Actuated Green, G (s)		14.3			13.3	43.8	9.7	9.7		6.8	6.8	
Effective Green, g (s)		14.3			14.3	43.8	9.7	9.7		7.8	7.8	
Actuated g/C Ratio		0.33			0.33	1.00	0.22	0.22		0.18	0.18	
Clearance Time (s)		4.0			5.0		4.0	4.0		5.0	5.0	
Vehicle Extension (s)		3.0			3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)		962			860	1500	377	715		276	561	
v/s Ratio Prot							0.05	c0.07		0.03	c0.03	
v/s Ratio Perm		0.03			c0.14	0.08						
v/c Ratio		0.09			0.42	0.08	0.22	0.32		0.14	0.19	
Uniform Delay, d1		10.2			11.5	0.0	13.9	14.3		15.2	15.3	
Progression Factor		1.00			1.00	1.00	1.00	1.00		1.00	1.00	
Incremental Delay, d2		0.0			0.3	0.1	0.3	0.3		0.2	0.2	
Delay (s)		10.3			11.9	0.1	14.2	14.6		15.4	15.5	
Level of Service		B			B	A	B	B		B	B	
Approach Delay (s)		10.3			8.9			14.5			15.5	
Approach LOS		B			A			B			B	

Intersection Summary			
HCM Average Control Delay	11.9	HCM Level of Service	B
HCM Volume to Capacity ratio	0.34		
Actuated Cycle Length (s)	43.8	Sum of lost time (s)	12.0
Intersection Capacity Utilization	44.6%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	10	151	10	140	405	30	20	90	230	40	80	20
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0			4.0			4.0	
Lane Util. Factor	1.00	0.95		1.00	0.95			1.00			1.00	
Frpb, ped/bikes	1.00	1.00		1.00	1.00			0.97			1.00	
Flpb, ped/bikes	1.00	1.00		1.00	1.00			1.00			1.00	
Frt	1.00	0.99		1.00	0.99			0.91			0.98	
Flt Protected	0.95	1.00		0.95	1.00			1.00			0.99	
Satd. Flow (prot)	1736	3429		1736	3425			1607			1752	
Flt Permitted	0.95	1.00		0.95	1.00			0.98			0.85	
Satd. Flow (perm)	1736	3429		1736	3425			1582			1515	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	11	164	11	152	440	33	22	98	250	43	87	22
RTOR Reduction (vph)	0	8	0	0	9	0	0	125	0	0	10	0
Lane Group Flow (vph)	11	167	0	152	464	0	0	245	0	0	142	0
Confl. Peds. (#/hr)	11		13	13		11	22		48	48		22
Confl. Bikes (#/hr)			1			2			1			
Heavy Vehicles (%)	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%
Turn Type	Prot			Prot			Perm			Perm		
Protected Phases	7	4		3	8			2			6	
Permitted Phases							2			6		
Actuated Green, G (s)	6.0	16.0		6.0	16.0			26.0			26.0	
Effective Green, g (s)	6.0	16.0		6.0	16.0			26.0			26.0	
Actuated g/C Ratio	0.10	0.27		0.10	0.27			0.43			0.43	
Clearance Time (s)	4.0	4.0		4.0	4.0			4.0			4.0	
Lane Grp Cap (vph)	174	914		174	913			686			657	
v/s Ratio Prot	0.01	0.05		c0.09	c0.14							
v/s Ratio Perm								c0.15			0.09	
v/c Ratio	0.06	0.18		0.87	0.51			0.36			0.22	
Uniform Delay, d1	24.5	17.0		26.6	18.7			11.4			10.6	
Progression Factor	1.00	1.00		1.00	1.00			1.00			1.00	
Incremental Delay, d2	0.7	0.4		41.4	2.0			1.4			0.8	
Delay (s)	25.2	17.4		68.0	20.7			12.8			11.4	
Level of Service	C	B		E	C			B			B	
Approach Delay (s)		17.9			32.2			12.8			11.4	
Approach LOS		B			C			B			B	

Intersection Summary			
HCM Average Control Delay	22.4	HCM Level of Service	C
HCM Volume to Capacity ratio	0.47		
Actuated Cycle Length (s)	60.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	54.5%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	327	265	120	40	351	70	140	890	70	100	480	444
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width	10	11	12	11	11	12	12	12	12	12	12	12
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0		4.0	4.0		4.0	4.0	4.0
Lane Util. Factor	0.97	0.95	1.00	1.00	0.95		1.00	0.95		1.00	0.95	1.00
Frpb, ped/bikes	1.00	1.00	0.97	1.00	0.98		1.00	1.00		1.00	1.00	0.95
Flpb, ped/bikes	1.00	1.00	1.00	1.00	1.00		1.00	1.00		1.00	1.00	1.00
Frt	1.00	1.00	0.85	1.00	0.98		1.00	0.99		1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00		0.95	1.00		0.95	1.00	1.00
Satd. Flow (prot)	2828	3020	1356	1510	2891		1562	3081		1562	3124	1279
Flt Permitted	0.95	1.00	1.00	0.95	1.00		0.95	1.00		0.95	1.00	1.00
Satd. Flow (perm)	2828	3020	1356	1510	2891		1562	3081		1562	3124	1279
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	355	288	130	43	382	76	152	967	76	109	522	483
RTOR Reduction (vph)	0	0	105	0	14	0	0	5	0	0	0	333
Lane Group Flow (vph)	355	288	25	43	444	0	152	1038	0	109	522	150
Confl. Peds. (#/hr)			16			85			25			37
Confl. Bikes (#/hr)						1			1			1
Heavy Vehicles (%)	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%
Bus Blockages (#/hr)	0	0	0	0	0	2	0	0	0	0	0	8
Turn Type	Split		Perm	Split			Prot			Prot		Perm
Protected Phases	4	4		8	8		5	2		1	6	
Permitted Phases			4									6
Actuated Green, G (s)	18.6	18.6	18.6	19.5	19.5		12.2	30.4		10.8	29.0	29.0
Effective Green, g (s)	18.6	18.6	18.6	19.5	19.5		12.2	31.4		10.8	30.0	30.0
Actuated g/C Ratio	0.19	0.19	0.19	0.20	0.20		0.13	0.33		0.11	0.31	0.31
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0		4.0	5.0		4.0	5.0	5.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0		3.0	3.0		3.0	3.0	3.0
Lane Grp Cap (vph)	546	583	262	306	585		198	1005		175	973	398
v/s Ratio Prot	c0.13	0.10		0.03	c0.15		c0.10	c0.34		0.07	0.17	
v/s Ratio Perm			0.02									0.12
v/c Ratio	0.65	0.49	0.10	0.14	0.76		0.77	1.03		0.62	0.54	0.38
Uniform Delay, d1	35.8	34.7	31.9	31.5	36.2		40.7	32.5		40.8	27.4	25.9
Progression Factor	1.00	1.00	1.00	1.00	1.00		1.00	1.00		1.00	1.00	1.00
Incremental Delay, d2	2.8	0.7	0.2	0.2	5.6		16.2	37.3		6.7	0.6	0.6
Delay (s)	38.6	35.3	32.1	31.7	41.8		56.9	69.7		47.5	28.0	26.5
Level of Service	D	D	C	C	D		E	E		D	C	C
Approach Delay (s)		36.3			40.9			68.1			29.2	
Approach LOS		D			D			E			C	

Intersection Summary			
HCM Average Control Delay	45.3	HCM Level of Service	D
HCM Volume to Capacity ratio	0.81		
Actuated Cycle Length (s)	96.3	Sum of lost time (s)	12.0
Intersection Capacity Utilization	80.3%	ICU Level of Service	D
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	80	203	92	50	196	100	155	790	50	90	350	70
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.9	4.9		4.9	4.9		4.3	4.8	4.8	4.3	4.8	4.8
Lane Util. Factor	1.00	0.95		1.00	0.95		0.97	0.95	1.00	0.97	0.95	1.00
Frpb, ped/bikes	1.00	0.99		1.00	0.99		1.00	1.00	0.98	1.00	1.00	0.98
Flpb, ped/bikes	1.00	1.00		1.00	1.00		1.00	1.00	1.00	1.00	1.00	1.00
Frt	1.00	0.95		1.00	0.95		1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	1770	3356		1770	3333		3433	3539	1558	3433	3539	1550
Flt Permitted	0.95	1.00		0.95	1.00		0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)	1770	3356		1770	3333		3433	3539	1558	3433	3539	1550
Peak-hour factor, PHF	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93
Adj. Flow (vph)	86	218	99	54	211	108	167	849	54	97	376	75
RTOR Reduction (vph)	0	55	0	0	68	0	0	0	37	0	0	32
Lane Group Flow (vph)	86	262	0	54	251	0	167	849	17	97	376	43
Confl. Peds. (#/hr)			7			13			6			11
Confl. Bikes (#/hr)						2						
Turn Type	Split			Split			Prot		Perm	Prot		Perm
Protected Phases	4	4		8	8		5	2		1	6	
Permitted Phases									2			6
Actuated Green, G (s)	11.8	11.8		11.6	11.6		7.3	21.1	21.1	4.3	18.1	18.1
Effective Green, g (s)	10.9	10.9		10.7	10.7		7.0	21.3	21.3	4.0	18.3	18.3
Actuated g/C Ratio	0.17	0.17		0.16	0.16		0.11	0.32	0.32	0.06	0.28	0.28
Clearance Time (s)	4.0	4.0		4.0	4.0		4.0	5.0	5.0	4.0	5.0	5.0
Vehicle Extension (s)	2.0	2.0		2.0	2.0		2.0	2.0	2.0	2.0	2.0	2.0
Lane Grp Cap (vph)	293	556		288	542		365	1146	504	209	984	431
v/s Ratio Prot	0.05	c0.08		0.03	c0.08		c0.05	c0.24		0.03	0.11	
v/s Ratio Perm									0.01			0.03
v/c Ratio	0.29	0.47		0.19	0.46		0.46	0.74	0.03	0.46	0.38	0.10
Uniform Delay, d1	24.1	24.8		23.8	25.0		27.6	19.8	15.2	29.9	19.2	17.6
Progression Factor	1.00	1.00		1.00	1.00		1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	0.2	0.2		0.1	0.2		0.3	2.3	0.0	0.6	0.1	0.0
Delay (s)	24.3	25.1		23.9	25.2		27.9	22.1	15.2	30.5	19.3	17.7
Level of Service	C	C		C	C		C	C	B	C	B	B
Approach Delay (s)		24.9			25.0			22.7			21.0	
Approach LOS		C			C			C			C	

Intersection Summary			
HCM Average Control Delay	23.0	HCM Level of Service	C
HCM Volume to Capacity ratio	0.61		
Actuated Cycle Length (s)	65.8	Sum of lost time (s)	18.9
Intersection Capacity Utilization	60.0%	ICU Level of Service	B
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	20	12	12	80	35	110	25	235	40	50	192	72
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0			4.0	4.0	4.0	4.0		4.0	4.0	
Lane Util. Factor		1.00			1.00	1.00	1.00	1.00		1.00	1.00	
Frpb, ped/bikes		0.99			1.00	0.98	1.00	0.99		1.00	0.99	
Flpb, ped/bikes		1.00			1.00	1.00	1.00	1.00		1.00	1.00	
Frt		0.96			1.00	0.85	1.00	0.98		1.00	0.96	
Flt Protected		0.98			0.97	1.00	0.95	1.00		0.95	1.00	
Satd. Flow (prot)		1744			1800	1556	1770	1809		1770	1768	
Flt Permitted		0.98			0.97	1.00	0.95	1.00		0.95	1.00	
Satd. Flow (perm)		1744			1800	1556	1770	1809		1770	1768	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	22	13	13	87	38	120	27	255	43	54	209	78
RTOR Reduction (vph)	0	12	0	0	0	101	0	7	0	0	15	0
Lane Group Flow (vph)	0	36	0	0	125	19	27	291	0	54	272	0
Confl. Peds. (#/hr)	2		1	1		2	13		20	20		13
Confl. Bikes (#/hr)						1			5			
Turn Type	Split			Split		Perm	Split			Split		
Protected Phases	2	2		1	1		4	4		3	3	
Permitted Phases						1						
Actuated Green, G (s)		4.9			9.8	9.8	15.8	15.8		15.8	15.8	
Effective Green, g (s)		4.9			9.8	9.8	15.8	15.8		15.8	15.8	
Actuated g/C Ratio		0.08			0.16	0.16	0.25	0.25		0.25	0.25	
Clearance Time (s)		4.0			4.0	4.0	4.0	4.0		4.0	4.0	
Vehicle Extension (s)		3.0			3.0	3.0	3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)		137			283	245	449	459		449	448	
v/s Ratio Prot		c0.02			c0.07		0.02	c0.16		0.03	c0.15	
v/s Ratio Perm						0.01						
v/c Ratio		0.26			0.44	0.08	0.06	0.63		0.12	0.61	
Uniform Delay, d1		27.0			23.8	22.4	17.6	20.7		17.9	20.5	
Progression Factor		1.00			1.00	1.00	1.00	1.00		1.00	1.00	
Incremental Delay, d2		1.0			1.1	0.1	0.1	2.9		0.1	2.3	
Delay (s)		28.0			24.9	22.5	17.7	23.5		18.0	22.8	
Level of Service		C			C	C	B	C		B	C	
Approach Delay (s)		28.0			23.7			23.1			22.1	
Approach LOS		C			C			C			C	

Intersection Summary			
HCM Average Control Delay	23.1	HCM Level of Service	C
HCM Volume to Capacity ratio	0.54		
Actuated Cycle Length (s)	62.3	Sum of lost time (s)	16.0
Intersection Capacity Utilization	40.7%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	250	222	50	50	295	50	60	610	30	30	330	90
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0			4.0			4.0	
Lane Util. Factor	1.00	0.95		1.00	0.95			0.95			0.95	
Frpb, ped/bikes	1.00	1.00		1.00	0.99			1.00			0.99	
Flpb, ped/bikes	0.98	1.00		0.99	1.00			1.00			1.00	
Frt	1.00	0.97		1.00	0.98			0.99			0.97	
Flt Protected	0.95	1.00		0.95	1.00			1.00			1.00	
Satd. Flow (prot)	1541	3053		1561	3063			3112			3027	
Flt Permitted	0.51	1.00		0.57	1.00			0.87			0.88	
Satd. Flow (perm)	834	3053		939	3063			2728			2683	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	272	241	54	54	321	54	65	663	33	33	359	98
RTOR Reduction (vph)	0	28	0	0	20	0	0	5	0	0	33	0
Lane Group Flow (vph)	272	267	0	54	355	0	0	756	0	0	457	0
Confl. Peds. (#/hr)	56		22	22		56	31		42	42		31
Confl. Bikes (#/hr)						2			5			1
Heavy Vehicles (%)	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%
Turn Type	Perm			Perm			Perm			Perm		
Protected Phases		4			4			2			2	
Permitted Phases	4			4			2			2		
Actuated Green, G (s)	30.0	30.0		30.0	30.0			32.0			32.0	
Effective Green, g (s)	29.0	29.0		29.0	29.0			31.0			31.0	
Actuated g/C Ratio	0.43	0.43		0.43	0.43			0.46			0.46	
Clearance Time (s)	3.0	3.0		3.0	3.0			3.0			3.0	
Lane Grp Cap (vph)	356	1302		400	1306			1244			1223	
v/s Ratio Prot		0.09			0.12							
v/s Ratio Perm	c0.33			0.06				c0.28			0.17	
v/c Ratio	0.76	0.20		0.14	0.27			0.61			0.37	
Uniform Delay, d1	16.6	12.3		11.9	12.6			13.9			12.1	
Progression Factor	1.00	1.00		1.00	1.00			1.00			1.00	
Incremental Delay, d2	14.4	0.4		0.7	0.5			2.2			0.9	
Delay (s)	31.0	12.6		12.6	13.2			16.1			13.0	
Level of Service	C	B		B	B			B			B	
Approach Delay (s)		21.4			13.1			16.1			13.0	
Approach LOS		C			B			B			B	

Intersection Summary			
HCM Average Control Delay	16.2	HCM Level of Service	B
HCM Volume to Capacity ratio	0.68		
Actuated Cycle Length (s)	68.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	101.2%	ICU Level of Service	G
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	20	222	40	20	305	265	30	560	20	172	290	20
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0			5.0			5.0		5.0	5.0	
Lane Util. Factor		0.95			0.95			0.95		0.97	1.00	
Frpb, ped/bikes		0.99			0.99			1.00		1.00	1.00	
Flpb, ped/bikes		1.00			1.00			1.00		1.00	1.00	
Frt		0.98			0.93			1.00		1.00	0.99	
Flt Protected		1.00			1.00			1.00		0.95	1.00	
Satd. Flow (prot)		3469			3304			3544		3467	1860	
Flt Permitted		0.86			0.94			1.00		0.95	1.00	
Satd. Flow (perm)		3004			3095			3544		3467	1860	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	22	241	43	22	332	288	33	609	22	187	315	22
RTOR Reduction (vph)	0	17	0	0	192	0	0	3	0	0	3	0
Lane Group Flow (vph)	0	289	0	0	450	0	0	661	0	187	334	0
Confl. Peds. (#/hr)	2		11	11		2	14		25	25		14
Confl. Bikes (#/hr)			1			2						
Heavy Vehicles (%)	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%
Turn Type	Perm			Perm			Split			Split		
Protected Phases		4			4		2	2		3	3	
Permitted Phases	4			4								
Actuated Green, G (s)		15.4			15.4			16.7		17.0	17.0	
Effective Green, g (s)		14.4			14.4			15.7		16.0	16.0	
Actuated g/C Ratio		0.24			0.24			0.26		0.26	0.26	
Clearance Time (s)		4.0			4.0			4.0		4.0	4.0	
Vehicle Extension (s)		3.0			3.0			3.0		3.0	3.0	
Lane Grp Cap (vph)		708			729			911		908	487	
v/s Ratio Prot								c0.19		0.05	c0.18	
v/s Ratio Perm		0.10			c0.15							
v/c Ratio		0.41			0.62			0.73		0.21	0.69	
Uniform Delay, d1		19.7			20.9			20.7		17.6	20.3	
Progression Factor		1.00			1.00			1.00		1.00	1.00	
Incremental Delay, d2		0.4			1.6			2.9		0.1	4.0	
Delay (s)		20.1			22.5			23.6		17.7	24.3	
Level of Service		C			C			C		B	C	
Approach Delay (s)		20.1			22.5			23.6			21.9	
Approach LOS		C			C			C			C	

Intersection Summary			
HCM Average Control Delay	22.4	HCM Level of Service	C
HCM Volume to Capacity ratio	0.68		
Actuated Cycle Length (s)	61.1	Sum of lost time (s)	15.0
Intersection Capacity Utilization	80.6%	ICU Level of Service	D
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	20	284	331	20	434	150	425	330	30	80	210	20
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0	4.0		4.0		4.0	4.0			4.0	
Lane Util. Factor		0.91	0.91		0.95		1.00	1.00			1.00	
Frpb, ped/bikes		0.99	0.96		0.99		1.00	1.00			1.00	
Flpb, ped/bikes		1.00	1.00		1.00		1.00	1.00			1.00	
Frt		0.96	0.85		0.96		1.00	0.99			0.99	
Flt Protected		1.00	1.00		1.00		0.95	1.00			0.99	
Satd. Flow (prot)		2970	1385		3136		1770	1578			1564	
Flt Permitted		0.83	1.00		0.93		0.95	1.00			0.99	
Satd. Flow (perm)		2485	1385		2914		1770	1578			1564	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	22	309	360	22	472	163	462	359	33	87	228	22
RTOR Reduction (vph)	0	51	167	0	39	0	0	4	0	0	3	0
Lane Group Flow (vph)	0	420	53	0	618	0	462	388	0	0	334	0
Confl. Peds. (#/hr)	16		21	21		16	20		16	16		20
Confl. Bikes (#/hr)			1			2			1			
Parking (#/hr)		8			8			8			8	
Turn Type	Perm		Perm	Perm			Split			Split		
Protected Phases		2			2		4	4		8	8	
Permitted Phases	2		2	2								
Actuated Green, G (s)		20.0	20.0		20.0		25.0	25.0			26.0	
Effective Green, g (s)		20.0	20.0		20.0		25.0	25.0			26.0	
Actuated g/C Ratio		0.24	0.24		0.24		0.30	0.30			0.31	
Clearance Time (s)		4.0	4.0		4.0		4.0	4.0			4.0	
Lane Grp Cap (vph)		599	334		702		533	475			490	
v/s Ratio Prot							c0.26	0.25			c0.21	
v/s Ratio Perm		0.17	0.04		c0.21							
v/c Ratio		0.70	0.16		0.88		0.87	0.82			0.68	
Uniform Delay, d1		28.8	24.9		30.4		27.4	26.9			24.9	
Progression Factor		1.00	1.00		1.00		1.00	1.00			1.00	
Incremental Delay, d2		6.7	1.0		14.8		17.1	14.4			7.5	
Delay (s)		35.5	25.9		45.2		44.5	41.2			32.4	
Level of Service		D	C		D		D	D			C	
Approach Delay (s)		32.4			45.2			43.0			32.4	
Approach LOS		C			D			D			C	

Intersection Summary			
HCM Average Control Delay	39.3	HCM Level of Service	D
HCM Volume to Capacity ratio	0.80		
Actuated Cycle Length (s)	83.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	87.5%	ICU Level of Service	E
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL2	EBL	EBT	EBR	NBT	NBR	NBR2	SBL2	SBL	SBT
Lane Configurations										
Volume (vph)	70	691	150	100	200	192	70	375	150	330
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0	4.0	4.5	4.0	4.0		4.0	4.0	4.0
Lane Util. Factor		0.91	0.91	1.00	0.95	1.00		1.00	1.00	1.00
Frpb, ped/bikes		1.00	1.00	0.87	1.00	0.93		1.00	1.00	1.00
Flpb, ped/bikes		1.00	1.00	1.00	1.00	1.00		1.00	1.00	1.00
Frt		1.00	1.00	0.85	1.00	0.85		1.00	1.00	1.00
Flt Protected		0.95	0.97	1.00	1.00	1.00		0.95	0.95	1.00
Satd. Flow (prot)		1610	3273	1370	3539	1479		1770	1770	1863
Flt Permitted		0.95	0.97	1.00	1.00	1.00		0.95	0.95	1.00
Satd. Flow (perm)		1610	3273	1370	3539	1479		1770	1770	1863
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	74	727	158	105	211	202	74	395	158	347
RTOR Reduction (vph)	0	0	0	77	0	20	0	0	0	0
Lane Group Flow (vph)	0	401	558	28	211	256	0	395	158	347
Confl. Peds. (#/hr)				50			50		50	
Confl. Bikes (#/hr)				10			10			
Turn Type	Perm	Perm		Perm		Perm		Prot	Prot	
Protected Phases			4		2			1	1	6
Permitted Phases	4	4		4		2				
Actuated Green, G (s)		18.7	18.7	18.7	19.2	19.2		23.6	23.6	46.3
Effective Green, g (s)		20.2	20.2	19.7	18.7	18.7		24.1	24.1	46.8
Actuated g/C Ratio		0.27	0.27	0.26	0.25	0.25		0.32	0.32	0.62
Clearance Time (s)		5.5	5.5	5.5	3.5	3.5		4.5	4.5	4.5
Vehicle Extension (s)		2.0	2.0	2.0	2.0	2.0		2.0	2.0	2.0
Lane Grp Cap (vph)		434	882	360	882	369		569	569	1163
v/s Ratio Prot					0.06			c0.22	0.09	0.19
v/s Ratio Perm		c0.25	0.17	0.02		c0.17				
v/c Ratio		0.92	0.88dl	0.08	0.24	0.70		0.69	0.28	0.30
Uniform Delay, d1		26.7	24.1	20.8	22.5	25.6		22.2	19.0	6.5
Progression Factor		1.00	1.00	1.00	1.00	1.00		1.00	1.00	1.00
Incremental Delay, d2		24.9	1.1	0.0	0.1	4.5		6.8	1.2	0.7
Delay (s)		51.6	25.2	20.8	22.5	30.1		29.1	20.2	7.2
Level of Service		D	C	C	C	C		C	C	A
Approach Delay (s)			34.7		26.8					19.1
Approach LOS			C		C					B

Intersection Summary			
HCM Average Control Delay	27.4	HCM Level of Service	C
HCM Volume to Capacity ratio	0.77		
Actuated Cycle Length (s)	75.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	69.2%	ICU Level of Service	C
Analysis Period (min)	15		

dl Defacto Left Lane. Recode with 1 though lane as a left lane.
c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	0	0	363	791	0	0	0	0	0	487	320
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)				4.0	4.0						4.0	4.0
Lane Util. Factor				0.86	0.86						0.86	0.86
Frpb, ped/bikes				1.00	1.00						1.00	1.00
Flpb, ped/bikes				1.00	1.00						1.00	1.00
Frt				1.00	1.00						0.97	0.85
Flt Protected				0.95	1.00						1.00	1.00
Satd. Flow (prot)				1522	4783						4629	1362
Flt Permitted				0.95	1.00						1.00	1.00
Satd. Flow (perm)				1522	4783						4629	1362
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	0	0	0	382	833	0	0	0	0	0	513	337
RTOR Reduction (vph)	0	0	0	220	15	0	0	0	0	0	60	81
Lane Group Flow (vph)	0	0	0	74	906	0	0	0	0	0	598	111
Confl. Bikes (#/hr)						9						10
Turn Type				Prot								Prot
Protected Phases				7	3						2	2
Permitted Phases												
Actuated Green, G (s)				20.0	40.0						31.0	31.0
Effective Green, g (s)				20.0	40.0						31.0	31.0
Actuated g/C Ratio				0.25	0.51						0.39	0.39
Clearance Time (s)				4.0	4.0						4.0	4.0
Lane Grp Cap (vph)				385	2422						1816	534
v/s Ratio Prot				0.05	c0.09						c0.13	0.08
v/s Ratio Perm					0.09							
v/c Ratio				0.19	0.37						0.33	0.21
Uniform Delay, d1				23.2	11.9						16.7	15.9
Progression Factor				1.00	1.00						1.00	1.00
Incremental Delay, d2				1.1	0.4						0.5	0.9
Delay (s)				24.3	12.3						17.2	16.8
Level of Service				C	B						B	B
Approach Delay (s)		0.0			15.2			0.0			17.1	
Approach LOS		A			B			A			B	

Intersection Summary			
HCM Average Control Delay	16.0	HCM Level of Service	B
HCM Volume to Capacity ratio	0.35		
Actuated Cycle Length (s)	79.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	36.9%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	130	330	0	0	0	0	0	1032	1785	0	0	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0						4.0	4.0			
Lane Util. Factor		0.91						0.91	0.88			
Frpb, ped/bikes		1.00						1.00	1.00			
Flpb, ped/bikes		1.00						1.00	1.00			
Frt		1.00						1.00	0.85			
Flt Protected		0.99						1.00	1.00			
Satd. Flow (prot)		5003						5085	2787			
Flt Permitted		0.99						1.00	1.00			
Satd. Flow (perm)		5003						5085	2787			
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	137	347	0	0	0	0	0	1086	1879	0	0	0
RTOR Reduction (vph)	0	11	0	0	0	0	0	0	376	0	0	0
Lane Group Flow (vph)	0	473	0	0	0	0	0	1086	1503	0	0	0
Confl. Peds. (#/hr)	12		21	21		12	42		29	29		42
Confl. Bikes (#/hr)			2			1						1
Turn Type	Perm								custom			
Protected Phases		4						2	2			
Permitted Phases	4								7			
Actuated Green, G (s)		27.0						23.0	23.0			
Effective Green, g (s)		27.0						24.0	24.0			
Actuated g/C Ratio		0.45						0.40	0.40			
Clearance Time (s)		5.0						5.0	5.0			
Vehicle Extension (s)		3.0						3.0	3.0			
Lane Grp Cap (vph)		2251						2034	1115			
v/s Ratio Prot								0.21	c0.54			
v/s Ratio Perm		0.09										
v/c Ratio		0.21						0.53	1.35			
Uniform Delay, d1		10.0						13.7	18.0			
Progression Factor		1.00						1.00	1.00			
Incremental Delay, d2		0.2						0.3	162.5			
Delay (s)		10.2						14.0	180.5			
Level of Service		B						B	F			
Approach Delay (s)		10.2			0.0			119.5			0.0	
Approach LOS		B			A			F			A	

Intersection Summary			
HCM Average Control Delay	104.2	HCM Level of Service	F
HCM Volume to Capacity ratio	0.75		
Actuated Cycle Length (s)	60.0	Sum of lost time (s)	9.0
Intersection Capacity Utilization	95.1%	ICU Level of Service	F
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	50	733	1322	0	0	0	0	270	100	60	320	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0	4.0					4.0			4.0	
Lane Util. Factor		0.86	0.86					1.00			1.00	
Frpb, ped/bikes		0.96	0.97					0.98			1.00	
Flpb, ped/bikes		1.00	1.00					1.00			0.99	
Frt		0.93	0.85					0.96			1.00	
Flt Protected		1.00	1.00					1.00			0.99	
Satd. Flow (prot)		4271	1315					1752			1838	
Flt Permitted		1.00	1.00					1.00			0.69	
Satd. Flow (perm)		4271	1315					1752			1270	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	53	772	1392	0	0	0	0	284	105	63	337	0
RTOR Reduction (vph)	0	84	0	0	0	0	0	22	0	0	0	0
Lane Group Flow (vph)	0	1437	696	0	0	0	0	367	0	0	400	0
Confl. Peds. (#/hr)	51		75	75		51	29		79	79		29
Confl. Bikes (#/hr)											1	1
Turn Type	Perm		Free							Perm		
Protected Phases		2						4			8	
Permitted Phases	2		Free							8		
Actuated Green, G (s)		33.0	60.0					18.0			18.0	
Effective Green, g (s)		34.0	60.0					18.0			18.0	
Actuated g/C Ratio		0.57	1.00					0.30			0.30	
Clearance Time (s)		5.0						4.0			4.0	
Vehicle Extension (s)		2.0						2.0			2.0	
Lane Grp Cap (vph)		2420	1315					526			381	
v/s Ratio Prot								0.21				
v/s Ratio Perm		0.34	0.53								c0.31	
v/c Ratio		0.59	0.53					0.70			1.05	
Uniform Delay, d1		8.5	0.0					18.6			21.0	
Progression Factor		0.72	1.00					1.00			1.00	
Incremental Delay, d2		0.1	0.1					3.2			59.8	
Delay (s)		6.2	0.1					21.8			80.8	
Level of Service		A	A					C			F	
Approach Delay (s)		4.3			0.0			21.8			80.8	
Approach LOS		A			A			C			F	

Intersection Summary			
HCM Average Control Delay	16.7	HCM Level of Service	B
HCM Volume to Capacity ratio	0.75		
Actuated Cycle Length (s)	60.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	81.0%	ICU Level of Service	D
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Volume (vph)	390	100	70	878	1225	580
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	0.97	1.00	1.00	0.95	0.91	0.88
Frpb, ped/bikes	1.00	0.98	1.00	1.00	1.00	1.00
Flpb, ped/bikes	1.00	1.00	1.00	1.00	1.00	1.00
Frt	1.00	0.85	1.00	1.00	1.00	0.85
Flt Protected	0.95	1.00	0.95	1.00	1.00	1.00
Satd. Flow (prot)	3433	1550	1770	3539	5085	2787
Flt Permitted	0.95	1.00	0.95	1.00	1.00	1.00
Satd. Flow (perm)	3433	1550	1770	3539	5085	2787
Peak-hour factor, PHF	0.94	0.94	0.94	0.94	0.94	0.94
Adj. Flow (vph)	415	106	74	934	1303	617
RTOR Reduction (vph)	0	0	0	0	0	432
Lane Group Flow (vph)	415	106	74	934	1303	185
Confl. Peds. (#/hr)	2	16	2			2
Turn Type		Perm	Prot			Prot
Protected Phases	4		5	2	6	6
Permitted Phases		4				
Actuated Green, G (s)	26.0	26.0	4.0	26.0	18.0	18.0
Effective Green, g (s)	26.0	26.0	4.0	26.0	18.0	18.0
Actuated g/C Ratio	0.43	0.43	0.07	0.43	0.30	0.30
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Lane Grp Cap (vph)	1488	672	118	1534	1526	836
v/s Ratio Prot	c0.12		0.04	c0.26	c0.26	0.07
v/s Ratio Perm		0.07				
v/c Ratio	0.28	0.16	0.63	0.61	0.85	0.22
Uniform Delay, d1	11.0	10.3	27.3	13.1	19.8	15.7
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	0.5	0.5	22.6	1.8	6.3	0.6
Delay (s)	11.4	10.8	49.9	14.9	26.1	16.4
Level of Service	B	B	D	B	C	B
Approach Delay (s)	11.3			17.5	22.9	
Approach LOS	B			B	C	

Intersection Summary			
HCM Average Control Delay	19.6	HCM Level of Service	B
HCM Volume to Capacity ratio	0.54		
Actuated Cycle Length (s)	60.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	63.4%	ICU Level of Service	B
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	22	221	74	59	111	60	62	92	107	90	150	10
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0			4.0	4.0	4.0	4.0		4.0	4.0	
Lane Util. Factor		0.95			0.95	1.00	1.00	0.95		0.91	0.91	
Frpb, ped/bikes		0.99			1.00	0.99	1.00	0.99		1.00	1.00	
Flpb, ped/bikes		1.00			1.00	1.00	1.00	1.00		1.00	1.00	
Frt		0.97			1.00	0.85	1.00	0.92		1.00	0.99	
Flt Protected		1.00			0.98	1.00	0.95	1.00		0.95	1.00	
Satd. Flow (prot)		3382			3476	1563	1770	3231		1610	3347	
Flt Permitted		0.93			0.77	1.00	0.95	1.00		0.95	1.00	
Satd. Flow (perm)		3152			2723	1563	1770	3231		1610	3347	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	24	240	80	64	121	65	67	100	116	98	163	11
RTOR Reduction (vph)	0	38	0	0	0	0	0	91	0	0	6	0
Lane Group Flow (vph)	0	306	0	0	185	65	67	125	0	88	178	0
Confl. Peds. (#/hr)	2		4	4		2	4		2	2		4
Confl. Bikes (#/hr)			2			1						2
Turn Type	Perm			Perm		Free	Split			Split		
Protected Phases		2			6		3	3		4	4	
Permitted Phases	2			6		Free						
Actuated Green, G (s)		12.1			11.1	41.1	8.7	8.7		7.3	7.3	
Effective Green, g (s)		12.1			12.1	41.1	8.7	8.7		8.3	8.3	
Actuated g/C Ratio		0.29			0.29	1.00	0.21	0.21		0.20	0.20	
Clearance Time (s)		4.0			5.0		4.0	4.0		5.0	5.0	
Vehicle Extension (s)		3.0			3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)		928			802	1563	375	684		325	676	
v/s Ratio Prot							0.04	c0.04		c0.05	0.05	
v/s Ratio Perm		c0.10			0.07	0.04						
v/c Ratio		0.33			0.23	0.04	0.18	0.18		0.27	0.26	
Uniform Delay, d1		11.3			11.0	0.0	13.3	13.3		13.8	13.8	
Progression Factor		1.00			1.00	1.00	1.00	1.00		1.00	1.00	
Incremental Delay, d2		0.2			0.1	0.0	0.2	0.1		0.5	0.2	
Delay (s)		11.5			11.1	0.0	13.5	13.4		14.3	14.0	
Level of Service		B			B	A	B	B		B	B	
Approach Delay (s)		11.5			8.2			13.4			14.1	
Approach LOS		B			A			B			B	

Intersection Summary			
HCM Average Control Delay	11.9	HCM Level of Service	B
HCM Volume to Capacity ratio	0.27		
Actuated Cycle Length (s)	41.1	Sum of lost time (s)	12.0
Intersection Capacity Utilization	41.7%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	10	387	10	190	220	40	10	40	130	30	40	10
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0			4.0			4.0	
Lane Util. Factor	1.00	0.95		1.00	0.95			1.00			1.00	
Frpb, ped/bikes	1.00	1.00		1.00	1.00			0.98			1.00	
Flpb, ped/bikes	1.00	1.00		1.00	1.00			1.00			1.00	
Frt	1.00	1.00		1.00	0.98			0.90			0.98	
Flt Protected	0.95	1.00		0.95	1.00			1.00			0.98	
Satd. Flow (prot)	1787	3561		1787	3476			1659			1804	
Flt Permitted	0.95	1.00		0.95	1.00			0.99			0.88	
Satd. Flow (perm)	1787	3561		1787	3476			1645			1610	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	11	421	11	207	239	43	11	43	141	33	43	11
RTOR Reduction (vph)	0	3	0	0	25	0	0	80	0	0	6	0
Lane Group Flow (vph)	11	429	0	207	257	0	0	115	0	0	81	0
Confl. Peds. (#/hr)	4					4	1		24	24		1
Confl. Bikes (#/hr)						2			1			
Heavy Vehicles (%)	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%
Turn Type	Prot			Prot			Perm			Perm		
Protected Phases	7	4		3	8			2			6	
Permitted Phases							2			6		
Actuated Green, G (s)	6.0	16.0		6.0	16.0			26.0			26.0	
Effective Green, g (s)	6.0	16.0		6.0	16.0			26.0			26.0	
Actuated g/C Ratio	0.10	0.27		0.10	0.27			0.43			0.43	
Clearance Time (s)	4.0	4.0		4.0	4.0			4.0			4.0	
Lane Grp Cap (vph)	179	950		179	927			713			698	
v/s Ratio Prot	0.01	c0.12		c0.12	0.07							
v/s Ratio Perm								c0.07			0.05	
v/c Ratio	0.06	0.45		1.16	0.28			0.16			0.12	
Uniform Delay, d1	24.5	18.3		27.0	17.4			10.4			10.1	
Progression Factor	1.00	1.00		1.00	1.00			1.00			1.00	
Incremental Delay, d2	0.7	1.6		115.6	0.7			0.5			0.3	
Delay (s)	25.1	19.9		142.6	18.2			10.8			10.5	
Level of Service	C	B		F	B			B			B	
Approach Delay (s)		20.0			70.9			10.8			10.5	
Approach LOS		C			E			B			B	

Intersection Summary			
HCM Average Control Delay	38.3	HCM Level of Service	D
HCM Volume to Capacity ratio	0.38		
Actuated Cycle Length (s)	60.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	54.9%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	358	249	80	90	285	70	100	530	100	120	840	365
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width	10	11	12	11	11	12	12	12	12	12	12	12
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0		4.0	4.0		4.0	4.0	4.0
Lane Util. Factor	0.97	0.95	1.00	1.00	0.95		1.00	0.95		1.00	0.95	1.00
Frpb, ped/bikes	1.00	1.00	0.94	1.00	0.98		1.00	0.99		1.00	1.00	0.90
Flpb, ped/bikes	1.00	1.00	1.00	1.00	1.00		1.00	1.00		1.00	1.00	1.00
Frt	1.00	1.00	0.85	1.00	0.97		1.00	0.98		1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00		0.95	1.00		0.95	1.00	1.00
Satd. Flow (prot)	2884	3079	1333	1540	2941		1593	3080		1593	3185	1248
Flt Permitted	0.95	1.00	1.00	0.95	1.00		0.95	1.00		0.95	1.00	1.00
Satd. Flow (perm)	2884	3079	1333	1540	2941		1593	3080		1593	3185	1248
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	389	271	87	98	310	76	109	576	109	130	913	397
RTOR Reduction (vph)	0	0	69	0	20	0	0	12	0	0	0	257
Lane Group Flow (vph)	389	271	18	98	366	0	109	673	0	130	913	140
Confl. Peds. (#/hr)			47			60			42			75
Confl. Bikes (#/hr)						1						
Bus Blockages (#/hr)	0	0	0	0	0	2	0	0	0	0	0	8
Turn Type	Split		Perm	Split			Prot			Prot		Perm
Protected Phases	4	4		8	8		5	2		1	6	
Permitted Phases			4									6
Actuated Green, G (s)	19.3	19.3	19.3	17.2	17.2		10.7	29.8		11.4	30.5	30.5
Effective Green, g (s)	19.3	19.3	19.3	17.2	17.2		10.7	30.8		11.4	31.5	31.5
Actuated g/C Ratio	0.20	0.20	0.20	0.18	0.18		0.11	0.33		0.12	0.33	0.33
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0		4.0	5.0		4.0	5.0	5.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0		3.0	3.0		3.0	3.0	3.0
Lane Grp Cap (vph)	588	628	272	280	534		180	1002		192	1059	415
v/s Ratio Prot	c0.13	0.09		0.06	c0.12		0.07	0.22		c0.08	c0.29	
v/s Ratio Perm			0.01									0.11
v/c Ratio	0.66	0.43	0.07	0.35	0.69		0.61	0.67		0.68	0.86	0.34
Uniform Delay, d1	34.7	32.9	30.4	33.9	36.2		40.0	27.6		39.9	29.6	23.8
Progression Factor	1.00	1.00	1.00	1.00	1.00		1.00	1.00		1.00	1.00	1.00
Incremental Delay, d2	2.8	0.5	0.1	0.8	3.6		5.7	1.8		9.1	7.4	0.5
Delay (s)	37.5	33.4	30.5	34.6	39.9		45.6	29.4		49.0	36.9	24.2
Level of Service	D	C	C	C	D		D	C		D	D	C
Approach Delay (s)		35.2			38.8			31.6			34.5	
Approach LOS		D			D			C			C	

Intersection Summary			
HCM Average Control Delay	34.6	HCM Level of Service	C
HCM Volume to Capacity ratio	0.72		
Actuated Cycle Length (s)	94.7	Sum of lost time (s)	12.0
Intersection Capacity Utilization	76.3%	ICU Level of Service	D
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	120	195	124	50	142	120	112	480	40	140	1200	140
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.9	4.9		4.9	4.9		4.3	4.8	4.8	4.3	4.8	4.8
Lane Util. Factor	1.00	0.95		1.00	0.95		0.97	0.95	1.00	0.97	0.95	1.00
Frpb, ped/bikes	1.00	0.99		1.00	0.99		1.00	1.00	0.98	1.00	1.00	0.99
Flpb, ped/bikes	1.00	1.00		1.00	1.00		1.00	1.00	1.00	1.00	1.00	1.00
Frt	1.00	0.94		1.00	0.93		1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	1787	3343		1787	3292		3467	3574	1571	3467	3574	1576
Flt Permitted	0.95	1.00		0.95	1.00		0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)	1787	3343		1787	3292		3467	3574	1571	3467	3574	1576
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	126	205	131	53	149	126	118	505	42	147	1263	147
RTOR Reduction (vph)	0	110	0	0	110	0	0	0	25	0	0	16
Lane Group Flow (vph)	126	226	0	53	165	0	118	505	17	147	1263	131
Confl. Peds. (#/hr)			7			14			8			3
Confl. Bikes (#/hr)						1						
Heavy Vehicles (%)	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%
Turn Type	Split			Split			Prot		Perm	Prot		Perm
Protected Phases	4	4		8	8		5	2		1	6	
Permitted Phases									2			6
Actuated Green, G (s)	11.3	11.3		10.1	10.1		5.2	29.6	29.6	4.2	28.6	28.6
Effective Green, g (s)	10.4	10.4		9.2	9.2		4.9	29.8	29.8	3.9	28.8	28.8
Actuated g/C Ratio	0.14	0.14		0.13	0.13		0.07	0.41	0.41	0.05	0.40	0.40
Clearance Time (s)	4.0	4.0		4.0	4.0		4.0	5.0	5.0	4.0	5.0	5.0
Vehicle Extension (s)	2.0	2.0		2.0	2.0		2.0	2.0	2.0	2.0	2.0	2.0
Lane Grp Cap (vph)	257	482		228	419		235	1475	648	187	1426	629
v/s Ratio Prot	c0.07	0.07		0.03	c0.05		0.03	0.14		c0.04	c0.35	
v/s Ratio Perm									0.01			0.08
v/c Ratio	0.49	0.47		0.23	0.39		0.50	0.34	0.03	0.79	0.89	0.21
Uniform Delay, d1	28.5	28.4		28.3	28.9		32.5	14.5	12.6	33.7	20.2	14.2
Progression Factor	1.00	1.00		1.00	1.00		1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	0.5	0.3		0.2	0.2		0.6	0.1	0.0	17.9	6.8	0.1
Delay (s)	29.0	28.6		28.5	29.2		33.1	14.5	12.6	51.6	26.9	14.3
Level of Service	C	C		C	C		C	B	B	D	C	B
Approach Delay (s)		28.7			29.1			17.7			28.1	
Approach LOS		C			C			B			C	

Intersection Summary			
HCM Average Control Delay	26.0	HCM Level of Service	C
HCM Volume to Capacity ratio	0.70		
Actuated Cycle Length (s)	72.2	Sum of lost time (s)	18.9
Intersection Capacity Utilization	72.9%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	68	24	24	20	12	40	12	132	30	70	214	19
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0			4.0	4.0	4.0	4.0		4.0	4.0	
Lane Util. Factor		1.00			1.00	1.00	1.00	1.00		1.00	1.00	
Frpb, ped/bikes		0.99			1.00	0.98	1.00	1.00		1.00	1.00	
Flpb, ped/bikes		1.00			1.00	1.00	1.00	1.00		1.00	1.00	
Frt		0.97			1.00	0.85	1.00	0.97		1.00	0.99	
Flt Protected		0.97			0.97	1.00	0.95	1.00		0.95	1.00	
Satd. Flow (prot)		1748			1806	1545	1770	1803		1770	1835	
Flt Permitted		0.97			0.97	1.00	0.95	1.00		0.95	1.00	
Satd. Flow (perm)		1748			1806	1545	1770	1803		1770	1835	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	74	26	26	22	13	43	13	143	33	76	233	21
RTOR Reduction (vph)	0	10	0	0	0	40	0	9	0	0	4	0
Lane Group Flow (vph)	0	116	0	0	35	3	13	167	0	76	250	0
Confl. Peds. (#/hr)	2		6	6		2	8		2	2		8
Confl. Bikes (#/hr)						1						
Turn Type	Split			Split		Perm	Split			Split		
Protected Phases	2	2		1	1		4	4		3	3	
Permitted Phases						1						
Actuated Green, G (s)		7.9			3.7	3.7	12.9	12.9		14.8	14.8	
Effective Green, g (s)		7.9			3.7	3.7	12.9	12.9		14.8	14.8	
Actuated g/C Ratio		0.14			0.07	0.07	0.23	0.23		0.27	0.27	
Clearance Time (s)		4.0			4.0	4.0	4.0	4.0		4.0	4.0	
Vehicle Extension (s)		3.0			3.0	3.0	3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)		250			121	103	413	421		474	491	
v/s Ratio Prot		c0.07			c0.02		0.01	c0.09		0.04	c0.14	
v/s Ratio Perm						0.00						
v/c Ratio		0.46			0.29	0.03	0.03	0.40		0.16	0.51	
Uniform Delay, d1		21.8			24.5	24.1	16.4	17.9		15.5	17.2	
Progression Factor		1.00			1.00	1.00	1.00	1.00		1.00	1.00	
Incremental Delay, d2		1.4			1.3	0.1	0.0	0.6		0.2	0.8	
Delay (s)		23.1			25.9	24.2	16.4	18.5		15.7	18.0	
Level of Service		C			C	C	B	B		B	B	
Approach Delay (s)		23.1			25.0			18.4			17.5	
Approach LOS		C			C			B			B	

Intersection Summary			
HCM Average Control Delay	19.5	HCM Level of Service	B
HCM Volume to Capacity ratio	0.44		
Actuated Cycle Length (s)	55.3	Sum of lost time (s)	16.0
Intersection Capacity Utilization	40.6%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	160	154	40	60	152	40	20	430	40	50	630	100
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0			4.0			4.0	
Lane Util. Factor	1.00	0.95		1.00	0.95			0.95			0.95	
Frpb, ped/bikes	1.00	0.99		1.00	1.00			1.00			0.99	
Flpb, ped/bikes	0.99	1.00		0.98	1.00			1.00			1.00	
Frt	1.00	0.97		1.00	0.97			0.99			0.98	
Flt Protected	0.95	1.00		0.95	1.00			1.00			1.00	
Satd. Flow (prot)	1584	3065		1568	3073			3129			3090	
Flt Permitted	0.63	1.00		0.62	1.00			0.91			0.89	
Satd. Flow (perm)	1044	3065		1032	3073			2867			2773	
Peak-hour factor, PHF	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96
Adj. Flow (vph)	167	160	42	62	158	42	21	448	42	52	656	104
RTOR Reduction (vph)	0	24	0	0	24	0	0	10	0	0	17	0
Lane Group Flow (vph)	167	178	0	62	176	0	0	501	0	0	795	0
Confl. Peds. (#/hr)	10		29	29		10	63		34	34		63
Confl. Bikes (#/hr)									1			
Parking (#/hr)							0					
Turn Type	Perm			Perm			Perm			Perm		
Protected Phases		4			4			2			2	
Permitted Phases	4			4			2			2		
Actuated Green, G (s)	30.0	30.0		30.0	30.0			32.0			32.0	
Effective Green, g (s)	29.0	29.0		29.0	29.0			31.0			31.0	
Actuated g/C Ratio	0.43	0.43		0.43	0.43			0.46			0.46	
Clearance Time (s)	3.0	3.0		3.0	3.0			3.0			3.0	
Lane Grp Cap (vph)	445	1307		440	1311			1307			1264	
v/s Ratio Prot		0.06			0.06							
v/s Ratio Perm	c0.16			0.06				0.17			c0.29	
v/c Ratio	0.38	0.14		0.14	0.13			0.38			0.63	
Uniform Delay, d1	13.3	11.9		11.9	11.9			12.2			14.1	
Progression Factor	1.00	1.00		1.00	1.00			1.00			1.00	
Incremental Delay, d2	2.4	0.2		0.7	0.2			0.9			2.4	
Delay (s)	15.7	12.1		12.6	12.1			13.1			16.5	
Level of Service	B	B		B	B			B			B	
Approach Delay (s)		13.7			12.2			13.1			16.5	
Approach LOS		B			B			B			B	

Intersection Summary			
HCM Average Control Delay	14.5	HCM Level of Service	B
HCM Volume to Capacity ratio	0.51		
Actuated Cycle Length (s)	68.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	96.6%	ICU Level of Service	F
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	20	184	30	20	172	142	20	420	40	564	550	40
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0			5.0			5.0		5.0	5.0	
Lane Util. Factor		0.95			0.95			0.95		0.97	1.00	
Frpb, ped/bikes		1.00			0.99			1.00		1.00	1.00	
Flpb, ped/bikes		1.00			1.00			1.00		1.00	1.00	
Frt		0.98			0.94			0.99		1.00	0.99	
Flt Protected		1.00			1.00			1.00		0.95	1.00	
Satd. Flow (prot)		3478			3312			3516		3467	1859	
Flt Permitted		0.90			0.92			1.00		0.95	1.00	
Satd. Flow (perm)		3140			3064			3516		3467	1859	
Peak-hour factor, PHF	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94
Adj. Flow (vph)	21	196	32	21	183	151	21	447	43	600	585	43
RTOR Reduction (vph)	0	17	0	0	126	0	0	9	0	0	3	0
Lane Group Flow (vph)	0	232	0	0	229	0	0	502	0	600	625	0
Confl. Peds. (#/hr)	2		6	6		2	11		10	10		11
Confl. Bikes (#/hr)						2						1
Heavy Vehicles (%)	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%
Turn Type	Perm			Perm			Split			Split		
Protected Phases		4			4		2	2		3	3	
Permitted Phases	4			4								
Actuated Green, G (s)		11.7			11.7			14.2		26.5	26.5	
Effective Green, g (s)		10.7			10.7			13.2		25.5	25.5	
Actuated g/C Ratio		0.17			0.17			0.20		0.40	0.40	
Clearance Time (s)		4.0			4.0			4.0		4.0	4.0	
Vehicle Extension (s)		3.0			3.0			3.0		3.0	3.0	
Lane Grp Cap (vph)		522			509			721		1373	736	
v/s Ratio Prot								c0.14		0.17	c0.34	
v/s Ratio Perm		0.07			c0.07							
v/c Ratio		0.45			0.45			0.70		0.44	0.85	
Uniform Delay, d1		24.2			24.2			23.7		14.2	17.7	
Progression Factor		1.00			1.00			1.00		1.00	1.00	
Incremental Delay, d2		0.6			0.6			2.9		0.2	9.0	
Delay (s)		24.8			24.8			26.7		14.4	26.7	
Level of Service		C			C			C		B	C	
Approach Delay (s)		24.8			24.8			26.7			20.7	
Approach LOS		C			C			C			C	

Intersection Summary			
HCM Average Control Delay	23.1	HCM Level of Service	C
HCM Volume to Capacity ratio	0.72		
Actuated Cycle Length (s)	64.4	Sum of lost time (s)	15.0
Intersection Capacity Utilization	82.1%	ICU Level of Service	E
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	20	352	415	20	304	120	351	290	40	100	390	30
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0	4.0		4.0		4.0	4.0			4.0	
Lane Util. Factor		0.91	0.91		0.95		1.00	1.00			1.00	
Frpb, ped/bikes		0.99	0.96		0.99		1.00	1.00			1.00	
Flpb, ped/bikes		1.00	1.00		1.00		1.00	1.00			1.00	
Frt		0.95	0.85		0.96		1.00	0.98			0.99	
Flt Protected		1.00	1.00		1.00		0.95	1.00			0.99	
Satd. Flow (prot)		2994	1399		3151		1787	1583			1586	
Flt Permitted		0.93	1.00		0.89		0.95	1.00			0.99	
Satd. Flow (perm)		2780	1399		2816		1787	1583			1586	
Peak-hour factor, PHF	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97
Adj. Flow (vph)	21	363	428	21	313	124	362	299	41	103	402	31
RTOR Reduction (vph)	0	55	195	0	46	0	0	6	0	0	3	0
Lane Group Flow (vph)	0	500	62	0	412	0	362	334	0	0	533	0
Confl. Peds. (#/hr)	17		21	21		17	30		15	15		30
Confl. Bikes (#/hr)			1			1						
Heavy Vehicles (%)	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%
Parking (#/hr)		8			8			8			8	
Turn Type	Perm		Perm	Perm			Split			Split		
Protected Phases		2			2		4	4		8	8	
Permitted Phases	2		2	2								
Actuated Green, G (s)		20.0	20.0		20.0		25.0	25.0			26.0	
Effective Green, g (s)		20.0	20.0		20.0		25.0	25.0			26.0	
Actuated g/C Ratio		0.24	0.24		0.24		0.30	0.30			0.31	
Clearance Time (s)		4.0	4.0		4.0		4.0	4.0			4.0	
Lane Grp Cap (vph)		670	337		679		538	477			497	
v/s Ratio Prot							0.20	c0.21			c0.34	
v/s Ratio Perm		c0.18	0.04		0.15							
v/c Ratio		0.75	0.18		0.61		0.67	0.70			1.07	
Uniform Delay, d1		29.1	25.0		28.0		25.4	25.7			28.5	
Progression Factor		1.00	1.00		1.00		1.00	1.00			1.00	
Incremental Delay, d2		7.4	1.2		4.0		6.6	8.3			61.3	
Delay (s)		36.5	26.2		32.0		32.0	34.0			89.8	
Level of Service		D	C		C		C	C			F	
Approach Delay (s)		33.3			32.0			32.9			89.8	
Approach LOS		C			C			C			F	

Intersection Summary			
HCM Average Control Delay	45.0	HCM Level of Service	D
HCM Volume to Capacity ratio	0.85		
Actuated Cycle Length (s)	83.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	87.4%	ICU Level of Service	E
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL2	EBL	EBT	EBR	NBT	NBR	NBR2	SBL2	SBL	SBT
Lane Configurations										
Volume (vph)	30	955	310	100	380	270	70	332	270	342
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0	4.0	4.5	4.0	4.0		4.0	4.0	4.0
Lane Util. Factor		0.91	0.91	1.00	0.95	1.00		1.00	1.00	1.00
Frpb, ped/bikes		1.00	1.00	0.85	1.00	0.92		1.00	1.00	1.00
Flpb, ped/bikes		1.00	1.00	1.00	1.00	1.00		1.00	1.00	1.00
Frt		1.00	1.00	0.85	1.00	0.85		1.00	1.00	1.00
Flt Protected		0.95	0.97	1.00	1.00	1.00		0.95	0.95	1.00
Satd. Flow (prot)		1610	3289	1343	3539	1452		1770	1770	1863
Flt Permitted		0.95	0.97	1.00	1.00	1.00		0.95	0.95	1.00
Satd. Flow (perm)		1610	3289	1343	3539	1452		1770	1770	1863
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	32	1005	326	105	400	284	74	349	284	360
RTOR Reduction (vph)	0	0	0	68	0	11	0	0	0	0
Lane Group Flow (vph)	0	514	849	37	400	347	0	349	284	360
Confl. Peds. (#/hr)				50			50		50	
Confl. Bikes (#/hr)				10			10			
Turn Type	Perm	Perm		Perm		Perm		Prot	Prot	
Protected Phases			4		2			1	1	6
Permitted Phases	4	4		4		2				
Actuated Green, G (s)		30.8	30.8	30.8	22.5	22.5		23.7	23.7	49.2
Effective Green, g (s)		32.3	32.3	31.8	22.0	22.0		23.7	23.7	49.7
Actuated g/C Ratio		0.36	0.36	0.35	0.24	0.24		0.26	0.26	0.55
Clearance Time (s)		5.5	5.5	5.5	3.5	3.5		4.0	4.0	4.5
Vehicle Extension (s)		2.0	2.0	2.0	2.0	2.0		2.0	2.0	2.0
Lane Grp Cap (vph)		578	1180	475	865	355		466	466	1029
v/s Ratio Prot					0.11			c0.20	0.16	0.19
v/s Ratio Perm		c0.32	0.26	0.03		c0.24				
v/c Ratio		0.89	0.87dl	0.08	0.46	0.98		0.75	0.61	0.35
Uniform Delay, d1		27.2	24.9	19.4	29.0	33.8		30.4	29.1	11.2
Progression Factor		1.00	1.00	1.00	1.00	1.00		1.00	1.00	1.00
Incremental Delay, d2		15.1	1.8	0.0	0.1	41.4		10.5	5.8	0.9
Delay (s)		42.2	26.7	19.4	29.1	75.2		41.0	34.9	12.1
Level of Service		D	C	B	C	E		D	C	B
Approach Delay (s)			31.6		50.9					28.8
Approach LOS			C		D					C

Intersection Summary			
HCM Average Control Delay	35.3	HCM Level of Service	D
HCM Volume to Capacity ratio	0.87		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	75.9%	ICU Level of Service	D
Analysis Period (min)	15		

dl Defacto Left Lane. Recode with 1 though lane as a left lane.
c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	0	0	365	664	0	0	0	0	0	891	350
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)				4.0	4.0						4.0	4.0
Lane Util. Factor				0.86	0.86						0.86	0.86
Frpb, ped/bikes				1.00	1.00						1.00	1.00
Flpb, ped/bikes				1.00	1.00						1.00	1.00
Frt				1.00	1.00						0.99	0.85
Flt Protected				0.95	0.99						1.00	1.00
Satd. Flow (prot)				1522	4770						4745	1362
Flt Permitted				0.95	0.99						1.00	1.00
Satd. Flow (perm)				1522	4770						4745	1362
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	0	0	0	384	699	0	0	0	0	0	938	368
RTOR Reduction (vph)	0	0	0	195	22	0	0	0	0	0	11	113
Lane Group Flow (vph)	0	0	0	66	800	0	0	0	0	0	1004	178
Confl. Bikes (#/hr)						5						9
Turn Type				Prot								Prot
Protected Phases				7	3						2	2
Permitted Phases												
Actuated Green, G (s)				20.0	40.0						31.0	31.0
Effective Green, g (s)				20.0	40.0						31.0	31.0
Actuated g/C Ratio				0.25	0.51						0.39	0.39
Clearance Time (s)				4.0	4.0						4.0	4.0
Lane Grp Cap (vph)				385	2415						1862	534
v/s Ratio Prot				0.04	c0.08						c0.21	0.13
v/s Ratio Perm					0.08							
v/c Ratio				0.17	0.33						0.54	0.33
Uniform Delay, d1				23.0	11.6						18.5	16.8
Progression Factor				1.00	1.00						1.00	1.00
Incremental Delay, d2				1.0	0.4						1.1	1.7
Delay (s)				24.0	11.9						19.6	18.5
Level of Service				C	B						B	B
Approach Delay (s)		0.0			14.8			0.0			19.4	
Approach LOS		A			B			A			B	

Intersection Summary			
HCM Average Control Delay	17.3	HCM Level of Service	B
HCM Volume to Capacity ratio	0.42		
Actuated Cycle Length (s)	79.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	41.7%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	210	740	0	0	0	0	0	811	1757	0	0	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0						4.0	4.0			
Lane Util. Factor		0.91						0.91	0.88			
Frpb, ped/bikes		1.00						1.00	1.00			
Flpb, ped/bikes		1.00						1.00	1.00			
Frt		1.00						1.00	0.85			
Flt Protected		0.99						1.00	1.00			
Satd. Flow (prot)		5013						5085	2787			
Flt Permitted		0.99						1.00	1.00			
Satd. Flow (perm)		5013						5085	2787			
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	221	779	0	0	0	0	0	854	1849	0	0	0
RTOR Reduction (vph)	0	3	0	0	0	0	0	0	231	0	0	0
Lane Group Flow (vph)	0	998	0	0	0	0	0	854	1618	0	0	0
Confl. Peds. (#/hr)	28		7	7		28	99		3	3		99
Confl. Bikes (#/hr)			1			2			1			
Turn Type	Perm								custom			
Protected Phases		4						2	2			
Permitted Phases	4								7			
Actuated Green, G (s)		34.0						16.0	16.0			
Effective Green, g (s)		35.0						17.0	17.0			
Actuated g/C Ratio		0.58						0.28	0.28			
Clearance Time (s)		5.0						5.0	5.0			
Vehicle Extension (s)		3.0						3.0	3.0			
Lane Grp Cap (vph)		2924						1441	790			
v/s Ratio Prot								0.17	c0.58			
v/s Ratio Perm		0.20										
v/c Ratio		0.34						0.59	2.05			
Uniform Delay, d1		6.5						18.5	21.5			
Progression Factor		1.00						1.00	1.00			
Incremental Delay, d2		0.3						0.7	475.8			
Delay (s)		6.8						19.2	497.3			
Level of Service		A						B	F			
Approach Delay (s)		6.8			0.0			346.2			0.0	
Approach LOS		A			A			F			A	

Intersection Summary			
HCM Average Control Delay	254.6	HCM Level of Service	F
HCM Volume to Capacity ratio	0.90		
Actuated Cycle Length (s)	60.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	96.8%	ICU Level of Service	F
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	50	1165	1302	0	0	0	0	230	240	80	340	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0	4.0					4.0			4.0	
Lane Util. Factor		0.86	0.86					1.00			1.00	
Frpb, ped/bikes		0.98	0.97					0.98			1.00	
Flpb, ped/bikes		1.00	1.00					1.00			1.00	
Frt		0.95	0.85					0.93			1.00	
Flt Protected		1.00	1.00					1.00			0.99	
Satd. Flow (prot)		4427	1323					1701			1842	
Flt Permitted		1.00	1.00					1.00			0.39	
Satd. Flow (perm)		4427	1323					1701			733	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	53	1226	1371	0	0	0	0	242	253	84	358	0
RTOR Reduction (vph)	0	70	0	0	0	0	0	32	0	0	0	0
Lane Group Flow (vph)	0	1895	685	0	0	0	0	463	0	0	442	0
Confl. Peds. (#/hr)	52		55	55		52	39		25	25		39
Confl. Bikes (#/hr)			1						2		1	2
Turn Type	Perm		Free							Perm		
Protected Phases		2						4			8	
Permitted Phases	2		Free							8		
Actuated Green, G (s)		33.0	60.0					18.0			18.0	
Effective Green, g (s)		34.0	60.0					18.0			18.0	
Actuated g/C Ratio		0.57	1.00					0.30			0.30	
Clearance Time (s)		5.0						4.0			4.0	
Vehicle Extension (s)		2.0						2.0			2.0	
Lane Grp Cap (vph)		2509	1323					510			220	
v/s Ratio Prot								0.27				
v/s Ratio Perm		0.43	0.52								c0.60	
v/c Ratio		0.76	0.52					0.91			2.01	
Uniform Delay, d1		9.8	0.0					20.2			21.0	
Progression Factor		0.61	1.00					1.00			1.00	
Incremental Delay, d2		0.2	0.1					19.4			469.8	
Delay (s)		6.2	0.1					39.6			490.8	
Level of Service		A	A					D			F	
Approach Delay (s)		4.6			0.0			39.6			490.8	
Approach LOS		A			A			D			F	

Intersection Summary			
HCM Average Control Delay	69.4	HCM Level of Service	E
HCM Volume to Capacity ratio	1.19		
Actuated Cycle Length (s)	60.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	96.9%	ICU Level of Service	F
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	130	330	0	0	0	0	0	1032	1785	0	0	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0						4.0	4.0			
Lane Util. Factor		0.91						0.91	0.88			
Frpb, ped/bikes		1.00						1.00	1.00			
Flpb, ped/bikes		1.00						1.00	1.00			
Frt		1.00						1.00	0.85			
Flt Protected		0.99						1.00	1.00			
Satd. Flow (prot)		4999						5085	2787			
Flt Permitted		0.99						1.00	1.00			
Satd. Flow (perm)		4999						5085	2787			
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	137	347	0	0	0	0	0	1086	1879	0	0	0
RTOR Reduction (vph)	0	12	0	0	0	0	0	0	392	0	0	0
Lane Group Flow (vph)	0	472	0	0	0	0	0	1086	1487	0	0	0
Confl. Peds. (#/hr)	12		21	21		12	42		29	29		42
Confl. Bikes (#/hr)			2			1						1
Turn Type	Perm								custom			
Protected Phases		4						2	2			
Permitted Phases	4								7			
Actuated Green, G (s)		38.0						32.0	32.0			
Effective Green, g (s)		38.0						33.0	33.0			
Actuated g/C Ratio		0.48						0.41	0.41			
Clearance Time (s)		5.0						5.0	5.0			
Vehicle Extension (s)		3.0						3.0	3.0			
Lane Grp Cap (vph)		2375						2098	1150			
v/s Ratio Prot								0.21	c0.53			
v/s Ratio Perm		0.09										
v/c Ratio		0.20						0.52	1.29			
Uniform Delay, d1		12.2						17.6	23.5			
Progression Factor		1.00						1.00	1.00			
Incremental Delay, d2		0.2						0.2	138.5			
Delay (s)		12.4						17.8	162.0			
Level of Service		B						B	F			
Approach Delay (s)		12.4			0.0			109.2			0.0	
Approach LOS		B			A			F			A	

Intersection Summary			
HCM Average Control Delay	95.6	HCM Level of Service	F
HCM Volume to Capacity ratio	0.71		
Actuated Cycle Length (s)	80.0	Sum of lost time (s)	9.0
Intersection Capacity Utilization	95.1%	ICU Level of Service	F
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	210	740	0	0	0	0	0	811	1757	0	0	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0						4.0	4.0			
Lane Util. Factor		0.91						0.91	0.88			
Frpb, ped/bikes		1.00						1.00	1.00			
Flpb, ped/bikes		1.00						1.00	1.00			
Frt		1.00						1.00	0.85			
Flt Protected		0.99						1.00	1.00			
Satd. Flow (prot)		5008						5085	2787			
Flt Permitted		0.99						1.00	1.00			
Satd. Flow (perm)		5008						5085	2787			
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	221	779	0	0	0	0	0	854	1849	0	0	0
RTOR Reduction (vph)	0	3	0	0	0	0	0	0	238	0	0	0
Lane Group Flow (vph)	0	997	0	0	0	0	0	854	1611	0	0	0
Confl. Peds. (#/hr)	28		7	7		28	99		3	3		99
Confl. Bikes (#/hr)			1			2			1			
Turn Type	Perm								custom			
Protected Phases		4						2	2			
Permitted Phases	4								7			
Actuated Green, G (s)		47.0						23.0	23.0			
Effective Green, g (s)		48.0						24.0	24.0			
Actuated g/C Ratio		0.60						0.30	0.30			
Clearance Time (s)		5.0						5.0	5.0			
Vehicle Extension (s)		3.0						3.0	3.0			
Lane Grp Cap (vph)		3005						1526	836			
v/s Ratio Prot								0.17	c0.58			
v/s Ratio Perm		0.20										
v/c Ratio		0.33						0.56	1.93			
Uniform Delay, d1		8.0						23.6	28.0			
Progression Factor		1.00						1.00	1.00			
Incremental Delay, d2		0.3						0.4	421.6			
Delay (s)		8.3						24.0	449.6			
Level of Service		A						C	F			
Approach Delay (s)		8.3			0.0			315.1			0.0	
Approach LOS		A			A			F			A	

Intersection Summary			
HCM Average Control Delay	232.3	HCM Level of Service	F
HCM Volume to Capacity ratio	0.86		
Actuated Cycle Length (s)	80.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	96.8%	ICU Level of Service	F
Analysis Period (min)	15		
c Critical Lane Group			

Cumulative (2035) No Project Conditions

FEHR PEERS

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Volume (vph)	560	90	50	1300	1050	770
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	0.97	1.00	1.00	0.95	0.91	0.88
Frpb, ped/bikes	1.00	0.98	1.00	1.00	1.00	1.00
Flpb, ped/bikes	1.00	1.00	1.00	1.00	1.00	1.00
Frt	1.00	0.85	1.00	1.00	1.00	0.85
Flt Protected	0.95	1.00	0.95	1.00	1.00	1.00
Satd. Flow (prot)	3400	1535	1752	3505	5036	2760
Flt Permitted	0.95	1.00	0.95	1.00	1.00	1.00
Satd. Flow (perm)	3400	1535	1752	3505	5036	2760
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	609	98	54	1413	1141	837
RTOR Reduction (vph)	0	0	0	0	0	586
Lane Group Flow (vph)	609	98	54	1413	1141	251
Confl. Peds. (#/hr)	3	11	4			4
Confl. Bikes (#/hr)		5				5
Heavy Vehicles (%)	3%	3%	3%	3%	3%	3%
Turn Type		Perm	Prot			Prot
Protected Phases	4		5	2	6	6
Permitted Phases		4				
Actuated Green, G (s)	26.0	26.0	4.0	26.0	18.0	18.0
Effective Green, g (s)	26.0	26.0	4.0	26.0	18.0	18.0
Actuated g/C Ratio	0.43	0.43	0.07	0.43	0.30	0.30
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Lane Grp Cap (vph)	1473	665	117	1519	1511	828
v/s Ratio Prot	c0.18		0.03	c0.40	0.23	0.09
v/s Ratio Perm		0.06				
v/c Ratio	0.41	0.15	0.46	0.93	0.76	0.30
Uniform Delay, d1	11.7	10.3	27.0	16.1	19.0	16.2
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	0.9	0.5	12.5	11.5	3.6	0.9
Delay (s)	12.6	10.8	39.5	27.7	22.6	17.1
Level of Service	B	B	D	C	C	B
Approach Delay (s)	12.3			28.1	20.3	
Approach LOS	B			C	C	

Intersection Summary			
HCM Average Control Delay	21.7	HCM Level of Service	C
HCM Volume to Capacity ratio	0.67		
Actuated Cycle Length (s)	60.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	68.4%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	20	60	40	180	120	130	80	220	90	80	100	30
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0			4.0	4.0	4.0	4.0		4.0	4.0	
Lane Util. Factor		0.95			0.95	1.00	1.00	0.95		0.91	0.91	
Frpb, ped/bikes		0.99			1.00	0.98	1.00	0.99		1.00	1.00	
Flpb, ped/bikes		1.00			1.00	1.00	1.00	1.00		1.00	1.00	
Frt		0.95			1.00	0.85	1.00	0.96		1.00	0.97	
Flt Protected		0.99			0.97	1.00	0.95	1.00		0.95	1.00	
Satd. Flow (prot)		3176			3291	1500	1703	3230		1550	3130	
Flt Permitted		0.88			0.74	1.00	0.95	1.00		0.95	1.00	
Satd. Flow (perm)		2829			2522	1500	1703	3230		1550	3130	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	22	65	43	196	130	141	87	239	98	87	109	33
RTOR Reduction (vph)	0	30	0	0	0	0	0	59	0	0	27	0
Lane Group Flow (vph)	0	100	0	0	326	141	87	278	0	76	126	0
Confl. Peds. (#/hr)	9		8	8		9	12		17	17		12
Confl. Bikes (#/hr)						3			5			2
Heavy Vehicles (%)	6%	6%	6%	6%	6%	6%	6%	6%	6%	6%	6%	6%
Turn Type	Perm			Perm		Free	Split			Split		
Protected Phases		2			6		3	3		4	4	
Permitted Phases	2			6		Free						
Actuated Green, G (s)		13.4			12.4	44.1	10.5	10.5		7.2	7.2	
Effective Green, g (s)		13.4			13.4	44.1	10.5	10.5		8.2	8.2	
Actuated g/C Ratio		0.30			0.30	1.00	0.24	0.24		0.19	0.19	
Clearance Time (s)		4.0			5.0		4.0	4.0		5.0	5.0	
Vehicle Extension (s)		3.0			3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)		860			766	1500	405	769		288	582	
v/s Ratio Prot							0.05	c0.09		c0.05	0.04	
v/s Ratio Perm		0.04			c0.13	0.09						
v/c Ratio		0.12			0.43	0.09	0.21	0.36		0.26	0.22	
Uniform Delay, d1		11.1			12.3	0.0	13.5	14.0		15.4	15.2	
Progression Factor		1.00			1.00	1.00	1.00	1.00		1.00	1.00	
Incremental Delay, d2		0.1			0.4	0.1	0.3	0.3		0.5	0.2	
Delay (s)		11.1			12.7	0.1	13.8	14.3		15.9	15.4	
Level of Service		B			B	A	B	B		B	B	
Approach Delay (s)		11.1			8.9			14.2			15.6	
Approach LOS		B			A			B			B	

Intersection Summary			
HCM Average Control Delay	12.1	HCM Level of Service	B
HCM Volume to Capacity ratio	0.36		
Actuated Cycle Length (s)	44.1	Sum of lost time (s)	12.0
Intersection Capacity Utilization	46.9%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	20	190	20	200	370	70	30	100	270	40	90	30
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0			4.0			4.0	
Lane Util. Factor	1.00	0.95		1.00	0.95			1.00			1.00	
Frpb, ped/bikes	1.00	1.00		1.00	0.99			0.97			1.00	
Flpb, ped/bikes	1.00	1.00		1.00	1.00			1.00			1.00	
Frt	1.00	0.99		1.00	0.98			0.91			0.97	
Flt Protected	0.95	1.00		0.95	1.00			1.00			0.99	
Satd. Flow (prot)	1736	3406		1736	3365			1606			1744	
Flt Permitted	0.95	1.00		0.95	1.00			0.97			0.85	
Satd. Flow (perm)	1736	3406		1736	3365			1566			1508	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	22	207	22	217	402	76	33	109	293	43	98	33
RTOR Reduction (vph)	0	13	0	0	26	0	0	124	0	0	14	0
Lane Group Flow (vph)	22	216	0	217	452	0	0	311	0	0	160	0
Confl. Peds. (#/hr)	11		13	13		11	22		48	48		22
Confl. Bikes (#/hr)			1			2			1			
Heavy Vehicles (%)	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%
Turn Type	Prot			Prot			Perm			Perm		
Protected Phases	7	4		3	8			2			6	
Permitted Phases							2			6		
Actuated Green, G (s)	6.0	16.0		6.0	16.0			26.0			26.0	
Effective Green, g (s)	6.0	16.0		6.0	16.0			26.0			26.0	
Actuated g/C Ratio	0.10	0.27		0.10	0.27			0.43			0.43	
Clearance Time (s)	4.0	4.0		4.0	4.0			4.0			4.0	
Lane Grp Cap (vph)	174	908		174	897			679			653	
v/s Ratio Prot	0.01	0.06		c0.13	c0.13							
v/s Ratio Perm								c0.20			0.11	
v/c Ratio	0.13	0.24		1.25	0.50			0.46			0.24	
Uniform Delay, d1	24.6	17.2		27.0	18.6			12.0			10.8	
Progression Factor	1.00	1.00		1.00	1.00			1.00			1.00	
Incremental Delay, d2	1.5	0.6		149.9	2.0			2.2			0.9	
Delay (s)	26.1	17.8		176.9	20.7			14.2			11.7	
Level of Service	C	B		F	C			B			B	
Approach Delay (s)		18.6			69.5			14.2			11.7	
Approach LOS		B			E			B			B	

Intersection Summary			
HCM Average Control Delay	39.3	HCM Level of Service	D
HCM Volume to Capacity ratio	0.57		
Actuated Cycle Length (s)	60.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	62.2%	ICU Level of Service	B
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	350	340	130	60	470	90	160	940	100	170	610	370
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width	10	11	12	11	11	12	12	12	12	12	12	12
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0		4.0	4.0		4.0	4.0	3.0
Lane Util. Factor	0.97	0.95	1.00	1.00	0.95		1.00	0.95		1.00	0.95	1.00
Frpb, ped/bikes	1.00	1.00	0.97	1.00	0.98		1.00	1.00		1.00	1.00	0.96
Flpb, ped/bikes	1.00	1.00	1.00	1.00	1.00		1.00	1.00		1.00	1.00	1.00
Frt	1.00	1.00	0.85	1.00	0.98		1.00	0.99		1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00		0.95	1.00		0.95	1.00	1.00
Satd. Flow (prot)	2828	3020	1353	1510	2890		1562	3064		1562	3124	1300
Flt Permitted	0.95	1.00	1.00	0.95	1.00		0.95	1.00		0.95	1.00	1.00
Satd. Flow (perm)	2828	3020	1353	1510	2890		1562	3064		1562	3124	1300
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	380	370	141	65	511	98	174	1022	109	185	663	402
RTOR Reduction (vph)	0	0	88	0	13	0	0	7	0	0	0	36
Lane Group Flow (vph)	380	370	53	65	596	0	174	1124	0	185	663	366
Confl. Peds. (#/hr)			16			85			25			37
Confl. Bikes (#/hr)						1			1			1
Heavy Vehicles (%)	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%
Bus Blockages (#/hr)	0	0	0	0	0	2	0	0	0	0	0	8
Turn Type	Prot		Perm	Prot			Prot			Prot		pm+ov
Protected Phases	7	4		3	8		5	2		1	6	7
Permitted Phases			4									6
Actuated Green, G (s)	17.0	36.6	36.6	8.2	27.8		17.7	43.0		15.0	40.3	57.3
Effective Green, g (s)	17.0	36.6	36.6	8.2	27.8		17.7	44.0		15.0	41.3	59.3
Actuated g/C Ratio	0.14	0.31	0.31	0.07	0.23		0.15	0.37		0.13	0.34	0.49
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0		4.0	5.0		4.0	5.0	4.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0		3.0	3.0		3.0	3.0	3.0
Lane Grp Cap (vph)	401	923	413	103	671		231	1125		196	1077	643
v/s Ratio Prot	c0.13	0.12		0.04	c0.21		0.11	c0.37		c0.12	0.21	0.09
v/s Ratio Perm			0.04									0.20
v/c Ratio	0.95	0.40	0.13	0.63	0.89		0.75	1.00		0.94	0.62	0.57
Uniform Delay, d1	51.0	32.9	30.1	54.3	44.5		49.0	37.9		52.0	32.6	21.3
Progression Factor	1.00	1.00	1.00	1.00	1.00		1.00	1.00		1.00	1.00	1.00
Incremental Delay, d2	31.5	0.3	0.1	11.9	13.6		13.0	26.4		48.1	1.1	1.2
Delay (s)	82.4	33.2	30.2	66.3	58.1		61.9	64.3		100.1	33.7	22.4
Level of Service	F	C	C	E	E		E	E		F	C	C
Approach Delay (s)		53.7			58.8			64.0			39.9	
Approach LOS		D			E			E			D	

Intersection Summary			
HCM Average Control Delay	53.6	HCM Level of Service	D
HCM Volume to Capacity ratio	0.95		
Actuated Cycle Length (s)	119.8	Sum of lost time (s)	16.0
Intersection Capacity Utilization	90.6%	ICU Level of Service	E
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	100	320	130	60	280	120	170	830	60	120	510	140
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.9	4.9		4.9	4.9		4.3	4.8	4.8	4.3	4.8	4.8
Lane Util. Factor	1.00	0.95		1.00	0.95		0.97	0.95	1.00	0.97	0.95	1.00
Frpb, ped/bikes	1.00	0.99		1.00	0.99		1.00	1.00	0.98	1.00	1.00	0.98
Flpb, ped/bikes	1.00	1.00		1.00	1.00		1.00	1.00	1.00	1.00	1.00	1.00
Frt	1.00	0.96		1.00	0.95		1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	1770	3368		1770	3355		3433	3539	1557	3433	3539	1548
Flt Permitted	0.95	1.00		0.95	1.00		0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)	1770	3368		1770	3355		3433	3539	1557	3433	3539	1548
Peak-hour factor, PHF	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93
Adj. Flow (vph)	108	344	140	65	301	129	183	892	65	129	548	151
RTOR Reduction (vph)	0	44	0	0	49	0	0	0	44	0	0	44
Lane Group Flow (vph)	108	440	0	65	381	0	183	892	21	129	548	107
Confl. Peds. (#/hr)			7			13			6			11
Confl. Bikes (#/hr)						2						
Turn Type	Split			Split			Prot		Perm	Prot		Perm
Protected Phases	4	4		8	8		5	2		1	6	
Permitted Phases									2			6
Actuated Green, G (s)	15.8	15.8		14.7	14.7		7.3	24.6	24.6	4.2	21.5	21.5
Effective Green, g (s)	14.9	14.9		13.8	13.8		7.0	24.8	24.8	3.9	21.7	21.7
Actuated g/C Ratio	0.20	0.20		0.18	0.18		0.09	0.33	0.33	0.05	0.28	0.28
Clearance Time (s)	4.0	4.0		4.0	4.0		4.0	5.0	5.0	4.0	5.0	5.0
Vehicle Extension (s)	2.0	2.0		2.0	2.0		2.0	2.0	2.0	2.0	2.0	2.0
Lane Grp Cap (vph)	346	658		320	607		315	1150	506	175	1007	440
v/s Ratio Prot	0.06	c0.13		0.04	c0.11		c0.05	c0.25		0.04	0.15	
v/s Ratio Perm									0.01			0.07
v/c Ratio	0.31	0.67		0.20	0.63		0.58	0.78	0.04	0.74	0.54	0.24
Uniform Delay, d1	26.3	28.4		26.6	28.9		33.2	23.2	17.6	35.7	23.1	21.0
Progression Factor	1.00	1.00		1.00	1.00		1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	0.2	2.0		0.1	1.5		1.8	3.0	0.0	13.0	0.3	0.1
Delay (s)	26.5	30.4		26.7	30.3		35.0	26.3	17.6	48.7	23.4	21.1
Level of Service	C	C		C	C		D	C	B	D	C	C
Approach Delay (s)		29.7			29.9			27.2			26.9	
Approach LOS		C			C			C			C	

Intersection Summary			
HCM Average Control Delay	28.0	HCM Level of Service	C
HCM Volume to Capacity ratio	0.72		
Actuated Cycle Length (s)	76.3	Sum of lost time (s)	18.9
Intersection Capacity Utilization	64.0%	ICU Level of Service	B
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	20	20	20	90	30	130	10	270	50	60	270	20
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0			4.0	4.0	4.0	4.0		4.0	4.0	
Lane Util. Factor		1.00			1.00	1.00	1.00	1.00		1.00	1.00	
Frpb, ped/bikes		0.99			1.00	0.98	1.00	0.99		1.00	1.00	
Flpb, ped/bikes		1.00			1.00	1.00	1.00	1.00		1.00	1.00	
Frt		0.95			1.00	0.85	1.00	0.98		1.00	0.99	
Flt Protected		0.98			0.96	1.00	0.95	1.00		0.95	1.00	
Satd. Flow (prot)		1737			1796	1556	1770	1804		1770	1838	
Flt Permitted		0.98			0.96	1.00	0.95	1.00		0.95	1.00	
Satd. Flow (perm)		1737			1796	1556	1770	1804		1770	1838	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	22	22	22	98	33	141	11	293	54	65	293	22
RTOR Reduction (vph)	0	20	0	0	0	120	0	7	0	0	3	0
Lane Group Flow (vph)	0	46	0	0	131	21	11	340	0	65	312	0
Confl. Peds. (#/hr)	2		1	1		2	13		20	20		13
Confl. Bikes (#/hr)						1			5			
Turn Type	Split			Split		Perm	Split			Split		
Protected Phases	2	2		1	1		4	4		3	3	
Permitted Phases						1						
Actuated Green, G (s)		6.8			10.1	10.1	18.4	18.4		17.4	17.4	
Effective Green, g (s)		6.8			10.1	10.1	18.4	18.4		17.4	17.4	
Actuated g/C Ratio		0.10			0.15	0.15	0.27	0.27		0.25	0.25	
Clearance Time (s)		4.0			4.0	4.0	4.0	4.0		4.0	4.0	
Vehicle Extension (s)		3.0			3.0	3.0	3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)		172			264	229	474	483		448	466	
v/s Ratio Prot		c0.03			c0.07		0.01	c0.19		0.04	c0.17	
v/s Ratio Perm						0.01						
v/c Ratio		0.27			0.50	0.09	0.02	0.70		0.15	0.67	
Uniform Delay, d1		28.6			27.0	25.3	18.5	22.7		19.9	23.1	
Progression Factor		1.00			1.00	1.00	1.00	1.00		1.00	1.00	
Incremental Delay, d2		0.8			1.5	0.2	0.0	4.6		0.1	3.6	
Delay (s)		29.5			28.4	25.5	18.5	27.3		20.0	26.7	
Level of Service		C			C	C	B	C		C	C	
Approach Delay (s)		29.5			26.9			27.1			25.6	
Approach LOS		C			C			C			C	

Intersection Summary			
HCM Average Control Delay	26.6	HCM Level of Service	C
HCM Volume to Capacity ratio	0.60		
Actuated Cycle Length (s)	68.7	Sum of lost time (s)	16.0
Intersection Capacity Utilization	45.3%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	280	250	60	60	320	70	70	650	30	60	410	100
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0			4.0			4.0	
Lane Util. Factor	1.00	0.95		1.00	0.95			0.95			0.95	
Frpb, ped/bikes	1.00	0.99		1.00	0.99			1.00			0.99	
Flpb, ped/bikes	0.98	1.00		0.99	1.00			1.00			1.00	
Frt	1.00	0.97		1.00	0.97			0.99			0.97	
Flt Protected	0.95	1.00		0.95	1.00			1.00			0.99	
Satd. Flow (prot)	1544	3047		1562	3041			3113			3034	
Flt Permitted	0.48	1.00		0.54	1.00			0.84			0.81	
Satd. Flow (perm)	777	3047		894	3041			2629			2466	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	304	272	65	65	348	76	76	707	33	65	446	109
RTOR Reduction (vph)	0	31	0	0	28	0	0	4	0	0	27	0
Lane Group Flow (vph)	304	306	0	65	396	0	0	812	0	0	593	0
Confl. Peds. (#/hr)	56		22	22		56	31		42	42		31
Confl. Bikes (#/hr)						2			5			1
Heavy Vehicles (%)	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%
Turn Type	Perm			Perm			Perm			Perm		
Protected Phases		4			4			2			2	
Permitted Phases	4			4			2			2		
Actuated Green, G (s)	30.0	30.0		30.0	30.0			32.0			32.0	
Effective Green, g (s)	29.0	29.0		29.0	29.0			31.0			31.0	
Actuated g/C Ratio	0.43	0.43		0.43	0.43			0.46			0.46	
Clearance Time (s)	3.0	3.0		3.0	3.0			3.0			3.0	
Lane Grp Cap (vph)	331	1299		381	1297			1199			1124	
v/s Ratio Prot		0.10			0.13							
v/s Ratio Perm	c0.39			0.07				c0.31			0.24	
v/c Ratio	0.92	0.24		0.17	0.31			0.68			0.53	
Uniform Delay, d1	18.4	12.4		12.1	12.9			14.6			13.3	
Progression Factor	1.00	1.00		1.00	1.00			1.00			1.00	
Incremental Delay, d2	32.5	0.4		1.0	0.6			3.1			1.8	
Delay (s)	50.9	12.9		13.0	13.5			17.6			15.0	
Level of Service	D	B		B	B			B			B	
Approach Delay (s)		30.9			13.4			17.6			15.0	
Approach LOS		C			B			B			B	

