DEPARTMENT OF ENVIRONMENTAL SERVICES
**CITY AND COUNTY OF HONOLULU**
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NOV 08 2012

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DEPUTY DIRECTOR

ROSS S. TANIMOTO, P.E.
DEPUTY DIRECTOR

October 25, 2012

IN REPLY REFER TO:
PRO 12-080

Mr. Gary Hooser, Director
State of Hawaii
Office of Environmental Quality Control
235 South Beretania Street, Room 702
Honolulu, Hawaii 96813

RECEIVED
'12 OCT 26 P3:37
OFC. OF ENVIRONMENTAL QUALITY CONTROL

Dear Mr. Hooser:

Subject: Proposed Kalia-Fort DeRussy Wastewater System Improvements

Hilton Hawaiian Village (HHV) Beach Resort & Spa proposes to construct sewer system improvements to accommodate the HHV Master Plan, Hale Koa Hotel, and sewer flows from the service area between the Ala Wai Canal, Kalakaua Avenue, and Fort DeRussy. A Draft Environmental Assessment and Anticipated Finding of No Significant Impact (DEA-AFONSI) for the proposed Kalia-Fort DeRussy Wastewater System Improvements is being transmitted by HHV to your office for publication in the next available edition of the Environmental Notice, as described in the attached publication form. The sewer lines that HHV proposes to construct in City streets and City sewer easements, some of which replace existing City sewers, will become City facilities under our department's jurisdiction when completed. We authorize HHV to submit the DEA-AFONSI documents for the proposed sewer system improvements.

If there are any questions, please contact Jack Pobuk, CIP Progam Coordinator, at 768-3464.

Sincerely,

Timothy E. Steinberger, P.E.
Director

Attachment

cc: Hilton Hawaiian Village Beach Resort & Spa
Group 70 International, Inc.
United States Army Garrison, Hawaii

## APPLICANT ACTIONS
## SECTION 343-5(C), HRS
## PUBLICATION FORM (JULY 2012 REVISION)

**Project Name:** Kalia-Fort DeRussy Wastewater System Improvements
**Island:** Oahu
**District:** Waikiki
**TMK:** (1) 2-6-005:001 (por.), Kalia Road, Ala Moana Boulevard, Kalakaua Avenue
**Permits:** Special District (Minor)
**Approving Agency:**
City and County of Honolulu, Department of Environmental Services
1000 Uluohia Street, Suite 308
Kapolei, Hawaii 96707
Contact: Jack Pobuk, CIP Program Coordinator
(808) 768-3464

**Applicant:**
Hilton Hawaiian Village® Beach Resort & Spa (Applicant)
2005 Kalia Road
Honolulu, Hawaii 96815
Contact: Gerard C. Gibson, Area Vice President
(808) 949-4321

**Consultant:**
Group 70 International, Inc.
925 Bethel Street, 5th Floor
Honolulu, Hawaii 96813
Contact: Jeffrey H. Overton, AICP, LEED AP
(808) 523-5866

**Status (check one only):**

| | |
|---|---|
| _**X**_DEA-AFNSI | Submit the approving agency notice of determination/transmittal on agency letterhead, a hard copy of DEA, a completed OEQC publication form, along with an electronic word processing summary and a PDF copy (you may send both summary and PDF to oeqc@doh.hawaii.gov); a 30-day comment period ensues upon publication in the periodic bulletin. |
| __FEA-FONSI | Submit the approving agency notice of determination/transmittal on agency letterhead, a hard copy of the FEA, an OEQC publication form, along with an electronic word processing summary and a PDF copy (send both summary and PDF to oeqc@doh.hawaii.gov); no comment period ensues upon publication in the periodic bulletin. |
| __FEA-EISPN | Submit the approving agency notice of determination/transmittal on agency letterhead, a hard copy of the FEA, an OEQC publication form, along with an electronic word processing summary and PDF copy (you may send both summary and PDF to oeqc@doh.hawaii.gov); a 30-day consultation period ensues upon publication in the periodic bulletin. |
| __Act 172-12 EISPN | Submit the approving agency notice of determination on agency letterhead, an OEQC publication form, and an electronic word processing summary (you may send the summary to oeqc@doh.hawaii.gov). NO environmental assessment is required and a 30-day consultation period upon publication in the periodic bulletin. |
| __DEIS | The applicant simultaneously transmits to both the OEQC and the approving agency, a hard copy of the DEIS, a completed OEQC publication form, a distribution list, along with an electronic word processing summary and PDF copy of the DEIS (you may send both the summary and PDF to oeqc@doh.hawaii.gov); a 45-day comment period ensues upon publication in the periodic bulletin. |
| __FEIS | The applicant simultaneously transmits to both the OEQC and the approving agency, a hard copy of the FEIS, a completed OEQC publication form, a distribution list, along with an electronic word processing summary and PDF copy of the FEIS (you may send both the summary and PDF to oeqc@doh.hawaii.gov); no comment period ensues upon publication in the periodic bulletin. |
| __ Section 11-200-23 Determination | The approving agency simultaneous transmits its determination of acceptance or nonacceptance (pursuant to Section 11-200-23, HAR) of the FEIS to both OEQC and the applicant. No comment period ensues upon publication in the periodic bulletin. |