Intersection Summary			
HCM Average Control Delay	19.5	HCM Level of Service	B
HCM Volume to Capacity ratio	0.79		
Actuated Cycle Length (s)	68.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	103.1%	ICU Level of Service	G
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	20	260	40	20	350	300	40	580	20	270	390	30
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0			5.0			5.0		5.0	5.0	
Lane Util. Factor		0.95			0.95			0.95		0.97	1.00	
Frpb, ped/bikes		1.00			0.99			1.00		1.00	1.00	
Flpb, ped/bikes		1.00			1.00			1.00		1.00	1.00	
Frt		0.98			0.93			1.00		1.00	0.99	
Flt Protected		1.00			1.00			1.00		0.95	1.00	
Satd. Flow (prot)		3480			3305			3542		3467	1858	
Flt Permitted		0.82			0.94			1.00		0.95	1.00	
Satd. Flow (perm)		2864			3098			3542		3467	1858	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	22	283	43	22	380	326	43	630	22	293	424	33
RTOR Reduction (vph)	0	14	0	0	187	0	0	3	0	0	4	0
Lane Group Flow (vph)	0	334	0	0	541	0	0	692	0	293	453	0
Confl. Peds. (#/hr)	2		11	11		2	14		25	25		14
Confl. Bikes (#/hr)			1			2						
Heavy Vehicles (%)	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%
Turn Type	Perm			Perm			Split			Split		
Protected Phases		4			4		2	2		3	3	
Permitted Phases	4			4								
Actuated Green, G (s)		18.5			18.5			17.9		22.0	22.0	
Effective Green, g (s)		17.5			17.5			16.9		21.0	21.0	
Actuated g/C Ratio		0.25			0.25			0.24		0.30	0.30	
Clearance Time (s)		4.0			4.0			4.0		4.0	4.0	
Vehicle Extension (s)		3.0			3.0			3.0		3.0	3.0	
Lane Grp Cap (vph)		712			770			850		1034	554	
v/s Ratio Prot								c0.20		0.08	c0.24	
v/s Ratio Perm		0.12			c0.17							
v/c Ratio		0.47			0.70			0.81		0.28	0.82	
Uniform Delay, d1		22.5			24.1			25.3		18.9	22.9	
Progression Factor		1.00			1.00			1.00		1.00	1.00	
Incremental Delay, d2		0.5			2.9			6.0		0.2	9.2	
Delay (s)		23.0			27.0			31.3		19.1	32.1	
Level of Service		C			C			C		B	C	
Approach Delay (s)		23.0			27.0			31.3			27.0	
Approach LOS		C			C			C			C	

Intersection Summary			
HCM Average Control Delay	27.6	HCM Level of Service	C
HCM Volume to Capacity ratio	0.78		
Actuated Cycle Length (s)	70.4	Sum of lost time (s)	15.0
Intersection Capacity Utilization	87.7%	ICU Level of Service	E
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	20	300	380	20	450	160	440	340	30	90	280	30
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0	4.0		4.0		4.0	4.0			4.0	
Lane Util. Factor		0.91	0.91		0.95		1.00	1.00			1.00	
Frpb, ped/bikes		0.99	0.96		0.99		1.00	1.00			1.00	
Flpb, ped/bikes		1.00	1.00		1.00		1.00	1.00			1.00	
Frt		0.95	0.85		0.96		1.00	0.99			0.99	
Flt Protected		1.00	1.00		1.00		0.95	1.00			0.99	
Satd. Flow (prot)		2954	1385		3133		1770	1578			1564	
Flt Permitted		0.82	1.00		0.92		0.95	1.00			0.99	
Satd. Flow (perm)		2424	1385		2894		1770	1578			1564	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	22	326	413	22	489	174	478	370	33	98	304	33
RTOR Reduction (vph)	0	64	185	0	40	0	0	4	0	0	3	0
Lane Group Flow (vph)	0	453	59	0	645	0	478	399	0	0	432	0
Confl. Peds. (#/hr)	16		21	21		16	20		16	16		20
Confl. Bikes (#/hr)			1			2			1			
Parking (#/hr)		8			8			8			8	
Turn Type	Perm		Perm	Perm			Split			Split		
Protected Phases		2			2		4	4		8	8	
Permitted Phases	2		2	2								
Actuated Green, G (s)		20.0	20.0		20.0		25.0	25.0			26.0	
Effective Green, g (s)		20.0	20.0		20.0		25.0	25.0			26.0	
Actuated g/C Ratio		0.24	0.24		0.24		0.30	0.30			0.31	
Clearance Time (s)		4.0	4.0		4.0		4.0	4.0			4.0	
Lane Grp Cap (vph)		584	334		697		533	475			490	
v/s Ratio Prot							c0.27	0.25			c0.28	
v/s Ratio Perm		0.19	0.04		c0.22							
v/c Ratio		0.78	0.18		0.93		0.90	0.84			0.88	
Uniform Delay, d1		29.4	25.0		30.8		27.8	27.1			27.0	
Progression Factor		1.00	1.00		1.00		1.00	1.00			1.00	
Incremental Delay, d2		9.7	1.1		20.0		20.4	16.2			19.8	
Delay (s)		39.2	26.1		50.8		48.2	43.3			46.8	
Level of Service		D	C		D		D	D			D	
Approach Delay (s)		35.0			50.8			45.9			46.8	
Approach LOS		C			D			D			D	

Intersection Summary			
HCM Average Control Delay	44.3	HCM Level of Service	D
HCM Volume to Capacity ratio	0.90		
Actuated Cycle Length (s)	83.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	89.1%	ICU Level of Service	E
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL2	EBL	EBT	EBR	NBT	NBR	NBR2	SBL2	SBL	SBT
Lane Configurations										
Volume (vph)	140	840	170	140	380	270	90	420	170	400
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0	4.0	4.5	4.0	4.0		4.0	4.0	4.0
Lane Util. Factor		0.91	0.91	1.00	0.95	1.00		1.00	1.00	1.00
Frpb, ped/bikes		1.00	1.00	0.87	1.00	0.93		1.00	1.00	1.00
Flpb, ped/bikes		1.00	1.00	1.00	1.00	1.00		1.00	1.00	1.00
Frt		1.00	1.00	0.85	1.00	0.85		1.00	1.00	1.00
Flt Protected		0.95	0.96	1.00	1.00	1.00		0.95	0.95	1.00
Satd. Flow (prot)		1610	3269	1370	3539	1480		1770	1770	1863
Flt Permitted		0.95	0.96	1.00	1.00	1.00		0.95	0.95	1.00
Satd. Flow (perm)		1610	3269	1370	3539	1480		1770	1770	1863
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	147	884	179	147	400	284	95	442	179	421
RTOR Reduction (vph)	0	0	0	108	0	17	0	0	0	0
Lane Group Flow (vph)	0	518	692	39	400	362	0	442	179	421
Confl. Peds. (#/hr)				50			50		50	
Confl. Bikes (#/hr)				10			10			
Turn Type	Perm	Perm		Perm		Perm		Prot	Prot	
Protected Phases			4		2			1	1	6
Permitted Phases	4	4		4		2				
Actuated Green, G (s)		19.0	19.0	19.0	21.3	21.3		21.2	21.2	46.0
Effective Green, g (s)		20.5	20.5	20.0	20.8	20.8		21.7	21.7	46.5
Actuated g/C Ratio		0.27	0.27	0.27	0.28	0.28		0.29	0.29	0.62
Clearance Time (s)		5.5	5.5	5.5	3.5	3.5		4.5	4.5	4.5
Vehicle Extension (s)		2.0	2.0	2.0	2.0	2.0		2.0	2.0	2.0
Lane Grp Cap (vph)		440	894	365	981	410		512	512	1155
v/s Ratio Prot					0.11			c0.25	0.10	0.23
v/s Ratio Perm		c0.32	0.21	0.03		c0.24				
v/c Ratio		1.18	1.12dl	0.11	0.41	0.88		0.86	0.35	0.36
Uniform Delay, d1		27.2	25.1	20.8	22.1	25.9		25.2	21.1	7.0
Progression Factor		1.00	1.00	1.00	1.00	1.00		1.00	1.00	1.00
Incremental Delay, d2		101.2	3.9	0.0	0.1	19.2		17.3	1.9	0.9
Delay (s)		128.4	29.0	20.8	22.2	45.1		42.6	22.9	7.9
Level of Service		F	C	C	C	D		D	C	A
Approach Delay (s)			66.1		33.3					25.2
Approach LOS			E		C					C

Intersection Summary			
HCM Average Control Delay	44.6	HCM Level of Service	D
HCM Volume to Capacity ratio	0.97		
Actuated Cycle Length (s)	75.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	78.8%	ICU Level of Service	D
Analysis Period (min)	15		

dl Defacto Left Lane. Recode with 1 though lane as a left lane.
c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	0	0	550	1430	0	0	0	0	0	640	570
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)				4.0	4.0						4.0	4.0
Lane Util. Factor				0.86	0.86						0.86	0.86
Frpb, ped/bikes				1.00	1.00						0.99	1.00
Flpb, ped/bikes				1.00	1.00						1.00	1.00
Frt				1.00	1.00						0.95	0.85
Flt Protected				0.95	1.00						1.00	1.00
Satd. Flow (prot)				1522	4795						4559	1362
Flt Permitted				0.95	1.00						1.00	1.00
Satd. Flow (perm)				1522	4795						4559	1362
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	0	0	0	579	1505	0	0	0	0	0	674	600
RTOR Reduction (vph)	0	0	0	333	6	0	0	0	0	0	16	16
Lane Group Flow (vph)	0	0	0	171	1574	0	0	0	0	0	958	284
Confl. Bikes (#/hr)						9						10
Turn Type				Prot								Prot
Protected Phases				7	3						2	2
Permitted Phases												
Actuated Green, G (s)				20.0	40.0						31.0	31.0
Effective Green, g (s)				20.0	40.0						31.0	31.0
Actuated g/C Ratio				0.25	0.51						0.39	0.39
Clearance Time (s)				4.0	4.0						4.0	4.0
Lane Grp Cap (vph)				385	2428						1789	534
v/s Ratio Prot				0.11	c0.16						c0.21	0.21
v/s Ratio Perm					0.16							
v/c Ratio				0.44	0.65						0.54	0.53
Uniform Delay, d1				24.8	14.3						18.5	18.4
Progression Factor				1.00	1.00						1.00	1.00
Incremental Delay, d2				3.7	1.4						1.2	3.8
Delay (s)				28.5	15.7						19.6	22.2
Level of Service				C	B						B	C
Approach Delay (s)		0.0			18.8			0.0			20.2	
Approach LOS		A			B			A			C	

Intersection Summary			
HCM Average Control Delay	19.3	HCM Level of Service	B
HCM Volume to Capacity ratio	0.60		
Actuated Cycle Length (s)	79.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	59.3%	ICU Level of Service	B
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	300	470	0	0	0	0	0	1260	1930	0	0	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0						4.0	4.0			
Lane Util. Factor		0.91						0.91	0.88			
Frpb, ped/bikes		1.00						1.00	1.00			
Flpb, ped/bikes		1.00						1.00	1.00			
Frt		1.00						1.00	0.85			
Flt Protected		0.98						1.00	1.00			
Satd. Flow (prot)		4973						5085	2787			
Flt Permitted		0.98						1.00	1.00			
Satd. Flow (perm)		4973						5085	2787			
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	316	495	0	0	0	0	0	1326	2032	0	0	0
RTOR Reduction (vph)	0	4	0	0	0	0	0	0	242	0	0	0
Lane Group Flow (vph)	0	807	0	0	0	0	0	1326	1790	0	0	0
Confl. Peds. (#/hr)	12		21	21		12	42		29	29		42
Confl. Bikes (#/hr)			2			1						1
Turn Type	Perm								custom			
Protected Phases		4						2	2			
Permitted Phases	4								7			
Actuated Green, G (s)		27.0						23.0	23.0			
Effective Green, g (s)		27.0						24.0	24.0			
Actuated g/C Ratio		0.45						0.40	0.40			
Clearance Time (s)		5.0						5.0	5.0			
Vehicle Extension (s)		3.0						3.0	3.0			
Lane Grp Cap (vph)		2238						2034	1115			
v/s Ratio Prot								0.26	c0.64			
v/s Ratio Perm		0.16										
v/c Ratio		0.36						0.65	1.61			
Uniform Delay, d1		10.8						14.6	18.0			
Progression Factor		1.00						1.00	1.00			
Incremental Delay, d2		0.5						0.8	276.5			
Delay (s)		11.3						15.4	294.5			
Level of Service		B						B	F			
Approach Delay (s)		11.3			0.0			184.3			0.0	
Approach LOS		B			A			F			A	

Intersection Summary			
HCM Average Control Delay	150.6	HCM Level of Service	F
HCM Volume to Capacity ratio	0.95		
Actuated Cycle Length (s)	60.0	Sum of lost time (s)	9.0
Intersection Capacity Utilization	100.2%	ICU Level of Service	G
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	70	830	1500	0	0	0	0	290	110	110	350	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0	4.0					4.0			4.0	
Lane Util. Factor		0.86	0.86					1.00			1.00	
Frpb, ped/bikes		0.96	0.97					0.98			1.00	
Flpb, ped/bikes		1.00	1.00					1.00			0.99	
Frt		0.93	0.85					0.96			1.00	
Flt Protected		1.00	1.00					1.00			0.99	
Satd. Flow (prot)		4270	1315					1749			1826	
Flt Permitted		1.00	1.00					1.00			0.45	
Satd. Flow (perm)		4270	1315					1749			834	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	74	874	1579	0	0	0	0	305	116	116	368	0
RTOR Reduction (vph)	0	73	0	0	0	0	0	23	0	0	0	0
Lane Group Flow (vph)	0	1665	789	0	0	0	0	398	0	0	484	0
Confl. Peds. (#/hr)	51		75	75		51	29		79	79		29
Confl. Bikes (#/hr)											1	1
Turn Type	Perm		Free							Perm		
Protected Phases		2						4			8	
Permitted Phases	2		Free							8		
Actuated Green, G (s)		33.0	60.0					18.0			18.0	
Effective Green, g (s)		34.0	60.0					18.0			18.0	
Actuated g/C Ratio		0.57	1.00					0.30			0.30	
Clearance Time (s)		5.0						4.0			4.0	
Vehicle Extension (s)		2.0						2.0			2.0	
Lane Grp Cap (vph)		2420	1315					525			250	
v/s Ratio Prot								0.23				
v/s Ratio Perm		0.39	0.60								c0.58	
v/c Ratio		0.89dr	0.60					0.76			1.94	
Uniform Delay, d1		9.2	0.0					19.0			21.0	
Progression Factor		0.71	1.00					1.00			1.00	
Incremental Delay, d2		0.1	0.2					5.5			435.6	
Delay (s)		6.7	0.2					24.5			456.6	
Level of Service		A	A					C			F	
Approach Delay (s)		4.7			0.0			24.5			456.6	
Approach LOS		A			A			C			F	

Intersection Summary			
HCM Average Control Delay	70.9	HCM Level of Service	E
HCM Volume to Capacity ratio	1.12		
Actuated Cycle Length (s)	60.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	90.6%	ICU Level of Service	E
Analysis Period (min)	15		

dr Defacto Right Lane. Recode with 1 though lane as a right lane.
c Critical Lane Group

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Volume (vph)	690	130	90	940	1290	850
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	0.97	1.00	1.00	0.95	0.91	0.88
Frpb, ped/bikes	1.00	0.98	1.00	1.00	1.00	1.00
Flpb, ped/bikes	1.00	1.00	1.00	1.00	1.00	1.00
Frt	1.00	0.85	1.00	1.00	1.00	0.85
Flt Protected	0.95	1.00	0.95	1.00	1.00	1.00
Satd. Flow (prot)	3433	1550	1770	3539	5085	2787
Flt Permitted	0.95	1.00	0.95	1.00	1.00	1.00
Satd. Flow (perm)	3433	1550	1770	3539	5085	2787
Peak-hour factor, PHF	0.94	0.94	0.94	0.94	0.94	0.94
Adj. Flow (vph)	734	138	96	1000	1372	904
RTOR Reduction (vph)	0	0	0	0	0	633
Lane Group Flow (vph)	734	138	96	1000	1372	271
Confl. Peds. (#/hr)	2	16	2			2
Turn Type		Perm	Prot			Prot
Protected Phases	4		5	2	6	6
Permitted Phases		4				
Actuated Green, G (s)	26.0	26.0	4.0	26.0	18.0	18.0
Effective Green, g (s)	26.0	26.0	4.0	26.0	18.0	18.0
Actuated g/C Ratio	0.43	0.43	0.07	0.43	0.30	0.30
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Lane Grp Cap (vph)	1488	672	118	1534	1526	836
v/s Ratio Prot	c0.21		0.05	c0.28	c0.27	0.10
v/s Ratio Perm		0.09				
v/c Ratio	0.49	0.21	0.81	0.65	0.90	0.32
Uniform Delay, d1	12.3	10.6	27.6	13.4	20.1	16.3
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	1.2	0.7	43.7	2.2	8.8	1.0
Delay (s)	13.4	11.3	71.4	15.6	28.9	17.3
Level of Service	B	B	E	B	C	B
Approach Delay (s)	13.1			20.5	24.3	
Approach LOS	B			C	C	

Intersection Summary			
HCM Average Control Delay	21.0	HCM Level of Service	C
HCM Volume to Capacity ratio	0.68		
Actuated Cycle Length (s)	60.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	65.7%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	30	180	70	80	110	90	70	120	70	110	180	20
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0			4.0	4.0	4.0	4.0		4.0	4.0	
Lane Util. Factor		0.95			0.95	1.00	1.00	0.95		0.91	0.91	
Frpb, ped/bikes		0.99			1.00	0.99	1.00	1.00		1.00	1.00	
Flpb, ped/bikes		1.00			1.00	1.00	1.00	1.00		1.00	1.00	
Frt		0.96			1.00	0.85	1.00	0.94		1.00	0.99	
Flt Protected		0.99			0.98	1.00	0.95	1.00		0.95	1.00	
Satd. Flow (prot)		3366			3462	1563	1770	3327		1610	3328	
Flt Permitted		0.91			0.74	1.00	0.95	1.00		0.95	1.00	
Satd. Flow (perm)		3078			2622	1563	1770	3327		1610	3328	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	33	196	76	87	120	98	76	130	76	120	196	22
RTOR Reduction (vph)	0	43	0	0	0	0	0	63	0	0	10	0
Lane Group Flow (vph)	0	262	0	0	207	98	76	143	0	108	220	0
Confl. Peds. (#/hr)	2		4	4		2	4		2	2		4
Confl. Bikes (#/hr)			2			1						2
Turn Type	Perm			Perm		Free	Split			Split		
Protected Phases		2			6		3	3		4	4	
Permitted Phases	2			6		Free						
Actuated Green, G (s)		12.5			11.5	42.1	7.0	7.0		9.6	9.6	
Effective Green, g (s)		12.5			12.5	42.1	7.0	7.0		10.6	10.6	
Actuated g/C Ratio		0.30			0.30	1.00	0.17	0.17		0.25	0.25	
Clearance Time (s)		4.0			5.0		4.0	4.0		5.0	5.0	
Vehicle Extension (s)		3.0			3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)		914			779	1563	294	553		405	838	
v/s Ratio Prot							c0.04	0.04		c0.07	0.07	
v/s Ratio Perm		c0.09			0.08	0.06						
v/c Ratio		0.29			0.27	0.06	0.26	0.26		0.27	0.26	
Uniform Delay, d1		11.4			11.3	0.0	15.3	15.3		12.6	12.6	
Progression Factor		1.00			1.00	1.00	1.00	1.00		1.00	1.00	
Incremental Delay, d2		0.2			0.2	0.1	0.5	0.2		0.4	0.2	
Delay (s)		11.5			11.5	0.1	15.8	15.5		13.0	12.8	
Level of Service		B			B	A	B	B		B	B	
Approach Delay (s)		11.5			7.8			15.6			12.9	
Approach LOS		B			A			B			B	

Intersection Summary			
HCM Average Control Delay	11.9	HCM Level of Service	B
HCM Volume to Capacity ratio	0.27		
Actuated Cycle Length (s)	42.1	Sum of lost time (s)	12.0
Intersection Capacity Utilization	42.0%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	20	320	20	210	250	50	20	50	170	40	50	20
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0			4.0			4.0	
Lane Util. Factor	1.00	0.95		1.00	0.95			1.00			1.00	
Frpb, ped/bikes	1.00	1.00		1.00	1.00			0.98			1.00	
Flpb, ped/bikes	1.00	1.00		1.00	1.00			1.00			1.00	
Frt	1.00	0.99		1.00	0.98			0.90			0.98	
Flt Protected	0.95	1.00		0.95	1.00			1.00			0.98	
Satd. Flow (prot)	1787	3542		1787	3468			1661			1791	
Flt Permitted	0.95	1.00		0.95	1.00			0.98			0.85	
Satd. Flow (perm)	1787	3542		1787	3468			1629			1553	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	22	348	22	228	272	54	22	54	185	43	54	22
RTOR Reduction (vph)	0	7	0	0	27	0	0	105	0	0	12	0
Lane Group Flow (vph)	22	363	0	228	299	0	0	156	0	0	107	0
Confl. Peds. (#/hr)	4					4	1		24	24		1
Confl. Bikes (#/hr)						2			1			
Heavy Vehicles (%)	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%
Turn Type	Prot			Prot			Perm			Perm		
Protected Phases	7	4		3	8			2			6	
Permitted Phases							2			6		
Actuated Green, G (s)	6.0	16.0		6.0	16.0			26.0			26.0	
Effective Green, g (s)	6.0	16.0		6.0	16.0			26.0			26.0	
Actuated g/C Ratio	0.10	0.27		0.10	0.27			0.43			0.43	
Clearance Time (s)	4.0	4.0		4.0	4.0			4.0			4.0	
Lane Grp Cap (vph)	179	945		179	925			706			673	
v/s Ratio Prot	0.01	c0.10		c0.13	0.09							
v/s Ratio Perm								c0.10			0.07	
v/c Ratio	0.12	0.38		1.27	0.32			0.22			0.16	
Uniform Delay, d1	24.6	18.0		27.0	17.7			10.7			10.3	
Progression Factor	1.00	1.00		1.00	1.00			1.00			1.00	
Incremental Delay, d2	1.4	1.2		159.4	0.9			0.7			0.5	
Delay (s)	26.0	19.2		186.4	18.6			11.4			10.8	
Level of Service	C	B		F	B			B			B	
Approach Delay (s)		19.5			87.6			11.4			10.8	
Approach LOS		B			F			B			B	

Intersection Summary			
HCM Average Control Delay	45.6	HCM Level of Service	D
HCM Volume to Capacity ratio	0.41		
Actuated Cycle Length (s)	60.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	54.4%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	350	270	90	140	350	100	110	580	150	150	870	400
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width	10	11	12	11	11	12	12	12	12	12	12	12
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0		4.0	4.0		4.0	4.0	4.0
Lane Util. Factor	0.97	0.95	1.00	1.00	0.95		1.00	0.95		1.00	0.95	1.00
Frpb, ped/bikes	1.00	1.00	0.93	1.00	0.98		1.00	0.99		1.00	1.00	0.90
Flpb, ped/bikes	1.00	1.00	1.00	1.00	1.00		1.00	1.00		1.00	1.00	1.00
Frt	1.00	1.00	0.85	1.00	0.97		1.00	0.97		1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00		0.95	1.00		0.95	1.00	1.00
Satd. Flow (prot)	2884	3079	1330	1540	2921		1593	3049		1593	3185	1243
Flt Permitted	0.95	1.00	1.00	0.95	1.00		0.95	1.00		0.95	1.00	1.00
Satd. Flow (perm)	2884	3079	1330	1540	2921		1593	3049		1593	3185	1243
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	380	293	98	152	380	109	120	630	163	163	946	435
RTOR Reduction (vph)	0	0	79	0	23	0	0	19	0	0	0	277
Lane Group Flow (vph)	380	293	19	152	466	0	120	774	0	163	946	158
Confl. Peds. (#/hr)			47			60			42			75
Confl. Bikes (#/hr)						1						
Bus Blockages (#/hr)	0	0	0	0	0	2	0	0	0	0	0	8
Turn Type	Split		Perm	Split			Prot			Prot		Perm
Protected Phases	4	4		8	8		5	2		1	6	
Permitted Phases			4									6
Actuated Green, G (s)	19.5	19.5	19.5	20.6	20.6		11.1	29.5		12.1	30.5	30.5
Effective Green, g (s)	19.5	19.5	19.5	20.6	20.6		11.1	30.5		12.1	31.5	31.5
Actuated g/C Ratio	0.20	0.20	0.20	0.21	0.21		0.11	0.31		0.12	0.32	0.32
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0		4.0	5.0		4.0	5.0	5.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0		3.0	3.0		3.0	3.0	3.0
Lane Grp Cap (vph)	570	608	263	321	610		179	942		195	1016	397
v/s Ratio Prot	c0.13	0.10		0.10	c0.16		0.08	0.25		c0.10	c0.30	
v/s Ratio Perm			0.01									0.13
v/c Ratio	0.67	0.48	0.07	0.47	0.76		0.67	0.82		0.84	0.93	0.40
Uniform Delay, d1	36.6	35.1	32.2	34.3	36.8		42.0	31.6		42.3	32.5	26.2
Progression Factor	1.00	1.00	1.00	1.00	1.00		1.00	1.00		1.00	1.00	1.00
Incremental Delay, d2	2.9	0.6	0.1	1.1	5.7		9.5	5.9		25.5	14.5	0.7
Delay (s)	39.5	35.7	32.4	35.4	42.4		51.5	37.4		67.8	47.0	26.9
Level of Service	D	D	C	D	D		D	D		E	D	C
Approach Delay (s)		37.2			40.8			39.3			43.5	
Approach LOS		D			D			D			D	

Intersection Summary			
HCM Average Control Delay	40.8	HCM Level of Service	D
HCM Volume to Capacity ratio	0.79		
Actuated Cycle Length (s)	98.7	Sum of lost time (s)	12.0
Intersection Capacity Utilization	78.0%	ICU Level of Service	D
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	150	260	120	60	220	140	130	520	50	170	1310	190
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.9	4.9		4.9	4.9		4.3	4.8	4.8	4.3	4.8	4.8
Lane Util. Factor	1.00	0.95		1.00	0.95		0.97	0.95	1.00	0.97	0.95	1.00
Frpb, ped/bikes	1.00	0.99		1.00	0.99		1.00	1.00	0.98	1.00	1.00	0.99
Flpb, ped/bikes	1.00	1.00		1.00	1.00		1.00	1.00	1.00	1.00	1.00	1.00
Frt	1.00	0.95		1.00	0.94		1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	1787	3386		1787	3334		3467	3574	1570	3467	3574	1575
Flt Permitted	0.95	1.00		0.95	1.00		0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)	1787	3386		1787	3334		3467	3574	1570	3467	3574	1575
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	158	274	126	63	232	147	137	547	53	179	1379	200
RTOR Reduction (vph)	0	56	0	0	108	0	0	0	32	0	0	20
Lane Group Flow (vph)	158	344	0	63	271	0	137	547	21	179	1379	180
Confl. Peds. (#/hr)			7			14			8			3
Confl. Bikes (#/hr)						1						
Heavy Vehicles (%)	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%
Turn Type	Split			Split			Prot		Perm	Prot		Perm
Protected Phases	4	4		8	8		5	2		1	6	
Permitted Phases									2			6
Actuated Green, G (s)	13.5	13.5		12.2	12.2		6.7	30.5	30.5	4.1	27.9	27.9
Effective Green, g (s)	12.6	12.6		11.3	11.3		6.4	30.7	30.7	3.8	28.1	28.1
Actuated g/C Ratio	0.16	0.16		0.15	0.15		0.08	0.40	0.40	0.05	0.36	0.36
Clearance Time (s)	4.0	4.0		4.0	4.0		4.0	5.0	5.0	4.0	5.0	5.0
Vehicle Extension (s)	2.0	2.0		2.0	2.0		2.0	2.0	2.0	2.0	2.0	2.0
Lane Grp Cap (vph)	291	552		261	487		287	1419	624	170	1299	573
v/s Ratio Prot	0.09	c0.10		0.04	c0.08		0.04	c0.15		c0.05	c0.39	
v/s Ratio Perm									0.01			0.11
v/c Ratio	0.54	0.62		0.24	0.56		0.48	0.39	0.03	1.05	1.06	0.31
Uniform Delay, d1	29.7	30.1		29.2	30.7		33.9	16.6	14.2	36.8	24.6	17.7
Progression Factor	1.00	1.00		1.00	1.00		1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	1.1	1.6		0.2	0.8		0.5	0.1	0.0	83.7	43.1	0.1
Delay (s)	30.8	31.7		29.4	31.4		34.3	16.6	14.2	120.5	67.7	17.8
Level of Service	C	C		C	C		C	B	B	F	E	B
Approach Delay (s)		31.5			31.2			19.8			67.4	
Approach LOS		C			C			B			E	

Intersection Summary			
HCM Average Control Delay	47.0	HCM Level of Service	D
HCM Volume to Capacity ratio	0.90		
Actuated Cycle Length (s)	77.3	Sum of lost time (s)	23.7
Intersection Capacity Utilization	79.7%	ICU Level of Service	D
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	20	20	20	30	20	40	20	180	40	80	250	20
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0			4.0	4.0	4.0	4.0		4.0	4.0	
Lane Util. Factor		1.00			1.00	1.00	1.00	1.00		1.00	1.00	
Frpb, ped/bikes		0.99			1.00	0.98	1.00	1.00		1.00	1.00	
Flpb, ped/bikes		1.00			1.00	1.00	1.00	1.00		1.00	1.00	
Frt		0.95			1.00	0.85	1.00	0.97		1.00	0.99	
Flt Protected		0.98			0.97	1.00	0.95	1.00		0.95	1.00	
Satd. Flow (prot)		1732			1808	1552	1770	1805		1770	1838	
Flt Permitted		0.98			0.97	1.00	0.95	1.00		0.95	1.00	
Satd. Flow (perm)		1732			1808	1552	1770	1805		1770	1838	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	22	22	22	33	22	43	22	196	43	87	272	22
RTOR Reduction (vph)	0	20	0	0	0	39	0	8	0	0	3	0
Lane Group Flow (vph)	0	46	0	0	55	4	22	231	0	87	291	0
Confl. Peds. (#/hr)	2		6	6		2	8		2	2		8
Confl. Bikes (#/hr)						1						
Turn Type	Split			Split		Perm	Split			Split		
Protected Phases	2	2		1	1		4	4		3	3	
Permitted Phases						1						
Actuated Green, G (s)		4.8			6.0	6.0	14.6	14.6		16.2	16.2	
Effective Green, g (s)		4.8			6.0	6.0	14.6	14.6		16.2	16.2	
Actuated g/C Ratio		0.08			0.10	0.10	0.25	0.25		0.28	0.28	
Clearance Time (s)		4.0			4.0	4.0	4.0	4.0		4.0	4.0	
Vehicle Extension (s)		3.0			3.0	3.0	3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)		144			188	162	449	458		498	517	
v/s Ratio Prot		c0.03			c0.03		0.01	c0.13		0.05	c0.16	
v/s Ratio Perm						0.00						
v/c Ratio		0.32			0.29	0.03	0.05	0.50		0.17	0.56	
Uniform Delay, d1		24.9			23.8	23.2	16.3	18.4		15.6	17.7	
Progression Factor		1.00			1.00	1.00	1.00	1.00		1.00	1.00	
Incremental Delay, d2		1.3			0.9	0.1	0.0	0.9		0.2	1.4	
Delay (s)		26.1			24.7	23.2	16.3	19.3		15.8	19.1	
Level of Service		C			C	C	B	B		B	B	
Approach Delay (s)		26.1			24.1			19.0			18.3	
Approach LOS		C			C			B			B	

Intersection Summary			
HCM Average Control Delay	19.9	HCM Level of Service	B
HCM Volume to Capacity ratio	0.48		
Actuated Cycle Length (s)	57.6	Sum of lost time (s)	16.0
Intersection Capacity Utilization	39.6%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	190	170	50	60	180	50	20	480	40	50	670	120
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0			4.0			4.0	
Lane Util. Factor	1.00	0.95		1.00	0.95			0.95			0.95	
Frpb, ped/bikes	1.00	0.99		1.00	1.00			1.00			0.99	
Flpb, ped/bikes	0.99	1.00		0.99	1.00			1.00			1.00	
Frt	1.00	0.97		1.00	0.97			0.99			0.98	
Flt Protected	0.95	1.00		0.95	1.00			1.00			1.00	
Satd. Flow (prot)	1585	3054		1569	3069			3134			3081	
Flt Permitted	0.60	1.00		0.61	1.00			0.91			0.89	
Satd. Flow (perm)	1005	3054		1006	3069			2871			2760	
Peak-hour factor, PHF	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96
Adj. Flow (vph)	198	177	52	62	188	52	21	500	42	52	698	125
RTOR Reduction (vph)	0	30	0	0	30	0	0	9	0	0	20	0
Lane Group Flow (vph)	198	199	0	62	210	0	0	554	0	0	855	0
Confl. Peds. (#/hr)	10		29	29		10	63		34	34		63
Confl. Bikes (#/hr)									1			
Parking (#/hr)							0					
Turn Type	Perm			Perm			Perm			Perm		
Protected Phases		4			4			2			2	
Permitted Phases	4			4			2			2		
Actuated Green, G (s)	30.0	30.0		30.0	30.0			32.0			32.0	
Effective Green, g (s)	29.0	29.0		29.0	29.0			31.0			31.0	
Actuated g/C Ratio	0.43	0.43		0.43	0.43			0.46			0.46	
Clearance Time (s)	3.0	3.0		3.0	3.0			3.0			3.0	
Lane Grp Cap (vph)	429	1302		429	1309			1309			1258	
v/s Ratio Prot		0.07			0.07							
v/s Ratio Perm	c0.20			0.06				0.19			c0.31	
v/c Ratio	0.46	0.15		0.14	0.16			0.42			0.68	
Uniform Delay, d1	13.9	12.0		11.9	12.0			12.5			14.6	
Progression Factor	1.00	1.00		1.00	1.00			1.00			1.00	
Incremental Delay, d2	3.5	0.2		0.7	0.3			1.0			3.0	
Delay (s)	17.5	12.2		12.6	12.3			13.5			17.6	
Level of Service	B	B		B	B			B			B	
Approach Delay (s)		14.7			12.3			13.5			17.6	
Approach LOS		B			B			B			B	

Intersection Summary			
HCM Average Control Delay	15.2	HCM Level of Service	B
HCM Volume to Capacity ratio	0.57		
Actuated Cycle Length (s)	68.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	100.5%	ICU Level of Service	G
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	20	200	40	30	200	150	30	470	50	620	580	40
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0			5.0			5.0		5.0	5.0	
Lane Util. Factor		0.95			0.95			0.95		0.97	1.00	
Frpb, ped/bikes		1.00			0.99			1.00		1.00	1.00	
Flpb, ped/bikes		1.00			1.00			1.00		1.00	1.00	
Frt		0.98			0.94			0.99		1.00	0.99	
Flt Protected		1.00			1.00			1.00		0.95	1.00	
Satd. Flow (prot)		3462			3326			3509		3467	1860	
Flt Permitted		0.90			0.90			1.00		0.95	1.00	
Satd. Flow (perm)		3128			3019			3509		3467	1860	
Peak-hour factor, PHF	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94
Adj. Flow (vph)	21	213	43	32	213	160	32	500	53	660	617	43
RTOR Reduction (vph)	0	21	0	0	132	0	0	9	0	0	2	0
Lane Group Flow (vph)	0	256	0	0	273	0	0	576	0	660	658	0
Confl. Peds. (#/hr)	2		6	6		2	11		10	10		11
Confl. Bikes (#/hr)						2						1
Heavy Vehicles (%)	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%
Turn Type	Perm			Perm			Split			Split		
Protected Phases		4			4		2	2		3	3	
Permitted Phases	4			4								
Actuated Green, G (s)		12.6			12.6			15.8		26.4	26.4	
Effective Green, g (s)		11.6			11.6			14.8		25.4	25.4	
Actuated g/C Ratio		0.17			0.17			0.22		0.38	0.38	
Clearance Time (s)		4.0			4.0			4.0		4.0	4.0	
Vehicle Extension (s)		3.0			3.0			3.0		3.0	3.0	
Lane Grp Cap (vph)		543			524			777		1318	707	
v/s Ratio Prot								c0.16		0.19	c0.35	
v/s Ratio Perm		0.08			c0.09							
v/c Ratio		0.47			0.52			0.74		0.50	0.93	
Uniform Delay, d1		24.8			25.1			24.2		15.8	19.8	
Progression Factor		1.00			1.00			1.00		1.00	1.00	
Incremental Delay, d2		0.7			0.9			3.8		0.3	18.8	
Delay (s)		25.5			26.0			28.0		16.1	38.7	
Level of Service		C			C			C		B	D	
Approach Delay (s)		25.5			26.0			28.0			27.4	
Approach LOS		C			C			C			C	

Intersection Summary			
HCM Average Control Delay	27.1	HCM Level of Service	C
HCM Volume to Capacity ratio	0.78		
Actuated Cycle Length (s)	66.8	Sum of lost time (s)	15.0
Intersection Capacity Utilization	87.0%	ICU Level of Service	E
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	20	360	440	20	350	130	380	330	40	120	400	40
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0	4.0		4.0		4.0	4.0			4.0	
Lane Util. Factor		0.91	0.91		0.95		1.00	1.00			1.00	
Frpb, ped/bikes		0.99	0.96		0.99		1.00	1.00			1.00	
Flpb, ped/bikes		1.00	1.00		1.00		1.00	1.00			1.00	
Frt		0.95	0.85		0.96		1.00	0.98			0.99	
Flt Protected		1.00	1.00		1.00		0.95	1.00			0.99	
Satd. Flow (prot)		2987	1399		3159		1787	1587			1581	
Flt Permitted		0.92	1.00		0.88		0.95	1.00			0.99	
Satd. Flow (perm)		2767	1399		2784		1787	1587			1581	
Peak-hour factor, PHF	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97
Adj. Flow (vph)	21	371	454	21	361	134	392	340	41	124	412	41
RTOR Reduction (vph)	0	61	203	0	42	0	0	5	0	0	3	0
Lane Group Flow (vph)	0	517	65	0	474	0	392	376	0	0	574	0
Confl. Peds. (#/hr)	17		21	21		17	30		15	15		30
Confl. Bikes (#/hr)			1			1						
Heavy Vehicles (%)	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%
Parking (#/hr)		8			8			8			8	
Turn Type	Perm		Perm	Perm			Split			Split		
Protected Phases		2			2		4	4		8	8	
Permitted Phases	2		2	2								
Actuated Green, G (s)		20.0	20.0		20.0		25.0	25.0			26.0	
Effective Green, g (s)		20.0	20.0		20.0		25.0	25.0			26.0	
Actuated g/C Ratio		0.24	0.24		0.24		0.30	0.30			0.31	
Clearance Time (s)		4.0	4.0		4.0		4.0	4.0			4.0	
Lane Grp Cap (vph)		667	337		671		538	478			495	
v/s Ratio Prot							0.22	c0.24			c0.36	
v/s Ratio Perm		c0.19	0.05		0.17							
v/c Ratio		0.77	0.19		0.71		0.73	0.79			1.16	
Uniform Delay, d1		29.4	25.1		28.8		26.0	26.6			28.5	
Progression Factor		1.00	1.00		1.00		1.00	1.00			1.00	
Incremental Delay, d2		8.5	1.3		6.2		8.4	12.3			92.0	
Delay (s)		37.9	26.3		35.0		34.4	38.9			120.5	
Level of Service		D	C		C		C	D			F	
Approach Delay (s)		34.3			35.0			36.6			120.5	
Approach LOS		C			C			D			F	

Intersection Summary			
HCM Average Control Delay	53.4	HCM Level of Service	D
HCM Volume to Capacity ratio	0.92		
Actuated Cycle Length (s)	83.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	91.8%	ICU Level of Service	F
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL2	EBL	EBT	EBR	NBT	NBR	NBR2	SBL2	SBL	SBT
Lane Configurations										
Volume (vph)	40	1100	400	150	620	370	110	390	320	540
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0	4.0	4.5	4.0	4.0		4.0	4.0	4.0
Lane Util. Factor		0.91	0.91	1.00	0.95	1.00		1.00	1.00	1.00
Frpb, ped/bikes		1.00	1.00	0.85	1.00	0.92		1.00	1.00	1.00
Flpb, ped/bikes		1.00	1.00	1.00	1.00	1.00		1.00	1.00	1.00
Frt		1.00	1.00	0.85	1.00	0.85		1.00	1.00	1.00
Flt Protected		0.95	0.97	1.00	1.00	1.00		0.95	0.95	1.00
Satd. Flow (prot)		1610	3293	1344	3539	1452		1770	1770	1863
Flt Permitted		0.95	0.97	1.00	1.00	1.00		0.95	0.95	1.00
Satd. Flow (perm)		1610	3293	1344	3539	1452		1770	1770	1863
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	42	1158	421	158	653	389	116	411	337	568
RTOR Reduction (vph)	0	0	0	99	0	12	0	0	0	0
Lane Group Flow (vph)	0	598	1023	59	653	493	0	411	337	568
Confl. Peds. (#/hr)				50			50		50	
Confl. Bikes (#/hr)				10			10			
Turn Type	Perm	Perm		Perm		Perm		Prot	Prot	
Protected Phases			4		2			1	1	6
Permitted Phases	4	4		4		2				
Actuated Green, G (s)		32.5	32.5	32.5	22.5	22.5		22.0	22.0	47.5
Effective Green, g (s)		34.0	34.0	33.5	22.0	22.0		22.0	22.0	48.0
Actuated g/C Ratio		0.38	0.38	0.37	0.24	0.24		0.24	0.24	0.53
Clearance Time (s)		5.5	5.5	5.5	3.5	3.5		4.0	4.0	4.5
Vehicle Extension (s)		2.0	2.0	2.0	2.0	2.0		2.0	2.0	2.0
Lane Grp Cap (vph)		608	1244	500	865	355		433	433	994
v/s Ratio Prot					0.18			c0.23	0.19	0.30
v/s Ratio Perm		c0.37	0.31	0.04		c0.34				
v/c Ratio		0.98	0.95dl	0.12	0.75	1.39		0.95	0.78	0.57
Uniform Delay, d1		27.7	25.3	18.5	31.5	34.0		33.5	31.7	14.1
Progression Factor		1.00	1.00	1.00	1.00	1.00		1.00	1.00	1.00
Incremental Delay, d2		32.0	4.3	0.0	3.4	191.4		32.2	12.9	2.4
Delay (s)		59.8	29.6	18.6	34.9	225.4		65.7	44.6	16.5
Level of Service		E	C	B	C	F		E	D	B
Approach Delay (s)			38.7		117.9					39.1
Approach LOS			D		F					D

Intersection Summary			
HCM Average Control Delay	60.4	HCM Level of Service	E
HCM Volume to Capacity ratio	1.09		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	91.8%	ICU Level of Service	F
Analysis Period (min)	15		

dl Defacto Left Lane. Recode with 1 though lane as a left lane.
c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	0	0	450	1280	0	0	0	0	0	970	580
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)				4.0	4.0						4.0	4.0
Lane Util. Factor				0.86	0.86						0.86	0.86
Frpb, ped/bikes				1.00	1.00						1.00	1.00
Flpb, ped/bikes				1.00	1.00						1.00	1.00
Frt				1.00	1.00						0.97	0.85
Flt Protected				0.95	1.00						1.00	1.00
Satd. Flow (prot)				1522	4798						4651	1362
Flt Permitted				0.95	1.00						1.00	1.00
Satd. Flow (perm)				1522	4798						4651	1362
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	0	0	0	474	1347	0	0	0	0	0	1021	611
RTOR Reduction (vph)	0	0	0	294	4	0	0	0	0	0	24	24
Lane Group Flow (vph)	0	0	0	133	1390	0	0	0	0	0	1241	343
Confl. Bikes (#/hr)						5						9
Turn Type				Prot								Prot
Protected Phases				7	3						2	2
Permitted Phases												
Actuated Green, G (s)				20.0	40.0						31.0	31.0
Effective Green, g (s)				20.0	40.0						31.0	31.0
Actuated g/C Ratio				0.25	0.51						0.39	0.39
Clearance Time (s)				4.0	4.0						4.0	4.0
Lane Grp Cap (vph)				385	2429						1825	534
v/s Ratio Prot				0.09	c0.14						c0.27	0.25
v/s Ratio Perm					0.14							
v/c Ratio				0.35	0.57						0.68	0.64
Uniform Delay, d1				24.2	13.6						19.9	19.5
Progression Factor				1.00	1.00						1.00	1.00
Incremental Delay, d2				2.5	1.0						2.1	5.9
Delay (s)				26.6	14.5						22.0	25.4
Level of Service				C	B						C	C
Approach Delay (s)		0.0			17.4			0.0			22.7	
Approach LOS		A			B			A			C	

Intersection Summary			
HCM Average Control Delay	19.9	HCM Level of Service	B
HCM Volume to Capacity ratio	0.62		
Actuated Cycle Length (s)	79.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	56.0%	ICU Level of Service	B
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	350	1090	0	0	0	0	0	1120	1970	0	0	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0						4.0	4.0			
Lane Util. Factor		0.91						0.91	0.88			
Frpb, ped/bikes		1.00						1.00	1.00			
Flpb, ped/bikes		1.00						1.00	1.00			
Frt		1.00						1.00	0.85			
Flt Protected		0.99						1.00	1.00			
Satd. Flow (prot)		5006						5085	2787			
Flt Permitted		0.99						1.00	1.00			
Satd. Flow (perm)		5006						5085	2787			
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	368	1147	0	0	0	0	0	1179	2074	0	0	0
RTOR Reduction (vph)	0	0	0	0	0	0	0	0	97	0	0	0
Lane Group Flow (vph)	0	1515	0	0	0	0	0	1179	1977	0	0	0
Confl. Peds. (#/hr)	28		7	7		28	99		3	3		99
Confl. Bikes (#/hr)			1			2			1			
Turn Type	Perm								custom			
Protected Phases		4						2	2			
Permitted Phases	4								7			
Actuated Green, G (s)		34.0						16.0	16.0			
Effective Green, g (s)		35.0						17.0	17.0			
Actuated g/C Ratio		0.58						0.28	0.28			
Clearance Time (s)		5.0						5.0	5.0			
Vehicle Extension (s)		3.0						3.0	3.0			
Lane Grp Cap (vph)		2920						1441	790			
v/s Ratio Prot								0.23	c0.71			
v/s Ratio Perm		0.30										
v/c Ratio		0.52						0.82	2.50			
Uniform Delay, d1		7.5						20.1	21.5			
Progression Factor		1.00						1.00	1.00			
Incremental Delay, d2		0.7						3.7	679.6			
Delay (s)		8.1						23.8	701.1			
Level of Service		A						C	F			
Approach Delay (s)		8.1			0.0			455.7			0.0	
Approach LOS		A			A			F			A	

Intersection Summary			
HCM Average Control Delay	313.5	HCM Level of Service	F
HCM Volume to Capacity ratio	1.17		
Actuated Cycle Length (s)	60.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	104.2%	ICU Level of Service	G
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	70	1500	1490	0	0	0	0	380	430	130	360	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0	4.0					4.0			4.0	
Lane Util. Factor		0.86	0.86					1.00			1.00	
Frpb, ped/bikes		0.98	0.97					0.98			1.00	
Flpb, ped/bikes		1.00	1.00					1.00			1.00	
Frt		0.95	0.85					0.93			1.00	
Flt Protected		1.00	1.00					1.00			0.99	
Satd. Flow (prot)		4453	1323					1694			1836	
Flt Permitted		1.00	1.00					1.00			0.14	
Satd. Flow (perm)		4453	1323					1694			262	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	74	1579	1568	0	0	0	0	400	453	137	379	0
RTOR Reduction (vph)	0	64	0	0	0	0	0	13	0	0	0	0
Lane Group Flow (vph)	0	2373	784	0	0	0	0	840	0	0	516	0
Confl. Peds. (#/hr)	52		55	55		52	39		25	25		39
Confl. Bikes (#/hr)			1						2		1	2
Turn Type	Perm		Free							Perm		
Protected Phases		2						4			8	
Permitted Phases	2		Free							8		
Actuated Green, G (s)		33.0	60.0					18.0			18.0	
Effective Green, g (s)		34.0	60.0					18.0			18.0	
Actuated g/C Ratio		0.57	1.00					0.30			0.30	
Clearance Time (s)		5.0						4.0			4.0	
Vehicle Extension (s)		2.0						2.0			2.0	
Lane Grp Cap (vph)		2523	1323					508			79	
v/s Ratio Prot								0.50				
v/s Ratio Perm		0.53	0.59								c1.97	
v/c Ratio		0.94	0.59					1.65			6.53	
Uniform Delay, d1		12.1	0.0					21.0			21.0	
Progression Factor		0.62	1.00					1.00			1.00	
Incremental Delay, d2		1.0	0.2					302.5			2515.9	
Delay (s)		8.4	0.2					323.5			2536.9	
Level of Service		A	A					F			F	
Approach Delay (s)		6.4			0.0			323.5			2536.9	
Approach LOS		A			A			F			F	

Intersection Summary			
HCM Average Control Delay	349.8	HCM Level of Service	F
HCM Volume to Capacity ratio	2.89		
Actuated Cycle Length (s)	60.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	128.4%	ICU Level of Service	H
Analysis Period (min)	15		
c Critical Lane Group			

Cumulative (2035) Plus Phase 1 Project Conditions

FEHR PEERS

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Volume (vph)	560	90	50	1317	1154	770
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	0.97	1.00	1.00	0.95	0.91	0.88
Frpb, ped/bikes	1.00	0.98	1.00	1.00	1.00	1.00
Flpb, ped/bikes	1.00	1.00	1.00	1.00	1.00	1.00
Frt	1.00	0.85	1.00	1.00	1.00	0.85
Flt Protected	0.95	1.00	0.95	1.00	1.00	1.00
Satd. Flow (prot)	3400	1535	1752	3505	5036	2760
Flt Permitted	0.95	1.00	0.95	1.00	1.00	1.00
Satd. Flow (perm)	3400	1535	1752	3505	5036	2760
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	609	98	54	1432	1254	837
RTOR Reduction (vph)	0	0	0	0	0	586
Lane Group Flow (vph)	609	98	54	1432	1254	251
Confl. Peds. (#/hr)	3	11	4			4
Confl. Bikes (#/hr)		5				5
Heavy Vehicles (%)	3%	3%	3%	3%	3%	3%
Turn Type		Perm	Prot			Prot
Protected Phases	4		5	2	6	6
Permitted Phases		4				
Actuated Green, G (s)	26.0	26.0	4.0	26.0	18.0	18.0
Effective Green, g (s)	26.0	26.0	4.0	26.0	18.0	18.0
Actuated g/C Ratio	0.43	0.43	0.07	0.43	0.30	0.30
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Lane Grp Cap (vph)	1473	665	117	1519	1511	828
v/s Ratio Prot	c0.18		0.03	c0.41	0.25	0.09
v/s Ratio Perm		0.06				
v/c Ratio	0.41	0.15	0.46	0.94	0.83	0.30
Uniform Delay, d1	11.7	10.3	27.0	16.3	19.6	16.2
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	0.9	0.5	12.5	13.0	5.4	0.9
Delay (s)	12.6	10.8	39.5	29.3	25.0	17.1
Level of Service	B	B	D	C	C	B
Approach Delay (s)	12.3			29.6	21.8	
Approach LOS	B			C	C	

Intersection Summary			
HCM Average Control Delay	23.0	HCM Level of Service	C
HCM Volume to Capacity ratio	0.68		
Actuated Cycle Length (s)	60.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	68.9%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	20	72	42	240	195	130	95	220	100	80	102	32
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0			4.0	4.0	4.0	4.0		4.0	4.0	
Lane Util. Factor		0.95			0.95	1.00	1.00	0.95		0.91	0.91	
Frpb, ped/bikes		0.99			1.00	0.98	1.00	0.99		1.00	0.99	
Flpb, ped/bikes		1.00			1.00	1.00	1.00	1.00		1.00	1.00	
Frt		0.95			1.00	0.85	1.00	0.95		1.00	0.97	
Flt Protected		0.99			0.97	1.00	0.95	1.00		0.95	1.00	
Satd. Flow (prot)		3189			3299	1500	1703	3216		1550	3126	
Flt Permitted		0.88			0.74	1.00	0.95	1.00		0.95	1.00	
Satd. Flow (perm)		2816			2522	1500	1703	3216		1550	3126	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	22	78	46	261	212	141	103	239	109	87	111	35
RTOR Reduction (vph)	0	30	0	0	0	0	0	72	0	0	29	0
Lane Group Flow (vph)	0	116	0	0	473	141	103	276	0	77	127	0
Confl. Peds. (#/hr)	9		8	8		9	12		17	17		12
Confl. Bikes (#/hr)						3			5			2
Heavy Vehicles (%)	6%	6%	6%	6%	6%	6%	6%	6%	6%	6%	6%	6%
Turn Type	Perm			Perm		Free	Split			Split		
Protected Phases		2			6		3	3		4	4	
Permitted Phases	2			6		Free						
Actuated Green, G (s)		16.4			15.4	47.5	10.8	10.8		7.3	7.3	
Effective Green, g (s)		16.4			16.4	47.5	10.8	10.8		8.3	8.3	
Actuated g/C Ratio		0.35			0.35	1.00	0.23	0.23		0.17	0.17	
Clearance Time (s)		4.0			5.0		4.0	4.0		5.0	5.0	
Vehicle Extension (s)		3.0			3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)		972			871	1500	387	731		271	546	
v/s Ratio Prot							0.06	c0.09		c0.05	0.04	
v/s Ratio Perm		0.04			c0.19	0.09						
v/c Ratio		0.12			0.54	0.09	0.27	0.38		0.28	0.23	
Uniform Delay, d1		10.6			12.5	0.0	15.1	15.5		17.0	16.9	
Progression Factor		1.00			1.00	1.00	1.00	1.00		1.00	1.00	
Incremental Delay, d2		0.1			0.7	0.1	0.4	0.3		0.6	0.2	
Delay (s)		10.7			13.2	0.1	15.5	15.8		17.6	17.1	
Level of Service		B			B	A	B	B		B	B	
Approach Delay (s)		10.7			10.2			15.8			17.3	
Approach LOS		B			B			B			B	

Intersection Summary			
HCM Average Control Delay	13.1	HCM Level of Service	B
HCM Volume to Capacity ratio	0.43		
Actuated Cycle Length (s)	47.5	Sum of lost time (s)	12.0
Intersection Capacity Utilization	50.5%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	20	211	20	200	505	70	30	100	270	40	90	30
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0			4.0			4.0	
Lane Util. Factor	1.00	0.95		1.00	0.95			1.00			1.00	
Frpb, ped/bikes	1.00	1.00		1.00	0.99			0.97			1.00	
Flpb, ped/bikes	1.00	1.00		1.00	1.00			1.00			1.00	
Frt	1.00	0.99		1.00	0.98			0.91			0.97	
Flt Protected	0.95	1.00		0.95	1.00			1.00			0.99	
Satd. Flow (prot)	1736	3412		1736	3390			1606			1744	
Flt Permitted	0.95	1.00		0.95	1.00			0.97			0.85	
Satd. Flow (perm)	1736	3412		1736	3390			1566			1508	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	22	229	22	217	549	76	33	109	293	43	98	33
RTOR Reduction (vph)	0	12	0	0	18	0	0	124	0	0	14	0
Lane Group Flow (vph)	22	239	0	217	607	0	0	311	0	0	160	0
Confl. Peds. (#/hr)	11		13	13		11	22		48	48		22
Confl. Bikes (#/hr)			1			2			1			
Heavy Vehicles (%)	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%
Turn Type	Prot			Prot			Perm			Perm		
Protected Phases	7	4		3	8			2			6	
Permitted Phases							2			6		
Actuated Green, G (s)	6.0	16.0		6.0	16.0			26.0			26.0	
Effective Green, g (s)	6.0	16.0		6.0	16.0			26.0			26.0	
Actuated g/C Ratio	0.10	0.27		0.10	0.27			0.43			0.43	
Clearance Time (s)	4.0	4.0		4.0	4.0			4.0			4.0	
Lane Grp Cap (vph)	174	910		174	904			679			653	
v/s Ratio Prot	0.01	0.07		c0.13	c0.18							
v/s Ratio Perm								c0.20			0.11	
v/c Ratio	0.13	0.26		1.25	0.67			0.46			0.24	
Uniform Delay, d1	24.6	17.3		27.0	19.6			12.0			10.8	
Progression Factor	1.00	1.00		1.00	1.00			1.00			1.00	
Incremental Delay, d2	1.5	0.7		149.9	4.0			2.2			0.9	
Delay (s)	26.1	18.1		176.9	23.6			14.2			11.7	
Level of Service	C	B		F	C			B			B	
Approach Delay (s)		18.7			63.1			14.2			11.7	
Approach LOS		B			E			B			B	

Intersection Summary			
HCM Average Control Delay	38.6	HCM Level of Service	D
HCM Volume to Capacity ratio	0.63		
Actuated Cycle Length (s)	60.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	62.2%	ICU Level of Service	B
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	367	345	130	60	501	90	160	940	100	170	610	474
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width	10	11	12	11	11	12	12	12	12	12	12	12
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0		4.0	4.0		4.0	4.0	4.0
Lane Util. Factor	0.97	0.95	1.00	1.00	0.95		1.00	0.95		1.00	0.95	1.00
Frpb, ped/bikes	1.00	1.00	0.97	1.00	0.98		1.00	1.00		1.00	1.00	1.00
Flpb, ped/bikes	1.00	1.00	1.00	1.00	1.00		1.00	1.00		1.00	1.00	1.00
Frt	1.00	1.00	0.85	1.00	0.98		1.00	0.99		1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00		0.95	1.00		0.95	1.00	1.00
Satd. Flow (prot)	2828	3020	1353	1510	2897		1562	3064		1562	3124	1353
Flt Permitted	0.95	1.00	1.00	0.95	1.00		0.95	1.00		0.95	1.00	1.00
Satd. Flow (perm)	2828	3020	1353	1510	2897		1562	3064		1562	3124	1353
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	399	375	141	65	545	98	174	1022	109	185	663	515
RTOR Reduction (vph)	0	0	87	0	12	0	0	7	0	0	0	37
Lane Group Flow (vph)	399	375	54	65	631	0	174	1124	0	185	663	478
Confl. Peds. (#/hr)			16			85			25			37
Confl. Bikes (#/hr)						1			1			1
Heavy Vehicles (%)	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%
Bus Blockages (#/hr)	0	0	0	0	0	2	0	0	0	0	0	8
Turn Type	Prot		Perm	Prot			Prot			Prot		pt+ov
Protected Phases	7	4		3	8		5	2		1	6	6 7
Permitted Phases			4									
Actuated Green, G (s)	18.0	38.2	38.2	8.2	28.4		18.0	44.0		13.0	39.0	62.0
Effective Green, g (s)	18.0	38.2	38.2	8.2	28.4		18.0	45.0		13.0	40.0	63.0
Actuated g/C Ratio	0.15	0.32	0.32	0.07	0.24		0.15	0.37		0.11	0.33	0.52
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0		4.0	5.0		4.0	5.0	
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	423	958	429	103	683		234	1145		169	1038	708
v/s Ratio Prot	c0.14	0.12		0.04	c0.22		c0.11	c0.37		c0.12	0.21	0.35
v/s Ratio Perm			0.04									
v/c Ratio	0.94	0.39	0.13	0.63	0.92		0.74	0.98		1.09	0.64	0.68
Uniform Delay, d1	50.7	32.0	29.2	54.6	44.9		49.0	37.3		53.7	34.1	21.2
Progression Factor	1.00	1.00	1.00	1.00	1.00		1.00	1.00		1.00	1.00	1.00
Incremental Delay, d2	29.6	0.3	0.1	11.9	18.2		12.0	22.1		96.8	1.3	2.6
Delay (s)	80.3	32.3	29.4	66.6	63.1		61.0	59.4		150.5	35.4	23.7
Level of Service	F	C	C	E	E		E	E		F	D	C
Approach Delay (s)		52.8			63.4			59.7			46.6	
Approach LOS		D			E			E			D	

Intersection Summary			
HCM Average Control Delay	54.7	HCM Level of Service	D
HCM Volume to Capacity ratio	0.94		
Actuated Cycle Length (s)	120.4	Sum of lost time (s)	12.0
Intersection Capacity Utilization	91.2%	ICU Level of Service	F
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	100	323	132	60	296	120	185	830	60	120	510	140
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.9	4.9		4.9	4.9		4.3	4.8	4.8	4.3	4.8	4.8
Lane Util. Factor	1.00	0.95		1.00	0.95		0.97	0.95	1.00	0.97	0.95	1.00
Frpb, ped/bikes	1.00	0.99		1.00	0.99		1.00	1.00	0.98	1.00	1.00	0.98
Flpb, ped/bikes	1.00	1.00		1.00	1.00		1.00	1.00	1.00	1.00	1.00	1.00
Frt	1.00	0.96		1.00	0.96		1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	1770	3368		1770	3362		3433	3539	1557	3433	3539	1548
Flt Permitted	0.95	1.00		0.95	1.00		0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)	1770	3368		1770	3362		3433	3539	1557	3433	3539	1548
Peak-hour factor, PHF	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93
Adj. Flow (vph)	108	347	142	65	318	129	199	892	65	129	548	151
RTOR Reduction (vph)	0	45	0	0	45	0	0	0	44	0	0	44
Lane Group Flow (vph)	108	444	0	65	402	0	199	892	21	129	548	107
Confl. Peds. (#/hr)			7			13			6			11
Confl. Bikes (#/hr)						2						
Turn Type	Split			Split			Prot		Perm	Prot		Perm
Protected Phases	4	4		8	8		5	2		1	6	
Permitted Phases									2			6
Actuated Green, G (s)	15.9	15.9		15.2	15.2		7.3	24.8	24.8	4.2	21.7	21.7
Effective Green, g (s)	15.0	15.0		14.3	14.3		7.0	25.0	25.0	3.9	21.9	21.9
Actuated g/C Ratio	0.19	0.19		0.19	0.19		0.09	0.32	0.32	0.05	0.28	0.28
Clearance Time (s)	4.0	4.0		4.0	4.0		4.0	5.0	5.0	4.0	5.0	5.0
Vehicle Extension (s)	2.0	2.0		2.0	2.0		2.0	2.0	2.0	2.0	2.0	2.0
Lane Grp Cap (vph)	344	655		328	624		312	1148	505	174	1005	440
v/s Ratio Prot	0.06	c0.13		0.04	c0.12		c0.06	c0.25		0.04	0.15	
v/s Ratio Perm									0.01			0.07
v/c Ratio	0.31	0.68		0.20	0.64		0.64	0.78	0.04	0.74	0.55	0.24
Uniform Delay, d1	26.6	28.8		26.6	29.0		33.8	23.5	17.8	36.1	23.4	21.2
Progression Factor	1.00	1.00		1.00	1.00		1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	0.2	2.2		0.1	1.7		3.1	3.1	0.0	13.8	0.3	0.1
Delay (s)	26.8	31.0		26.7	30.8		37.0	26.6	17.9	49.9	23.7	21.3
Level of Service	C	C		C	C		D	C	B	D	C	C
Approach Delay (s)		30.2			30.2			27.9			27.4	
Approach LOS		C			C			C			C	

Intersection Summary			
HCM Average Control Delay	28.6	HCM Level of Service	C
HCM Volume to Capacity ratio	0.73		
Actuated Cycle Length (s)	77.1	Sum of lost time (s)	18.9
Intersection Capacity Utilization	64.3%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	30	22	22	90	45	130	25	285	50	60	272	82
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0			4.0	4.0	4.0	4.0		4.0	4.0	
Lane Util. Factor		1.00			1.00	1.00	1.00	1.00		1.00	1.00	
Frpb, ped/bikes		0.99			1.00	0.98	1.00	0.99		1.00	0.99	
Flpb, ped/bikes		1.00			1.00	1.00	1.00	1.00		1.00	1.00	
Frt		0.96			1.00	0.85	1.00	0.98		1.00	0.97	
Flt Protected		0.98			0.97	1.00	0.95	1.00		0.95	1.00	
Satd. Flow (prot)		1741			1803	1555	1770	1806		1770	1781	
Flt Permitted		0.98			0.97	1.00	0.95	1.00		0.95	1.00	
Satd. Flow (perm)		1741			1803	1555	1770	1806		1770	1781	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	33	24	24	98	49	141	27	310	54	65	296	89
RTOR Reduction (vph)	0	18	0	0	0	121	0	7	0	0	12	0
Lane Group Flow (vph)	0	63	0	0	147	20	27	357	0	65	373	0
Confl. Peds. (#/hr)	2		1	1		2	13		20	20		13
Confl. Bikes (#/hr)						1			5			
Turn Type	Split			Split		Perm	Split			Split		
Protected Phases	2	2		1	1		4	4		3	3	
Permitted Phases						1						
Actuated Green, G (s)		7.4			10.4	10.4	19.6	19.6		20.6	20.6	
Effective Green, g (s)		7.4			10.4	10.4	19.6	19.6		20.6	20.6	
Actuated g/C Ratio		0.10			0.14	0.14	0.26	0.26		0.28	0.28	
Clearance Time (s)		4.0			4.0	4.0	4.0	4.0		4.0	4.0	
Vehicle Extension (s)		3.0			3.0	3.0	3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)		174			253	219	469	478		493	496	
v/s Ratio Prot		c0.04			c0.08		0.02	c0.20		0.04	c0.21	
v/s Ratio Perm						0.01						
v/c Ratio		0.36			0.58	0.09	0.06	0.75		0.13	0.75	
Uniform Delay, d1		31.1			29.8	27.7	20.3	24.9		20.0	24.4	
Progression Factor		1.00			1.00	1.00	1.00	1.00		1.00	1.00	
Incremental Delay, d2		1.3			3.4	0.2	0.1	6.3		0.1	6.4	
Delay (s)		32.4			33.1	27.9	20.4	31.2		20.1	30.8	
Level of Service		C			C	C	C	C		C	C	
Approach Delay (s)		32.4			30.6			30.5			29.2	
Approach LOS		C			C			C			C	

Intersection Summary			
HCM Average Control Delay	30.2	HCM Level of Service	C
HCM Volume to Capacity ratio	0.67		
Actuated Cycle Length (s)	74.0	Sum of lost time (s)	16.0
Intersection Capacity Utilization	45.0%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	280	252	60	60	335	70	70	650	30	60	410	100
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0			4.0			4.0	
Lane Util. Factor	1.00	0.95		1.00	0.95			0.95			0.95	
Frpb, ped/bikes	1.00	0.99		1.00	0.99			1.00			0.99	
Flpb, ped/bikes	0.98	1.00		0.99	1.00			1.00			1.00	
Frt	1.00	0.97		1.00	0.97			0.99			0.97	
Flt Protected	0.95	1.00		0.95	1.00			1.00			0.99	
Satd. Flow (prot)	1544	3048		1562	3045			3113			3034	
Flt Permitted	0.47	1.00		0.54	1.00			0.84			0.81	
Satd. Flow (perm)	759	3048		892	3045			2629			2466	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	304	274	65	65	364	76	76	707	33	65	446	109
RTOR Reduction (vph)	0	30	0	0	26	0	0	4	0	0	27	0
Lane Group Flow (vph)	304	309	0	65	414	0	0	812	0	0	593	0
Confl. Peds. (#/hr)	56		22	22		56	31		42	42		31
Confl. Bikes (#/hr)						2			5			1
Heavy Vehicles (%)	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%
Turn Type	Perm			Perm			Perm			Perm		
Protected Phases		4			4			2			2	
Permitted Phases	4			4			2			2		
Actuated Green, G (s)	30.0	30.0		30.0	30.0			32.0			32.0	
Effective Green, g (s)	29.0	29.0		29.0	29.0			31.0			31.0	
Actuated g/C Ratio	0.43	0.43		0.43	0.43			0.46			0.46	
Clearance Time (s)	3.0	3.0		3.0	3.0			3.0			3.0	
Lane Grp Cap (vph)	324	1300		380	1299			1199			1124	
v/s Ratio Prot		0.10			0.14							
v/s Ratio Perm	c0.40			0.07				c0.31			0.24	
v/c Ratio	0.94	0.24		0.17	0.32			0.68			0.53	
Uniform Delay, d1	18.6	12.4		12.1	12.9			14.6			13.3	
Progression Factor	1.00	1.00		1.00	1.00			1.00			1.00	
Incremental Delay, d2	36.5	0.4		1.0	0.6			3.1			1.8	
Delay (s)	55.1	12.9		13.0	13.6			17.6			15.0	
Level of Service	E	B		B	B			B			B	
Approach Delay (s)		32.9			13.5			17.6			15.0	
Approach LOS		C			B			B			B	

Intersection Summary			
HCM Average Control Delay	20.0	HCM Level of Service	B
HCM Volume to Capacity ratio	0.80		
Actuated Cycle Length (s)	68.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	103.1%	ICU Level of Service	G
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	20	262	40	20	365	315	40	580	20	272	390	30
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0			5.0			5.0		5.0	5.0	
Lane Util. Factor		0.95			0.95			0.95		0.97	1.00	
Frpb, ped/bikes		1.00			0.99			1.00		1.00	1.00	
Flpb, ped/bikes		1.00			1.00			1.00		1.00	1.00	
Frt		0.98			0.93			1.00		1.00	0.99	
Flt Protected		1.00			1.00			1.00		0.95	1.00	
Satd. Flow (prot)		3481			3304			3542		3467	1858	
Flt Permitted		0.81			0.94			1.00		0.95	1.00	
Satd. Flow (perm)		2812			3100			3542		3467	1858	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	22	285	43	22	397	342	43	630	22	296	424	33
RTOR Reduction (vph)	0	14	0	0	188	0	0	3	0	0	4	0
Lane Group Flow (vph)	0	336	0	0	573	0	0	692	0	296	453	0
Confl. Peds. (#/hr)	2		11	11		2	14		25	25		14
Confl. Bikes (#/hr)			1			2						
Heavy Vehicles (%)	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%
Turn Type	Perm			Perm			Split			Split		
Protected Phases		4			4		2	2		3	3	
Permitted Phases	4			4								
Actuated Green, G (s)		18.9			18.9			18.0		22.1	22.1	
Effective Green, g (s)		17.9			17.9			17.0		21.1	21.1	
Actuated g/C Ratio		0.25			0.25			0.24		0.30	0.30	
Clearance Time (s)		4.0			4.0			4.0		4.0	4.0	
Vehicle Extension (s)		3.0			3.0			3.0		3.0	3.0	
Lane Grp Cap (vph)		709			782			848		1030	552	
v/s Ratio Prot								c0.20		0.09	c0.24	
v/s Ratio Perm		0.12			c0.18							
v/c Ratio		0.47			0.73			0.82		0.29	0.82	
Uniform Delay, d1		22.5			24.4			25.5		19.2	23.2	
Progression Factor		1.00			1.00			1.00		1.00	1.00	
Incremental Delay, d2		0.5			3.6			6.1		0.2	9.6	
Delay (s)		23.1			27.9			31.6		19.3	32.8	
Level of Service		C			C			C		B	C	
Approach Delay (s)		23.1			27.9			31.6			27.5	
Approach LOS		C			C			C			C	

Intersection Summary			
HCM Average Control Delay	28.1	HCM Level of Service	C
HCM Volume to Capacity ratio	0.79		
Actuated Cycle Length (s)	71.0	Sum of lost time (s)	15.0
Intersection Capacity Utilization	88.6%	ICU Level of Service	E
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	20	304	381	20	474	160	445	340	30	90	280	30
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0	4.0		4.0		4.0	4.0			4.0	
Lane Util. Factor		0.91	0.91		0.95		1.00	1.00			1.00	
Frpb, ped/bikes		0.99	0.96		0.99		1.00	1.00			1.00	
Flpb, ped/bikes		1.00	1.00		1.00		1.00	1.00			1.00	
Frt		0.95	0.85		0.96		1.00	0.99			0.99	
Flt Protected		1.00	1.00		1.00		0.95	1.00			0.99	
Satd. Flow (prot)		2957	1385		3139		1770	1578			1564	
Flt Permitted		0.80	1.00		0.92		0.95	1.00			0.99	
Satd. Flow (perm)		2376	1385		2900		1770	1578			1564	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	22	330	414	22	515	174	484	370	33	98	304	33
RTOR Reduction (vph)	0	61	188	0	38	0	0	4	0	0	3	0
Lane Group Flow (vph)	0	457	60	0	673	0	484	399	0	0	432	0
Confl. Peds. (#/hr)	16		21	21		16	20		16	16		20
Confl. Bikes (#/hr)			1			2			1			
Parking (#/hr)		8			8			8			8	
Turn Type	Perm		Perm	Perm			Split			Split		
Protected Phases		2			2		4	4		8	8	
Permitted Phases	2		2	2								
Actuated Green, G (s)		20.0	20.0		20.0		25.0	25.0			26.0	
Effective Green, g (s)		20.0	20.0		20.0		25.0	25.0			26.0	
Actuated g/C Ratio		0.24	0.24		0.24		0.30	0.30			0.31	
Clearance Time (s)		4.0	4.0		4.0		4.0	4.0			4.0	
Lane Grp Cap (vph)		573	334		699		533	475			490	
v/s Ratio Prot							c0.27	0.25			c0.28	
v/s Ratio Perm		0.19	0.04		c0.23							
v/c Ratio		0.80	0.18		0.96		0.91	0.84			0.88	
Uniform Delay, d1		29.6	25.0		31.1		27.9	27.1			27.0	
Progression Factor		1.00	1.00		1.00		1.00	1.00			1.00	
Incremental Delay, d2		11.1	1.2		26.1		21.8	16.2			19.8	
Delay (s)		40.7	26.2		57.2		49.7	43.3			46.8	
Level of Service		D	C		E		D	D			D	
Approach Delay (s)		36.0			57.2			46.8			46.8	
Approach LOS		D			E			D			D	

Intersection Summary			
HCM Average Control Delay	46.5	HCM Level of Service	D
HCM Volume to Capacity ratio	0.91		
Actuated Cycle Length (s)	83.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	89.9%	ICU Level of Service	E
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL2	EBL	EBT	EBR	NBT	NBR	NBR2	SBL2	SBL	SBT
Lane Configurations										
Volume (vph)	140	871	170	140	380	272	90	435	170	400
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0	4.0	4.5	4.0	4.0		4.0	4.0	4.0
Lane Util. Factor		0.91	0.91	1.00	0.95	1.00		1.00	1.00	1.00
Frpb, ped/bikes		1.00	1.00	0.87	1.00	0.93		1.00	1.00	1.00
Flpb, ped/bikes		1.00	1.00	1.00	1.00	1.00		1.00	1.00	1.00
Frt		1.00	1.00	0.85	1.00	0.85		1.00	1.00	1.00
Flt Protected		0.95	0.96	1.00	1.00	1.00		0.95	0.95	1.00
Satd. Flow (prot)		1610	3268	1370	3539	1480		1770	1770	1863
Flt Permitted		0.95	0.96	1.00	1.00	1.00		0.95	0.95	1.00
Satd. Flow (perm)		1610	3268	1370	3539	1480		1770	1770	1863
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	147	917	179	147	400	286	95	458	179	421
RTOR Reduction (vph)	0	0	0	108	0	17	0	0	0	0
Lane Group Flow (vph)	0	532	711	39	400	364	0	458	179	421
Confl. Peds. (#/hr)				50			50		50	
Confl. Bikes (#/hr)				10			10			
Turn Type	Perm	Perm		Perm		Perm		Prot	Prot	
Protected Phases			4		2			1	1	6
Permitted Phases	4	4		4		2				
Actuated Green, G (s)		19.0	19.0	19.0	21.4	21.4		21.1	21.1	46.0
Effective Green, g (s)		20.5	20.5	20.0	20.9	20.9		21.6	21.6	46.5
Actuated g/C Ratio		0.27	0.27	0.27	0.28	0.28		0.29	0.29	0.62
Clearance Time (s)		5.5	5.5	5.5	3.5	3.5		4.5	4.5	4.5
Vehicle Extension (s)		2.0	2.0	2.0	2.0	2.0		2.0	2.0	2.0
Lane Grp Cap (vph)		440	893	365	986	412		510	510	1155
v/s Ratio Prot					0.11			c0.26	0.10	0.23
v/s Ratio Perm		c0.33	0.22	0.03		c0.25				
v/c Ratio		1.21	1.16dl	0.11	0.41	0.88		0.90	0.35	0.36
Uniform Delay, d1		27.2	25.3	20.8	22.0	25.9		25.6	21.1	7.0
Progression Factor		1.00	1.00	1.00	1.00	1.00		1.00	1.00	1.00
Incremental Delay, d2		113.7	4.6	0.0	0.1	19.2		21.2	1.9	0.9
Delay (s)		140.9	30.0	20.8	22.1	45.1		46.9	23.0	7.9
Level of Service		F	C	C	C	D		D	C	A
Approach Delay (s)			71.5		33.3					27.3
Approach LOS			E		C					C

Intersection Summary			
HCM Average Control Delay	47.8	HCM Level of Service	D
HCM Volume to Capacity ratio	0.99		
Actuated Cycle Length (s)	75.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	80.6%	ICU Level of Service	D
Analysis Period (min)	15		

dl Defacto Left Lane. Recode with 1 though lane as a left lane.
c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	0	0	583	1431	0	0	0	0	0	647	570
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)				4.0	4.0						4.0	4.0
Lane Util. Factor				0.86	0.86						0.86	0.86
Frpb, ped/bikes				1.00	1.00						0.99	1.00
Flpb, ped/bikes				1.00	1.00						1.00	1.00
Frt				1.00	1.00						0.95	0.85
Flt Protected				0.95	1.00						1.00	1.00
Satd. Flow (prot)				1522	4790						4561	1362
Flt Permitted				0.95	1.00						1.00	1.00
Satd. Flow (perm)				1522	4790						4561	1362
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	0	0	0	614	1506	0	0	0	0	0	681	600
RTOR Reduction (vph)	0	0	0	332	9	0	0	0	0	0	16	16
Lane Group Flow (vph)	0	0	0	178	1601	0	0	0	0	0	965	284
Confl. Bikes (#/hr)						9						10
Turn Type				Prot								Prot
Protected Phases				7	3						2	2
Permitted Phases												
Actuated Green, G (s)				20.0	40.0						31.0	31.0
Effective Green, g (s)				20.0	40.0						31.0	31.0
Actuated g/C Ratio				0.25	0.51						0.39	0.39
Clearance Time (s)				4.0	4.0						4.0	4.0
Lane Grp Cap (vph)				385	2425						1790	534
v/s Ratio Prot				0.12	c0.17						c0.21	0.21
v/s Ratio Perm					0.17							
v/c Ratio				0.46	0.66						0.54	0.53
Uniform Delay, d1				25.0	14.5						18.5	18.4
Progression Factor				1.00	1.00						1.00	1.00
Incremental Delay, d2				4.0	1.4						1.2	3.8
Delay (s)				28.9	15.9						19.7	22.2
Level of Service				C	B						B	C
Approach Delay (s)		0.0			19.0			0.0			20.3	
Approach LOS		A			B			A			C	

Intersection Summary			
HCM Average Control Delay	19.5	HCM Level of Service	B
HCM Volume to Capacity ratio	0.61		
Actuated Cycle Length (s)	79.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	59.8%	ICU Level of Service	B
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	300	470	0	0	0	0	0	1262	1945	0	0	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0						4.0	4.0			
Lane Util. Factor		0.91						0.91	0.88			
Frpb, ped/bikes		1.00						1.00	1.00			
Flpb, ped/bikes		1.00						1.00	1.00			
Frt		1.00						1.00	0.85			
Flt Protected		0.98						1.00	1.00			
Satd. Flow (prot)		4973						5085	2787			
Flt Permitted		0.98						1.00	1.00			
Satd. Flow (perm)		4973						5085	2787			
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	316	495	0	0	0	0	0	1328	2047	0	0	0
RTOR Reduction (vph)	0	4	0	0	0	0	0	0	242	0	0	0
Lane Group Flow (vph)	0	807	0	0	0	0	0	1328	1805	0	0	0
Confl. Peds. (#/hr)	12		21	21		12	42		29	29		42
Confl. Bikes (#/hr)			2			1						1
Turn Type	Perm								custom			
Protected Phases		4						2	2			
Permitted Phases	4								7			
Actuated Green, G (s)		27.0						23.0	23.0			
Effective Green, g (s)		27.0						24.0	24.0			
Actuated g/C Ratio		0.45						0.40	0.40			
Clearance Time (s)		5.0						5.0	5.0			
Vehicle Extension (s)		3.0						3.0	3.0			
Lane Grp Cap (vph)		2238						2034	1115			
v/s Ratio Prot								0.26	c0.65			
v/s Ratio Perm		0.16										
v/c Ratio		0.36						0.65	1.62			
Uniform Delay, d1		10.8						14.6	18.0			
Progression Factor		1.00						1.00	1.00			
Incremental Delay, d2		0.5						0.8	282.5			
Delay (s)		11.3						15.4	300.5			
Level of Service		B						B	F			
Approach Delay (s)		11.3			0.0			188.3			0.0	
Approach LOS		B			A			F			A	

Intersection Summary			
HCM Average Control Delay	154.0	HCM Level of Service	F
HCM Volume to Capacity ratio	0.95		
Actuated Cycle Length (s)	60.0	Sum of lost time (s)	9.0
Intersection Capacity Utilization	100.7%	ICU Level of Service	G
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	70	833	1512	0	0	0	0	290	110	110	350	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0	4.0					4.0			4.0	
Lane Util. Factor		0.86	0.86					1.00			1.00	
Frpb, ped/bikes		0.96	0.97					0.98			1.00	
Flpb, ped/bikes		1.00	1.00					1.00			0.99	
Frt		0.93	0.85					0.96			1.00	
Flt Protected		1.00	1.00					1.00			0.99	
Satd. Flow (prot)		4269	1315					1749			1826	
Flt Permitted		1.00	1.00					1.00			0.45	
Satd. Flow (perm)		4269	1315					1749			834	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	74	877	1592	0	0	0	0	305	116	116	368	0
RTOR Reduction (vph)	0	73	0	0	0	0	0	23	0	0	0	0
Lane Group Flow (vph)	0	1674	796	0	0	0	0	398	0	0	484	0
Confl. Peds. (#/hr)	51		75	75		51	29		79	79		29
Confl. Bikes (#/hr)											1	1
Turn Type	Perm		Free							Perm		
Protected Phases		2						4			8	
Permitted Phases	2		Free							8		
Actuated Green, G (s)		33.0	60.0					18.0			18.0	
Effective Green, g (s)		34.0	60.0					18.0			18.0	
Actuated g/C Ratio		0.57	1.00					0.30			0.30	
Clearance Time (s)		5.0						4.0			4.0	
Vehicle Extension (s)		2.0						2.0			2.0	
Lane Grp Cap (vph)		2419	1315					525			250	
v/s Ratio Prot								0.23				
v/s Ratio Perm		0.39	0.61								c0.58	
v/c Ratio		0.90dr	0.61					0.76			1.94	
Uniform Delay, d1		9.3	0.0					19.0			21.0	
Progression Factor		0.72	1.00					1.00			1.00	
Incremental Delay, d2		0.2	0.2					5.5			435.6	
Delay (s)		6.8	0.2					24.5			456.6	
Level of Service		A	A					C			F	
Approach Delay (s)		4.7			0.0			24.5			456.6	
Approach LOS		A			A			C			F	

Intersection Summary			
HCM Average Control Delay	70.6	HCM Level of Service	E
HCM Volume to Capacity ratio	1.12		
Actuated Cycle Length (s)	60.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	90.8%	ICU Level of Service	E
Analysis Period (min)	15		

dr Defacto Right Lane. Recode with 1 though lane as a right lane.
c Critical Lane Group

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Volume (vph)	690	130	90	1038	1305	850
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	0.97	1.00	1.00	0.95	0.91	0.88
Frpb, ped/bikes	1.00	0.98	1.00	1.00	1.00	1.00
Flpb, ped/bikes	1.00	1.00	1.00	1.00	1.00	1.00
Frt	1.00	0.85	1.00	1.00	1.00	0.85
Flt Protected	0.95	1.00	0.95	1.00	1.00	1.00
Satd. Flow (prot)	3433	1550	1770	3539	5085	2787
Flt Permitted	0.95	1.00	0.95	1.00	1.00	1.00
Satd. Flow (perm)	3433	1550	1770	3539	5085	2787
Peak-hour factor, PHF	0.94	0.94	0.94	0.94	0.94	0.94
Adj. Flow (vph)	734	138	96	1104	1388	904
RTOR Reduction (vph)	0	0	0	0	0	633
Lane Group Flow (vph)	734	138	96	1104	1388	271
Confl. Peds. (#/hr)	2	16	2			2
Turn Type		Perm	Prot			Prot
Protected Phases	4		5	2	6	6
Permitted Phases		4				
Actuated Green, G (s)	26.0	26.0	4.0	26.0	18.0	18.0
Effective Green, g (s)	26.0	26.0	4.0	26.0	18.0	18.0
Actuated g/C Ratio	0.43	0.43	0.07	0.43	0.30	0.30
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Lane Grp Cap (vph)	1488	672	118	1534	1526	836
v/s Ratio Prot	c0.21		0.05	c0.31	c0.27	0.10
v/s Ratio Perm		0.09				
v/c Ratio	0.49	0.21	0.81	0.72	0.91	0.32
Uniform Delay, d1	12.3	10.6	27.6	14.0	20.2	16.3
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	1.2	0.7	43.7	2.9	9.6	1.0
Delay (s)	13.4	11.3	71.4	16.9	29.8	17.3
Level of Service	B	B	E	B	C	B
Approach Delay (s)	13.1			21.3	24.9	
Approach LOS	B			C	C	