__Statutory hammer Acceptance — The approving agency simultaneously transmits its notice to both the applicant and the OEQC that it failed to timely make a determination on the acceptance or nonacceptance of the applicant's FEIS under Section 343-5(c), HRS, and that the applicant's FEIS is deemed accepted as a matter of law.

__Section 11-200-27 Determination — The approving agency simultaneously transmits its notice to both the applicant and the OEQC that it has reviewed (pursuant to Section 11-200-27, HAR) the previously accepted FEIS and determines that a supplemental EIS is not required. No EA is required and no comment period ensues upon publication in the periodic bulletin.

__Withdrawal (explain)

**Summary** (Provide proposed action and purpose/need in less than 200 words. Please keep the summary brief and on this one page)**:**

The City and County of Honolulu, Department of Environmental Services has identified sewer system improvements to accommodate the Hilton Hawaiian Village (HHV) Master Plan, Hale Koa Hotel and sewer flows from the service area between the Ala Wai Canal, Kalakaua Avenue and Fort DeRussy. The proposed system improvements include:

- The existing 1950's 12-inch diameter sewer line in Kalia Road will be replaced with a new 21-inch diameter sewer line. The replacement sewer line will begin at the intersection of Paoa Place and Kälia Road and end at the intersection of Ala Moana Boulevard and Kalia Road. The existing 16-inch diameter sewer line, which traverses across Fort DeRussy in a sewer line easement, would be cut and plugged at the Ala Moana Boulevard and Kälia Road intersection.

- The existing 1960's 24-inch diameter sewer line on Ala Moana Boulevard and Kalakaua Avenue will be replaced by a 30-inch diameter sewer line. The replacement sewer line will begin at the intersection of Kalia Road and Ala Moana Boulevard and end at the Fort DeRussy WWPS. Work at Fort DeRussy will be contained within a City sewer line easement.

The project will help the City to meet the 2010 Wastewater Consent Decree with U.S. Environmental Protection Agency. The project will also provide capacity for the HHV Master Plan improvements, including a new Timeshare Tower.

# Draft Environmental Assessment for the Kalia-Fort DeRussy Wastewater System Improvements

**Waikiki, Oahu, Hawaii**

***Prepared for:***
**City and County of Honolulu, Department of Environmental Services**
**Hilton Hawaiian Village® Beach Resort & Spa**
**U.S. Army Garrison, Hawaii**

***Prepared by:***
**Group 70 International, Inc.**

**October 2012**

***Abstract:***
This environmental assessment is an evaluation of the proposal to construct the Kalia-Fort DeRussy Wastewater System Improvements in Waikiki, on the island of Oahu, Hawaii.

# Draft Environmental Assessment for the Proposed Construction of the Kalia-Fort DeRussy Wastewater System Improvements

**Waikiki, Oahu, Hawaii**

This environmental document is prepared in accordance with the requirements of the National Environmental Policy Act (NEPA) and Chapter 343, HRS and Hawaii Administrative Rules, Title 11, Department of Health.