Intersection Summary			
HCM Average Control Delay	21.5	HCM Level of Service	C
HCM Volume to Capacity ratio	0.69		
Actuated Cycle Length (s)	60.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	66.0%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	32	251	84	89	121	90	72	122	127	110	180	20
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0			4.0	4.0	4.0	4.0		4.0	4.0	
Lane Util. Factor		0.95			0.95	1.00	1.00	0.95		0.91	0.91	
Frpb, ped/bikes		0.99			1.00	0.99	1.00	0.99		1.00	1.00	
Flpb, ped/bikes		1.00			1.00	1.00	1.00	1.00		1.00	1.00	
Frt		0.97			1.00	0.85	1.00	0.92		1.00	0.99	
Flt Protected		1.00			0.98	1.00	0.95	1.00		0.95	1.00	
Satd. Flow (prot)		3382			3462	1563	1770	3247		1610	3328	
Flt Permitted		0.91			0.70	1.00	0.95	1.00		0.95	1.00	
Satd. Flow (perm)		3101			2461	1563	1770	3247		1610	3328	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	35	273	91	97	132	98	78	133	138	120	196	22
RTOR Reduction (vph)	0	38	0	0	0	0	0	110	0	0	10	0
Lane Group Flow (vph)	0	361	0	0	229	98	78	161	0	108	220	0
Confl. Peds. (#/hr)	2		4	4		2	4		2	2		4
Confl. Bikes (#/hr)			2			1						2
Turn Type	Perm			Perm		Free	Split			Split		
Protected Phases		2			6		3	3		4	4	
Permitted Phases	2			6		Free						
Actuated Green, G (s)		11.5			10.5	42.9	8.8	8.8		9.6	9.6	
Effective Green, g (s)		11.5			11.5	42.9	8.8	8.8		10.6	10.6	
Actuated g/C Ratio		0.27			0.27	1.00	0.21	0.21		0.25	0.25	
Clearance Time (s)		4.0			5.0		4.0	4.0		5.0	5.0	
Vehicle Extension (s)		3.0			3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)		831			660	1563	363	666		398	822	
v/s Ratio Prot							0.04	c0.05		c0.07	0.07	
v/s Ratio Perm		c0.12			0.09	0.06						
v/c Ratio		0.43			0.35	0.06	0.21	0.24		0.27	0.27	
Uniform Delay, d1		13.0			12.7	0.0	14.2	14.3		13.0	13.0	
Progression Factor		1.00			1.00	1.00	1.00	1.00		1.00	1.00	
Incremental Delay, d2		0.4			0.3	0.1	0.3	0.2		0.4	0.2	
Delay (s)		13.4			13.0	0.1	14.5	14.5		13.4	13.2	
Level of Service		B			B	A	B	B		B	B	
Approach Delay (s)		13.4			9.1			14.5			13.3	
Approach LOS		B			A			B			B	

Intersection Summary			
HCM Average Control Delay	12.6	HCM Level of Service	B
HCM Volume to Capacity ratio	0.32		
Actuated Cycle Length (s)	42.9	Sum of lost time (s)	12.0
Intersection Capacity Utilization	46.4%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	20	447	20	210	270	50	20	50	170	40	50	20
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0			4.0			4.0	
Lane Util. Factor	1.00	0.95		1.00	0.95			1.00			1.00	
Frpb, ped/bikes	1.00	1.00		1.00	1.00			0.98			1.00	
Flpb, ped/bikes	1.00	1.00		1.00	1.00			1.00			1.00	
Frt	1.00	0.99		1.00	0.98			0.90			0.98	
Flt Protected	0.95	1.00		0.95	1.00			1.00			0.98	
Satd. Flow (prot)	1787	3551		1787	3474			1661			1791	
Flt Permitted	0.95	1.00		0.95	1.00			0.98			0.85	
Satd. Flow (perm)	1787	3551		1787	3474			1629			1553	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	22	486	22	228	293	54	22	54	185	43	54	22
RTOR Reduction (vph)	0	5	0	0	25	0	0	105	0	0	12	0
Lane Group Flow (vph)	22	503	0	228	322	0	0	156	0	0	107	0
Confl. Peds. (#/hr)	4					4	1		24	24		1
Confl. Bikes (#/hr)						2			1			
Heavy Vehicles (%)	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%
Turn Type	Prot			Prot			Perm			Perm		
Protected Phases	7	4		3	8			2			6	
Permitted Phases							2			6		
Actuated Green, G (s)	6.0	16.0		6.0	16.0			26.0			26.0	
Effective Green, g (s)	6.0	16.0		6.0	16.0			26.0			26.0	
Actuated g/C Ratio	0.10	0.27		0.10	0.27			0.43			0.43	
Clearance Time (s)	4.0	4.0		4.0	4.0			4.0			4.0	
Lane Grp Cap (vph)	179	947		179	926			706			673	
v/s Ratio Prot	0.01	c0.14		c0.13	0.09							
v/s Ratio Perm								c0.10			0.07	
v/c Ratio	0.12	0.53		1.27	0.35			0.22			0.16	
Uniform Delay, d1	24.6	18.8		27.0	17.8			10.7			10.3	
Progression Factor	1.00	1.00		1.00	1.00			1.00			1.00	
Incremental Delay, d2	1.4	2.1		159.4	1.0			0.7			0.5	
Delay (s)	26.0	20.9		186.4	18.8			11.4			10.8	
Level of Service	C	C		F	B			B			B	
Approach Delay (s)		21.1			85.2			11.4			10.8	
Approach LOS		C			F			B			B	

Intersection Summary			
HCM Average Control Delay	43.4	HCM Level of Service	D
HCM Volume to Capacity ratio	0.46		
Actuated Cycle Length (s)	60.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	58.0%	ICU Level of Service	B
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	448	299	90	140	355	100	110	580	150	150	870	415
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width	10	11	12	11	11	12	12	12	12	12	12	12
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0		4.0	4.0		4.0	4.0	4.0
Lane Util. Factor	0.97	0.95	1.00	1.00	0.95		1.00	0.95		1.00	0.95	1.00
Frpb, ped/bikes	1.00	1.00	0.93	1.00	0.98		1.00	0.99		1.00	1.00	0.90
Flpb, ped/bikes	1.00	1.00	1.00	1.00	1.00		1.00	1.00		1.00	1.00	1.00
Frt	1.00	1.00	0.85	1.00	0.97		1.00	0.97		1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00		0.95	1.00		0.95	1.00	1.00
Satd. Flow (prot)	2884	3079	1326	1540	2921		1593	3047		1593	3185	1237
Flt Permitted	0.95	1.00	1.00	0.95	1.00		0.95	1.00		0.95	1.00	1.00
Satd. Flow (perm)	2884	3079	1326	1540	2921		1593	3047		1593	3185	1237
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	487	325	98	152	386	109	120	630	163	163	946	451
RTOR Reduction (vph)	0	0	75	0	22	0	0	19	0	0	0	294
Lane Group Flow (vph)	487	325	23	152	473	0	120	774	0	163	946	157
Confl. Peds. (#/hr)			47			60			42			75
Confl. Bikes (#/hr)						1						
Bus Blockages (#/hr)	0	0	0	0	0	2	0	0	0	0	0	8
Turn Type	Split		Perm	Split			Prot			Prot		Perm
Protected Phases	4	4		8	8		5	2		1	6	
Permitted Phases			4									6
Actuated Green, G (s)	24.0	24.0	24.0	21.2	21.2		11.1	29.5		12.1	30.5	30.5
Effective Green, g (s)	24.0	24.0	24.0	21.2	21.2		11.1	30.5		12.1	31.5	31.5
Actuated g/C Ratio	0.23	0.23	0.23	0.20	0.20		0.11	0.29		0.12	0.30	0.30
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0		4.0	5.0		4.0	5.0	5.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0		3.0	3.0		3.0	3.0	3.0
Lane Grp Cap (vph)	667	712	307	315	597		170	895		186	967	375
v/s Ratio Prot	c0.17	0.11		0.10	c0.16		0.08	0.25		c0.10	c0.30	
v/s Ratio Perm			0.02									0.13
v/c Ratio	0.73	0.46	0.07	0.48	0.79		0.71	0.86		0.88	0.98	0.42
Uniform Delay, d1	36.9	34.3	31.2	36.5	39.2		44.8	34.7		45.1	35.8	28.8
Progression Factor	1.00	1.00	1.00	1.00	1.00		1.00	1.00		1.00	1.00	1.00
Incremental Delay, d2	4.1	0.5	0.1	1.2	7.1		12.5	8.7		33.8	23.5	0.8
Delay (s)	41.0	34.8	31.3	37.6	46.3		57.3	43.4		78.9	59.3	29.6
Level of Service	D	C	C	D	D		E	D		E	E	C
Approach Delay (s)		37.7			44.3			45.2			52.8	
Approach LOS		D			D			D			D	

Intersection Summary			
HCM Average Control Delay	46.3	HCM Level of Service	D
HCM Volume to Capacity ratio	0.83		
Actuated Cycle Length (s)	103.8	Sum of lost time (s)	12.0
Intersection Capacity Utilization	81.1%	ICU Level of Service	D
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	150	275	134	60	222	140	132	520	50	170	1310	190
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.9	4.9		4.9	4.9		4.3	4.8	4.8	4.3	4.8	4.8
Lane Util. Factor	1.00	0.95		1.00	0.95		0.97	0.95	1.00	0.97	0.95	1.00
Frpb, ped/bikes	1.00	0.99		1.00	0.99		1.00	1.00	0.98	1.00	1.00	0.99
Flpb, ped/bikes	1.00	1.00		1.00	1.00		1.00	1.00	1.00	1.00	1.00	1.00
Frt	1.00	0.95		1.00	0.94		1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	1787	3379		1787	3335		3467	3574	1570	3467	3574	1575
Flt Permitted	0.95	1.00		0.95	1.00		0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)	1787	3379		1787	3335		3467	3574	1570	3467	3574	1575
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	158	289	141	63	234	147	139	547	53	179	1379	200
RTOR Reduction (vph)	0	62	0	0	105	0	0	0	32	0	0	21
Lane Group Flow (vph)	158	368	0	63	276	0	139	547	21	179	1379	179
Confl. Peds. (#/hr)			7			14			8			3
Confl. Bikes (#/hr)						1						
Heavy Vehicles (%)	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%
Turn Type	Split			Split			Prot		Perm	Prot		Perm
Protected Phases	4	4		8	8		5	2		1	6	
Permitted Phases									2			6
Actuated Green, G (s)	14.0	14.0		12.4	12.4		6.8	30.5	30.5	4.1	27.8	27.8
Effective Green, g (s)	13.1	13.1		11.5	11.5		6.5	30.7	30.7	3.8	28.0	28.0
Actuated g/C Ratio	0.17	0.17		0.15	0.15		0.08	0.39	0.39	0.05	0.36	0.36
Clearance Time (s)	4.0	4.0		4.0	4.0		4.0	5.0	5.0	4.0	5.0	5.0
Vehicle Extension (s)	2.0	2.0		2.0	2.0		2.0	2.0	2.0	2.0	2.0	2.0
Lane Grp Cap (vph)	300	567		263	492		289	1407	618	169	1283	565
v/s Ratio Prot	0.09	c0.11		0.04	c0.08		0.04	c0.15		c0.05	c0.39	
v/s Ratio Perm									0.01			0.11
v/c Ratio	0.53	0.65		0.24	0.56		0.48	0.39	0.03	1.06	1.07	0.32
Uniform Delay, d1	29.6	30.3		29.4	30.9		34.1	16.9	14.5	37.1	25.0	18.1
Progression Factor	1.00	1.00		1.00	1.00		1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	0.8	1.9		0.2	0.9		0.5	0.1	0.0	85.8	47.9	0.1
Delay (s)	30.4	32.2		29.6	31.8		34.6	17.0	14.5	122.9	72.9	18.2
Level of Service	C	C		C	C		C	B	B	F	E	B
Approach Delay (s)		31.7			31.5			20.1			71.7	
Approach LOS		C			C			C			E	

Intersection Summary			
HCM Average Control Delay	49.2	HCM Level of Service	D
HCM Volume to Capacity ratio	0.91		
Actuated Cycle Length (s)	78.0	Sum of lost time (s)	23.7
Intersection Capacity Utilization	79.7%	ICU Level of Service	D
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	78	34	34	30	22	40	22	182	40	80	264	29
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0			4.0	4.0	4.0	4.0		4.0	4.0	
Lane Util. Factor		1.00			1.00	1.00	1.00	1.00		1.00	1.00	
Frpb, ped/bikes		0.99			1.00	0.98	1.00	1.00		1.00	1.00	
Flpb, ped/bikes		1.00			1.00	1.00	1.00	1.00		1.00	1.00	
Frt		0.97			1.00	0.85	1.00	0.97		1.00	0.98	
Flt Protected		0.97			0.97	1.00	0.95	1.00		0.95	1.00	
Satd. Flow (prot)		1745			1810	1550	1770	1806		1770	1829	
Flt Permitted		0.97			0.97	1.00	0.95	1.00		0.95	1.00	
Satd. Flow (perm)		1745			1810	1550	1770	1806		1770	1829	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	85	37	37	33	24	43	24	198	43	87	287	32
RTOR Reduction (vph)	0	12	0	0	0	39	0	8	0	0	4	0
Lane Group Flow (vph)	0	147	0	0	57	4	24	233	0	87	315	0
Confl. Peds. (#/hr)	2		6	6		2	8		2	2		8
Confl. Bikes (#/hr)						1						
Turn Type	Split			Split		Perm	Split			Split		
Protected Phases	2	2		1	1		4	4		3	3	
Permitted Phases						1						
Actuated Green, G (s)		8.8			5.9	5.9	15.5	15.5		17.9	17.9	
Effective Green, g (s)		8.8			5.9	5.9	15.5	15.5		17.9	17.9	
Actuated g/C Ratio		0.14			0.09	0.09	0.24	0.24		0.28	0.28	
Clearance Time (s)		4.0			4.0	4.0	4.0	4.0		4.0	4.0	
Vehicle Extension (s)		3.0			3.0	3.0	3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)		240			167	143	428	437		494	511	
v/s Ratio Prot		c0.08			c0.03		0.01	c0.13		0.05	c0.17	
v/s Ratio Perm						0.00						
v/c Ratio		0.61			0.34	0.03	0.06	0.53		0.18	0.62	
Uniform Delay, d1		26.0			27.3	26.5	18.7	21.1		17.5	20.1	
Progression Factor		1.00			1.00	1.00	1.00	1.00		1.00	1.00	
Incremental Delay, d2		4.6			1.2	0.1	0.1	1.2		0.2	2.2	
Delay (s)		30.6			28.5	26.6	18.7	22.4		17.7	22.3	
Level of Service		C			C	C	B	C		B	C	
Approach Delay (s)		30.6			27.7			22.1			21.3	
Approach LOS		C			C			C			C	

Intersection Summary			
HCM Average Control Delay	23.8	HCM Level of Service	C
HCM Volume to Capacity ratio	0.56		
Actuated Cycle Length (s)	64.1	Sum of lost time (s)	16.0
Intersection Capacity Utilization	44.7%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	190	184	50	60	182	50	20	480	40	50	670	120
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0			4.0			4.0	
Lane Util. Factor	1.00	0.95		1.00	0.95			0.95			0.95	
Frpb, ped/bikes	1.00	0.99		1.00	1.00			1.00			0.99	
Flpb, ped/bikes	0.99	1.00		0.99	1.00			1.00			1.00	
Frt	1.00	0.97		1.00	0.97			0.99			0.98	
Flt Protected	0.95	1.00		0.95	1.00			1.00			1.00	
Satd. Flow (prot)	1585	3062		1569	3070			3134			3081	
Flt Permitted	0.60	1.00		0.60	1.00			0.91			0.89	
Satd. Flow (perm)	1003	3062		992	3070			2871			2760	
Peak-hour factor, PHF	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96
Adj. Flow (vph)	198	192	52	62	190	52	21	500	42	52	698	125
RTOR Reduction (vph)	0	30	0	0	30	0	0	9	0	0	20	0
Lane Group Flow (vph)	198	214	0	62	212	0	0	554	0	0	855	0
Confl. Peds. (#/hr)	10		29	29		10	63		34	34		63
Confl. Bikes (#/hr)									1			
Parking (#/hr)							0					
Turn Type	Perm			Perm			Perm			Perm		
Protected Phases		4			4			2			2	
Permitted Phases	4			4			2			2		
Actuated Green, G (s)	30.0	30.0		30.0	30.0			32.0			32.0	
Effective Green, g (s)	29.0	29.0		29.0	29.0			31.0			31.0	
Actuated g/C Ratio	0.43	0.43		0.43	0.43			0.46			0.46	
Clearance Time (s)	3.0	3.0		3.0	3.0			3.0			3.0	
Lane Grp Cap (vph)	428	1306		423	1309			1309			1258	
v/s Ratio Prot		0.07			0.07							
v/s Ratio Perm	c0.20			0.06				0.19			c0.31	
v/c Ratio	0.46	0.16		0.15	0.16			0.42			0.68	
Uniform Delay, d1	13.9	12.0		11.9	12.0			12.5			14.6	
Progression Factor	1.00	1.00		1.00	1.00			1.00			1.00	
Incremental Delay, d2	3.6	0.3		0.7	0.3			1.0			3.0	
Delay (s)	17.5	12.3		12.7	12.3			13.5			17.6	
Level of Service	B	B		B	B			B			B	
Approach Delay (s)		14.6			12.4			13.5			17.6	
Approach LOS		B			B			B			B	

Intersection Summary			
HCM Average Control Delay	15.2	HCM Level of Service	B
HCM Volume to Capacity ratio	0.57		
Actuated Cycle Length (s)	68.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	100.5%	ICU Level of Service	G
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	20	214	40	30	202	152	30	470	50	634	580	40
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0			5.0			5.0		5.0	5.0	
Lane Util. Factor		0.95			0.95			0.95		0.97	1.00	
Frpb, ped/bikes		1.00			0.99			1.00		1.00	1.00	
Flpb, ped/bikes		1.00			1.00			1.00		1.00	1.00	
Frt		0.98			0.94			0.99		1.00	0.99	
Flt Protected		1.00			1.00			1.00		0.95	1.00	
Satd. Flow (prot)		3468			3326			3509		3467	1860	
Flt Permitted		0.90			0.90			1.00		0.95	1.00	
Satd. Flow (perm)		3142			3015			3509		3467	1860	
Peak-hour factor, PHF	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94
Adj. Flow (vph)	21	228	43	32	215	162	32	500	53	674	617	43
RTOR Reduction (vph)	0	20	0	0	133	0	0	9	0	0	2	0
Lane Group Flow (vph)	0	272	0	0	276	0	0	576	0	674	658	0
Confl. Peds. (#/hr)	2		6	6		2	11		10	10		11
Confl. Bikes (#/hr)						2						1
Heavy Vehicles (%)	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%
Turn Type	Perm			Perm			Split			Split		
Protected Phases		4			4		2	2		3	3	
Permitted Phases	4			4								
Actuated Green, G (s)		12.9			12.9			15.8		26.4	26.4	
Effective Green, g (s)		11.9			11.9			14.8		25.4	25.4	
Actuated g/C Ratio		0.18			0.18			0.22		0.38	0.38	
Clearance Time (s)		4.0			4.0			4.0		4.0	4.0	
Vehicle Extension (s)		3.0			3.0			3.0		3.0	3.0	
Lane Grp Cap (vph)		557			535			774		1312	704	
v/s Ratio Prot								c0.16		0.19	c0.35	
v/s Ratio Perm		0.09			c0.09							
v/c Ratio		0.49			0.52			0.74		0.51	0.93	
Uniform Delay, d1		24.9			25.0			24.4		16.1	20.0	
Progression Factor		1.00			1.00			1.00		1.00	1.00	
Incremental Delay, d2		0.7			0.8			3.9		0.3	19.4	
Delay (s)		25.5			25.8			28.3		16.4	39.5	
Level of Service		C			C			C		B	D	
Approach Delay (s)		25.5			25.8			28.3			27.8	
Approach LOS		C			C			C			C	

Intersection Summary			
HCM Average Control Delay	27.4	HCM Level of Service	C
HCM Volume to Capacity ratio	0.78		
Actuated Cycle Length (s)	67.1	Sum of lost time (s)	15.0
Intersection Capacity Utilization	87.4%	ICU Level of Service	E
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	20	382	445	20	354	130	381	330	40	120	400	40
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0	4.0		4.0		4.0	4.0			4.0	
Lane Util. Factor		0.91	0.91		0.95		1.00	1.00			1.00	
Frpb, ped/bikes		0.99	0.96		0.99		1.00	1.00			1.00	
Flpb, ped/bikes		1.00	1.00		1.00		1.00	1.00			1.00	
Frt		0.95	0.85		0.96		1.00	0.98			0.99	
Flt Protected		1.00	1.00		1.00		0.95	1.00			0.99	
Satd. Flow (prot)		2995	1399		3160		1787	1587			1581	
Flt Permitted		0.93	1.00		0.87		0.95	1.00			0.99	
Satd. Flow (perm)		2777	1399		2741		1787	1587			1581	
Peak-hour factor, PHF	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97
Adj. Flow (vph)	21	394	459	21	365	134	393	340	41	124	412	41
RTOR Reduction (vph)	0	55	209	0	42	0	0	5	0	0	3	0
Lane Group Flow (vph)	0	544	66	0	478	0	393	376	0	0	574	0
Confl. Peds. (#/hr)	17		21	21		17	30		15	15		30
Confl. Bikes (#/hr)			1			1						
Heavy Vehicles (%)	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%
Parking (#/hr)		8			8			8			8	
Turn Type	Perm		Perm	Perm			Split			Split		
Protected Phases		2			2		4	4		8	8	
Permitted Phases	2		2	2								
Actuated Green, G (s)		20.0	20.0		20.0		25.0	25.0			26.0	
Effective Green, g (s)		20.0	20.0		20.0		25.0	25.0			26.0	
Actuated g/C Ratio		0.24	0.24		0.24		0.30	0.30			0.31	
Clearance Time (s)		4.0	4.0		4.0		4.0	4.0			4.0	
Lane Grp Cap (vph)		669	337		660		538	478			495	
v/s Ratio Prot							0.22	c0.24			c0.36	
v/s Ratio Perm		c0.20	0.05		0.17							
v/c Ratio		0.81	0.20		0.72		0.73	0.79			1.16	
Uniform Delay, d1		29.7	25.1		29.0		26.0	26.6			28.5	
Progression Factor		1.00	1.00		1.00		1.00	1.00			1.00	
Incremental Delay, d2		10.4	1.3		6.8		8.5	12.3			92.0	
Delay (s)		40.1	26.4		35.8		34.5	38.9			120.5	
Level of Service		D	C		D		C	D			F	
Approach Delay (s)		35.8			35.8			36.6			120.5	
Approach LOS		D			D			D			F	

Intersection Summary			
HCM Average Control Delay	53.8	HCM Level of Service	D
HCM Volume to Capacity ratio	0.93		
Actuated Cycle Length (s)	83.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	92.4%	ICU Level of Service	F
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL2	EBL	EBT	EBR	NBT	NBR	NBR2	SBL2	SBL	SBT
Lane Configurations										
Volume (vph)	40	1105	400	150	620	370	110	392	320	542
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0	4.0	4.5	4.0	4.0		4.0	4.0	4.0
Lane Util. Factor		0.91	0.91	1.00	0.95	1.00		1.00	1.00	1.00
Frpb, ped/bikes		1.00	1.00	0.85	1.00	0.92		1.00	1.00	1.00
Flpb, ped/bikes		1.00	1.00	1.00	1.00	1.00		1.00	1.00	1.00
Frt		1.00	1.00	0.85	1.00	0.85		1.00	1.00	1.00
Flt Protected		0.95	0.97	1.00	1.00	1.00		0.95	0.95	1.00
Satd. Flow (prot)		1610	3293	1344	3539	1452		1770	1770	1863
Flt Permitted		0.95	0.97	1.00	1.00	1.00		0.95	0.95	1.00
Satd. Flow (perm)		1610	3293	1344	3539	1452		1770	1770	1863
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	42	1163	421	158	653	389	116	413	337	571
RTOR Reduction (vph)	0	0	0	99	0	12	0	0	0	0
Lane Group Flow (vph)	0	600	1026	59	653	493	0	413	337	571
Confl. Peds. (#/hr)				50			50		50	
Confl. Bikes (#/hr)				10			10			
Turn Type	Perm	Perm		Perm		Perm		Prot	Prot	
Protected Phases			4		2			1	1	6
Permitted Phases	4	4		4		2				
Actuated Green, G (s)		32.5	32.5	32.5	22.5	22.5		22.0	22.0	47.5
Effective Green, g (s)		34.0	34.0	33.5	22.0	22.0		22.0	22.0	48.0
Actuated g/C Ratio		0.38	0.38	0.37	0.24	0.24		0.24	0.24	0.53
Clearance Time (s)		5.5	5.5	5.5	3.5	3.5		4.0	4.0	4.5
Vehicle Extension (s)		2.0	2.0	2.0	2.0	2.0		2.0	2.0	2.0
Lane Grp Cap (vph)		608	1244	500	865	355		433	433	994
v/s Ratio Prot					0.18			c0.23	0.19	0.31
v/s Ratio Perm		c0.37	0.31	0.04		c0.34				
v/c Ratio		0.99	0.95dl	0.12	0.75	1.39		0.95	0.78	0.57
Uniform Delay, d1		27.8	25.3	18.5	31.5	34.0		33.5	31.7	14.1
Progression Factor		1.00	1.00	1.00	1.00	1.00		1.00	1.00	1.00
Incremental Delay, d2		32.8	4.4	0.0	3.4	191.4		33.1	12.9	2.4
Delay (s)		60.5	29.7	18.6	34.9	225.4		66.6	44.6	16.5
Level of Service		E	C	B	C	F		E	D	B
Approach Delay (s)			39.1		117.9					39.4
Approach LOS			D		F					D

Intersection Summary			
HCM Average Control Delay	60.6	HCM Level of Service	E
HCM Volume to Capacity ratio	1.09		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	92.0%	ICU Level of Service	F
Analysis Period (min)	15		

dl Defacto Left Lane. Recode with 1 though lane as a left lane.
c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	0	0	455	1284	0	0	0	0	0	971	580
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)				4.0	4.0						4.0	4.0
Lane Util. Factor				0.86	0.86						0.86	0.86
Frpb, ped/bikes				1.00	1.00						1.00	1.00
Flpb, ped/bikes				1.00	1.00						1.00	1.00
Frt				1.00	1.00						0.97	0.85
Flt Protected				0.95	1.00						1.00	1.00
Satd. Flow (prot)				1522	4798						4652	1362
Flt Permitted				0.95	1.00						1.00	1.00
Satd. Flow (perm)				1522	4798						4652	1362
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	0	0	0	479	1352	0	0	0	0	0	1022	611
RTOR Reduction (vph)	0	0	0	294	4	0	0	0	0	0	23	23
Lane Group Flow (vph)	0	0	0	137	1396	0	0	0	0	0	1243	344
Confl. Bikes (#/hr)						5						9
Turn Type				Prot								Prot
Protected Phases				7	3						2	2
Permitted Phases												
Actuated Green, G (s)				20.0	40.0						31.0	31.0
Effective Green, g (s)				20.0	40.0						31.0	31.0
Actuated g/C Ratio				0.25	0.51						0.39	0.39
Clearance Time (s)				4.0	4.0						4.0	4.0
Lane Grp Cap (vph)				385	2429						1825	534
v/s Ratio Prot				0.09	c0.15						c0.27	0.25
v/s Ratio Perm					0.15							
v/c Ratio				0.36	0.57						0.68	0.64
Uniform Delay, d1				24.2	13.6						19.9	19.5
Progression Factor				1.00	1.00						1.00	1.00
Incremental Delay, d2				2.6	1.0						2.1	5.9
Delay (s)				26.8	14.6						22.0	25.4
Level of Service				C	B						C	C
Approach Delay (s)		0.0			17.4			0.0			22.7	
Approach LOS		A			B			A			C	

Intersection Summary			
HCM Average Control Delay	19.9	HCM Level of Service	B
HCM Volume to Capacity ratio	0.62		
Actuated Cycle Length (s)	79.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	56.1%	ICU Level of Service	B
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	350	1090	0	0	0	0	0	1131	2057	0	0	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0						4.0	4.0			
Lane Util. Factor		0.91						0.91	0.88			
Frpb, ped/bikes		1.00						1.00	1.00			
Flpb, ped/bikes		1.00						1.00	1.00			
Frt		1.00						1.00	0.85			
Flt Protected		0.99						1.00	1.00			
Satd. Flow (prot)		5006						5085	2787			
Flt Permitted		0.99						1.00	1.00			
Satd. Flow (perm)		5006						5085	2787			
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	368	1147	0	0	0	0	0	1191	2165	0	0	0
RTOR Reduction (vph)	0	0	0	0	0	0	0	0	97	0	0	0
Lane Group Flow (vph)	0	1515	0	0	0	0	0	1191	2068	0	0	0
Confl. Peds. (#/hr)	28		7	7		28	99		3	3		99
Confl. Bikes (#/hr)			1			2			1			
Turn Type	Perm								custom			
Protected Phases		4						2	2			
Permitted Phases	4								7			
Actuated Green, G (s)		34.0						16.0	16.0			
Effective Green, g (s)		35.0						17.0	17.0			
Actuated g/C Ratio		0.58						0.28	0.28			
Clearance Time (s)		5.0						5.0	5.0			
Vehicle Extension (s)		3.0						3.0	3.0			
Lane Grp Cap (vph)		2920						1441	790			
v/s Ratio Prot								0.23	c0.74			
v/s Ratio Perm		0.30										
v/c Ratio		0.52						0.83	2.62			
Uniform Delay, d1		7.5						20.1	21.5			
Progression Factor		1.00						1.00	1.00			
Incremental Delay, d2		0.7						4.0	731.4			
Delay (s)		8.1						24.1	752.9			
Level of Service		A						C	F			
Approach Delay (s)		8.1			0.0			494.3			0.0	
Approach LOS		A			A			F			A	

Intersection Summary			
HCM Average Control Delay	343.1	HCM Level of Service	F
HCM Volume to Capacity ratio	1.21		
Actuated Cycle Length (s)	60.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	107.3%	ICU Level of Service	G
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	70	1515	1562	0	0	0	0	380	430	130	360	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0	4.0					4.0			4.0	
Lane Util. Factor		0.86	0.86					1.00			1.00	
Frpb, ped/bikes		0.98	0.97					0.98			1.00	
Flpb, ped/bikes		1.00	1.00					1.00			1.00	
Frt		0.95	0.85					0.93			1.00	
Flt Protected		1.00	1.00					1.00			0.99	
Satd. Flow (prot)		4445	1323					1694			1836	
Flt Permitted		1.00	1.00					1.00			0.14	
Satd. Flow (perm)		4445	1323					1694			262	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	74	1595	1644	0	0	0	0	400	453	137	379	0
RTOR Reduction (vph)	0	64	0	0	0	0	0	13	0	0	0	0
Lane Group Flow (vph)	0	2427	822	0	0	0	0	840	0	0	516	0
Confl. Peds. (#/hr)	52		55	55		52	39		25	25		39
Confl. Bikes (#/hr)			1						2		1	2
Turn Type	Perm		Free							Perm		
Protected Phases		2						4			8	
Permitted Phases	2		Free							8		
Actuated Green, G (s)		33.0	60.0					18.0			18.0	
Effective Green, g (s)		34.0	60.0					18.0			18.0	
Actuated g/C Ratio		0.57	1.00					0.30			0.30	
Clearance Time (s)		5.0						4.0			4.0	
Vehicle Extension (s)		2.0						2.0			2.0	
Lane Grp Cap (vph)		2519	1323					508			79	
v/s Ratio Prot								0.50				
v/s Ratio Perm		0.55	0.62								c1.97	
v/c Ratio		0.96	0.62					1.65			6.53	
Uniform Delay, d1		12.4	0.0					21.0			21.0	
Progression Factor		0.63	1.00					1.00			1.00	
Incremental Delay, d2		1.5	0.2					303.2			2515.9	
Delay (s)		9.4	0.2					324.2			2536.9	
Level of Service		A	A					F			F	
Approach Delay (s)		7.1			0.0			324.2			2536.9	
Approach LOS		A			A			F			F	

Intersection Summary			
HCM Average Control Delay	343.7	HCM Level of Service	F
HCM Volume to Capacity ratio	2.90		
Actuated Cycle Length (s)	60.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	129.3%	ICU Level of Service	H
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	350	1090	0	0	0	0	0	1131	2057	0	0	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0						4.0	4.0			
Lane Util. Factor		0.91						0.91	0.88			
Frpb, ped/bikes		1.00						1.00	1.00			
Flpb, ped/bikes		1.00						1.00	1.00			
Frt		1.00						1.00	0.85			
Flt Protected		0.99						1.00	1.00			
Satd. Flow (prot)		5002						5085	2787			
Flt Permitted		0.99						1.00	1.00			
Satd. Flow (perm)		5002						5085	2787			
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	368	1147	0	0	0	0	0	1191	2165	0	0	0
RTOR Reduction (vph)	0	1	0	0	0	0	0	0	88	0	0	0
Lane Group Flow (vph)	0	1514	0	0	0	0	0	1191	2077	0	0	0
Confl. Peds. (#/hr)	28		7	7		28	99		3	3		99
Confl. Bikes (#/hr)			1			2			1			
Turn Type	Perm								custom			
Protected Phases		4						2	2			
Permitted Phases	4								7			
Actuated Green, G (s)		42.0						23.0	23.0			
Effective Green, g (s)		43.0						24.0	24.0			
Actuated g/C Ratio		0.57						0.32	0.32			
Clearance Time (s)		5.0						5.0	5.0			
Vehicle Extension (s)		3.0						3.0	3.0			
Lane Grp Cap (vph)		2868						1627	892			
v/s Ratio Prot								0.23	c0.75			
v/s Ratio Perm		0.30										
v/c Ratio		0.53						0.73	2.33			
Uniform Delay, d1		9.8						22.6	25.5			
Progression Factor		1.00						1.00	1.00			
Incremental Delay, d2		0.7						1.7	601.5			
Delay (s)		10.5						24.4	627.0			
Level of Service		B						C	F			
Approach Delay (s)		10.5			0.0			413.1			0.0	
Approach LOS		B			A			F			A	

Intersection Summary			
HCM Average Control Delay	287.9	HCM Level of Service	F
HCM Volume to Capacity ratio	1.17		
Actuated Cycle Length (s)	75.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	107.3%	ICU Level of Service	G
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	70	1515	1562	0	0	0	0	380	430	130	360	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0	4.0					4.0			4.0	
Lane Util. Factor		0.86	0.86					1.00			1.00	
Frpb, ped/bikes		0.97	0.97					0.98			1.00	
Flpb, ped/bikes		1.00	1.00					1.00			1.00	
Frt		0.95	0.85					0.93			1.00	
Flt Protected		1.00	1.00					1.00			0.99	
Satd. Flow (prot)		4420	1323					1689			1838	
Flt Permitted		1.00	1.00					1.00			0.28	
Satd. Flow (perm)		4420	1323					1689			531	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	74	1595	1644	0	0	0	0	400	453	137	379	0
RTOR Reduction (vph)	0	118	0	0	0	0	0	0	0	0	0	0
Lane Group Flow (vph)	0	2373	822	0	0	0	0	853	0	0	516	0
Confl. Peds. (#/hr)	52		55	55		52	39		25	25		39
Confl. Bikes (#/hr)			1						2		1	2
Turn Type	Perm		Free							Perm		
Protected Phases		2						4			8	
Permitted Phases	2		Free							8		
Actuated Green, G (s)		26.0	75.0					40.0			40.0	
Effective Green, g (s)		27.0	75.0					40.0			40.0	
Actuated g/C Ratio		0.36	1.00					0.53			0.53	
Clearance Time (s)		5.0						4.0			4.0	
Vehicle Extension (s)		2.0						2.0			2.0	
Lane Grp Cap (vph)		1591	1323					901			283	
v/s Ratio Prot								0.50				
v/s Ratio Perm		0.54	0.62								c0.97	
v/c Ratio		1.49	0.62					0.95			1.82	
Uniform Delay, d1		24.0	0.0					16.5			17.5	
Progression Factor		1.11	1.00					1.00			1.00	
Incremental Delay, d2		221.4	0.2					18.0			384.1	
Delay (s)		248.1	0.2					34.5			401.6	
Level of Service		F	A					C			F	
Approach Delay (s)		186.6			0.0			34.5			401.6	
Approach LOS		F			A			C			F	

Intersection Summary			
HCM Average Control Delay	182.6	HCM Level of Service	F
HCM Volume to Capacity ratio	1.69		
Actuated Cycle Length (s)	75.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	129.3%	ICU Level of Service	H
Analysis Period (min)	15		
c Critical Lane Group			

Near-Term (2018) Plus Additional Employment Alternative Conditions

FEHR PEERS

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Volume (vph)	410	60	40	1238	1026	530
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	0.97	1.00	1.00	0.95	0.91	0.88
Frpb, ped/bikes	1.00	0.98	1.00	1.00	1.00	1.00
Flpb, ped/bikes	1.00	1.00	1.00	1.00	1.00	1.00
Frt	1.00	0.85	1.00	1.00	1.00	0.85
Flt Protected	0.95	1.00	0.95	1.00	1.00	1.00
Satd. Flow (prot)	3400	1535	1752	3505	5036	2760
Flt Permitted	0.95	1.00	0.95	1.00	1.00	1.00
Satd. Flow (perm)	3400	1535	1752	3505	5036	2760
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	446	65	43	1346	1115	576
RTOR Reduction (vph)	0	0	0	0	0	403
Lane Group Flow (vph)	446	65	43	1346	1115	173
Confl. Peds. (#/hr)	3	11	4			4
Confl. Bikes (#/hr)		5				5
Heavy Vehicles (%)	3%	3%	3%	3%	3%	3%
Turn Type		Perm	Prot			Prot
Protected Phases	4		5	2	6	6
Permitted Phases		4				
Actuated Green, G (s)	26.0	26.0	4.0	26.0	18.0	18.0
Effective Green, g (s)	26.0	26.0	4.0	26.0	18.0	18.0
Actuated g/C Ratio	0.43	0.43	0.07	0.43	0.30	0.30
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Lane Grp Cap (vph)	1473	665	117	1519	1511	828
v/s Ratio Prot	c0.13		0.02	c0.38	0.22	0.06
v/s Ratio Perm		0.04				
v/c Ratio	0.30	0.10	0.37	0.89	0.74	0.21
Uniform Delay, d1	11.1	10.1	26.8	15.6	18.9	15.7
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	0.5	0.3	8.7	8.0	3.3	0.6
Delay (s)	11.6	10.4	35.5	23.6	22.1	16.3
Level of Service	B	B	D	C	C	B
Approach Delay (s)	11.5			24.0	20.1	
Approach LOS	B			C	C	

Intersection Summary			
HCM Average Control Delay	20.4	HCM Level of Service	C
HCM Volume to Capacity ratio	0.59		
Actuated Cycle Length (s)	60.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	66.7%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	10	70	34	202	227	110	85	190	86	40	93	23
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0			4.0	4.0	4.0	4.0		4.0	4.0	
Lane Util. Factor		0.95			0.95	1.00	1.00	0.95		0.91	0.91	
Frpb, ped/bikes		0.99			1.00	0.98	1.00	0.99		1.00	1.00	
Flpb, ped/bikes		1.00			1.00	1.00	1.00	1.00		1.00	1.00	
Frt		0.96			1.00	0.85	1.00	0.95		1.00	0.97	
Flt Protected		1.00			0.98	1.00	0.95	1.00		0.95	1.00	
Satd. Flow (prot)		3209			3315	1500	1703	3218		1550	3149	
Flt Permitted		0.91			0.77	1.00	0.95	1.00		0.95	1.00	
Satd. Flow (perm)		2948			2618	1500	1703	3218		1550	3149	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	11	76	37	220	247	120	92	207	93	43	101	25
RTOR Reduction (vph)	0	24	0	0	0	0	0	70	0	0	21	0
Lane Group Flow (vph)	0	100	0	0	467	120	92	230	0	39	109	0
Confl. Peds. (#/hr)	9		8	8		9	12		17	17		12
Confl. Bikes (#/hr)						3			5			2
Heavy Vehicles (%)	6%	6%	6%	6%	6%	6%	6%	6%	6%	6%	6%	6%
Turn Type	Perm			Perm		Free	Split			Split		
Protected Phases		2			6		3	3		4	4	
Permitted Phases	2			6		Free						
Actuated Green, G (s)		16.2			15.2	46.0	10.0	10.0		6.8	6.8	
Effective Green, g (s)		16.2			16.2	46.0	10.0	10.0		7.8	7.8	
Actuated g/C Ratio		0.35			0.35	1.00	0.22	0.22		0.17	0.17	
Clearance Time (s)		4.0			5.0		4.0	4.0		5.0	5.0	
Vehicle Extension (s)		3.0			3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)		1038			922	1500	370	700		263	534	
v/s Ratio Prot							0.05	c0.07		0.03	c0.03	
v/s Ratio Perm		0.03			c0.18	0.08						
v/c Ratio		0.10			0.51	0.08	0.25	0.33		0.15	0.20	
Uniform Delay, d1		10.0			11.7	0.0	14.9	15.2		16.3	16.4	
Progression Factor		1.00			1.00	1.00	1.00	1.00		1.00	1.00	
Incremental Delay, d2		0.0			0.4	0.1	0.4	0.3		0.3	0.2	
Delay (s)		10.0			12.2	0.1	15.2	15.4		16.5	16.6	
Level of Service		B			B	A	B	B		B	B	
Approach Delay (s)		10.0			9.7			15.4			16.6	
Approach LOS		B			A			B			B	

Intersection Summary			
HCM Average Control Delay	12.4	HCM Level of Service	B
HCM Volume to Capacity ratio	0.38		
Actuated Cycle Length (s)	46.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	47.0%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	10	166	10	140	499	30	20	90	230	40	80	20
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0			4.0			4.0	
Lane Util. Factor	1.00	0.95		1.00	0.95			1.00			1.00	
Frpb, ped/bikes	1.00	1.00		1.00	1.00			0.97			1.00	
Flpb, ped/bikes	1.00	1.00		1.00	1.00			1.00			1.00	
Frt	1.00	0.99		1.00	0.99			0.91			0.98	
Flt Protected	0.95	1.00		0.95	1.00			1.00			0.99	
Satd. Flow (prot)	1736	3432		1736	3433			1607			1752	
Flt Permitted	0.95	1.00		0.95	1.00			0.98			0.85	
Satd. Flow (perm)	1736	3432		1736	3433			1582			1515	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	11	180	11	152	542	33	22	98	250	43	87	22
RTOR Reduction (vph)	0	7	0	0	7	0	0	125	0	0	10	0
Lane Group Flow (vph)	11	184	0	152	568	0	0	245	0	0	142	0
Confl. Peds. (#/hr)	11		13	13		11	22		48	48		22
Confl. Bikes (#/hr)			1			2			1			
Heavy Vehicles (%)	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%
Turn Type	Prot			Prot			Perm			Perm		
Protected Phases	7	4		3	8			2			6	
Permitted Phases							2			6		
Actuated Green, G (s)	6.0	16.0		6.0	16.0			26.0			26.0	
Effective Green, g (s)	6.0	16.0		6.0	16.0			26.0			26.0	
Actuated g/C Ratio	0.10	0.27		0.10	0.27			0.43			0.43	
Clearance Time (s)	4.0	4.0		4.0	4.0			4.0			4.0	
Lane Grp Cap (vph)	174	915		174	915			686			657	
v/s Ratio Prot	0.01	0.05		c0.09	c0.17							
v/s Ratio Perm								c0.15			0.09	
v/c Ratio	0.06	0.20		0.87	0.62			0.36			0.22	
Uniform Delay, d1	24.5	17.0		26.6	19.3			11.4			10.6	
Progression Factor	1.00	1.00		1.00	1.00			1.00			1.00	
Incremental Delay, d2	0.7	0.5		41.4	3.2			1.4			0.8	
Delay (s)	25.2	17.5		68.0	22.5			12.8			11.4	
Level of Service	C	B		E	C			B			B	
Approach Delay (s)		18.0			32.0			12.8			11.4	
Approach LOS		B			C			B			B	

Intersection Summary			
HCM Average Control Delay	23.0	HCM Level of Service	C
HCM Volume to Capacity ratio	0.51		
Actuated Cycle Length (s)	60.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	54.5%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	338	268	120	40	373	70	140	890	70	100	480	516
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width	10	11	12	11	11	12	12	12	12	12	12	12
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0		4.0	4.0		4.0	4.0	4.0
Lane Util. Factor	0.97	0.95	1.00	1.00	0.95		1.00	0.95		1.00	0.95	1.00
Frpb, ped/bikes	1.00	1.00	0.97	1.00	0.98		1.00	1.00		1.00	1.00	0.94
Flpb, ped/bikes	1.00	1.00	1.00	1.00	1.00		1.00	1.00		1.00	1.00	1.00
Frt	1.00	1.00	0.85	1.00	0.98		1.00	0.99		1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00		0.95	1.00		0.95	1.00	1.00
Satd. Flow (prot)	2828	3020	1355	1510	2897		1562	3081		1562	3124	1278
Flt Permitted	0.95	1.00	1.00	0.95	1.00		0.95	1.00		0.95	1.00	1.00
Satd. Flow (perm)	2828	3020	1355	1510	2897		1562	3081		1562	3124	1278
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	367	291	130	43	405	76	152	967	76	109	522	561
RTOR Reduction (vph)	0	0	104	0	13	0	0	5	0	0	0	363
Lane Group Flow (vph)	367	291	26	43	468	0	152	1038	0	109	522	198
Confl. Peds. (#/hr)			16			85			25			37
Confl. Bikes (#/hr)						1			1			1
Heavy Vehicles (%)	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%
Bus Blockages (#/hr)	0	0	0	0	0	2	0	0	0	0	0	8
Turn Type	Split		Perm	Split			Prot			Prot		Perm
Protected Phases	4	4		8	8		5	2		1	6	
Permitted Phases			4									6
Actuated Green, G (s)	19.2	19.2	19.2	20.4	20.4		12.2	30.4		10.8	29.0	29.0
Effective Green, g (s)	19.2	19.2	19.2	20.4	20.4		12.2	31.4		10.8	30.0	30.0
Actuated g/C Ratio	0.20	0.20	0.20	0.21	0.21		0.12	0.32		0.11	0.31	0.31
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0		4.0	5.0		4.0	5.0	5.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0		3.0	3.0		3.0	3.0	3.0
Lane Grp Cap (vph)	555	593	266	315	604		195	989		172	958	392
v/s Ratio Prot	c0.13	0.10		0.03	c0.16		c0.10	c0.34		0.07	0.17	
v/s Ratio Perm			0.02									0.15
v/c Ratio	0.66	0.49	0.10	0.14	0.77		0.78	1.05		0.63	0.54	0.50
Uniform Delay, d1	36.3	35.0	32.2	31.5	36.5		41.5	33.2		41.6	28.2	27.8
Progression Factor	1.00	1.00	1.00	1.00	1.00		1.00	1.00		1.00	1.00	1.00
Incremental Delay, d2	3.0	0.6	0.2	0.2	6.1		17.7	42.6		7.4	0.6	1.0
Delay (s)	39.3	35.6	32.3	31.7	42.7		59.2	75.8		49.0	28.9	28.8
Level of Service	D	D	C	C	D		E	E		D	C	C
Approach Delay (s)		36.8			41.8			73.7			30.7	
Approach LOS		D			D			E			C	

Intersection Summary			
HCM Average Control Delay	47.4	HCM Level of Service	D
HCM Volume to Capacity ratio	0.83		
Actuated Cycle Length (s)	97.8	Sum of lost time (s)	12.0
Intersection Capacity Utilization	80.7%	ICU Level of Service	D
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	80	204	94	50	208	100	165	790	50	90	350	70
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.9	4.9		4.9	4.9		4.3	4.8	4.8	4.3	4.8	4.8
Lane Util. Factor	1.00	0.95		1.00	0.95		0.97	0.95	1.00	0.97	0.95	1.00
Frpb, ped/bikes	1.00	0.99		1.00	0.99		1.00	1.00	0.98	1.00	1.00	0.98
Flpb, ped/bikes	1.00	1.00		1.00	1.00		1.00	1.00	1.00	1.00	1.00	1.00
Frt	1.00	0.95		1.00	0.95		1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	1770	3354		1770	3341		3433	3539	1558	3433	3539	1550
Flt Permitted	0.95	1.00		0.95	1.00		0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)	1770	3354		1770	3341		3433	3539	1558	3433	3539	1550
Peak-hour factor, PHF	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93
Adj. Flow (vph)	86	219	101	54	224	108	177	849	54	97	376	75
RTOR Reduction (vph)	0	57	0	0	61	0	0	0	37	0	0	32
Lane Group Flow (vph)	86	263	0	54	271	0	177	849	17	97	376	43
Confl. Peds. (#/hr)			7			13			6			11
Confl. Bikes (#/hr)						2						
Turn Type	Split			Split			Prot		Perm	Prot		Perm
Protected Phases	4	4		8	8		5	2		1	6	
Permitted Phases									2			6
Actuated Green, G (s)	11.9	11.9		12.0	12.0		7.4	21.2	21.2	4.3	18.1	18.1
Effective Green, g (s)	11.0	11.0		11.1	11.1		7.1	21.4	21.4	4.0	18.3	18.3
Actuated g/C Ratio	0.17	0.17		0.17	0.17		0.11	0.32	0.32	0.06	0.28	0.28
Clearance Time (s)	4.0	4.0		4.0	4.0		4.0	5.0	5.0	4.0	5.0	5.0
Vehicle Extension (s)	2.0	2.0		2.0	2.0		2.0	2.0	2.0	2.0	2.0	2.0
Lane Grp Cap (vph)	293	556		296	559		367	1141	502	207	975	427
v/s Ratio Prot	0.05	c0.08		0.03	c0.08		c0.05	c0.24		0.03	0.11	
v/s Ratio Perm									0.01			0.03
v/c Ratio	0.29	0.47		0.18	0.49		0.48	0.74	0.03	0.47	0.39	0.10
Uniform Delay, d1	24.3	25.1		23.8	25.1		27.9	20.1	15.4	30.2	19.5	17.9
Progression Factor	1.00	1.00		1.00	1.00		1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	0.2	0.2		0.1	0.2		0.4	2.3	0.0	0.6	0.1	0.0
Delay (s)	24.5	25.3		23.9	25.3		28.3	22.4	15.4	30.8	19.6	18.0
Level of Service	C	C		C	C		C	C	B	C	B	B
Approach Delay (s)		25.1			25.1			23.0			21.3	
Approach LOS		C			C			C			C	

Intersection Summary			
HCM Average Control Delay	23.3	HCM Level of Service	C
HCM Volume to Capacity ratio	0.62		
Actuated Cycle Length (s)	66.4	Sum of lost time (s)	18.9
Intersection Capacity Utilization	60.2%	ICU Level of Service	B
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	27	14	14	80	45	110	35	245	40	50	194	115
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0			4.0	4.0	4.0	4.0		4.0	4.0	
Lane Util. Factor		1.00			1.00	1.00	1.00	1.00		1.00	1.00	
Frpb, ped/bikes		0.99			1.00	0.98	1.00	0.99		1.00	0.99	
Flpb, ped/bikes		1.00			1.00	1.00	1.00	1.00		1.00	1.00	
Frt		0.97			1.00	0.85	1.00	0.98		1.00	0.94	
Flt Protected		0.98			0.97	1.00	0.95	1.00		0.95	1.00	
Satd. Flow (prot)		1746			1805	1556	1770	1810		1770	1733	
Flt Permitted		0.98			0.97	1.00	0.95	1.00		0.95	1.00	
Satd. Flow (perm)		1746			1805	1556	1770	1810		1770	1733	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	29	15	15	87	49	120	38	266	43	54	211	125
RTOR Reduction (vph)	0	14	0	0	0	101	0	6	0	0	23	0
Lane Group Flow (vph)	0	45	0	0	136	19	38	303	0	54	313	0
Confl. Peds. (#/hr)	2		1	1		2	13		20	20		13
Confl. Bikes (#/hr)						1			5			
Turn Type	Split			Split		Perm	Split			Split		
Protected Phases	2	2		1	1		4	4		3	3	
Permitted Phases						1						
Actuated Green, G (s)		5.2			10.3	10.3	16.9	16.9		17.8	17.8	
Effective Green, g (s)		5.2			10.3	10.3	16.9	16.9		17.8	17.8	
Actuated g/C Ratio		0.08			0.16	0.16	0.26	0.26		0.27	0.27	
Clearance Time (s)		4.0			4.0	4.0	4.0	4.0		4.0	4.0	
Vehicle Extension (s)		3.0			3.0	3.0	3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)		137			281	242	452	462		476	466	
v/s Ratio Prot		c0.03			c0.08		0.02	c0.17		0.03	c0.18	
v/s Ratio Perm						0.01						
v/c Ratio		0.33			0.48	0.08	0.08	0.66		0.11	0.67	
Uniform Delay, d1		28.9			25.5	23.9	18.8	22.0		18.2	21.6	
Progression Factor		1.00			1.00	1.00	1.00	1.00		1.00	1.00	
Incremental Delay, d2		1.4			1.3	0.1	0.1	3.3		0.1	3.8	
Delay (s)		30.3			26.8	24.0	18.8	25.4		18.4	25.4	
Level of Service		C			C	C	B	C		B	C	
Approach Delay (s)		30.3			25.5			24.7			24.4	
Approach LOS		C			C			C			C	

Intersection Summary			
HCM Average Control Delay	25.1	HCM Level of Service	C
HCM Volume to Capacity ratio	0.59		
Actuated Cycle Length (s)	66.2	Sum of lost time (s)	16.0
Intersection Capacity Utilization	41.2%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	250	224	50	50	305	50	60	610	30	30	330	90
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0			4.0			4.0	
Lane Util. Factor	1.00	0.95		1.00	0.95			0.95			0.95	
Frpb, ped/bikes	1.00	1.00		1.00	0.99			1.00			0.99	
Flpb, ped/bikes	0.98	1.00		0.99	1.00			1.00			1.00	
Frt	1.00	0.97		1.00	0.98			0.99			0.97	
Flt Protected	0.95	1.00		0.95	1.00			1.00			1.00	
Satd. Flow (prot)	1541	3053		1561	3066			3112			3027	
Flt Permitted	0.51	1.00		0.57	1.00			0.87			0.88	
Satd. Flow (perm)	821	3053		937	3066			2728			2683	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	272	243	54	54	332	54	65	663	33	33	359	98
RTOR Reduction (vph)	0	28	0	0	19	0	0	5	0	0	33	0
Lane Group Flow (vph)	272	269	0	54	367	0	0	756	0	0	457	0
Confl. Peds. (#/hr)	56		22	22		56	31		42	42		31
Confl. Bikes (#/hr)						2			5			1
Heavy Vehicles (%)	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%
Turn Type	Perm			Perm			Perm			Perm		
Protected Phases		4			4			2			2	
Permitted Phases	4			4			2			2		
Actuated Green, G (s)	30.0	30.0		30.0	30.0			32.0			32.0	
Effective Green, g (s)	29.0	29.0		29.0	29.0			31.0			31.0	
Actuated g/C Ratio	0.43	0.43		0.43	0.43			0.46			0.46	
Clearance Time (s)	3.0	3.0		3.0	3.0			3.0			3.0	
Lane Grp Cap (vph)	350	1302		400	1308			1244			1223	
v/s Ratio Prot		0.09			0.12							
v/s Ratio Perm	c0.33			0.06				c0.28			0.17	
v/c Ratio	0.78	0.21		0.14	0.28			0.61			0.37	
Uniform Delay, d1	16.7	12.3		11.9	12.7			13.9			12.1	
Progression Factor	1.00	1.00		1.00	1.00			1.00			1.00	
Incremental Delay, d2	15.5	0.4		0.7	0.5			2.2			0.9	
Delay (s)	32.3	12.6		12.6	13.2			16.1			13.0	
Level of Service	C	B		B	B			B			B	
Approach Delay (s)		22.0			13.2			16.1			13.0	
Approach LOS		C			B			B			B	

Intersection Summary			
HCM Average Control Delay	16.4	HCM Level of Service	B
HCM Volume to Capacity ratio	0.69		
Actuated Cycle Length (s)	68.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	101.2%	ICU Level of Service	G
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	20	224	40	20	315	275	30	560	20	174	290	20
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0			5.0			5.0		5.0	5.0	
Lane Util. Factor		0.95			0.95			0.95		0.97	1.00	
Frpb, ped/bikes		0.99			0.99			1.00		1.00	1.00	
Flpb, ped/bikes		1.00			1.00			1.00		1.00	1.00	
Frt		0.98			0.93			1.00		1.00	0.99	
Flt Protected		1.00			1.00			1.00		0.95	1.00	
Satd. Flow (prot)		3469			3303			3544		3467	1860	
Flt Permitted		0.85			0.94			1.00		0.95	1.00	
Satd. Flow (perm)		2971			3096			3544		3467	1860	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	22	243	43	22	342	299	33	609	22	189	315	22
RTOR Reduction (vph)	0	17	0	0	193	0	0	3	0	0	3	0
Lane Group Flow (vph)	0	291	0	0	470	0	0	661	0	189	334	0
Confl. Peds. (#/hr)	2		11	11		2	14		25	25		14
Confl. Bikes (#/hr)			1			2						
Heavy Vehicles (%)	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%
Turn Type	Perm			Perm			Split			Split		
Protected Phases		4			4		2	2		3	3	
Permitted Phases	4			4								
Actuated Green, G (s)		15.7			15.7			16.8		17.1	17.1	
Effective Green, g (s)		14.7			14.7			15.8		16.1	16.1	
Actuated g/C Ratio		0.24			0.24			0.26		0.26	0.26	
Clearance Time (s)		4.0			4.0			4.0		4.0	4.0	
Vehicle Extension (s)		3.0			3.0			3.0		3.0	3.0	
Lane Grp Cap (vph)		709			739			909		906	486	
v/s Ratio Prot								c0.19		0.05	c0.18	
v/s Ratio Perm		0.10			c0.15							
v/c Ratio		0.41			0.64			0.73		0.21	0.69	
Uniform Delay, d1		19.8			21.1			20.9		17.8	20.5	
Progression Factor		1.00			1.00			1.00		1.00	1.00	
Incremental Delay, d2		0.4			1.8			2.9		0.1	4.0	
Delay (s)		20.2			22.9			23.9		17.9	24.5	
Level of Service		C			C			C		B	C	
Approach Delay (s)		20.2			22.9			23.9			22.1	
Approach LOS		C			C			C			C	

Intersection Summary			
HCM Average Control Delay	22.6	HCM Level of Service	C
HCM Volume to Capacity ratio	0.68		
Actuated Cycle Length (s)	61.6	Sum of lost time (s)	15.0
Intersection Capacity Utilization	81.2%	ICU Level of Service	D
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	20	286	331	20	450	150	429	330	30	80	210	20
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0	4.0		4.0		4.0	4.0			4.0	
Lane Util. Factor		0.91	0.91		0.95		1.00	1.00			1.00	
Frpb, ped/bikes		0.99	0.96		0.99		1.00	1.00			1.00	
Flpb, ped/bikes		1.00	1.00		1.00		1.00	1.00			1.00	
Frt		0.96	0.85		0.96		1.00	0.99			0.99	
Flt Protected		1.00	1.00		1.00		0.95	1.00			0.99	
Satd. Flow (prot)		2973	1385		3140		1770	1578			1564	
Flt Permitted		0.82	1.00		0.93		0.95	1.00			0.99	
Satd. Flow (perm)		2455	1385		2920		1770	1578			1564	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	22	311	360	22	489	163	466	359	33	87	228	22
RTOR Reduction (vph)	0	49	169	0	37	0	0	4	0	0	3	0
Lane Group Flow (vph)	0	421	54	0	637	0	466	388	0	0	334	0
Confl. Peds. (#/hr)	16		21	21		16	20		16	16		20
Confl. Bikes (#/hr)			1			2			1			
Parking (#/hr)		8			8			8			8	
Turn Type	Perm		Perm	Perm			Split			Split		
Protected Phases		2			2		4	4		8	8	
Permitted Phases	2		2	2								
Actuated Green, G (s)		20.0	20.0		20.0		25.0	25.0			26.0	
Effective Green, g (s)		20.0	20.0		20.0		25.0	25.0			26.0	
Actuated g/C Ratio		0.24	0.24		0.24		0.30	0.30			0.31	
Clearance Time (s)		4.0	4.0		4.0		4.0	4.0			4.0	
Lane Grp Cap (vph)		592	334		704		533	475			490	
v/s Ratio Prot							c0.26	0.25			c0.21	
v/s Ratio Perm		0.17	0.04		c0.22							
v/c Ratio		0.71	0.16		0.90		0.87	0.82			0.68	
Uniform Delay, d1		28.8	24.9		30.6		27.5	26.9			24.9	
Progression Factor		1.00	1.00		1.00		1.00	1.00			1.00	
Incremental Delay, d2		7.1	1.0		17.3		17.9	14.4			7.5	
Delay (s)		35.9	25.9		47.9		45.4	41.2			32.4	
Level of Service		D	C		D		D	D			C	
Approach Delay (s)		32.7			47.9			43.5			32.4	
Approach LOS		C			D			D			C	

Intersection Summary			
HCM Average Control Delay	40.3	HCM Level of Service	D
HCM Volume to Capacity ratio	0.81		
Actuated Cycle Length (s)	83.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	88.1%	ICU Level of Service	E
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL2	EBL	EBT	EBR	NBT	NBR	NBR2	SBL2	SBL	SBT
Lane Configurations										
Volume (vph)	75	713	150	100	200	193	70	385	150	330
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0	4.0	4.5	4.0	4.0		4.0	4.0	4.0
Lane Util. Factor		0.91	0.91	1.00	0.95	1.00		1.00	1.00	1.00
Frpb, ped/bikes		1.00	1.00	0.87	1.00	0.93		1.00	1.00	1.00
Flpb, ped/bikes		1.00	1.00	1.00	1.00	1.00		1.00	1.00	1.00
Frt		1.00	1.00	0.85	1.00	0.85		1.00	1.00	1.00
Flt Protected		0.95	0.97	1.00	1.00	1.00		0.95	0.95	1.00
Satd. Flow (prot)		1610	3272	1370	3539	1478		1770	1770	1863
Flt Permitted		0.95	0.97	1.00	1.00	1.00		0.95	0.95	1.00
Satd. Flow (perm)		1610	3272	1370	3539	1478		1770	1770	1863
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	79	751	158	105	211	203	74	405	158	347
RTOR Reduction (vph)	0	0	0	77	0	19	0	0	0	0
Lane Group Flow (vph)	0	417	571	28	211	258	0	405	158	347
Confl. Peds. (#/hr)				50			50		50	
Confl. Bikes (#/hr)				10			10			
Turn Type	Perm	Perm		Perm		Perm		Prot	Prot	
Protected Phases			4		2			1	1	6
Permitted Phases	4	4		4		2				
Actuated Green, G (s)		19.0	19.0	19.0	17.8	17.8		24.7	24.7	46.0
Effective Green, g (s)		20.5	20.5	20.0	17.3	17.3		25.2	25.2	46.5
Actuated g/C Ratio		0.27	0.27	0.27	0.23	0.23		0.34	0.34	0.62
Clearance Time (s)		5.5	5.5	5.5	3.5	3.5		4.5	4.5	4.5
Vehicle Extension (s)		2.0	2.0	2.0	2.0	2.0		2.0	2.0	2.0
Lane Grp Cap (vph)		440	894	365	816	341		595	595	1155
v/s Ratio Prot					0.06			c0.23	0.09	0.19
v/s Ratio Perm		c0.26	0.17	0.02		c0.17				
v/c Ratio		0.95	0.90dl	0.08	0.26	0.76		0.68	0.27	0.30
Uniform Delay, d1		26.7	24.0	20.6	23.6	26.9		21.4	18.2	6.7
Progression Factor		1.00	1.00	1.00	1.00	1.00		1.00	1.00	1.00
Incremental Delay, d2		29.4	1.1	0.0	0.1	8.2		6.2	1.1	0.7
Delay (s)		56.1	25.1	20.6	23.7	35.1		27.6	19.2	7.3
Level of Service		E	C	C	C	D		C	B	A
Approach Delay (s)			36.5		30.2					18.4
Approach LOS			D		C					B

Intersection Summary			
HCM Average Control Delay	28.7	HCM Level of Service	C
HCM Volume to Capacity ratio	0.79		
Actuated Cycle Length (s)	75.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	70.4%	ICU Level of Service	C
Analysis Period (min)	15		

dl Defacto Left Lane. Recode with 1 though lane as a left lane.
c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	0	0	387	791	0	0	0	0	0	492	320
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)				4.0	4.0						4.0	4.0
Lane Util. Factor				0.86	0.86						0.86	0.86
Frpb, ped/bikes				1.00	1.00						1.00	1.00
Flpb, ped/bikes				1.00	1.00						1.00	1.00
Frt				1.00	1.00						0.97	0.85
Flt Protected				0.95	0.99						1.00	1.00
Satd. Flow (prot)				1522	4779						4633	1362
Flt Permitted				0.95	0.99						1.00	1.00
Satd. Flow (perm)				1522	4779						4633	1362
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	0	0	0	407	833	0	0	0	0	0	518	337
RTOR Reduction (vph)	0	0	0	225	19	0	0	0	0	0	57	81
Lane Group Flow (vph)	0	0	0	76	920	0	0	0	0	0	603	114
Confl. Bikes (#/hr)						9						10
Turn Type				Prot								Prot
Protected Phases				7	3						2	2
Permitted Phases												
Actuated Green, G (s)				20.0	40.0						31.0	31.0
Effective Green, g (s)				20.0	40.0						31.0	31.0
Actuated g/C Ratio				0.25	0.51						0.39	0.39
Clearance Time (s)				4.0	4.0						4.0	4.0
Lane Grp Cap (vph)				385	2420						1818	534
v/s Ratio Prot				0.05	c0.10						c0.13	0.08
v/s Ratio Perm					0.10							
v/c Ratio				0.20	0.38						0.33	0.21
Uniform Delay, d1				23.2	11.9						16.8	15.9
Progression Factor				1.00	1.00						1.00	1.00
Incremental Delay, d2				1.2	0.5						0.5	0.9
Delay (s)				24.3	12.4						17.3	16.8
Level of Service				C	B						B	B
Approach Delay (s)		0.0			15.3			0.0			17.2	
Approach LOS		A			B			A			B	

Intersection Summary			
HCM Average Control Delay	16.0	HCM Level of Service	B
HCM Volume to Capacity ratio	0.36		
Actuated Cycle Length (s)	79.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	37.2%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	130	330	0	0	0	0	0	1033	1795	0	0	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0						4.0	4.0			
Lane Util. Factor		0.91						0.91	0.88			
Frpb, ped/bikes		1.00						1.00	1.00			
Flpb, ped/bikes		1.00						1.00	1.00			
Frt		1.00						1.00	0.85			
Flt Protected		0.99						1.00	1.00			
Satd. Flow (prot)		5003						5085	2787			
Flt Permitted		0.99						1.00	1.00			
Satd. Flow (perm)		5003						5085	2787			
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	137	347	0	0	0	0	0	1087	1889	0	0	0
RTOR Reduction (vph)	0	11	0	0	0	0	0	0	376	0	0	0
Lane Group Flow (vph)	0	473	0	0	0	0	0	1087	1513	0	0	0
Confl. Peds. (#/hr)	12		21	21		12	42		29	29		42
Confl. Bikes (#/hr)			2			1						1
Turn Type	Perm								custom			
Protected Phases		4						2	2			
Permitted Phases	4								7			
Actuated Green, G (s)		27.0						23.0	23.0			
Effective Green, g (s)		27.0						24.0	24.0			
Actuated g/C Ratio		0.45						0.40	0.40			
Clearance Time (s)		5.0						5.0	5.0			
Vehicle Extension (s)		3.0						3.0	3.0			
Lane Grp Cap (vph)		2251						2034	1115			
v/s Ratio Prot								0.21	c0.54			
v/s Ratio Perm		0.09										
v/c Ratio		0.21						0.53	1.36			
Uniform Delay, d1		10.0						13.7	18.0			
Progression Factor		1.00						1.00	1.00			
Incremental Delay, d2		0.2						0.3	166.5			
Delay (s)		10.2						14.0	184.5			
Level of Service		B						B	F			
Approach Delay (s)		10.2			0.0			122.2			0.0	
Approach LOS		B			A			F			A	

Intersection Summary			
HCM Average Control Delay	106.5	HCM Level of Service	F
HCM Volume to Capacity ratio	0.75		
Actuated Cycle Length (s)	60.0	Sum of lost time (s)	9.0
Intersection Capacity Utilization	95.4%	ICU Level of Service	F
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	50	734	1331	0	0	0	0	270	100	60	320	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0	4.0					4.0			4.0	
Lane Util. Factor		0.86	0.86					1.00			1.00	
Frpb, ped/bikes		0.96	0.97					0.98			1.00	
Flpb, ped/bikes		1.00	1.00					1.00			0.99	
Frt		0.93	0.85					0.96			1.00	
Flt Protected		1.00	1.00					1.00			0.99	
Satd. Flow (prot)		4270	1315					1752			1838	
Flt Permitted		1.00	1.00					1.00			0.69	
Satd. Flow (perm)		4270	1315					1752			1270	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	53	773	1401	0	0	0	0	284	105	63	337	0
RTOR Reduction (vph)	0	84	0	0	0	0	0	22	0	0	0	0
Lane Group Flow (vph)	0	1443	700	0	0	0	0	367	0	0	400	0
Confl. Peds. (#/hr)	51		75	75		51	29		79	79		29
Confl. Bikes (#/hr)											1	1
Turn Type	Perm		Free							Perm		
Protected Phases		2						4			8	
Permitted Phases	2		Free							8		
Actuated Green, G (s)		33.0	60.0					18.0			18.0	
Effective Green, g (s)		34.0	60.0					18.0			18.0	
Actuated g/C Ratio		0.57	1.00					0.30			0.30	
Clearance Time (s)		5.0						4.0			4.0	
Vehicle Extension (s)		2.0						2.0			2.0	
Lane Grp Cap (vph)		2420	1315					526			381	
v/s Ratio Prot								0.21				
v/s Ratio Perm		0.34	0.53								c0.31	
v/c Ratio		0.60	0.53					0.70			1.05	
Uniform Delay, d1		8.5	0.0					18.6			21.0	
Progression Factor		0.72	1.00					1.00			1.00	
Incremental Delay, d2		0.1	0.1					3.2			59.8	
Delay (s)		6.2	0.1					21.8			80.8	
Level of Service		A	A					C			F	
Approach Delay (s)		4.3			0.0			21.8			80.8	
Approach LOS		A			A			C			F	

Intersection Summary			
HCM Average Control Delay	16.7	HCM Level of Service	B
HCM Volume to Capacity ratio	0.75		
Actuated Cycle Length (s)	60.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	81.1%	ICU Level of Service	D
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Volume (vph)	390	100	70	947	1236	580
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	0.97	1.00	1.00	0.95	0.91	0.88
Frpb, ped/bikes	1.00	0.98	1.00	1.00	1.00	1.00
Flpb, ped/bikes	1.00	1.00	1.00	1.00	1.00	1.00
Frt	1.00	0.85	1.00	1.00	1.00	0.85
Flt Protected	0.95	1.00	0.95	1.00	1.00	1.00
Satd. Flow (prot)	3433	1550	1770	3539	5085	2787
Flt Permitted	0.95	1.00	0.95	1.00	1.00	1.00
Satd. Flow (perm)	3433	1550	1770	3539	5085	2787
Peak-hour factor, PHF	0.94	0.94	0.94	0.94	0.94	0.94
Adj. Flow (vph)	415	106	74	1007	1315	617
RTOR Reduction (vph)	0	0	0	0	0	432
Lane Group Flow (vph)	415	106	74	1007	1315	185
Confl. Peds. (#/hr)	2	16	2			2
Turn Type		Perm	Prot			Prot
Protected Phases	4		5	2	6	6
Permitted Phases		4				
Actuated Green, G (s)	26.0	26.0	4.0	26.0	18.0	18.0
Effective Green, g (s)	26.0	26.0	4.0	26.0	18.0	18.0
Actuated g/C Ratio	0.43	0.43	0.07	0.43	0.30	0.30
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0	4.0
Lane Grp Cap (vph)	1488	672	118	1534	1526	836
v/s Ratio Prot	c0.12		0.04	c0.28	c0.26	0.07
v/s Ratio Perm		0.07				
v/c Ratio	0.28	0.16	0.63	0.66	0.86	0.22
Uniform Delay, d1	11.0	10.3	27.3	13.5	19.8	15.7
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	0.5	0.5	22.6	2.2	6.6	0.6
Delay (s)	11.4	10.8	49.9	15.7	26.5	16.4
Level of Service	B	B	D	B	C	B
Approach Delay (s)	11.3			18.0	23.2	
Approach LOS	B			B	C	

Intersection Summary			
HCM Average Control Delay	19.9	HCM Level of Service	B
HCM Volume to Capacity ratio	0.55		
Actuated Cycle Length (s)	60.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	63.6%	ICU Level of Service	B
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	23	270	83	65	118	60	64	93	147	90	150	10
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0			4.0	4.0	4.0	4.0		4.0	4.0	
Lane Util. Factor		0.95			0.95	1.00	1.00	0.95		0.91	0.91	
Frpb, ped/bikes		0.99			1.00	0.99	1.00	0.99		1.00	1.00	
Flpb, ped/bikes		1.00			1.00	1.00	1.00	1.00		1.00	1.00	
Frt		0.97			1.00	0.85	1.00	0.91		1.00	0.99	
Flt Protected		1.00			0.98	1.00	0.95	1.00		0.95	1.00	
Satd. Flow (prot)		3391			3474	1563	1770	3188		1610	3347	
Flt Permitted		0.93			0.74	1.00	0.95	1.00		0.95	1.00	
Satd. Flow (perm)		3165			2631	1563	1770	3188		1610	3347	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	25	293	90	71	128	65	70	101	160	98	163	11
RTOR Reduction (vph)	0	35	0	0	0	0	0	126	0	0	6	0
Lane Group Flow (vph)	0	373	0	0	199	65	70	135	0	88	178	0
Confl. Peds. (#/hr)	2		4	4		2	4		2	2		4
Confl. Bikes (#/hr)			2			1						2
Turn Type	Perm			Perm		Free	Split			Split		
Protected Phases		2			6		3	3		4	4	
Permitted Phases	2			6		Free						
Actuated Green, G (s)		12.0			11.0	41.0	8.8	8.8		7.2	7.2	
Effective Green, g (s)		12.0			12.0	41.0	8.8	8.8		8.2	8.2	
Actuated g/C Ratio		0.29			0.29	1.00	0.21	0.21		0.20	0.20	
Clearance Time (s)		4.0			5.0		4.0	4.0		5.0	5.0	
Vehicle Extension (s)		3.0			3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)		926			770	1563	380	684		322	669	
v/s Ratio Prot							0.04	c0.04		c0.05	0.05	
v/s Ratio Perm		c0.12			0.08	0.04						
v/c Ratio		0.40			0.26	0.04	0.18	0.20		0.27	0.27	
Uniform Delay, d1		11.6			11.1	0.0	13.2	13.2		13.9	13.9	
Progression Factor		1.00			1.00	1.00	1.00	1.00		1.00	1.00	
Incremental Delay, d2		0.3			0.2	0.0	0.2	0.1		0.5	0.2	
Delay (s)		11.9			11.3	0.0	13.4	13.3		14.3	14.1	
Level of Service		B			B	A	B	B		B	B	
Approach Delay (s)		11.9			8.5			13.4			14.2	
Approach LOS		B			A			B			B	

Intersection Summary			
HCM Average Control Delay	12.1	HCM Level of Service	B
HCM Volume to Capacity ratio	0.30		
Actuated Cycle Length (s)	41.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	44.8%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	10	477	10	190	233	40	10	40	130	30	40	10
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0			4.0			4.0	
Lane Util. Factor	1.00	0.95		1.00	0.95			1.00			1.00	
Frpb, ped/bikes	1.00	1.00		1.00	1.00			0.98			1.00	
Flpb, ped/bikes	1.00	1.00		1.00	1.00			1.00			1.00	
Frt	1.00	1.00		1.00	0.98			0.90			0.98	
Flt Protected	0.95	1.00		0.95	1.00			1.00			0.98	
Satd. Flow (prot)	1787	3563		1787	3481			1659			1804	
Flt Permitted	0.95	1.00		0.95	1.00			0.99			0.88	
Satd. Flow (perm)	1787	3563		1787	3481			1645			1610	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	11	518	11	207	253	43	11	43	141	33	43	11
RTOR Reduction (vph)	0	2	0	0	23	0	0	80	0	0	6	0
Lane Group Flow (vph)	11	527	0	207	273	0	0	115	0	0	81	0
Confl. Peds. (#/hr)	4					4	1		24	24		1
Confl. Bikes (#/hr)						2			1			
Heavy Vehicles (%)	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%
Turn Type	Prot			Prot			Perm			Perm		
Protected Phases	7	4		3	8			2			6	
Permitted Phases							2			6		
Actuated Green, G (s)	6.0	16.0		6.0	16.0			26.0			26.0	
Effective Green, g (s)	6.0	16.0		6.0	16.0			26.0			26.0	
Actuated g/C Ratio	0.10	0.27		0.10	0.27			0.43			0.43	
Clearance Time (s)	4.0	4.0		4.0	4.0			4.0			4.0	
Lane Grp Cap (vph)	179	950		179	928			713			698	
v/s Ratio Prot	0.01	c0.15		c0.12	0.08							
v/s Ratio Perm								c0.07			0.05	
v/c Ratio	0.06	0.55		1.16	0.29			0.16			0.12	
Uniform Delay, d1	24.5	18.9		27.0	17.5			10.4			10.1	
Progression Factor	1.00	1.00		1.00	1.00			1.00			1.00	
Incremental Delay, d2	0.7	2.3		115.6	0.8			0.5			0.3	
Delay (s)	25.1	21.3		142.6	18.3			10.8			10.5	
Level of Service	C	C		F	B			B			B	
Approach Delay (s)		21.3			69.5			10.8			10.5	
Approach LOS		C			E			B			B	

Intersection Summary			
HCM Average Control Delay	37.4	HCM Level of Service	D
HCM Volume to Capacity ratio	0.42		
Actuated Cycle Length (s)	60.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	57.4%	ICU Level of Service	B
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	427	270	80	90	288	70	100	530	100	120	840	376
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width	10	11	12	11	11	12	12	12	12	12	12	12
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0		4.0	4.0		4.0	4.0	4.0
Lane Util. Factor	0.97	0.95	1.00	1.00	0.95		1.00	0.95		1.00	0.95	1.00
Frpb, ped/bikes	1.00	1.00	0.93	1.00	0.98		1.00	0.99		1.00	1.00	0.90
Flpb, ped/bikes	1.00	1.00	1.00	1.00	1.00		1.00	1.00		1.00	1.00	1.00
Frt	1.00	1.00	0.85	1.00	0.97		1.00	0.98		1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00		0.95	1.00		0.95	1.00	1.00
Satd. Flow (prot)	2884	3079	1331	1540	2941		1593	3079		1593	3185	1243
Flt Permitted	0.95	1.00	1.00	0.95	1.00		0.95	1.00		0.95	1.00	1.00
Satd. Flow (perm)	2884	3079	1331	1540	2941		1593	3079		1593	3185	1243
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	464	293	87	98	313	76	109	576	109	130	913	409
RTOR Reduction (vph)	0	0	67	0	19	0	0	12	0	0	0	269
Lane Group Flow (vph)	464	293	20	98	370	0	109	673	0	130	913	140
Confl. Peds. (#/hr)			47			60			42			75
Confl. Bikes (#/hr)						1						
Bus Blockages (#/hr)	0	0	0	0	0	2	0	0	0	0	0	8
Turn Type	Split		Perm	Split			Prot			Prot		Perm
Protected Phases	4	4		8	8		5	2		1	6	
Permitted Phases			4									6
Actuated Green, G (s)	22.3	22.3	22.3	17.7	17.7		10.7	29.7		11.5	30.5	30.5
Effective Green, g (s)	22.3	22.3	22.3	17.7	17.7		10.7	30.7		11.5	31.5	31.5
Actuated g/C Ratio	0.23	0.23	0.23	0.18	0.18		0.11	0.31		0.12	0.32	0.32
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0		4.0	5.0		4.0	5.0	5.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0		3.0	3.0		3.0	3.0	3.0
Lane Grp Cap (vph)	655	699	302	278	530		174	963		187	1022	399
v/s Ratio Prot	c0.16	0.10		0.06	c0.13		0.07	0.22		c0.08	c0.29	
v/s Ratio Perm			0.01									0.11
v/c Ratio	0.71	0.42	0.07	0.35	0.70		0.63	0.70		0.70	0.89	0.35
Uniform Delay, d1	35.0	32.4	29.8	35.2	37.7		41.8	29.7		41.7	31.8	25.5
Progression Factor	1.00	1.00	1.00	1.00	1.00		1.00	1.00		1.00	1.00	1.00
Incremental Delay, d2	3.5	0.4	0.1	0.8	4.0		6.9	2.2		10.7	10.1	0.5
Delay (s)	38.5	32.8	29.9	36.0	41.7		48.7	31.9		52.3	41.8	26.1
Level of Service	D	C	C	D	D		D	C		D	D	C
Approach Delay (s)		35.6			40.6			34.2			38.3	
Approach LOS		D			D			C			D	

Intersection Summary			
HCM Average Control Delay	37.1	HCM Level of Service	D
HCM Volume to Capacity ratio	0.75		
Actuated Cycle Length (s)	98.2	Sum of lost time (s)	12.0
Intersection Capacity Utilization	78.5%	ICU Level of Service	D
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	120	206	133	50	144	120	114	480	40	140	1200	140
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.9	4.9		4.9	4.9		4.3	4.8	4.8	4.3	4.8	4.8
Lane Util. Factor	1.00	0.95		1.00	0.95		0.97	0.95	1.00	0.97	0.95	1.00
Frpb, ped/bikes	1.00	0.99		1.00	0.99		1.00	1.00	0.98	1.00	1.00	0.99
Flpb, ped/bikes	1.00	1.00		1.00	1.00		1.00	1.00	1.00	1.00	1.00	1.00
Frt	1.00	0.94		1.00	0.93		1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	1787	3341		1787	3295		3467	3574	1571	3467	3574	1576
Flt Permitted	0.95	1.00		0.95	1.00		0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)	1787	3341		1787	3295		3467	3574	1571	3467	3574	1576
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	126	217	140	53	152	126	120	505	42	147	1263	147
RTOR Reduction (vph)	0	112	0	0	110	0	0	0	25	0	0	16
Lane Group Flow (vph)	126	245	0	53	168	0	120	505	17	147	1263	131
Confl. Peds. (#/hr)			7			14			8			3
Confl. Bikes (#/hr)						1						
Heavy Vehicles (%)	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%
Turn Type	Split			Split			Prot		Perm	Prot		Perm
Protected Phases	4	4		8	8		5	2		1	6	
Permitted Phases									2			6
Actuated Green, G (s)	11.4	11.4		10.1	10.1		5.2	29.6	29.6	4.2	28.6	28.6
Effective Green, g (s)	10.5	10.5		9.2	9.2		4.9	29.8	29.8	3.9	28.8	28.8
Actuated g/C Ratio	0.15	0.15		0.13	0.13		0.07	0.41	0.41	0.05	0.40	0.40
Clearance Time (s)	4.0	4.0		4.0	4.0		4.0	5.0	5.0	4.0	5.0	5.0
Vehicle Extension (s)	2.0	2.0		2.0	2.0		2.0	2.0	2.0	2.0	2.0	2.0
Lane Grp Cap (vph)	260	485		227	419		235	1473	648	187	1424	628
v/s Ratio Prot	0.07	c0.07		0.03	c0.05		0.03	0.14		c0.04	c0.35	
v/s Ratio Perm									0.01			0.08
v/c Ratio	0.48	0.51		0.23	0.40		0.51	0.34	0.03	0.79	0.89	0.21
Uniform Delay, d1	28.4	28.5		28.4	29.0		32.5	14.5	12.6	33.8	20.2	14.3
Progression Factor	1.00	1.00		1.00	1.00		1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	0.5	0.3		0.2	0.2		0.8	0.1	0.0	17.9	6.9	0.1
Delay (s)	28.9	28.8		28.6	29.2		33.3	14.6	12.6	51.7	27.1	14.3
Level of Service	C	C		C	C		C	B	B	D	C	B
Approach Delay (s)		28.8			29.1			17.8			28.2	
Approach LOS		C			C			B			C	

Intersection Summary			
HCM Average Control Delay	26.1	HCM Level of Service	C
HCM Volume to Capacity ratio	0.70		
Actuated Cycle Length (s)	72.3	Sum of lost time (s)	18.9
Intersection Capacity Utilization	72.9%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	110	33	33	20	14	40	14	134	30	70	223	25
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0			4.0	4.0	4.0	4.0		4.0	4.0	
Lane Util. Factor		1.00			1.00	1.00	1.00	1.00		1.00	1.00	
Frpb, ped/bikes		0.99			1.00	0.98	1.00	1.00		1.00	1.00	
Flpb, ped/bikes		1.00			1.00	1.00	1.00	1.00		1.00	1.00	
Frt		0.97			1.00	0.85	1.00	0.97		1.00	0.98	
Flt Protected		0.97			0.97	1.00	0.95	1.00		0.95	1.00	
Satd. Flow (prot)		1751			1809	1545	1770	1804		1770	1829	
Flt Permitted		0.97			0.97	1.00	0.95	1.00		0.95	1.00	
Satd. Flow (perm)		1751			1809	1545	1770	1804		1770	1829	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	120	36	36	22	15	43	15	146	33	76	242	27
RTOR Reduction (vph)	0	9	0	0	0	40	0	9	0	0	4	0
Lane Group Flow (vph)	0	183	0	0	37	3	15	170	0	76	265	0
Confl. Peds. (#/hr)	2		6	6		2	8		2	2		8
Confl. Bikes (#/hr)						1						
Turn Type	Split			Split		Perm	Split			Split		
Protected Phases	2	2		1	1		4	4		3	3	
Permitted Phases						1						
Actuated Green, G (s)		12.2			3.9	3.9	12.7	12.7		15.1	15.1	
Effective Green, g (s)		12.2			3.9	3.9	12.7	12.7		15.1	15.1	
Actuated g/C Ratio		0.20			0.07	0.07	0.21	0.21		0.25	0.25	
Clearance Time (s)		4.0			4.0	4.0	4.0	4.0		4.0	4.0	
Vehicle Extension (s)		3.0			3.0	3.0	3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)		357			118	101	375	382		446	461	
v/s Ratio Prot		c0.10			c0.02		0.01	c0.09		0.04	c0.14	
v/s Ratio Perm						0.00						
v/c Ratio		0.51			0.31	0.03	0.04	0.44		0.17	0.57	
Uniform Delay, d1		21.2			26.7	26.2	18.8	20.5		17.5	19.6	
Progression Factor		1.00			1.00	1.00	1.00	1.00		1.00	1.00	
Incremental Delay, d2		1.2			1.5	0.1	0.0	0.8		0.2	1.7	
Delay (s)		22.5			28.2	26.3	18.8	21.4		17.7	21.3	
Level of Service		C			C	C	B	C		B	C	
Approach Delay (s)		22.5			27.2			21.2			20.5	
Approach LOS		C			C			C			C	

Intersection Summary			
HCM Average Control Delay	21.8	HCM Level of Service	C
HCM Volume to Capacity ratio	0.50		
Actuated Cycle Length (s)	59.9	Sum of lost time (s)	16.0
Intersection Capacity Utilization	44.5%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	160	163	40	60	154	40	20	430	40	50	630	100
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0			4.0			4.0	
Lane Util. Factor	1.00	0.95		1.00	0.95			0.95			0.95	
Frpb, ped/bikes	1.00	0.99		1.00	1.00			1.00			0.99	
Flpb, ped/bikes	0.99	1.00		0.98	1.00			1.00			1.00	
Frt	1.00	0.97		1.00	0.97			0.99			0.98	
Flt Protected	0.95	1.00		0.95	1.00			1.00			1.00	
Satd. Flow (prot)	1584	3071		1568	3074			3129			3090	
Flt Permitted	0.62	1.00		0.62	1.00			0.91			0.89	
Satd. Flow (perm)	1042	3071		1022	3074			2867			2773	
Peak-hour factor, PHF	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96
Adj. Flow (vph)	167	170	42	62	160	42	21	448	42	52	656	104
RTOR Reduction (vph)	0	24	0	0	24	0	0	10	0	0	17	0
Lane Group Flow (vph)	167	188	0	62	178	0	0	501	0	0	795	0
Confl. Peds. (#/hr)	10		29	29		10	63		34	34		63
Confl. Bikes (#/hr)									1			
Parking (#/hr)							0					
Turn Type	Perm			Perm			Perm			Perm		
Protected Phases		4			4			2			2	
Permitted Phases	4			4			2			2		
Actuated Green, G (s)	30.0	30.0		30.0	30.0			32.0			32.0	
Effective Green, g (s)	29.0	29.0		29.0	29.0			31.0			31.0	
Actuated g/C Ratio	0.43	0.43		0.43	0.43			0.46			0.46	
Clearance Time (s)	3.0	3.0		3.0	3.0			3.0			3.0	
Lane Grp Cap (vph)	444	1310		436	1311			1307			1264	
v/s Ratio Prot		0.06			0.06							
v/s Ratio Perm	c0.16			0.06				0.17			c0.29	
v/c Ratio	0.38	0.14		0.14	0.14			0.38			0.63	
Uniform Delay, d1	13.3	11.9		11.9	11.9			12.2			14.1	
Progression Factor	1.00	1.00		1.00	1.00			1.00			1.00	
Incremental Delay, d2	2.4	0.2		0.7	0.2			0.9			2.4	
Delay (s)	15.7	12.1		12.6	12.1			13.1			16.5	
Level of Service	B	B		B	B			B			B	
Approach Delay (s)		13.7			12.2			13.1			16.5	
Approach LOS		B			B			B			B	

Intersection Summary			
HCM Average Control Delay	14.5	HCM Level of Service	B
HCM Volume to Capacity ratio	0.51		
Actuated Cycle Length (s)	68.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	96.6%	ICU Level of Service	F
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	20	193	30	20	174	144	20	420	40	573	550	40
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0			5.0			5.0		5.0	5.0	
Lane Util. Factor		0.95			0.95			0.95		0.97	1.00	
Frpb, ped/bikes		1.00			0.99			1.00		1.00	1.00	
Flpb, ped/bikes		1.00			1.00			1.00		1.00	1.00	
Frt		0.98			0.94			0.99		1.00	0.99	
Flt Protected		1.00			1.00			1.00		0.95	1.00	
Satd. Flow (prot)		3481			3312			3516		3467	1859	
Flt Permitted		0.90			0.92			1.00		0.95	1.00	
Satd. Flow (perm)		3149			3064			3516		3467	1859	
Peak-hour factor, PHF	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94
Adj. Flow (vph)	21	205	32	21	185	153	21	447	43	610	585	43
RTOR Reduction (vph)	0	16	0	0	127	0	0	9	0	0	3	0
Lane Group Flow (vph)	0	242	0	0	232	0	0	502	0	610	625	0
Confl. Peds. (#/hr)	2		6	6		2	11		10	10		11
Confl. Bikes (#/hr)						2						1
Heavy Vehicles (%)	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%
Turn Type	Perm			Perm			Split			Split		
Protected Phases		4			4		2	2		3	3	
Permitted Phases	4			4								
Actuated Green, G (s)		12.0			12.0			14.3		26.4	26.4	
Effective Green, g (s)		11.0			11.0			13.3		25.4	25.4	
Actuated g/C Ratio		0.17			0.17			0.21		0.39	0.39	
Clearance Time (s)		4.0			4.0			4.0		4.0	4.0	
Vehicle Extension (s)		3.0			3.0			3.0		3.0	3.0	
Lane Grp Cap (vph)		535			521			723		1361	730	
v/s Ratio Prot								c0.14		0.18	c0.34	
v/s Ratio Perm		c0.08			0.08							
v/c Ratio		0.45			0.45			0.69		0.45	0.86	
Uniform Delay, d1		24.1			24.1			23.8		14.5	18.0	
Progression Factor		1.00			1.00			1.00		1.00	1.00	
Incremental Delay, d2		0.6			0.6			2.9		0.2	9.7	
Delay (s)		24.8			24.7			26.7		14.7	27.7	
Level of Service		C			C			C		B	C	
Approach Delay (s)		24.8			24.7			26.7			21.3	
Approach LOS		C			C			C			C	

Intersection Summary			
HCM Average Control Delay	23.4	HCM Level of Service	C
HCM Volume to Capacity ratio	0.72		
Actuated Cycle Length (s)	64.7	Sum of lost time (s)	15.0
Intersection Capacity Utilization	82.4%	ICU Level of Service	E
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	20	368	419	20	306	120	351	290	40	100	390	30
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0	4.0		4.0		4.0	4.0			4.0	
Lane Util. Factor		0.91	0.91		0.95		1.00	1.00			1.00	
Frpb, ped/bikes		0.99	0.96		0.99		1.00	1.00			1.00	
Flpb, ped/bikes		1.00	1.00		1.00		1.00	1.00			1.00	
Frt		0.95	0.85		0.96		1.00	0.98			0.99	
Flt Protected		1.00	1.00		1.00		0.95	1.00			0.99	
Satd. Flow (prot)		2998	1399		3152		1787	1583			1586	
Flt Permitted		0.93	1.00		0.88		0.95	1.00			0.99	
Satd. Flow (perm)		2786	1399		2779		1787	1583			1586	
Peak-hour factor, PHF	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97
Adj. Flow (vph)	21	379	432	21	315	124	362	299	41	103	402	31
RTOR Reduction (vph)	0	53	197	0	46	0	0	6	0	0	3	0
Lane Group Flow (vph)	0	520	62	0	414	0	362	334	0	0	533	0
Confl. Peds. (#/hr)	17		21	21		17	30		15	15		30
Confl. Bikes (#/hr)			1			1						
Heavy Vehicles (%)	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%
Parking (#/hr)		8			8			8			8	
Turn Type	Perm		Perm	Perm			Split			Split		
Protected Phases		2			2		4	4		8	8	
Permitted Phases	2		2	2								
Actuated Green, G (s)		20.0	20.0		20.0		25.0	25.0			26.0	
Effective Green, g (s)		20.0	20.0		20.0		25.0	25.0			26.0	
Actuated g/C Ratio		0.24	0.24		0.24		0.30	0.30			0.31	
Clearance Time (s)		4.0	4.0		4.0		4.0	4.0			4.0	
Lane Grp Cap (vph)		671	337		670		538	477			497	
v/s Ratio Prot							0.20	c0.21			c0.34	
v/s Ratio Perm		c0.19	0.04		0.15							
v/c Ratio		0.77	0.19		0.62		0.67	0.70			1.07	
Uniform Delay, d1		29.4	25.0		28.1		25.4	25.7			28.5	
Progression Factor		1.00	1.00		1.00		1.00	1.00			1.00	
Incremental Delay, d2		8.5	1.2		4.3		6.6	8.3			61.3	
Delay (s)		37.9	26.2		32.3		32.0	34.0			89.8	
Level of Service		D	C		C		C	C			F	
Approach Delay (s)		34.3			32.3			32.9			89.8	
Approach LOS		C			C			C			F	

Intersection Summary			
HCM Average Control Delay	45.3	HCM Level of Service	D
HCM Volume to Capacity ratio	0.86		
Actuated Cycle Length (s)	83.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	87.8%	ICU Level of Service	E
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL2	EBL	EBT	EBR	NBT	NBR	NBR2	SBL2	SBL	SBT
Lane Configurations										
Volume (vph)	30	958	310	100	380	270	70	334	270	343
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0	4.0	4.5	4.0	4.0		4.0	4.0	4.0
Lane Util. Factor		0.91	0.91	1.00	0.95	1.00		1.00	1.00	1.00
Frpb, ped/bikes		1.00	1.00	0.85	1.00	0.92		1.00	1.00	1.00
Flpb, ped/bikes		1.00	1.00	1.00	1.00	1.00		1.00	1.00	1.00
Frt		1.00	1.00	0.85	1.00	0.85		1.00	1.00	1.00
Flt Protected		0.95	0.97	1.00	1.00	1.00		0.95	0.95	1.00
Satd. Flow (prot)		1610	3289	1343	3539	1450		1770	1770	1863
Flt Permitted		0.95	0.97	1.00	1.00	1.00		0.95	0.95	1.00
Satd. Flow (perm)		1610	3289	1343	3539	1450		1770	1770	1863
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	32	1008	326	105	400	284	74	352	284	361
RTOR Reduction (vph)	0	0	0	68	0	11	0	0	0	0
Lane Group Flow (vph)	0	516	850	37	400	347	0	352	284	361
Confl. Peds. (#/hr)				50			50		50	
Confl. Bikes (#/hr)				10			10			
Turn Type	Perm	Perm		Perm		Perm		Prot	Prot	
Protected Phases			4		2			1	1	6
Permitted Phases	4	4		4		2				
Actuated Green, G (s)		30.9	30.9	30.9	20.4	20.4		25.7	25.7	49.1
Effective Green, g (s)		32.4	32.4	31.9	19.9	19.9		25.7	25.7	49.6
Actuated g/C Ratio		0.36	0.36	0.35	0.22	0.22		0.29	0.29	0.55
Clearance Time (s)		5.5	5.5	5.5	3.5	3.5		4.0	4.0	4.5
Vehicle Extension (s)		2.0	2.0	2.0	2.0	2.0		2.0	2.0	2.0
Lane Grp Cap (vph)		580	1184	476	783	321		505	505	1027
v/s Ratio Prot					0.11			c0.20	0.16	0.19
v/s Ratio Perm		c0.32	0.26	0.03		c0.24				
v/c Ratio		0.89	0.87dl	0.08	0.51	1.08		0.70	0.56	0.35
Uniform Delay, d1		27.1	24.9	19.3	30.8	35.0		28.7	27.4	11.2
Progression Factor		1.00	1.00	1.00	1.00	1.00		1.00	1.00	1.00
Incremental Delay, d2		15.1	1.8	0.0	0.2	73.6		7.8	4.5	0.9
Delay (s)		42.2	26.6	19.3	31.0	108.7		36.4	31.8	12.2
Level of Service		D	C	B	C	F		D	C	B
Approach Delay (s)			31.5		67.7					26.3
Approach LOS			C		E					C

Intersection Summary			
HCM Average Control Delay	38.4	HCM Level of Service	D
HCM Volume to Capacity ratio	0.88		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	76.1%	ICU Level of Service	D
Analysis Period (min)	15		

dl Defacto Left Lane. Recode with 1 though lane as a left lane.
c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	0	0	368	667	0	0	0	0	0	892	350
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)				4.0	4.0						4.0	4.0
Lane Util. Factor				0.86	0.86						0.86	0.86
Frpb, ped/bikes				1.00	1.00						1.00	1.00
Flpb, ped/bikes				1.00	1.00						1.00	1.00
Frt				1.00	1.00						0.99	0.85
Flt Protected				0.95	0.99						1.00	1.00
Satd. Flow (prot)				1522	4770						4745	1362
Flt Permitted				0.95	0.99						1.00	1.00
Satd. Flow (perm)				1522	4770						4745	1362
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	0	0	0	387	702	0	0	0	0	0	939	368
RTOR Reduction (vph)	0	0	0	196	22	0	0	0	0	0	11	112
Lane Group Flow (vph)	0	0	0	67	804	0	0	0	0	0	1005	179
Confl. Bikes (#/hr)						5						9
Turn Type				Prot								Prot
Protected Phases				7	3						2	2
Permitted Phases												
Actuated Green, G (s)				20.0	40.0						31.0	31.0
Effective Green, g (s)				20.0	40.0						31.0	31.0
Actuated g/C Ratio				0.25	0.51						0.39	0.39
Clearance Time (s)				4.0	4.0						4.0	4.0
Lane Grp Cap (vph)				385	2415						1862	534
v/s Ratio Prot				0.04	c0.08						c0.21	0.13
v/s Ratio Perm					0.08							
v/c Ratio				0.17	0.33						0.54	0.33
Uniform Delay, d1				23.0	11.6						18.5	16.8
Progression Factor				1.00	1.00						1.00	1.00
Incremental Delay, d2				1.0	0.4						1.1	1.7
Delay (s)				24.0	12.0						19.6	18.5
Level of Service				C	B						B	B
Approach Delay (s)		0.0			14.9			0.0			19.4	
Approach LOS		A			B			A			B	

Intersection Summary			
HCM Average Control Delay	17.3	HCM Level of Service	B
HCM Volume to Capacity ratio	0.42		
Actuated Cycle Length (s)	79.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	41.8%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	210	740	0	0	0	0	0	819	1818	0	0	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0						4.0	4.0			
Lane Util. Factor		0.91						0.91	0.88			
Frpb, ped/bikes		1.00						1.00	1.00			
Flpb, ped/bikes		1.00						1.00	1.00			
Frt		1.00						1.00	0.85			
Flt Protected		0.99						1.00	1.00			
Satd. Flow (prot)		5013						5085	2787			
Flt Permitted		0.99						1.00	1.00			
Satd. Flow (perm)		5013						5085	2787			
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	221	779	0	0	0	0	0	862	1914	0	0	0
RTOR Reduction (vph)	0	3	0	0	0	0	0	0	231	0	0	0
Lane Group Flow (vph)	0	998	0	0	0	0	0	862	1683	0	0	0
Confl. Peds. (#/hr)	28		7	7		28	99		3	3		99
Confl. Bikes (#/hr)			1			2			1			
Turn Type	Perm								custom			
Protected Phases		4						2	2			
Permitted Phases	4								7			
Actuated Green, G (s)		34.0						16.0	16.0			
Effective Green, g (s)		35.0						17.0	17.0			
Actuated g/C Ratio		0.58						0.28	0.28			
Clearance Time (s)		5.0						5.0	5.0			
Vehicle Extension (s)		3.0						3.0	3.0			
Lane Grp Cap (vph)		2924						1441	790			
v/s Ratio Prot								0.17	c0.60			
v/s Ratio Perm		0.20										
v/c Ratio		0.34						0.60	2.13			
Uniform Delay, d1		6.5						18.6	21.5			
Progression Factor		1.00						1.00	1.00			
Incremental Delay, d2		0.3						0.7	512.7			
Delay (s)		6.8						19.2	534.2			
Level of Service		A						B	F			
Approach Delay (s)		6.8			0.0			374.3			0.0	
Approach LOS		A			A			F			A	

Intersection Summary			
HCM Average Control Delay	277.0	HCM Level of Service	F
HCM Volume to Capacity ratio	0.93		
Actuated Cycle Length (s)	60.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	98.9%	ICU Level of Service	F
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	50	1176	1353	0	0	0	0	230	240	80	340	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0	4.0					4.0			4.0	
Lane Util. Factor		0.86	0.86					1.00			1.00	
Frpb, ped/bikes		0.98	0.97					0.98			1.00	
Flpb, ped/bikes		1.00	1.00					1.00			1.00	
Frt		0.95	0.85					0.93			1.00	
Flt Protected		1.00	1.00					1.00			0.99	
Satd. Flow (prot)		4421	1323					1701			1842	
Flt Permitted		1.00	1.00					1.00			0.39	
Satd. Flow (perm)		4421	1323					1701			733	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	53	1238	1424	0	0	0	0	242	253	84	358	0
RTOR Reduction (vph)	0	70	0	0	0	0	0	31	0	0	0	0
Lane Group Flow (vph)	0	1933	712	0	0	0	0	464	0	0	442	0
Confl. Peds. (#/hr)	52		55	55		52	39		25	25		39
Confl. Bikes (#/hr)			1						2		1	2
Turn Type	Perm		Free							Perm		
Protected Phases		2						4			8	
Permitted Phases	2		Free							8		
Actuated Green, G (s)		33.0	60.0					18.0			18.0	
Effective Green, g (s)		34.0	60.0					18.0			18.0	
Actuated g/C Ratio		0.57	1.00					0.30			0.30	
Clearance Time (s)		5.0						4.0			4.0	
Vehicle Extension (s)		2.0						2.0			2.0	
Lane Grp Cap (vph)		2505	1323					510			220	
v/s Ratio Prot								0.27				
v/s Ratio Perm		0.44	0.54								c0.60	
v/c Ratio		0.77	0.54					0.91			2.01	
Uniform Delay, d1		10.0	0.0					20.2			21.0	
Progression Factor		0.62	1.00					1.00			1.00	
Incremental Delay, d2		0.2	0.1					20.0			469.8	
Delay (s)		6.4	0.1					40.3			490.8	
Level of Service		A	A					D			F	
Approach Delay (s)		4.8			0.0			40.3			490.8	
Approach LOS		A			A			D			F	

Intersection Summary			
HCM Average Control Delay	68.4	HCM Level of Service	E
HCM Volume to Capacity ratio	1.20		
Actuated Cycle Length (s)	60.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	97.5%	ICU Level of Service	F
Analysis Period (min)	15		
c Critical Lane Group			

Appendix F: Freeway LOS Calculations
Alameda Point

FEHR PEERS

Existing Conditions

FEHR PEERS

HCM 2000
Basic Freeway Segments
Capacity Analysis

Jurisdiction
Analysis Year Existing
Analyst TL

Agency or Company
Date
Project Description

General Information				*Flow Rate Calculation*														*Speed Calculation*		*Results*	
	Freeway/ Direction	From/To	Analysis Time Period	Volume (vph)	PHF	Lanes	HOV Lane?	HOV Lane Volume	Terrain	Truck/ Bus %	RV %	E_T	E_R	f_{HV}	f_P	Flow Rate v_p (pcphpl)	Measured FFS (mph)	S (mph)	Density, D (pcplpm)	Level of Service
A-1	I-880 NB	I-880, west of SR 24	AM	7,490	0.92	3	No		Level	11%	0%	1.5	1.2	0.949	1.00	2,859	65.0	-	**-**	**F**
A-2	I-880 NB	I-880, between SR 24 and Oak Street	AM	7,270	0.92	4	No		Level	11%	0%	1.5	1.2	0.949	1.00	2,081	65.0	59.9	**34.7**	**D**
A-3	I-880 NB	I-880, south of Oak Street	AM	7,060	0.92	4	No		Level	11%	0%	1.5	1.2	0.949	1.00	2,021	65.0	61.1	**33.1**	**D**
A-4	Posey Tube	Alameda to Oakland	AM	2,650	0.92	2	No		Level	2%	0%	1.5	1.2	0.990	1.00	1,455	65.0	65.0	**22.4**	**C**
A-1	I-880 SB	I-880, west of SR 24	AM	7,630	0.92	3	No		Level	11%	0%	1.5	1.2	0.949	1.00	2,912	65.0	-	**-**	**F**
A-2	I-880 SB	I-880, between SR 24 and Oak Street	AM	9,130	0.92	4	No		Level	11%	0%	1.5	1.2	0.949	1.00	2,614	65.0	-	**-**	**F**
A-3	I-880 SB	I-880, south of Oak Street	AM	6,980	0.92	4	No		Level	11%	0%	1.5	1.2	0.949	1.00	1,998	65.0	61.5	**32.5**	**D**
A-4	Webster Tube	Oakland to Alameda	AM	1,750	0.92	2	No		Level	2%	0%	1.5	1.2	0.990	1.00	961	65.0	65.0	**14.8**	**B**
A-1	I-880 NB	I-880, west of SR 24	PM	7,150	0.92	3	No		Level	11%	0%	1.5	1.2	0.949	1.00	2,729	65.0	-	**-**	**F**
A-2	I-880 NB	I-880, between SR 24 and Oak Street	PM	7,430	0.92	4	No		Level	11%	0%	1.5	1.2	0.949	1.00	2,127	65.0	58.9	**36.1**	**E**
A-3	I-880 NB	I-880, south of Oak Street	PM	7,050	0.92	4	No		Level	11%	0%	1.5	1.2	0.949	1.00	2,018	65.0	61.1	**33.0**	**D**
A-4	Posey Tube	Alameda to Oakland	PM	2,250	0.92	2	No		Level	2%	0%	1.5	1.2	0.990	1.00	1,235	65.0	65.0	**19.0**	**C**
A-1	I-880 SB	I-880, west of SR 24	PM	8,090	0.92	3	No		Level	11%	0%	1.5	1.2	0.949	1.00	3,088	65.0	-	**-**	**F**
A-2	I-880 SB	I-880, between SR 24 and Oak Street	PM	9,210	0.92	4	No		Level	11%	0%	1.5	1.2	0.949	1.00	2,637	65.0	-	**-**	**F**
A-3	I-880 SB	I-880, south of Oak Street	PM	7,480	0.92	4	No		Level	11%	0%	1.5	1.2	0.949	1.00	2,141	65.0	58.6	**36.6**	**E**
A-4	Webster Tube	Oakland to Alameda	PM	2,610	0.92	2	No		Level	2%	0%	1.5	1.2	0.990	1.00	1,433	65.0	65.0	**22.0**	**C**

Near-Term (2018) No Project Conditions

FEHR PEERS

HCM 2000
Basic Freeway Segments
Capacity Analysis

Jurisdiction
Analysis Year Near-Term
Analyst TL

Agency or Company
Date
Project Description

General Information				*Flow Rate Calculation*														*Speed Calculation*		*Results*	
	Freeway/ Direction	From/To	Analysis Time Period	Volume (vph)	PHF	Lanes	HOV Lane?	HOV Lane Volume	Terrain	Truck/ Bus %	RV %	E_T	E_R	f_{HV}	f_P	Flow Rate v_p (pcphpl)	Measured FFS (mph)	S (mph)	Density, D (pcplpm)	Level of Service
A-1	I-880 NB	I-880, west of SR 24	AM	7,620	0.92	3	No		Level	11%	0%	1.5	1.2	0.949	1.00	2,909	65.0	-	**-**	**F**
A-2	I-880 NB	I-880, between SR 24 and Oak Street	AM	7,380	0.92	4	No		Level	11%	0%	1.5	1.2	0.949	1.00	2,113	65.0	59.2	**35.7**	**E**
A-3	I-880 NB	I-880, south of Oak Street	AM	7,200	0.92	4	No		Level	11%	0%	1.5	1.2	0.949	1.00	2,061	65.0	60.3	**34.2**	**D**
A-4	Posey Tube	Alameda to Oakland	AM	2,770	0.92	2	No		Level	2%	0%	1.5	1.2	0.990	1.00	1,520	65.0	65.0	**23.4**	**C**
A-1	I-880 SB	I-880, west of SR 24	AM	7,650	0.92	3	No		Level	11%	0%	1.5	1.2	0.949	1.00	2,920	65.0	-	**-**	**F**
A-2	I-880 SB	I-880, between SR 24 and Oak Street	AM	9,320	0.92	4	No		Level	11%	0%	1.5	1.2	0.949	1.00	2,668	65.0	-	**-**	**F**
A-3	I-880 SB	I-880, south of Oak Street	AM	7,180	0.92	4	No		Level	11%	0%	1.5	1.2	0.949	1.00	2,055	65.0	60.4	**34.0**	**D**
A-4	Webster Tube	Oakland to Alameda	AM	2,010	0.92	2	No		Level	2%	0%	1.5	1.2	0.990	1.00	1,103	65.0	65.0	**17.0**	**B**
A-1	I-880 NB	I-880, west of SR 24	PM	7,400	0.92	3	No		Level	11%	0%	1.5	1.2	0.949	1.00	2,825	65.0	-	**-**	**F**
A-2	I-880 NB	I-880, between SR 24 and Oak Street	PM	7,710	0.92	4	No		Level	11%	0%	1.5	1.2	0.949	1.00	2,207	65.0	56.8	**38.8**	**E**
A-3	I-880 NB	I-880, south of Oak Street	PM	7,390	0.92	4	No		Level	11%	0%	1.5	1.2	0.949	1.00	2,116	65.0	59.2	**35.8**	**E**
A-4	Posey Tube	Alameda to Oakland	PM	2,450	0.92	2	No		Level	2%	0%	1.5	1.2	0.990	1.00	1,345	65.0	65.0	**20.7**	**C**
A-1	I-880 SB	I-880, west of SR 24	PM	8,170	0.92	3	No		Level	11%	0%	1.5	1.2	0.949	1.00	3,119	65.0	-	**-**	**F**
A-2	I-880 SB	I-880, between SR 24 and Oak Street	PM	9,390	0.92	4	No		Level	11%	0%	1.5	1.2	0.949	1.00	2,688	65.0	-	**-**	**F**
A-3	I-880 SB	I-880, south of Oak Street	PM	7,700	0.92	4	No		Level	11%	0%	1.5	1.2	0.949	1.00	2,204	65.0	56.9	**38.7**	**E**
A-4	Webster Tube	Oakland to Alameda	PM	2,810	0.92	2	No		Level	2%	0%	1.5	1.2	0.990	1.00	1,542	65.0	65.0	**23.7**	**C**

Near-Term (2018) Plus Phase 1 Project Conditions

FEHR PEERS

HCM 2000
Basic Freeway Segments
Capacity Analysis

Jurisdiction
Analysis Year Near-Term + Project (Phase 1)
Analyst TL

Agency or Company
Date
Project Description

General Information				*Flow Rate Calculation*														*Speed Calculation*		*Results*	
	Freeway/ Direction	From/To	Analysis Time Period	Volume (vph)	PHF	Lanes	HOV Lane?	HOV Lane Volume	Terrain	Truck/ Bus %	RV %	E_T	E_R	f_{HV}	f_P	Flow Rate v_p (pcphpl)	Measured FFS (mph)	S (mph)	Density, D (pcplpm)	Level of Service
A-1	I-880 NB	I-880, west of SR 24	AM	7,623	0.92	3	No		Level	11%	0%	1.5	1.2	0.949	1.00	2,910	65.0	-	**-**	**F**
A-2	I-880 NB	I-880, between SR 24 and Oak Street	AM	7,387	0.92	4	No		Level	11%	0%	1.5	1.2	0.949	1.00	2,115	65.0	59.2	**35.7**	**E**
A-3	I-880 NB	I-880, south of Oak Street	AM	7,240	0.92	4	No		Level	11%	0%	1.5	1.2	0.949	1.00	2,073	65.0	60.1	**34.5**	**D**
A-4	Posey Tube	Alameda to Oakland	AM	2,787	0.92	2	No		Level	2%	0%	1.5	1.2	0.990	1.00	1,530	65.0	65.0	**23.5**	**C**
A-1	I-880 SB	I-880, west of SR 24	AM	7,668	0.92	3	No		Level	11%	0%	1.5	1.2	0.949	1.00	2,927	65.0	-	**-**	**F**
A-2	I-880 SB	I-880, between SR 24 and Oak Street	AM	9,320	0.92	4	No		Level	11%	0%	1.5	1.2	0.949	1.00	2,668	65.0	-	**-**	**F**
A-3	I-880 SB	I-880, south of Oak Street	AM	7,187	0.92	4	No		Level	11%	0%	1.5	1.2	0.949	1.00	2,057	65.0	60.4	**34.1**	**D**
A-4	Webster Tube	Oakland to Alameda	AM	2,114	0.92	2	No		Level	2%	0%	1.5	1.2	0.990	1.00	1,160	65.0	65.0	**17.9**	**B**
A-1	I-880 NB	I-880, west of SR 24	PM	7,417	0.92	3	No		Level	11%	0%	1.5	1.2	0.949	1.00	2,831	65.0	-	**-**	**F**
A-2	I-880 NB	I-880, between SR 24 and Oak Street	PM	7,751	0.92	4	No		Level	11%	0%	1.5	1.2	0.949	1.00	2,219	65.0	56.5	**39.3**	**E**
A-3	I-880 NB	I-880, south of Oak Street	PM	7,396	0.92	4	No		Level	11%	0%	1.5	1.2	0.949	1.00	2,117	65.0	59.1	**35.8**	**E**
A-4	Posey Tube	Alameda to Oakland	PM	2,548	0.92	2	No		Level	2%	0%	1.5	1.2	0.990	1.00	1,399	65.0	65.0	**21.5**	**C**
A-1	I-880 SB	I-880, west of SR 24	PM	8,173	0.92	3	No		Level	11%	0%	1.5	1.2	0.949	1.00	3,120	65.0	-	**-**	**F**
A-2	I-880 SB	I-880, between SR 24 and Oak Street	PM	9,390	0.92	4	No		Level	11%	0%	1.5	1.2	0.949	1.00	2,688	65.0	-	**-**	**F**
A-3	I-880 SB	I-880, south of Oak Street	PM	7,738	0.92	4	No		Level	11%	0%	1.5	1.2	0.949	1.00	2,215	65.0	56.6	**39.1**	**E**
A-4	Webster Tube	Oakland to Alameda	PM	2,825	0.92	2	No		Level	2%	0%	1.5	1.2	0.990	1.00	1,551	65.0	65.0	**23.9**	**C**

Cumulative (2035) No Project Conditions

FEHR PEERS

HCM 2000
Basic Freeway Segments
Capacity Analysis

Jurisdiction
Analysis Year Cumulative
Analyst TL

Agency or Company
Date
Project Description

General Information				*Flow Rate Calculation*														*Speed Calculation*		*Results*	
	Freeway/ Direction	From/To	Analysis Time Period	Volume (vph)	PHF	Lanes	HOV Lane?	HOV Lane Volume	Terrain	Truck/ Bus %	RV %	E_T	E_R	f_{HV}	f_P	Flow Rate v_p (pcphpl)	Measured FFS (mph)	S (mph)	Density, D (pcplpm)	Level of Service
A-1	I-880 NB	I-880, west of SR 24	AM	7,990	0.92	3	No		Level	11%	0%	1.5	1.2	0.949	1.00	3,050	65.0	-	**-**	**F**
A-2	I-880 NB	I-880, between SR 24 and Oak Street	AM	7,710	0.92	4	No		Level	11%	0%	1.5	1.2	0.949	1.00	2,207	65.0	56.8	**38.8**	**E**
A-3	I-880 NB	I-880, south of Oak Street	AM	7,610	0.92	4	No		Level	11%	0%	1.5	1.2	0.949	1.00	2,179	65.0	57.6	**37.8**	**E**
A-4	Posey Tube	Alameda to Oakland	AM	3,120	0.92	2	No		Level	2%	0%	1.5	1.2	0.990	1.00	1,713	65.0	64.5	**26.6**	**D**
A-1	I-880 SB	I-880, west of SR 24	AM	7,710	0.92	3	No		Level	11%	0%	1.5	1.2	0.949	1.00	2,943	65.0	-	**-**	**F**
A-2	I-880 SB	I-880, between SR 24 and Oak Street	AM	9,870	0.92	4	No		Level	11%	0%	1.5	1.2	0.949	1.00	2,826	65.0	-	**-**	**F**
A-3	I-880 SB	I-880, south of Oak Street	AM	7,750	0.92	4	No		Level	11%	0%	1.5	1.2	0.949	1.00	2,219	65.0	56.5	**39.3**	**E**
A-4	Webster Tube	Oakland to Alameda	AM	2,730	0.92	2	No		Level	2%	0%	1.5	1.2	0.990	1.00	1,499	65.0	65.0	**23.1**	**C**
A-1	I-880 NB	I-880, west of SR 24	PM	8,090	0.92	3	No		Level	11%	0%	1.5	1.2	0.949	1.00	3,088	65.0	-	**-**	**F**
A-2	I-880 NB	I-880, between SR 24 and Oak Street	PM	8,510	0.92	4	No		Level	11%	0%	1.5	1.2	0.949	1.00	2,436	65.0	-	**-**	**F**
A-3	I-880 NB	I-880, south of Oak Street	PM	8,340	0.92	4	No		Level	11%	0%	1.5	1.2	0.949	1.00	2,388	65.0	-	**-**	**F**
A-4	Posey Tube	Alameda to Oakland	PM	3,030	0.92	2	No		Level	2%	0%	1.5	1.2	0.990	1.00	1,663	65.0	64.7	**25.7**	**C**
A-1	I-880 SB	I-880, west of SR 24	PM	8,380	0.92	3	No		Level	11%	0%	1.5	1.2	0.949	1.00	3,199	65.0	-	**-**	**F**
A-2	I-880 SB	I-880, between SR 24 and Oak Street	PM	9,910	0.92	4	No		Level	11%	0%	1.5	1.2	0.949	1.00	2,837	65.0	-	**-**	**F**
A-3	I-880 SB	I-880, south of Oak Street	PM	8,330	0.92	4	No		Level	11%	0%	1.5	1.2	0.949	1.00	2,385	65.0	-	**-**	**F**
A-4	Webster Tube	Oakland to Alameda	PM	3,370	0.92	2	No		Level	2%	0%	1.5	1.2	0.990	1.00	1,850	65.0	63.5	**29.2**	**D**

Cumulative (2035) Plus Phase 1 Project Conditions

FEHR PEERS

HCM 2000
Basic Freeway Segments
Capacity Analysis

Jurisdiction
Analysis Year Cumulative + Project (Phase 1)
Analyst TL

Agency or Company
Date
Project Description

General Information				*Flow Rate Calculation*														*Speed Calculation*		*Results*	
	Freeway/ Direction	From/To	Analysis Time Period	Volume (vph)	PHF	Lanes	HOV Lane?	HOV Lane Volume	Terrain	Truck/ Bus %	RV %	E_T	E_R	f_{HV}	f_P	Flow Rate v_p (pcphpl)	Measured FFS (mph)	S (mph)	Density, D (pcplpm)	Level of Service
A-1	I-880 NB	I-880, west of SR 24	AM	7,993	0.92	3	No		Level	11%	0%	1.5	1.2	0.949	1.00	3,051	65.0	-	**-**	**F**
A-2	I-880 NB	I-880, between SR 24 and Oak Street	AM	7,717	0.92	4	No		Level	11%	0%	1.5	1.2	0.949	1.00	2,209	65.0	56.8	**38.9**	**E**
A-3	I-880 NB	I-880, south of Oak Street	AM	7,650	0.92	4	No		Level	11%	0%	1.5	1.2	0.949	1.00	2,190	65.0	57.3	**38.2**	**E**
A-4	Posey Tube	Alameda to Oakland	AM	3,137	0.92	2	No		Level	2%	0%	1.5	1.2	0.990	1.00	1,722	65.0	64.4	**26.7**	**D**
A-1	I-880 SB	I-880, west of SR 24	AM	7,728	0.92	3	No		Level	11%	0%	1.5	1.2	0.949	1.00	2,950	65.0	-	**-**	**F**
A-2	I-880 SB	I-880, between SR 24 and Oak Street	AM	9,870	0.92	4	No		Level	11%	0%	1.5	1.2	0.949	1.00	2,826	65.0	-	**-**	**F**
A-3	I-880 SB	I-880, south of Oak Street	AM	7,757	0.92	4	No		Level	11%	0%	1.5	1.2	0.949	1.00	2,221	65.0	56.5	**39.3**	**E**
A-4	Webster Tube	Oakland to Alameda	AM	2,834	0.92	2	No		Level	2%	0%	1.5	1.2	0.990	1.00	1,556	65.0	65.0	**24.0**	**C**
A-1	I-880 NB	I-880, west of SR 24	PM	8,107	0.92	3	No		Level	11%	0%	1.5	1.2	0.949	1.00	3,094	65.0	-	**-**	**F**
A-2	I-880 NB	I-880, between SR 24 and Oak Street	PM	8,551	0.92	4	No		Level	11%	0%	1.5	1.2	0.949	1.00	2,448	65.0	-	**-**	**F**
A-3	I-880 NB	I-880, south of Oak Street	PM	8,346	0.92	4	No		Level	11%	0%	1.5	1.2	0.949	1.00	2,389	65.0	-	**-**	**F**
A-4	Posey Tube	Alameda to Oakland	PM	3,128	0.92	2	No		Level	2%	0%	1.5	1.2	0.990	1.00	1,717	65.0	64.5	**26.6**	**D**
A-1	I-880 SB	I-880, west of SR 24	PM	8,383	0.92	3	No		Level	11%	0%	1.5	1.2	0.949	1.00	3,200	65.0	-	**-**	**F**
A-2	I-880 SB	I-880, between SR 24 and Oak Street	PM	9,910	0.92	4	No		Level	11%	0%	1.5	1.2	0.949	1.00	2,837	65.0	-	**-**	**F**
A-3	I-880 SB	I-880, south of Oak Street	PM	8,368	0.92	4	No		Level	11%	0%	1.5	1.2	0.949	1.00	2,396	65.0	-	**-**	**F**
A-4	Webster Tube	Oakland to Alameda	PM	3,385	0.92	2	No		Level	2%	0%	1.5	1.2	0.990	1.00	1,858	65.0	63.4	**29.3**	**D**

Near-Term (2018) Plus Additional Employment Alternative Conditions

FEHR PEERS

HCM 2000
Basic Freeway Segments
Capacity Analysis

Jurisdiction
Analysis Year Near-Term + Phase 1 Alternative
Analyst SN

Agency or Company
Date
Project Description

General Information				*Flow Rate Calculation*														*Speed Calculation*		*Results*	
	Freeway/ Direction	From/To	Analysis Time Period	Volume (vph)	PHF	Lanes	HOV Lane?	HOV Lane Volume	Terrain	Truck/ Bus %	RV %	E_T	E_R	f_{HV}	f_P	Flow Rate v_p (pcphpl)	Measured FFS (mph)	S (mph)	Density, D (pcplpm)	Level of Service
A-1	I-880 NB	I-880, west of SR 24	AM	7,625	0.92	3	No		Level	11%	0%	1.5	1.2	0.949	1.00	2,910	65.0	-	**-**	**F**
A-2	I-880 NB	I-880, between SR 24 and Oak Street	AM	7,392	0.92	4	No		Level	11%	0%	1.5	1.2	0.949	1.00	2,116	65.0	59.2	**35.8**	**E**
A-3	I-880 NB	I-880, south of Oak Street	AM	7,268	0.92	4	No		Level	11%	0%	1.5	1.2	0.949	1.00	2,081	65.0	59.9	**34.7**	**D**
A-4	Posey Tube	Alameda to Oakland	AM	2,798	0.92	2	No		Level	2%	0%	1.5	1.2	0.990	1.00	1,536	65.0	65.0	**23.6**	**C**
A-1	I-880 SB	I-880, west of SR 24	AM	7,681	0.92	3	No		Level	11%	0%	1.5	1.2	0.949	1.00	2,932	65.0	-	**-**	**F**
A-2	I-880 SB	I-880, between SR 24 and Oak Street	AM	9,320	0.92	4	No		Level	11%	0%	1.5	1.2	0.949	1.00	2,668	65.0	-	**-**	**F**
A-3	I-880 SB	I-880, south of Oak Street	AM	7,191	0.92	4	No		Level	11%	0%	1.5	1.2	0.949	1.00	2,059	65.0	60.4	**34.1**	**D**
A-4	Webster Tube	Oakland to Alameda	AM	2,186	0.92	2	No		Level	2%	0%	1.5	1.2	0.990	1.00	1,200	65.0	65.0	**18.5**	**C**
A-1	I-880 NB	I-880, west of SR 24	PM	7,429	0.92	3	No		Level	11%	0%	1.5	1.2	0.949	1.00	2,836	65.0	-	**-**	**F**
A-2	I-880 NB	I-880, between SR 24 and Oak Street	PM	7,780	0.92	4	No		Level	11%	0%	1.5	1.2	0.949	1.00	2,227	65.0	56.3	**39.6**	**E**
A-3	I-880 NB	I-880, south of Oak Street	PM	7,400	0.92	4	No		Level	11%	0%	1.5	1.2	0.949	1.00	2,118	65.0	59.1	**35.8**	**E**
A-4	Posey Tube	Alameda to Oakland	PM	2,617	0.92	2	No		Level	2%	0%	1.5	1.2	0.990	1.00	1,437	65.0	65.0	**22.1**	**C**
A-1	I-880 SB	I-880, west of SR 24	PM	8,175	0.92	3	No		Level	11%	0%	1.5	1.2	0.949	1.00	3,120	65.0	-	**-**	**F**
A-2	I-880 SB	I-880, between SR 24 and Oak Street	PM	9,390	0.92	4	No		Level	11%	0%	1.5	1.2	0.949	1.00	2,688	65.0	-	**-**	**F**
A-3	I-880 SB	I-880, south of Oak Street	PM	7,765	0.92	4	No		Level	11%	0%	1.5	1.2	0.949	1.00	2,223	65.0	56.4	**39.4**	**E**
A-4	Webster Tube	Oakland to Alameda	PM	2,836	0.92	2	No		Level	2%	0%	1.5	1.2	0.990	1.00	1,557	65.0	65.0	**24.0**	**C**

Appendix G: Intersection Count Data Sheets
LBNL

FEHR PEERS

Study Name University Ave/Shattuck Ave TMC
Start Date 01/31/2013
Start Time 7:00 AM
Site Code WC12-2953_#1

	Southbound Street Southbound				Westbound Street Westbound				Northbound Street Northbound				Eastbound Street Eastbound			
Start Time	Right	Thru	Left	U-Turn	Right	Thru	Left	U-Turn	Right	Thru	Left	U-Turn	Right	Thru	Left	U-Turn
7:00 AM	0	3	0	0	1	1	0	0	0	0	0	0	1	0	0	0
7:15 AM	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0
7:30 AM	0	2	1	0	1	0	0	0	0	0	0	0	1	2	0	0
7:45 AM	0	2	0	0	1	0	0	0	0	0	0	0	0	4	0	0
8:00 AM	0	3	0	0	0	0	0	0	0	0	0	0	0	2	0	0
8:15 AM	0	2	0	0	0	1	0	0	0	0	0	0	2	1	0	0
8:30 AM	0	7	1	0	2	1	0	0	0	0	0	0	1	2	0	0
8:45 AM	0	5	0	0	1	3	0	0	0	1	0	0	1	4	0	0
4:00 PM	0	3	0	0	0	2	0	0	0	0	0	0	1	2	0	0
4:15 PM	0	6	0	0	0	2	0	0	0	0	0	0	0	0	0	0
4:30 PM	1	3	0	0	0	5	1	0	0	0	0	0	0	0	0	0
4:45 PM	0	6	0	0	2	3	0	0	0	0	0	0	0	0	1	0
5:00 PM	0	8	0	0	1	5	0	0	0	0	0	0	1	4	0	0
5:15 PM	0	8	0	0	0	6	0	0	0	0	0	0	0	2	0	0
5:30 PM	0	3	0	0	3	0	1	0	0	0	0	0	0	4	0	0
5:45 PM	0	7	0	0	0	2	0	0	0	0	0	0	1	0	0	0

Study Name University Ave/Shattuck Ave TMC
Start Date 01/31/2013
Start Time 7:00 AM
Site Code WC12-2953_#1

	Southbound Street Southbound		Westbound Street Westbound		Northbound Street Northbound		Eastbound Street Eastbound	
Start Time	Peds CCW	Peds CW	Peds CCW	Peds CW	Peds CCW	Peds CW	Peds CCW	Peds CW
7:00 AM	3	6	5	8	3	0	12	7
7:15 AM	4	4	6	18	5	2	18	18
7:30 AM	7	13	15	17	17	3	32	15
7:45 AM	8	17	11	23	30	2	30	22
8:00 AM	10	8	7	18	15	0	36	24
8:15 AM	6	17	15	20	10	5	45	21
8:30 AM	3	18	13	38	21	5	41	41
8:45 AM	11	21	24	34	28	5	56	43
4:00 PM	32	22	30	35	20	26	62	86
4:15 PM	33	21	20	29	22	23	59	61
4:30 PM	26	13	13	26	22	22	54	60
4:45 PM	36	17	25	21	33	29	81	74
5:00 PM	43	22	21	35	24	35	85	93
5:15 PM	48	23	16	27	26	41	77	91
5:30 PM	44	28	41	30	23	35	83	103
5:45 PM	43	30	27	45	19	23	61	88

Study Name University Ave/Shattuck Ave TMC
Start Date 01/31/2013
Start Time 7:00 AM
Site Code WC12-2953_#1

	Southbound Street Southbound				Westbound Street Westbound				Northbound Street Northbound				Eastbound Street Eastbound			
Start Time	Right	Thru	Left	U-Turn	Right	Thru	Left	U-Turn	Right	Thru	Left	U-Turn	Right	Thru	Left	U-Turn
7:00 AM	15	67	0	0	16	51	3	0	0	0	0	0	23	52	10	1
7:15 AM	11	76	1	0	40	49	5	0	0	0	0	0	23	59	9	0
7:30 AM	14	109	9	0	33	65	9	0	0	0	0	0	30	88	11	0
7:45 AM	17	155	7	0	61	58	3	0	0	0	0	0	32	102	27	1
8:00 AM	28	176	9	0	36	68	3	0	0	0	0	0	41	90	16	0
8:15 AM	15	199	9	0	69	96	3	0	0	0	0	0	50	92	23	0
8:30 AM	23	155	6	0	59	82	8	0	0	0	0	0	33	96	25	0
8:45 AM	23	180	12	0	73	70	9	0	0	1	0	0	47	103	25	2
4:00 PM	24	137	7	0	74	144	13	0	0	0	0	0	46	67	27	0
4:15 PM	34	127	5	0	88	123	16	0	0	0	0	0	48	82	23	0
4:30 PM	26	114	9	0	96	156	14	0	0	0	0	0	38	83	22	0
4:45 PM	22	128	4	0	93	120	15	0	0	0	0	0	57	103	27	0
5:00 PM	27	131	2	0	112	140	12	0	0	0	0	0	51	87	31	0
5:15 PM	32	128	9	0	84	139	18	1	0	0	0	0	62	100	28	0
5:30 PM	31	125	10	0	123	129	20	0	0	0	0	0	52	104	22	0
5:45 PM	27	138	12	0	121	144	17	1	0	0	0	0	62	106	34	0

Totals

Study Name Hearst Ave/Shattuck Ave TMC
Start Date 01/31/2013
Start Time 7:00 AM
Site Code WC12-2953_#2

	Southbound Street Southbound				Westbound Street Westbound				Northbound Street Northbound				Eastbound Street Eastbound			
Start Time	Right	Thru	Left	U-Turn	Right	Thru	Left	U-Turn	Right	Thru	Left	U-Turn	Right	Thru	Left	U-Turn
7:00 AM	0	2	0	0	0	3	0	0	0	1	0	0	0	3	0	0
7:15 AM	0	1	1	0	0	2	0	0	0	3	0	0	0	3	0	0
7:30 AM	0	4	3	0	0	0	0	0	0	0	0	0	0	5	0	0
7:45 AM	0	3	2	0	0	0	0	0	0	4	0	0	1	2	0	0
8:00 AM	0	3	4	0	0	0	0	0	0	0	0	0	2	5	0	0
8:15 AM	1	2	3	0	0	2	2	0	0	2	1	0	1	11	1	0
8:30 AM	0	8	1	0	0	3	1	0	1	0	0	0	2	17	0	0
8:45 AM	0	3	9	0	0	1	0	0	0	2	0	0	5	23	0	0
4:00 PM	0	2	0	0	0	8	0	0	0	3	0	0	2	1	0	0
4:15 PM	0	1	0	0	0	10	2	0	0	5	0	0	1	0	0	0
4:30 PM	0	4	2	0	0	11	0	0	0	7	2	0	0	0	0	0
4:45 PM	0	7	1	0	0	8	0	0	0	6	3	0	0	4	0	0
5:00 PM	0	4	0	0	1	29	3	0	0	4	1	0	1	4	0	0
5:15 PM	1	9	1	0	3	17	3	0	0	3	2	0	1	1	0	0
5:30 PM	1	4	1	0	2	23	2	0	0	7	0	0	1	2	0	0
5:45 PM	0	3	0	0	1	14	2	0	0	3	1	0	0	2	0	0

Study Name Hearst Ave/Shattuck Ave TMC
Start Date 01/31/2013
Start Time 7:00 AM
Site Code WC12-2953_#2

	Southbound Street Southbound		Westbound Street Westbound		Northbound Street Northbound		Eastbound Street Eastbound	
Start Time	Peds CCW	Peds CW	Peds CCW	Peds CW	Peds CCW	Peds CW	Peds CCW	Peds CW
7:00 AM	0	0	1	3	3	1	12	1
7:15 AM	1	4	2	13	2	0	10	6
7:30 AM	3	7	2	14	10	0	29	4
7:45 AM	1	9	8	22	24	0	29	14
8:00 AM	5	12	3	18	7	2	28	7
8:15 AM	1	11	7	17	11	3	30	17
8:30 AM	1	15	6	31	12	3	34	19
8:45 AM	2	18	15	24	30	3	40	16
4:00 PM	13	1	22	14	3	9	25	39
4:15 PM	8	6	20	15	7	15	28	39
4:30 PM	5	4	28	17	8	11	22	31
4:45 PM	13	4	31	13	7	5	37	45
5:00 PM	38	8	22	15	0	5	39	45
5:15 PM	42	6	35	26	5	27	42	48
5:30 PM	20	3	34	27	5	26	47	48
5:45 PM	13	32	30	16	6	12	37	57

Study Name Hearst Ave/Shattuck Ave TMC
Start Date 01/31/2013
Start Time 7:00 AM
Site Code WC12-2953_#2

	Southbound Street Southbound				Westbound Street Westbound				Northbound Street Northbound				Eastbound Street Eastbound			
Start Time	Right	Thru	Left	U-Turn	Right	Thru	Left	U-Turn	Right	Thru	Left	U-Turn	Right	Thru	Left	U-Turn
7:00 AM	2	81	9	0	0	11	4	0	3	17	0	0	3	20	3	0
7:15 AM	6	88	18	0	9	8	4	0	4	40	0	1	3	27	3	0
7:30 AM	4	121	38	0	6	12	13	0	4	34	1	0	8	29	2	0
7:45 AM	2	176	38	0	6	25	13	0	9	73	2	0	9	50	5	0
8:00 AM	15	209	32	0	7	51	16	0	8	52	3	0	9	50	4	0
8:15 AM	11	219	32	0	11	50	15	0	3	94	2	0	12	64	9	0
8:30 AM	10	184	40	0	11	42	12	0	6	84	0	0	7	62	9	0
8:45 AM	16	205	47	0	17	33	16	1	9	95	4	0	21	82	5	0
4:00 PM	12	131	13	0	20	56	26	0	5	125	9	0	11	28	6	0
4:15 PM	10	128	15	0	30	69	23	0	3	123	9	1	7	27	14	0
4:30 PM	6	103	15	0	18	90	19	0	6	120	7	1	8	25	14	0
4:45 PM	11	143	26	2	26	63	21	0	6	133	8	2	8	41	8	0
5:00 PM	14	122	16	1	36	107	30	0	8	126	12	1	12	42	10	0
5:15 PM	11	135	16	0	45	97	30	0	6	130	9	1	10	39	12	0
5:30 PM	8	124	15	1	36	102	27	0	9	155	6	0	17	46	14	0
5:45 PM	9	158	21	0	24	77	25	0	8	155	5	2	6	39	17	0

Totals

Study Name University Ave/Oxford St TMC
Start Date 01/31/2013
Start Time 7:00 AM
Site Code WC12-2953_#3

	Southbound Street Southbound				Westbound Street Westbound				Northbound Street Northbound				Eastbound Street Eastbound			
Start Time	Right	Thru	Left	U-Turn	Right	Thru	Left	U-Turn	Right	Thru	Left	U-Turn	Right	Thru	Left	U-Turn
7:00 AM	0	3	2	0	0	0	0	0	0	2	0	0	0	0	0	0
7:15 AM	0	2	2	0	1	0	0	0	0	3	1	0	0	0	0	0
7:30 AM	0	7	2	0	0	0	0	0	0	3	1	0	1	0	0	0
7:45 AM	0	6	8	0	0	0	0	0	0	3	2	0	0	3	2	0
8:00 AM	1	8	3	0	0	0	0	0	4	2	1	0	0	4	0	0
8:15 AM	0	11	1	0	1	1	0	0	0	4	2	0	0	0	0	0
8:30 AM	1	8	10	0	0	2	0	0	0	0	0	0	3	2	0	0
8:45 AM	1	8	3	0	0	2	0	0	0	6	2	0	0	5	1	0
4:00 PM	0	5	0	0	4	4	0	0	0	4	2	0	0	1	1	0
4:15 PM	0	4	1	0	2	1	1	0	0	2	1	0	0	1	1	0
4:30 PM	0	7	0	0	1	6	0	0	0	4	2	0	0	0	0	0
4:45 PM	1	1	0	0	3	2	0	0	0	3	1	0	0	0	0	0
5:00 PM	0	10	0	0	0	1	0	0	0	3	2	0	1	1	1	0
5:15 PM	0	7	0	0	0	3	1	0	0	1	1	0	0	2	0	0
5:30 PM	1	7	2	0	0	0	2	0	0	5	2	0	1	1	0	0
5:45 PM	0	9	0	0	0	1	0	0	0	5	3	0	3	0	1	0

Study Name University Ave/Oxford St TMC
Start Date 01/31/2013
Start Time 7:00 AM
Site Code WC12-2953_#3

	Southbound Street Southbound		Westbound Street Westbound		Northbound Street Northbound		Eastbound Street Eastbound	
Start Time	Peds CCW	Peds CW	Peds CCW	Peds CW	Peds CCW	Peds CW	Peds CCW	Peds CW
7:00 AM	1	1	0	0	5	0	5	6
7:15 AM	1	3	0	7	2	1	2	4
7:30 AM	0	20	0	2	9	0	7	15
7:45 AM	1	59	11	6	13	0	11	10
8:00 AM	3	26	14	7	9	2	7	11
8:15 AM	3	22	7	7	9	2	15	7
8:30 AM	2	23	8	12	12	4	20	12
8:45 AM	9	30	4	15	19	10	23	22
4:00 PM	37	14	7	8	22	24	24	22
4:15 PM	26	12	14	8	10	11	7	6
4:30 PM	17	11	8	10	5	10	14	15
4:45 PM	35	20	12	12	21	24	11	23
5:00 PM	54	14	9	32	8	41	23	43
5:15 PM	42	8	18	10	21	23	19	17
5:30 PM	36	17	10	18	8	27	18	10
5:45 PM	34	16	11	7	17	18	18	8

Study Name University Ave/Oxford St TMC
Start Date 01/31/2013
Start Time 7:00 AM
Site Code WC12-2953_#3

	Southbound Street Southbound				Westbound Street Westbound				Northbound Street Northbound				Eastbound Street Eastbound			
Start Time	Right	Thru	Left	U-Turn	Right	Thru	Left	U-Turn	Right	Thru	Left	U-Turn	Right	Thru	Left	U-Turn
7:00 AM	13	72	3	0	0	2	0	0	0	35	15	0	24	1	48	0
7:15 AM	12	77	6	0	3	1	0	0	0	44	18	0	30	3	41	0
7:30 AM	13	136	3	0	2	5	0	0	0	50	18	0	53	10	48	0
7:45 AM	9	180	12	1	2	1	0	0	1	88	24	0	60	7	84	0
8:00 AM	13	212	6	0	4	5	1	0	4	86	19	0	48	9	74	0
8:15 AM	16	211	4	0	5	1	0	0	1	107	34	0	63	2	85	0
8:30 AM	18	165	15	0	2	4	1	0	0	90	28	1	48	5	77	0
8:45 AM	15	157	12	0	3	3	0	0	0	90	24	0	54	9	88	0
4:00 PM	21	129	0	1	9	6	1	0	0	134	56	1	54	4	46	1
4:15 PM	24	110	4	2	5	3	4	0	1	134	42	0	66	6	51	1
4:30 PM	31	118	3	0	4	7	1	0	1	112	51	0	52	4	54	0
4:45 PM	18	110	2	1	5	2	1	0	0	129	41	3	76	3	74	0
5:00 PM	35	158	9	0	4	8	1	0	1	165	52	0	57	6	54	0
5:15 PM	30	154	4	2	12	6	1	0	0	148	40	1	83	6	68	1
5:30 PM	36	152	6	0	2	4	3	0	5	181	45	2	58	6	62	0
5:45 PM	7	167	4	1	6	5	1	0	8	156	54	4	73	3	81	1

Totals

Study Name Hearst Ave/Oxford St TMC
Start Date 01/31/2013
Start Time 7:00 AM
Site Code WC12-2953_#4

	Southbound Street Southbound				Westbound Street Westbound				Northbound Street Northbound				Eastbound Street Eastbound			
Start Time	Right	Thru	Left	U-Turn	Right	Thru	Left	U-Turn	Right	Thru	Left	U-Turn	Right	Thru	Left	U-Turn
7:00 AM	0	4	0	0	0	1	0	0	0	0	1	0	4	0	0	0
7:15 AM	0	4	1	0	0	2	0	0	0	2	0	0	1	2	1	0
7:30 AM	0	1	1	0	0	0	0	0	3	1	1	0	8	4	0	0
7:45 AM	0	5	0	0	0	1	1	0	0	0	0	0	12	12	0	0
8:00 AM	0	3	0	0	0	0	2	0	0	0	0	0	8	8	0	0
8:15 AM	0	5	0	0	0	0	0	0	0	0	0	0	5	14	0	0
8:30 AM	1	9	0	0	0	1	1	0	0	0	2	0	5	8	0	0
8:45 AM	0	1	1	0	0	1	2	0	0	0	1	0	9	26	0	0
4:00 PM	0	3	0	0	0	7	1	0	0	3	3	0	1	4	0	0
4:15 PM	0	1	0	0	1	11	1	0	1	2	1	0	0	0	0	0
4:30 PM	0	0	0	0	0	10	5	0	0	2	2	0	0	1	0	0
4:45 PM	0	0	0	0	0	9	0	0	0	1	0	0	2	1	0	0
5:00 PM	0	2	0	0	1	22	4	0	0	4	8	0	0	2	0	0
5:15 PM	0	3	0	0	1	17	2	0	1	1	8	0	3	1	0	0
5:30 PM	0	1	0	0	0	19	5	0	1	5	8	0	2	0	0	0
5:45 PM	0	2	0	0	0	17	1	0	0	2	2	0	2	2	0	0

Study Name Hearst Ave/Oxford St TMC
Start Date 01/31/2013
Start Time 7:00 AM
Site Code WC12-2953_#4

	Southbound Street Southbound		Westbound Street Westbound		Northbound Street Northbound		Eastbound Street Eastbound	
Start Time	Peds CCW	Peds CW	Peds CCW	Peds CW	Peds CCW	Peds CW	Peds CCW	Peds CW
7:00 AM	2	5	1	4	2	1	4	5
7:15 AM	5	6	1	5	2	0	7	5
7:30 AM	3	7	0	13	7	0	13	5
7:45 AM	5	32	11	18	32	2	22	9
8:00 AM	11	13	2	13	27	1	20	2
8:15 AM	4	23	1	11	11	4	13	3
8:30 AM	9	17	0	21	17	4	16	2
8:45 AM	9	29	3	20	29	4	26	2
4:00 PM	30	8	27	8	2	12	8	10
4:15 PM	25	7	12	6	8	13	7	6
4:30 PM	23	11	15	4	3	10	6	11
4:45 PM	22	19	16	22	6	6	9	13
5:00 PM	73	11	29	8	8	15	11	15
5:15 PM	71	13	55	17	4	12	6	10
5:30 PM	46	11	25	4	6	5	12	10
5:45 PM	36	19	31	7	9	15	27	8

Study Name Hearst Ave/Oxford St TMC
Start Date 01/31/2013
Start Time 7:00 AM
Site Code WC12-2953_#4

	Southbound Street Southbound				Westbound Street Westbound				Northbound Street Northbound				Eastbound Street Eastbound			
Start Time	Right	Thru	Left	U-Turn	Right	Thru	Left	U-Turn	Right	Thru	Left	U-Turn	Right	Thru	Left	U-Turn
7:00 AM	3	52	5	0	3	11	23	0	44	22	5	0	6	24	1	0
7:15 AM	0	62	2	0	1	15	25	0	54	23	7	2	5	42	1	0
7:30 AM	4	79	7	0	4	19	43	0	59	22	8	0	19	62	0	0
7:45 AM	4	124	10	0	1	23	39	0	63	66	8	0	23	75	2	0
8:00 AM	13	158	8	0	1	48	50	0	88	56	10	1	24	70	3	0
8:15 AM	6	128	8	0	4	54	75	0	100	66	8	0	21	73	5	0
8:30 AM	8	116	6	0	2	39	52	0	83	80	14	0	26	75	6	0
8:45 AM	12	112	4	0	7	44	51	0	83	60	12	0	25	111	5	0
4:00 PM	4	68	9	0	15	68	49	0	63	104	19	4	11	36	4	0
4:15 PM	6	60	6	0	12	91	62	0	46	113	22	1	15	31	7	0
4:30 PM	7	46	7	0	13	97	64	0	60	98	17	0	12	24	4	0
4:45 PM	1	69	2	0	11	82	49	0	78	103	18	1	20	51	8	0
5:00 PM	11	56	2	0	13	121	88	0	63	129	26	0	17	37	8	0
5:15 PM	9	81	1	0	15	132	81	0	78	158	29	0	19	41	8	0
5:30 PM	10	71	4	0	17	118	83	0	78	145	28	0	12	47	10	0
5:45 PM	4	85	6	0	16	97	81	0	80	147	24	2	27	43	8	0

Totals

Study Name Channing Way/Piedmont Ave Roundabout
Start Date 01/31/2013
Start Time 7:00 AM
Site Code WC12-2953_#10

	Southbound Street Southbound				Westbound Street Westbound				Northbound Street Northbound				Eastbound Street Eastbound			
Start Time	Right	Thru	Left	U-Turn	Right	Thru	Left	U-Turn	Right	Thru	Left	U-Turn	Right	Thru	Left	U-Turn
7:00 AM	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0
7:15 AM	0	0	0	0	1	0	1	0	0	1	0	0	0	0	0	0
7:30 AM	0	0	0	0	2	0	0	0	0	3	0	0	0	0	0	0
7:45 AM	0	0	0	0	2	2	0	0	0	2	0	0	0	0	0	0
8:00 AM	0	1	0	0	3	0	0	0	0	10	1	0	0	0	0	0
8:15 AM	0	2	0	0	0	1	0	0	0	5	0	0	0	0	0	0
8:30 AM	0	0	0	0	1	2	0	0	1	8	0	0	0	0	0	0
8:45 AM	0	0	0	0	1	0	0	0	0	3	0	0	0	1	0	0
4:00 PM	1	4	0	0	0	0	0	0	1	10	0	0	0	0	0	0
4:15 PM	4	8	2	0	0	0	0	0	0	3	0	0	0	0	0	0
4:30 PM	0	10	1	1	1	1	1	0	1	6	0	0	1	0	0	0
4:45 PM	1	10	1	0	1	0	1	0	0	5	0	0	0	0	0	0
5:00 PM	1	8	3	0	0	2	0	0	1	4	0	0	0	0	1	0
5:15 PM	0	9	0	0	0	0	0	0	0	2	0	0	0	1	0	0
5:30 PM	0	5	2	0	0	1	1	0	0	1	0	0	0	0	0	0
5:45 PM	1	10	0	0	1	0	0	0	0	1	0	0	0	0	0	0

Study Name Channing Way/Piedmont Ave Roundabout
Start Date 01/31/2013
Start Time 7:00 AM
Site Code WC12-2953_#10

	Southbound Street Southbound		Westbound Street Westbound		Northbound Street Northbound		Eastbound Street Eastbound	
Start Time	Peds CCW	Peds CW	Peds CCW	Peds CW	Peds CCW	Peds CW	Peds CCW	Peds CW
7:00 AM	1	2	0	0	0	0	0	4
7:15 AM	0	2	0	0	0	0	1	1
7:30 AM	0	1	0	0	0	0	0	5
7:45 AM	1	4	0	0	0	0	2	24
8:00 AM	0	0	0	0	0	0	2	15
8:15 AM	0	0	0	0	1	0	3	4
8:30 AM	2	2	1	0	1	0	2	6
8:45 AM	0	2	0	0	0	2	0	19
4:00 PM	11	2	0	1	9	3	25	10
4:15 PM	4	4	0	0	3	1	22	7
4:30 PM	3	4	0	0	3	0	14	4
4:45 PM	6	1	0	0	4	1	14	16
5:00 PM	17	3	0	2	8	5	42	16
5:15 PM	21	10	0	4	10	3	54	7
5:30 PM	22	6	0	0	14	8	19	8
5:45 PM	10	13	1	1	15	5	21	16

Study Name Channing Way/Piedmont Ave Roundabout
Start Date 01/31/2013
Start Time 7:00 AM
Site Code WC12-2953_#10

	Southbound Street Southbound				Westbound Street Westbound				Northbound Street Northbound				Eastbound Street Eastbound			
Start Time	Right	Thru	Left	U-Turn	Right	Thru	Left	U-Turn	Right	Thru	Left	U-Turn	Right	Thru	Left	U-Turn
7:00 AM	6	27	2	0	5	5	6	0	0	78	11	0	0	2	3	0
7:15 AM	2	45	2	0	5	11	3	0	4	87	14	0	1	0	2	0
7:30 AM	3	48	4	0	4	8	2	0	3	94	13	1	4	3	4	0
7:45 AM	7	72	3	0	3	13	6	0	2	103	17	0	1	1	7	0
8:00 AM	11	82	7	0	5	15	9	0	11	79	17	0	2	5	6	0
8:15 AM	9	65	8	0	4	11	10	0	1	101	12	0	2	4	7	0
8:30 AM	8	51	3	0	1	16	5	0	2	114	12	0	3	8	7	0
8:45 AM	4	78	0	1	2	8	5	0	3	100	13	0	1	7	6	0
4:00 PM	34	102	7	3	10	15	10	1	6	97	9	1	16	3	10	0
4:15 PM	31	99	11	2	3	13	8	0	4	82	5	0	19	7	3	1
4:30 PM	23	107	7	4	10	19	8	0	7	84	10	1	7	7	8	0
4:45 PM	9	108	14	1	12	17	16	0	1	98	9	2	5	15	13	0
5:00 PM	17	105	13	0	5	20	11	0	7	89	16	3	8	12	8	1
5:15 PM	25	104	19	0	5	30	19	1	7	74	20	2	16	10	6	2
5:30 PM	20	98	14	0	6	32	12	1	12	71	35	0	7	8	8	2
5:45 PM	14	100	14	2	4	24	12	0	5	87	28	0	15	15	6	0

Totals

Study Name Dwight Way/Piedmont Ave TMC
Start Date 01/31/2013
Start Time 7:00 AM
Site Code WC12-2953_#11

	Southbound Street Southbound				Westbound Street Westbound				Northbound Street Northbound				Eastbound Street Eastbound			
Start Time	Right	Thru	Left	U-Turn	Right	Thru	Left	U-Turn	Right	Thru	Left	U-Turn	Right	Thru	Left	U-Turn
7:00 AM	0	0	0	0	1	0	0	0	0	3	0	0	0	0	1	0
7:15 AM	0	1	0	0	0	0	0	0	0	1	0	0	1	0	0	0
7:30 AM	0	1	0	0	3	0	0	0	0	2	0	0	0	0	1	0
7:45 AM	0	0	0	0	3	0	0	0	0	9	0	0	1	0	5	0
8:00 AM	0	0	1	0	2	0	0	0	0	4	0	0	0	0	1	0
8:15 AM	0	0	0	0	2	0	0	0	0	1	0	0	0	1	5	0
8:30 AM	0	0	0	0	1	0	0	0	0	2	0	0	0	0	3	0
8:45 AM	0	0	0	0	0	0	0	0	0	4	0	0	0	0	4	0
4:00 PM	0	1	0	0	3	0	0	0	0	7	0	0	0	0	0	0
4:15 PM	1	4	0	0	0	0	0	0	0	1	0	0	0	0	0	0
4:30 PM	0	6	0	0	0	0	0	0	0	4	0	0	0	0	0	0
4:45 PM	0	2	1	0	1	0	0	0	0	1	0	0	0	0	1	0
5:00 PM	0	5	1	0	1	0	0	0	0	2	0	0	0	0	0	0
5:15 PM	0	2	0	0	0	0	0	0	0	1	0	0	0	1	1	0
5:30 PM	0	2	0	0	0	0	0	0	0	0	0	0	1	0	1	0
5:45 PM	0	3	0	0	0	0	0	0	0	8	0	0	0	2	2	0

Study Name Dwight Way/Piedmont Ave TMC
Start Date 01/31/2013
Start Time 7:00 AM
Site Code WC12-2953_#11

	Southbound Street Southbound		Westbound Street Westbound		Northbound Street Northbound		Eastbound Street Eastbound	
Start Time	Peds CCW	Peds CW	Peds CCW	Peds CW	Peds CCW	Peds CW	Peds CCW	Peds CW
7:00 AM	3	1	0	0	1	1	3	0
7:15 AM	1	1	4	2	1	3	0	2
7:30 AM	9	0	18	3	0	7	0	9
7:45 AM	19	4	33	0	3	10	1	25
8:00 AM	3	4	5	2	4	1	4	6
8:15 AM	5	20	2	1	7	1	3	0
8:30 AM	6	5	14	5	5	4	4	2
8:45 AM	6	3	14	0	4	9	5	17
4:00 PM	7	15	7	11	13	6	19	5
4:15 PM	10	16	3	8	10	6	11	6
4:30 PM	10	7	3	5	9	26	10	4
4:45 PM	9	10	17	4	9	12	10	14
5:00 PM	8	14	12	17	31	6	27	5
5:15 PM	7	23	13	23	29	4	26	7
5:30 PM	8	15	25	15	10	7	15	4
5:45 PM	20	14	19	9	12	7	15	6

Study Name Dwight Way/Piedmont Ave TMC
Start Date 01/31/2013
Start Time 7:00 AM
Site Code WC12-2953_#11

	Southbound Street Southbound				Westbound Street Westbound				Northbound Street Northbound				Eastbound Street Eastbound			
Start Time	Right	Thru	Left	U-Turn	Right	Thru	Left	U-Turn	Right	Thru	Left	U-Turn	Right	Thru	Left	U-Turn
7:00 AM	0	28	0	0	11	0	0	0	0	102	0	0	16	11	8	0
7:15 AM	0	44	0	0	12	0	3	0	0	105	0	0	17	10	12	0
7:30 AM	0	48	0	0	11	0	2	0	0	141	0	0	28	11	17	0
7:45 AM	0	68	4	0	17	0	5	0	0	132	0	0	24	22	24	0
8:00 AM	0	74	2	0	12	0	3	0	0	137	0	0	38	31	23	0
8:15 AM	0	51	1	0	14	0	5	0	0	153	0	0	31	28	24	0
8:30 AM	0	58	2	0	9	0	11	0	0	146	0	0	33	27	25	0
8:45 AM	0	64	1	0	6	0	2	0	0	152	0	0	35	28	26	0
4:00 PM	0	110	6	0	17	0	12	0	0	100	0	0	41	21	23	0
4:15 PM	1	111	2	0	16	0	5	0	0	85	0	0	57	22	21	0
4:30 PM	0	105	0	0	13	0	14	0	0	93	0	0	59	21	22	0
4:45 PM	0	99	2	0	12	0	13	0	0	108	0	0	44	28	24	0
5:00 PM	0	99	5	0	24	0	10	0	2	109	0	0	50	19	23	0
5:15 PM	0	89	1	0	23	0	7	0	1	93	0	0	62	25	30	0
5:30 PM	0	102	1	0	24	0	7	0	2	123	0	0	45	33	28	0
5:45 PM	0	96	3	0	26	0	6	0	0	147	0	0	42	33	27	0

Totals

Study Name Prospect St/Canyon Rd-Panoramic Way TMC
Start Date 01/31/2013
Start Time 7:00 AM
Site Code Wc12-2953_#12

	Southbound Street Southbound			Northbound Street Northbound			Eastbound Street Eastbound		
Start Time	Right	Thru	U-Turn	Thru	Left	U-Turn	Right	Left	U-Turn
7:00 AM	2	0	0	0	2	0	0	0	0
7:15 AM	0	0	0	0	0	0	0	0	0
7:30 AM	0	0	0	0	3	0	0	0	0
7:45 AM	0	0	0	0	0	0	0	0	0
8:00 AM	0	0	0	0	0	0	0	0	0
8:15 AM	0	0	0	1	1	0	0	0	0
8:30 AM	0	0	0	0	0	0	0	1	0
8:45 AM	0	0	0	0	3	0	0	0	0
4:00 PM	0	0	0	0	0	0	0	0	0
4:15 PM	2	2	0	0	0	0	0	0	0
4:30 PM	2	0	0	0	0	0	1	0	0
4:45 PM	2	0	0	0	0	0	1	0	0
5:00 PM	1	0	0	0	0	0	0	0	0
5:15 PM	6	0	0	0	0	0	1	0	0
5:30 PM	3	0	0	0	0	0	1	0	0
5:45 PM	1	0	0	0	0	0	0	0	0

Study Name Prospect St/Canyon Rd-Panoramic Way TMC
Start Date 01/31/2013
Start Time 7:00 AM
Site Code Wc12-2953_#12

	Southbound Street Southbound		Northbound Street Northbound		Eastbound Street Eastbound	
Start Time	Peds CCW	Peds CW	Peds CCW	Peds CW	Peds CCW	Peds CW
7:00 AM	0	0	0	0	0	1
7:15 AM	0	0	0	0	0	1
7:30 AM	0	0	0	0	0	2
7:45 AM	0	0	0	0	1	0
8:00 AM	0	0	0	0	0	0
8:15 AM	0	0	0	0	0	1
8:30 AM	0	0	0	0	0	0
8:45 AM	0	0	0	0	0	1
4:00 PM	0	0	0	0	0	0
4:15 PM	0	0	0	0	0	0
4:30 PM	1	0	0	0	0	0
4:45 PM	1	0	0	0	0	0
5:00 PM	0	0	0	0	0	2
5:15 PM	0	0	0	0	1	0
5:30 PM	0	0	0	0	2	0
5:45 PM	0	0	0	1	1	1

Study Name Prospect St/Canyon Rd-Panoramic Way TMC
Start Date 01/31/2013
Start Time 7:00 AM
Site Code Wc12-2953_#12

	Southbound Street Southbound			Northbound Street Northbound			Eastbound Street Eastbound		
Start Time	Right	Thru	U-Turn	Thru	Left	U-Turn	Right	Left	U-Turn
7:00 AM	22	1	0	0	9	0	0	25	0
7:15 AM	15	0	0	0	4	0	3	44	0
7:30 AM	28	0	0	2	17	0	4	45	0
7:45 AM	22	0	0	3	5	0	2	40	0
8:00 AM	27	2	0	4	18	0	4	63	1
8:15 AM	24	4	0	3	9	0	6	48	1
8:30 AM	20	1	0	6	12	0	7	55	0
8:45 AM	20	1	0	3	13	0	5	40	0
4:00 PM	33	4	0	4	5	0	10	33	0
4:15 PM	38	5	0	1	8	0	5	33	0
4:30 PM	45	5	0	1	10	0	10	35	0
4:45 PM	40	1	0	4	7	0	8	42	0
5:00 PM	60	3	0	4	13	0	8	44	0
5:15 PM	51	4	0	5	7	0	9	42	0
5:30 PM	57	3	0	8	8	0	13	47	0
5:45 PM	37	2	0	5	12	0	10	31	1

Totals

Study Name Centennial Dr/Stadium Rim Way TMC
Start Date 01/31/2013
Start Time 7:00 AM
Site Code WC12-2953_#13

	Southbound Street Southbound			Westbound Street Westbound			Northbound Street Northbound		
Start Time	Thru	Left	U-Turn	Right	Left	U-Turn	Right	Thru	U-Turn
7:00 AM	0	1	0	1	2	0	0	0	0
7:15 AM	0	0	0	0	0	0	0	0	0
7:30 AM	0	0	0	0	0	0	0	0	0
7:45 AM	0	1	0	1	1	0	0	0	0
8:00 AM	0	0	0	0	0	0	0	0	0
8:15 AM	0	0	0	0	0	0	0	1	0
8:30 AM	0	1	0	1	0	0	1	0	0
8:45 AM	0	0	0	0	0	0	0	0	0
4:00 PM	0	1	0	0	0	0	1	0	0
4:15 PM	2	0	0	3	2	0	0	0	0
4:30 PM	0	0	0	1	2	0	0	0	0
4:45 PM	0	0	0	1	2	0	1	0	0
5:00 PM	0	0	0	1	1	0	0	0	0
5:15 PM	2	0	0	2	4	0	0	0	0
5:30 PM	0	0	0	2	2	0	1	0	0
5:45 PM	0	0	0	2	1	0	0	0	0

Study Name Centennial Dr/Stadium Rim Way TMC
Start Date 01/31/2013
Start Time 7:00 AM
Site Code WC12-2953_#13

	Southbound Street Southbound		Westbound Street Westbound		Northbound Street Northbound			
Start Time	Peds CCW	Peds CW	Peds CCW	Peds CW	Peds CCW	Peds CW	Hourly Total	15-min Total
7:00 AM	0	1	0	0	0	1		
7:15 AM	0	1	0	0	3	0		
7:30 AM	1	1	1	1	1	1		
7:45 AM	0	4	0	0	4	1		
8:00 AM	0	0	0	0	1	1		
8:15 AM	1	0	0	1	0	4		
8:30 AM	0	1	0	0	1	1		
8:45 AM	0	1	1	0	1	0		
4:00 PM	1	3	0	0	4	2		
4:15 PM	3	5	2	0	2	2		
4:30 PM	1	0	0	2	3	4		
4:45 PM	1	1	0	3	5	3		
5:00 PM	3	2	1	0	6	1		
5:15 PM	6	1	4	5	6	7		
5:30 PM	4	2	2	0	4	9		
5:45 PM	3	7	1	0	1	4		

Study Name Centennial Dr/Stadium Rim Way TMC
Start Date 01/31/2013
Start Time 7:00 AM
Site Code WC12-2953_#13

	Southbound Street Southbound			Westbound Street Westbound			Northbound Street Northbound				
Start Time	Thru	Left	U-Turn	Right	Left	U-Turn	Right	Thru	U-Turn	Hourly Total	15-min Total
7:00 AM	1	4	0	5	21	0	23	1	0	316	55
7:15 AM	0	11	0	5	13	0	35	7	0	378	71
7:30 AM	1	10	0	12	25	0	32	15	0	416	95
7:45 AM	2	11	0	18	20	0	28	16	0	445	95
8:00 AM	5	14	0	13	21	0	43	21	0	462	117
8:15 AM	5	14	0	19	24	0	39	8	0		109
8:30 AM	1	24	0	20	19	0	50	10	0		124
8:45 AM	3	21	0	21	19	0	35	13	0		112
4:00 PM	7	19	0	10	31	0	20	15	0	483	102
4:15 PM	9	18	0	28	33	0	22	13	0	538	123
4:30 PM	10	21	0	18	40	0	24	10	0	560	123
4:45 PM	7	14	0	27	36	0	34	17	0	583	135
5:00 PM	9	29	0	20	53	0	28	18	0	550	157
5:15 PM	9	21	0	25	44	0	23	23	0		145
5:30 PM	10	12	0	20	47	0	32	25	0		146
5:45 PM	7	14	0	14	31	0	25	11	0		102

Totals

Appendix H: Intersection LOS Calculation
LBNL

FEHR PEERS

Existing Conditions

FEHR PEERS

HCM Signalized Intersection Capacity Analysis
1: University Ave & Shattuck Ave

2/28/2013

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	91	372	167	23	311	234	0	0	0	35	693	89
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0			4.0	4.0					4.0	
Lane Util. Factor	1.00	0.95			0.91	0.91					0.91	
Frpb, ped/bikes	1.00	0.97			0.99	0.90					0.97	
Flpb, ped/bikes	0.95	1.00			1.00	1.00					0.99	
Frt	1.00	0.95			0.98	0.85					0.98	
Flt Protected	0.95	1.00			1.00	1.00					1.00	
Satd. Flow (prot)	1624	3150			3131	1248					4622	
Flt Permitted	0.47	1.00			0.91	1.00					1.00	
Satd. Flow (perm)	800	3150			2844	1248					4622	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	99	404	182	25	338	254	0	0	0	38	753	97
RTOR Reduction (vph)	0	5	0	0	14	94	0	0	0	0	17	0
Lane Group Flow (vph)	99	581	0	0	410	99	0	0	0	0	871	0
Confl. Peds. (#/hr)	94		89	89		94	307		169	169		307
Confl. Bikes (#/hr)			9			5			1			17
Heavy Vehicles (%)	6%	6%	6%	6%	6%	6%	6%	6%	6%	6%	6%	6%
Turn Type	Perm			Perm		Perm				Perm		
Protected Phases		4			8						6	
Permitted Phases	4			8		8				6		
Actuated Green, G (s)	46.0	46.0			46.0	46.0					36.0	
Effective Green, g (s)	46.0	46.0			46.0	46.0					36.0	
Actuated g/C Ratio	0.51	0.51			0.51	0.51					0.40	
Clearance Time (s)	4.0	4.0			4.0	4.0					4.0	
Lane Grp Cap (vph)	409	1610			1454	638					1849	
v/s Ratio Prot		c0.18										
v/s Ratio Perm	0.12				0.14	0.08					0.19	
v/c Ratio	0.24	0.36			0.28	0.15					0.47	
Uniform Delay, d1	12.3	13.2			12.6	11.7					20.0	
Progression Factor	1.00	1.00			1.39	2.97					0.67	
Incremental Delay, d2	1.4	0.6			0.5	0.5					0.8	
Delay (s)	13.7	13.8			17.9	35.1					14.1	
Level of Service	B	B			B	D					B	
Approach Delay (s)		13.8			23.3			0.0			14.1	
Approach LOS		B			C			A			B	

Intersection Summary			
HCM Average Control Delay	16.6	HCM Level of Service	B
HCM Volume to Capacity ratio	0.41		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	83.3%	ICU Level of Service	E
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	26	202	39	56	170	46	8	321	25	134	801	51
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0	4.0		4.0		4.0	4.0		4.0	4.0	
Lane Util. Factor		0.95	1.00		0.95		1.00	0.95		1.00	0.95	
Frpb, ped/bikes		1.00	0.90		0.99		1.00	0.99		1.00	0.99	
Flpb, ped/bikes		1.00	1.00		0.99		0.97	1.00		0.96	1.00	
Frt		1.00	0.85		0.97		1.00	0.99		1.00	0.99	
Flt Protected		0.99	1.00		0.99		0.95	1.00		0.95	1.00	
Satd. Flow (prot)		3471	1408		3314		1704	3446		1679	3447	
Flt Permitted		0.90	1.00		0.84		0.25	1.00		0.52	1.00	
Satd. Flow (perm)		3135	1408		2821		440	3446		921	3447	
Peak-hour factor, PHF	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93
Adj. Flow (vph)	28	217	42	60	183	49	9	345	27	144	861	55
RTOR Reduction (vph)	0	0	27	0	19	0	0	6	0	0	5	0
Lane Group Flow (vph)	0	245	15	0	273	0	9	366	0	144	911	0
Confl. Peds. (#/hr)	65		71	71		65	191		121	121		191
Confl. Bikes (#/hr)			56			6			4			16
Heavy Vehicles (%)	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%
Turn Type	Perm		Perm	Perm			Perm			Perm		
Protected Phases		4			8			2			6	
Permitted Phases	4		4	8			2			6		
Actuated Green, G (s)		32.0	32.0		32.0		50.0	50.0		50.0	50.0	
Effective Green, g (s)		32.0	32.0		32.0		50.0	50.0		50.0	50.0	
Actuated g/C Ratio		0.36	0.36		0.36		0.56	0.56		0.56	0.56	
Clearance Time (s)		4.0	4.0		4.0		4.0	4.0		4.0	4.0	
Lane Grp Cap (vph)		1115	501		1003		244	1914		512	1915	
v/s Ratio Prot								0.11			c0.26	
v/s Ratio Perm		0.08	0.01		c0.10		0.02			0.16		
v/c Ratio		0.22	0.03		0.27		0.04	0.19		0.28	0.48	
Uniform Delay, d1		20.3	18.9		20.7		9.1	9.9		10.5	12.1	
Progression Factor		1.00	1.00		0.86		2.01	1.97		1.00	1.00	
Incremental Delay, d2		0.5	0.1		0.6		0.3	0.2		1.4	0.8	
Delay (s)		20.7	19.0		18.4		18.5	19.8		11.9	12.9	
Level of Service		C	B		B		B	B		B	B	
Approach Delay (s)		20.5			18.4			19.7			12.8	
Approach LOS		C			B			B			B	

Intersection Summary			
HCM Average Control Delay	16.0	HCM Level of Service	B
HCM Volume to Capacity ratio	0.40		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	104.7%	ICU Level of Service	G
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	323	14	210	2	8	13	101	361	1	20	710	59
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0			4.0		4.0	4.0		4.0	4.0	4.0
Lane Util. Factor	0.95	0.95			1.00		1.00	0.95		1.00	0.95	1.00
Frpb, ped/bikes	1.00	0.94			0.93		1.00	1.00		1.00	1.00	0.87
Flpb, ped/bikes	0.90	0.98			1.00		1.00	1.00		0.94	1.00	1.00
Frt	1.00	0.88			0.92		1.00	1.00		1.00	1.00	0.85
Flt Protected	0.95	0.99			1.00		0.95	1.00		0.95	1.00	1.00
Satd. Flow (prot)	1480	1401			1559		1736	3469		1630	3471	1358
Flt Permitted	0.74	0.96			0.98		0.95	1.00		0.51	1.00	1.00
Satd. Flow (perm)	1153	1352			1539		1736	3469		880	3471	1358
Peak-hour factor, PHF	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89
Adj. Flow (vph)	363	16	236	2	9	15	113	406	1	22	798	66
RTOR Reduction (vph)	0	124	0	0	10	0	0	0	0	0	0	29
Lane Group Flow (vph)	319	172	0	0	16	0	113	407	0	22	798	37
Confl. Peds. (#/hr)	118		67	67		118	117		74	74		117
Confl. Bikes (#/hr)			11			5			12			35
Heavy Vehicles (%)	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%
Turn Type	Perm			Perm			Prot			Perm		Perm
Protected Phases		4			8		5	2			6	
Permitted Phases	4			8						6		6
Actuated Green, G (s)	30.0	30.0			30.0		6.0	52.0		42.0	42.0	42.0
Effective Green, g (s)	30.0	30.0			30.0		6.0	52.0		42.0	42.0	42.0
Actuated g/C Ratio	0.33	0.33			0.33		0.07	0.58		0.47	0.47	0.47
Clearance Time (s)	4.0	4.0			4.0		4.0	4.0		4.0	4.0	4.0
Lane Grp Cap (vph)	384	451			513		116	2004		411	1620	634
v/s Ratio Prot							c0.07	0.12			c0.23	
v/s Ratio Perm	c0.28	0.13			0.01					0.03		0.03
v/c Ratio	0.83	0.38			0.03		0.97	0.20		0.05	0.49	0.06
Uniform Delay, d1	27.7	22.9			20.2		41.9	9.1		13.1	16.6	13.2
Progression Factor	0.70	0.43			1.00		1.00	1.00		0.46	0.45	0.30
Incremental Delay, d2	18.2	2.4			0.1		76.9	0.2		0.2	0.9	0.2
Delay (s)	37.4	12.2			20.3		118.8	9.3		6.2	8.4	4.2
Level of Service	D	B			C		F	A		A	A	A
Approach Delay (s)		25.3			20.3			33.1			8.1	
Approach LOS		C			C			C			A	

Intersection Summary			
HCM Average Control Delay	19.8	HCM Level of Service	B
HCM Volume to Capacity ratio	0.66		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	66.4%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	19	273	69	223	183	14	42	262	354	25	496	38
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	2.5	2.5		2.5	2.5		2.5	2.5	2.5		2.5	
Lane Util. Factor	1.00	0.95		0.91	0.91		1.00	0.95	1.00		0.95	
Frpb, ped/bikes	1.00	0.98		1.00	0.99		1.00	1.00	0.91		0.99	
Flpb, ped/bikes	1.00	1.00		1.00	1.00		0.97	1.00	1.00		1.00	
Frt	1.00	0.97		1.00	0.99		1.00	1.00	0.85		0.99	
Flt Protected	0.95	1.00		0.95	0.99		0.95	1.00	1.00		1.00	
Satd. Flow (prot)	1736	3282		1579	3229		1681	3471	1418		3394	
Flt Permitted	0.95	1.00		0.95	0.99		0.25	1.00	1.00		0.93	
Satd. Flow (perm)	1736	3282		1579	3229		436	3471	1418		3176	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	20	287	73	235	193	15	44	276	373	26	522	40
RTOR Reduction (vph)	0	25	0	0	4	0	0	0	267	0	6	0
Lane Group Flow (vph)	20	335	0	146	293	0	44	276	106	0	582	0
Confl. Peds. (#/hr)	115		97	97		115	84		71	71		84
Confl. Bikes (#/hr)			56			2						18
Heavy Vehicles (%)	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%
Turn Type	Split			Split			Perm		Perm	Perm		
Protected Phases	4	4		8	8			2			6	
Permitted Phases							2		2	6		
Actuated Green, G (s)	32.0	32.0		25.0	25.0		25.5	25.5	25.5		25.5	
Effective Green, g (s)	32.0	32.0		25.0	25.0		25.5	25.5	25.5		25.5	
Actuated g/C Ratio	0.36	0.36		0.28	0.28		0.28	0.28	0.28		0.28	
Clearance Time (s)	2.5	2.5		2.5	2.5		2.5	2.5	2.5		2.5	
Lane Grp Cap (vph)	617	1167		439	897		124	983	402		900	
v/s Ratio Prot	0.01	c0.10		c0.09	0.09			0.08				
v/s Ratio Perm							0.10		0.07		c0.18	
v/c Ratio	0.03	0.29		0.33	0.33		0.35	0.28	0.26		0.65	
Uniform Delay, d1	18.9	20.8		25.9	25.8		25.7	25.1	25.0		28.3	
Progression Factor	1.41	1.50		1.00	1.00		0.75	0.74	1.13		1.00	
Incremental Delay, d2	0.1	0.6		2.0	1.0		7.0	0.6	1.4		3.6	
Delay (s)	26.7	31.9		27.9	26.8		26.3	19.2	29.7		31.9	
Level of Service	C	C		C	C		C	B	C		C	
Approach Delay (s)		31.6			27.1			25.3			31.9	
Approach LOS		C			C			C			C	

Intersection Summary			
HCM Average Control Delay	28.7	HCM Level of Service	C
HCM Volume to Capacity ratio	0.41		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	7.5
Intersection Capacity Utilization	92.4%	ICU Level of Service	F
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (vph)	79	423	190	13	41	118
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0		4.0	
Lane Util. Factor	1.00	0.95	1.00		1.00	
Frpb, ped/bikes	1.00	1.00	0.97		0.88	
Flpb, ped/bikes	1.00	1.00	1.00		1.00	
Frt	1.00	1.00	0.99		0.90	
Flt Protected	0.95	1.00	1.00		0.99	
Satd. Flow (prot)	1703	3406	1716		1401	
Flt Permitted	0.95	1.00	1.00		0.99	
Satd. Flow (perm)	1703	3406	1716		1401	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	83	445	200	14	43	124
RTOR Reduction (vph)	0	0	3	0	75	0
Lane Group Flow (vph)	83	445	211	0	92	0
Confl. Peds. (#/hr)				246	116	116
Confl. Bikes (#/hr)				4		
Heavy Vehicles (%)	6%	6%	6%	6%	6%	6%
Turn Type	Prot					
Protected Phases	7	4	8		6	
Permitted Phases						
Actuated Green, G (s)	6.2	31.8	21.6		26.0	
Effective Green, g (s)	6.2	31.8	21.6		26.0	
Actuated g/C Ratio	0.09	0.48	0.33		0.40	
Clearance Time (s)	4.0	4.0	4.0		4.0	
Vehicle Extension (s)	3.0	3.0	3.0		3.0	
Lane Grp Cap (vph)	160	1646	563		554	
v/s Ratio Prot	c0.05	0.13	c0.12		c0.07	
v/s Ratio Perm						
v/c Ratio	0.52	0.27	0.37		0.17	
Uniform Delay, d1	28.4	10.1	16.9		12.9	
Progression Factor	1.00	1.00	1.00		1.00	
Incremental Delay, d2	2.8	0.4	1.9		0.6	
Delay (s)	31.2	10.5	18.8		13.5	
Level of Service	C	B	B		B	
Approach Delay (s)		13.8	18.8		13.5	
Approach LOS		B	B		B	

Intersection Summary			
HCM Average Control Delay	14.9	HCM Level of Service	B
HCM Volume to Capacity ratio	0.29		
Actuated Cycle Length (s)	65.8	Sum of lost time (s)	12.0
Intersection Capacity Utilization	41.2%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	13	184	207	17	40	0	82	146	175	15	195	19
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0	4.0		4.0			4.0			4.0	
Lane Util. Factor		1.00	1.00		1.00			1.00			1.00	
Frpb, ped/bikes		1.00	0.81		1.00			0.95			0.99	
Flpb, ped/bikes		0.99	1.00		0.96			0.99			1.00	
Frt		1.00	0.85		1.00			0.94			0.99	
Flt Protected		1.00	1.00		0.99			0.99			1.00	
Satd. Flow (prot)		1783	1250		1718			1578			1760	
Flt Permitted		0.98	1.00		0.90			0.89			0.97	
Satd. Flow (perm)		1762	1250		1578			1424			1711	
Peak-hour factor, PHF	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96
Adj. Flow (vph)	14	192	216	18	42	0	85	152	182	16	203	20
RTOR Reduction (vph)	0	0	143	0	0	0	0	42	0	0	5	0
Lane Group Flow (vph)	0	206	73	0	60	0	0	377	0	0	234	0
Confl. Peds. (#/hr)	87		83	83		87	44		51	51		44
Confl. Bikes (#/hr)			2									16
Heavy Vehicles (%)	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%
Turn Type	Perm		Perm	Perm		Perm	Perm			Perm		
Protected Phases		4			8			2			6	
Permitted Phases	4		4	8		8	2			6		
Actuated Green, G (s)		21.5	21.5		21.5			34.5			34.5	
Effective Green, g (s)		22.0	22.0		22.0			35.0			35.0	
Actuated g/C Ratio		0.34	0.34		0.34			0.54			0.54	
Clearance Time (s)		4.5	4.5		4.5			4.5			4.5	
Lane Grp Cap (vph)		596	423		534			767			921	
v/s Ratio Prot												
v/s Ratio Perm		c0.12	0.06		0.04			c0.26			0.14	
v/c Ratio		0.35	0.17		0.11			0.49			0.25	
Uniform Delay, d1		16.1	15.1		14.8			9.4			8.0	
Progression Factor		1.00	1.00		1.00			1.00			1.00	
Incremental Delay, d2		1.6	0.9		0.4			2.2			0.7	
Delay (s)		17.7	16.0		15.2			11.7			8.7	
Level of Service		B	B		B			B			A	
Approach Delay (s)		16.8			15.2			11.7			8.7	
Approach LOS		B			B			B			A	

Intersection Summary			
HCM Average Control Delay	13.1	HCM Level of Service	B
HCM Volume to Capacity ratio	0.43		
Actuated Cycle Length (s)	65.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	65.1%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Stop			Stop			Stop			Stop	
Volume (vph)	6	6	13	32	1	83	3	315	14	63	356	1
Peak Hour Factor	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94
Hourly flow rate (vph)	6	6	14	34	1	88	3	335	15	67	379	1

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total (vph)	27	123	353	447
Volume Left (vph)	6	34	3	67
Volume Right (vph)	14	88	15	1
Hadj (s)	-0.15	-0.26	0.10	0.15
Departure Headway (s)	6.0	5.7	5.0	5.0
Degree Utilization, x	0.04	0.19	0.49	0.62
Capacity (veh/h)	491	558	693	706
Control Delay (s)	9.3	10.0	12.8	15.6
Approach Delay (s)	9.3	10.0	12.8	15.6
Approach LOS	A	B	B	C

Intersection Summary			
Delay	13.7		
HCM Level of Service	B		
Intersection Capacity Utilization	63.4%	ICU Level of Service	B
Analysis Period (min)	15		

SimTraffic Post-Processor **LBNL 2nd Campus**
Average Results from 10 Runs **Existing**
Volume and Delay by Movement **AM Peak Hour**

Intersection 8 **Piedmont Avenue/Bancroft Way** **Unsignalized**

		Volume (veh/hr)			Total Delay (sec/veh)		
Direction	**Movement**	**Demand**	**Served**	**% Served**	**Average**	**Std. Dev.**	**LOS**
NB	Left Turn	81	72	89.1%	49.1	16.1	E
	Through	442	394	89.2%	49.7	15.6	E
	Right Turn						
	Subtotal	**523**	**466**	**89.2%**	**49.6**	**15.7**	**E**
SB	Left Turn						
	Through	262	241	91.8%	12.2	1.6	B
	Right Turn	93	85	91.2%	10.2	0.7	B
	Subtotal	**355**	**325**	**91.7%**	**11.7**	**1.3**	**B**
EB	Left Turn						
	Through						
	Right Turn						
	Subtotal						
WB	Left Turn						
	Through						
	Right Turn						
	Subtotal						
Total		**878**	**792**	**90.2%**	**34.3**	**9.8**	**D**

Intersection 9 **Piedmont Avenue/Durant Avenue** **Unsignalized**

		Volume (veh/hr)			Total Delay (sec/veh)		
Direction	**Movement**	**Demand**	**Served**	**% Served**	**Average**	**Std. Dev.**	**LOS**
NB	Left Turn						
	Through	403	361	89.6%	22.8	8.8	C
	Right Turn						
	Subtotal	**403**	**361**	**89.6%**	**22.8**	**8.8**	**C**
SB	Left Turn						
	Through	257	241	93.9%	11.5	1.8	B
	Right Turn						
	Subtotal	**257**	**241**	**93.9%**	**11.5**	**1.8**	**B**
EB	Left Turn	111	97	87.6%	9.6	2.7	A
	Through						
	Right Turn	72	70	97.4%	6.6	0.9	A
	Subtotal	**183**	**167**	**91.4%**	**8.4**	**1.7**	**A**
WB	Left Turn						
	Through						
	Right Turn						
	Subtotal						
Total		**843**	**770**	**91.3%**	**16.2**	**4.6**	**C**

Intersection	
Intersection Delay (sec/veh)	8.0
Intersection LOS	A

Approach	EB	WB	NB	SB
Entry Lanes	1	1	1	1
Conflicting Circle Lanes	1	1	1	1
Adjusted Approach Flow (vph)	59	86	455	336
Demand Flow Rate (pc/h)	61	89	473	349
Vehicles Circulating (pc/h)	346	483	73	139
Vehicles Exiting (pc/h)	142	63	334	433
Follow-Up Headway (s)	3.186	3.186	3.186	3.186
Ped Vol. Crossing Leg (#/hr)	1	51	6	4
Ped Capacity Adjustment	1.000	0.993	0.999	0.999
Approach Delay (sec/veh)	5.4	6.8	8.7	7.7
Approach LOS	A	A	A	A

Lane	Left	Left	Left	Left
Designated moves	LTR	LTR	LTR	LTR
Assumed Moves	LTR	LTR	LTR	LTR
Right Turn Channelized				
Lane Utilization	1.000	1.000	1.000	1.000
Critical Headway (s)	5.193	5.193	5.193	5.193
Entry Flow Rate (pc/h)	61	89	473	349
Capacity, Entry Lane (pc/h)	799	697	1050	983
Entry HV Adjustment Factor	0.968	0.967	0.961	0.962
Flow Rate, Entry (vph)	59	86	455	336
Capacity, Entry (vph)	774	669	1009	945
Volume to Capacity Ratio	0.076	0.129	0.451	0.355
Control Delay (sec/veh)	5.4	6.8	8.7	7.7
Level of Service	A	A	A	A
95th-Percentile Queue (veh)	0	0	2	2

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	85	113	137	21	0	36	0	577	0	5	247	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	3.0	3.0	3.0	3.0		3.0		3.0			3.0	
Lane Util. Factor	1.00	1.00	1.00	1.00		1.00		*0.60			*0.60	
Frpb, ped/bikes	1.00	1.00	0.96	1.00		0.94		1.00			1.00	
Flpb, ped/bikes	0.96	1.00	1.00	0.97		1.00		1.00			1.00	
Frt	1.00	1.00	0.85	1.00		0.85		1.00			1.00	
Flt Protected	0.95	1.00	1.00	0.95		1.00		1.00			1.00	
Satd. Flow (prot)	1705	1863	1513	1720		1495		2235			2232	
Flt Permitted	0.95	1.00	1.00	0.68		1.00		1.00			0.94	
Satd. Flow (perm)	1705	1863	1513	1237		1495		2235			2107	
Peak-hour factor, PHF	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98
Adj. Flow (vph)	87	115	140	21	0	37	0	589	0	5	252	0
RTOR Reduction (vph)	0	0	73	0	0	19	0	0	0	0	0	0
Lane Group Flow (vph)	87	115	67	21	0	18	0	589	0	0	257	0
Confl. Peds. (#/hr)	35		52	52		35	41		43	43		41
Confl. Bikes (#/hr)			1						11			
Turn Type	Perm		Perm	custom		custom				Perm		
Protected Phases		4						2			6	
Permitted Phases	4		4	8		8				6		
Actuated Green, G (s)	31.0	31.0	31.0	31.0		31.0		28.0			28.0	
Effective Green, g (s)	31.0	31.0	31.0	31.0		31.0		28.0			28.0	
Actuated g/C Ratio	0.48	0.48	0.48	0.48		0.48		0.43			0.43	
Clearance Time (s)	3.0	3.0	3.0	3.0		3.0		3.0			3.0	
Lane Grp Cap (vph)	813	889	722	590		713		963			908	
v/s Ratio Prot		c0.06						c0.26				
v/s Ratio Perm	0.05		0.04	0.02		0.01					0.12	
v/c Ratio	0.11	0.13	0.09	0.04		0.02		0.61			0.28	
Uniform Delay, d1	9.4	9.5	9.3	9.0		9.0		14.3			12.0	
Progression Factor	1.00	1.00	1.00	1.00		1.00		1.00			1.00	
Incremental Delay, d2	0.3	0.3	0.3	0.1		0.1		2.9			0.8	
Delay (s)	9.6	9.8	9.6	9.2		9.1		17.2			12.8	
Level of Service	A	A	A	A		A		B			B	
Approach Delay (s)		9.7			9.1			17.2			12.8	
Approach LOS		A			A			B			B	

Intersection Summary			
HCM Average Control Delay	13.8	HCM Level of Service	B
HCM Volume to Capacity ratio	0.36		
Actuated Cycle Length (s)	65.0	Sum of lost time (s)	6.0
Intersection Capacity Utilization	60.5%	ICU Level of Service	B
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Volume (veh/h)	207	22	8	91	48	15
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.82	0.82	0.82	0.82	0.82	0.82
Hourly flow rate (vph)	252	27	10	111	59	18
Pedestrians	2					
Lane Width (ft)	12.0					
Walking Speed (ft/s)	4.0					
Percent Blockage	0					
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume			279		398	266
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			279		398	266
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			99		90	98
cM capacity (veh/h)			1283		602	773

Direction, Lane #	EB 1	WB 1	NB 1
Volume Total	279	121	77
Volume Left	0	10	59
Volume Right	27	0	18
cSH	1700	1283	635
Volume to Capacity	0.16	0.01	0.12
Queue Length 95th (ft)	0	1	10
Control Delay (s)	0.0	0.7	11.4
Lane LOS		A	B
Approach Delay (s)	0.0	0.7	11.4
Approach LOS			B

Intersection Summary			
Average Delay	2.0		
Intersection Capacity Utilization	22.5%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Sign Control	Stop		Stop			Stop
Volume (vph)	83	72	51	166	72	14
Peak Hour Factor	0.95	0.95	0.95	0.95	0.95	0.95
Hourly flow rate (vph)	87	76	54	175	76	15

Direction, Lane #	WB 1	NB 1	SB 1
Volume Total (vph)	163	228	91
Volume Left (vph)	87	0	76
Volume Right (vph)	76	175	0
Hadj (s)	-0.10	-0.39	0.24
Departure Headway (s)	4.5	4.0	4.8
Degree Utilization, x	0.20	0.25	0.12
Capacity (veh/h)	747	859	714
Control Delay (s)	8.6	8.4	8.4
Approach Delay (s)	8.6	8.4	8.4
Approach LOS	A	A	A

Intersection Summary			
Delay	8.5		
HCM Level of Service	A		
Intersection Capacity Utilization	37.4%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Stop			Stop			Stop			Stop	
Volume (vph)	2	109	99	156	71	8	21	12	18	7	50	2
Peak Hour Factor	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88
Hourly flow rate (vph)	2	124	112	177	81	9	24	14	20	8	57	2

Direction, Lane #	EB 1	WB 1	NB 1	SB 1	SB 2
Volume Total (vph)	239	267	58	65	2
Volume Left (vph)	2	177	24	8	0
Volume Right (vph)	113	9	20	0	2
Hadj (s)	-0.26	0.13	-0.11	0.04	-0.58
Departure Headway (s)	4.3	4.6	5.0	5.2	3.2
Degree Utilization, x	0.28	0.34	0.08	0.09	0.00
Capacity (veh/h)	808	749	640	622	1121
Control Delay (s)	9.0	10.0	8.5	8.7	6.2
Approach Delay (s)	9.0	10.0	8.5	8.6	
Approach LOS	A	A	A	A	

Intersection Summary			
Delay	9.3		
HCM Level of Service	A		
Intersection Capacity Utilization	44.8%	ICU Level of Service	A
Analysis Period (min)	15		

HCM Signalized Intersection Capacity Analysis
1: University Ave & Shattuck Ave

2/28/2013

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	115	387	225	66	539	436	0	0	0	35	693	89
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0			4.0	4.0					4.0	
Lane Util. Factor	1.00	0.95			0.91	0.91					0.91	
Frpb, ped/bikes	1.00	0.92			0.96	0.73					0.96	
Flpb, ped/bikes	0.92	1.00			0.99	1.00					0.99	
Frt	1.00	0.94			0.98	0.85					0.98	
Flt Protected	0.95	1.00			1.00	1.00					1.00	
Satd. Flow (prot)	1617	3042			3122	1040					4697	
Flt Permitted	0.29	1.00			0.83	1.00					1.00	
Satd. Flow (perm)	491	3042			2590	1040					4697	
Peak-hour factor, PHF	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93
Adj. Flow (vph)	124	416	242	71	580	469	0	0	0	38	745	96
RTOR Reduction (vph)	0	0	0	0	14	168	0	0	0	0	17	0
Lane Group Flow (vph)	124	658	0	0	745	193	0	0	0	0	862	0
Confl. Peds. (#/hr)	281		226	226		281	681		242	242		681
Confl. Bikes (#/hr)			10			13						26
Heavy Vehicles (%)	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%
Turn Type	Perm			Perm		Perm				Perm		
Protected Phases		4			8						6	
Permitted Phases	4			8		8				6		
Actuated Green, G (s)	48.0	48.0			48.0	48.0					34.0	
Effective Green, g (s)	48.0	48.0			48.0	48.0					34.0	
Actuated g/C Ratio	0.53	0.53			0.53	0.53					0.38	
Clearance Time (s)	4.0	4.0			4.0	4.0					4.0	
Lane Grp Cap (vph)	262	1622			1381	555					1774	
v/s Ratio Prot		0.22										
v/s Ratio Perm	0.25				c0.29	0.19					0.18	
v/c Ratio	0.47	0.41			0.54	0.35					0.49	
Uniform Delay, d1	13.1	12.5			13.8	12.0					21.3	
Progression Factor	1.00	1.00			1.44	4.02					0.75	
Incremental Delay, d2	6.0	0.8			1.5	1.7					0.9	
Delay (s)	19.1	13.3			21.3	50.0					16.9	
Level of Service	B	B			C	D					B	
Approach Delay (s)		14.2			30.6			0.0			16.9	
Approach LOS		B			C			A			B	

Intersection Summary			
HCM Average Control Delay	21.6	HCM Level of Service	C
HCM Volume to Capacity ratio	0.52		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	83.3%	ICU Level of Service	E
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	53	157	42	102	300	134	32	549	31	68	519	40
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0	4.0		4.0		4.0	4.0		4.0	4.0	
Lane Util. Factor		0.95	1.00		0.95		1.00	0.95		1.00	0.95	
Frpb, ped/bikes		1.00	0.91		0.95		1.00	0.99		1.00	0.98	
Flpb, ped/bikes		0.99	1.00		0.99		0.91	1.00		0.95	1.00	
Frt		1.00	0.85		0.96		1.00	0.99		1.00	0.99	
Flt Protected		0.99	1.00		0.99		0.95	1.00		0.95	1.00	
Satd. Flow (prot)		3445	1444		3186		1608	3485		1682	3445	
Flt Permitted		0.76	1.00		0.83		0.40	1.00		0.39	1.00	
Satd. Flow (perm)		2655	1444		2684		672	3485		682	3445	
Peak-hour factor, PHF	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97
Adj. Flow (vph)	55	162	43	105	309	138	33	566	32	70	535	41
RTOR Reduction (vph)	0	0	27	0	36	0	0	5	0	0	6	0
Lane Group Flow (vph)	0	217	16	0	516	0	33	593	0	70	570	0
Confl. Peds. (#/hr)	162		86	86		162	363		205	205		363
Confl. Bikes (#/hr)			9			83			17			20
Turn Type	Perm		Perm	Perm			Perm			Perm		
Protected Phases		4			8			2			6	
Permitted Phases	4		4	8			2			6		
Actuated Green, G (s)		33.0	33.0		33.0		49.0	49.0		49.0	49.0	
Effective Green, g (s)		33.0	33.0		33.0		49.0	49.0		49.0	49.0	
Actuated g/C Ratio		0.37	0.37		0.37		0.54	0.54		0.54	0.54	
Clearance Time (s)		4.0	4.0		4.0		4.0	4.0		4.0	4.0	
Lane Grp Cap (vph)		974	529		984		366	1897		371	1876	
v/s Ratio Prot								c0.17			0.17	
v/s Ratio Perm		0.08	0.01		c0.19		0.05			0.10		
v/c Ratio		0.22	0.03		0.52		0.09	0.31		0.19	0.30	
Uniform Delay, d1		19.7	18.2		22.3		9.8	11.3		10.4	11.2	
Progression Factor		1.00	1.00		1.48		1.73	1.72		1.00	1.00	
Incremental Delay, d2		0.5	0.1		1.7		0.4	0.4		1.1	0.4	
Delay (s)		20.2	18.4		34.6		17.4	19.7		11.5	11.6	
Level of Service		C	B		C		B	B		B	B	
Approach Delay (s)		19.9			34.6			19.6			11.6	
Approach LOS		B			C			B			B	

Intersection Summary			
HCM Average Control Delay	21.1	HCM Level of Service	C
HCM Volume to Capacity ratio	0.40		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	108.8%	ICU Level of Service	G
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	265	17	266	3	18	24	190	636	14	24	598	107
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0			4.0		4.0	4.0		4.0	4.0	4.0
Lane Util. Factor	0.95	0.95			1.00		1.00	0.95		1.00	0.95	1.00
Frpb, ped/bikes	1.00	0.86			0.89		1.00	1.00		1.00	1.00	0.84
Flpb, ped/bikes	0.81	0.98			0.99		1.00	1.00		0.93	1.00	1.00
Frt	1.00	0.87			0.93		1.00	1.00		1.00	1.00	0.85
Flt Protected	0.95	1.00			1.00		0.95	1.00		0.95	1.00	1.00
Satd. Flow (prot)	1354	1293			1508		1752	3480		1636	3505	1319
Flt Permitted	0.73	0.98			0.98		0.95	1.00		0.40	1.00	1.00
Satd. Flow (perm)	1037	1269			1487		1752	3480		688	3505	1319
Peak-hour factor, PHF	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98
Adj. Flow (vph)	270	17	271	3	18	24	194	649	14	24	610	109
RTOR Reduction (vph)	0	178	0	0	16	0	0	2	0	0	0	62
Lane Group Flow (vph)	243	137	0	0	29	0	194	661	0	24	610	47
Confl. Peds. (#/hr)	221		163	163		221	156		115	115		156
Confl. Bikes (#/hr)			4			5			14			33
Heavy Vehicles (%)	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%
Turn Type	Perm			Perm			Prot			Perm		Perm
Protected Phases		4			8		5	2			6	
Permitted Phases	4			8						6		6
Actuated Green, G (s)	31.0	31.0			31.0		10.0	51.0		37.0	37.0	37.0
Effective Green, g (s)	31.0	31.0			31.0		10.0	51.0		37.0	37.0	37.0
Actuated g/C Ratio	0.34	0.34			0.34		0.11	0.57		0.41	0.41	0.41
Clearance Time (s)	4.0	4.0			4.0		4.0	4.0		4.0	4.0	4.0
Lane Grp Cap (vph)	357	437			512		195	1972		283	1441	542
v/s Ratio Prot							c0.11	0.19			c0.17	
v/s Ratio Perm	c0.23	0.11			0.02					0.03		0.04
v/c Ratio	0.68	0.31			0.06		0.99	0.34		0.08	0.42	0.09
Uniform Delay, d1	25.3	21.7			19.7		40.0	10.4		16.2	18.9	16.2
Progression Factor	0.68	0.34			1.00		1.00	1.00		0.44	0.49	0.40
Incremental Delay, d2	9.7	1.8			0.2		63.1	0.5		0.5	0.8	0.3
Delay (s)	26.8	9.2			19.9		103.1	10.9		7.6	10.1	6.8
Level of Service	C	A			B		F	B		A	B	A
Approach Delay (s)		16.9			19.9			31.8			9.5	
Approach LOS		B			B			C			A	

Intersection Summary			
HCM Average Control Delay	20.2	HCM Level of Service	C
HCM Volume to Capacity ratio	0.60		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	72.5%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	34	163	68	321	393	59	83	567	297	13	285	34
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	2.0	2.0		2.0	2.0		2.0	2.0			2.0	
Lane Util. Factor	1.00	0.95		0.91	0.91		1.00	0.95			0.95	
Frpb, ped/bikes	1.00	0.98		1.00	0.98		1.00	0.96			0.99	
Flpb, ped/bikes	1.00	1.00		1.00	1.00		0.95	1.00			1.00	
Frt	1.00	0.96		1.00	0.98		1.00	0.95			0.98	
Flt Protected	0.95	1.00		0.95	0.99		0.95	1.00			1.00	
Satd. Flow (prot)	1770	3304		1610	3235		1689	3227			3441	
Flt Permitted	0.95	1.00		0.95	0.99		0.43	1.00			0.82	
Satd. Flow (perm)	1770	3304		1610	3235		762	3227			2815	
Peak-hour factor, PHF	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94
Adj. Flow (vph)	36	173	72	341	418	63	88	603	316	14	303	36
RTOR Reduction (vph)	0	45	0	0	10	0	0	75	0	0	10	0
Lane Group Flow (vph)	36	200	0	269	543	0	88	844	0	0	343	0
Confl. Peds. (#/hr)	129		83	83		129	80		91	91		80
Confl. Bikes (#/hr)			5			75			12			8
Turn Type	Split			Split			Perm			Perm		
Protected Phases	4	4		8	8			2			6	
Permitted Phases							2			6		
Actuated Green, G (s)	34.0	34.0		24.0	24.0		26.0	26.0			26.0	
Effective Green, g (s)	34.0	34.0		24.0	24.0		26.0	26.0			26.0	
Actuated g/C Ratio	0.38	0.38		0.27	0.27		0.29	0.29			0.29	
Clearance Time (s)	2.0	2.0		2.0	2.0		2.0	2.0			2.0	
Lane Grp Cap (vph)	669	1248		429	863		220	932			813	
v/s Ratio Prot	0.02	c0.06		0.17	c0.17			c0.26				
v/s Ratio Perm							0.12				0.12	
v/c Ratio	0.05	0.16		0.63	0.63		0.40	0.91			0.42	
Uniform Delay, d1	17.8	18.5		29.1	29.1		25.7	30.8			25.9	
Progression Factor	1.57	1.88		1.00	1.00		0.75	0.77			1.00	
Incremental Delay, d2	0.2	0.3		6.8	3.5		5.0	13.2			1.6	
Delay (s)	28.0	35.1		35.8	32.5		24.4	36.9			27.5	
Level of Service	C	D		D	C		C	D			C	
Approach Delay (s)		34.2			33.6			35.8			27.5	
Approach LOS		C			C			D			C	

Intersection Summary			
HCM Average Control Delay	33.7	HCM Level of Service	C
HCM Volume to Capacity ratio	0.51		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	6.0
Intersection Capacity Utilization	110.5%	ICU Level of Service	H
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (vph)	100	230	314	39	45	79
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0		4.0	
Lane Util. Factor	1.00	0.95	1.00		1.00	
Frpb, ped/bikes	1.00	1.00	0.93		0.85	
Flpb, ped/bikes	1.00	1.00	1.00		1.00	
Frt	1.00	1.00	0.99		0.91	
Flt Protected	0.95	1.00	1.00		0.98	
Satd. Flow (prot)	1719	3438	1666		1379	
Flt Permitted	0.95	1.00	1.00		0.98	
Satd. Flow (perm)	1719	3438	1666		1379	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	105	242	331	41	47	83
RTOR Reduction (vph)	0	0	6	0	53	0
Lane Group Flow (vph)	105	242	366	0	77	0
Confl. Peds. (#/hr)				365	162	162
Confl. Bikes (#/hr)				28		
Heavy Vehicles (%)	5%	5%	5%	5%	5%	5%
Turn Type	Prot					
Protected Phases	7	4	8		6	
Permitted Phases						
Actuated Green, G (s)	6.4	36.8	26.4		26.0	
Effective Green, g (s)	6.4	36.8	26.4		26.0	
Actuated g/C Ratio	0.09	0.52	0.37		0.37	
Clearance Time (s)	4.0	4.0	4.0		4.0	
Vehicle Extension (s)	3.0	3.0	3.0		3.0	
Lane Grp Cap (vph)	155	1787	621		506	
v/s Ratio Prot	c0.06	0.07	c0.22		c0.06	
v/s Ratio Perm						
v/c Ratio	0.68	0.14	0.59		0.15	
Uniform Delay, d1	31.2	8.8	17.8		15.0	
Progression Factor	1.00	1.00	1.00		1.00	
Incremental Delay, d2	11.1	0.2	4.1		0.6	
Delay (s)	42.3	8.9	21.9		15.7	
Level of Service	D	A	C		B	
Approach Delay (s)		19.0	21.9		15.7	
Approach LOS		B	C		B	

Intersection Summary			
HCM Average Control Delay	19.8	HCM Level of Service	B
HCM Volume to Capacity ratio	0.41		
Actuated Cycle Length (s)	70.8	Sum of lost time (s)	12.0
Intersection Capacity Utilization	47.9%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	11	28	226	41	124	15	16	213	192	16	176	1
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0	4.0		4.0	4.0		4.0			4.0	
Lane Util. Factor		1.00	1.00		1.00	1.00		1.00			1.00	
Frpb, ped/bikes		1.00	0.79		1.00	0.74		0.92			1.00	
Flpb, ped/bikes		0.95	1.00		0.95	1.00		1.00			1.00	
Frt		1.00	0.85		1.00	0.85		0.94			1.00	
Flt Protected		0.99	1.00		0.99	1.00		1.00			1.00	
Satd. Flow (prot)		1729	1235		1738	1161		1589			1826	
Flt Permitted		0.93	1.00		0.93	1.00		0.99			0.96	
Satd. Flow (perm)		1623	1235		1636	1161		1573			1757	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	12	30	246	45	135	16	17	232	209	17	191	1
RTOR Reduction (vph)	0	0	158	0	0	10	0	43	0	0	0	0
Lane Group Flow (vph)	0	42	88	0	180	6	0	415	0	0	209	0
Confl. Peds. (#/hr)	105		89	89		105	71		65	65		71
Confl. Bikes (#/hr)			2			18			15			5
Heavy Vehicles (%)	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%
Turn Type	Perm		Perm	Perm		Perm	Perm			Perm		
Protected Phases		4			8			2			6	
Permitted Phases	4		4	8		8	2			6		
Actuated Green, G (s)		24.5	24.5		24.5	24.5		36.5			36.5	
Effective Green, g (s)		25.0	25.0		25.0	25.0		37.0			37.0	
Actuated g/C Ratio		0.36	0.36		0.36	0.36		0.53			0.53	
Clearance Time (s)		4.5	4.5		4.5	4.5		4.5			4.5	
Lane Grp Cap (vph)		580	441		584	415		831			929	
v/s Ratio Prot												
v/s Ratio Perm		0.03	0.07		c0.11	0.00		c0.26			0.12	
v/c Ratio		0.07	0.20		0.31	0.01		0.50			0.22	
Uniform Delay, d1		14.8	15.6		16.3	14.5		10.6			8.8	
Progression Factor		1.00	1.00		1.00	1.00		1.00			1.00	
Incremental Delay, d2		0.2	1.0		1.4	0.1		2.1			0.6	
Delay (s)		15.1	16.6		17.6	14.6		12.7			9.4	
Level of Service		B	B		B	B		B			A	
Approach Delay (s)		16.4			17.4			12.7			9.4	
Approach LOS		B			B			B			A	

Intersection Summary			
HCM Average Control Delay	13.8	HCM Level of Service	B
HCM Volume to Capacity ratio	0.42		
Actuated Cycle Length (s)	70.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	62.6%	ICU Level of Service	B
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Stop			Stop			Stop			Stop	
Volume (vph)	21	8	9	40	1	114	2	278	26	83	366	1
Peak Hour Factor	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98
Hourly flow rate (vph)	21	8	9	41	1	116	2	284	27	85	373	1

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total (vph)	39	158	312	459
Volume Left (vph)	21	41	2	85
Volume Right (vph)	9	116	27	1
Hadj (s)	0.02	-0.34	0.00	0.09
Departure Headway (s)	6.2	5.6	5.1	5.0
Degree Utilization, x	0.07	0.24	0.44	0.64
Capacity (veh/h)	476	571	673	699
Control Delay (s)	9.7	10.4	12.1	16.4
Approach Delay (s)	9.7	10.4	12.1	16.4
Approach LOS	A	B	B	C

Intersection Summary			
Delay	13.8		
HCM Level of Service	B		
Intersection Capacity Utilization	64.1%	ICU Level of Service	C
Analysis Period (min)	15		

SimTraffic Post-Processor **LBNL 2nd Campus**
Average Results from 10 Runs **Existing**
Volume and Delay by Movement **PM Peak Hour**

Intersection 8 **Piedmont Avenue/Bancroft Way** **Unsignalized**

		Volume (veh/hr)			Total Delay (sec/veh)		
Direction	**Movement**	**Demand**	**Served**	**% Served**	**Average**	**Std. Dev.**	**LOS**
NB	Left Turn	118	112	95.3%	118.6	47.6	F
	Through	381	361	94.9%	119.8	48.2	F
	Right Turn						
	Subtotal	**499**	**474**	**94.9%**	**119.5**	**48.0**	**F**
SB	Left Turn						
	Through	333	336	101.0%	32.9	27.6	D
	Right Turn	116	114	98.6%	24.5	24.0	C
	Subtotal	**449**	**451**	**100.4%**	**30.8**	**26.7**	**D**
EB	Left Turn						
	Through						
	Right Turn						
	Subtotal						
WB	Left Turn						
	Through						
	Right Turn						
	Subtotal						
Total		**948**	**925**	**97.5%**	**76.4**	**33.0**	**F**

Intersection 9 **Piedmont Avenue/Durant Avenue** **Unsignalized**

		Volume (veh/hr)			Total Delay (sec/veh)		
Direction	**Movement**	**Demand**	**Served**	**% Served**	**Average**	**Std. Dev.**	**LOS**
NB	Left Turn						
	Through	375	360	95.9%	86.2	42.9	F
	Right Turn						
	Subtotal	**375**	**360**	**95.9%**	**86.2**	**42.9**	**F**
SB	Left Turn						
	Through	324	331	102.3%	48.0	12.2	E
	Right Turn						
	Subtotal	**324**	**331**	**102.3%**	**48.0**	**12.2**	**E**
EB	Left Turn	112	106	95.0%	12.2	2.0	B
	Through						
	Right Turn	169	178	105.5%	19.9	4.4	C
	Subtotal	**281**	**285**	**101.3%**	**17.2**	**3.3**	**C**
WB	Left Turn						
	Through						
	Right Turn						
	Subtotal						
Total		**980**	**976**	**99.6%**	**53.2**	**19.2**	**F**

Intersection	
Intersection Delay (sec/veh)	11.4
Intersection LOS	B

Approach	EB	WB	NB	SB
Entry Lanes	1	1	1	1
Conflicting Circle Lanes	1	1	1	1
Adjusted Approach Flow (vph)	122	184	465	531
Demand Flow Rate (pc/h)	125	187	475	542
Vehicles Circulating (pc/h)	519	471	135	273
Vehicles Exiting (pc/h)	296	139	509	385
Follow-Up Headway (s)	3.186	3.186	3.186	3.186
Ped Vol. Crossing Leg (#/hr)	183	8	102	68
Ped Capacity Adjustment	0.960	0.999	0.987	0.991
Approach Delay (sec/veh)	8.0	8.4	9.7	14.7
Approach LOS	A	A	A	B

Lane	Left	Left	Left	Left
Designated moves	LTR	LTR	LTR	LTR
Assumed Moves	LTR	LTR	LTR	LTR
Right Turn Channelized				
Lane Utilization	1.000	1.000	1.000	1.000
Critical Headway (s)	5.193	5.193	5.193	5.193
Entry Flow Rate (pc/h)	125	187	475	542
Capacity, Entry Lane (pc/h)	672	706	987	860
Entry HV Adjustment Factor	0.977	0.983	0.980	0.980
Flow Rate, Entry (vph)	122	184	465	531
Capacity, Entry (vph)	630	693	955	835
Volume to Capacity Ratio	0.194	0.265	0.488	0.636
Control Delay (sec/veh)	8.0	8.4	9.7	14.7
Level of Service	A	A	A	B
95th-Percentile Queue (veh)	1	1	3	5

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	104	107	198	30	0	96	0	461	5	9	374	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	3.0	3.0	3.0	3.0		3.0		3.0			3.0	
Lane Util. Factor	1.00	1.00	1.00	1.00		1.00		*0.60			*0.60	
Frpb, ped/bikes	1.00	1.00	0.92	1.00		0.87		1.00			1.00	
Flpb, ped/bikes	0.89	1.00	1.00	0.94		1.00		1.00			1.00	
Frt	1.00	1.00	0.85	1.00		0.85		1.00			1.00	
Flt Protected	0.95	1.00	1.00	0.95		1.00		1.00			1.00	
Satd. Flow (prot)	1583	1881	1473	1685		1393		2249			2251	
Flt Permitted	0.95	1.00	1.00	0.68		1.00		1.00			0.94	
Satd. Flow (perm)	1583	1881	1473	1214		1393		2249			2120	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	109	113	208	32	0	101	0	485	5	9	394	0
RTOR Reduction (vph)	0	0	90	0	0	53	0	1	0	0	0	0
Lane Group Flow (vph)	109	113	118	32	0	48	0	489	0	0	403	0
Confl. Peds. (#/hr)	109		106	106		106	105		133	133		105
Confl. Bikes (#/hr)			4						11			12
Heavy Vehicles (%)	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%
Turn Type	Perm		Perm	custom		custom				Perm		
Protected Phases		4						2			6	
Permitted Phases	4		4	8		8				6		
Actuated Green, G (s)	31.0	31.0	31.0	31.0		31.0		28.0			28.0	
Effective Green, g (s)	31.0	31.0	31.0	31.0		31.0		28.0			28.0	
Actuated g/C Ratio	0.48	0.48	0.48	0.48		0.48		0.43			0.43	
Clearance Time (s)	3.0	3.0	3.0	3.0		3.0		3.0			3.0	
Lane Grp Cap (vph)	755	897	703	579		664		969			913	
v/s Ratio Prot		0.06						c0.22				
v/s Ratio Perm	0.07		c0.08	0.03		0.03					0.19	
v/c Ratio	0.14	0.13	0.17	0.06		0.07		0.51			0.44	
Uniform Delay, d1	9.5	9.5	9.7	9.1		9.2		13.5			13.0	
Progression Factor	1.00	1.00	1.00	1.00		1.00		1.00			1.00	
Incremental Delay, d2	0.4	0.3	0.5	0.2		0.2		1.9			1.5	
Delay (s)	10.0	9.7	10.2	9.3		9.4		15.3			14.6	
Level of Service	A	A	B	A		A		B			B	
Approach Delay (s)		10.0			9.4			15.3			14.6	
Approach LOS		B			A			B			B	

Intersection Summary			
HCM Average Control Delay	13.0	HCM Level of Service	B
HCM Volume to Capacity ratio	0.33		
Actuated Cycle Length (s)	65.0	Sum of lost time (s)	6.0
Intersection Capacity Utilization	61.6%	ICU Level of Service	B
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Volume (veh/h)	165	38	12	194	40	22
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.89	0.89	0.89	0.89	0.89	0.89
Hourly flow rate (vph)	185	43	13	218	45	25
Pedestrians	7			1		
Lane Width (ft)	12.0			12.0		
Walking Speed (ft/s)	4.0			4.0		
Percent Blockage	1			0		
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume			228		459	208
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			228		459	208
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			99		92	97
cM capacity (veh/h)			1346		553	834

Direction, Lane #	EB 1	WB 1	NB 1
Volume Total	228	231	70
Volume Left	0	13	45
Volume Right	43	0	25
cSH	1700	1346	628
Volume to Capacity	0.13	0.01	0.11
Queue Length 95th (ft)	0	1	9
Control Delay (s)	0.0	0.5	11.4
Lane LOS		A	B
Approach Delay (s)	0.0	0.5	11.4
Approach LOS			B

Intersection Summary			
Average Delay	1.7		
Intersection Capacity Utilization	30.3%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Sign Control	Stop		Stop			Stop
Volume (vph)	167	72	77	107	76	33
Peak Hour Factor	0.86	0.86	0.86	0.86	0.86	0.86
Hourly flow rate (vph)	194	84	90	124	88	38

Direction, Lane #	WB 1	NB 1	SB 1
Volume Total (vph)	278	214	127
Volume Left (vph)	194	0	88
Volume Right (vph)	84	124	0
Hadj (s)	0.01	-0.30	0.19
Departure Headway (s)	4.7	4.5	5.1
Degree Utilization, x	0.36	0.27	0.18
Capacity (veh/h)	718	757	663
Control Delay (s)	10.4	9.1	9.2
Approach Delay (s)	10.4	9.1	9.2
Approach LOS	B	A	A

Intersection Summary			
Delay	9.7		
HCM Level of Service	A		
Intersection Capacity Utilization	42.6%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Stop			Stop			Stop			Stop	
Volume (vph)	2	99	32	11	73	12	72	57	134	14	14	4
Peak Hour Factor	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93
Hourly flow rate (vph)	2	106	34	12	78	13	77	61	144	15	15	4

Direction, Lane #	EB 1	WB 1	NB 1	SB 1	SB 2
Volume Total (vph)	143	103	283	30	4
Volume Left (vph)	2	12	77	15	0
Volume Right (vph)	34	13	144	0	4
Hadj (s)	-0.12	-0.04	-0.23	0.12	-0.58
Departure Headway (s)	4.6	4.8	4.3	5.0	3.2
Degree Utilization, x	0.18	0.14	0.34	0.04	0.00
Capacity (veh/h)	725	697	798	669	1121
Control Delay (s)	8.7	8.5	9.5	8.2	6.2
Approach Delay (s)	8.7	8.5	9.5	7.9	
Approach LOS	A	A	A	A	

Intersection Summary			
Delay	9.0		
HCM Level of Service	A		
Intersection Capacity Utilization	39.9%	ICU Level of Service	A
Analysis Period (min)	15		

Near-Term (2018) No Project Conditions

FEHR PEERS

HCM Signalized Intersection Capacity Analysis
1: University Ave & Shattuck Ave

3/15/2013

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	111	416	180	30	353	250	0	0	0	40	710	111
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0			4.0	4.0					4.0	
Lane Util. Factor	1.00	0.95			0.91	0.91					0.91	
Frpb, ped/bikes	1.00	0.97			0.99	0.89					0.96	
Flpb, ped/bikes	0.95	1.00			1.00	1.00					0.99	
Frt	1.00	0.95			0.98	0.85					0.98	
Flt Protected	0.95	1.00			1.00	1.00					1.00	
Satd. Flow (prot)	1619	3144			3146	1230					4556	
Flt Permitted	0.44	1.00			0.88	1.00					1.00	
Satd. Flow (perm)	746	3144			2789	1230					4556	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	121	452	196	33	384	272	0	0	0	43	772	121
RTOR Reduction (vph)	0	3	0	0	11	107	0	0	0	0	22	0
Lane Group Flow (vph)	121	645	0	0	460	111	0	0	0	0	914	0
Confl. Peds. (#/hr)	108		102	102		108	353		194	194		353
Confl. Bikes (#/hr)			10			6			1			20
Heavy Vehicles (%)	6%	6%	6%	6%	6%	6%	6%	6%	6%	6%	6%	6%
Turn Type	Perm			Perm		Perm				Perm		
Protected Phases		4			8						6	
Permitted Phases	4			8		8				6		
Actuated Green, G (s)	46.0	46.0			46.0	46.0					36.0	
Effective Green, g (s)	46.0	46.0			46.0	46.0					36.0	
Actuated g/C Ratio	0.51	0.51			0.51	0.51					0.40	
Clearance Time (s)	4.0	4.0			4.0	4.0					4.0	
Lane Grp Cap (vph)	381	1607			1425	629					1822	
v/s Ratio Prot		c0.21										
v/s Ratio Perm	0.16				0.17	0.09					0.20	
v/c Ratio	0.32	0.40			0.32	0.18					0.50	
Uniform Delay, d1	12.8	13.5			12.9	11.8					20.3	
Progression Factor	1.00	1.00			1.39	3.18					0.66	
Incremental Delay, d2	2.2	0.7			0.6	0.6					0.9	
Delay (s)	15.0	14.3			18.5	38.2					14.3	
Level of Service	B	B			B	D					B	
Approach Delay (s)		14.4			24.8			0.0			14.3	
Approach LOS		B			C			A			B	

Intersection Summary			
HCM Average Control Delay	17.3	HCM Level of Service	B
HCM Volume to Capacity ratio	0.45		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	83.3%	ICU Level of Service	E
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	40	234	50	61	191	52	20	340	41	166	830	70
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0	4.0		4.0		4.0	4.0		4.0	4.0	
Lane Util. Factor		0.95	1.00		0.95		1.00	0.95		1.00	0.95	
Frpb, ped/bikes		1.00	0.88		0.99		1.00	0.99		1.00	0.99	
Flpb, ped/bikes		0.99	1.00		0.99		0.97	1.00		0.95	1.00	
Frt		1.00	0.85		0.97		1.00	0.98		1.00	0.99	
Flt Protected		0.99	1.00		0.99		0.95	1.00		0.95	1.00	
Satd. Flow (prot)		3460	1387		3305		1701	3414		1673	3425	
Flt Permitted		0.87	1.00		0.83		0.23	1.00		0.50	1.00	
Satd. Flow (perm)		3017	1387		2766		405	3414		874	3425	
Peak-hour factor, PHF	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93
Adj. Flow (vph)	43	252	54	66	205	56	22	366	44	178	892	75
RTOR Reduction (vph)	0	0	28	0	19	0	0	10	0	0	7	0
Lane Group Flow (vph)	0	295	26	0	308	0	22	400	0	178	960	0
Confl. Peds. (#/hr)	75		82	82		75	220		139	139		220
Confl. Bikes (#/hr)			64			7			5			18
Heavy Vehicles (%)	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%
Turn Type	Perm		Perm	Perm			Perm			Perm		
Protected Phases		4			8			2			6	
Permitted Phases	4		4	8			2			6		
Actuated Green, G (s)		32.0	32.0		32.0		50.0	50.0		50.0	50.0	
Effective Green, g (s)		32.0	32.0		32.0		50.0	50.0		50.0	50.0	
Actuated g/C Ratio		0.36	0.36		0.36		0.56	0.56		0.56	0.56	
Clearance Time (s)		4.0	4.0		4.0		4.0	4.0		4.0	4.0	
Lane Grp Cap (vph)		1073	493		983		225	1897		486	1903	
v/s Ratio Prot								0.12			c0.28	
v/s Ratio Perm		0.10	0.02		c0.11		0.05			0.20		
v/c Ratio		0.27	0.05		0.31		0.10	0.21		0.37	0.50	
Uniform Delay, d1		20.7	19.1		21.0		9.4	10.1		11.2	12.3	
Progression Factor		1.00	1.00		0.91		1.95	1.94		1.00	1.00	
Incremental Delay, d2		0.6	0.2		0.8		0.8	0.2		2.1	1.0	
Delay (s)		21.3	19.3		19.9		19.2	19.8		13.3	13.3	
Level of Service		C	B		B		B	B		B	B	
Approach Delay (s)		21.0			19.9			19.8			13.3	
Approach LOS		C			B			B			B	

Intersection Summary			
HCM Average Control Delay	16.7	HCM Level of Service	B
HCM Volume to Capacity ratio	0.43		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	110.9%	ICU Level of Service	H
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	379	20	230	10	20	20	120	370	10	30	750	72
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0			4.0		4.0	4.0		4.0	4.0	4.0
Lane Util. Factor	0.95	0.95			1.00		1.00	0.95		1.00	0.95	1.00
Frpb, ped/bikes	1.00	0.93			0.95		1.00	1.00		1.00	1.00	0.86
Flpb, ped/bikes	0.89	0.98			0.99		1.00	1.00		0.93	1.00	1.00
Frt	1.00	0.89			0.95		1.00	1.00		1.00	1.00	0.85
Flt Protected	0.95	0.99			0.99		0.95	1.00		0.95	1.00	1.00
Satd. Flow (prot)	1462	1395			1607		1736	3444		1617	3471	1332
Flt Permitted	0.78	0.94			0.93		0.95	1.00		0.50	1.00	1.00
Satd. Flow (perm)	1199	1322			1502		1736	3444		856	3471	1332
Peak-hour factor, PHF	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89
Adj. Flow (vph)	426	22	258	11	22	22	135	416	11	34	843	81
RTOR Reduction (vph)	0	117	0	0	15	0	0	2	0	0	0	34
Lane Group Flow (vph)	366	223	0	0	40	0	135	425	0	34	843	47
Confl. Peds. (#/hr)	136		77	77		136	135		85	85		135
Confl. Bikes (#/hr)			13			6			14			40
Heavy Vehicles (%)	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%
Turn Type	Perm			Perm			Prot			Perm		Perm
Protected Phases		4			8		5	2			6	
Permitted Phases	4			8						6		6
Actuated Green, G (s)	30.0	30.0			30.0		6.0	52.0		42.0	42.0	42.0
Effective Green, g (s)	30.0	30.0			30.0		6.0	52.0		42.0	42.0	42.0
Actuated g/C Ratio	0.33	0.33			0.33		0.07	0.58		0.47	0.47	0.47
Clearance Time (s)	4.0	4.0			4.0		4.0	4.0		4.0	4.0	4.0
Lane Grp Cap (vph)	400	441			501		116	1990		399	1620	622
v/s Ratio Prot							c0.08	0.12			c0.24	
v/s Ratio Perm	c0.31	0.17			0.03					0.04		0.04
v/c Ratio	0.92	0.51			0.08		1.16	0.21		0.09	0.52	0.08
Uniform Delay, d1	28.8	24.1			20.6		42.0	9.2		13.3	16.9	13.3
Progression Factor	0.70	0.48			1.00		1.00	1.00		0.47	0.46	0.29
Incremental Delay, d2	27.4	4.0			0.3		134.2	0.2		0.4	1.0	0.2
Delay (s)	47.5	15.5			20.9		176.2	9.4		6.6	8.8	4.0
Level of Service	D	B			C		F	A		A	A	A
Approach Delay (s)		32.1			20.9			49.5			8.3	
Approach LOS		C			C			D			A	

Intersection Summary			
HCM Average Control Delay	26.1	HCM Level of Service	C
HCM Volume to Capacity ratio	0.72		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	69.1%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	30	331	80	242	205	21	50	280	399	42	530	50
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	2.5	2.5		2.5	2.5		2.5	2.5	2.5		2.5	
Lane Util. Factor	1.00	0.95		0.91	0.91		1.00	0.95	1.00		0.95	
Frpb, ped/bikes	1.00	0.97		1.00	0.99		1.00	1.00	0.90		0.99	
Flpb, ped/bikes	1.00	1.00		1.00	1.00		0.97	1.00	1.00		1.00	
Frt	1.00	0.97		1.00	0.99		1.00	1.00	0.85		0.99	
Flt Protected	0.95	1.00		0.95	0.99		0.95	1.00	1.00		1.00	
Satd. Flow (prot)	1736	3279		1579	3213		1681	3471	1399		3370	
Flt Permitted	0.95	1.00		0.95	0.99		0.20	1.00	1.00		0.91	
Satd. Flow (perm)	1736	3279		1579	3213		356	3471	1399		3088	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	32	348	84	255	216	22	53	295	420	44	558	53
RTOR Reduction (vph)	0	23	0	0	6	0	0	0	301	0	7	0
Lane Group Flow (vph)	32	409	0	161	326	0	53	295	119	0	648	0
Confl. Peds. (#/hr)	132		112	112		132	97		82	82		97
Confl. Bikes (#/hr)			64			2						21
Heavy Vehicles (%)	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%
Turn Type	Split			Split			Perm		Perm	Perm		
Protected Phases	4	4		8	8			2			6	
Permitted Phases							2		2	6		
Actuated Green, G (s)	32.0	32.0		25.0	25.0		25.5	25.5	25.5		25.5	
Effective Green, g (s)	32.0	32.0		25.0	25.0		25.5	25.5	25.5		25.5	
Actuated g/C Ratio	0.36	0.36		0.28	0.28		0.28	0.28	0.28		0.28	
Clearance Time (s)	2.5	2.5		2.5	2.5		2.5	2.5	2.5		2.5	
Lane Grp Cap (vph)	617	1166		439	893		101	983	396		875	
v/s Ratio Prot	0.02	c0.12		c0.10	0.10			0.08				
v/s Ratio Perm							0.15		0.09		c0.21	
v/c Ratio	0.05	0.35		0.37	0.37		0.52	0.30	0.30		0.74	
Uniform Delay, d1	19.0	21.4		26.1	26.1		27.1	25.3	25.3		29.2	
Progression Factor	1.33	1.41		1.00	1.00		0.78	0.74	1.47		1.00	
Incremental Delay, d2	0.2	0.8		2.4	1.2		15.7	0.7	1.7		5.6	
Delay (s)	25.5	31.0		28.5	27.3		37.0	19.3	38.8		34.8	
Level of Service	C	C		C	C		D	B	D		C	
Approach Delay (s)		30.6			27.7			31.2			34.8	
Approach LOS		C			C			C			C	

Intersection Summary			
HCM Average Control Delay	31.4	HCM Level of Service	C
HCM Volume to Capacity ratio	0.48		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	7.5
Intersection Capacity Utilization	102.5%	ICU Level of Service	G
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (vph)	90	531	218	22	65	130
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0		4.0	
Lane Util. Factor	1.00	0.95	1.00		1.00	
Frpb, ped/bikes	1.00	1.00	0.95		0.88	
Flpb, ped/bikes	1.00	1.00	1.00		1.00	
Frt	1.00	1.00	0.99		0.91	
Flt Protected	0.95	1.00	1.00		0.98	
Satd. Flow (prot)	1703	3406	1684		1407	
Flt Permitted	0.95	1.00	1.00		0.98	
Satd. Flow (perm)	1703	3406	1684		1407	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	95	559	229	23	68	137
RTOR Reduction (vph)	0	0	5	0	83	0
Lane Group Flow (vph)	95	559	247	0	122	0
Confl. Peds. (#/hr)				283	133	133
Confl. Bikes (#/hr)				5		
Heavy Vehicles (%)	6%	6%	6%	6%	6%	6%
Turn Type	Prot					
Protected Phases	7	4	8		6	
Permitted Phases						
Actuated Green, G (s)	6.3	31.8	21.5		26.0	
Effective Green, g (s)	6.3	31.8	21.5		26.0	
Actuated g/C Ratio	0.10	0.48	0.33		0.40	
Clearance Time (s)	4.0	4.0	4.0		4.0	
Vehicle Extension (s)	3.0	3.0	3.0		3.0	
Lane Grp Cap (vph)	163	1646	550		556	
v/s Ratio Prot	c0.06	0.16	c0.15		c0.09	
v/s Ratio Perm						
v/c Ratio	0.58	0.34	0.45		0.22	
Uniform Delay, d1	28.5	10.5	17.5		13.2	
Progression Factor	1.00	1.00	1.00		1.00	
Incremental Delay, d2	5.2	0.6	2.6		0.9	
Delay (s)	33.7	11.1	20.1		14.1	
Level of Service	C	B	C		B	
Approach Delay (s)		14.4	20.1		14.1	
Approach LOS		B	C		B	

Intersection Summary			
HCM Average Control Delay	15.6	HCM Level of Service	B
HCM Volume to Capacity ratio	0.35		
Actuated Cycle Length (s)	65.8	Sum of lost time (s)	12.0
Intersection Capacity Utilization	44.7%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	20	205	311	22	42	10	97	161	191	21	217	30
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0	4.0		4.0	4.0		4.0			4.0	
Lane Util. Factor		1.00	1.00		1.00	1.00		1.00			1.00	
Frpb, ped/bikes		1.00	0.79		1.00	0.78		0.94			0.99	
Flpb, ped/bikes		0.98	1.00		0.96	1.00		0.99			1.00	
Frt		1.00	0.85		1.00	0.85		0.94			0.98	
Flt Protected		1.00	1.00		0.98	1.00		0.99			1.00	
Satd. Flow (prot)		1772	1214		1700	1201		1567			1742	
Flt Permitted		0.98	1.00		0.88	1.00		0.87			0.96	
Satd. Flow (perm)		1738	1214		1520	1201		1381			1671	
Peak-hour factor, PHF	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96
Adj. Flow (vph)	21	214	324	23	44	10	101	168	199	22	226	31
RTOR Reduction (vph)	0	0	214	0	0	7	0	41	0	0	7	0
Lane Group Flow (vph)	0	235	110	0	67	3	0	427	0	0	272	0
Confl. Peds. (#/hr)	100		95	95		100	51		59	59		51
Confl. Bikes (#/hr)			2									18
Heavy Vehicles (%)	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%
Turn Type	Perm		Perm	Perm		Perm	Perm			Perm		
Protected Phases		4			8			2			6	
Permitted Phases	4		4	8		8	2			6		
Actuated Green, G (s)		21.5	21.5		21.5	21.5		34.5			34.5	
Effective Green, g (s)		22.0	22.0		22.0	22.0		35.0			35.0	
Actuated g/C Ratio		0.34	0.34		0.34	0.34		0.54			0.54	
Clearance Time (s)		4.5	4.5		4.5	4.5		4.5			4.5	
Lane Grp Cap (vph)		588	411		514	406		744			900	
v/s Ratio Prot												
v/s Ratio Perm		c0.14	0.09		0.04	0.00		c0.31			0.16	
v/c Ratio		0.40	0.27		0.13	0.01		0.57			0.30	
Uniform Delay, d1		16.4	15.6		14.9	14.3		10.0			8.3	
Progression Factor		1.00	1.00		1.00	1.00		1.00			1.00	
Incremental Delay, d2		2.0	1.6		0.5	0.0		3.2			0.9	
Delay (s)		18.5	17.2		15.4	14.3		13.2			9.1	
Level of Service		B	B		B	B		B			A	
Approach Delay (s)		17.7			15.3			13.2			9.1	
Approach LOS		B			B			B			A	

Intersection Summary			
HCM Average Control Delay	14.3	HCM Level of Service	B
HCM Volume to Capacity ratio	0.51		
Actuated Cycle Length (s)	65.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	74.0%	ICU Level of Service	D
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Stop			Stop			Stop			Stop	
Volume (vph)	10	10	20	50	10	108	10	341	126	167	382	10
Peak Hour Factor	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94
Hourly flow rate (vph)	11	11	21	53	11	115	11	363	134	178	406	11

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total (vph)	43	179	507	595
Volume Left (vph)	11	53	11	178
Volume Right (vph)	21	115	134	11
Hadj (s)	-0.13	-0.21	-0.04	0.17
Departure Headway (s)	7.4	6.7	5.6	5.7
Degree Utilization, x	0.09	0.33	0.79	0.94
Capacity (veh/h)	443	502	624	595
Control Delay (s)	11.1	13.1	26.8	46.1
Approach Delay (s)	11.1	13.1	26.8	46.1
Approach LOS	B	B	D	E

Intersection Summary			
Delay	33.1		
HCM Level of Service	D		
Intersection Capacity Utilization	83.2%	ICU Level of Service	E
Analysis Period (min)	15		

SimTraffic Post-Processor **LBNL 2nd Campus**
Average Results from 10 Runs **Near-Term (2018) Baseline**
Volume and Delay by Movement **AM Peak Hour**

Intersection 8 **Piedmont Avenue/Bancroft Way** **Unsignalized**

		Volume (veh/hr)			Total Delay (sec/veh)		
Direction	**Movement**	**Demand**	**Served**	**% Served**	**Average**	**Std. Dev.**	**LOS**
NB	Left Turn	100	86	86.3%	55.0	19.1	F
	Through	587	500	85.1%	58.4	14.4	F
	Right Turn						
	Subtotal	**687**	**586**	**85.3%**	**57.9**	**14.9**	**F**
SB	Left Turn						
	Through	285	294	103.1%	14.0	1.7	B
	Right Turn	117	110	94.3%	11.2	1.0	B
	Subtotal	**402**	**404**	**100.5%**	**13.2**	**1.4**	**B**
EB	Left Turn						
	Through						
	Right Turn						
	Subtotal						
WB	Left Turn						
	Through						
	Right Turn						
	Subtotal						
Total		**1089**	**990**	**90.9%**	**39.7**	**8.9**	**E**

Intersection 9 **Piedmont Avenue/Durant Avenue** **Unsignalized**

		Volume (veh/hr)			Total Delay (sec/veh)		
Direction	**Movement**	**Demand**	**Served**	**% Served**	**Average**	**Std. Dev.**	**LOS**
NB	Left Turn						
	Through	529	431	81.5%	484.4	185.1	F
	Right Turn						
	Subtotal	**529**	**431**	**81.5%**	**484.4**	**185.1**	**F**
SB	Left Turn						
	Through	275	294	106.9%	14.8	2.3	B
	Right Turn						
	Subtotal	**275**	**294**	**106.9%**	**14.8**	**2.3**	**B**
EB	Left Turn	150	150	99.9%	16.0	2.8	C
	Through						
	Right Turn	80	86	107.6%	8.0	0.6	A
	Subtotal	**230**	**236**	**102.6%**	**13.1**	**2.1**	**B**
WB	Left Turn						
	Through						
	Right Turn						
	Subtotal						
Total		**1034**	**961**	**92.9%**	**223.9**	**81.2**	**F**

Intersection	
Intersection Delay (sec/veh)	10.1
Intersection LOS	B

Approach	EB	WB	NB	SB
Entry Lanes	1	1	1	1
Conflicting Circle Lanes	1	1	1	1
Adjusted Approach Flow (vph)	83	126	594	370
Demand Flow Rate (pc/h)	86	132	618	385
Vehicles Circulating (pc/h)	385	627	86	176
Vehicles Exiting (pc/h)	176	77	385	583
Follow-Up Headway (s)	3.186	3.186	3.186	3.186
Ped Vol. Crossing Leg (#/hr)	1	59	7	5
Ped Capacity Adjustment	1.000	0.992	0.999	0.999
Approach Delay (sec/veh)	6.0	9.1	11.8	8.7
Approach LOS	A	A	B	A

Lane	Left	Left	Left	Left
Designated moves	LTR	LTR	LTR	LTR
Assumed Moves	LTR	LTR	LTR	LTR
Right Turn Channelized				
Lane Utilization	1.000	1.000	1.000	1.000
Critical Headway (s)	5.193	5.193	5.193	5.193
Entry Flow Rate (pc/h)	86	132	618	385
Capacity, Entry Lane (pc/h)	769	604	1037	948
Entry HV Adjustment Factor	0.962	0.958	0.961	0.960
Flow Rate, Entry (vph)	83	126	594	370
Capacity, Entry (vph)	740	574	995	909
Volume to Capacity Ratio	0.112	0.220	0.597	0.407
Control Delay (sec/veh)	6.0	9.1	11.8	8.7
Level of Service	A	A	B	A
95th-Percentile Queue (veh)	0	1	4	2

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	153	131	150	30	0	50	0	647	11	10	274	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	3.0	3.0	3.0	3.0		3.0		3.0			3.0	
Lane Util. Factor	1.00	1.00	1.00	1.00		1.00		*0.60			*0.60	
Frpb, ped/bikes	1.00	1.00	0.95	1.00		0.94		1.00			1.00	
Flpb, ped/bikes	0.96	1.00	1.00	0.97		1.00		1.00			1.00	
Frt	1.00	1.00	0.85	1.00		0.85		1.00			1.00	
Flt Protected	0.95	1.00	1.00	0.95		1.00		1.00			1.00	
Satd. Flow (prot)	1695	1863	1505	1714		1487		2226			2230	
Flt Permitted	0.95	1.00	1.00	0.67		1.00		1.00			0.92	
Satd. Flow (perm)	1695	1863	1505	1211		1487		2226			2063	
Peak-hour factor, PHF	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98
Adj. Flow (vph)	156	134	153	31	0	51	0	660	11	10	280	0
RTOR Reduction (vph)	0	0	80	0	0	27	0	1	0	0	0	0
Lane Group Flow (vph)	156	134	73	31	0	24	0	670	0	0	290	0
Confl. Peds. (#/hr)	40		60	60		40	47		49	49		47
Confl. Bikes (#/hr)			1						13			
Turn Type	Perm		Perm	custom		custom				Perm		
Protected Phases		4						2			6	
Permitted Phases	4		4	8		8				6		
Actuated Green, G (s)	31.0	31.0	31.0	31.0		31.0		28.0			28.0	
Effective Green, g (s)	31.0	31.0	31.0	31.0		31.0		28.0			28.0	
Actuated g/C Ratio	0.48	0.48	0.48	0.48		0.48		0.43			0.43	
Clearance Time (s)	3.0	3.0	3.0	3.0		3.0		3.0			3.0	
Lane Grp Cap (vph)	808	889	718	578		709		959			889	
v/s Ratio Prot		0.07						c0.30				
v/s Ratio Perm	c0.09		0.05	0.03		0.02					0.14	
v/c Ratio	0.19	0.15	0.10	0.05		0.03		0.70			0.33	
Uniform Delay, d1	9.8	9.6	9.3	9.1		9.0		15.1			12.3	
Progression Factor	1.00	1.00	1.00	1.00		1.00		1.00			1.00	
Incremental Delay, d2	0.5	0.4	0.3	0.2		0.1		4.2			1.0	
Delay (s)	10.3	9.9	9.6	9.3		9.1		19.3			13.2	
Level of Service	B	A	A	A		A		B			B	
Approach Delay (s)		10.0			9.2			19.3			13.2	
Approach LOS		A			A			B			B	

Intersection Summary			
HCM Average Control Delay	14.8	HCM Level of Service	B
HCM Volume to Capacity ratio	0.43		
Actuated Cycle Length (s)	65.0	Sum of lost time (s)	6.0
Intersection Capacity Utilization	64.3%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

HCM Unsignalized Intersection Capacity Analysis
12: Prospect St & Panoramic Way

3/19/2013

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Volume (veh/h)	224	30	10	100	50	20
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.82	0.82	0.82	0.82	0.82	0.82
Hourly flow rate (vph)	273	37	12	122	61	24
Pedestrians	2					
Lane Width (ft)	12.0					
Walking Speed (ft/s)	4.0					
Percent Blockage	0					
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume			310		440	291
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			310		440	291
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			99		89	97
cM capacity (veh/h)			1251		568	748

Direction, Lane #	EB 1	WB 1	NB 1
Volume Total	310	134	85
Volume Left	0	12	61
Volume Right	37	0	24
cSH	1700	1251	610
Volume to Capacity	0.18	0.01	0.14
Queue Length 95th (ft)	0	1	12
Control Delay (s)	0.0	0.8	11.9
Lane LOS		A	B
Approach Delay (s)	0.0	0.8	11.9
Approach LOS			B

Intersection Summary			
Average Delay	2.1		
Intersection Capacity Utilization	24.3%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Sign Control	Stop		Stop			Stop
Volume (vph)	91	90	60	184	90	20
Peak Hour Factor	0.95	0.95	0.95	0.95	0.95	0.95
Hourly flow rate (vph)	96	95	63	194	95	21

Direction, Lane #	WB 1	NB 1	SB 1
Volume Total (vph)	191	257	116
Volume Left (vph)	96	0	95
Volume Right (vph)	95	194	0
Hadj (s)	-0.13	-0.38	0.23
Departure Headway (s)	4.6	4.1	4.9
Degree Utilization, x	0.24	0.29	0.16
Capacity (veh/h)	726	832	695
Control Delay (s)	9.1	8.9	8.8
Approach Delay (s)	9.1	8.9	8.8
Approach LOS	A	A	A

Intersection Summary			
Delay	8.9		
HCM Level of Service	A		
Intersection Capacity Utilization	41.7%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Stop			Stop			Stop			Stop	
Volume (vph)	10	120	123	201	80	20	31	20	34	20	60	10
Peak Hour Factor	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88
Hourly flow rate (vph)	11	136	140	228	91	23	35	23	39	23	68	11

Direction, Lane #	EB 1	WB 1	NB 1	SB 1	SB 2
Volume Total (vph)	288	342	97	91	11
Volume Left (vph)	11	228	35	23	0
Volume Right (vph)	140	23	39	0	11
Hadj (s)	-0.27	0.11	-0.15	0.07	-0.58
Departure Headway (s)	4.6	4.9	5.4	5.7	3.2
Degree Utilization, x	0.37	0.47	0.15	0.14	0.01
Capacity (veh/h)	742	703	576	558	1121
Control Delay (s)	10.3	12.1	9.4	9.6	6.2
Approach Delay (s)	10.3	12.1	9.4	9.2	
Approach LOS	B	B	A	A	

Intersection Summary			
Delay	10.8		
HCM Level of Service	B		
Intersection Capacity Utilization	52.8%	ICU Level of Service	A
Analysis Period (min)	15		

HCM Signalized Intersection Capacity Analysis
1: University Ave & Shattuck Ave

3/15/2013

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	151	423	250	81	603	470	0	0	0	50	751	120
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0			4.0	4.0					4.0	
Lane Util. Factor	1.00	0.95			0.91	0.91					0.91	
Frpb, ped/bikes	1.00	0.91			0.96	0.69					0.95	
Flpb, ped/bikes	0.92	1.00			0.99	1.00					0.99	
Frt	1.00	0.94			0.98	0.85					0.98	
Flt Protected	0.95	1.00			0.99	1.00					1.00	
Satd. Flow (prot)	1617	2999			3131	986					4609	
Flt Permitted	0.25	1.00			0.78	1.00					1.00	
Satd. Flow (perm)	434	2999			2467	986					4609	
Peak-hour factor, PHF	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93
Adj. Flow (vph)	162	455	269	87	648	505	0	0	0	54	808	129
RTOR Reduction (vph)	0	0	0	0	11	189	0	0	0	0	22	0
Lane Group Flow (vph)	162	724	0	0	825	215	0	0	0	0	969	0
Confl. Peds. (#/hr)	323		260	260		323	783		278	278		783
Confl. Bikes (#/hr)			12			15						30
Heavy Vehicles (%)	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%
Turn Type	Perm			Perm		Perm				Perm		
Protected Phases		4			8						6	
Permitted Phases	4			8		8				6		
Actuated Green, G (s)	48.0	48.0			48.0	48.0					34.0	
Effective Green, g (s)	48.0	48.0			48.0	48.0					34.0	
Actuated g/C Ratio	0.53	0.53			0.53	0.53					0.38	
Clearance Time (s)	4.0	4.0			4.0	4.0					4.0	
Lane Grp Cap (vph)	231	1599			1316	526					1741	
v/s Ratio Prot		0.24										
v/s Ratio Perm	c0.37				0.33	0.22					0.21	
v/c Ratio	0.70	0.45			0.63	0.41					0.56	
Uniform Delay, d1	15.7	12.9			14.7	12.5					22.1	
Progression Factor	1.00	1.00			1.40	3.93					0.73	
Incremental Delay, d2	16.3	0.9			2.2	2.3					1.2	
Delay (s)	32.0	13.8			22.9	51.6					17.4	
Level of Service	C	B			C	D					B	
Approach Delay (s)		17.2			32.2			0.0			17.4	
Approach LOS		B			C			A			B	

Intersection Summary			
HCM Average Control Delay	23.2	HCM Level of Service	C
HCM Volume to Capacity ratio	0.64		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	84.8%	ICU Level of Service	E
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	70	172	50	131	332	164	40	600	41	82	580	50
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0	4.0		4.0		4.0	4.0		4.0	4.0	
Lane Util. Factor		0.95	1.00		0.95		1.00	0.95		1.00	0.95	
Frpb, ped/bikes		1.00	0.90		0.95		1.00	0.99		1.00	0.98	
Flpb, ped/bikes		0.98	1.00		0.99		0.91	1.00		0.95	1.00	
Frt		1.00	0.85		0.96		1.00	0.99		1.00	0.99	
Flt Protected		0.99	1.00		0.99		0.95	1.00		0.95	1.00	
Satd. Flow (prot)		3434	1426		3143		1605	3471		1678	3425	
Flt Permitted		0.67	1.00		0.80		0.36	1.00		0.35	1.00	
Satd. Flow (perm)		2338	1426		2546		605	3471		623	3425	
Peak-hour factor, PHF	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97
Adj. Flow (vph)	72	177	52	135	342	169	41	619	42	85	598	52
RTOR Reduction (vph)	0	0	20	0	39	0	0	5	0	0	7	0
Lane Group Flow (vph)	0	249	32	0	607	0	41	656	0	85	643	0
Confl. Peds. (#/hr)	186		99	99		186	417		236	236		417
Confl. Bikes (#/hr)			10			95			20			23
Turn Type	Perm		Perm	Perm			Perm			Perm		
Protected Phases		4			8			2			6	
Permitted Phases	4		4	8			2			6		
Actuated Green, G (s)		33.0	33.0		33.0		49.0	49.0		49.0	49.0	
Effective Green, g (s)		33.0	33.0		33.0		49.0	49.0		49.0	49.0	
Actuated g/C Ratio		0.37	0.37		0.37		0.54	0.54		0.54	0.54	
Clearance Time (s)		4.0	4.0		4.0		4.0	4.0		4.0	4.0	
Lane Grp Cap (vph)		857	523		934		329	1890		339	1865	
v/s Ratio Prot								c0.19			0.19	
v/s Ratio Perm		0.11	0.02		c0.24		0.07			0.14		
v/c Ratio		0.29	0.06		0.65		0.12	0.35		0.25	0.34	
Uniform Delay, d1		20.2	18.5		23.7		10.0	11.5		10.8	11.5	
Progression Factor		1.00	1.00		1.55		1.63	1.65		1.00	1.00	
Incremental Delay, d2		0.9	0.2		2.5		0.6	0.4		1.8	0.5	
Delay (s)		21.1	18.7		39.2		17.0	19.4		12.6	12.0	
Level of Service		C	B		D		B	B		B	B	
Approach Delay (s)		20.7			39.2			19.2			12.1	
Approach LOS		C			D			B			B	

Intersection Summary			
HCM Average Control Delay	22.6	HCM Level of Service	C
HCM Volume to Capacity ratio	0.47		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	109.5%	ICU Level of Service	H
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	294	30	300	10	30	30	200	680	20	30	630	138
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0			4.0		4.0	4.0		4.0	4.0	4.0
Lane Util. Factor	0.95	0.95			1.00		1.00	0.95		1.00	0.95	1.00
Frpb, ped/bikes	1.00	0.85			0.90		1.00	0.99		1.00	1.00	0.82
Flpb, ped/bikes	0.80	0.98			0.99		1.00	1.00		0.93	1.00	1.00
Frt	1.00	0.87			0.94		1.00	1.00		1.00	1.00	0.85
Flt Protected	0.95	1.00			0.99		0.95	1.00		0.95	1.00	1.00
Satd. Flow (prot)	1326	1277			1531		1752	3469		1628	3505	1286
Flt Permitted	0.75	0.98			0.94		0.95	1.00		0.38	1.00	1.00
Satd. Flow (perm)	1048	1251			1457		1752	3469		651	3505	1286
Peak-hour factor, PHF	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98
Adj. Flow (vph)	300	31	306	10	31	31	204	694	20	31	643	141
RTOR Reduction (vph)	0	174	0	0	20	0	0	2	0	0	0	75
Lane Group Flow (vph)	270	193	0	0	52	0	204	712	0	31	643	66
Confl. Peds. (#/hr)	254		187	187		254	179		132	132		179
Confl. Bikes (#/hr)			5			6			16			38
Heavy Vehicles (%)	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%
Turn Type	Perm			Perm			Prot			Perm		Perm
Protected Phases		4			8		5	2			6	
Permitted Phases	4			8						6		6
Actuated Green, G (s)	31.0	31.0			31.0		10.0	51.0		37.0	37.0	37.0
Effective Green, g (s)	31.0	31.0			31.0		10.0	51.0		37.0	37.0	37.0
Actuated g/C Ratio	0.34	0.34			0.34		0.11	0.57		0.41	0.41	0.41
Clearance Time (s)	4.0	4.0			4.0		4.0	4.0		4.0	4.0	4.0
Lane Grp Cap (vph)	361	431			502		195	1966		268	1441	529
v/s Ratio Prot							c0.12	0.21			c0.18	
v/s Ratio Perm	c0.26	0.15			0.04					0.05		0.05
v/c Ratio	0.75	0.45			0.10		1.05	0.36		0.12	0.45	0.12
Uniform Delay, d1	26.0	22.9			20.0		40.0	10.6		16.4	19.1	16.4
Progression Factor	0.69	0.45			1.00		1.00	1.00		0.44	0.48	0.36
Incremental Delay, d2	12.6	3.2			0.4		77.1	0.5		0.7	0.8	0.4
Delay (s)	30.5	13.5			20.5		117.1	11.1		7.8	10.0	6.3
Level of Service	C	B			C		F	B		A	A	A
Approach Delay (s)		20.7			20.5			34.7			9.3	
Approach LOS		C			C			C			A	

Intersection Summary			
HCM Average Control Delay	22.1	HCM Level of Service	C
HCM Volume to Capacity ratio	0.64		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	75.4%	ICU Level of Service	D
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	40	185	80	358	457	80	100	610	334	21	310	50
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	2.0	2.0		2.0	2.0		2.0	2.0			2.0	
Lane Util. Factor	1.00	0.95		0.91	0.91		1.00	0.95			0.95	
Frpb, ped/bikes	1.00	0.97		1.00	0.97		1.00	0.95			0.99	
Flpb, ped/bikes	1.00	1.00		1.00	1.00		0.95	1.00			1.00	
Frt	1.00	0.95		1.00	0.98		1.00	0.95			0.98	
Flt Protected	0.95	1.00		0.95	0.99		0.95	1.00			1.00	
Satd. Flow (prot)	1770	3289		1610	3205		1685	3200			3407	
Flt Permitted	0.95	1.00		0.95	0.99		0.38	1.00			0.72	
Satd. Flow (perm)	1770	3289		1610	3205		680	3200			2451	
Peak-hour factor, PHF	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94
Adj. Flow (vph)	43	197	85	381	486	85	106	649	355	22	330	53
RTOR Reduction (vph)	0	53	0	0	12	0	0	82	0	0	14	0
Lane Group Flow (vph)	43	229	0	312	628	0	106	922	0	0	391	0
Confl. Peds. (#/hr)	148		95	95		148	92		105	105		92
Confl. Bikes (#/hr)			6			86			14			9
Turn Type	Split			Split			Perm			Perm		
Protected Phases	4	4		8	8			2			6	
Permitted Phases							2			6		
Actuated Green, G (s)	34.0	34.0		24.0	24.0		26.0	26.0			26.0	
Effective Green, g (s)	34.0	34.0		24.0	24.0		26.0	26.0			26.0	
Actuated g/C Ratio	0.38	0.38		0.27	0.27		0.29	0.29			0.29	
Clearance Time (s)	2.0	2.0		2.0	2.0		2.0	2.0			2.0	
Lane Grp Cap (vph)	669	1243		429	855		196	924			708	
v/s Ratio Prot	0.02	c0.07		0.19	c0.20			c0.29				
v/s Ratio Perm							0.16				0.16	
v/c Ratio	0.06	0.18		0.73	0.73		0.54	1.00			0.55	
Uniform Delay, d1	17.9	18.7		30.0	30.1		27.0	32.0			27.1	
Progression Factor	1.48	1.76		1.00	1.00		0.78	0.78			1.00	
Incremental Delay, d2	0.2	0.3		10.3	5.6		9.5	27.9			3.1	
Delay (s)	26.6	33.3		40.3	35.6		30.4	52.9			30.2	
Level of Service	C	C		D	D		C	D			C	
Approach Delay (s)		32.4			37.2			50.7			30.2	
Approach LOS		C			D			D			C	

Intersection Summary			
HCM Average Control Delay	41.0	HCM Level of Service	D
HCM Volume to Capacity ratio	0.58		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	6.0
Intersection Capacity Utilization	113.1%	ICU Level of Service	H
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (vph)	120	270	405	63	62	90
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0		4.0	
Lane Util. Factor	1.00	0.95	1.00		1.00	
Frpb, ped/bikes	1.00	1.00	0.92		0.84	
Flpb, ped/bikes	1.00	1.00	1.00		1.00	
Frt	1.00	1.00	0.98		0.92	
Flt Protected	0.95	1.00	1.00		0.98	
Satd. Flow (prot)	1719	3438	1629		1370	
Flt Permitted	0.95	1.00	1.00		0.98	
Satd. Flow (perm)	1719	3438	1629		1370	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	126	284	426	66	65	95
RTOR Reduction (vph)	0	0	8	0	60	0
Lane Group Flow (vph)	126	284	484	0	100	0
Confl. Peds. (#/hr)				420	186	186
Confl. Bikes (#/hr)				32		
Heavy Vehicles (%)	5%	5%	5%	5%	5%	5%
Turn Type	Prot					
Protected Phases	7	4	8		6	
Permitted Phases						
Actuated Green, G (s)	6.4	36.8	26.4		26.0	
Effective Green, g (s)	6.4	36.8	26.4		26.0	
Actuated g/C Ratio	0.09	0.52	0.37		0.37	
Clearance Time (s)	4.0	4.0	4.0		4.0	
Vehicle Extension (s)	3.0	3.0	3.0		3.0	
Lane Grp Cap (vph)	155	1787	607		503	
v/s Ratio Prot	c0.07	0.08	c0.30		c0.07	
v/s Ratio Perm						
v/c Ratio	0.81	0.16	0.80		0.20	
Uniform Delay, d1	31.6	8.9	19.8		15.3	
Progression Factor	1.00	1.00	1.00		1.00	
Incremental Delay, d2	26.7	0.2	10.5		0.9	
Delay (s)	58.3	9.1	30.3		16.2	
Level of Service	E	A	C		B	
Approach Delay (s)		24.2	30.3		16.2	
Approach LOS		C	C		B	

Intersection Summary			
HCM Average Control Delay	25.8	HCM Level of Service	C
HCM Volume to Capacity ratio	0.53		
Actuated Cycle Length (s)	70.8	Sum of lost time (s)	12.0
Intersection Capacity Utilization	56.5%	ICU Level of Service	B
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	20	32	260	60	144	21	84	236	202	20	191	10
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0	4.0		4.0	4.0		4.0			4.0	
Lane Util. Factor		1.00	1.00		1.00	1.00		1.00			1.00	
Frpb, ped/bikes		1.00	0.76		1.00	0.70		0.93			0.99	
Flpb, ped/bikes		0.93	1.00		0.94	1.00		0.98			1.00	
Frt		1.00	0.85		1.00	0.85		0.95			0.99	
Flt Protected		0.98	1.00		0.99	1.00		0.99			1.00	
Satd. Flow (prot)		1684	1191		1708	1105		1576			1800	
Flt Permitted		0.87	1.00		0.90	1.00		0.91			0.94	
Satd. Flow (perm)		1500	1191		1569	1105		1446			1699	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	22	35	283	65	157	23	91	257	220	22	208	11
RTOR Reduction (vph)	0	0	182	0	0	14	0	33	0	0	2	0
Lane Group Flow (vph)	0	57	101	0	222	9	0	535	0	0	239	0
Confl. Peds. (#/hr)	121		102	102		121	82		75	75		82
Confl. Bikes (#/hr)			2			21			17			6
Heavy Vehicles (%)	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%
Turn Type	Perm		Perm	Perm		Perm	Perm			Perm		
Protected Phases		4			8			2			6	
Permitted Phases	4		4	8		8	2			6		
Actuated Green, G (s)		24.5	24.5		24.5	24.5		36.5			36.5	
Effective Green, g (s)		25.0	25.0		25.0	25.0		37.0			37.0	
Actuated g/C Ratio		0.36	0.36		0.36	0.36		0.53			0.53	
Clearance Time (s)		4.5	4.5		4.5	4.5		4.5			4.5	
Lane Grp Cap (vph)		536	425		560	395		764			898	
v/s Ratio Prot												
v/s Ratio Perm		0.04	0.08		c0.14	0.01		c0.37			0.14	
v/c Ratio		0.11	0.24		0.40	0.02		0.70			0.27	
Uniform Delay, d1		15.0	15.8		16.8	14.6		12.4			9.0	
Progression Factor		1.00	1.00		1.00	1.00		1.00			1.00	
Incremental Delay, d2		0.4	1.3		2.1	0.1		5.3			0.7	
Delay (s)		15.4	17.1		18.9	14.7		17.7			9.8	
Level of Service		B	B		B	B		B			A	
Approach Delay (s)		16.8			18.5			17.7			9.8	
Approach LOS		B			B			B			A	

Intersection Summary			
HCM Average Control Delay	16.3	HCM Level of Service	B
HCM Volume to Capacity ratio	0.58		
Actuated Cycle Length (s)	70.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	74.2%	ICU Level of Service	D
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Stop			Stop			Stop			Stop	
Volume (vph)	30	20	20	141	10	190	10	302	42	111	400	10
Peak Hour Factor	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98
Hourly flow rate (vph)	31	20	20	144	10	194	10	308	43	113	408	10

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total (vph)	71	348	361	532
Volume Left (vph)	31	144	10	113
Volume Right (vph)	20	194	43	10
Hadj (s)	-0.03	-0.20	-0.01	0.08
Departure Headway (s)	7.9	6.7	6.6	6.3
Degree Utilization, x	0.16	0.65	0.66	0.93
Capacity (veh/h)	391	518	527	532
Control Delay (s)	12.4	21.1	21.3	47.6
Approach Delay (s)	12.4	21.1	21.3	47.6
Approach LOS	B	C	C	E

Intersection Summary			
Delay	31.4		
HCM Level of Service	D		
Intersection Capacity Utilization	85.8%	ICU Level of Service	E
Analysis Period (min)	15		

SimTraffic Post-Processor | **LBNL 2nd Campus**
Average Results from 10 Runs | **Near-Term (2018) Baseline**
Volume and Delay by Movement | **PM Peak Hour**

Intersection 8 **Piedmont Avenue/Bancroft Way** **Unsignalized**

		Volume (veh/hr)			Total Delay (sec/veh)		
Direction	**Movement**	**Demand**	**Served**	**% Served**	**Average**	**Std. Dev.**	**LOS**
NB	Left Turn	131	115	87.5%	50.1	9.8	F
	Through	424	372	87.7%	51.3	9.5	F
	Right Turn						
	Subtotal	**555**	**487**	**87.7%**	**51.0**	**9.4**	**F**
SB	Left Turn						
	Through	399	354	88.7%	256.2	139.0	F
	Right Turn	192	172	89.6%	242.0	135.9	F
	Subtotal	**591**	**526**	**89.0%**	**251.5**	**137.8**	**F**
EB	Left Turn						
	Through						
	Right Turn						
	Subtotal						
WB	Left Turn						
	Through						
	Right Turn						
	Subtotal						
Total		**1146**	**1013**	**88.4%**	**154.1**	**67.4**	**F**

Intersection 9 **Piedmont Avenue/Durant Avenue** **Unsignalized**

		Volume (veh/hr)			Total Delay (sec/veh)		
Direction	**Movement**	**Demand**	**Served**	**% Served**	**Average**	**Std. Dev.**	**LOS**
NB	Left Turn						
	Through	411	341	82.9%	428.2	165.0	F
	Right Turn						
	Subtotal	**411**	**341**	**82.9%**	**428.2**	**165.0**	**F**
SB	Left Turn						
	Through	390	352	90.2%	85.2	13.7	F
	Right Turn						
	Subtotal	**390**	**352**	**90.2%**	**85.2**	**13.7**	**F**
EB	Left Turn	133	136	102.0%	19.1	5.0	C
	Through						
	Right Turn	180	178	98.9%	21.9	6.3	C
	Subtotal	**313**	**314**	**100.2%**	**20.7**	**4.2**	**C**
WB	Left Turn						
	Through						
	Right Turn						
	Subtotal						
Total		**1114**	**1006**	**90.3%**	**180.2**	**57.9**	**F**

Intersection	
Intersection Delay (sec/veh)	15.1
Intersection LOS	C

Approach	EB	WB	NB	SB
Entry Lanes	1	1	1	1
Conflicting Circle Lanes	1	1	1	1
Adjusted Approach Flow (vph)	138	212	527	621
Demand Flow Rate (pc/h)	141	216	537	633
Vehicles Circulating (pc/h)	612	527	151	301
Vehicles Exiting (pc/h)	322	161	602	442
Follow-Up Headway (s)	3.186	3.186	3.186	3.186
Ped Vol. Crossing Leg (#/hr)	210	9	117	78
Ped Capacity Adjustment	0.958	0.999	0.979	0.989
Approach Delay (sec/veh)	9.4	9.8	11.6	21.2
Approach LOS	A	A	B	C

Lane	Left	Left	Left	Left
Designated moves	LTR	LTR	LTR	LTR
Assumed Moves	LTR	LTR	LTR	LTR
Right Turn Channelized				
Lane Utilization	1.000	1.000	1.000	1.000
Critical Headway (s)	5.193	5.193	5.193	5.193
Entry Flow Rate (pc/h)	141	216	537	633
Capacity, Entry Lane (pc/h)	613	667	972	836
Entry HV Adjustment Factor	0.978	0.980	0.981	0.980
Flow Rate, Entry (vph)	138	212	527	621
Capacity, Entry (vph)	574	653	932	811
Volume to Capacity Ratio	0.240	0.324	0.565	0.765
Control Delay (sec/veh)	9.4	9.8	11.6	21.2
Level of Service	A	A	B	C
95th-Percentile Queue (veh)	1	1	4	7

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	127	120	220	41	0	100	0	495	10	20	432	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	3.0	3.0	3.0	3.0		3.0		3.0			3.0	
Lane Util. Factor	1.00	1.00	1.00	1.00		1.00		*0.60			*0.60	
Frpb, ped/bikes	1.00	1.00	0.91	1.00		0.85		1.00			1.00	
Flpb, ped/bikes	0.87	1.00	1.00	0.94		1.00		1.00			1.00	
Frt	1.00	1.00	0.85	1.00		0.85		1.00			1.00	
Flt Protected	0.95	1.00	1.00	0.95		1.00		1.00			1.00	
Satd. Flow (prot)	1553	1881	1456	1672		1367		2240			2244	
Flt Permitted	0.95	1.00	1.00	0.68		1.00		1.00			0.91	
Satd. Flow (perm)	1553	1881	1456	1190		1367		2240			2051	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	134	126	232	43	0	105	0	521	11	21	455	0
RTOR Reduction (vph)	0	0	67	0	0	44	0	1	0	0	0	0
Lane Group Flow (vph)	134	126	165	43	0	61	0	531	0	0	476	0
Confl. Peds. (#/hr)	125		122	122		122	121		153	153		121
Confl. Bikes (#/hr)			5						13			14
Heavy Vehicles (%)	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%
Turn Type	Perm		Perm	custom		custom				Perm		
Protected Phases		4						2			6	
Permitted Phases	4		4	8		8				6		
Actuated Green, G (s)	31.0	31.0	31.0	31.0		31.0		28.0			28.0	
Effective Green, g (s)	31.0	31.0	31.0	31.0		31.0		28.0			28.0	
Actuated g/C Ratio	0.48	0.48	0.48	0.48		0.48		0.43			0.43	
Clearance Time (s)	3.0	3.0	3.0	3.0		3.0		3.0			3.0	
Lane Grp Cap (vph)	741	897	694	568		652		965			884	
v/s Ratio Prot		0.07						c0.24				
v/s Ratio Perm	0.09		c0.11	0.04		0.04					0.23	
v/c Ratio	0.18	0.14	0.24	0.08		0.09		0.55			0.54	
Uniform Delay, d1	9.7	9.5	10.0	9.2		9.3		13.8			13.7	
Progression Factor	1.00	1.00	1.00	1.00		1.00		1.00			1.00	
Incremental Delay, d2	0.5	0.3	0.8	0.3		0.3		2.3			2.3	
Delay (s)	10.3	9.9	10.8	9.5		9.6		16.1			16.1	
Level of Service	B	A	B	A		A		B			B	
Approach Delay (s)		10.4			9.6			16.1			16.1	
Approach LOS		B			A			B			B	

Intersection Summary			
HCM Average Control Delay	13.8	HCM Level of Service	B
HCM Volume to Capacity ratio	0.39		
Actuated Cycle Length (s)	65.0	Sum of lost time (s)	6.0
Intersection Capacity Utilization	62.9%	ICU Level of Service	B
Analysis Period (min)	15		
c Critical Lane Group			

HCM Unsignalized Intersection Capacity Analysis
12: Prospect St & Panoramic Way

3/19/2013

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Volume (veh/h)	180	40	20	204	40	30
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.89	0.89	0.89	0.89	0.89	0.89
Hourly flow rate (vph)	202	45	22	229	45	34
Pedestrians	8			1		
Lane Width (ft)	12.0			12.0		
Walking Speed (ft/s)	4.0			4.0		
Percent Blockage	1			0		
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume			247		507	226
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			247		507	226
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			98		91	96
cM capacity (veh/h)			1325		515	815

Direction, Lane #	EB 1	WB 1	NB 1
Volume Total	247	252	79
Volume Left	0	22	45
Volume Right	45	0	34
cSH	1700	1325	611
Volume to Capacity	0.15	0.02	0.13
Queue Length 95th (ft)	0	1	11
Control Delay (s)	0.0	0.8	11.8
Lane LOS		A	B
Approach Delay (s)	0.0	0.8	11.8
Approach LOS			B

Intersection Summary			
Average Delay	2.0		
Intersection Capacity Utilization	37.8%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Sign Control	Stop		Stop			Stop
Volume (vph)	183	80	90	121	80	50
Peak Hour Factor	0.86	0.86	0.86	0.86	0.86	0.86
Hourly flow rate (vph)	213	93	105	141	93	58

Direction, Lane #	WB 1	NB 1	SB 1
Volume Total (vph)	306	245	151
Volume Left (vph)	213	0	93
Volume Right (vph)	93	141	0
Hadj (s)	0.01	-0.29	0.17
Departure Headway (s)	4.9	4.6	5.2
Degree Utilization, x	0.41	0.32	0.22
Capacity (veh/h)	696	733	645
Control Delay (s)	11.3	9.7	9.6
Approach Delay (s)	11.3	9.7	9.6
Approach LOS	B	A	A

Intersection Summary			
Delay	10.4		
HCM Level of Service	B		
Intersection Capacity Utilization	46.3%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Stop			Stop			Stop			Stop	
Volume (vph)	10	120	62	24	90	20	92	70	168	20	20	10
Peak Hour Factor	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93
Hourly flow rate (vph)	11	129	67	26	97	22	99	75	181	22	22	11

Direction, Lane #	EB 1	WB 1	NB 1	SB 1	SB 2
Volume Total (vph)	206	144	355	43	11
Volume Left (vph)	11	26	99	22	0
Volume Right (vph)	67	22	181	0	11
Hadj (s)	-0.17	-0.04	-0.23	0.12	-0.58
Departure Headway (s)	4.9	5.1	4.6	5.4	3.2
Degree Utilization, x	0.28	0.21	0.46	0.06	0.01
Capacity (veh/h)	675	638	740	593	1121
Control Delay (s)	9.9	9.5	11.5	8.8	6.2
Approach Delay (s)	9.9	9.5	11.5	8.3	
Approach LOS	A	A	B	A	

Intersection Summary			
Delay	10.4		
HCM Level of Service	B		
Intersection Capacity Utilization	47.5%	ICU Level of Service	A
Analysis Period (min)	15		

Near-Term (2018) Plus Phase 1 Project Conditions

FEHR PEERS

HCM Signalized Intersection Capacity Analysis
1: University Ave & Shattuck Ave

3/15/2013

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	122	427	180	31	355	250	0	0	0	40	711	113
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0			4.0	4.0					4.0	
Lane Util. Factor	1.00	0.95			0.91	0.91					0.91	
Frpb, ped/bikes	1.00	0.97			0.99	0.89					0.96	
Flpb, ped/bikes	0.95	1.00			1.00	1.00					0.99	
Frt	1.00	0.96			0.98	0.85					0.98	
Flt Protected	0.95	1.00			1.00	1.00					1.00	
Satd. Flow (prot)	1619	3149			3149	1230					4552	
Flt Permitted	0.44	1.00			0.88	1.00					1.00	
Satd. Flow (perm)	745	3149			2780	1230					4552	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	133	464	196	34	386	272	0	0	0	43	773	123
RTOR Reduction (vph)	0	3	0	0	10	108	0	0	0	0	22	0
Lane Group Flow (vph)	133	657	0	0	462	112	0	0	0	0	917	0
Confl. Peds. (#/hr)	108		102	102		108	353		194	194		353
Confl. Bikes (#/hr)			10			6			1			20
Heavy Vehicles (%)	6%	6%	6%	6%	6%	6%	6%	6%	6%	6%	6%	6%
Turn Type	Perm			Perm		Perm				Perm		
Protected Phases		4			8						6	
Permitted Phases	4			8		8				6		
Actuated Green, G (s)	46.0	46.0			46.0	46.0					36.0	
Effective Green, g (s)	46.0	46.0			46.0	46.0					36.0	
Actuated g/C Ratio	0.51	0.51			0.51	0.51					0.40	
Clearance Time (s)	4.0	4.0			4.0	4.0					4.0	
Lane Grp Cap (vph)	381	1609			1421	629					1821	
v/s Ratio Prot		c0.21										
v/s Ratio Perm	0.18				0.17	0.09					0.20	
v/c Ratio	0.35	0.41			0.32	0.18					0.50	
Uniform Delay, d1	13.1	13.6			12.9	11.8					20.3	
Progression Factor	1.00	1.00			1.39	3.19					0.66	
Incremental Delay, d2	2.5	0.8			0.6	0.6					0.9	
Delay (s)	15.6	14.4			18.5	38.4					14.3	
Level of Service	B	B			B	D					B	
Approach Delay (s)		14.6			24.8			0.0			14.3	
Approach LOS		B			C			A			B	

Intersection Summary			
HCM Average Control Delay	17.4	HCM Level of Service	B
HCM Volume to Capacity ratio	0.45		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	83.3%	ICU Level of Service	E
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	40	237	50	64	192	53	20	340	52	176	830	70
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0	4.0		4.0		4.0	4.0		4.0	4.0	
Lane Util. Factor		0.95	1.00		0.95		1.00	0.95		1.00	0.95	
Frpb, ped/bikes		1.00	0.88		0.99		1.00	0.99		1.00	0.99	
Flpb, ped/bikes		0.99	1.00		0.99		0.97	1.00		0.96	1.00	
Frt		1.00	0.85		0.97		1.00	0.98		1.00	0.99	
Flt Protected		0.99	1.00		0.99		0.95	1.00		0.95	1.00	
Satd. Flow (prot)		3460	1387		3303		1701	3392		1674	3425	
Flt Permitted		0.87	1.00		0.82		0.23	1.00		0.49	1.00	
Satd. Flow (perm)		3017	1387		2746		405	3392		862	3425	
Peak-hour factor, PHF	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93
Adj. Flow (vph)	43	255	54	69	206	57	22	366	56	189	892	75
RTOR Reduction (vph)	0	0	28	0	19	0	0	13	0	0	7	0
Lane Group Flow (vph)	0	298	26	0	313	0	22	409	0	189	960	0
Confl. Peds. (#/hr)	75		82	82		75	220		139	139		220
Confl. Bikes (#/hr)			64			7			5			18
Heavy Vehicles (%)	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%
Turn Type	Perm		Perm	Perm			Perm			Perm		
Protected Phases		4			8			2			6	
Permitted Phases	4		4	8			2			6		
Actuated Green, G (s)		32.0	32.0		32.0		50.0	50.0		50.0	50.0	
Effective Green, g (s)		32.0	32.0		32.0		50.0	50.0		50.0	50.0	
Actuated g/C Ratio		0.36	0.36		0.36		0.56	0.56		0.56	0.56	
Clearance Time (s)		4.0	4.0		4.0		4.0	4.0		4.0	4.0	
Lane Grp Cap (vph)		1073	493		976		225	1884		479	1903	
v/s Ratio Prot								0.12			c0.28	
v/s Ratio Perm		0.10	0.02		c0.11		0.05			0.22		
v/c Ratio		0.28	0.05		0.32		0.10	0.22		0.39	0.50	
Uniform Delay, d1		20.7	19.1		21.1		9.4	10.1		11.4	12.3	
Progression Factor		1.00	1.00		0.91		1.98	1.96		1.00	1.00	
Incremental Delay, d2		0.6	0.2		0.8		0.8	0.3		2.4	1.0	
Delay (s)		21.4	19.3		20.0		19.4	20.1		13.8	13.3	
Level of Service		C	B		C		B	C		B	B	
Approach Delay (s)		21.1			20.0			20.1			13.4	
Approach LOS		C			C			C			B	

Intersection Summary			
HCM Average Control Delay	16.8	HCM Level of Service	B
HCM Volume to Capacity ratio	0.43		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	114.0%	ICU Level of Service	H
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	398	20	230	10	20	20	120	370	10	30	750	75
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0			4.0		4.0	4.0		4.0	4.0	4.0
Lane Util. Factor	0.95	0.95			1.00		1.00	0.95		1.00	0.95	1.00
Frpb, ped/bikes	1.00	0.94			0.95		1.00	1.00		1.00	1.00	0.86
Flpb, ped/bikes	0.89	0.98			0.99		1.00	1.00		0.93	1.00	1.00
Frt	1.00	0.89			0.95		1.00	1.00		1.00	1.00	0.85
Flt Protected	0.95	0.99			0.99		0.95	1.00		0.95	1.00	1.00
Satd. Flow (prot)	1462	1398			1608		1736	3444		1617	3471	1332
Flt Permitted	0.78	0.93			0.92		0.95	1.00		0.50	1.00	1.00
Satd. Flow (perm)	1199	1310			1500		1736	3444		856	3471	1332
Peak-hour factor, PHF	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89
Adj. Flow (vph)	447	22	258	11	22	22	135	416	11	34	843	84
RTOR Reduction (vph)	0	110	0	0	15	0	0	2	0	0	0	35
Lane Group Flow (vph)	375	242	0	0	40	0	135	425	0	34	843	49
Confl. Peds. (#/hr)	136		77	77		136	135		85	85		135
Confl. Bikes (#/hr)			13			6			14			40
Heavy Vehicles (%)	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%
Turn Type	Perm			Perm			Prot			Perm		Perm
Protected Phases		4			8		5	2			6	
Permitted Phases	4			8						6		6
Actuated Green, G (s)	30.0	30.0			30.0		6.0	52.0		42.0	42.0	42.0
Effective Green, g (s)	30.0	30.0			30.0		6.0	52.0		42.0	42.0	42.0
Actuated g/C Ratio	0.33	0.33			0.33		0.07	0.58		0.47	0.47	0.47
Clearance Time (s)	4.0	4.0			4.0		4.0	4.0		4.0	4.0	4.0
Lane Grp Cap (vph)	400	437			500		116	1990		399	1620	622
v/s Ratio Prot							c0.08	0.12			c0.24	
v/s Ratio Perm	c0.31	0.18			0.03					0.04		0.04
v/c Ratio	0.94	0.55			0.08		1.16	0.21		0.09	0.52	0.08
Uniform Delay, d1	29.1	24.5			20.6		42.0	9.2		13.3	16.9	13.3
Progression Factor	0.70	0.50			1.00		1.00	1.00		0.47	0.46	0.29
Incremental Delay, d2	31.1	4.8			0.3		134.2	0.2		0.3	1.0	0.2
Delay (s)	51.4	17.0			20.9		176.2	9.4		6.6	8.8	4.0
Level of Service	D	B			C		F	A		A	A	A
Approach Delay (s)		34.8			20.9			49.5			8.3	
Approach LOS		C			C			D			A	

Intersection Summary			
HCM Average Control Delay	27.0	HCM Level of Service	C
HCM Volume to Capacity ratio	0.73		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	69.6%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	30	354	80	245	209	22	50	280	418	45	530	50
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	2.5	2.5		2.5	2.5		2.5	2.5	2.5		2.5	
Lane Util. Factor	1.00	0.95		0.91	0.91		1.00	0.95	1.00		0.95	
Frpb, ped/bikes	1.00	0.97		1.00	0.99		1.00	1.00	0.90		0.99	
Flpb, ped/bikes	1.00	1.00		1.00	1.00		0.97	1.00	1.00		1.00	
Frt	1.00	0.97		1.00	0.99		1.00	1.00	0.85		0.99	
Flt Protected	0.95	1.00		0.95	0.99		0.95	1.00	1.00		1.00	
Satd. Flow (prot)	1736	3290		1579	3212		1681	3471	1399		3369	
Flt Permitted	0.95	1.00		0.95	0.99		0.20	1.00	1.00		0.91	
Satd. Flow (perm)	1736	3290		1579	3212		352	3471	1399		3075	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	32	373	84	258	220	23	53	295	440	47	558	53
RTOR Reduction (vph)	0	21	0	0	6	0	0	0	315	0	7	0
Lane Group Flow (vph)	32	436	0	165	330	0	53	295	125	0	651	0
Confl. Peds. (#/hr)	132		112	112		132	97		82	82		97
Confl. Bikes (#/hr)			64			2						21
Heavy Vehicles (%)	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%
Turn Type	Split			Split			Perm		Perm	Perm		
Protected Phases	4	4		8	8			2			6	
Permitted Phases							2		2	6		
Actuated Green, G (s)	32.0	32.0		25.0	25.0		25.5	25.5	25.5		25.5	
Effective Green, g (s)	32.0	32.0		25.0	25.0		25.5	25.5	25.5		25.5	
Actuated g/C Ratio	0.36	0.36		0.28	0.28		0.28	0.28	0.28		0.28	
Clearance Time (s)	2.5	2.5		2.5	2.5		2.5	2.5	2.5		2.5	
Lane Grp Cap (vph)	617	1170		439	892		100	983	396		871	
v/s Ratio Prot	0.02	c0.13		c0.10	0.10			0.08				
v/s Ratio Perm							0.15		0.09		c0.21	
v/c Ratio	0.05	0.37		0.38	0.37		0.53	0.30	0.31		0.75	
Uniform Delay, d1	19.0	21.5		26.2	26.2		27.2	25.3	25.4		29.3	
Progression Factor	1.29	1.37		1.00	1.00		0.79	0.74	1.59		1.00	
Incremental Delay, d2	0.2	0.9		2.4	1.2		15.9	0.7	1.7		5.8	
Delay (s)	24.7	30.4		28.7	27.3		37.3	19.4	42.2		35.1	
Level of Service	C	C		C	C		D	B	D		D	
Approach Delay (s)		30.0			27.8			33.3			35.1	
Approach LOS		C			C			C			D	

Intersection Summary			
HCM Average Control Delay	32.0	HCM Level of Service	C
HCM Volume to Capacity ratio	0.49		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	7.5
Intersection Capacity Utilization	102.5%	ICU Level of Service	G
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (vph)	90	577	225	22	70	130
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0		4.0	
Lane Util. Factor	1.00	0.95	1.00		1.00	
Frpb, ped/bikes	1.00	1.00	0.95		0.88	
Flpb, ped/bikes	1.00	1.00	1.00		1.00	
Frt	1.00	1.00	0.99		0.91	
Flt Protected	0.95	1.00	1.00		0.98	
Satd. Flow (prot)	1703	3406	1687		1416	
Flt Permitted	0.95	1.00	1.00		0.98	
Satd. Flow (perm)	1703	3406	1687		1416	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	95	607	237	23	74	137
RTOR Reduction (vph)	0	0	5	0	83	0
Lane Group Flow (vph)	95	607	255	0	128	0
Confl. Peds. (#/hr)				283	133	133
Confl. Bikes (#/hr)				5		
Heavy Vehicles (%)	6%	6%	6%	6%	6%	6%
Turn Type	Prot					
Protected Phases	7	4	8		6	
Permitted Phases						
Actuated Green, G (s)	6.3	31.8	21.5		26.0	
Effective Green, g (s)	6.3	31.8	21.5		26.0	
Actuated g/C Ratio	0.10	0.48	0.33		0.40	
Clearance Time (s)	4.0	4.0	4.0		4.0	
Vehicle Extension (s)	3.0	3.0	3.0		3.0	
Lane Grp Cap (vph)	163	1646	551		560	
v/s Ratio Prot	c0.06	0.18	c0.15		c0.09	
v/s Ratio Perm						
v/c Ratio	0.58	0.37	0.46		0.23	
Uniform Delay, d1	28.5	10.7	17.6		13.2	
Progression Factor	1.00	1.00	1.00		1.00	
Incremental Delay, d2	5.2	0.6	2.8		1.0	
Delay (s)	33.7	11.3	20.3		14.2	
Level of Service	C	B	C		B	
Approach Delay (s)		14.4	20.3		14.2	
Approach LOS		B	C		B	

Intersection Summary			
HCM Average Control Delay	15.7	HCM Level of Service	B
HCM Volume to Capacity ratio	0.36		
Actuated Cycle Length (s)	65.8	Sum of lost time (s)	12.0
Intersection Capacity Utilization	45.2%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	20	257	311	28	50	11	97	161	229	25	217	30
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0	4.0		4.0	4.0		4.0			4.0	
Lane Util. Factor		1.00	1.00		1.00	1.00		1.00			1.00	
Frpb, ped/bikes		1.00	0.79		1.00	0.78		0.94			0.99	
Flpb, ped/bikes		0.99	1.00		0.96	1.00		0.99			1.00	
Frt		1.00	0.85		1.00	0.85		0.94			0.99	
Flt Protected		1.00	1.00		0.98	1.00		0.99			1.00	
Satd. Flow (prot)		1779	1214		1706	1201		1550			1742	
Flt Permitted		0.98	1.00		0.85	1.00		0.88			0.94	
Satd. Flow (perm)		1750	1214		1479	1201		1377			1648	
Peak-hour factor, PHF	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96
Adj. Flow (vph)	21	268	324	29	52	11	101	168	239	26	226	31
RTOR Reduction (vph)	0	0	187	0	0	7	0	49	0	0	7	0
Lane Group Flow (vph)	0	289	137	0	81	4	0	459	0	0	276	0
Confl. Peds. (#/hr)	100		95	95		100	51		59	59		51
Confl. Bikes (#/hr)			2									18
Heavy Vehicles (%)	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%
Turn Type	Perm		Perm	Perm		Perm	Perm			Perm		
Protected Phases		4			8			2			6	
Permitted Phases	4		4	8		8	2			6		
Actuated Green, G (s)		21.5	21.5		21.5	21.5		34.5			34.5	
Effective Green, g (s)		22.0	22.0		22.0	22.0		35.0			35.0	
Actuated g/C Ratio		0.34	0.34		0.34	0.34		0.54			0.54	
Clearance Time (s)		4.5	4.5		4.5	4.5		4.5			4.5	
Lane Grp Cap (vph)		592	411		501	406		741			887	
v/s Ratio Prot												
v/s Ratio Perm		c0.17	0.11		0.05	0.00		c0.33			0.17	
v/c Ratio		0.49	0.33		0.16	0.01		0.62			0.31	
Uniform Delay, d1		17.0	16.0		15.0	14.3		10.4			8.3	
Progression Factor		1.00	1.00		1.00	1.00		1.00			1.00	
Incremental Delay, d2		2.9	2.2		0.7	0.0		3.9			0.9	
Delay (s)		19.9	18.2		15.7	14.3		14.2			9.2	
Level of Service		B	B		B	B		B			A	
Approach Delay (s)		19.0			15.6			14.2			9.2	
Approach LOS		B			B			B			A	

Intersection Summary			
HCM Average Control Delay	15.3	HCM Level of Service	B
HCM Volume to Capacity ratio	0.57		
Actuated Cycle Length (s)	65.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	82.5%	ICU Level of Service	E
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Stop			Stop			Stop			Stop	
Volume (vph)	10	10	20	50	10	108	10	379	126	167	388	10
Peak Hour Factor	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94
Hourly flow rate (vph)	11	11	21	53	11	115	11	403	134	178	413	11

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total (vph)	43	179	548	601
Volume Left (vph)	11	53	11	178
Volume Right (vph)	21	115	134	11
Hadj (s)	-0.13	-0.21	-0.02	0.17
Departure Headway (s)	7.6	6.9	5.7	5.8
Degree Utilization, x	0.09	0.34	0.87	0.97
Capacity (veh/h)	443	500	622	601
Control Delay (s)	11.3	13.4	34.6	51.9
Approach Delay (s)	11.3	13.4	34.6	51.9
Approach LOS	B	B	D	F

Intersection Summary			
Delay	38.7		
HCM Level of Service	E		
Intersection Capacity Utilization	85.5%	ICU Level of Service	E
Analysis Period (min)	15		

SimTraffic Post-Processor **LBNL 2nd Campus**
Average Results from 10 Runs **Near-Term (2018) Plus Phase 1**
Volume and Delay by Movement **AM Peak Hour**

Intersection 8 **Piedmont Avenue/Bancroft Way** **Unsignalized**

		Volume (veh/hr)			Total Delay (sec/veh)		
Direction	**Movement**	**Demand**	**Served**	**% Served**	**Average**	**Std. Dev.**	**LOS**
NB	Left Turn	100	79	78.8%	56.7	13.1	F
	Through	625	502	80.3%	62.2	12.5	F
	Right Turn						
	Subtotal	**725**	**581**	**80.1%**	**61.4**	**11.8**	**F**
SB	Left Turn						
	Through	289	297	102.9%	13.5	1.1	B
	Right Turn	119	117	98.7%	11.3	0.7	B
	Subtotal	**408**	**415**	**101.7%**	**12.9**	**1.0**	**B**
EB	Left Turn						
	Through						
	Right Turn						
	Subtotal						
WB	Left Turn						
	Through						
	Right Turn						
	Subtotal						
Total		**1133**	**996**	**87.9%**	**41.2**	**6.8**	**E**

Intersection 9 **Piedmont Avenue/Durant Avenue** **Unsignalized**

		Volume (veh/hr)			Total Delay (sec/veh)		
Direction	**Movement**	**Demand**	**Served**	**% Served**	**Average**	**Std. Dev.**	**LOS**
NB	Left Turn						
	Through	559	414	74.1%	746.4	206.4	F
	Right Turn						
	Subtotal	**559**	**414**	**74.1%**	**746.4**	**206.4**	**F**
SB	Left Turn						
	Through	280	297	105.9%	15.0	1.5	B
	Right Turn						
	Subtotal	**280**	**297**	**105.9%**	**15.0**	**1.5**	**B**
EB	Left Turn	162	160	98.8%	19.9	3.3	C
	Through						
	Right Turn	80	84	104.6%	7.6	0.8	A
	Subtotal	**242**	**244**	**100.7%**	**15.7**	**2.4**	**C**
WB	Left Turn						
	Through						
	Right Turn						
	Subtotal						
Total		**1081**	**955**	**88.3%**	**330.4**	**80.4**	**F**

Intersection	
Intersection Delay (sec/veh)	10.8
Intersection LOS	B

Approach	EB	WB	NB	SB
Entry Lanes	1	1	1	1
Conflicting Circle Lanes	1	1	1	1
Adjusted Approach Flow (vph)	83	127	630	376
Demand Flow Rate (pc/h)	86	133	656	392
Vehicles Circulating (pc/h)	393	661	86	177
Vehicles Exiting (pc/h)	176	81	393	617
Follow-Up Headway (s)	3.186	3.186	3.186	3.186
Ped Vol. Crossing Leg (#/hr)	1	59	7	5
Ped Capacity Adjustment	1.000	0.992	0.999	0.999
Approach Delay (sec/veh)	6.1	9.6	12.8	8.8
Approach LOS	A	A	B	A

Lane	Left	Left	Left	Left
Designated moves	LTR	LTR	LTR	LTR
Assumed Moves	LTR	LTR	LTR	LTR
Right Turn Channelized				
Lane Utilization	1.000	1.000	1.000	1.000
Critical Headway (s)	5.193	5.193	5.193	5.193
Entry Flow Rate (pc/h)	86	133	656	392
Capacity, Entry Lane (pc/h)	763	583	1037	947
Entry HV Adjustment Factor	0.962	0.958	0.961	0.960
Flow Rate, Entry (vph)	83	127	630	376
Capacity, Entry (vph)	734	555	995	908
Volume to Capacity Ratio	0.113	0.230	0.633	0.414
Control Delay (sec/veh)	6.1	9.6	12.8	8.8
Level of Service	A	A	B	A
95th-Percentile Queue (veh)	0	1	5	2

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	167	132	150	30	0	50	0	667	12	10	277	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	3.0	3.0	3.0	3.0		3.0		3.0			3.0	
Lane Util. Factor	1.00	1.00	1.00	1.00		1.00		*0.60			*0.60	
Frpb, ped/bikes	1.00	1.00	0.95	1.00		0.94		1.00			1.00	
Flpb, ped/bikes	0.96	1.00	1.00	0.97		1.00		1.00			1.00	
Frt	1.00	1.00	0.85	1.00		0.85		1.00			1.00	
Flt Protected	0.95	1.00	1.00	0.95		1.00		1.00			1.00	
Satd. Flow (prot)	1695	1863	1505	1714		1487		2226			2230	
Flt Permitted	0.95	1.00	1.00	0.67		1.00		1.00			0.92	
Satd. Flow (perm)	1695	1863	1505	1210		1487		2226			2061	
Peak-hour factor, PHF	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98
Adj. Flow (vph)	170	135	153	31	0	51	0	681	12	10	283	0
RTOR Reduction (vph)	0	0	80	0	0	27	0	1	0	0	0	0
Lane Group Flow (vph)	170	135	73	31	0	24	0	692	0	0	293	0
Confl. Peds. (#/hr)	40		60	60		40	47		49	49		47
Confl. Bikes (#/hr)			1						13			
Turn Type	Perm		Perm	custom		custom				Perm		
Protected Phases		4						2			6	
Permitted Phases	4		4	8		8				6		
Actuated Green, G (s)	31.0	31.0	31.0	31.0		31.0		28.0			28.0	
Effective Green, g (s)	31.0	31.0	31.0	31.0		31.0		28.0			28.0	
Actuated g/C Ratio	0.48	0.48	0.48	0.48		0.48		0.43			0.43	
Clearance Time (s)	3.0	3.0	3.0	3.0		3.0		3.0			3.0	
Lane Grp Cap (vph)	808	889	718	577		709		959			888	
v/s Ratio Prot		0.07						c0.31				
v/s Ratio Perm	c0.10		0.05	0.03		0.02					0.14	
v/c Ratio	0.21	0.15	0.10	0.05		0.03		0.72			0.33	
Uniform Delay, d1	9.9	9.6	9.3	9.1		9.0		15.3			12.3	
Progression Factor	1.00	1.00	1.00	1.00		1.00		1.00			1.00	
Incremental Delay, d2	0.6	0.4	0.3	0.2		0.1		4.7			1.0	
Delay (s)	10.5	9.9	9.6	9.3		9.1		20.0			13.3	
Level of Service	B	A	A	A		A		B			B	
Approach Delay (s)		10.0			9.2			20.0			13.3	
Approach LOS		B			A			B			B	

Intersection Summary			
HCM Average Control Delay	15.1	HCM Level of Service	B
HCM Volume to Capacity ratio	0.45		
Actuated Cycle Length (s)	65.0	Sum of lost time (s)	6.0
Intersection Capacity Utilization	65.1%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

HCM Unsignalized Intersection Capacity Analysis
12: Prospect St & Panoramic Way

3/19/2013

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Volume (veh/h)	235	30	10	103	50	20
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.82	0.82	0.82	0.82	0.82	0.82
Hourly flow rate (vph)	287	37	12	126	61	24
Pedestrians	2					
Lane Width (ft)	12.0					
Walking Speed (ft/s)	4.0					
Percent Blockage	0					
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume			323		457	305
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			323		457	305
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			99		89	97
cM capacity (veh/h)			1237		555	735

Direction, Lane #	EB 1	WB 1	NB 1
Volume Total	323	138	85
Volume Left	0	12	61
Volume Right	37	0	24
cSH	1700	1237	597
Volume to Capacity	0.19	0.01	0.14
Queue Length 95th (ft)	0	1	12
Control Delay (s)	0.0	0.8	12.0
Lane LOS		A	B
Approach Delay (s)	0.0	0.8	12.0
Approach LOS			B

Intersection Summary			
Average Delay	2.1		
Intersection Capacity Utilization	24.8%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Sign Control	Stop		Stop			Stop
Volume (vph)	93	90	60	196	90	20
Peak Hour Factor	0.95	0.95	0.95	0.95	0.95	0.95
Hourly flow rate (vph)	98	95	63	206	95	21

Direction, Lane #	WB 1	NB 1	SB 1
Volume Total (vph)	193	269	116
Volume Left (vph)	98	0	95
Volume Right (vph)	95	206	0
Hadj (s)	-0.13	-0.39	0.23
Departure Headway (s)	4.6	4.1	4.9
Degree Utilization, x	0.25	0.31	0.16
Capacity (veh/h)	721	832	691
Control Delay (s)	9.2	9.0	8.8
Approach Delay (s)	9.2	9.0	8.8
Approach LOS	A	A	A

Intersection Summary			
Delay	9.0		
HCM Level of Service	A		
Intersection Capacity Utilization	42.5%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Stop			Stop			Stop			Stop	
Volume (vph)	10	120	132	226	80	20	33	20	37	20	60	10
Peak Hour Factor	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88
Hourly flow rate (vph)	11	136	150	257	91	23	38	23	42	23	68	11

Direction, Lane #	EB 1	WB 1	NB 1	SB 1	SB 2
Volume Total (vph)	298	370	102	91	11
Volume Left (vph)	11	257	38	23	0
Volume Right (vph)	150	23	42	0	11
Hadj (s)	-0.28	0.12	-0.16	0.07	-0.58
Departure Headway (s)	4.7	5.0	5.6	5.8	3.2
Degree Utilization, x	0.39	0.51	0.16	0.15	0.01
Capacity (veh/h)	732	697	561	542	1121
Control Delay (s)	10.6	13.1	9.6	9.8	6.2
Approach Delay (s)	10.6	13.1	9.6	9.4	
Approach LOS	B	B	A	A	

Intersection Summary			
Delay	11.4		
HCM Level of Service	B		
Intersection Capacity Utilization	55.0%	ICU Level of Service	A
Analysis Period (min)	15		

HCM Signalized Intersection Capacity Analysis
1: University Ave & Shattuck Ave

3/15/2013

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	153	425	250	85	614	470	0	0	0	50	755	130
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0			4.0	4.0					4.0	
Lane Util. Factor	1.00	0.95			0.91	0.91					0.91	
Frpb, ped/bikes	1.00	0.91			0.96	0.69					0.95	
Flpb, ped/bikes	0.92	1.00			0.99	1.00					0.99	
Frt	1.00	0.94			0.98	0.85					0.98	
Flt Protected	0.95	1.00			0.99	1.00					1.00	
Satd. Flow (prot)	1620	3001			3141	986					4587	
Flt Permitted	0.25	1.00			0.77	1.00					1.00	
Satd. Flow (perm)	427	3001			2442	986					4587	
Peak-hour factor, PHF	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93
Adj. Flow (vph)	165	457	269	91	660	505	0	0	0	54	812	140
RTOR Reduction (vph)	0	0	0	0	10	191	0	0	0	0	24	0
Lane Group Flow (vph)	165	726	0	0	837	218	0	0	0	0	982	0
Confl. Peds. (#/hr)	323		260	260		323	783		278	278		783
Confl. Bikes (#/hr)			12			15						30
Heavy Vehicles (%)	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%
Turn Type	Perm			Perm		Perm				Perm		
Protected Phases		4			8						6	
Permitted Phases	4			8		8				6		
Actuated Green, G (s)	48.0	48.0			48.0	48.0					34.0	
Effective Green, g (s)	48.0	48.0			48.0	48.0					34.0	
Actuated g/C Ratio	0.53	0.53			0.53	0.53					0.38	
Clearance Time (s)	4.0	4.0			4.0	4.0					4.0	
Lane Grp Cap (vph)	228	1601			1302	526					1733	
v/s Ratio Prot		0.24										
v/s Ratio Perm	c0.39				0.34	0.22					0.21	
v/c Ratio	0.72	0.45			0.64	0.41					0.57	
Uniform Delay, d1	16.0	12.9			14.9	12.6					22.2	
Progression Factor	1.00	1.00			1.40	3.96					0.73	
Incremental Delay, d2	18.1	0.9			2.4	2.4					1.3	
Delay (s)	34.0	13.9			23.3	52.2					17.5	
Level of Service	C	B			C	D					B	
Approach Delay (s)		17.6			32.7			0.0			17.5	
Approach LOS		B			C			A			B	

Intersection Summary			
HCM Average Control Delay	23.6	HCM Level of Service	C
HCM Volume to Capacity ratio	0.66		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	85.2%	ICU Level of Service	E
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	70	172	50	145	335	173	40	600	43	83	580	50
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0	4.0		4.0		4.0	4.0		4.0	4.0	
Lane Util. Factor		0.95	1.00		0.95		1.00	0.95		1.00	0.95	
Frpb, ped/bikes		1.00	0.90		0.94		1.00	0.99		1.00	0.98	
Flpb, ped/bikes		0.98	1.00		0.99		0.91	1.00		0.95	1.00	
Frt		1.00	0.85		0.96		1.00	0.99		1.00	0.99	
Flt Protected		0.99	1.00		0.99		0.95	1.00		0.95	1.00	
Satd. Flow (prot)		3436	1426		3135		1605	3468		1678	3425	
Flt Permitted		0.66	1.00		0.80		0.36	1.00		0.35	1.00	
Satd. Flow (perm)		2308	1426		2522		605	3468		622	3425	
Peak-hour factor, PHF	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97
Adj. Flow (vph)	72	177	52	149	345	178	41	619	44	86	598	52
RTOR Reduction (vph)	0	0	20	0	41	0	0	6	0	0	7	0
Lane Group Flow (vph)	0	249	32	0	631	0	41	657	0	86	643	0
Confl. Peds. (#/hr)	186		99	99		186	417		236	236		417
Confl. Bikes (#/hr)			10			95			20			23
Turn Type	Perm		Perm	Perm			Perm			Perm		
Protected Phases		4			8			2			6	
Permitted Phases	4		4	8			2			6		
Actuated Green, G (s)		33.0	33.0		33.0		49.0	49.0		49.0	49.0	
Effective Green, g (s)		33.0	33.0		33.0		49.0	49.0		49.0	49.0	
Actuated g/C Ratio		0.37	0.37		0.37		0.54	0.54		0.54	0.54	
Clearance Time (s)		4.0	4.0		4.0		4.0	4.0		4.0	4.0	
Lane Grp Cap (vph)		846	523		925		329	1888		339	1865	
v/s Ratio Prot								c0.19			0.19	
v/s Ratio Perm		0.11	0.02		c0.25		0.07			0.14		
v/c Ratio		0.29	0.06		0.68		0.12	0.35		0.25	0.34	
Uniform Delay, d1		20.2	18.5		24.1		10.0	11.5		10.8	11.5	
Progression Factor		1.00	1.00		1.56		1.61	1.63		1.00	1.00	
Incremental Delay, d2		0.9	0.2		2.8		0.6	0.4		1.8	0.5	
Delay (s)		21.1	18.7		40.4		16.8	19.2		12.6	12.0	
Level of Service		C	B		D		B	B		B	B	
Approach Delay (s)		20.7			40.4			19.0			12.1	
Approach LOS		C			D			B			B	

Intersection Summary			
HCM Average Control Delay	23.1	HCM Level of Service	C
HCM Volume to Capacity ratio	0.48		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	109.6%	ICU Level of Service	H
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	296	30	300	10	30	30	200	680	20	30	630	152
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0			4.0		4.0	4.0		4.0	4.0	4.0
Lane Util. Factor	0.95	0.95			1.00		1.00	0.95		1.00	0.95	1.00
Frpb, ped/bikes	1.00	0.85			0.90		1.00	0.99		1.00	1.00	0.82
Flpb, ped/bikes	0.80	0.98			0.99		1.00	1.00		0.93	1.00	1.00
Frt	1.00	0.87			0.94		1.00	1.00		1.00	1.00	0.85
Flt Protected	0.95	1.00			0.99		0.95	1.00		0.95	1.00	1.00
Satd. Flow (prot)	1326	1277			1531		1752	3469		1628	3505	1286
Flt Permitted	0.75	0.98			0.94		0.95	1.00		0.38	1.00	1.00
Satd. Flow (perm)	1048	1251			1457		1752	3469		651	3505	1286
Peak-hour factor, PHF	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98
Adj. Flow (vph)	302	31	306	10	31	31	204	694	20	31	643	155
RTOR Reduction (vph)	0	174	0	0	20	0	0	2	0	0	0	75
Lane Group Flow (vph)	272	193	0	0	52	0	204	712	0	31	643	80
Confl. Peds. (#/hr)	254		187	187		254	179		132	132		179
Confl. Bikes (#/hr)			5			6			16			38
Heavy Vehicles (%)	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%
Turn Type	Perm			Perm			Prot			Perm		Perm
Protected Phases		4			8		5	2			6	
Permitted Phases	4			8						6		6
Actuated Green, G (s)	31.0	31.0			31.0		10.0	51.0		37.0	37.0	37.0
Effective Green, g (s)	31.0	31.0			31.0		10.0	51.0		37.0	37.0	37.0
Actuated g/C Ratio	0.34	0.34			0.34		0.11	0.57		0.41	0.41	0.41
Clearance Time (s)	4.0	4.0			4.0		4.0	4.0		4.0	4.0	4.0
Lane Grp Cap (vph)	361	431			502		195	1966		268	1441	529
v/s Ratio Prot							c0.12	0.21			c0.18	
v/s Ratio Perm	c0.26	0.15			0.04					0.05		0.06
v/c Ratio	0.75	0.45			0.10		1.05	0.36		0.12	0.45	0.15
Uniform Delay, d1	26.1	22.9			20.0		40.0	10.6		16.4	19.1	16.6
Progression Factor	0.69	0.45			1.00		1.00	1.00		0.43	0.47	0.33
Incremental Delay, d2	12.9	3.2			0.4		77.1	0.5		0.7	0.8	0.5
Delay (s)	30.8	13.5			20.5		117.1	11.1		7.7	9.8	5.9
Level of Service	C	B			C		F	B		A	A	A
Approach Delay (s)		20.9			20.5			34.7			9.0	
Approach LOS		C			C			C			A	

Intersection Summary			
HCM Average Control Delay	22.0	HCM Level of Service	C
HCM Volume to Capacity ratio	0.65		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	75.4%	ICU Level of Service	D
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	40	189	80	372	484	83	100	610	336	22	310	50
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	2.0	2.0		2.0	2.0		2.0	2.0			2.0	
Lane Util. Factor	1.00	0.95		0.91	0.91		1.00	0.95			0.95	
Frpb, ped/bikes	1.00	0.97		1.00	0.97		1.00	0.95			0.99	
Flpb, ped/bikes	1.00	1.00		1.00	1.00		0.95	1.00			1.00	
Frt	1.00	0.96		1.00	0.98		1.00	0.95			0.98	
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00			1.00	
Satd. Flow (prot)	1770	3292		1610	3208		1686	3199			3407	
Flt Permitted	0.95	1.00		0.95	1.00		0.38	1.00			0.71	
Satd. Flow (perm)	1770	3292		1610	3208		679	3199			2429	
Peak-hour factor, PHF	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94
Adj. Flow (vph)	43	201	85	396	515	88	106	649	357	23	330	53
RTOR Reduction (vph)	0	52	0	0	12	0	0	83	0	0	14	0
Lane Group Flow (vph)	43	234	0	329	658	0	106	923	0	0	392	0
Confl. Peds. (#/hr)	148		95	95		148	92		105	105		92
Confl. Bikes (#/hr)			6			86			14			9
Turn Type	Split			Split			Perm			Perm		
Protected Phases	4	4		8	8			2			6	
Permitted Phases							2			6		
Actuated Green, G (s)	34.0	34.0		24.0	24.0		26.0	26.0			26.0	
Effective Green, g (s)	34.0	34.0		24.0	24.0		26.0	26.0			26.0	
Actuated g/C Ratio	0.38	0.38		0.27	0.27		0.29	0.29			0.29	
Clearance Time (s)	2.0	2.0		2.0	2.0		2.0	2.0			2.0	
Lane Grp Cap (vph)	669	1244		429	855		196	924			702	
v/s Ratio Prot	0.02	c0.07		0.20	c0.20			c0.29				
v/s Ratio Perm							0.16				0.16	
v/c Ratio	0.06	0.19		0.77	0.77		0.54	1.00			0.56	
Uniform Delay, d1	17.9	18.8		30.4	30.4		27.0	32.0			27.1	
Progression Factor	1.46	1.73		1.00	1.00		0.77	0.78			1.00	
Incremental Delay, d2	0.2	0.3		12.4	6.6		9.5	28.1			3.2	
Delay (s)	26.3	32.8		42.8	37.0		30.4	53.0			30.3	
Level of Service	C	C		D	D		C	D			C	
Approach Delay (s)		31.9			38.9			50.8			30.3	
Approach LOS		C			D			D			C	

Intersection Summary			
HCM Average Control Delay	41.5	HCM Level of Service	D
HCM Volume to Capacity ratio	0.59		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	6.0
Intersection Capacity Utilization	113.1%	ICU Level of Service	H
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (vph)	120	277	449	68	63	90
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0		4.0	
Lane Util. Factor	1.00	0.95	1.00		1.00	
Frpb, ped/bikes	1.00	1.00	0.92		0.84	
Flpb, ped/bikes	1.00	1.00	1.00		1.00	
Frt	1.00	1.00	0.98		0.92	
Flt Protected	0.95	1.00	1.00		0.98	
Satd. Flow (prot)	1719	3438	1632		1372	
Flt Permitted	0.95	1.00	1.00		0.98	
Satd. Flow (perm)	1719	3438	1632		1372	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	126	292	473	72	66	95
RTOR Reduction (vph)	0	0	8	0	60	0
Lane Group Flow (vph)	126	292	537	0	101	0
Confl. Peds. (#/hr)				420	186	186
Confl. Bikes (#/hr)				32		
Heavy Vehicles (%)	5%	5%	5%	5%	5%	5%
Turn Type	Prot					
Protected Phases	7	4	8		6	
Permitted Phases						
Actuated Green, G (s)	6.4	36.8	26.4		26.0	
Effective Green, g (s)	6.4	36.8	26.4		26.0	
Actuated g/C Ratio	0.09	0.52	0.37		0.37	
Clearance Time (s)	4.0	4.0	4.0		4.0	
Vehicle Extension (s)	3.0	3.0	3.0		3.0	
Lane Grp Cap (vph)	155	1787	609		504	
v/s Ratio Prot	c0.07	0.08	c0.33		c0.07	
v/s Ratio Perm						
v/c Ratio	0.81	0.16	0.88		0.20	
Uniform Delay, d1	31.6	8.9	20.8		15.3	
Progression Factor	1.00	1.00	1.00		1.00	
Incremental Delay, d2	26.7	0.2	16.8		0.9	
Delay (s)	58.3	9.1	37.6		16.2	
Level of Service	E	A	D		B	
Approach Delay (s)		23.9	37.6		16.2	
Approach LOS		C	D		B	

Intersection Summary			
HCM Average Control Delay	29.4	HCM Level of Service	C
HCM Volume to Capacity ratio	0.57		
Actuated Cycle Length (s)	70.8	Sum of lost time (s)	12.0
Intersection Capacity Utilization	59.1%	ICU Level of Service	B
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	20	40	260	96	193	25	84	236	207	21	191	10
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0	4.0		4.0	4.0		4.0			4.0	
Lane Util. Factor		1.00	1.00		1.00	1.00		1.00			1.00	
Frpb, ped/bikes		1.00	0.76		1.00	0.70		0.93			0.99	
Flpb, ped/bikes		0.95	1.00		0.93	1.00		0.98			1.00	
Frt		1.00	0.85		1.00	0.85		0.95			0.99	
Flt Protected		0.98	1.00		0.98	1.00		0.99			1.00	
Satd. Flow (prot)		1727	1191		1692	1105		1574			1799	
Flt Permitted		0.87	1.00		0.88	1.00		0.91			0.94	
Satd. Flow (perm)		1522	1191		1509	1105		1444			1692	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	22	43	283	104	210	27	91	257	225	23	208	11
RTOR Reduction (vph)	0	0	182	0	0	12	0	33	0	0	2	0
Lane Group Flow (vph)	0	65	101	0	314	15	0	540	0	0	240	0
Confl. Peds. (#/hr)	121		102	102		121	82		75	75		82
Confl. Bikes (#/hr)			2			21			17			6
Heavy Vehicles (%)	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%
Turn Type	Perm		Perm	Perm		Perm	Perm			Perm		
Protected Phases		4			8			2			6	
Permitted Phases	4		4	8		8	2			6		
Actuated Green, G (s)		24.5	24.5		24.5	24.5		36.5			36.5	
Effective Green, g (s)		25.0	25.0		25.0	25.0		37.0			37.0	
Actuated g/C Ratio		0.36	0.36		0.36	0.36		0.53			0.53	
Clearance Time (s)		4.5	4.5		4.5	4.5		4.5			4.5	
Lane Grp Cap (vph)		544	425		539	395		763			894	
v/s Ratio Prot												
v/s Ratio Perm		0.04	0.08		c0.21	0.01		c0.37			0.14	
v/c Ratio		0.12	0.24		0.58	0.04		0.71			0.27	
Uniform Delay, d1		15.1	15.8		18.3	14.7		12.4			9.1	
Progression Factor		1.00	1.00		1.00	1.00		1.00			1.00	
Incremental Delay, d2		0.4	1.3		4.6	0.2		5.5			0.7	
Delay (s)		15.6	17.1		22.8	14.9		17.9			9.8	
Level of Service		B	B		C	B		B			A	
Approach Delay (s)		16.8			22.2			17.9			9.8	
Approach LOS		B			C			B			A	

Intersection Summary			
HCM Average Control Delay	17.3	HCM Level of Service	B
HCM Volume to Capacity ratio	0.66		
Actuated Cycle Length (s)	70.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	77.2%	ICU Level of Service	D
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Stop			Stop			Stop			Stop	
Volume (vph)	30	20	20	141	10	190	10	307	42	111	436	10
Peak Hour Factor	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98
Hourly flow rate (vph)	31	20	20	144	10	194	10	313	43	113	445	10

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total (vph)	71	348	366	568
Volume Left (vph)	31	144	10	113
Volume Right (vph)	20	194	43	10
Hadj (s)	-0.03	-0.20	-0.01	0.08
Departure Headway (s)	7.9	6.7	6.6	6.4
Degree Utilization, x	0.16	0.65	0.67	1.00
Capacity (veh/h)	391	518	530	560
Control Delay (s)	12.4	21.3	21.9	63.5
Approach Delay (s)	12.4	21.3	21.9	63.5
Approach LOS	B	C	C	F

Intersection Summary			
Delay	38.7		
HCM Level of Service	E		
Intersection Capacity Utilization	87.9%	ICU Level of Service	E
Analysis Period (min)	15		

SimTraffic Post-Processor | **LBNL 2nd Campus**
Average Results from 10 Runs | **Near-Term (2018) Plus Phase 1**
Volume and Delay by Movement | **PM Peak Hour**

Intersection 8 **Piedmont Avenue/Bancroft Way** **Unsignalized**

		Volume (veh/hr)			Total Delay (sec/veh)		
Direction	**Movement**	**Demand**	**Served**	**% Served**	**Average**	**Std. Dev.**	**LOS**
NB	Left Turn	133	120	89.8%	46.1	8.1	E
	Through	429	377	87.9%	47.1	5.6	E
	Right Turn						
	Subtotal	**562**	**497**	**88.3%**	**46.8**	**6.1**	**E**
SB	Left Turn						
	Through	425	356	83.8%	354.1	146.6	F
	Right Turn	202	168	83.1%	332.8	137.6	F
	Subtotal	**627**	**524**	**83.6%**	**347.2**	**143.5**	**F**
EB	Left Turn						
	Through						
	Right Turn						
	Subtotal						
WB	Left Turn						
	Through						
	Right Turn						
	Subtotal						
Total		**1189**	**1021**	**85.8%**	**200.2**	**71.7**	**F**

Intersection 9 **Piedmont Avenue/Durant Avenue** **Unsignalized**

		Volume (veh/hr)			Total Delay (sec/veh)		
Direction	**Movement**	**Demand**	**Served**	**% Served**	**Average**	**Std. Dev.**	**LOS**
NB	Left Turn						
	Through	416	347	83.4%	475.8	257.8	F
	Right Turn						
	Subtotal	**416**	**347**	**83.4%**	**475.8**	**257.8**	**F**
SB	Left Turn						
	Through	420	354	84.3%	90.1	7.4	F
	Right Turn						
	Subtotal	**420**	**354**	**84.3%**	**90.1**	**7.4**	**F**
EB	Left Turn	134	138	103.2%	18.6	3.5	C
	Through						
	Right Turn	180	177	98.1%	20.9	5.5	C
	Subtotal	**314**	**315**	**100.3%**	**20.1**	**3.0**	**C**
WB	Left Turn						
	Through						
	Right Turn						
	Subtotal						
Total		**1150**	**1016**	**88.4%**	**199.5**	**86.5**	**F**

Intersection	
Intersection Delay (sec/veh)	16.6
Intersection LOS	C

Approach	EB	WB	NB	SB
Entry Lanes	1	1	1	1
Conflicting Circle Lanes	1	1	1	1
Adjusted Approach Flow (vph)	138	216	534	652
Demand Flow Rate (pc/h)	141	220	544	665
Vehicles Circulating (pc/h)	648	533	151	305
Vehicles Exiting (pc/h)	322	162	638	448
Follow-Up Headway (s)	3.186	3.186	3.186	3.186
Ped Vol. Crossing Leg (#/hr)	210	9	117	78
Ped Capacity Adjustment	0.962	0.999	0.979	0.989
Approach Delay (sec/veh)	9.8	9.9	11.8	24.3
Approach LOS	A	A	B	C

Lane	Left	Left	Left	Left
Designated moves	LTR	LTR	LTR	LTR
Assumed Moves	LTR	LTR	LTR	LTR
Right Turn Channelized				
Lane Utilization	1.000	1.000	1.000	1.000
Critical Headway (s)	5.193	5.193	5.193	5.193
Entry Flow Rate (pc/h)	141	220	544	665
Capacity, Entry Lane (pc/h)	591	663	972	833
Entry HV Adjustment Factor	0.978	0.980	0.981	0.980
Flow Rate, Entry (vph)	138	216	534	652
Capacity, Entry (vph)	556	649	932	808
Volume to Capacity Ratio	0.248	0.332	0.572	0.807
Control Delay (sec/veh)	9.8	9.9	11.8	24.3
Level of Service	A	A	B	C
95th-Percentile Queue (veh)	1	1	4	9

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	129	120	220	42	0	100	0	498	10	20	452	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	3.0	3.0	3.0	3.0		3.0		3.0			3.0	
Lane Util. Factor	1.00	1.00	1.00	1.00		1.00		*0.60			*0.60	
Frpb, ped/bikes	1.00	1.00	0.91	1.00		0.85		1.00			1.00	
Flpb, ped/bikes	0.87	1.00	1.00	0.94		1.00		1.00			1.00	
Frt	1.00	1.00	0.85	1.00		0.85		1.00			1.00	
Flt Protected	0.95	1.00	1.00	0.95		1.00		1.00			1.00	
Satd. Flow (prot)	1553	1881	1456	1672		1367		2240			2245	
Flt Permitted	0.95	1.00	1.00	0.68		1.00		1.00			0.91	
Satd. Flow (perm)	1553	1881	1456	1190		1367		2240			2054	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	136	126	232	44	0	105	0	524	11	21	476	0
RTOR Reduction (vph)	0	0	63	0	0	44	0	1	0	0	0	0
Lane Group Flow (vph)	136	126	169	44	0	61	0	534	0	0	497	0
Confl. Peds. (#/hr)	125		122	122		122	121		153	153		121
Confl. Bikes (#/hr)			5						13			14
Heavy Vehicles (%)	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%
Turn Type	Perm		Perm	custom		custom				Perm		
Protected Phases		4						2			6	
Permitted Phases	4		4	8		8				6		
Actuated Green, G (s)	31.0	31.0	31.0	31.0		31.0		28.0			28.0	
Effective Green, g (s)	31.0	31.0	31.0	31.0		31.0		28.0			28.0	
Actuated g/C Ratio	0.48	0.48	0.48	0.48		0.48		0.43			0.43	
Clearance Time (s)	3.0	3.0	3.0	3.0		3.0		3.0			3.0	
Lane Grp Cap (vph)	741	897	694	568		652		965			885	
v/s Ratio Prot		0.07						0.24				
v/s Ratio Perm	0.09		c0.12	0.04		0.04					c0.24	
v/c Ratio	0.18	0.14	0.24	0.08		0.09		0.55			0.56	
Uniform Delay, d1	9.7	9.5	10.1	9.2		9.3		13.8			13.9	
Progression Factor	1.00	1.00	1.00	1.00		1.00		1.00			1.00	
Incremental Delay, d2	0.5	0.3	0.8	0.3		0.3		2.3			2.6	
Delay (s)	10.3	9.9	10.9	9.5		9.6		16.1			16.5	
Level of Service	B	A	B	A		A		B			B	
Approach Delay (s)		10.5			9.6			16.1			16.5	
Approach LOS		B			A			B			B	

Intersection Summary			
HCM Average Control Delay	14.0	HCM Level of Service	B
HCM Volume to Capacity ratio	0.39		
Actuated Cycle Length (s)	65.0	Sum of lost time (s)	6.0
Intersection Capacity Utilization	63.0%	ICU Level of Service	B
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Volume (veh/h)	181	40	27	208	40	31
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.89	0.89	0.89	0.89	0.89	0.89
Hourly flow rate (vph)	203	45	30	234	45	35
Pedestrians	8			1		
Lane Width (ft)	12.0			12.0		
Walking Speed (ft/s)	4.0			4.0		
Percent Blockage	1			0		
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume			248		528	227
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			248		528	227
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			98		91	96
cM capacity (veh/h)			1323		497	814

Direction, Lane #	EB 1	WB 1	NB 1
Volume Total	248	264	80
Volume Left	0	30	45
Volume Right	45	0	35
cSH	1700	1323	599
Volume to Capacity	0.15	0.02	0.13
Queue Length 95th (ft)	0	2	11
Control Delay (s)	0.0	1.1	11.9
Lane LOS		A	B
Approach Delay (s)	0.0	1.1	11.9
Approach LOS			B

Intersection Summary			
Average Delay	2.1		
Intersection Capacity Utilization	38.5%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Sign Control	Stop		Stop			Stop
Volume (vph)	195	80	90	122	80	50
Peak Hour Factor	0.86	0.86	0.86	0.86	0.86	0.86
Hourly flow rate (vph)	227	93	105	142	93	58

Direction, Lane #	WB 1	NB 1	SB 1
Volume Total (vph)	320	247	151
Volume Left (vph)	227	0	93
Volume Right (vph)	93	142	0
Hadj (s)	0.02	-0.29	0.17
Departure Headway (s)	4.9	4.7	5.2
Degree Utilization, x	0.44	0.32	0.22
Capacity (veh/h)	694	725	638
Control Delay (s)	11.6	9.8	9.7
Approach Delay (s)	11.6	9.8	9.7
Approach LOS	B	A	A

Intersection Summary			
Delay	10.6		
HCM Level of Service	B		
Intersection Capacity Utilization	47.0%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Stop			Stop			Stop			Stop	
Volume (vph)	10	120	63	28	90	20	100	70	192	20	20	10
Peak Hour Factor	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93
Hourly flow rate (vph)	11	129	68	30	97	22	108	75	206	22	22	11

Direction, Lane #	EB 1	WB 1	NB 1	SB 1	SB 2
Volume Total (vph)	208	148	389	43	11
Volume Left (vph)	11	30	108	22	0
Volume Right (vph)	68	22	206	0	11
Hadj (s)	-0.17	-0.03	-0.25	0.12	-0.58
Departure Headway (s)	5.0	5.3	4.7	5.5	3.2
Degree Utilization, x	0.29	0.22	0.50	0.07	0.01
Capacity (veh/h)	659	622	729	581	1121
Control Delay (s)	10.1	9.7	12.3	8.9	6.2
Approach Delay (s)	10.1	9.7	12.3	8.4	
Approach LOS	B	A	B	A	

Intersection Summary			
Delay	11.0		
HCM Level of Service	B		
Intersection Capacity Utilization	51.2%	ICU Level of Service	A
Analysis Period (min)	15		

Cumulative (2035) No Project Conditions

FEHR PEERS

HCM Signalized Intersection Capacity Analysis
1: University Ave & Shattuck Ave

3/15/2013

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	131	466	200	30	453	270	0	0	0	50	740	141
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0			4.0	4.0					4.0	
Lane Util. Factor	1.00	0.95			0.91	0.91					0.91	
Frpb, ped/bikes	1.00	0.96			0.99	0.87					0.95	
Flpb, ped/bikes	0.95	1.00			1.00	1.00					0.99	
Frt	1.00	0.96			0.99	0.85					0.98	
Flt Protected	0.95	1.00			1.00	1.00					1.00	
Satd. Flow (prot)	1622	3133			3190	1212					4488	
Flt Permitted	0.38	1.00			0.89	1.00					1.00	
Satd. Flow (perm)	655	3133			2833	1212					4488	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	142	507	217	33	492	293	0	0	0	54	804	153
RTOR Reduction (vph)	0	2	0	0	5	126	0	0	0	0	28	0
Lane Group Flow (vph)	142	722	0	0	555	132	0	0	0	0	983	0
Confl. Peds. (#/hr)	122		116	116		122	399		220	220		399
Confl. Bikes (#/hr)			12			7			1			22
Heavy Vehicles (%)	6%	6%	6%	6%	6%	6%	6%	6%	6%	6%	6%	6%
Turn Type	Perm			Perm		Perm				Perm		
Protected Phases		4			8						6	
Permitted Phases	4			8		8				6		
Actuated Green, G (s)	46.0	46.0			46.0	46.0					36.0	
Effective Green, g (s)	46.0	46.0			46.0	46.0					36.0	
Actuated g/C Ratio	0.51	0.51			0.51	0.51					0.40	
Clearance Time (s)	4.0	4.0			4.0	4.0					4.0	
Lane Grp Cap (vph)	335	1601			1448	619					1795	
v/s Ratio Prot		c0.23										
v/s Ratio Perm	0.22				0.20	0.11					0.22	
v/c Ratio	0.42	0.45			0.38	0.21					0.55	
Uniform Delay, d1	13.7	14.0			13.4	12.1					20.7	
Progression Factor	1.00	1.00			1.37	3.33					0.69	
Incremental Delay, d2	3.9	0.9			0.8	0.8					1.0	
Delay (s)	17.6	14.9			19.1	40.9					15.3	
Level of Service	B	B			B	D					B	
Approach Delay (s)		15.3			26.0			0.0			15.3	
Approach LOS		B			C			A			B	

Intersection Summary			
HCM Average Control Delay	18.5	HCM Level of Service	B
HCM Volume to Capacity ratio	0.49		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	83.3%	ICU Level of Service	E
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	50	264	50	71	231	62	20	360	51	176	890	90
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0	4.0		4.0		4.0	4.0		4.0	4.0	
Lane Util. Factor		0.95	1.00		0.95		1.00	0.95		1.00	0.95	
Frpb, ped/bikes		1.00	0.87		0.99		1.00	0.99		1.00	0.99	
Flpb, ped/bikes		0.99	1.00		0.99		0.97	1.00		0.95	1.00	
Frt		1.00	0.85		0.97		1.00	0.98		1.00	0.99	
Flt Protected		0.99	1.00		0.99		0.95	1.00		0.95	1.00	
Satd. Flow (prot)		3455	1368		3301		1702	3395		1667	3405	
Flt Permitted		0.84	1.00		0.81		0.20	1.00		0.48	1.00	
Satd. Flow (perm)		2917	1368		2716		352	3395		836	3405	
Peak-hour factor, PHF	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93
Adj. Flow (vph)	54	284	54	76	248	67	22	387	55	189	957	97
RTOR Reduction (vph)	0	0	21	0	19	0	0	12	0	0	8	0
Lane Group Flow (vph)	0	338	33	0	372	0	22	430	0	189	1046	0
Confl. Peds. (#/hr)	85		92	92		85	248		157	157		248
Confl. Bikes (#/hr)			73			8			5			21
Heavy Vehicles (%)	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%
Turn Type	Perm		Perm	Perm			Perm			Perm		
Protected Phases		4			8			2			6	
Permitted Phases	4		4	8			2			6		
Actuated Green, G (s)		32.0	32.0		32.0		50.0	50.0		50.0	50.0	
Effective Green, g (s)		32.0	32.0		32.0		50.0	50.0		50.0	50.0	
Actuated g/C Ratio		0.36	0.36		0.36		0.56	0.56		0.56	0.56	
Clearance Time (s)		4.0	4.0		4.0		4.0	4.0		4.0	4.0	
Lane Grp Cap (vph)		1037	486		966		196	1886		464	1892	
v/s Ratio Prot								0.13			c0.31	
v/s Ratio Perm		0.12	0.02		c0.14		0.06			0.23		
v/c Ratio		0.33	0.07		0.38		0.11	0.23		0.41	0.55	
Uniform Delay, d1		21.1	19.2		21.7		9.5	10.2		11.5	12.8	
Progression Factor		1.00	1.00		0.95		1.92	1.88		1.00	1.00	
Incremental Delay, d2		0.8	0.3		1.0		1.1	0.3		2.6	1.2	
Delay (s)		22.0	19.4		21.6		19.3	19.4		14.1	14.0	
Level of Service		C	B		C		B	B		B	B	
Approach Delay (s)		21.6			21.6			19.4			14.0	
Approach LOS		C			C			B			B	

Intersection Summary			
HCM Average Control Delay	17.4	HCM Level of Service	B
HCM Volume to Capacity ratio	0.49		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	114.8%	ICU Level of Service	H
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	419	20	250	10	20	20	140	390	10	30	860	92
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0			4.0		4.0	4.0		4.0	4.0	4.0
Lane Util. Factor	0.95	0.95			1.00		1.00	0.95		1.00	0.95	1.00
Frpb, ped/bikes	1.00	0.93			0.94		1.00	1.00		1.00	1.00	0.84
Flpb, ped/bikes	0.87	0.98			0.99		1.00	1.00		0.93	1.00	1.00
Frt	1.00	0.89			0.95		1.00	1.00		1.00	1.00	0.85
Flt Protected	0.95	0.99			0.99		0.95	1.00		0.95	1.00	1.00
Satd. Flow (prot)	1439	1380			1596		1736	3444		1606	3471	1306
Flt Permitted	0.78	0.93			0.92		0.95	1.00		0.49	1.00	1.00
Satd. Flow (perm)	1180	1299			1484		1736	3444		832	3471	1306
Peak-hour factor, PHF	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89
Adj. Flow (vph)	471	22	281	11	22	22	157	438	11	34	966	103
RTOR Reduction (vph)	0	107	0	0	15	0	0	2	0	0	0	37
Lane Group Flow (vph)	400	267	0	0	40	0	157	447	0	34	966	66
Confl. Peds. (#/hr)	153		87	87		153	152		96	96		152
Confl. Bikes (#/hr)			14			7			16			46
Heavy Vehicles (%)	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%
Turn Type	Perm			Perm			Prot			Perm		Perm
Protected Phases		4			8		5	2			6	
Permitted Phases	4			8						6		6
Actuated Green, G (s)	30.0	30.0			30.0		6.0	52.0		42.0	42.0	42.0
Effective Green, g (s)	30.0	30.0			30.0		6.0	52.0		42.0	42.0	42.0
Actuated g/C Ratio	0.33	0.33			0.33		0.07	0.58		0.47	0.47	0.47
Clearance Time (s)	4.0	4.0			4.0		4.0	4.0		4.0	4.0	4.0
Lane Grp Cap (vph)	393	433			495		116	1990		388	1620	609
v/s Ratio Prot							c0.09	0.13			c0.28	
v/s Ratio Perm	c0.34	0.21			0.03					0.04		0.05
v/c Ratio	1.02	0.62			0.08		1.35	0.22		0.09	0.60	0.11
Uniform Delay, d1	30.0	25.2			20.6		42.0	9.2		13.3	17.7	13.5
Progression Factor	0.68	0.49			1.00		1.00	1.00		0.46	0.44	0.25
Incremental Delay, d2	49.0	6.2			0.3		205.1	0.3		0.3	1.3	0.3
Delay (s)	69.5	18.6			20.9		247.1	9.5		6.5	9.1	3.6
Level of Service	E	B			C		F	A		A	A	A
Approach Delay (s)		44.9			20.9			71.0			8.5	
Approach LOS		D			C			E			A	

Intersection Summary			
HCM Average Control Delay	34.8	HCM Level of Service	C
HCM Volume to Capacity ratio	0.82		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	72.1%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	30	371	90	272	235	21	60	300	409	42	610	60
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	2.5	2.5		2.5	2.5		2.5	2.5	2.5		2.5	
Lane Util. Factor	1.00	0.95		0.91	0.91		1.00	0.95	1.00		0.95	
Frpb, ped/bikes	1.00	0.97		1.00	0.99		1.00	1.00	0.89		0.99	
Flpb, ped/bikes	1.00	1.00		1.00	1.00		0.97	1.00	1.00		1.00	
Frt	1.00	0.97		1.00	0.99		1.00	1.00	0.85		0.99	
Flt Protected	0.95	1.00		0.95	0.99		0.95	1.00	1.00		1.00	
Satd. Flow (prot)	1736	3268		1579	3217		1686	3471	1383		3365	
Flt Permitted	0.95	1.00		0.95	0.99		0.16	1.00	1.00		0.92	
Satd. Flow (perm)	1736	3268		1579	3217		278	3471	1383		3092	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	32	391	95	286	247	22	63	316	431	44	642	63
RTOR Reduction (vph)	0	24	0	0	5	0	0	0	309	0	8	0
Lane Group Flow (vph)	32	462	0	183	367	0	63	316	122	0	741	0
Confl. Peds. (#/hr)	150		126	126		150	109		92	92		109
Confl. Bikes (#/hr)			73			3						23
Heavy Vehicles (%)	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%
Turn Type	Split			Split			Perm		Perm	Perm		
Protected Phases	4	4		8	8			2			6	
Permitted Phases							2		2	6		
Actuated Green, G (s)	32.0	32.0		25.0	25.0		25.5	25.5	25.5		25.5	
Effective Green, g (s)	32.0	32.0		25.0	25.0		25.5	25.5	25.5		25.5	
Actuated g/C Ratio	0.36	0.36		0.28	0.28		0.28	0.28	0.28		0.28	
Clearance Time (s)	2.5	2.5		2.5	2.5		2.5	2.5	2.5		2.5	
Lane Grp Cap (vph)	617	1162		439	894		79	983	392		876	
v/s Ratio Prot	0.02	c0.14		c0.12	0.11			0.09				
v/s Ratio Perm							0.23		0.09		c0.24	
v/c Ratio	0.05	0.40		0.42	0.41		0.80	0.32	0.31		0.85	
Uniform Delay, d1	19.0	21.8		26.5	26.5		29.9	25.4	25.4		30.4	
Progression Factor	1.32	1.41		1.00	1.00		0.79	0.73	1.53		1.00	
Incremental Delay, d2	0.2	1.0		2.9	1.4		47.4	0.7	1.7		9.9	
Delay (s)	25.3	31.6		29.4	27.9		71.0	19.4	40.6		40.3	
Level of Service	C	C		C	C		E	B	D		D	
Approach Delay (s)		31.2			28.4			34.7			40.3	
Approach LOS		C			C			C			D	

Intersection Summary			
HCM Average Control Delay	34.3	HCM Level of Service	C
HCM Volume to Capacity ratio	0.54		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	7.5
Intersection Capacity Utilization	102.5%	ICU Level of Service	G
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (vph)	90	581	248	22	85	160
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0		4.0	
Lane Util. Factor	1.00	0.95	1.00		1.00	
Frpb, ped/bikes	1.00	1.00	0.96		0.86	
Flpb, ped/bikes	1.00	1.00	1.00		1.00	
Frt	1.00	1.00	0.99		0.91	
Flt Protected	0.95	1.00	1.00		0.98	
Satd. Flow (prot)	1703	3406	1694		1389	
Flt Permitted	0.95	1.00	1.00		0.98	
Satd. Flow (perm)	1703	3406	1694		1389	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	95	612	261	23	89	168
RTOR Reduction (vph)	0	0	5	0	102	0
Lane Group Flow (vph)	95	612	279	0	155	0
Confl. Peds. (#/hr)				320	151	151
Confl. Bikes (#/hr)				5		
Heavy Vehicles (%)	6%	6%	6%	6%	6%	6%
Turn Type	Prot					
Protected Phases	7	4	8		6	
Permitted Phases						
Actuated Green, G (s)	6.3	31.8	21.5		26.0	
Effective Green, g (s)	6.3	31.8	21.5		26.0	
Actuated g/C Ratio	0.10	0.48	0.33		0.40	
Clearance Time (s)	4.0	4.0	4.0		4.0	
Vehicle Extension (s)	3.0	3.0	3.0		3.0	
Lane Grp Cap (vph)	163	1646	554		549	
v/s Ratio Prot	c0.06	0.18	c0.16		c0.11	
v/s Ratio Perm						
v/c Ratio	0.58	0.37	0.50		0.28	
Uniform Delay, d1	28.5	10.7	17.9		13.6	
Progression Factor	1.00	1.00	1.00		1.00	
Incremental Delay, d2	5.2	0.6	3.3		1.3	
Delay (s)	33.7	11.4	21.1		14.8	
Level of Service	C	B	C		B	
Approach Delay (s)		14.4	21.1		14.8	
Approach LOS		B	C		B	

Intersection Summary			
HCM Average Control Delay	16.0	HCM Level of Service	B
HCM Volume to Capacity ratio	0.41		
Actuated Cycle Length (s)	65.8	Sum of lost time (s)	12.0
Intersection Capacity Utilization	49.3%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	30	205	341	22	42	10	107	171	191	21	257	40
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0	4.0		4.0	4.0		4.0			4.0	
Lane Util. Factor		1.00	1.00		1.00	1.00		1.00			1.00	
Frpb, ped/bikes		1.00	0.76		1.00	0.76		0.94			0.98	
Flpb, ped/bikes		0.97	1.00		0.95	1.00		0.99			1.00	
Frt		1.00	0.85		1.00	0.85		0.94			0.98	
Flt Protected		0.99	1.00		0.98	1.00		0.99			1.00	
Satd. Flow (prot)		1751	1173		1692	1161		1564			1734	
Flt Permitted		0.96	1.00		0.88	1.00		0.85			0.96	
Satd. Flow (perm)		1697	1173		1508	1161		1343			1671	
Peak-hour factor, PHF	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96
Adj. Flow (vph)	31	214	355	23	44	10	111	178	199	22	268	42
RTOR Reduction (vph)	0	0	235	0	0	7	0	38	0	0	8	0
Lane Group Flow (vph)	0	245	120	0	67	3	0	450	0	0	324	0
Confl. Peds. (#/hr)	113		108	108		113	57		66	66		57
Confl. Bikes (#/hr)			3									21
Heavy Vehicles (%)	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%
Turn Type	Perm		Perm	Perm		Perm	Perm			Perm		
Protected Phases		4			8			2			6	
Permitted Phases	4		4	8		8	2			6		
Actuated Green, G (s)		21.5	21.5		21.5	21.5		34.5			34.5	
Effective Green, g (s)		22.0	22.0		22.0	22.0		35.0			35.0	
Actuated g/C Ratio		0.34	0.34		0.34	0.34		0.54			0.54	
Clearance Time (s)		4.5	4.5		4.5	4.5		4.5			4.5	
Lane Grp Cap (vph)		574	397		510	393		723			900	
v/s Ratio Prot												
v/s Ratio Perm		c0.14	0.10		0.04	0.00		c0.33			0.19	
v/c Ratio		0.43	0.30		0.13	0.01		0.62			0.36	
Uniform Delay, d1		16.6	15.8		14.9	14.3		10.4			8.6	
Progression Factor		1.00	1.00		1.00	1.00		1.00			1.00	
Incremental Delay, d2		2.3	2.0		0.5	0.0		4.0			1.1	
Delay (s)		18.9	17.8		15.4	14.3		14.4			9.7	
Level of Service		B	B		B	B		B			A	
Approach Delay (s)		18.3			15.3			14.4			9.7	
Approach LOS		B			B			B			A	

Intersection Summary			
HCM Average Control Delay	15.0	HCM Level of Service	B
HCM Volume to Capacity ratio	0.55		
Actuated Cycle Length (s)	65.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	77.9%	ICU Level of Service	D
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Stop			Stop			Stop			Stop	
Volume (vph)	10	10	20	60	10	118	20	381	136	177	412	30
Peak Hour Factor	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94
Hourly flow rate (vph)	11	11	21	64	11	126	21	405	145	188	438	32

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total (vph)	43	200	571	659
Volume Left (vph)	11	64	21	188
Volume Right (vph)	21	126	145	32
Hadj (s)	-0.13	-0.19	-0.03	0.15
Departure Headway (s)	7.7	6.9	5.8	5.9
Degree Utilization, x	0.09	0.38	0.91	1.08
Capacity (veh/h)	436	499	612	615
Control Delay (s)	11.4	14.1	41.7	83.9
Approach Delay (s)	11.4	14.1	41.7	83.9
Approach LOS	B	B	E	F

Intersection Summary			
Delay	56.0		
HCM Level of Service	F		
Intersection Capacity Utilization	92.4%	ICU Level of Service	F
Analysis Period (min)	15		

SimTraffic Post-Processor **LBNL 2nd Campus**
Average Results from 10 Runs **Cumulative (2035) Baseline**
Volume and Delay by Movement **AM Peak Hour**

Intersection 8 **Piedmont Avenue/Bancroft Way** **Unsignalized**

		Volume (veh/hr)			Total Delay (sec/veh)		
Direction	**Movement**	**Demand**	**Served**	**% Served**	**Average**	**Std. Dev.**	**LOS**
NB	Left Turn	130	91	70.1%	63.2	27.9	F
	Through	687	482	70.1%	62.4	9.6	F
	Right Turn						
	Subtotal	**817**	**573**	**70.1%**	**62.4**	**9.5**	**F**
SB	Left Turn						
	Through	315	322	102.1%	16.5	2.0	C
	Right Turn	127	127	99.8%	12.4	1.2	B
	Subtotal	**442**	**448**	**101.4%**	**15.3**	**1.7**	**C**
EB	Left Turn						
	Through						
	Right Turn						
	Subtotal						
WB	Left Turn						
	Through						
	Right Turn						
	Subtotal						
Total		**1259**	**1021**	**81.1%**	**41.7**	**5.3**	**E**

Intersection 9 **Piedmont Avenue/Durant Avenue** **Unsignalized**

		Volume (veh/hr)			Total Delay (sec/veh)		
Direction	**Movement**	**Demand**	**Served**	**% Served**	**Average**	**Std. Dev.**	**LOS**
NB	Left Turn						
	Through	619	385	62.1%	1373.6	211.9	F
	Right Turn						
	Subtotal	**619**	**385**	**62.1%**	**1373.6**	**211.9**	**F**
SB	Left Turn						
	Through	305	321	105.3%	19.7	5.0	C
	Right Turn						
	Subtotal	**305**	**321**	**105.3%**	**19.7**	**5.0**	**C**
EB	Left Turn	190	181	95.3%	22.9	3.8	C
	Through						
	Right Turn	100	106	106.0%	9.0	0.5	A
	Subtotal	**290**	**287**	**99.0%**	**17.8**	**2.2**	**C**
WB	Left Turn						
	Through						
	Right Turn						
	Subtotal						
Total		**1214**	**993**	**81.8%**	**542.6**	**76.1**	**F**

Intersection	
Intersection Delay (sec/veh)	11.7
Intersection LOS	B

Approach	EB	WB	NB	SB
Entry Lanes	1	1	1	1
Conflicting Circle Lanes	1	1	1	1
Adjusted Approach Flow (vph)	94	126	657	412
Demand Flow Rate (pc/h)	98	132	684	429
Vehicles Circulating (pc/h)	429	705	98	176
Vehicles Exiting (pc/h)	176	77	429	661
Follow-Up Headway (s)	3.186	3.186	3.186	3.186
Ped Vol. Crossing Leg (#/hr)	1	66	8	5
Ped Capacity Adjustment	1.000	0.991	0.999	0.999
Approach Delay (sec/veh)	6.6	10.1	14.1	9.5
Approach LOS	A	B	B	A

Lane	Left	Left	Left	Left
Designated moves	LTR	LTR	LTR	LTR
Assumed Moves	LTR	LTR	LTR	LTR
Right Turn Channelized				
Lane Utilization	1.000	1.000	1.000	1.000
Critical Headway (s)	5.193	5.193	5.193	5.193
Entry Flow Rate (pc/h)	98	132	684	429
Capacity, Entry Lane (pc/h)	736	558	1024	948
Entry HV Adjustment Factor	0.957	0.958	0.961	0.960
Flow Rate, Entry (vph)	94	126	657	412
Capacity, Entry (vph)	704	530	983	910
Volume to Capacity Ratio	0.133	0.239	0.668	0.453
Control Delay (sec/veh)	6.6	10.1	14.1	9.5
Level of Service	A	B	B	A
95th-Percentile Queue (veh)	0	1	5	2

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	163	141	160	50	0	60	0	717	11	20	324	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	3.0	3.0	3.0	3.0		3.0		3.0			3.0	
Lane Util. Factor	1.00	1.00	1.00	1.00		1.00		*0.60			*0.60	
Frpb, ped/bikes	1.00	1.00	0.95	1.00		0.93		1.00			1.00	
Flpb, ped/bikes	0.95	1.00	1.00	0.96		1.00		1.00			1.00	
Frt	1.00	1.00	0.85	1.00		0.85		1.00			1.00	
Flt Protected	0.95	1.00	1.00	0.95		1.00		1.00			1.00	
Satd. Flow (prot)	1684	1863	1497	1708		1477		2227			2227	
Flt Permitted	0.95	1.00	1.00	0.67		1.00		1.00			0.87	
Satd. Flow (perm)	1684	1863	1497	1196		1477		2227			1940	
Peak-hour factor, PHF	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98
Adj. Flow (vph)	166	144	163	51	0	61	0	732	11	20	331	0
RTOR Reduction (vph)	0	0	85	0	0	32	0	1	0	0	0	0
Lane Group Flow (vph)	166	144	78	51	0	29	0	742	0	0	351	0
Confl. Peds. (#/hr)	46		68	68		46	53		56	56		53
Confl. Bikes (#/hr)			1						14			
Turn Type	Perm		Perm	custom		custom				Perm		
Protected Phases		4						2			6	
Permitted Phases	4		4	8		8				6		
Actuated Green, G (s)	31.0	31.0	31.0	31.0		31.0		28.0			28.0	
Effective Green, g (s)	31.0	31.0	31.0	31.0		31.0		28.0			28.0	
Actuated g/C Ratio	0.48	0.48	0.48	0.48		0.48		0.43			0.43	
Clearance Time (s)	3.0	3.0	3.0	3.0		3.0		3.0			3.0	
Lane Grp Cap (vph)	803	889	714	570		704		959			836	
v/s Ratio Prot		0.08						c0.33				
v/s Ratio Perm	c0.10		0.05	0.04		0.02					0.18	
v/c Ratio	0.21	0.16	0.11	0.09		0.04		0.77			0.42	
Uniform Delay, d1	9.9	9.6	9.4	9.3		9.1		15.8			12.9	
Progression Factor	1.00	1.00	1.00	1.00		1.00		1.00			1.00	
Incremental Delay, d2	0.6	0.4	0.3	0.3		0.1		6.1			1.5	
Delay (s)	10.4	10.0	9.7	9.6		9.2		21.8			14.4	
Level of Service	B	B	A	A		A		C			B	
Approach Delay (s)		10.1			9.4			21.8			14.4	
Approach LOS		B			A			C			B	

Intersection Summary			
HCM Average Control Delay	16.1	HCM Level of Service	B
HCM Volume to Capacity ratio	0.48		
Actuated Cycle Length (s)	65.0	Sum of lost time (s)	6.0
Intersection Capacity Utilization	65.1%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

HCM Unsignalized Intersection Capacity Analysis
12: Prospect St & Panoramic Way

3/19/2013

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Volume (veh/h)	234	30	10	110	50	20
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.82	0.82	0.82	0.82	0.82	0.82
Hourly flow rate (vph)	285	37	12	134	61	24
Pedestrians	3					
Lane Width (ft)	12.0					
Walking Speed (ft/s)	4.0					
Percent Blockage	0					
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume			322		465	304
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			322		465	304
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			99		89	97
cM capacity (veh/h)			1238		549	736

Direction, Lane #	EB 1	WB 1	NB 1
Volume Total	322	146	85
Volume Left	0	12	61
Volume Right	37	0	24
cSH	1700	1238	592
Volume to Capacity	0.19	0.01	0.14
Queue Length 95th (ft)	0	1	13
Control Delay (s)	0.0	0.7	12.1
Lane LOS		A	B
Approach Delay (s)	0.0	0.7	12.1
Approach LOS			B

Intersection Summary			
Average Delay	2.1		
Intersection Capacity Utilization	24.8%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Sign Control	Stop		Stop			Stop
Volume (vph)	101	110	60	204	110	30
Peak Hour Factor	0.95	0.95	0.95	0.95	0.95	0.95
Hourly flow rate (vph)	106	116	63	215	116	32

Direction, Lane #	WB 1	NB 1	SB 1
Volume Total (vph)	222	278	147
Volume Left (vph)	106	0	116
Volume Right (vph)	116	215	0
Hadj (s)	-0.15	-0.40	0.23
Departure Headway (s)	4.7	4.3	5.0
Degree Utilization, x	0.29	0.33	0.20
Capacity (veh/h)	707	804	676
Control Delay (s)	9.7	9.3	9.3
Approach Delay (s)	9.7	9.3	9.3
Approach LOS	A	A	A

Intersection Summary			
Delay	9.4		
HCM Level of Service	A		
Intersection Capacity Utilization	46.3%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Stop			Stop			Stop			Stop	
Volume (vph)	20	130	133	211	90	20	41	40	44	30	80	20
Peak Hour Factor	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88
Hourly flow rate (vph)	23	148	151	240	102	23	47	45	50	34	91	23

Direction, Lane #	EB 1	WB 1	NB 1	SB 1	SB 2
Volume Total (vph)	322	365	142	125	23
Volume Left (vph)	23	240	47	34	0
Volume Right (vph)	151	23	50	0	23
Hadj (s)	-0.25	0.11	-0.13	0.07	-0.58
Departure Headway (s)	5.0	5.3	5.8	6.1	3.2
Degree Utilization, x	0.45	0.54	0.23	0.21	0.02
Capacity (veh/h)	667	648	537	517	1121
Control Delay (s)	12.1	14.3	10.5	10.7	6.3
Approach Delay (s)	12.1	14.3	10.5	10.0	
Approach LOS	B	B	B	A	

Intersection Summary			
Delay	12.4		
HCM Level of Service	B		
Intersection Capacity Utilization	57.7%	ICU Level of Service	B
Analysis Period (min)	15		

HCM Signalized Intersection Capacity Analysis
1: University Ave & Shattuck Ave

3/15/2013

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	221	513	290	91	703	530	0	0	0	70	891	160
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0			4.0	4.0					4.0	
Lane Util. Factor	1.00	0.95			0.91	0.91					0.91	
Frpb, ped/bikes	1.00	0.90			0.97	0.68					0.94	
Flpb, ped/bikes	0.94	1.00			0.99	1.00					0.98	
Frt	1.00	0.95			0.99	0.85					0.98	
Flt Protected	0.95	1.00			0.99	1.00					1.00	
Satd. Flow (prot)	1640	2976			3169	974					4544	
Flt Permitted	0.21	1.00			0.72	1.00					1.00	
Satd. Flow (perm)	365	2976			2294	974					4544	
Peak-hour factor, PHF	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93
Adj. Flow (vph)	238	552	312	98	756	570	0	0	0	75	958	172
RTOR Reduction (vph)	0	0	0	0	8	224	0	0	0	0	26	0
Lane Group Flow (vph)	238	864	0	0	937	255	0	0	0	0	1179	0
Confl. Peds. (#/hr)	365		294	294		365	885		315	315		885
Confl. Bikes (#/hr)			13			17						34
Heavy Vehicles (%)	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%
Turn Type	Perm			Perm		Perm				Perm		
Protected Phases		4			8						6	
Permitted Phases	4			8		8				6		
Actuated Green, G (s)	48.0	48.0			48.0	48.0					34.0	
Effective Green, g (s)	48.0	48.0			48.0	48.0					34.0	
Actuated g/C Ratio	0.53	0.53			0.53	0.53					0.38	
Clearance Time (s)	4.0	4.0			4.0	4.0					4.0	
Lane Grp Cap (vph)	195	1587			1223	519					1717	
v/s Ratio Prot		0.29										
v/s Ratio Perm	c0.65				0.41	0.26					0.26	
v/c Ratio	1.22	0.54			0.77	0.49					0.69	
Uniform Delay, d1	21.0	13.8			16.6	13.3					23.5	
Progression Factor	1.00	1.00			1.33	3.69					0.70	
Incremental Delay, d2	136.4	1.3			4.6	3.3					2.1	
Delay (s)	157.4	15.2			26.7	52.3					18.5	
Level of Service	F	B			C	D					B	
Approach Delay (s)		45.9			35.3			0.0			18.5	
Approach LOS		D			D			A			B	

Intersection Summary			
HCM Average Control Delay	33.0	HCM Level of Service	C
HCM Volume to Capacity ratio	1.00		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	92.1%	ICU Level of Service	F
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	90	192	70	151	382	204	40	740	51	102	750	70
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0	4.0		4.0		4.0	4.0		4.0	4.0	
Lane Util. Factor		0.95	1.00		0.95		1.00	0.95		1.00	0.95	
Frpb, ped/bikes		1.00	0.89		0.94		1.00	0.99		1.00	0.98	
Flpb, ped/bikes		0.98	1.00		0.99		0.92	1.00		0.95	1.00	
Frt		1.00	0.85		0.96		1.00	0.99		1.00	0.99	
Flt Protected		0.98	1.00		0.99		0.95	1.00		0.95	1.00	
Satd. Flow (prot)		3428	1408		3102		1634	3466		1689	3408	
Flt Permitted		0.59	1.00		0.78		0.27	1.00		0.28	1.00	
Satd. Flow (perm)		2052	1408		2449		464	3466		501	3408	
Peak-hour factor, PHF	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97
Adj. Flow (vph)	93	198	72	156	394	210	41	763	53	105	773	72
RTOR Reduction (vph)	0	0	10	0	28	0	0	5	0	0	8	0
Lane Group Flow (vph)	0	291	63	0	732	0	41	811	0	105	837	0
Confl. Peds. (#/hr)	211		112	112		211	472		267	267		472
Confl. Bikes (#/hr)			12			108			22			26
Turn Type	Perm		Perm	Perm			Perm			Perm		
Protected Phases		4			8			2			6	
Permitted Phases	4		4	8			2			6		
Actuated Green, G (s)		33.0	33.0		33.0		49.0	49.0		49.0	49.0	
Effective Green, g (s)		33.0	33.0		33.0		49.0	49.0		49.0	49.0	
Actuated g/C Ratio		0.37	0.37		0.37		0.54	0.54		0.54	0.54	
Clearance Time (s)		4.0	4.0		4.0		4.0	4.0		4.0	4.0	
Lane Grp Cap (vph)		752	516		898		253	1887		273	1855	
v/s Ratio Prot								0.23			c0.25	
v/s Ratio Perm		0.14	0.04		c0.30		0.09			0.21		
v/c Ratio		0.39	0.12		0.82		0.16	0.43		0.38	0.45	
Uniform Delay, d1		21.0	18.9		25.7		10.2	12.2		11.8	12.4	
Progression Factor		1.00	1.00		1.52		1.52	1.53		1.00	1.00	
Incremental Delay, d2		1.5	0.5		4.9		0.8	0.4		4.1	0.8	
Delay (s)		22.5	19.4		44.0		16.4	19.1		15.9	13.2	
Level of Service		C	B		D		B	B		B	B	
Approach Delay (s)		21.9			44.0			19.0			13.5	
Approach LOS		C			D			B			B	

Intersection Summary			
HCM Average Control Delay	24.1	HCM Level of Service	C
HCM Volume to Capacity ratio	0.60		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	110.7%	ICU Level of Service	H
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	354	30	370	20	30	40	210	800	20	30	720	158
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0			4.0		4.0	4.0		4.0	4.0	4.0
Lane Util. Factor	0.95	0.95			1.00		1.00	0.95		1.00	0.95	1.00
Frpb, ped/bikes	1.00	0.83			0.88		1.00	0.99		1.00	1.00	0.80
Flpb, ped/bikes	0.78	0.98			0.98		1.00	1.00		0.93	1.00	1.00
Frt	1.00	0.87			0.94		1.00	1.00		1.00	1.00	0.85
Flt Protected	0.95	1.00			0.99		0.95	1.00		0.95	1.00	1.00
Satd. Flow (prot)	1299	1240			1486		1752	3472		1633	3505	1252
Flt Permitted	0.72	0.97			0.81		0.95	1.00		0.34	1.00	1.00
Satd. Flow (perm)	981	1211			1212		1752	3472		580	3505	1252
Peak-hour factor, PHF	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98
Adj. Flow (vph)	361	31	378	20	31	41	214	816	20	31	735	161
RTOR Reduction (vph)	0	165	0	0	27	0	0	2	0	0	0	59
Lane Group Flow (vph)	325	280	0	0	65	0	214	834	0	31	735	102
Confl. Peds. (#/hr)	287		212	212		287	203		150	150		203
Confl. Bikes (#/hr)			5			7			18			43
Heavy Vehicles (%)	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%
Turn Type	Perm			Perm			Prot			Perm		Perm
Protected Phases		4			8		5	2			6	
Permitted Phases	4			8						6		6
Actuated Green, G (s)	31.0	31.0			31.0		10.0	51.0		37.0	37.0	37.0
Effective Green, g (s)	31.0	31.0			31.0		10.0	51.0		37.0	37.0	37.0
Actuated g/C Ratio	0.34	0.34			0.34		0.11	0.57		0.41	0.41	0.41
Clearance Time (s)	4.0	4.0			4.0		4.0	4.0		4.0	4.0	4.0
Lane Grp Cap (vph)	338	417			417		195	1967		238	1441	515
v/s Ratio Prot							c0.12	0.24			c0.21	
v/s Ratio Perm	c0.33	0.23			0.05					0.05		0.08
v/c Ratio	0.96	0.67			0.16		1.10	0.42		0.13	0.51	0.20
Uniform Delay, d1	28.9	25.2			20.4		40.0	11.1		16.5	19.7	17.0
Progression Factor	0.73	0.61			1.00		1.00	1.00		0.48	0.51	0.25
Incremental Delay, d2	37.8	7.6			0.8		92.9	0.7		0.9	1.0	0.7
Delay (s)	58.9	22.9			21.2		132.9	11.8		8.7	11.0	5.0
Level of Service	E	C			C		F	B		A	B	A
Approach Delay (s)		38.1			21.2			36.5			9.9	
Approach LOS		D			C			D			A	

Intersection Summary			
HCM Average Control Delay	27.7	HCM Level of Service	C
HCM Volume to Capacity ratio	0.77		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	79.9%	ICU Level of Service	D
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	50	195	110	378	517	90	130	700	394	21	350	60
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	2.0	2.0		2.0	2.0		2.0	2.0			2.0	
Lane Util. Factor	1.00	0.95		0.91	0.91		1.00	0.95			0.95	
Frpb, ped/bikes	1.00	0.96		1.00	0.97		1.00	0.95			0.98	
Flpb, ped/bikes	1.00	1.00		1.00	1.00		0.95	1.00			1.00	
Frt	1.00	0.95		1.00	0.98		1.00	0.95			0.98	
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00			1.00	
Satd. Flow (prot)	1770	3227		1610	3193		1684	3177			3395	
Flt Permitted	0.95	1.00		0.95	1.00		0.34	1.00			0.70	
Satd. Flow (perm)	1770	3227		1610	3193		602	3177			2375	
Peak-hour factor, PHF	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94
Adj. Flow (vph)	53	207	117	402	550	96	138	745	419	22	372	64
RTOR Reduction (vph)	0	69	0	0	13	0	0	86	0	0	14	0
Lane Group Flow (vph)	53	255	0	346	689	0	138	1078	0	0	444	0
Confl. Peds. (#/hr)	168		108	108		168	104		118	118		104
Confl. Bikes (#/hr)			7			98			16			10
Turn Type	Split			Split			Perm			Perm		
Protected Phases	4	4		8	8			2			6	
Permitted Phases							2			6		
Actuated Green, G (s)	34.0	34.0		24.0	24.0		26.0	26.0			26.0	
Effective Green, g (s)	34.0	34.0		24.0	24.0		26.0	26.0			26.0	
Actuated g/C Ratio	0.38	0.38		0.27	0.27		0.29	0.29			0.29	
Clearance Time (s)	2.0	2.0		2.0	2.0		2.0	2.0			2.0	
Lane Grp Cap (vph)	669	1219		429	851		174	918			686	
v/s Ratio Prot	0.03	c0.08		0.21	c0.22			c0.34				
v/s Ratio Perm							0.23				0.19	
v/c Ratio	0.08	0.21		0.81	0.81		0.79	1.17			0.65	
Uniform Delay, d1	18.0	18.9		30.8	30.9		29.5	32.0			28.0	
Progression Factor	1.39	1.68		1.00	1.00		0.77	0.76			1.00	
Incremental Delay, d2	0.2	0.4		14.9	8.2		26.4	88.4			4.7	
Delay (s)	25.1	32.1		45.8	39.1		49.3	112.9			32.7	
Level of Service	C	C		D	D		D	F			C	
Approach Delay (s)		31.1			41.3			106.2			32.7	
Approach LOS		C			D			F			C	

Intersection Summary			
HCM Average Control Delay	65.4	HCM Level of Service	E
HCM Volume to Capacity ratio	0.67		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	6.0
Intersection Capacity Utilization	117.6%	ICU Level of Service	H
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (vph)	140	330	455	73	72	110
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0		4.0	
Lane Util. Factor	1.00	0.95	1.00		1.00	
Frpb, ped/bikes	1.00	1.00	0.91		0.82	
Flpb, ped/bikes	1.00	1.00	1.00		1.00	
Frt	1.00	1.00	0.98		0.92	
Flt Protected	0.95	1.00	1.00		0.98	
Satd. Flow (prot)	1719	3438	1617		1333	
Flt Permitted	0.95	1.00	1.00		0.98	
Satd. Flow (perm)	1719	3438	1617		1333	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	147	347	479	77	76	116
RTOR Reduction (vph)	0	0	9	0	73	0
Lane Group Flow (vph)	147	347	547	0	119	0
Confl. Peds. (#/hr)				475	211	211
Confl. Bikes (#/hr)				36		
Heavy Vehicles (%)	5%	5%	5%	5%	5%	5%
Turn Type	Prot					
Protected Phases	7	4	8		6	
Permitted Phases						
Actuated Green, G (s)	7.9	36.0	24.1		26.0	
Effective Green, g (s)	7.9	36.0	24.1		26.0	
Actuated g/C Ratio	0.11	0.51	0.34		0.37	
Clearance Time (s)	4.0	4.0	4.0		4.0	
Vehicle Extension (s)	3.0	3.0	3.0		3.0	
Lane Grp Cap (vph)	194	1768	557		495	
v/s Ratio Prot	c0.09	0.10	c0.34		c0.09	
v/s Ratio Perm						
v/c Ratio	0.76	0.20	0.98		0.24	
Uniform Delay, d1	30.1	9.2	22.7		15.2	
Progression Factor	1.00	1.00	1.00		1.00	
Incremental Delay, d2	15.5	0.2	34.2		1.1	
Delay (s)	45.6	9.4	56.9		16.3	
Level of Service	D	A	E		B	
Approach Delay (s)		20.2	56.9		16.3	
Approach LOS		C	E		B	

Intersection Summary			
HCM Average Control Delay	36.0	HCM Level of Service	D
HCM Volume to Capacity ratio	0.62		
Actuated Cycle Length (s)	70.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	63.0%	ICU Level of Service	B
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	30	32	320	60	144	21	94	256	202	20	201	10
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0	4.0		4.0	4.0		4.0			4.0	
Lane Util. Factor		1.00	1.00		1.00	1.00		1.00			1.00	
Frpb, ped/bikes		1.00	0.73		1.00	0.67		0.92			0.99	
Flpb, ped/bikes		0.90	1.00		0.93	1.00		0.98			1.00	
Frt		1.00	0.85		1.00	0.85		0.95			0.99	
Flt Protected		0.98	1.00		0.99	1.00		0.99			1.00	
Satd. Flow (prot)		1623	1143		1695	1050		1568			1799	
Flt Permitted		0.83	1.00		0.90	1.00		0.90			0.94	
Satd. Flow (perm)		1378	1143		1551	1050		1423			1697	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	33	35	348	65	157	23	102	278	220	22	218	11
RTOR Reduction (vph)	0	0	224	0	0	14	0	30	0	0	2	0
Lane Group Flow (vph)	0	68	124	0	222	9	0	570	0	0	249	0
Confl. Peds. (#/hr)	137		116	116		137	92		85	85		92
Confl. Bikes (#/hr)			3			23			20			7
Heavy Vehicles (%)	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%
Turn Type	Perm		Perm	Perm		Perm	Perm			Perm		
Protected Phases		4			8			2			6	
Permitted Phases	4		4	8		8	2			6		
Actuated Green, G (s)		24.5	24.5		24.5	24.5		36.5			36.5	
Effective Green, g (s)		25.0	25.0		25.0	25.0		37.0			37.0	
Actuated g/C Ratio		0.36	0.36		0.36	0.36		0.53			0.53	
Clearance Time (s)		4.5	4.5		4.5	4.5		4.5			4.5	
Lane Grp Cap (vph)		492	408		554	375		752			897	
v/s Ratio Prot												
v/s Ratio Perm		0.05	0.11		c0.14	0.01		c0.40			0.15	
v/c Ratio		0.14	0.30		0.40	0.02		0.76			0.28	
Uniform Delay, d1		15.2	16.2		16.9	14.6		13.0			9.1	
Progression Factor		1.00	1.00		1.00	1.00		1.00			1.00	
Incremental Delay, d2		0.6	1.9		2.2	0.1		7.1			0.8	
Delay (s)		15.8	18.2		19.0	14.7		20.0			9.9	
Level of Service		B	B		B	B		C			A	
Approach Delay (s)		17.8			18.6			20.0			9.9	
Approach LOS		B			B			C			A	

Intersection Summary			
HCM Average Control Delay	17.5	HCM Level of Service	B
HCM Volume to Capacity ratio	0.61		
Actuated Cycle Length (s)	70.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	84.8%	ICU Level of Service	E
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Stop			Stop			Stop			Stop	
Volume (vph)	30	20	20	141	10	200	10	342	52	121	460	10
Peak Hour Factor	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98
Hourly flow rate (vph)	31	20	20	144	10	204	10	349	53	123	469	10

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total (vph)	71	358	412	603
Volume Left (vph)	31	144	10	123
Volume Right (vph)	20	204	53	10
Hadj (s)	-0.03	-0.21	-0.02	0.08
Departure Headway (s)	8.2	6.8	6.6	6.5
Degree Utilization, x	0.16	0.68	0.76	1.10
Capacity (veh/h)	376	509	528	540
Control Delay (s)	12.8	23.2	27.8	92.1
Approach Delay (s)	12.8	23.2	27.8	92.1
Approach LOS	B	C	D	F

Intersection Summary			
Delay	52.7		
HCM Level of Service	F		
Intersection Capacity Utilization	93.1%	ICU Level of Service	F
Analysis Period (min)	15		

SimTraffic Post-Processor | **LBNL 2nd Campus**
Average Results from 10 Runs | **Cumulative (2035) Baseline**
Volume and Delay by Movement | **PM Peak Hour**

Intersection 8 **Piedmont Avenue/Bancroft Way** **Unsignalized**

		Volume (veh/hr)			Total Delay (sec/veh)		
Direction	**Movement**	**Demand**	**Served**	**% Served**	**Average**	**Std. Dev.**	**LOS**
NB	Left Turn	151	117	77.5%	56.2	4.6	F
	Through	504	395	78.4%	58.1	9.9	F
	Right Turn						
	Subtotal	**655**	**512**	**78.2%**	**57.6**	**8.4**	**F**
SB	Left Turn						
	Through	469	328	69.8%	924.1	195.8	F
	Right Turn	212	146	69.0%	928.4	216.8	F
	Subtotal	**681**	**474**	**69.6%**	**925.0**	**200.7**	**F**
EB	Left Turn						
	Through						
	Right Turn						
	Subtotal						
WB	Left Turn						
	Through						
	Right Turn						
	Subtotal						
Total		**1336**	**986**	**73.8%**	**473.4**	**91.8**	**F**

Intersection 9 **Piedmont Avenue/Durant Avenue** **Unsignalized**

		Volume (veh/hr)			Total Delay (sec/veh)		
Direction	**Movement**	**Demand**	**Served**	**% Served**	**Average**	**Std. Dev.**	**LOS**
NB	Left Turn						
	Through	471	327	69.4%	941.9	231.0	F
	Right Turn						
	Subtotal	**471**	**327**	**69.4%**	**941.9**	**231.0**	**F**
SB	Left Turn						
	Through	460	327	71.1%	102.7	6.3	F
	Right Turn						
	Subtotal	**460**	**327**	**71.1%**	**102.7**	**6.3**	**F**
EB	Left Turn	163	166	102.0%	21.7	2.4	C
	Through						
	Right Turn	210	210	99.8%	26.1	6.1	D
	Subtotal	**373**	**376**	**100.8%**	**24.2**	**3.3**	**C**
WB	Left Turn						
	Through						
	Right Turn						
	Subtotal						
Total		**1304**	**1030**	**79.0%**	**339.3**	**69.8**	**F**

Intersection	
Intersection Delay (sec/veh)	22.6
Intersection LOS	C

Approach	EB	WB	NB	SB
Entry Lanes	1	1	1	1
Conflicting Circle Lanes	1	1	1	1
Adjusted Approach Flow (vph)	158	222	590	716
Demand Flow Rate (pc/h)	161	227	602	730
Vehicles Circulating (pc/h)	698	592	172	323
Vehicles Exiting (pc/h)	355	182	687	496
Follow-Up Headway (s)	3.186	3.186	3.186	3.186
Ped Vol. Crossing Leg (#/hr)	238	10	133	88
Ped Capacity Adjustment	0.961	0.999	0.970	0.988
Approach Delay (sec/veh)	11.1	11.0	14.4	35.5
Approach LOS	B	B	B	E

Lane	Left	Left	Left	Left
Designated moves	LTR	LTR	LTR	LTR
Assumed Moves	LTR	LTR	LTR	LTR
Right Turn Channelized				
Lane Utilization	1.000	1.000	1.000	1.000
Critical Headway (s)	5.193	5.193	5.193	5.193
Entry Flow Rate (pc/h)	161	227	602	730
Capacity, Entry Lane (pc/h)	562	625	951	818
Entry HV Adjustment Factor	0.980	0.980	0.979	0.981
Flow Rate, Entry (vph)	158	222	590	716
Capacity, Entry (vph)	530	612	904	793
Volume to Capacity Ratio	0.298	0.364	0.652	0.903
Control Delay (sec/veh)	11.1	11.0	14.4	35.5
Level of Service	B	B	B	E
95th-Percentile Queue (veh)	1	2	5	12

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	137	150	270	41	0	110	0	575	20	20	502	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	3.0	3.0	3.0	3.0		3.0		3.0			3.0	
Lane Util. Factor	1.00	1.00	1.00	1.00		1.00		*0.60			*0.60	
Frpb, ped/bikes	1.00	1.00	0.90	1.00		0.84		0.99			1.00	
Flpb, ped/bikes	0.85	1.00	1.00	0.93		1.00		1.00			1.00	
Frt	1.00	1.00	0.85	1.00		0.85		0.99			1.00	
Flt Protected	0.95	1.00	1.00	0.95		1.00		1.00			1.00	
Satd. Flow (prot)	1521	1881	1441	1663		1340		2227			2247	
Flt Permitted	0.95	1.00	1.00	0.65		1.00		1.00			0.91	
Satd. Flow (perm)	1521	1881	1441	1140		1340		2227			2046	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	144	158	284	43	0	116	0	605	21	21	528	0
RTOR Reduction (vph)	0	0	48	0	0	30	0	2	0	0	0	0
Lane Group Flow (vph)	144	158	236	43	0	86	0	624	0	0	549	0
Confl. Peds. (#/hr)	142		138	138		138	137		173	173		137
Confl. Bikes (#/hr)			5						14			16
Heavy Vehicles (%)	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%
Turn Type	Perm		Perm	custom		custom				Perm		
Protected Phases		4						2			6	
Permitted Phases	4		4	8		8				6		
Actuated Green, G (s)	31.0	31.0	31.0	31.0		31.0		28.0			28.0	
Effective Green, g (s)	31.0	31.0	31.0	31.0		31.0		28.0			28.0	
Actuated g/C Ratio	0.48	0.48	0.48	0.48		0.48		0.43			0.43	
Clearance Time (s)	3.0	3.0	3.0	3.0		3.0		3.0			3.0	
Lane Grp Cap (vph)	725	897	687	544		639		959			881	
v/s Ratio Prot		0.08						c0.28				
v/s Ratio Perm	0.09		c0.16	0.04		0.06					0.27	
v/c Ratio	0.20	0.18	0.34	0.08		0.13		0.65			0.62	
Uniform Delay, d1	9.8	9.7	10.6	9.2		9.5		14.6			14.4	
Progression Factor	1.00	1.00	1.00	1.00		1.00		1.00			1.00	
Incremental Delay, d2	0.6	0.4	1.4	0.3		0.4		3.4			3.3	
Delay (s)	10.4	10.1	12.0	9.5		9.9		18.0			17.7	
Level of Service	B	B	B	A		A		B			B	
Approach Delay (s)		11.1			9.8			18.0			17.7	
Approach LOS		B			A			B			B	

Intersection Summary			
HCM Average Control Delay	15.2	HCM Level of Service	B
HCM Volume to Capacity ratio	0.49		
Actuated Cycle Length (s)	65.0	Sum of lost time (s)	6.0
Intersection Capacity Utilization	67.7%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Volume (veh/h)	200	40	22	212	40	30
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.89	0.89	0.89	0.89	0.89	0.89
Hourly flow rate (vph)	225	45	25	238	45	34
Pedestrians	9			1		
Lane Width (ft)	12.0			12.0		
Walking Speed (ft/s)	4.0			4.0		
Percent Blockage	1			0		
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume			270		544	248
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			270		544	248
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			98		91	96
cM capacity (veh/h)			1300		489	792

Direction, Lane #	EB 1	WB 1	NB 1
Volume Total	270	263	79
Volume Left	0	25	45
Volume Right	45	0	34
cSH	1700	1300	585
Volume to Capacity	0.16	0.02	0.13
Queue Length 95th (ft)	0	1	12
Control Delay (s)	0.0	0.9	12.1
Lane LOS		A	B
Approach Delay (s)	0.0	0.9	12.1
Approach LOS			B

Intersection Summary			
Average Delay	1.9		
Intersection Capacity Utilization	39.4%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Sign Control	Stop		Stop			Stop
Volume (vph)	193	90	100	131	90	60
Peak Hour Factor	0.86	0.86	0.86	0.86	0.86	0.86
Hourly flow rate (vph)	224	105	116	152	105	70

Direction, Lane #	WB 1	NB 1	SB 1
Volume Total (vph)	329	269	174
Volume Left (vph)	224	0	105
Volume Right (vph)	105	152	0
Hadj (s)	0.00	-0.29	0.17
Departure Headway (s)	5.0	4.8	5.3
Degree Utilization, x	0.46	0.35	0.26
Capacity (veh/h)	679	713	630
Control Delay (s)	12.1	10.3	10.2
Approach Delay (s)	12.1	10.3	10.2
Approach LOS	B	B	B

Intersection Summary			
Delay	11.1		
HCM Level of Service	B		
Intersection Capacity Utilization	49.8%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Stop			Stop			Stop			Stop	
Volume (vph)	20	150	112	24	110	20	92	80	178	30	30	10
Peak Hour Factor	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93
Hourly flow rate (vph)	22	161	120	26	118	22	99	86	191	32	32	11

Direction, Lane #	EB 1	WB 1	NB 1	SB 1	SB 2
Volume Total (vph)	303	166	376	65	11
Volume Left (vph)	22	26	99	32	0
Volume Right (vph)	120	22	191	0	11
Hadj (s)	-0.21	-0.03	-0.24	0.12	-0.58
Departure Headway (s)	5.2	5.6	5.0	5.9	3.2
Degree Utilization, x	0.44	0.26	0.53	0.11	0.01
Capacity (veh/h)	644	586	669	525	1121
Control Delay (s)	12.1	10.5	13.5	9.6	6.2
Approach Delay (s)	12.1	10.5	13.5	9.1	
Approach LOS	B	B	B	A	

Intersection Summary			
Delay	12.2		
HCM Level of Service	B		
Intersection Capacity Utilization	51.7%	ICU Level of Service	A
Analysis Period (min)	15		

Cumulative (2035) Plus Phase 1 Project Conditions

FEHR PEERS

HCM Signalized Intersection Capacity Analysis
1: University Ave & Shattuck Ave

3/15/2013

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	142	477	200	31	455	270	0	0	0	50	741	143
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0			4.0	4.0					4.0	
Lane Util. Factor	1.00	0.95			0.91	0.91					0.91	
Frpb, ped/bikes	1.00	0.96			0.99	0.87					0.95	
Flpb, ped/bikes	0.95	1.00			1.00	1.00					0.99	
Frt	1.00	0.96			0.99	0.85					0.98	
Flt Protected	0.95	1.00			1.00	1.00					1.00	
Satd. Flow (prot)	1622	3137			3195	1212					4485	
Flt Permitted	0.38	1.00			0.88	1.00					1.00	
Satd. Flow (perm)	655	3137			2826	1212					4485	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	154	518	217	34	495	293	0	0	0	54	805	155
RTOR Reduction (vph)	0	2	0	0	4	128	0	0	0	0	29	0
Lane Group Flow (vph)	154	733	0	0	557	133	0	0	0	0	985	0
Confl. Peds. (#/hr)	122		116	116		122	399		220	220		399
Confl. Bikes (#/hr)			12			7			1			22
Heavy Vehicles (%)	6%	6%	6%	6%	6%	6%	6%	6%	6%	6%	6%	6%
Turn Type	Perm			Perm		Perm				Perm		
Protected Phases		4			8						6	
Permitted Phases	4			8		8				6		
Actuated Green, G (s)	46.0	46.0			46.0	46.0					36.0	
Effective Green, g (s)	46.0	46.0			46.0	46.0					36.0	
Actuated g/C Ratio	0.51	0.51			0.51	0.51					0.40	
Clearance Time (s)	4.0	4.0			4.0	4.0					4.0	
Lane Grp Cap (vph)	335	1603			1444	619					1794	
v/s Ratio Prot		0.23										
v/s Ratio Perm	c0.24				0.20	0.11					0.22	
v/c Ratio	0.46	0.46			0.39	0.22					0.55	
Uniform Delay, d1	14.1	14.0			13.4	12.1					20.8	
Progression Factor	1.00	1.00			1.37	3.32					0.68	
Incremental Delay, d2	4.5	0.9			0.8	0.8					1.1	
Delay (s)	18.5	15.0			19.1	40.9					15.3	
Level of Service	B	B			B	D					B	
Approach Delay (s)		15.6			26.0			0.0			15.3	
Approach LOS		B			C			A			B	

Intersection Summary			
HCM Average Control Delay	18.6	HCM Level of Service	B
HCM Volume to Capacity ratio	0.50		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	83.3%	ICU Level of Service	E
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	50	267	50	74	232	63	20	360	62	186	890	90
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0	4.0		4.0		4.0	4.0		4.0	4.0	
Lane Util. Factor		0.95	1.00		0.95		1.00	0.95		1.00	0.95	
Frpb, ped/bikes		1.00	0.87		0.99		1.00	0.98		1.00	0.99	
Flpb, ped/bikes		0.99	1.00		0.99		0.97	1.00		0.95	1.00	
Frt		1.00	0.85		0.97		1.00	0.98		1.00	0.99	
Flt Protected		0.99	1.00		0.99		0.95	1.00		0.95	1.00	
Satd. Flow (prot)		3456	1368		3299		1702	3375		1668	3405	
Flt Permitted		0.84	1.00		0.81		0.20	1.00		0.47	1.00	
Satd. Flow (perm)		2916	1368		2693		352	3375		824	3405	
Peak-hour factor, PHF	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93
Adj. Flow (vph)	54	287	54	80	249	68	22	387	67	200	957	97
RTOR Reduction (vph)	0	0	21	0	19	0	0	16	0	0	8	0
Lane Group Flow (vph)	0	341	33	0	378	0	22	438	0	200	1046	0
Confl. Peds. (#/hr)	85		92	92		85	248		157	157		248
Confl. Bikes (#/hr)			73			8			5			21
Heavy Vehicles (%)	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%
Turn Type	Perm		Perm	Perm			Perm			Perm		
Protected Phases		4			8			2			6	
Permitted Phases	4		4	8			2			6		
Actuated Green, G (s)		32.0	32.0		32.0		50.0	50.0		50.0	50.0	
Effective Green, g (s)		32.0	32.0		32.0		50.0	50.0		50.0	50.0	
Actuated g/C Ratio		0.36	0.36		0.36		0.56	0.56		0.56	0.56	
Clearance Time (s)		4.0	4.0		4.0		4.0	4.0		4.0	4.0	
Lane Grp Cap (vph)		1037	486		958		196	1875		458	1892	
v/s Ratio Prot								0.13			c0.31	
v/s Ratio Perm		0.12	0.02		c0.14		0.06			0.24		
v/c Ratio		0.33	0.07		0.39		0.11	0.23		0.44	0.55	
Uniform Delay, d1		21.2	19.2		21.7		9.5	10.2		11.7	12.8	
Progression Factor		1.00	1.00		0.97		1.91	1.89		1.00	1.00	
Incremental Delay, d2		0.8	0.3		1.0		1.1	0.3		3.0	1.2	
Delay (s)		22.0	19.4		22.0		19.2	19.6		14.7	14.0	
Level of Service		C	B		C		B	B		B	B	
Approach Delay (s)		21.7			22.0			19.5			14.1	
Approach LOS		C			C			B			B	

Intersection Summary			
HCM Average Control Delay	17.6	HCM Level of Service	B
HCM Volume to Capacity ratio	0.49		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	115.3%	ICU Level of Service	H
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	438	20	250	10	20	20	140	390	10	30	860	95
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0			4.0		4.0	4.0		4.0	4.0	4.0
Lane Util. Factor	0.95	0.95			1.00		1.00	0.95		1.00	0.95	1.00
Frpb, ped/bikes	1.00	0.93			0.94		1.00	1.00		1.00	1.00	0.84
Flpb, ped/bikes	0.87	0.97			0.99		1.00	1.00		0.93	1.00	1.00
Frt	1.00	0.89			0.95		1.00	1.00		1.00	1.00	0.85
Flt Protected	0.95	0.99			0.99		0.95	1.00		0.95	1.00	1.00
Satd. Flow (prot)	1439	1383			1597		1736	3444		1606	3471	1306
Flt Permitted	0.78	0.92			0.92		0.95	1.00		0.49	1.00	1.00
Satd. Flow (perm)	1180	1287			1482		1736	3444		832	3471	1306
Peak-hour factor, PHF	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89
Adj. Flow (vph)	492	22	281	11	22	22	157	438	11	34	966	107
RTOR Reduction (vph)	0	106	0	0	15	0	0	2	0	0	0	39
Lane Group Flow (vph)	408	281	0	0	40	0	157	447	0	34	966	68
Confl. Peds. (#/hr)	153		87	87		153	152		96	96		152
Confl. Bikes (#/hr)			14			7			16			46
Heavy Vehicles (%)	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%
Turn Type	Perm			Perm			Prot			Perm		Perm
Protected Phases		4			8		5	2			6	
Permitted Phases	4			8						6		6
Actuated Green, G (s)	30.0	30.0			30.0		6.0	52.0		42.0	42.0	42.0
Effective Green, g (s)	30.0	30.0			30.0		6.0	52.0		42.0	42.0	42.0
Actuated g/C Ratio	0.33	0.33			0.33		0.07	0.58		0.47	0.47	0.47
Clearance Time (s)	4.0	4.0			4.0		4.0	4.0		4.0	4.0	4.0
Lane Grp Cap (vph)	393	429			494		116	1990		388	1620	609
v/s Ratio Prot							c0.09	0.13			c0.28	
v/s Ratio Perm	c0.35	0.22			0.03					0.04		0.05
v/c Ratio	1.04	0.66			0.08		1.35	0.22		0.09	0.60	0.11
Uniform Delay, d1	30.0	25.6			20.6		42.0	9.2		13.3	17.7	13.5
Progression Factor	0.68	0.50			1.00		1.00	1.00		0.46	0.44	0.25
Incremental Delay, d2	54.7	7.3			0.3		205.1	0.3		0.3	1.2	0.3
Delay (s)	75.2	20.1			20.9		247.1	9.5		6.5	9.1	3.7
Level of Service	E	C			C		F	A		A	A	A
Approach Delay (s)		48.4			20.9			71.0			8.5	
Approach LOS		D			C			E			A	

Intersection Summary			
HCM Average Control Delay	35.9	HCM Level of Service	D
HCM Volume to Capacity ratio	0.82		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	72.5%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	30	394	90	275	239	22	60	300	428	45	610	60
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	2.5	2.5		2.5	2.5		2.5	2.5	2.5		2.5	
Lane Util. Factor	1.00	0.95		0.91	0.91		1.00	0.95	1.00		0.95	
Frpb, ped/bikes	1.00	0.97		1.00	0.99		1.00	1.00	0.89		0.99	
Flpb, ped/bikes	1.00	1.00		1.00	1.00		0.97	1.00	1.00		1.00	
Frt	1.00	0.97		1.00	0.99		1.00	1.00	0.85		0.99	
Flt Protected	0.95	1.00		0.95	0.99		0.95	1.00	1.00		1.00	
Satd. Flow (prot)	1736	3278		1579	3216		1686	3471	1383		3364	
Flt Permitted	0.95	1.00		0.95	0.99		0.16	1.00	1.00		0.91	
Satd. Flow (perm)	1736	3278		1579	3216		278	3471	1383		3080	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	32	415	95	289	252	23	63	316	451	47	642	63
RTOR Reduction (vph)	0	22	0	0	5	0	0	0	323	0	8	0
Lane Group Flow (vph)	32	488	0	185	374	0	63	316	128	0	744	0
Confl. Peds. (#/hr)	150		126	126		150	109		92	92		109
Confl. Bikes (#/hr)			73			3						23
Heavy Vehicles (%)	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%
Turn Type	Split			Split			Perm		Perm	Perm		
Protected Phases	4	4		8	8			2			6	
Permitted Phases							2		2	6		
Actuated Green, G (s)	32.0	32.0		25.0	25.0		25.5	25.5	25.5		25.5	
Effective Green, g (s)	32.0	32.0		25.0	25.0		25.5	25.5	25.5		25.5	
Actuated g/C Ratio	0.36	0.36		0.28	0.28		0.28	0.28	0.28		0.28	
Clearance Time (s)	2.5	2.5		2.5	2.5		2.5	2.5	2.5		2.5	
Lane Grp Cap (vph)	617	1166		439	893		79	983	392		873	
v/s Ratio Prot	0.02	c0.15		c0.12	0.12			0.09				
v/s Ratio Perm							0.23		0.09		c0.24	
v/c Ratio	0.05	0.42		0.42	0.42		0.80	0.32	0.33		0.85	
Uniform Delay, d1	19.0	22.0		26.6	26.6		29.9	25.4	25.5		30.5	
Progression Factor	1.29	1.36		1.00	1.00		0.79	0.74	1.65		1.00	
Incremental Delay, d2	0.2	1.1		3.0	1.4		46.8	0.7	1.7		10.3	
Delay (s)	24.6	31.0		29.5	28.0		70.4	19.4	43.7		40.8	
Level of Service	C	C		C	C		E	B	D		D	
Approach Delay (s)		30.6			28.5			36.5			40.8	
Approach LOS		C			C			D			D	

Intersection Summary			
HCM Average Control Delay	34.8	HCM Level of Service	C
HCM Volume to Capacity ratio	0.55		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	7.5
Intersection Capacity Utilization	102.5%	ICU Level of Service	G
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (vph)	90	627	255	22	90	160
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0		4.0	
Lane Util. Factor	1.00	0.95	1.00		1.00	
Frpb, ped/bikes	1.00	1.00	0.96		0.87	
Flpb, ped/bikes	1.00	1.00	1.00		1.00	
Frt	1.00	1.00	0.99		0.91	
Flt Protected	0.95	1.00	1.00		0.98	
Satd. Flow (prot)	1703	3406	1696		1396	
Flt Permitted	0.95	1.00	1.00		0.98	
Satd. Flow (perm)	1703	3406	1696		1396	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	95	660	268	23	95	168
RTOR Reduction (vph)	0	0	5	0	99	0
Lane Group Flow (vph)	95	660	286	0	164	0
Confl. Peds. (#/hr)				320	151	151
Confl. Bikes (#/hr)				5		
Heavy Vehicles (%)	6%	6%	6%	6%	6%	6%
Turn Type	Prot					
Protected Phases	7	4	8		6	
Permitted Phases						
Actuated Green, G (s)	6.3	31.8	21.5		26.0	
Effective Green, g (s)	6.3	31.8	21.5		26.0	
Actuated g/C Ratio	0.10	0.48	0.33		0.40	
Clearance Time (s)	4.0	4.0	4.0		4.0	
Vehicle Extension (s)	3.0	3.0	3.0		3.0	
Lane Grp Cap (vph)	163	1646	554		552	
v/s Ratio Prot	c0.06	0.19	c0.17		c0.12	
v/s Ratio Perm						
v/c Ratio	0.58	0.40	0.52		0.30	
Uniform Delay, d1	28.5	10.9	17.9		13.6	
Progression Factor	1.00	1.00	1.00		1.00	
Incremental Delay, d2	5.2	0.7	3.4		1.4	
Delay (s)	33.7	11.6	21.4		15.0	
Level of Service	C	B	C		B	
Approach Delay (s)		14.4	21.4		15.0	
Approach LOS		B	C		B	

Intersection Summary			
HCM Average Control Delay	16.1	HCM Level of Service	B
HCM Volume to Capacity ratio	0.42		
Actuated Cycle Length (s)	65.8	Sum of lost time (s)	12.0
Intersection Capacity Utilization	49.8%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	30	257	341	28	50	11	107	171	229	25	257	40
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0	4.0		4.0	4.0		4.0			4.0	
Lane Util. Factor		1.00	1.00		1.00	1.00		1.00			1.00	
Frpb, ped/bikes		1.00	0.76		1.00	0.76		0.93			0.98	
Flpb, ped/bikes		0.98	1.00		0.96	1.00		0.99			1.00	
Frt		1.00	0.85		1.00	0.85		0.94			0.98	
Flt Protected		0.99	1.00		0.98	1.00		0.99			1.00	
Satd. Flow (prot)		1762	1173		1699	1161		1546			1733	
Flt Permitted		0.97	1.00		0.85	1.00		0.86			0.95	
Satd. Flow (perm)		1715	1173		1468	1161		1339			1651	
Peak-hour factor, PHF	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96
Adj. Flow (vph)	31	268	355	29	52	11	111	178	239	26	268	42
RTOR Reduction (vph)	0	0	197	0	0	7	0	46	0	0	8	0
Lane Group Flow (vph)	0	299	158	0	81	4	0	482	0	0	328	0
Confl. Peds. (#/hr)	113		108	108		113	57		66	66		57
Confl. Bikes (#/hr)			3									21
Heavy Vehicles (%)	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%
Turn Type	Perm		Perm	Perm		Perm	Perm			Perm		
Protected Phases		4			8			2			6	
Permitted Phases	4		4	8		8	2			6		
Actuated Green, G (s)		21.5	21.5		21.5	21.5		34.5			34.5	
Effective Green, g (s)		22.0	22.0		22.0	22.0		35.0			35.0	
Actuated g/C Ratio		0.34	0.34		0.34	0.34		0.54			0.54	
Clearance Time (s)		4.5	4.5		4.5	4.5		4.5			4.5	
Lane Grp Cap (vph)		580	397		497	393		721			889	
v/s Ratio Prot												
v/s Ratio Perm		c0.17	0.13		0.06	0.00		c0.36			0.20	
v/c Ratio		0.52	0.40		0.16	0.01		0.67			0.37	
Uniform Delay, d1		17.2	16.4		15.1	14.3		10.8			8.6	
Progression Factor		1.00	1.00		1.00	1.00		1.00			1.00	
Incremental Delay, d2		3.3	3.0		0.7	0.0		4.9			1.2	
Delay (s)		20.5	19.4		15.8	14.3		15.7			9.8	
Level of Service		C	B		B	B		B			A	
Approach Delay (s)		19.9			15.6			15.7			9.8	
Approach LOS		B			B			B			A	

Intersection Summary			
HCM Average Control Delay	16.2	HCM Level of Service	B
HCM Volume to Capacity ratio	0.61		
Actuated Cycle Length (s)	65.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	86.4%	ICU Level of Service	E
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Stop			Stop			Stop			Stop	
Volume (vph)	10	10	20	60	10	118	20	419	136	177	418	30
Peak Hour Factor	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94
Hourly flow rate (vph)	11	11	21	64	11	126	21	446	145	188	445	32

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total (vph)	43	200	612	665
Volume Left (vph)	11	64	21	188
Volume Right (vph)	21	126	145	32
Hadj (s)	-0.13	-0.19	-0.02	0.15
Departure Headway (s)	7.8	7.0	5.8	6.0
Degree Utilization, x	0.09	0.39	0.98	1.11
Capacity (veh/h)	435	499	612	602
Control Delay (s)	11.6	14.4	55.6	93.3
Approach Delay (s)	11.6	14.4	55.6	93.3
Approach LOS	B	B	F	F

Intersection Summary			
Delay	65.5		
HCM Level of Service	F		
Intersection Capacity Utilization	94.6%	ICU Level of Service	F
Analysis Period (min)	15		

SimTraffic Post-Processor | **LBNL 2nd Campus**
Average Results from 10 Runs | **Cumulative (2035) Plus Phase 1**
Volume and Delay by Movement | **AM Peak Hour**

Intersection 8 **Piedmont Avenue/Bancroft Way** **Unsignalized**

		Volume (veh/hr)			Total Delay (sec/veh)		
Direction	**Movement**	**Demand**	**Served**	**% Served**	**Average**	**Std. Dev.**	**LOS**
NB	Left Turn	130	91	69.6%	65.5	13.9	F
	Through	725	479	66.1%	67.2	13.3	F
	Right Turn						
	Subtotal	**855**	**569**	**66.6%**	**66.8**	**11.6**	**F**
SB	Left Turn						
	Through	319	331	103.9%	17.8	3.9	C
	Right Turn	129	120	93.3%	13.6	2.9	B
	Subtotal	**448**	**452**	**100.8%**	**16.7**	**3.7**	**C**
EB	Left Turn						
	Through						
	Right Turn						
	Subtotal						
WB	Left Turn						
	Through						
	Right Turn						
	Subtotal						
Total		**1303**	**1021**	**78.4%**	**44.6**	**6.6**	**E**

Intersection 9 **Piedmont Avenue/Durant Avenue** **Unsignalized**

		Volume (veh/hr)			Total Delay (sec/veh)		
Direction	**Movement**	**Demand**	**Served**	**% Served**	**Average**	**Std. Dev.**	**LOS**
NB	Left Turn						
	Through	649	367	56.6%	1664.1	282.0	F
	Right Turn						
	Subtotal	**649**	**367**	**56.6%**	**1664.1**	**282.0**	**F**
SB	Left Turn						
	Through	310	329	106.2%	20.8	5.7	C
	Right Turn						
	Subtotal	**310**	**329**	**106.2%**	**20.8**	**5.7**	**C**
EB	Left Turn	202	197	97.6%	29.1	10.6	D
	Through						
	Right Turn	100	99	99.0%	8.6	0.7	A
	Subtotal	**302**	**296**	**98.1%**	**22.4**	**7.8**	**C**
WB	Left Turn						
	Through						
	Right Turn						
	Subtotal						
Total		**1261**	**993**	**78.7%**	**626.6**	**93.0**	**F**

Intersection	
Intersection Delay (sec/veh)	12.5
Intersection LOS	B

Approach	EB	WB	NB	SB
Entry Lanes	1	1	1	1
Conflicting Circle Lanes	1	1	1	1
Adjusted Approach Flow (vph)	94	127	692	417
Demand Flow Rate (pc/h)	98	133	720	434
Vehicles Circulating (pc/h)	435	737	98	177
Vehicles Exiting (pc/h)	176	81	435	693
Follow-Up Headway (s)	3.186	3.186	3.186	3.186
Ped Vol. Crossing Leg (#/hr)	1	66	8	5
Ped Capacity Adjustment	1.000	0.991	0.999	0.999
Approach Delay (sec/veh)	6.6	10.6	15.4	9.6
Approach LOS	A	B	C	A

Lane	Left	Left	Left	Left
Designated moves	LTR	LTR	LTR	LTR
Assumed Moves	LTR	LTR	LTR	LTR
Right Turn Channelized				
Lane Utilization	1.000	1.000	1.000	1.000
Critical Headway (s)	5.193	5.193	5.193	5.193
Entry Flow Rate (pc/h)	98	133	720	434
Capacity, Entry Lane (pc/h)	731	541	1024	947
Entry HV Adjustment Factor	0.957	0.958	0.961	0.960
Flow Rate, Entry (vph)	94	127	692	417
Capacity, Entry (vph)	700	514	983	909
Volume to Capacity Ratio	0.134	0.248	0.704	0.459
Control Delay (sec/veh)	6.6	10.6	15.4	9.6
Level of Service	A	B	C	A
95th-Percentile Queue (veh)	0	1	6	2

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	177	142	160	50	0	60	0	737	12	20	327	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	3.0	3.0	3.0	3.0		3.0		3.0			3.0	
Lane Util. Factor	1.00	1.00	1.00	1.00		1.00		*0.60			*0.60	
Frpb, ped/bikes	1.00	1.00	0.95	1.00		0.93		1.00			1.00	
Flpb, ped/bikes	0.95	1.00	1.00	0.97		1.00		1.00			1.00	
Frt	1.00	1.00	0.85	1.00		0.85		1.00			1.00	
Flt Protected	0.95	1.00	1.00	0.95		1.00		1.00			1.00	
Satd. Flow (prot)	1684	1863	1497	1708		1477		2226			2227	
Flt Permitted	0.95	1.00	1.00	0.66		1.00		1.00			0.86	
Satd. Flow (perm)	1684	1863	1497	1195		1477		2226			1913	
Peak-hour factor, PHF	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98
Adj. Flow (vph)	181	145	163	51	0	61	0	752	12	20	334	0
RTOR Reduction (vph)	0	0	85	0	0	32	0	1	0	0	0	0
Lane Group Flow (vph)	181	145	78	51	0	29	0	763	0	0	354	0
Confl. Peds. (#/hr)	46		68	68		46	53		56	56		53
Confl. Bikes (#/hr)			1						14			
Turn Type	Perm		Perm	custom		custom				Perm		
Protected Phases		4						2			6	
Permitted Phases	4		4	8		8				6		
Actuated Green, G (s)	31.0	31.0	31.0	31.0		31.0		28.0			28.0	
Effective Green, g (s)	31.0	31.0	31.0	31.0		31.0		28.0			28.0	
Actuated g/C Ratio	0.48	0.48	0.48	0.48		0.48		0.43			0.43	
Clearance Time (s)	3.0	3.0	3.0	3.0		3.0		3.0			3.0	
Lane Grp Cap (vph)	803	889	714	570		704		959			824	
v/s Ratio Prot		0.08						c0.34				
v/s Ratio Perm	c0.11		0.05	0.04		0.02					0.19	
v/c Ratio	0.23	0.16	0.11	0.09		0.04		0.80			0.43	
Uniform Delay, d1	10.0	9.6	9.4	9.3		9.1		16.0			12.9	
Progression Factor	1.00	1.00	1.00	1.00		1.00		1.00			1.00	
Incremental Delay, d2	0.7	0.4	0.3	0.3		0.1		6.8			1.6	
Delay (s)	10.6	10.0	9.7	9.6		9.2		22.8			14.6	
Level of Service	B	B	A	A		A		C			B	
Approach Delay (s)		10.1			9.4			22.8			14.6	
Approach LOS		B			A			C			B	

Intersection Summary			
HCM Average Control Delay	16.6	HCM Level of Service	B
HCM Volume to Capacity ratio	0.50		
Actuated Cycle Length (s)	65.0	Sum of lost time (s)	6.0
Intersection Capacity Utilization	66.5%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

HCM Unsignalized Intersection Capacity Analysis
12: Prospect St & Panoramic Way

3/19/2013

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Volume (veh/h)	245	30	10	113	50	20
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.82	0.82	0.82	0.82	0.82	0.82
Hourly flow rate (vph)	299	37	12	138	61	24
Pedestrians	3					
Lane Width (ft)	12.0					
Walking Speed (ft/s)	4.0					
Percent Blockage	0					
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume			335		482	317
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			335		482	317
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			99		89	97
cM capacity (veh/h)			1224		536	723

Direction, Lane #	EB 1	WB 1	NB 1
Volume Total	335	150	85
Volume Left	0	12	61
Volume Right	37	0	24
cSH	1700	1224	579
Volume to Capacity	0.20	0.01	0.15
Queue Length 95th (ft)	0	1	13
Control Delay (s)	0.0	0.7	12.3
Lane LOS		A	B
Approach Delay (s)	0.0	0.7	12.3
Approach LOS			B

Intersection Summary			
Average Delay	2.0		
Intersection Capacity Utilization	25.4%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Sign Control	Stop		Stop			Stop
Volume (vph)	103	110	60	216	110	30
Peak Hour Factor	0.95	0.95	0.95	0.95	0.95	0.95
Hourly flow rate (vph)	108	116	63	227	116	32

Direction, Lane #	WB 1	NB 1	SB 1
Volume Total (vph)	224	291	147
Volume Left (vph)	108	0	116
Volume Right (vph)	116	227	0
Hadj (s)	-0.15	-0.40	0.23
Departure Headway (s)	4.8	4.3	5.0
Degree Utilization, x	0.30	0.34	0.21
Capacity (veh/h)	702	804	672
Control Delay (s)	9.7	9.5	9.3
Approach Delay (s)	9.7	9.5	9.3
Approach LOS	A	A	A

Intersection Summary			
Delay	9.5		
HCM Level of Service	A		
Intersection Capacity Utilization	47.1%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Stop			Stop			Stop			Stop	
Volume (vph)	20	130	142	236	90	20	43	40	47	30	80	20
Peak Hour Factor	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88
Hourly flow rate (vph)	23	148	161	268	102	23	49	45	53	34	91	23

Direction, Lane #	EB 1	WB 1	NB 1	SB 1	SB 2
Volume Total (vph)	332	393	148	125	23
Volume Left (vph)	23	268	49	34	0
Volume Right (vph)	161	23	53	0	23
Hadj (s)	-0.26	0.12	-0.13	0.07	-0.58
Departure Headway (s)	5.1	5.4	5.9	6.2	3.2
Degree Utilization, x	0.47	0.59	0.24	0.22	0.02
Capacity (veh/h)	657	641	524	498	1121
Control Delay (s)	12.6	15.7	10.9	10.9	6.3
Approach Delay (s)	12.6	15.7	10.9	10.2	
Approach LOS	B	C	B	B	

Intersection Summary			
Delay	13.2		
HCM Level of Service	B		
Intersection Capacity Utilization	60.0%	ICU Level of Service	B
Analysis Period (min)	15		

HCM Signalized Intersection Capacity Analysis
1: University Ave & Shattuck Ave

3/15/2013

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	223	515	290	95	714	530	0	0	0	70	895	170
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0			4.0	4.0					4.0	
Lane Util. Factor	1.00	0.95			0.91	0.91					0.91	
Frpb, ped/bikes	1.00	0.90			0.97	0.68					0.94	
Flpb, ped/bikes	0.94	1.00			0.99	1.00					0.98	
Frt	1.00	0.95			0.99	0.85					0.98	
Flt Protected	0.95	1.00			0.99	1.00					1.00	
Satd. Flow (prot)	1642	2977			3177	974					4525	
Flt Permitted	0.21	1.00			0.71	1.00					1.00	
Satd. Flow (perm)	359	2977			2270	974					4525	
Peak-hour factor, PHF	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93
Adj. Flow (vph)	240	554	312	102	768	570	0	0	0	75	962	183
RTOR Reduction (vph)	0	0	0	0	8	226	0	0	0	0	28	0
Lane Group Flow (vph)	240	866	0	0	948	258	0	0	0	0	1192	0
Confl. Peds. (#/hr)	365		294	294		365	885		315	315		885
Confl. Bikes (#/hr)			13			17						34
Heavy Vehicles (%)	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%
Turn Type	Perm			Perm		Perm				Perm		
Protected Phases		4			8						6	
Permitted Phases	4			8		8				6		
Actuated Green, G (s)	48.0	48.0			48.0	48.0					34.0	
Effective Green, g (s)	48.0	48.0			48.0	48.0					34.0	
Actuated g/C Ratio	0.53	0.53			0.53	0.53					0.38	
Clearance Time (s)	4.0	4.0			4.0	4.0					4.0	
Lane Grp Cap (vph)	191	1588			1211	519					1709	
v/s Ratio Prot		0.29										
v/s Ratio Perm	c0.67				0.42	0.26					0.26	
v/c Ratio	1.26	0.55			0.78	0.50					0.70	
Uniform Delay, d1	21.0	13.8			16.8	13.3					23.7	
Progression Factor	1.00	1.00			1.33	3.71					0.69	
Incremental Delay, d2	150.8	1.4			5.0	3.3					2.2	
Delay (s)	171.8	15.2			27.5	52.9					18.6	
Level of Service	F	B			C	D					B	
Approach Delay (s)		49.2			36.0			0.0			18.6	
Approach LOS		D			D			A			B	

Intersection Summary			
HCM Average Control Delay	34.2	HCM Level of Service	C
HCM Volume to Capacity ratio	1.02		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	92.9%	ICU Level of Service	F
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	90	192	70	165	385	213	40	740	53	103	750	70
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0	4.0		4.0		4.0	4.0		4.0	4.0	
Lane Util. Factor		0.95	1.00		0.95		1.00	0.95		1.00	0.95	
Frpb, ped/bikes		1.00	0.89		0.94		1.00	0.99		1.00	0.98	
Flpb, ped/bikes		0.98	1.00		0.99		0.92	1.00		0.95	1.00	
Frt		1.00	0.85		0.96		1.00	0.99		1.00	0.99	
Flt Protected		0.98	1.00		0.99		0.95	1.00		0.95	1.00	
Satd. Flow (prot)		3431	1408		3095		1634	3463		1689	3408	
Flt Permitted		0.58	1.00		0.78		0.27	1.00		0.28	1.00	
Satd. Flow (perm)		2028	1408		2427		464	3463		500	3408	
Peak-hour factor, PHF	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97
Adj. Flow (vph)	93	198	72	170	397	220	41	763	55	106	773	72
RTOR Reduction (vph)	0	0	10	0	28	0	0	6	0	0	8	0
Lane Group Flow (vph)	0	291	63	0	759	0	41	812	0	106	837	0
Confl. Peds. (#/hr)	211		112	112		211	472		267	267		472
Confl. Bikes (#/hr)			12			108			22			26
Turn Type	Perm		Perm	Perm			Perm			Perm		
Protected Phases		4			8			2			6	
Permitted Phases	4		4	8			2			6		
Actuated Green, G (s)		33.0	33.0		33.0		49.0	49.0		49.0	49.0	
Effective Green, g (s)		33.0	33.0		33.0		49.0	49.0		49.0	49.0	
Actuated g/C Ratio		0.37	0.37		0.37		0.54	0.54		0.54	0.54	
Clearance Time (s)		4.0	4.0		4.0		4.0	4.0		4.0	4.0	
Lane Grp Cap (vph)		744	516		890		253	1885		272	1855	
v/s Ratio Prot								0.23			c0.25	
v/s Ratio Perm		0.14	0.04		c0.31		0.09			0.21		
v/c Ratio		0.39	0.12		0.85		0.16	0.43		0.39	0.45	
Uniform Delay, d1		21.1	18.9		26.3		10.2	12.2		11.9	12.4	
Progression Factor		1.00	1.00		1.54		1.51	1.52		1.00	1.00	
Incremental Delay, d2		1.5	0.5		5.9		0.8	0.4		4.2	0.8	
Delay (s)		22.6	19.4		46.3		16.3	19.0		16.0	13.2	
Level of Service		C	B		D		B	B		B	B	
Approach Delay (s)		22.0			46.3			18.9			13.5	
Approach LOS		C			D			B			B	

Intersection Summary			
HCM Average Control Delay	24.8	HCM Level of Service	C
HCM Volume to Capacity ratio	0.61		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	110.7%	ICU Level of Service	H
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	356	30	370	20	30	40	210	800	20	30	720	172
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0			4.0		4.0	4.0		4.0	4.0	4.0
Lane Util. Factor	0.95	0.95			1.00		1.00	0.95		1.00	0.95	1.00
Frpb, ped/bikes	1.00	0.83			0.88		1.00	0.99		1.00	1.00	0.80
Flpb, ped/bikes	0.78	0.98			0.98		1.00	1.00		0.93	1.00	1.00
Frt	1.00	0.87			0.94		1.00	1.00		1.00	1.00	0.85
Flt Protected	0.95	1.00			0.99		0.95	1.00		0.95	1.00	1.00
Satd. Flow (prot)	1299	1240			1486		1752	3472		1633	3505	1252
Flt Permitted	0.72	0.97			0.81		0.95	1.00		0.34	1.00	1.00
Satd. Flow (perm)	981	1211			1212		1752	3472		580	3505	1252
Peak-hour factor, PHF	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98
Adj. Flow (vph)	363	31	378	20	31	41	214	816	20	31	735	176
RTOR Reduction (vph)	0	165	0	0	27	0	0	2	0	0	0	59
Lane Group Flow (vph)	327	280	0	0	65	0	214	834	0	31	735	117
Confl. Peds. (#/hr)	287		212	212		287	203		150	150		203
Confl. Bikes (#/hr)			5			7			18			43
Heavy Vehicles (%)	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%
Turn Type	Perm			Perm			Prot			Perm		Perm
Protected Phases		4			8		5	2			6	
Permitted Phases	4			8						6		6
Actuated Green, G (s)	31.0	31.0			31.0		10.0	51.0		37.0	37.0	37.0
Effective Green, g (s)	31.0	31.0			31.0		10.0	51.0		37.0	37.0	37.0
Actuated g/C Ratio	0.34	0.34			0.34		0.11	0.57		0.41	0.41	0.41
Clearance Time (s)	4.0	4.0			4.0		4.0	4.0		4.0	4.0	4.0
Lane Grp Cap (vph)	338	417			417		195	1967		238	1441	515
v/s Ratio Prot							c0.12	0.24			c0.21	
v/s Ratio Perm	c0.33	0.23			0.05					0.05		0.09
v/c Ratio	0.97	0.67			0.16		1.10	0.42		0.13	0.51	0.23
Uniform Delay, d1	29.0	25.2			20.4		40.0	11.1		16.5	19.7	17.2
Progression Factor	0.73	0.61			1.00		1.00	1.00		0.47	0.50	0.25
Incremental Delay, d2	39.0	7.6			0.8		92.9	0.7		0.8	1.0	0.8
Delay (s)	60.2	22.9			21.2		132.9	11.8		8.6	10.9	5.1
Level of Service	E	C			C		F	B		A	B	A
Approach Delay (s)		38.7			21.2			36.5			9.8	
Approach LOS		D			C			D			A	

Intersection Summary			
HCM Average Control Delay	27.8	HCM Level of Service	C
HCM Volume to Capacity ratio	0.77		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	80.0%	ICU Level of Service	D
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	50	199	110	392	544	93	130	700	396	22	350	60
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	2.0	2.0		2.0	2.0		2.0	2.0			2.0	
Lane Util. Factor	1.00	0.95		0.91	0.91		1.00	0.95			0.95	
Frpb, ped/bikes	1.00	0.96		1.00	0.97		1.00	0.95			0.98	
Flpb, ped/bikes	1.00	1.00		1.00	1.00		0.95	1.00			1.00	
Frt	1.00	0.95		1.00	0.98		1.00	0.95			0.98	
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00			1.00	
Satd. Flow (prot)	1770	3232		1610	3196		1684	3176			3395	
Flt Permitted	0.95	1.00		0.95	1.00		0.34	1.00			0.69	
Satd. Flow (perm)	1770	3232		1610	3196		601	3176			2358	
Peak-hour factor, PHF	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94
Adj. Flow (vph)	53	212	117	417	579	99	138	745	421	23	372	64
RTOR Reduction (vph)	0	66	0	0	13	0	0	87	0	0	14	0
Lane Group Flow (vph)	53	263	0	359	723	0	138	1079	0	0	445	0
Confl. Peds. (#/hr)	168		108	108		168	104		118	118		104
Confl. Bikes (#/hr)			7			98			16			10
Turn Type	Split			Split			Perm			Perm		
Protected Phases	4	4		8	8			2			6	
Permitted Phases							2			6		
Actuated Green, G (s)	34.0	34.0		24.0	24.0		26.0	26.0			26.0	
Effective Green, g (s)	34.0	34.0		24.0	24.0		26.0	26.0			26.0	
Actuated g/C Ratio	0.38	0.38		0.27	0.27		0.29	0.29			0.29	
Clearance Time (s)	2.0	2.0		2.0	2.0		2.0	2.0			2.0	
Lane Grp Cap (vph)	669	1221		429	852		174	918			681	
v/s Ratio Prot	0.03	c0.08		0.22	c0.23			c0.34				
v/s Ratio Perm							0.23				0.19	
v/c Ratio	0.08	0.22		0.84	0.85		0.79	1.17			0.65	
Uniform Delay, d1	18.0	19.0		31.2	31.3		29.5	32.0			28.0	
Progression Factor	1.36	1.63		1.00	1.00		0.77	0.76			1.00	
Incremental Delay, d2	0.2	0.4		17.4	10.3		26.4	88.7			4.8	
Delay (s)	24.7	31.3		48.5	41.5		49.2	113.1			32.9	
Level of Service	C	C		D	D		D	F			C	
Approach Delay (s)		30.4			43.8			106.4			32.9	
Approach LOS		C			D			F			C	

Intersection Summary			
HCM Average Control Delay	65.9	HCM Level of Service	E
HCM Volume to Capacity ratio	0.68		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	6.0
Intersection Capacity Utilization	118.0%	ICU Level of Service	H
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (vph)	140	337	499	78	73	110
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0		4.0	
Lane Util. Factor	1.00	0.95	1.00		1.00	
Frpb, ped/bikes	1.00	1.00	0.91		0.82	
Flpb, ped/bikes	1.00	1.00	1.00		1.00	
Frt	1.00	1.00	0.98		0.92	
Flt Protected	0.95	1.00	1.00		0.98	
Satd. Flow (prot)	1719	3438	1622		1335	
Flt Permitted	0.95	1.00	1.00		0.98	
Satd. Flow (perm)	1719	3438	1622		1335	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	147	355	525	82	77	116
RTOR Reduction (vph)	0	0	8	0	73	0
Lane Group Flow (vph)	147	355	599	0	120	0
Confl. Peds. (#/hr)				475	211	211
Confl. Bikes (#/hr)				36		
Heavy Vehicles (%)	5%	5%	5%	5%	5%	5%
Turn Type	Prot					
Protected Phases	7	4	8		6	
Permitted Phases						
Actuated Green, G (s)	7.9	36.0	24.1		26.0	
Effective Green, g (s)	7.9	36.0	24.1		26.0	
Actuated g/C Ratio	0.11	0.51	0.34		0.37	
Clearance Time (s)	4.0	4.0	4.0		4.0	
Vehicle Extension (s)	3.0	3.0	3.0		3.0	
Lane Grp Cap (vph)	194	1768	558		496	
v/s Ratio Prot	c0.09	0.10	c0.37		c0.09	
v/s Ratio Perm						
v/c Ratio	0.76	0.20	1.07		0.24	
Uniform Delay, d1	30.1	9.2	22.9		15.2	
Progression Factor	1.00	1.00	1.00		1.00	
Incremental Delay, d2	15.5	0.3	59.4		1.2	
Delay (s)	45.6	9.5	82.4		16.4	
Level of Service	D	A	F		B	
Approach Delay (s)		20.1	82.4		16.4	
Approach LOS		C	F		B	

Intersection Summary			
HCM Average Control Delay	48.5	HCM Level of Service	D
HCM Volume to Capacity ratio	0.66		
Actuated Cycle Length (s)	70.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	65.6%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	30	40	320	96	193	25	94	256	207	21	201	10
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0	4.0		4.0	4.0		4.0			4.0	
Lane Util. Factor		1.00	1.00		1.00	1.00		1.00			1.00	
Frpb, ped/bikes		1.00	0.73		1.00	0.67		0.92			0.99	
Flpb, ped/bikes		0.93	1.00		0.92	1.00		0.98			1.00	
Frt		1.00	0.85		1.00	0.85		0.95			0.99	
Flt Protected		0.98	1.00		0.98	1.00		0.99			1.00	
Satd. Flow (prot)		1680	1143		1677	1050		1565			1799	
Flt Permitted		0.82	1.00		0.87	1.00		0.90			0.94	
Satd. Flow (perm)		1401	1143		1490	1050		1421			1691	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	33	43	348	104	210	27	102	278	225	23	218	11
RTOR Reduction (vph)	0	0	224	0	0	12	0	31	0	0	2	0
Lane Group Flow (vph)	0	76	124	0	314	15	0	574	0	0	250	0
Confl. Peds. (#/hr)	137		116	116		137	92		85	85		92
Confl. Bikes (#/hr)			3			23			20			7
Heavy Vehicles (%)	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%
Turn Type	Perm		Perm	Perm		Perm	Perm			Perm		
Protected Phases		4			8			2			6	
Permitted Phases	4		4	8		8	2			6		
Actuated Green, G (s)		24.5	24.5		24.5	24.5		36.5			36.5	
Effective Green, g (s)		25.0	25.0		25.0	25.0		37.0			37.0	
Actuated g/C Ratio		0.36	0.36		0.36	0.36		0.53			0.53	
Clearance Time (s)		4.5	4.5		4.5	4.5		4.5			4.5	
Lane Grp Cap (vph)		500	408		532	375		751			894	
v/s Ratio Prot												
v/s Ratio Perm		0.05	0.11		c0.21	0.01		c0.40			0.15	
v/c Ratio		0.15	0.30		0.59	0.04		0.76			0.28	
Uniform Delay, d1		15.3	16.2		18.3	14.7		13.1			9.1	
Progression Factor		1.00	1.00		1.00	1.00		1.00			1.00	
Incremental Delay, d2		0.6	1.9		4.8	0.2		7.3			0.8	
Delay (s)		15.9	18.2		23.1	14.9		20.3			9.9	
Level of Service		B	B		C	B		C			A	
Approach Delay (s)		17.8			22.4			20.3			9.9	
Approach LOS		B			C			C			A	

Intersection Summary			
HCM Average Control Delay	18.5	HCM Level of Service	B
HCM Volume to Capacity ratio	0.69		
Actuated Cycle Length (s)	70.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	85.5%	ICU Level of Service	E
Analysis Period (min)	15		
c Critical Lane Group			

HCM Unsignalized Intersection Capacity Analysis
7: Stadium Rim Way & Piedmont Ave

3/15/2013

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Stop			Stop			Stop			Stop	
Volume (vph)	30	20	20	141	10	200	10	347	52	121	496	10
Peak Hour Factor	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98
Hourly flow rate (vph)	31	20	20	144	10	204	10	354	53	123	506	10

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total (vph)	71	358	417	640
Volume Left (vph)	31	144	10	123
Volume Right (vph)	20	204	53	10
Hadj (s)	-0.03	-0.21	-0.02	0.08
Departure Headway (s)	8.2	6.9	6.6	6.6
Degree Utilization, x	0.16	0.68	0.77	1.16
Capacity (veh/h)	377	507	528	549
Control Delay (s)	12.8	23.3	28.5	115.9
Approach Delay (s)	12.8	23.3	28.5	115.9
Approach LOS	B	C	D	F

Intersection Summary			
Delay	64.1		
HCM Level of Service	F		
Intersection Capacity Utilization	95.2%	ICU Level of Service	F
Analysis Period (min)	15		

SimTraffic Post-Processor | **LBNL 2nd Campus**
Average Results from 10 Runs | **Cumulative (2035) Plus Phase 1**
Volume and Delay by Movement | **PM Peak Hour**

Intersection 8 **Piedmont Avenue/Bancroft Way** **Unsignalized**

		Volume (veh/hr)			Total Delay (sec/veh)		
Direction	**Movement**	**Demand**	**Served**	**% Served**	**Average**	**Std. Dev.**	**LOS**
NB	Left Turn	153	120	78.5%	61.8	23.5	F
	Through	509	378	74.2%	60.5	11.3	F
	Right Turn						
	Subtotal	**662**	**498**	**75.2%**	**60.8**	**13.6**	**F**
SB	Left Turn						
	Through	495	322	64.9%	1208.8	243.4	F
	Right Turn	222	141	63.5%	1211.4	257.3	F
	Subtotal	**717**	**463**	**64.5%**	**1209.6**	**246.9**	**F**
EB	Left Turn						
	Through						
	Right Turn						
	Subtotal						
WB	Left Turn						
	Through						
	Right Turn						
	Subtotal						
Total		**1379**	**961**	**69.7%**	**613.2**	**114.7**	**F**

Intersection 9 **Piedmont Avenue/Durant Avenue** **Unsignalized**

		Volume (veh/hr)			Total Delay (sec/veh)		
Direction	**Movement**	**Demand**	**Served**	**% Served**	**Average**	**Std. Dev.**	**LOS**
NB	Left Turn						
	Through	476	313	65.7%	1060.4	200.7	F
	Right Turn						
	Subtotal	**476**	**313**	**65.7%**	**1060.4**	**200.7**	**F**
SB	Left Turn						
	Through	490	322	65.7%	106.7	7.0	F
	Right Turn						
	Subtotal	**490**	**322**	**65.7%**	**106.7**	**7.0**	**F**
EB	Left Turn	164	165	100.4%	21.3	3.3	C
	Through						
	Right Turn	210	216	103.0%	30.5	8.8	D
	Subtotal	**374**	**381**	**101.9%**	**26.6**	**4.9**	**D**
WB	Left Turn						
	Through						
	Right Turn						
	Subtotal						
Total		**1340**	**1016**	**75.8%**	**369.2**	**59.2**	**F**

Intersection	
Intersection Delay (sec/veh)	26.3
Intersection LOS	D

Approach	EB	WB	NB	SB
Entry Lanes	1	1	1	1
Conflicting Circle Lanes	1	1	1	1
Adjusted Approach Flow (vph)	158	226	596	748
Demand Flow Rate (pc/h)	161	231	609	763
Vehicles Circulating (pc/h)	735	598	172	327
Vehicles Exiting (pc/h)	355	183	724	502
Follow-Up Headway (s)	3.186	3.186	3.186	3.186
Ped Vol. Crossing Leg (#/hr)	238	10	133	88
Ped Capacity Adjustment	0.967	0.999	0.970	0.988
Approach Delay (sec/veh)	11.6	11.2	14.7	43.2
Approach LOS	B	B	B	E

Lane	Left	Left	Left	Left
Designated moves	LTR	LTR	LTR	LTR
Assumed Moves	LTR	LTR	LTR	LTR
Right Turn Channelized				
Lane Utilization	1.000	1.000	1.000	1.000
Critical Headway (s)	5.193	5.193	5.193	5.193
Entry Flow Rate (pc/h)	161	231	609	763
Capacity, Entry Lane (pc/h)	542	621	951	815
Entry HV Adjustment Factor	0.980	0.980	0.979	0.981
Flow Rate, Entry (vph)	158	226	596	748
Capacity, Entry (vph)	513	608	904	790
Volume to Capacity Ratio	0.307	0.372	0.660	0.948
Control Delay (sec/veh)	11.6	11.2	14.7	43.2
Level of Service	B	B	B	E
95th-Percentile Queue (veh)	1	2	5	14

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	139	150	270	42	0	110	0	578	20	20	522	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	3.0	3.0	3.0	3.0		3.0		3.0			3.0	
Lane Util. Factor	1.00	1.00	1.00	1.00		1.00		*0.60			*0.60	
Frpb, ped/bikes	1.00	1.00	0.90	1.00		0.84		0.99			1.00	
Flpb, ped/bikes	0.85	1.00	1.00	0.93		1.00		1.00			1.00	
Frt	1.00	1.00	0.85	1.00		0.85		0.99			1.00	
Flt Protected	0.95	1.00	1.00	0.95		1.00		1.00			1.00	
Satd. Flow (prot)	1521	1881	1441	1663		1340		2227			2247	
Flt Permitted	0.95	1.00	1.00	0.65		1.00		1.00			0.91	
Satd. Flow (perm)	1521	1881	1441	1140		1340		2227			2049	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	146	158	284	44	0	116	0	608	21	21	549	0
RTOR Reduction (vph)	0	0	45	0	0	29	0	2	0	0	0	0
Lane Group Flow (vph)	146	158	239	44	0	87	0	627	0	0	570	0
Confl. Peds. (#/hr)	142		138	138		138	137		173	173		137
Confl. Bikes (#/hr)			5						14			16
Heavy Vehicles (%)	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%
Turn Type	Perm		Perm	custom		custom				Perm		
Protected Phases		4						2			6	
Permitted Phases	4		4	8		8				6		
Actuated Green, G (s)	31.0	31.0	31.0	31.0		31.0		28.0			28.0	
Effective Green, g (s)	31.0	31.0	31.0	31.0		31.0		28.0			28.0	
Actuated g/C Ratio	0.48	0.48	0.48	0.48		0.48		0.43			0.43	
Clearance Time (s)	3.0	3.0	3.0	3.0		3.0		3.0			3.0	
Lane Grp Cap (vph)	725	897	687	544		639		959			883	
v/s Ratio Prot		0.08						c0.28				
v/s Ratio Perm	0.10		c0.17	0.04		0.06					0.28	
v/c Ratio	0.20	0.18	0.35	0.08		0.14		0.65			0.65	
Uniform Delay, d1	9.8	9.7	10.7	9.2		9.5		14.7			14.6	
Progression Factor	1.00	1.00	1.00	1.00		1.00		1.00			1.00	
Incremental Delay, d2	0.6	0.4	1.4	0.3		0.4		3.5			3.6	
Delay (s)	10.5	10.1	12.1	9.5		9.9		18.1			18.2	
Level of Service	B	B	B	A		A		B			B	
Approach Delay (s)		11.1			9.8			18.1			18.2	
Approach LOS		B			A			B			B	

Intersection Summary			
HCM Average Control Delay	15.4	HCM Level of Service	B
HCM Volume to Capacity ratio	0.49		
Actuated Cycle Length (s)	65.0	Sum of lost time (s)	6.0
Intersection Capacity Utilization	68.2%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

HCM Unsignalized Intersection Capacity Analysis
12: Prospect St & Panoramic Way

3/19/2013

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Volume (veh/h)	204	40	20	228	40	30
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.89	0.89	0.89	0.89	0.89	0.89
Hourly flow rate (vph)	229	45	22	256	45	34
Pedestrians	9			1		
Lane Width (ft)	12.0			12.0		
Walking Speed (ft/s)	4.0			4.0		
Percent Blockage	1			0		
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume			274		562	253
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			274		562	253
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			98		91	96
cM capacity (veh/h)			1295		478	788

Direction, Lane #	EB 1	WB 1	NB 1
Volume Total	274	279	79
Volume Left	0	22	45
Volume Right	45	0	34
cSH	1700	1295	575
Volume to Capacity	0.16	0.02	0.14
Queue Length 95th (ft)	0	1	12
Control Delay (s)	0.0	0.8	12.3
Lane LOS		A	B
Approach Delay (s)	0.0	0.8	12.3
Approach LOS			B

Intersection Summary			
Average Delay	1.9		
Intersection Capacity Utilization	39.3%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Sign Control	Stop		Stop			Stop
Volume (vph)	205	90	100	132	90	60
Peak Hour Factor	0.86	0.86	0.86	0.86	0.86	0.86
Hourly flow rate (vph)	238	105	116	153	105	70

Direction, Lane #	WB 1	NB 1	SB 1
Volume Total (vph)	343	270	174
Volume Left (vph)	238	0	105
Volume Right (vph)	105	153	0
Hadj (s)	0.01	-0.29	0.17
Departure Headway (s)	5.0	4.8	5.4
Degree Utilization, x	0.48	0.36	0.26
Capacity (veh/h)	677	706	623
Control Delay (s)	12.5	10.5	10.2
Approach Delay (s)	12.5	10.5	10.2
Approach LOS	B	B	B

Intersection Summary			
Delay	11.3		
HCM Level of Service	B		
Intersection Capacity Utilization	50.5%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Stop			Stop			Stop			Stop	
Volume (vph)	20	150	113	28	110	20	100	80	202	30	30	10
Peak Hour Factor	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93
Hourly flow rate (vph)	22	161	122	30	118	22	108	86	217	32	32	11

Direction, Lane #	EB 1	WB 1	NB 1	SB 1	SB 2
Volume Total (vph)	304	170	411	65	11
Volume Left (vph)	22	30	108	32	0
Volume Right (vph)	122	22	217	0	11
Hadj (s)	-0.21	-0.02	-0.25	0.12	-0.58
Departure Headway (s)	5.3	5.7	5.1	6.0	3.2
Degree Utilization, x	0.45	0.27	0.58	0.11	0.01
Capacity (veh/h)	629	570	669	502	1121
Control Delay (s)	12.5	10.8	14.8	9.8	6.2
Approach Delay (s)	12.5	10.8	14.8	9.3	
Approach LOS	B	B	B	A	

Intersection Summary			
Delay	12.9		
HCM Level of Service	B		
Intersection Capacity Utilization	53.3%	ICU Level of Service	A
Analysis Period (min)	15		

Near-Term (2018) Plus Additional Employment Alternative Conditions

FEHR PEERS

HCM Signalized Intersection Capacity Analysis
1: University Ave & Shattuck Ave

8/2/2013

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	130	435	180	31	356	250	0	0	0	40	711	114
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0			4.0	4.0					4.0	
Lane Util. Factor	1.00	0.95			0.91	0.91					0.91	
Frpb, ped/bikes	1.00	0.97			0.99	0.89					0.96	
Flpb, ped/bikes	0.95	1.00			1.00	1.00					0.99	
Frt	1.00	0.96			0.98	0.85					0.98	
Flt Protected	0.95	1.00			1.00	1.00					1.00	
Satd. Flow (prot)	1619	3152			3150	1230					4550	
Flt Permitted	0.44	1.00			0.88	1.00					1.00	
Satd. Flow (perm)	744	3152			2777	1230					4550	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	141	473	196	34	387	272	0	0	0	43	773	124
RTOR Reduction (vph)	0	3	0	0	10	108	0	0	0	0	23	0
Lane Group Flow (vph)	141	666	0	0	463	112	0	0	0	0	917	0
Confl. Peds. (#/hr)	108		102	102		108	353		194	194		353
Confl. Bikes (#/hr)			10			6			1			20
Heavy Vehicles (%)	6%	6%	6%	6%	6%	6%	6%	6%	6%	6%	6%	6%
Turn Type	Perm			Perm		Perm				Perm		
Protected Phases		4			8						6	
Permitted Phases	4			8		8				6		
Actuated Green, G (s)	46.0	46.0			46.0	46.0					36.0	
Effective Green, g (s)	46.0	46.0			46.0	46.0					36.0	
Actuated g/C Ratio	0.51	0.51			0.51	0.51					0.40	
Clearance Time (s)	4.0	4.0			4.0	4.0					4.0	
Lane Grp Cap (vph)	380	1611			1419	629					1820	
v/s Ratio Prot		c0.21										
v/s Ratio Perm	0.19				0.17	0.09					0.20	
v/c Ratio	0.37	0.41			0.33	0.18					0.50	
Uniform Delay, d1	13.3	13.6			12.9	11.8					20.3	
Progression Factor	1.00	1.00			1.39	3.18					0.66	
Incremental Delay, d2	2.8	0.8			0.6	0.6					0.9	
Delay (s)	16.0	14.4			18.5	38.3					14.3	
Level of Service	B	B			B	D					B	
Approach Delay (s)		14.7			24.8			0.0			14.3	
Approach LOS		B			C			A			B	

Intersection Summary			
HCM Average Control Delay	17.4	HCM Level of Service	B
HCM Volume to Capacity ratio	0.45		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	83.3%	ICU Level of Service	E
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	40	239	50	66	192	54	20	340	60	182	830	70
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0	4.0		4.0		4.0	4.0		4.0	4.0	
Lane Util. Factor		0.95	1.00		0.95		1.00	0.95		1.00	0.95	
Frpb, ped/bikes		1.00	0.88		0.99		1.00	0.99		1.00	0.99	
Flpb, ped/bikes		0.99	1.00		0.99		0.97	1.00		0.96	1.00	
Frt		1.00	0.85		0.97		1.00	0.98		1.00	0.99	
Flt Protected		0.99	1.00		0.99		0.95	1.00		0.95	1.00	
Satd. Flow (prot)		3461	1387		3301		1701	3377		1675	3425	
Flt Permitted		0.87	1.00		0.82		0.23	1.00		0.48	1.00	
Satd. Flow (perm)		3017	1387		2733		405	3377		852	3425	
Peak-hour factor, PHF	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93
Adj. Flow (vph)	43	257	54	71	206	58	22	366	65	196	892	75
RTOR Reduction (vph)	0	0	28	0	20	0	0	16	0	0	7	0
Lane Group Flow (vph)	0	300	26	0	315	0	22	415	0	196	960	0
Confl. Peds. (#/hr)	75		82	82		75	220		139	139		220
Confl. Bikes (#/hr)			64			7			5			18
Heavy Vehicles (%)	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%
Turn Type	Perm		Perm	Perm			Perm			Perm		
Protected Phases		4			8			2			6	
Permitted Phases	4		4	8			2			6		
Actuated Green, G (s)		32.0	32.0		32.0		50.0	50.0		50.0	50.0	
Effective Green, g (s)		32.0	32.0		32.0		50.0	50.0		50.0	50.0	
Actuated g/C Ratio		0.36	0.36		0.36		0.56	0.56		0.56	0.56	
Clearance Time (s)		4.0	4.0		4.0		4.0	4.0		4.0	4.0	
Lane Grp Cap (vph)		1073	493		972		225	1876		473	1903	
v/s Ratio Prot								0.12			c0.28	
v/s Ratio Perm		0.10	0.02		c0.12		0.05			0.23		
v/c Ratio		0.28	0.05		0.32		0.10	0.22		0.41	0.50	
Uniform Delay, d1		20.8	19.1		21.1		9.4	10.1		11.5	12.3	
Progression Factor		1.00	1.00		0.92		1.98	1.98		1.00	1.00	
Incremental Delay, d2		0.6	0.2		0.8		0.8	0.3		2.7	1.0	
Delay (s)		21.4	19.3		20.1		19.5	20.3		14.2	13.3	
Level of Service		C	B		C		B	C		B	B	
Approach Delay (s)		21.1			20.1			20.3			13.5	
Approach LOS		C			C			C			B	

Intersection Summary			
HCM Average Control Delay	16.9	HCM Level of Service	B
HCM Volume to Capacity ratio	0.43		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	115.1%	ICU Level of Service	H
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	412	20	230	10	20	20	120	370	10	30	750	76
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0			4.0		4.0	4.0		4.0	4.0	4.0
Lane Util. Factor	0.95	0.95			1.00		1.00	0.95		1.00	0.95	1.00
Frpb, ped/bikes	1.00	0.94			0.95		1.00	1.00		1.00	1.00	0.86
Flpb, ped/bikes	0.89	0.98			0.99		1.00	1.00		0.93	1.00	1.00
Frt	1.00	0.89			0.95		1.00	1.00		1.00	1.00	0.85
Flt Protected	0.95	0.99			0.99		0.95	1.00		0.95	1.00	1.00
Satd. Flow (prot)	1462	1399			1608		1736	3444		1617	3471	1332
Flt Permitted	0.78	0.92			0.92		0.95	1.00		0.50	1.00	1.00
Satd. Flow (perm)	1199	1303			1498		1736	3444		856	3471	1332
Peak-hour factor, PHF	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89
Adj. Flow (vph)	463	22	258	11	22	22	135	416	11	34	843	85
RTOR Reduction (vph)	0	102	0	0	15	0	0	2	0	0	0	35
Lane Group Flow (vph)	384	257	0	0	40	0	135	425	0	34	843	50
Confl. Peds. (#/hr)	136		77	77		136	135		85	85		135
Confl. Bikes (#/hr)			13			6			14			40
Heavy Vehicles (%)	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%
Turn Type	Perm			Perm			Prot			Perm		Perm
Protected Phases		4			8		5	2			6	
Permitted Phases	4			8						6		6
Actuated Green, G (s)	30.0	30.0			30.0		6.0	52.0		42.0	42.0	42.0
Effective Green, g (s)	30.0	30.0			30.0		6.0	52.0		42.0	42.0	42.0
Actuated g/C Ratio	0.33	0.33			0.33		0.07	0.58		0.47	0.47	0.47
Clearance Time (s)	4.0	4.0			4.0		4.0	4.0		4.0	4.0	4.0
Lane Grp Cap (vph)	400	434			499		116	1990		399	1620	622
v/s Ratio Prot							c0.08	0.12			c0.24	
v/s Ratio Perm	c0.32	0.20			0.03					0.04		0.04
v/c Ratio	0.96	0.59			0.08		1.16	0.21		0.09	0.52	0.08
Uniform Delay, d1	29.4	24.9			20.6		42.0	9.2		13.3	16.9	13.3
Progression Factor	0.70	0.52			1.00		1.00	1.00		0.47	0.46	0.28
Incremental Delay, d2	35.4	5.7			0.3		134.2	0.2		0.3	1.0	0.2
Delay (s)	56.0	18.6			20.9		176.2	9.4		6.6	8.8	4.0
Level of Service	E	B			C		F	A		A	A	A
Approach Delay (s)		37.9			20.9			49.5			8.3	
Approach LOS		D			C			D			A	

Intersection Summary			
HCM Average Control Delay	28.0	HCM Level of Service	C
HCM Volume to Capacity ratio	0.74		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	69.9%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	30	371	80	246	212	22	50	280	432	46	530	50
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	2.5	2.5		2.5	2.5		2.5	2.5	2.5		2.5	
Lane Util. Factor	1.00	0.95		0.91	0.91		1.00	0.95	1.00		0.95	
Frpb, ped/bikes	1.00	0.98		1.00	0.99		1.00	1.00	0.90		0.99	
Flpb, ped/bikes	1.00	1.00		1.00	1.00		0.97	1.00	1.00		1.00	
Frt	1.00	0.97		1.00	0.99		1.00	1.00	0.85		0.99	
Flt Protected	0.95	1.00		0.95	0.99		0.95	1.00	1.00		1.00	
Satd. Flow (prot)	1736	3296		1579	3213		1682	3471	1399		3368	
Flt Permitted	0.95	1.00		0.95	0.99		0.20	1.00	1.00		0.91	
Satd. Flow (perm)	1736	3296		1579	3213		351	3471	1399		3071	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	32	391	84	259	223	23	53	295	455	48	558	53
RTOR Reduction (vph)	0	20	0	0	6	0	0	0	326	0	7	0
Lane Group Flow (vph)	32	455	0	166	333	0	53	295	129	0	652	0
Confl. Peds. (#/hr)	132		112	112		132	97		82	82		97
Confl. Bikes (#/hr)			64			2						21
Heavy Vehicles (%)	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%
Turn Type	Split			Split			Perm		Perm	Perm		
Protected Phases	4	4		8	8			2			6	
Permitted Phases							2		2	6		
Actuated Green, G (s)	32.0	32.0		25.0	25.0		25.5	25.5	25.5		25.5	
Effective Green, g (s)	32.0	32.0		25.0	25.0		25.5	25.5	25.5		25.5	
Actuated g/C Ratio	0.36	0.36		0.28	0.28		0.28	0.28	0.28		0.28	
Clearance Time (s)	2.5	2.5		2.5	2.5		2.5	2.5	2.5		2.5	
Lane Grp Cap (vph)	617	1172		439	893		99	983	396		870	
v/s Ratio Prot	0.02	c0.14		c0.11	0.10			0.08				
v/s Ratio Perm							0.15		0.09		c0.21	
v/c Ratio	0.05	0.39		0.38	0.37		0.54	0.30	0.33		0.75	
Uniform Delay, d1	19.0	21.7		26.2	26.2		27.2	25.3	25.5		29.3	
Progression Factor	1.27	1.34		1.00	1.00		0.79	0.74	1.70		1.00	
Incremental Delay, d2	0.2	0.9		2.5	1.2		16.1	0.6	1.8		5.9	
Delay (s)	24.3	30.0		28.7	27.4		37.6	19.3	45.1		35.2	
Level of Service	C	C		C	C		D	B	D		D	
Approach Delay (s)		29.6			27.8			35.1			35.2	
Approach LOS		C			C			D			D	

Intersection Summary			
HCM Average Control Delay	32.5	HCM Level of Service	C
HCM Volume to Capacity ratio	0.50		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	7.5
Intersection Capacity Utilization	102.5%	ICU Level of Service	G
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (vph)	90	609	231	23	74	130
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0		4.0	
Lane Util. Factor	1.00	0.95	1.00		1.00	
Frpb, ped/bikes	1.00	1.00	0.95		0.88	
Flpb, ped/bikes	1.00	1.00	1.00		1.00	
Frt	1.00	1.00	0.99		0.91	
Flt Protected	0.95	1.00	1.00		0.98	
Satd. Flow (prot)	1703	3406	1685		1421	
Flt Permitted	0.95	1.00	1.00		0.98	
Satd. Flow (perm)	1703	3406	1685		1421	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	95	641	243	24	78	137
RTOR Reduction (vph)	0	0	5	0	83	0
Lane Group Flow (vph)	95	641	262	0	132	0
Confl. Peds. (#/hr)				283	133	133
Confl. Bikes (#/hr)				5		
Heavy Vehicles (%)	6%	6%	6%	6%	6%	6%
Turn Type	Prot					
Protected Phases	7	4	8		6	
Permitted Phases						
Actuated Green, G (s)	6.3	31.8	21.5		26.0	
Effective Green, g (s)	6.3	31.8	21.5		26.0	
Actuated g/C Ratio	0.10	0.48	0.33		0.40	
Clearance Time (s)	4.0	4.0	4.0		4.0	
Vehicle Extension (s)	3.0	3.0	3.0		3.0	
Lane Grp Cap (vph)	163	1646	551		561	
v/s Ratio Prot	c0.06	0.19	c0.16		c0.09	
v/s Ratio Perm						
v/c Ratio	0.58	0.39	0.47		0.24	
Uniform Delay, d1	28.5	10.8	17.7		13.3	
Progression Factor	1.00	1.00	1.00		1.00	
Incremental Delay, d2	5.2	0.7	2.9		1.0	
Delay (s)	33.7	11.5	20.6		14.3	
Level of Service	C	B	C		B	
Approach Delay (s)		14.4	20.6		14.3	
Approach LOS		B	C		B	

Intersection Summary			
HCM Average Control Delay	15.7	HCM Level of Service	B
HCM Volume to Capacity ratio	0.37		
Actuated Cycle Length (s)	65.8	Sum of lost time (s)	12.0
Intersection Capacity Utilization	45.7%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	20	292	311	32	56	11	97	161	255	28	217	30
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0	4.0		4.0	4.0		4.0			4.0	
Lane Util. Factor		1.00	1.00		1.00	1.00		1.00			1.00	
Frpb, ped/bikes		1.00	0.79		1.00	0.78		0.93			0.99	
Flpb, ped/bikes		0.99	1.00		0.96	1.00		0.99			1.00	
Frt		1.00	0.85		1.00	0.85		0.93			0.99	
Flt Protected		1.00	1.00		0.98	1.00		0.99			0.99	
Satd. Flow (prot)		1783	1214		1712	1201		1540			1741	
Flt Permitted		0.98	1.00		0.83	1.00		0.88			0.93	
Satd. Flow (perm)		1756	1214		1454	1201		1374			1630	
Peak-hour factor, PHF	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96
Adj. Flow (vph)	21	304	324	33	58	11	101	168	266	29	226	31
RTOR Reduction (vph)	0	0	165	0	0	7	0	55	0	0	7	0
Lane Group Flow (vph)	0	325	159	0	91	4	0	480	0	0	279	0
Confl. Peds. (#/hr)	100		95	95		100	51		59	59		51
Confl. Bikes (#/hr)			2									18
Heavy Vehicles (%)	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%
Turn Type	Perm		Perm	Perm		Perm	Perm			Perm		
Protected Phases		4			8			2			6	
Permitted Phases	4		4	8		8	2			6		
Actuated Green, G (s)		21.5	21.5		21.5	21.5		34.5			34.5	
Effective Green, g (s)		22.0	22.0		22.0	22.0		35.0			35.0	
Actuated g/C Ratio		0.34	0.34		0.34	0.34		0.54			0.54	
Clearance Time (s)		4.5	4.5		4.5	4.5		4.5			4.5	
Lane Grp Cap (vph)		594	411		492	406		740			878	
v/s Ratio Prot												
v/s Ratio Perm		c0.19	0.13		0.06	0.00		c0.35			0.17	
v/c Ratio		0.55	0.39		0.18	0.01		0.65			0.32	
Uniform Delay, d1		17.5	16.4		15.2	14.3		10.6			8.4	
Progression Factor		1.00	1.00		1.00	1.00		1.00			1.00	
Incremental Delay, d2		3.6	2.7		0.8	0.0		4.4			1.0	
Delay (s)		21.1	19.1		16.0	14.3		15.0			9.3	
Level of Service		C	B		B	B		B			A	
Approach Delay (s)		20.1			15.8			15.0			9.3	
Approach LOS		C			B			B			A	

Intersection Summary			
HCM Average Control Delay	16.1	HCM Level of Service	B
HCM Volume to Capacity ratio	0.61		
Actuated Cycle Length (s)	65.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	88.2%	ICU Level of Service	E
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Stop			Stop			Stop			Stop	
Volume (vph)	10	10	20	50	10	108	10	405	126	167	392	10
Peak Hour Factor	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94
Hourly flow rate (vph)	11	11	21	53	11	115	11	431	134	178	417	11

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total (vph)	43	179	576	605
Volume Left (vph)	11	53	11	178
Volume Right (vph)	21	115	134	11
Hadj (s)	-0.13	-0.21	-0.02	0.17
Departure Headway (s)	7.7	7.0	5.7	5.9
Degree Utilization, x	0.09	0.35	0.92	0.98
Capacity (veh/h)	443	499	615	605
Control Delay (s)	11.5	13.7	42.2	56.3
Approach Delay (s)	11.5	13.7	42.2	56.3
Approach LOS	B	B	E	F

Intersection Summary			
Delay	43.7		
HCM Level of Service	E		
Intersection Capacity Utilization	87.0%	ICU Level of Service	E
Analysis Period (min)	15		

Intersection	
Intersection Delay, s/veh	11.3
Intersection LOS	B

Approach	EB	WB	NB	SB
Entry Lanes	1	1	1	1
Conflicting Circle Lanes	1	1	1	1
Adj Approach Flow, veh/h	83	127	655	380
Demand Flow Rate, veh/h	86	133	682	396
Vehicles Circulating, veh/h	397	685	86	177
Vehicles Exiting, veh/h	176	83	397	641
Follow-Up Headway, s	3.186	3.186	3.186	3.186
Ped Vol Crossing Leg, #/h	1	59	7	5
Ped Cap Adj	1.000	0.992	0.999	0.999
Approach Delay, s/veh	6.1	9.9	13.6	8.9
Approach LOS	A	A	B	A

Lane	Left	Left	Left	Left
Designated Moves	LTR	LTR	LTR	LTR
Assumed Moves	LTR	LTR	LTR	LTR
RT Channelized				
Lane Util	1.000	1.000	1.000	1.000
Critical Headway, s	5.193	5.193	5.193	5.193
Entry Flow, veh/h	86	133	682	396
Cap Entry Lane, veh/h	760	570	1037	947
Entry HV Adj Factor	0.962	0.958	0.961	0.960
Flow Entry, veh/h	83	127	655	380
Cap Entry, veh/h	731	541	995	909
V/C Ratio	0.113	0.235	0.658	0.419
Control Delay, s/veh	6.1	9.9	13.6	8.9
LOS	A	A	B	A
95th %tile Queue, veh	0	1	5	2

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	177	133	150	31	0	50	0	681	14	10	280	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	3.0	3.0	3.0	3.0		3.0		3.0			3.0	
Lane Util. Factor	1.00	1.00	1.00	1.00		1.00		*0.60			*0.60	
Frpb, ped/bikes	1.00	1.00	0.95	1.00		0.94		1.00			1.00	
Flpb, ped/bikes	0.96	1.00	1.00	0.97		1.00		1.00			1.00	
Frt	1.00	1.00	0.85	1.00		0.85		1.00			1.00	
Flt Protected	0.95	1.00	1.00	0.95		1.00		1.00			1.00	
Satd. Flow (prot)	1695	1863	1505	1714		1487		2224			2230	
Flt Permitted	0.95	1.00	1.00	0.67		1.00		1.00			0.92	
Satd. Flow (perm)	1695	1863	1505	1209		1487		2224			2060	
Peak-hour factor, PHF	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98
Adj. Flow (vph)	181	136	153	32	0	51	0	695	14	10	286	0
RTOR Reduction (vph)	0	0	80	0	0	27	0	1	0	0	0	0
Lane Group Flow (vph)	181	136	73	32	0	24	0	708	0	0	296	0
Confl. Peds. (#/hr)	40		60	60		40	47		49	49		47
Confl. Bikes (#/hr)			1						13			
Turn Type	Perm		Perm	custom		custom				Perm		
Protected Phases		4						2			6	
Permitted Phases	4		4	8		8				6		
Actuated Green, G (s)	31.0	31.0	31.0	31.0		31.0		28.0			28.0	
Effective Green, g (s)	31.0	31.0	31.0	31.0		31.0		28.0			28.0	
Actuated g/C Ratio	0.48	0.48	0.48	0.48		0.48		0.43			0.43	
Clearance Time (s)	3.0	3.0	3.0	3.0		3.0		3.0			3.0	
Lane Grp Cap (vph)	808	889	718	577		709		958			887	
v/s Ratio Prot		0.07						c0.32				
v/s Ratio Perm	c0.11		0.05	0.03		0.02					0.14	
v/c Ratio	0.22	0.15	0.10	0.06		0.03		0.74			0.33	
Uniform Delay, d1	10.0	9.6	9.3	9.1		9.0		15.4			12.3	
Progression Factor	1.00	1.00	1.00	1.00		1.00		1.00			1.00	
Incremental Delay, d2	0.6	0.4	0.3	0.2		0.1		5.1			1.0	
Delay (s)	10.6	10.0	9.6	9.3		9.1		20.5			13.3	
Level of Service	B	A	A	A		A		C			B	
Approach Delay (s)		10.1			9.2			20.5			13.3	
Approach LOS		B			A			C			B	

Intersection Summary			
HCM Average Control Delay	15.4	HCM Level of Service	B
HCM Volume to Capacity ratio	0.47		
Actuated Cycle Length (s)	65.0	Sum of lost time (s)	6.0
Intersection Capacity Utilization	65.6%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Volume (veh/h)	231	30	12	102	50	34
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.82	0.82	0.82	0.82	0.82	0.82
Hourly flow rate (vph)	282	37	15	124	61	41
Pedestrians	2					
Lane Width (ft)	12.0					
Walking Speed (ft/s)	4.0					
Percent Blockage	0					
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume			318		456	300
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			318		456	300
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			99		89	94
cM capacity (veh/h)			1242		555	740

Direction, Lane #	EB 1	WB 1	NB 1
Volume Total	318	139	102
Volume Left	0	15	61
Volume Right	37	0	41
cSH	1700	1242	617
Volume to Capacity	0.19	0.01	0.17
Queue Length 95th (ft)	0	1	15
Control Delay (s)	0.0	0.9	12.0
Lane LOS		A	B
Approach Delay (s)	0.0	0.9	12.0
Approach LOS			B

Intersection Summary			
Average Delay	2.4		
Intersection Capacity Utilization	26.9%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Sign Control	Stop		Stop			Stop
Volume (vph)	94	90	60	205	90	20
Peak Hour Factor	0.95	0.95	0.95	0.95	0.95	0.95
Hourly flow rate (vph)	99	95	63	216	95	21

Direction, Lane #	WB 1	NB 1	SB 1
Volume Total (vph)	194	279	116
Volume Left (vph)	99	0	95
Volume Right (vph)	95	216	0
Hadj (s)	-0.12	-0.40	0.23
Departure Headway (s)	4.7	4.1	4.9
Degree Utilization, x	0.25	0.32	0.16
Capacity (veh/h)	717	832	688
Control Delay (s)	9.2	9.1	8.8
Approach Delay (s)	9.2	9.1	8.8
Approach LOS	A	A	A

Intersection Summary			
Delay	9.1		
HCM Level of Service	A		
Intersection Capacity Utilization	43.1%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Stop			Stop			Stop			Stop	
Volume (vph)	10	120	138	244	80	20	34	20	40	20	60	10
Peak Hour Factor	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88
Hourly flow rate (vph)	11	136	157	277	91	23	39	23	45	23	68	11

Direction, Lane #	EB 1	WB 1	NB 1	SB 1	SB 2
Volume Total (vph)	305	391	107	91	11
Volume Left (vph)	11	277	39	23	0
Volume Right (vph)	157	23	45	0	11
Hadj (s)	-0.28	0.12	-0.17	0.07	-0.58
Departure Headway (s)	4.7	5.0	5.6	5.9	3.2
Degree Utilization, x	0.40	0.54	0.17	0.15	0.01
Capacity (veh/h)	722	693	553	530	1121
Control Delay (s)	10.9	13.8	9.8	9.9	6.2
Approach Delay (s)	10.9	13.8	9.8	9.5	
Approach LOS	B	B	A	A	

Intersection Summary			
Delay	11.9		
HCM Level of Service	B		
Intersection Capacity Utilization	56.6%	ICU Level of Service	B
Analysis Period (min)	15		

HCM Signalized Intersection Capacity Analysis
1: University Ave & Shattuck Ave

8/2/2013

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	154	426	250	88	621	470	0	0	0	50	758	138
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0			4.0	4.0					4.0	
Lane Util. Factor	1.00	0.95			0.91	0.91					0.91	
Frpb, ped/bikes	1.00	0.91			0.97	0.69					0.94	
Flpb, ped/bikes	0.93	1.00			0.99	1.00					0.99	
Frt	1.00	0.94			0.98	0.85					0.98	
Flt Protected	0.95	1.00			0.99	1.00					1.00	
Satd. Flow (prot)	1622	3001			3150	986					4571	
Flt Permitted	0.25	1.00			0.76	1.00					1.00	
Satd. Flow (perm)	422	3001			2417	986					4571	
Peak-hour factor, PHF	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93
Adj. Flow (vph)	166	458	269	95	668	505	0	0	0	54	815	148
RTOR Reduction (vph)	0	0	0	0	10	193	0	0	0	0	24	0
Lane Group Flow (vph)	166	727	0	0	844	221	0	0	0	0	993	0
Confl. Peds. (#/hr)	323		260	260		323	783		278	278		783
Confl. Bikes (#/hr)			12			15						30
Heavy Vehicles (%)	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%
Turn Type	Perm			Perm		Perm				Perm		
Protected Phases		4			8						6	
Permitted Phases	4			8		8				6		
Actuated Green, G (s)	48.0	48.0			48.0	48.0					34.0	
Effective Green, g (s)	48.0	48.0			48.0	48.0					34.0	
Actuated g/C Ratio	0.53	0.53			0.53	0.53					0.38	
Clearance Time (s)	4.0	4.0			4.0	4.0					4.0	
Lane Grp Cap (vph)	225	1601			1289	526					1727	
v/s Ratio Prot		0.24										
v/s Ratio Perm	c0.39				0.35	0.22					0.22	
v/c Ratio	0.74	0.45			0.65	0.42					0.57	
Uniform Delay, d1	16.2	12.9			15.1	12.6					22.3	
Progression Factor	1.00	1.00			1.40	3.96					0.73	
Incremental Delay, d2	19.3	0.9			2.6	2.4					1.3	
Delay (s)	35.5	13.9			23.7	52.4					17.6	
Level of Service	D	B			C	D					B	
Approach Delay (s)		17.9			33.0			0.0			17.6	
Approach LOS		B			C			A			B	

Intersection Summary			
HCM Average Control Delay	23.8	HCM Level of Service	C
HCM Volume to Capacity ratio	0.67		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	85.5%	ICU Level of Service	E
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	70	172	50	156	337	180	40	600	44	84	580	50
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0	4.0		4.0		4.0	4.0		4.0	4.0	
Lane Util. Factor		0.95	1.00		0.95		1.00	0.95		1.00	0.95	
Frpb, ped/bikes		1.00	0.90		0.94		1.00	0.99		1.00	0.98	
Flpb, ped/bikes		0.99	1.00		0.99		0.91	1.00		0.95	1.00	
Frt		1.00	0.85		0.96		1.00	0.99		1.00	0.99	
Flt Protected		0.99	1.00		0.99		0.95	1.00		0.95	1.00	
Satd. Flow (prot)		3438	1426		3127		1605	3467		1678	3425	
Flt Permitted		0.65	1.00		0.79		0.36	1.00		0.35	1.00	
Satd. Flow (perm)		2284	1426		2502		605	3467		621	3425	
Peak-hour factor, PHF	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97
Adj. Flow (vph)	72	177	52	161	347	186	41	619	45	87	598	52
RTOR Reduction (vph)	0	0	20	0	42	0	0	6	0	0	7	0
Lane Group Flow (vph)	0	249	32	0	652	0	41	658	0	87	643	0
Confl. Peds. (#/hr)	186		99	99		186	417		236	236		417
Confl. Bikes (#/hr)			10			95			20			23
Turn Type	Perm		Perm	Perm			Perm			Perm		
Protected Phases		4			8			2			6	
Permitted Phases	4		4	8			2			6		
Actuated Green, G (s)		33.0	33.0		33.0		49.0	49.0		49.0	49.0	
Effective Green, g (s)		33.0	33.0		33.0		49.0	49.0		49.0	49.0	
Actuated g/C Ratio		0.37	0.37		0.37		0.54	0.54		0.54	0.54	
Clearance Time (s)		4.0	4.0		4.0		4.0	4.0		4.0	4.0	
Lane Grp Cap (vph)		837	523		917		329	1888		338	1865	
v/s Ratio Prot								c0.19			0.19	
v/s Ratio Perm		0.11	0.02		c0.26		0.07			0.14		
v/c Ratio		0.30	0.06		0.71		0.12	0.35		0.26	0.34	
Uniform Delay, d1		20.3	18.5		24.4		10.0	11.5		10.9	11.5	
Progression Factor		1.00	1.00		1.57		1.60	1.61		1.00	1.00	
Incremental Delay, d2		0.9	0.2		3.1		0.6	0.4		1.8	0.5	
Delay (s)		21.2	18.7		41.5		16.7	19.0		12.7	12.0	
Level of Service		C	B		D		B	B		B	B	
Approach Delay (s)		20.7			41.5			18.9			12.1	
Approach LOS		C			D			B			B	

Intersection Summary			
HCM Average Control Delay	23.5	HCM Level of Service	C
HCM Volume to Capacity ratio	0.49		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	109.7%	ICU Level of Service	H
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	298	30	300	10	30	30	200	680	20	30	630	162
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0			4.0		4.0	4.0		4.0	4.0	4.0
Lane Util. Factor	0.95	0.95			1.00		1.00	0.95		1.00	0.95	1.00
Frpb, ped/bikes	1.00	0.85			0.90		1.00	0.99		1.00	1.00	0.82
Flpb, ped/bikes	0.80	0.98			0.99		1.00	1.00		0.93	1.00	1.00
Frt	1.00	0.87			0.94		1.00	1.00		1.00	1.00	0.85
Flt Protected	0.95	1.00			0.99		0.95	1.00		0.95	1.00	1.00
Satd. Flow (prot)	1326	1277			1531		1752	3469		1628	3505	1286
Flt Permitted	0.75	0.98			0.94		0.95	1.00		0.38	1.00	1.00
Satd. Flow (perm)	1048	1251			1457		1752	3469		651	3505	1286
Peak-hour factor, PHF	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98
Adj. Flow (vph)	304	31	306	10	31	31	204	694	20	31	643	165
RTOR Reduction (vph)	0	174	0	0	20	0	0	2	0	0	0	75
Lane Group Flow (vph)	274	193	0	0	52	0	204	712	0	31	643	90
Confl. Peds. (#/hr)	254		187	187		254	179		132	132		179
Confl. Bikes (#/hr)			5			6			16			38
Heavy Vehicles (%)	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%
Turn Type	Perm			Perm			Prot			Perm		Perm
Protected Phases		4			8		5	2			6	
Permitted Phases	4			8						6		6
Actuated Green, G (s)	31.0	31.0			31.0		10.0	51.0		37.0	37.0	37.0
Effective Green, g (s)	31.0	31.0			31.0		10.0	51.0		37.0	37.0	37.0
Actuated g/C Ratio	0.34	0.34			0.34		0.11	0.57		0.41	0.41	0.41
Clearance Time (s)	4.0	4.0			4.0		4.0	4.0		4.0	4.0	4.0
Lane Grp Cap (vph)	361	431			502		195	1966		268	1441	529
v/s Ratio Prot							c0.12	0.21			c0.18	
v/s Ratio Perm	c0.26	0.15			0.04					0.05		0.07
v/c Ratio	0.76	0.45			0.10		1.05	0.36		0.12	0.45	0.17
Uniform Delay, d1	26.2	22.9			20.0		40.0	10.6		16.4	19.1	16.8
Progression Factor	0.69	0.45			1.00		1.00	1.00		0.42	0.47	0.32
Incremental Delay, d2	13.2	3.2			0.4		77.1	0.5		0.7	0.8	0.5
Delay (s)	31.2	13.5			20.5		117.1	11.1		7.6	9.8	5.9
Level of Service	C	B			C		F	B		A	A	A
Approach Delay (s)		21.1			20.5			34.7			8.9	
Approach LOS		C			C			C			A	

Intersection Summary			
HCM Average Control Delay	22.0	HCM Level of Service	C
HCM Volume to Capacity ratio	0.65		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	75.5%	ICU Level of Service	D
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	40	191	80	382	502	85	100	610	338	22	310	50
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	2.0	2.0		2.0	2.0		2.0	2.0			2.0	
Lane Util. Factor	1.00	0.95		0.91	0.91		1.00	0.95			0.95	
Frpb, ped/bikes	1.00	0.97		1.00	0.97		1.00	0.95			0.99	
Flpb, ped/bikes	1.00	1.00		1.00	1.00		0.95	1.00			1.00	
Frt	1.00	0.96		1.00	0.98		1.00	0.95			0.98	
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00			1.00	
Satd. Flow (prot)	1770	3294		1610	3210		1686	3197			3407	
Flt Permitted	0.95	1.00		0.95	1.00		0.38	1.00			0.71	
Satd. Flow (perm)	1770	3294		1610	3210		679	3197			2423	
Peak-hour factor, PHF	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94
Adj. Flow (vph)	43	203	85	406	534	90	106	649	360	23	330	53
RTOR Reduction (vph)	0	51	0	0	12	0	0	84	0	0	14	0
Lane Group Flow (vph)	43	237	0	337	681	0	106	925	0	0	392	0
Confl. Peds. (#/hr)	148		95	95		148	92		105	105		92
Confl. Bikes (#/hr)			6			86			14			9
Turn Type	Split			Split			Perm			Perm		
Protected Phases	4	4		8	8			2			6	
Permitted Phases							2			6		
Actuated Green, G (s)	34.0	34.0		24.0	24.0		26.0	26.0			26.0	
Effective Green, g (s)	34.0	34.0		24.0	24.0		26.0	26.0			26.0	
Actuated g/C Ratio	0.38	0.38		0.27	0.27		0.29	0.29			0.29	
Clearance Time (s)	2.0	2.0		2.0	2.0		2.0	2.0			2.0	
Lane Grp Cap (vph)	669	1244		429	856		196	924			700	
v/s Ratio Prot	0.02	c0.07		0.21	c0.21			c0.29				
v/s Ratio Perm							0.16				0.16	
v/c Ratio	0.06	0.19		0.79	0.80		0.54	1.00			0.56	
Uniform Delay, d1	17.9	18.8		30.6	30.7		27.0	32.0			27.2	
Progression Factor	1.46	1.71		1.00	1.00		0.78	0.78			1.00	
Incremental Delay, d2	0.2	0.3		13.5	7.5		9.5	28.6			3.2	
Delay (s)	26.2	32.4		44.1	38.3		30.4	53.6			30.4	
Level of Service	C	C		D	D		C	D			C	
Approach Delay (s)		31.6			40.2			51.4			30.4	
Approach LOS		C			D			D			C	

Intersection Summary			
HCM Average Control Delay	42.2	HCM Level of Service	D
HCM Volume to Capacity ratio	0.60		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	6.0
Intersection Capacity Utilization	113.2%	ICU Level of Service	H
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (vph)	120	282	479	72	63	90
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0		4.0	
Lane Util. Factor	1.00	0.95	1.00		1.00	
Frpb, ped/bikes	1.00	1.00	0.92		0.84	
Flpb, ped/bikes	1.00	1.00	1.00		1.00	
Frt	1.00	1.00	0.98		0.92	
Flt Protected	0.95	1.00	1.00		0.98	
Satd. Flow (prot)	1719	3438	1633		1372	
Flt Permitted	0.95	1.00	1.00		0.98	
Satd. Flow (perm)	1719	3438	1633		1372	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	126	297	504	76	66	95
RTOR Reduction (vph)	0	0	8	0	60	0
Lane Group Flow (vph)	126	297	572	0	101	0
Confl. Peds. (#/hr)				420	186	186
Confl. Bikes (#/hr)				32		
Heavy Vehicles (%)	5%	5%	5%	5%	5%	5%
Turn Type	Prot					
Protected Phases	7	4	8		6	
Permitted Phases						
Actuated Green, G (s)	6.4	36.8	26.4		26.0	
Effective Green, g (s)	6.4	36.8	26.4		26.0	
Actuated g/C Ratio	0.09	0.52	0.37		0.37	
Clearance Time (s)	4.0	4.0	4.0		4.0	
Vehicle Extension (s)	3.0	3.0	3.0		3.0	
Lane Grp Cap (vph)	155	1787	609		504	
v/s Ratio Prot	c0.07	0.09	c0.35		c0.07	
v/s Ratio Perm						
v/c Ratio	0.81	0.17	0.94		0.20	
Uniform Delay, d1	31.6	8.9	21.4		15.3	
Progression Factor	1.00	1.00	1.00		1.00	
Incremental Delay, d2	26.7	0.2	24.4		0.9	
Delay (s)	58.3	9.1	45.8		16.2	
Level of Service	E	A	D		B	
Approach Delay (s)		23.8	45.8		16.2	
Approach LOS		C	D		B	

Intersection Summary			
HCM Average Control Delay	33.7	HCM Level of Service	C
HCM Volume to Capacity ratio	0.60		
Actuated Cycle Length (s)	70.8	Sum of lost time (s)	12.0
Intersection Capacity Utilization	61.0%	ICU Level of Service	B
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	20	45	260	121	227	28	84	236	211	21	191	10
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0	4.0		4.0	4.0		4.0			4.0	
Lane Util. Factor		1.00	1.00		1.00	1.00		1.00			1.00	
Frpb, ped/bikes		1.00	0.76		1.00	0.70		0.92			0.99	
Flpb, ped/bikes		0.96	1.00		0.93	1.00		0.98			1.00	
Frt		1.00	0.85		1.00	0.85		0.95			0.99	
Flt Protected		0.98	1.00		0.98	1.00		0.99			1.00	
Satd. Flow (prot)		1751	1191		1685	1105		1572			1799	
Flt Permitted		0.86	1.00		0.86	1.00		0.91			0.94	
Satd. Flow (perm)		1532	1191		1479	1105		1443			1692	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	22	49	283	132	247	30	91	257	229	23	208	11
RTOR Reduction (vph)	0	0	182	0	0	10	0	34	0	0	2	0
Lane Group Flow (vph)	0	71	101	0	379	20	0	543	0	0	240	0
Confl. Peds. (#/hr)	121		102	102		121	82		75	75		82
Confl. Bikes (#/hr)			2			21			17			6
Heavy Vehicles (%)	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%
Turn Type	Perm		Perm	Perm		Perm	Perm			Perm		
Protected Phases		4			8			2			6	
Permitted Phases	4		4	8		8	2			6		
Actuated Green, G (s)		24.5	24.5		24.5	24.5		36.5			36.5	
Effective Green, g (s)		25.0	25.0		25.0	25.0		37.0			37.0	
Actuated g/C Ratio		0.36	0.36		0.36	0.36		0.53			0.53	
Clearance Time (s)		4.5	4.5		4.5	4.5		4.5			4.5	
Lane Grp Cap (vph)		547	425		528	395		763			894	
v/s Ratio Prot												
v/s Ratio Perm		0.05	0.08		c0.26	0.02		c0.38			0.14	
v/c Ratio		0.13	0.24		0.72	0.05		0.71			0.27	
Uniform Delay, d1		15.2	15.8		19.5	14.7		12.5			9.1	
Progression Factor		1.00	1.00		1.00	1.00		1.00			1.00	
Incremental Delay, d2		0.5	1.3		8.1	0.2		5.6			0.7	
Delay (s)		15.7	17.1		27.6	15.0		18.1			9.8	
Level of Service		B	B		C	B		B			A	
Approach Delay (s)		16.8			26.7			18.1			9.8	
Approach LOS		B			C			B			A	

Intersection Summary			
HCM Average Control Delay	18.7	HCM Level of Service	B
HCM Volume to Capacity ratio	0.71		
Actuated Cycle Length (s)	70.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	80.6%	ICU Level of Service	D
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Stop			Stop			Stop			Stop	
Volume (vph)	30	20	20	141	10	190	10	311	42	111	461	10
Peak Hour Factor	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98
Hourly flow rate (vph)	31	20	20	144	10	194	10	317	43	113	470	10

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total (vph)	71	348	370	594
Volume Left (vph)	31	144	10	113
Volume Right (vph)	20	194	43	10
Hadj (s)	-0.03	-0.20	-0.01	0.08
Departure Headway (s)	7.9	6.7	6.6	6.3
Degree Utilization, x	0.16	0.65	0.68	1.05
Capacity (veh/h)	390	517	529	560
Control Delay (s)	12.4	21.3	22.2	75.5
Approach Delay (s)	12.4	21.3	22.2	75.5
Approach LOS	B	C	C	F

Intersection Summary			
Delay	44.3		
HCM Level of Service	E		
Intersection Capacity Utilization	89.5%	ICU Level of Service	E
Analysis Period (min)	15		

Intersection	
Intersection Delay, s/veh	18.0
Intersection LOS	C

Approach	EB	WB	NB	SB
Entry Lanes	1	1	1	1
Conflicting Circle Lanes	1	1	1	1
Adj Approach Flow, veh/h	138	220	537	673
Demand Flow Rate, veh/h	141	224	548	687
Vehicles Circulating, veh/h	674	537	151	309
Vehicles Exiting, veh/h	322	162	664	452
Follow-Up Headway, s	3.186	3.186	3.186	3.186
Ped Vol Crossing Leg, #/h	210	9	117	78
Ped Cap Adj	0.965	0.999	0.979	0.989
Approach Delay, s/veh	10.1	10.1	11.9	27.0
Approach LOS	B	B	B	D

Lane	Left	Left	Left	Left
Designated Moves	LTR	LTR	LTR	LTR
Assumed Moves	LTR	LTR	LTR	LTR
RT Channelized				
Lane Util	1.000	1.000	1.000	1.000
Critical Headway, s	5.193	5.193	5.193	5.193
Entry Flow, veh/h	141	224	548	687
Cap Entry Lane, veh/h	576	660	972	830
Entry HV Adj Factor	0.978	0.981	0.981	0.980
Flow Entry, veh/h	138	220	537	673
Cap Entry, veh/h	544	647	932	805
V/C Ratio	0.254	0.340	0.576	0.837
Control Delay, s/veh	10.1	10.1	11.9	27.0
LOS	B	B	B	D
95th %tile Queue, veh	1	2	4	10

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	130	121	220	43	0	100	0	500	11	20	465	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	3.0	3.0	3.0	3.0		3.0		3.0			3.0	
Lane Util. Factor	1.00	1.00	1.00	1.00		1.00		*0.60			*0.60	
Frpb, ped/bikes	1.00	1.00	0.91	1.00		0.85		0.99			1.00	
Flpb, ped/bikes	0.87	1.00	1.00	0.94		1.00		1.00			1.00	
Frt	1.00	1.00	0.85	1.00		0.85		1.00			1.00	
Flt Protected	0.95	1.00	1.00	0.95		1.00		1.00			1.00	
Satd. Flow (prot)	1553	1881	1456	1672		1367		2238			2245	
Flt Permitted	0.95	1.00	1.00	0.68		1.00		1.00			0.91	
Satd. Flow (perm)	1553	1881	1456	1189		1367		2238			2056	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	137	127	232	45	0	105	0	526	12	21	489	0
RTOR Reduction (vph)	0	0	61	0	0	44	0	2	0	0	0	0
Lane Group Flow (vph)	137	127	171	45	0	61	0	536	0	0	510	0
Confl. Peds. (#/hr)	125		122	122		122	121		153	153		121
Confl. Bikes (#/hr)			5						13			14
Heavy Vehicles (%)	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%
Turn Type	Perm		Perm	custom		custom				Perm		
Protected Phases		4						2			6	
Permitted Phases	4		4	8		8				6		
Actuated Green, G (s)	31.0	31.0	31.0	31.0		31.0		28.0			28.0	
Effective Green, g (s)	31.0	31.0	31.0	31.0		31.0		28.0			28.0	
Actuated g/C Ratio	0.48	0.48	0.48	0.48		0.48		0.43			0.43	
Clearance Time (s)	3.0	3.0	3.0	3.0		3.0		3.0			3.0	
Lane Grp Cap (vph)	741	897	694	567		652		964			886	
v/s Ratio Prot		0.07						0.24				
v/s Ratio Perm	0.09		c0.12	0.04		0.04					c0.25	
v/c Ratio	0.18	0.14	0.25	0.08		0.09		0.56			0.58	
Uniform Delay, d1	9.8	9.5	10.1	9.2		9.3		13.8			14.0	
Progression Factor	1.00	1.00	1.00	1.00		1.00		1.00			1.00	
Incremental Delay, d2	0.6	0.3	0.8	0.3		0.3		2.3			2.7	
Delay (s)	10.3	9.9	10.9	9.5		9.6		16.2			16.7	
Level of Service	B	A	B	A		A		B			B	
Approach Delay (s)		10.5			9.6			16.2			16.7	
Approach LOS		B			A			B			B	

Intersection Summary			
HCM Average Control Delay	14.1	HCM Level of Service	B
HCM Volume to Capacity ratio	0.40		
Actuated Cycle Length (s)	65.0	Sum of lost time (s)	6.0
Intersection Capacity Utilization	66.7%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Volume (veh/h)	182	40	31	212	40	32
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.89	0.89	0.89	0.89	0.89	0.89
Hourly flow rate (vph)	204	45	35	238	45	36
Pedestrians	8			1		
Lane Width (ft)	12.0			12.0		
Walking Speed (ft/s)	4.0			4.0		
Percent Blockage	1			0		
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume			249		543	228
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			249		543	228
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			97		91	96
cM capacity (veh/h)			1322		486	813

Direction, Lane #	EB 1	WB 1	NB 1
Volume Total	249	273	81
Volume Left	0	35	45
Volume Right	45	0	36
cSH	1700	1322	592
Volume to Capacity	0.15	0.03	0.14
Queue Length 95th (ft)	0	2	12
Control Delay (s)	0.0	1.2	12.0
Lane LOS		A	B
Approach Delay (s)	0.0	1.2	12.0
Approach LOS			B

Intersection Summary			
Average Delay	2.2		
Intersection Capacity Utilization	39.1%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Sign Control	Stop		Stop			Stop
Volume (vph)	204	80	90	124	80	50
Peak Hour Factor	0.86	0.86	0.86	0.86	0.86	0.86
Hourly flow rate (vph)	237	93	105	144	93	58

Direction, Lane #	WB 1	NB 1	SB 1
Volume Total (vph)	330	249	151
Volume Left (vph)	237	0	93
Volume Right (vph)	93	144	0
Hadj (s)	0.03	-0.30	0.17
Departure Headway (s)	4.9	4.7	5.3
Degree Utilization, x	0.45	0.32	0.22
Capacity (veh/h)	692	720	633
Control Delay (s)	11.9	9.9	9.8
Approach Delay (s)	11.9	9.9	9.8
Approach LOS	B	A	A

Intersection Summary			
Delay	10.8		
HCM Level of Service	B		
Intersection Capacity Utilization	47.5%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Stop			Stop			Stop			Stop	
Volume (vph)	10	120	64	30	90	20	105	70	208	20	20	10
Peak Hour Factor	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93
Hourly flow rate (vph)	11	129	69	32	97	22	113	75	224	22	22	11

Direction, Lane #	EB 1	WB 1	NB 1	SB 1	SB 2
Volume Total (vph)	209	151	412	43	11
Volume Left (vph)	11	32	113	22	0
Volume Right (vph)	69	22	224	0	11
Hadj (s)	-0.17	-0.03	-0.25	0.12	-0.58
Departure Headway (s)	5.1	5.3	4.7	5.6	3.2
Degree Utilization, x	0.30	0.22	0.54	0.07	0.01
Capacity (veh/h)	639	613	730	571	1121
Control Delay (s)	10.3	9.9	12.9	9.0	6.2
Approach Delay (s)	10.3	9.9	12.9	8.4	
Approach LOS	B	A	B	A	

Intersection Summary			
Delay	11.4		
HCM Level of Service	B		
Intersection Capacity Utilization	53.3%	ICU Level of Service	A
Analysis Period (min)	15		

Appendix G

Coastal Terrace Prairie Management Plan

Richmond Bay Campus Coastal Terrace Prairie Management Plan

Prepared for

University of California, Berkeley

by

Mark R. Stromberg

April 16, 2014

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1.0 Introduction

1.1 Background

This is the first iteration of a comprehensive resource management plan for the Coastal Terrace Prairie at the proposed Richmond Bay Campus (RBC). As of spring 2014, management of the resource has largely consisted of mowing to reduce invasive plant species and efforts to minimize disturbance of the area, along with some notable small scale research and restoration efforts. The Coastal Terrace Prairie is a key feature of the upland portion of the Natural Open Space area in the Richmond Bay Campus 2014 Long Range Development Plan. The Management Plan is intended to help protect and restore this area in keeping with objectives of the Long Range Development Plan to establish an appealing and inspirational character for the new campus, sensitive and responsible to its natural environment.

This Management Plan anticipates that implementation of the Richmond Bay Campus, and implementation of this Management Plan, will occur at varying degrees of intensity over time. During periods of limited development at the RBC and limited resources for stewardship, steps can nonetheless be taken to reduce the threat of invasive plant species, as described elsewhere (Farrell et al. 2007, Cai et al. 2012). As development at the RBC proceeds, as open space areas outside the Natural Open Space are developed or altered, sod salvage and other more intensive management practices can proceed.

Historically, the Richmond Field Station portion of the Richmond Bay Campus housed companies involved in explosives manufacturing, and some contaminants remain in soil and groundwater. Any activity under this Management Plan must be undertaken with full cognizance of the history of the site, and in accordance with soil management plans approved by regulatory agencies. This Management Plan does not provide authority to undertake any action; activities can only be undertaken with full review and approval of the University, which is responsible for ensuring compliance with regulatory requirements.

1.1.a. Definition of the Units for Conservation and Management

The University of California acquired the Richmond Field Station of the Richmond Bay Campus (RBC) lands in the 1950s, and recently is involved in a planning process for development of new facilities. Part of the Richmond Bay Campus land contains relict areas of an assembly of plants in a natural community, an example of a "coastal terrace prairie". Although no federal or state-listed protected species occur on the site, this relict coastal terrace prairie is considered a "sensitive natural community" under widely used CEQA guidelines.

This natural grassland community has been finely divided by past land use, so some consideration should be given to define what is meant by an occurrence of an intact "coastal terrace grassland" and occurrences of small shreds of the natural community, each with only a few native plants.

Immediate shorelines of Richmond, California were open grasslands before European settlement from 1845-1900, and were dominated by a complex of plant species that included California Oat Grass (Danthonia californica) and Purple Needle Grass (Nassella pulchra). A square meter of undisturbed, native coastal terrace prairie may be home to over 20 native plant species, and these grasslands may have over 100 species in a hectare (Stromberg et al. 2001). These dominant grasses are part of a much richer assembly of native flowering plants (Stromberg et al. 2001) that are collectively recognized as a unique plant community, California's "coastal terrace prairie" (Barbour et al. 2007). Plant ecologists in California have used several methods to define and describe native plant communities, largely initiated in the 1940s as the Wieslander Vegetation Type Map ("VTM") survey, with units of about 40 acres (Barbour et al. 2007) grouped into about 23 units. In the 1970s, California used a minimum mapping unit of 400-800 acres in the CalVeg system with 220 distinct plant community names. In the 1990's, California participated in the national GAP analysis system to classify plant communities based on a minimum mapping unit of 247 ac. into many thousand of named map polygons (Barbour et al. 2007). By the late 1990s, an effort led by the California Native Plant Society (CNPS), working with The Nature Conservancy (TNC) and the Ecological Society of America (ESA) developed an integrated vegetation mapping and classification system (Barbour et al. 2007). Based on this work, the International Terrestrial Ecological System Classification was developed based on vegetation community units from 2.5 ac to 2500 acres (NatureServe 2014). By 2011, CNPS developed widely used guidelines for mapping rare vegetation (CNPS 2011) with a minimum mapping unit of 0.25 to 0.5 acre. This reflects the general practice in plant ecology of working from natural units that are large enough to be relatively consistent in relative abundance of the same plant species across what is often called a "stand" or unit of vegetation classification (Mueller-Dombois and Ellenberg 1974).

A re-analysis of data from 32 relict coastal terrace prairies (Stromberg et al. 1996) reveals that representative coastal terrace prairies are defined as those areas where *Nassella pulchra* and/or *Danthonia californica* are the dominant native grasses and average total canopy cover of native plants is 57% (42% grass) and the average total canopy cover of non-native plants is 44% (33% grass). Even the best remaining examples of California coastal terrace prairies are invaded by non-native plants. Coastal terrace prairies are dominated by grasses but can be quite showy in late spring. Grasses provide the matrix and fibrous underpinning of the coastal terrace prairie community.

Within the identified Natural Open Space area, the least disturbed coastal prairie contains 50% cover of native prairie species. In some areas native vegetation constitutes up to 100% of vegetative cover (Wildlife RA 2014).

1.2 Management Goals

UC Berkeley's goal is to restore and manage approximately 15 acres of contiguous relict coastal grassland on the Richmond Bay Campus. The University recognizes that very small polygons (from a few square centimeters to a few square meters) can occur anywhere on the RBC site and may include some of the indicator species for "coastal terrace prairie" but these occurrences are too small to define a "stand" or minimum mapping unit of this "sensitive natural community" (see 1.1.a. above). The decision to distinguish these occurrences from the core "stands" of this named plant community, as done in studies prepared for the University, and reflected in the EIR, is supportable under CEQA, and under CDFW guidance for evaluating impacts to sensitive natural communities.

These small occurrences or patches of native vegetation, which are often too small to contain the broad array of up to 100 plant species that define the coastal terrace prairie community, can continue to have a role in preserving the overall biodiversity of the RBC. These can serve as source plant material for restoration of the 15 acre coastal prairie. Relict coastal prairie anywhere on the RBC with cover of over 50% of native plants and not more than 30% cover of non-native plants, can be salvaged. See section 3.3, Plant Material Salvage, below.

UC Berkeley has committed to maintain as much of the natural diversity and ecosystem processes as possible as the site includes a significant example, however degraded, of the former grassland and marshes that were the pre-settlement natural community. Teaching, research and outreach will be integral parts of the ongoing maintenance of the ecosystem processes of this relict grassland area.

2.0 Project Description

2.1 Land-Use History

From the gold rush in 1849 to rapid urbanization after World War II, a variety of low-density housing and industrial use slowly dissected the larger prairie on the RBC.

This site has been impacted by many roads, industrial waste and building sites since pre-settlement times. From 1840-1950, the site has been a part of gradual change of a broad, open grassland leading directly to tidal marshes and wetlands, into an industrial area. The nature of the area is shown in Figures 1 through 3 during settlement. Note the open grassland leading to the edge of San Francisco Bay. Open spaces, even

where *Danthonia* or *Nassella* may occur, are often previously occupied by buildings, roads, or railroads, and may include soils with various chemical wastes.

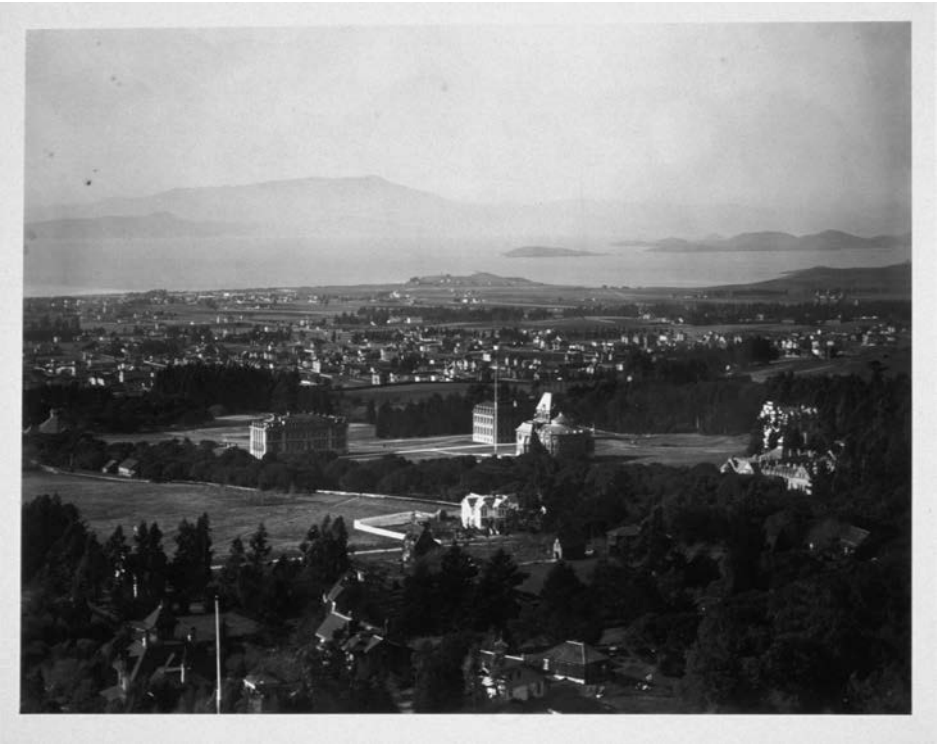

Figure 1. Richmond area as seen from UC Berkeley Campus, c. 1880. University of California, Berkeley, Bancroft Library.

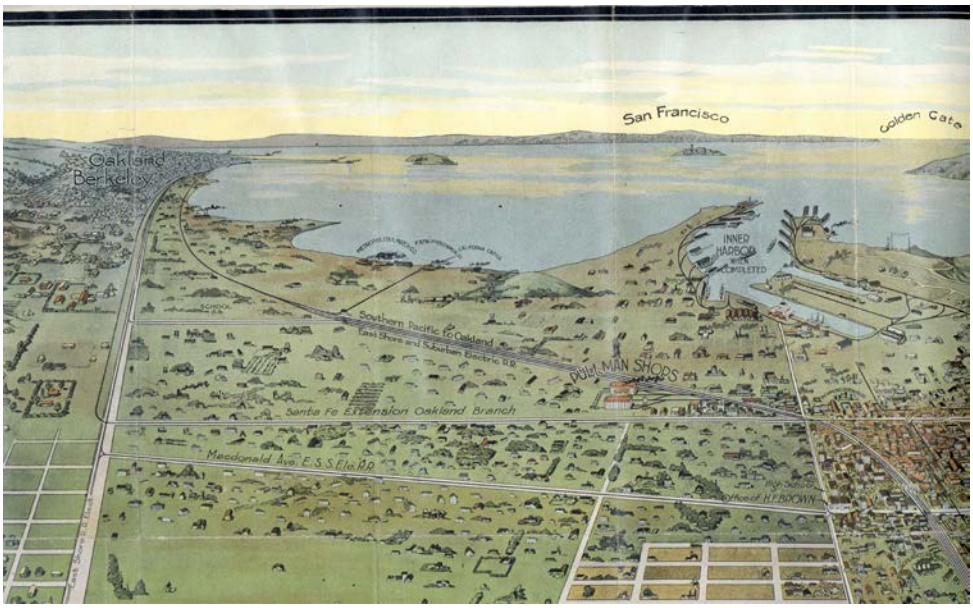

Figure 2. Richmond area, 1911. Bird's eye view painting for real estate development description. Source: UC Berkeley Earth Sciences and Map Library.

Figure 3. Lucol Plant (predecessor to the California Cap Company) on RBC. Source: University of California, Berkeley, Bancroft Library Oliver Family Photographic Collection.

As the land in the current RBC was developed (Figures 2 through 5), it was at various times covered with wagon roads, railroads, buildings and soil disposal sites.

Portions of the RBC were heavily used for housing and industry. This historic land use left small patches of grasslands in the core of the industrial area, often on the scale of urban lawns or small parking lots. Open grassland in this portion of the RBC site was used to store explosives and chemicals, and reported to have pyrite cinders used for fill, berms, and as weed control around buildings (2008 Current Conditions Report, Tetra Tech).

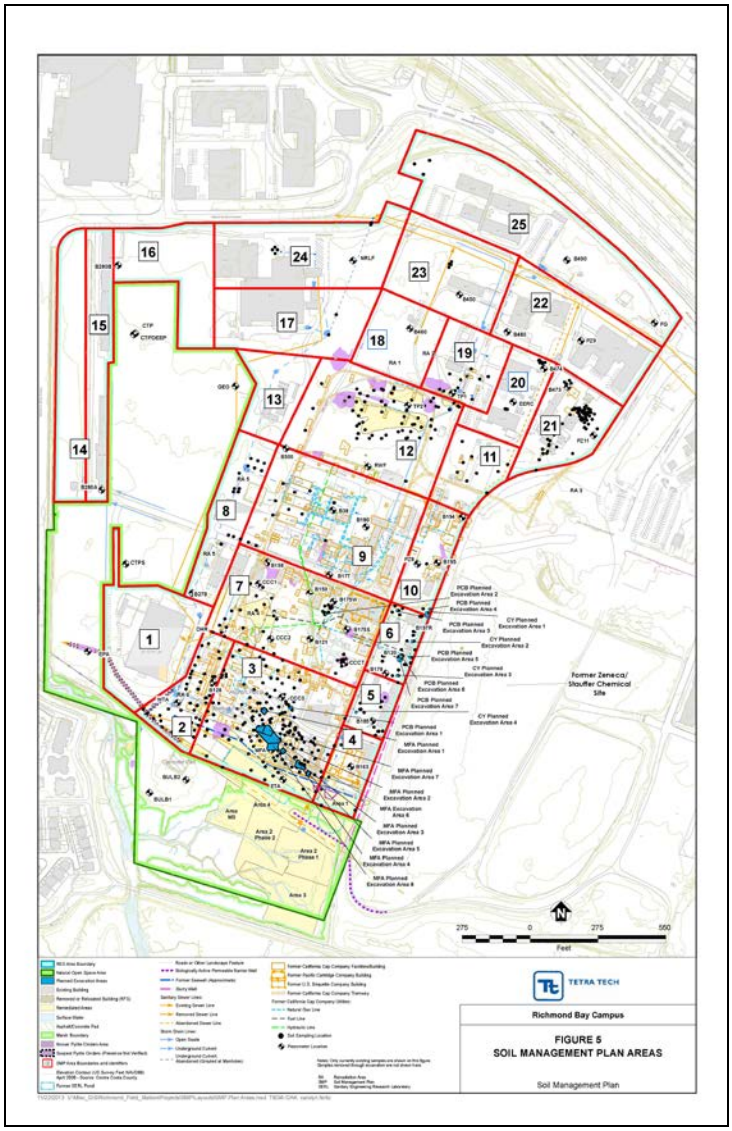

Figure 4. Land-use history of the RBC. Previous and current building and structures are outlined. Some small patches of native species remain in the many small interstitial spaces in the eastern parts of the RBC. One large stand of native coast terrace prairie persists on the western areas of the RBC. Source: Fig 5 "Soil Management Plans Areas" from the Public Draft Removal Action Workplan, Attachment C Soils Management Plan (Tetra Tech November 25, 2013). http://rfs-env.berkeley.edu/documents/PublicDraftRAW_11-25-13_000.pdf

Figure 5. Map showing some historic land uses on the RBC. Source: Figure 2-4 Location of Former and Current Facilities in the Southern and Northern Portions of the Site, from the Public Draft Removal Action Workplan (Tetra Tech November 25, 2013).

2.2 Site Description

A wide variety of non-native plants were introduced to the site, both reflecting the larger invasion of California's grasslands (Biswell 1956, Stromberg et al. 2007a), and the local horticultural practices associated with houses and light industrial parks. Some of these introduced plants are highly competitive and can displace the native grasses

and flowers. Many of these (Farrell et al. 2007) will require ongoing efforts to reduce their relative abundance (e.g. Harding grass, *Phalaris aquatica*).

Hydrology of the site was not substantially altered locally, as the deep drainage ditch and several smaller drains are lined with cement, primarily carrying water through the site from developed sites higher in the watershed. The heavy clay soils were not tiled or drained in the core area of coastal terrace prairie. The stand of coastal terrace prairie ("Big Meadow") is surviving without additional irrigation, and thus suggests that the immediate soil moisture and hydrology regime is still adequate to support the grassland. Elevation varies from about 5 to 15 feet above sea level, and small areas of jurisdictional wetlands, with associated wetland species, have been mapped in the larger stand of coastal terrace prairie. Perched water tables, either on clay or hardpan of rock, are typical of coastal terrace prairies so small included wetlands are common elsewhere in these grasslands.

An area of about 10 acres, with about 6.5 acres of relative intact patches of native grassland exists in the northwest parts of the site (Amme, 2005) (Figure 4). This core area remained relatively undisturbed although bisected by building sites, piles of spoils, roads and cement sidewalks. For the past 20 years, a series of biologists have visited the site and a list of plant and animal species was compiled for both this area and the surrounding patches between the built environment (Figures 4, 5). The dominant native grasses are purple needle grass, *Nassella pulchra*, and California oat grass, *Danthonia californica*. These co-occurrence of these two grasses as dominants is used to classify the community of plants as a native coastal grassland (Barbour et al. 2007). No listed rare or endangered plant or animal species (State of California or Federal) have been observed in this portion of the RBC.

2.2.a. Population and Species Stability

Scattered grassland patches collectively on the site have been thoroughly disturbed since the turn of the century (Amme, 2005), but still include populations of grass plants that are very long-lived. Individuals of *Nassella pulchra* were tagged and followed for 40 years elsewhere in coastal California and there was essentially no death of established individuals. Population analysis suggests that the minimum ages of individual plants exceeds 200 years (Hamilton et al. 2002) and may be much longer, as the population had only been tracked 40 years. Individual patches of flowers and bulbs have been informally tracked and individually marked plants persist at least 10-15 years (e.g., *Sisyrichium bellum*, pers. obs.).

In addition to being long-lived, the grasses of the coastal terrace prairie can tolerate repeated removal of the above-ground vegetation. The growing points of these native grasses are a few inches below ground. Thus, they are very tolerant of foot traffic and can tolerate frequent fires. Tillage however will destroy the growing point and

eliminate the long-lived individual grass plants. For a long time, California's Indians burned the coastal grasslands, keeping the native shrubs (eg. *Baccharis* spp., coyote brush) and trees (Monterey Pine, Douglas Fir) from invading the grasslands (Greenlee and Langenheim 1990). The long roots of these grasses (up to 6 feet) can reach water deep in even clay soils in the dry seasons (Figure 6). Plowing or discing effectively destroys the native grass sod and they have almost no ability to spread and re-establish, even on reserves over 75 years (Stromberg and Griffin 1996).

Figure 6. *Danthonia californica*, California Oat Grass with roots and above-ground leaves. Smaller fine roots and root hairs could not be recovered, and extended much further into the soil. Specimens from Richmond area. This display, about 2 m. tall, was at the Oakland Museum, Oakland, CA.

2.2.b. Species Diversity

Species diversity is measured by a simple count of different species observed. Thus, either the larger the area one examines, or the more time one spends searching will result in a higher count. Further, California has a highly variable climate with

"good" and "bad" years for specific plants. For example, a dry winter and wet spring might result in an 11-fold increase in one year for lupines (Knops and Barthell 1996) in places where in a previous year very few were seen. Some plants are only seen every few years. Several relatively open areas in the RBC as well as the larger NW meadow have been inventoried over the last 20 years for occurrence of plant species (Lidicker et al. 2003). The number of species in a coastal grassland has been surveyed elsewhere in California (Stromberg et al. 2001) but each of these reference sites were only visited one day for a few hours. The reference areas of other California coastal terrace grasslands where *Danthonia* and *Nassella* occur, were often only large enough to sample about 1 hectare. The Richmond Field Station grasslands at about 10 acres (~4,000 square meters) are far larger. The species/area curve for plants in California coastal prairies, with the RBC, is shown in Figure 9. Keep in mind that the scale is not linear, but jumps from 2 square meters, to 1000 and then 4000. As the smaller reference study areas could not be sampled for many years, and were only visited once, their apparent species abundance appears low (Figure 7). However, if one were to extrapolate the curves from the reference study areas to 4000 sq. meters, they appear to be on track to reach comparable numbers of species as those observed at the RBC.

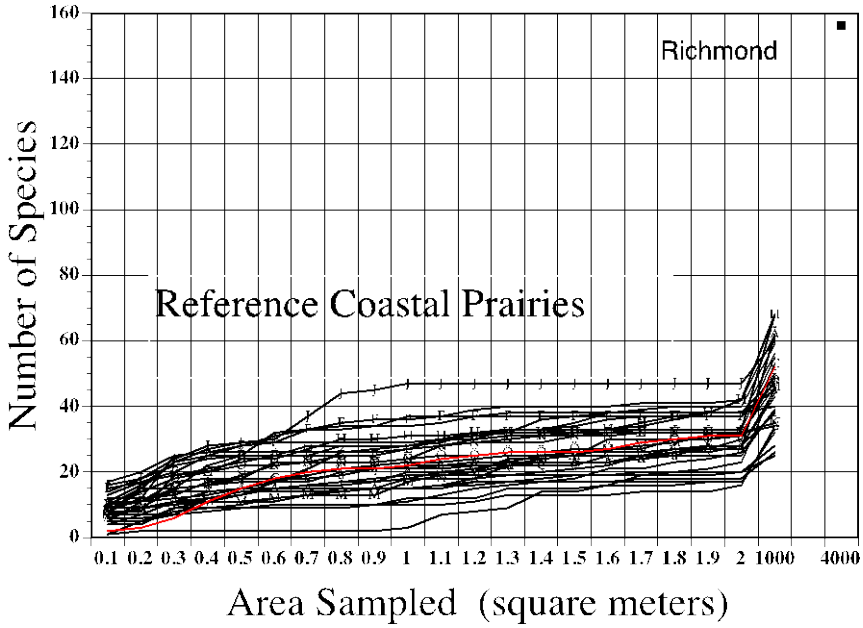

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Figure 7. Species-area curve for reference coastal prairies in California (Stromberg et al. 2001), including the species list for the Richmond Bay Campus (Lidicker et al. 2003). Note that the scale along the x-axis is not linear, but includes a large jump to 4000 sq meters. A projection of the other grasslands to that scale would approximate the overall plant species count at the Richmond Bay Campus.

But a count of all plant species numbers does not give the native perspective of the RBC grassland. Some of the plant species in the total count are non-native, and many are invasive. All of the grasslands in California are heavily invaded by non-native

plant species, with both grass-like plants and flowering, broad-leaf plants ("forbs"). Abundant non-native plants are found at the RBC as well. Thus, a count of the native plant species in coastal terrace prairies can give some idea of the intact nature of a given site.

A plot of the number of native species, classified into grasses and forbs, (Figure 8) shows that the RBC grasslands are not exceptional with regard to diversity of native grass species as compared to other California coastal grasslands (Stromberg et al. 2001). The count of native grass species at RBC comes in at the middle to high end of other similar coastal terrace prairies in California. However, the number of native forb species at the RBC is relatively high.

This larger number of native broad-leafed plants probably reflects both the effects of looking at a larger sampling area and over a longer observation period, including many seasons. Stromberg et al (2001) were only able to visit the reference coastal terrace prairies in one season in one year, while taxonomists at the RBC were able to look for flowering plants over 20 years and over many seasons (Lidicker et al. 2003). There are seasonal changes in flowering, as well as differences between years- on some years, particular flowers are rare or absent, while on others, formerly sparse plant species can be abundant.

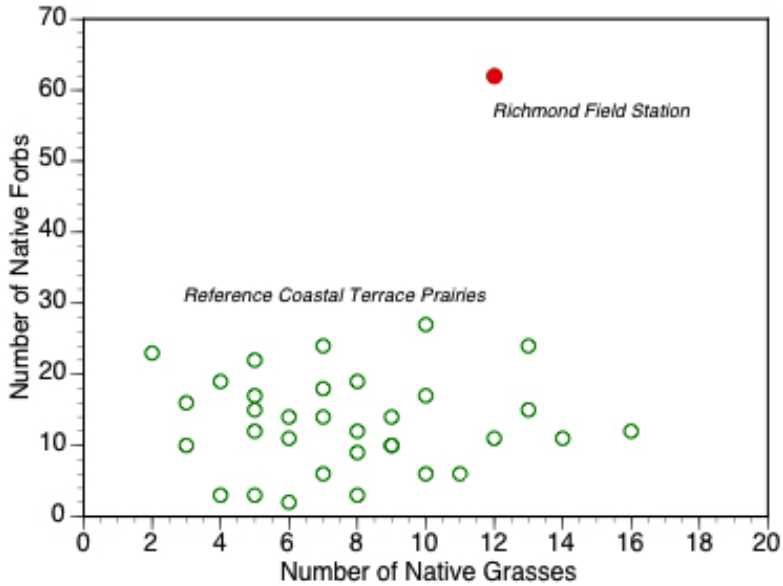

Figure 8. Plot of the number of native grasses and native forbs in various California coastal grasslands and the entire RBC.

3.0 On-Site Re-Establishment

3.1 On-Site Protection Measures

A core area of fifteen acres, contiguous with the restored marsh, including the Big Meadow, EPA Meadow, and West Meadow, will be established as a contiguous coastal terrace prairie (Figure 9). This area is a complex of relict, intact grasslands and disturbed patches. Disturbance includes piles of soil, areas dominated by non-native plants, including aggressive, spreading exotics (e. g., Harding grass, *Phalaris aquatica*, teasel, etc.) (Farrell et al. 2007).

Figure 9. Coastal terrace prairie core area, contiguous to the restored marsh, as indicated in the Illustrative Development Scenario for the RBC 2014 Long Range Development Plan.

The larger, intact patches in this core area will require monitoring for invasive plants, but can be expected to largely persist with ongoing maintenance management (Farrell et al. 2007, Cai et al. 2012). Maintenance management will include a variety of methods, almost all selected to reduce the abundance of non-native, spreading plants that can displace the native species in the coastal terrace prairie. Many of these methods, and associated costs, have been described in detail elsewhere (Farrell et al. 2007, Cai et al. 2012). The restoration objectives for the on-site protection of existing stands of the coastal terrace prairie are presented in Table 1.

Table 1

Summary of broad restoration program objectives, as assessed based on the literature review and data collection in this report (Cai et al. 2012)

Restoration Objective
1. Protect and expand native rare grassland species
2. Reduce cover of non-native and invasive species
3. Resist reinvasion by best practices in the core native remnant
4. Increase community involvement and interest in the RFS prairie.
5. Institute robust, accountable monitoring system for recording the geographic location of all treatments applied to the field, experimental sites, and the subsequent results and analysis.

Based on observations and experience of The Watershed Project with the RBC grasslands, these management objectives should be pursued on the extant stands in the core area. UC will develop a monitoring program that will use quantitative methods (Elzinga et al. 1998) to go beyond the simple measures of presence/absence (Cai et al. 2012) to measure frequency, density and cover of all plants managed in the core area. These data will allow comparisons of abundance over time and allow UC to measure the effectiveness of the conservation and management actions.

Many small patches of coastal terrace grasslands persist in various places on the RBC and can contribute to the larger core site. Plant materials included in a sod layer, as well as soils, can be salvaged on these many small areas and moved to restore disturbed sites in the core area.

3.1.a. Core Area Delineation and Signage

For the foreseeable future the RBC site is fenced and gated, and site controls limit unintentional disruption of natural open space areas; as the RBC develops, landscaping controls would help to define the boundaries of these areas.

Prior to construction activities commencing under the RBC LRDP, a construction specification should ensure contractors are trained to be aware of the sensitivity of the Natural Open Space area. For any construction in the immediate vicinity of the grassland portion of the Natural Open Space area, the core prairie area should be marked at a minimum with temporary fencing and signage.

Temporary construction fencing in the vicinity of the grassland portion of the Natural Open Space area shall consist, at minimum, of steel t-posts and 4' tall red

plastic netting (e.g., Hanes Geo Components Orange Contractor Barrier Fence or equivalent).

As the campus grows, where possible, the boundaries of the grassland portion of the Natural Open Space should be marked with barriers that would deter unauthorized vehicle access. Re-use of materials now stored on the site could provide such landscape barriers. These include the stored granite blocks, logs from eucalyptus as they are removed, etc.

Signage should be developed to explain the presence and significance of this relict of California coastal terrace prairie. In early years of RBC development, relatively simple custom 12″ x12″ metal signs suitable for mounting on steel posts, wood posts or barrier fencing can be quickly prepared and purchased (eg: Voss Signs); as the campus develops more elaborate signage and curation will be warranted.

3.2 Receiver Site Preparation

The core area includes not only a very high density of native plant species defining a coastal terrace grassland plant community, but also areas that are disturbed. Over the next five to ten years, as funds permit, the disturbed patches in the core area can be prepared for receiving remnants of native sod.

3.2.a. Near-Term Receiver Site Preparation

As development plans progress, salvage sites of native coastal terrace grassland sod will be identified (see below). Now, in the near future, or at the latest prior to any development at the RBC that may alter an open space area with indicator species, disturbed parts of the core area can be identified as receiver sites, cleared of non-native soil and invasive plants, and set up for near-term receivership of high quality sod salvaged from other sites in the RBC. As needed, some small areas should be cleared of spoil piles and prepared to receive sod from areas that will be developed. In the next year, one of the piles of soil on the EPA meadow could be removed to expose native soil, and graded to match the adjacent grassland. A water source is nearby that would allow installation of a small irrigation system. As native sod needs to be salvaged, it can be installed adjacent to the high-quality grassland, in the case on the EPA meadow. The schedule of work to prepare areas for native sod will be based on the immediate needs to salvage relict, intact sod from source sites on the RBC. In general, harvesting the sod relicts should be done only during the dormant season (late summer, fall) when the soil is not saturated and the plants are not actively growing. However, in other seasons, if the area is not saturated with water, sod could also be mowed closely and then moved to a receiver site where it could be placed, rolled and thoroughly irrigated immediately.

Control of non-native invasive plants should be expanded on all disturbed areas now present in the core area, and continued until these disturbed areas can be removed

from the core area. Control of invasive plants is an ongoing management activity in the core area (Cai et al. 2012).

3.2.b . Long-Term Receiver Site Preparation

As funds allow, restoration will be carried out on the disturbed sites in the core area. This may be an activity scheduled over the next five to ten years. Where non-native soil stockpiles are now present, and where non-native plants dominate in patches (Farrell et al. 2007, Cai et al. 2012) they will be removed and the surface excavated to reveal the native clay soils. The surface will be scarified, leveled and contoured to match the surrounding levels of native clay soils. Receiver sites will be treated with herbicides for one growing season, or as needed, to control any rhizomes of invasive, non-native plants left in the soil after site preparation. Salvaged sod from relict patches of will be identified (see below) and moved to these prepared sites as soon as possible during the dormant season.

3.3 Plant Material Salvage

Small patches of the coastal terrace prairie sod, indicative of only a small subset the entire span of diversity in an intact coastal terrace prairie, persist in between building foundations, and along roads, adjacent to spoils piles, etc. Salvaging and relocating these small patches can add to the overall grassland management goal.

Attempting to restore individual species of flowering plants in coastal prairies is extremely difficult unless the seed bank in the soil is included (Holl and Hayes 2006). Furthermore, restoring native grasslands is often limited by the drastic changes in the soil microbial community brought on by tillage and disturbances associated with land development (Eviner and Chapin 2003, Jackson et al. 2003, Potoff et al. 2005).

Many small, relatively undisturbed patches on the RBC have native soil dominated by *Nassella* or *Danthonia* and may include some native flowering plants. We cannot rebuild the coastal terrace grassland (Amme 2005). But at this scale, we can move the best of the remaining patches to assemble a grassland on native soils in the core protected area after those receiver sites are cleared and prepared. We can move patches of relict native sod and soil to places with clean native soil where it can thrive. This salvage of the small relicts is comparable to commercial sod farms where they grow sod in one area to install in other areas.

A biologist able to identify *Nassella* and *Danthonia* from vegetative characteristics will be hired to identify the relicts outside the core area for salvage. Patches that qualify would be defined as those areas where basal cover of *Nassella* and /or *Danthonia* are largely continuous and cover of native plants exceeds 60%; further, cover of non-native plants would not exceed 30%. These values were derived from estimates of native and non-native cover in reference coastal terrace prairies (see section 1.1.1 above). Using

these criteria, salvage areas can be surveyed and marked. To delineate the areas to be salvaged, a biologist able to recognize the plants from vegetative characteristics should use standard methods for measuring plant canopy cover (Daubenmire 1959, Bonham 1989, Elzinga et al. 1998) with a stratified and or randomized sampling design.

3.4 Salvage Sod Planting

During the dormant season, these relatively undisturbed relicts of coastal terrace grassland sod can be excavated in lifts including a 10" deep layer of soil and plant material, and placed on prepared sites in the core area. Salvaged sod will be placed adjacent to high quality grassland, and then rolled (ring roller, sod roller) into the receiving site. Vehicles with appropriate tire pressure on the soil will be used to roll the sod to provide good sod/soil contact, but not creating pressures that would harm the sod. Where larger areas of clean soil can be prepared, salvaged sod can be broken up into plugs that can be installed at 6″ to 12″ spacing, irrigated and allowed to grow together over time.

Longer-term restoration can include the addition of native, local plant species appropriate for the coastal terrace grassland. This can involve citizen volunteers and/or educational groups. For example, at Russian Ridge, where costs were monitored for ongoing non-native plant control, volunteers hand-collected seeds from 20 species at adjacent grasslands and these were planted in seed production plots to produce enough seed to use a no-till native grass drill (tractor-mounted) to re-introduce the native flowering plants to areas treated to remove non-native invasive plants (Kephart 2001).

3.4.a. Irrigation

Salvaged sod, or areas planted with plugs from salvaged sod will be established using supplemental irrigation during summer/spring periods of dry weather and especially during the first summer after installation. Irrigation events are anticipated to occur on a weekly basis during the summer and as needed during dry periods during the winter/spring. Plants will be watered via a temporary installation of irrigation piping and overhead sprinkler system (Figure 10).

Figure 10. An example of temporary irrigation pipes and sprinklers for establishing plant material in prepared soil.

3.5 Erosion Control

Development at the Richmond Bay Campus will be subject to both the Construction General Stormwater Permit and to the General Permit for Discharge of Stormwater from Small Municipal Separate Storm Sewer Systems (Small MS4s) which UC Berkeley became subject to (including the Richmond Field Station) in July 2013 as a non-traditional small MS4. These permits are required by State and Federal Clean Water Acts and are administered by the State of California Water Resources Control Board (SWRCB) and the San Francisco Bay Regional Water Quality Control Board They require the University to prevent stormwater pollution in operations and construction and to implement post-construction low-impact development design measures to reduce runoff and pollution. Implementation of programs through these permits will improve runoff conditions to Western Stege Marsh and the San Francisco Bay.

All areas cleared of non-native vegetation will follow the existing stormwater runoff control protocols. Any remaining stockpiles with steep slopes will require protection from erosion during the winter, particularly following any final grading activities.

In general, only small, nearly level areas will be prepared as receiver sites. These will need only minimal erosion control efforts. As plant material plantings may be delayed due to project conditions, any erosion control must be in place by October 15th, well before winter storms. Temporary erosion control measures may include the following:

- On slopes, installation of jute netting: Jute will be secured at top by laying at least 6 inches of material below grade at least 6 inches deep and secured with staples

spacing staples every 18 to 24 inches on center. The steeper the slope, the closer the staples should be placed. Jute netting will be applied by unrolling it down the slope and terminate at a 12-foot contour terrace and install 6 inches of netting under itself and secured with staples. All seams will overlap at least 2 to 6 inches.

- Installation of straw wattles: Straw wattles shall be placed along each 12- foot contour of the slope and anchored with 12-inch wooden stakes placed at 4-foot-intervals. One wattle shall be installed for every 20 feet of slope length and each shall be keyed in to a shallow trench in order to prevent water from flowing beneath. Wooden stakes shall extend above the top of the wattle by 2 inches.

3.5.a. Mulch Top Dressing

The top two inches of prepared receiver sites that are not immediately to be planted and remaining as tilled soil surface during winter rains, shall be top-dressed with organic sterile composted mulch. The top dressing will be hydraulically blown in place with a mulch blower truck. By placing this top dressing on the surface, any weeds in the cleared, scarified soil will be adequately buried yet the profile will allow for remnant native grass rhizomes to establish. The top dressing will also augment erosion control.

3.6 Fertilization

Fertilization often favors non-native, annual invasive plant species in native California grasslands (Weiss 1999, Cai et al. 2012) and in the coastal native grasslands, high levels of carbon or nitrogen do are not necessarily related to dominance of native species (Corbin et al. 2004, Corbin and D'Antonio 2011).

Fertilizers or nutrient additions are not necessary or helpful and should not be applied unless new data and ongoing monitoring suggests otherwise.

4.0 Ongoing Invasive Plant Species Control

4.1 Overview of Ecological Processes for Prairie Maintenance

Coastal grasslands in California are subject to invasion by a wide variety of native shrubs and trees. Historically, the open landscape (Figures 1, 2 and 3) was maintained by California Indians by low-intensity fires conducted every 1-5 years (Greenlee and Langenheim 1990, Tyler et al. 2007). In nearby Tilden Park, the effects of fire suppression, even with some ongoing grazing, is dramatic (Figures 11 through 15). Mowing can largely replace fire in reducing both native and non-native woody plant invasions (DiTomaso et al. 2007).

Figure 11. Tilden Park, c 1880. Note open grasslands with oaks only on north-facing slopes and along creeks. Source: Tilden Park archives.

Figure 12. Tilden Park, 1951. Open grasslands are invaded. Source: Tilden Park archives.

Figure 13. Tilden Park, 1971. Invasion by woody vegetation continues. Source: Tilden Park archives.

Figure 14. Tilden Park, 1994. Open grasslands are only small patches. Source: Tilden Park archives.

Figure 15. Tilden Park, 2014. Conversion to woody vegetation. Source: Google Earth.

4.2 Current Prairie Maintenance Program

Control of non-native invasive plants should be continued on all disturbed areas now present in the core area, and continued until these disturbed areas can be removed from the core area. Control of invasive plants is an ongoing management activity in the

core area (Cai et al. 2012) and can be undertaken with varying degrees of intensity sensitive to resource constraints and opportunities.

4.2.a. Mowing

Currently, the primary grassland management activity implemented to maintain the open grassland is mowing, as prescribed by The Watershed Project (Project 2007). This prescription will be continued and is adequately detailed and addresses issues related to protected areas, timing and scheduling. In addition to the mowing operation, additional work should be done to control exotic plants.

4.2.b. Other Maintenance Options (Tree, Brush Control)

Where various native and non-native invasive shrubs or small trees have been established, they should be removed. Coyote brush (*Baccharis pilularis*), Monterey Cypress (*Cupressus macrocarpa*) and a variety of shrubs and small trees of various species, often established from trimmings and debris from urban garden refuse dumped on site must be removed. The brush and trees can be trimmed back, and when new growth emerges, the plants can be sprayed with RoundUp at label rates. When dead, the plant stem can be cut level with the soil and the area mowed as a part of the ongoing program to eliminate seedling regrowth. Wherever possible on the relict grassland, soil disturbance should be minimized. Thus, digging out root balls, or excavation of Harding grass should be avoided. Where Harding grass occurs in a patch as the only species in the core area, it should be mowed as close as possible and allowed to regrow. When it reaches about 3" of height, it should be treated with RoundUp at label rates. Where Harding grass grows as interstitial in the native prairie plants, RoundUp can be selectively applied to only Harding grass shoots with either hand-held or tractor mounted saturated ropes. In such infestations in the native grassland, Harding grass can be allowed to grow above and over the native prairie sod, and can then be treated with a contact herbicide that only is applied to the emergent, taller Harding grass shoots and leaves. Other means of Harding grass control will be explored in the ongoing research into restoration methodology and needs. These control methods should be initiated at a small scale, in up to 10 square yards, and results observed and methods modified as indicated.

Avoidance of soil disturbance is not an issue on the piles of soil tailings. There, plants can be grubbed out. Herbicide and manual weeding of the spoils pile can be effective for catching small populations of invasive weeds including *Oxalis pes-caprae*. Plants like this can spread into the native grassland and are extremely difficult to remove. The *Oxalis* should be grubbed out as soon as possible from adjacent soil spoils piles. Although not as aggressive, the Blackberries (*Rubus* spp.) can be a serious pest and should be eliminated as soon as possible. In noncrop areas, tebuthiuron (Spike) is registered for use by licensed applicators for brush control. Tebuthiuron is a

nonselective urea herbicide that is used for total control (i.e., it eliminates other vegetation in the treatment area) of shrubs, trees, and other weeds. It can be applied in a pelleted formulation at the base of the plant to provide long-term control of wild blackberries (IPM 2014).

5.0 Monitoring

Adaptive management must include observations of the past and ongoing results towards a landscape model. These ongoing observations must include the relative costs and effectiveness for all of the management activities.

Parts of the grasslands can be zoned for research into the most cost-effective tools for non-native plant species management. If possible, small research grants could be made available to research faculty at UC Berkeley and elsewhere for graduate and undergraduate explorations in restoration tools.

Monitoring of plant species is necessary each year, and a long-term relationship with visiting classes and volunteer groups could provide learning experiences and long-term data sets on plant responses to management. RBC's coastal terrace grassland is an ideal place for undergraduate research and training (Hodder 2009).

Monitoring the edges of the grassland core area, along the roadsides and paths should be a high priority. Roadsides serve as routes of introduction of non-native, invasive plants into California grasslands (Gelbard and Harrison 2005). As a part of the ongoing mowing program for fire management, the roadsides should be walked each spring to detect any new plant invasions. Monitoring the roadsides could be a project that would appeal to volunteers and others who might be walking or running along the roadside for other reasons.

Tools for managing the native grassland should include as many as possible, without any a-priori restrictions. Mowing, timed grazing, hand-weeding, targeted and controlled herbicides, fire, and many other techniques can be tried and evaluated to address the primary threat of non-native invasive plants. (Stromberg et al. 2007b). An ongoing relationship with the grassland restoration community and California agronomy researchers should be pursued to keep up with the most current understanding of the mechanisms and ecological processes that are underway in the grassland(Cai et al. 2012).

Detailed management activities and methodology have been worked out with the current Richmond Field Station staff with ongoing management plans. Invasive plant control, monitoring and continued management recommendations are presented in detail elsewhere (Farrell et al. 2007).

5.1 Photo-Documentation

Time series photos, taken from a series of fixed points with the same camera and lens over a long period of time have proven very useful for seeing long-term changes in ways that are otherwise difficult in tables or statistical comparisons (Hastings and Turner 1965, Browning et al. 2008). Further, such sequences of photos are often useful in public education programs and interpretive signage.

5.2 Plant Abundance Measures

Previous management plans for the RBC coastal terrace prairie have relied on monitoring based on presence/absence of plants in quadrats. This is a relatively fast method (Cai et al. 2012).

To provide a basis for quantitative measures in a long-term data set that would be adequate for formal publication in the ecological literature, methods to measure the abundance of the grasslands plants should be more quantitative (Elzinga et al. 1998). Measures of density, cover and frequency should be collected every year for the dominant 25-30 plant species. Qualified biologists should be hired to conduct these surveys in the core area on several transects that are re-located each year. Data should be archived both on-site and in digital archives (UC Digital Library, Merritt Repository).

Over time, these data would form a unique and deep contribution to the understanding of one of the most diverse natural communities of California. And of course, changes observed would inform ongoing management activities.

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