**Applicant:**
Hilton Hawaiian Village® Beach Resort & Spa
2005 Kalia Road
Honolulu, Hawaii 96815

**Approving Agency:**
City and County of Honolulu
Department of Environmental Services
1000 Uluohia Street, Suite 308
Kapolei, Hawaii 96707

**Cooperating Agency:**
United States Army Garrison, Hawaii
947 Wright Avenue
Schofield Barracks, Hawaii 96857

**Prepared by:**
Group 70 International, Inc.
925 Bethel Street, 5th Floor
Honolulu, HI 96813

**October 2012**

*Aloha mai kakou. While we greatly respect and honor the Hawaiian language as ka olelo makuahine o Hawaii (the mother tongue of Hawaii) and recognize it is one of two official languages in the State of Hawaii, we acknowledge that the global use and readability of diacritical markers (the kahako and okina – macron and glottal stop, respectively) in electronic formatting may cause words to display incorrectly when presented in different documentation formats. Diacritical markers have been omitted from Hawaiian words and place names in this report and we apologize for its non-inclusion in this draft. Mahalo for your understanding in this regard.*

# ENVIRONMENTAL ASSESSMENT ORGANIZATION

This Environmental Assessment addresses the Proposed Action to construct certain improvements (described below) to the City of Honolulu's wastewater system in Waikiki, Oahu, Hawaii, in the area lying generally between the Ala Wai Canal, Kalakaua Avenue, and Fort DeRussy (referred to herein as the Kalia-Fort DeRussy Wastewater Service District" or the "Service District"), which includes the Hale Koa Hotel and the Hilton Hawaiian Village. The Proposed Action consists of the following: (1) replacement of an existing 12-inch diameter sewer line along Kalia Road (between Paoa Place and Ena Road) with a new 21-inch diameter sewer line in Kalia Road, (2) replacement of an existing 24-inch diameter sewer line located within the area of a City easement across portions of the Fort DeRussy property fronting Ala Moana Boulevard and Kalakaua Avenue with a new 30-inch diameter sewer line, (3) cutting and plugging an existing 16-inch diameter sewer line traversing diagonally across Fort DeRussy, and (4) replacing sewer lines between existing manholes at or in the vicinity of the Fort DeRussy wastewater pumping station. As required by Environmental Analysis of Army Actions (32 Code of Federal Regulations, Part 351), National Environmental Policy Act, and Chapter 343, Hawaii Revised Statutes, the potential environmental, cultural and socioeconomic impacts of the Proposed Action are analyzed in this document.

An **EXECUTIVE SUMMARY** briefly describes the Proposed Action (Preferred Alternative) and No Action Alternatives, including the environmental and socioeconomic consequences of each, and certain mitigation measures that will be implemented. The term Proposed Action will be used to describe the Preferred Alternative throughout this document. Alternatives to the Proposed Action are considered in this Environmental Assessment.

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**SECTION 1.0: PURPOSE, NEED, AND SCOPE** is a summary of the purpose of and need for the Proposed Action and a description of the scope of the environmental impact analysis process. This section includes a discussion of the Proposed Action (Preferred Alternative) and the No Action Alternatives.

**SECTION 2.0: AFFECTED ENVIRONMENT AND ENVIRONMENTAL CONSEQUENCES** describes the existing environmental and socioeconomic setting in Waikiki, on the island of Oahu. The section also identifies potential effects of implementing the Proposed Action (Preferred Alternative) and No Action Alternative, and summarizes the resulting environmental effects.

**SECTION 3.0: CUMULATIVE IMPACTS** identifies potential cumulative effects of implementing the Proposed Action and other known or contemplated actions and summarizes the resulting environmental effects.

**SECTION 4.0: APPLICABLE LAND USE PLANS AND POLICIES** provides an analysis of the project's consistency with applicable land use policies.

**SECTION 5.0: OTHER REQUIRED NEPA AND HRS CHAPTER 343 ANALYSIS** is concerned with the relationship between local short-term uses and long-term productivity and includes any irreversible and irretrievable commitment of resources. The anticipated determination of the project's environmental impact analysis and reasons for its believed outcome are also discussed.

**SECTION 6.0: LIST OF REFERENCES** are bibliographical information for cited sources.

**SECTION 7.0: LIST OF PREPARERS AND PARTICIPANTS** are persons who prepared the document.

**SECTION 8.0: LIST OF AGENCIES, ORGANIZATIONS, AND INDIVIDUALS RECEIVING COPIES OF THE EA** are those consulted during the Environmental Assessment process.

**APPENDICES**

A Agency Consultation: Comment Letters and Responses

B Preliminary Engineering Report - Belt Collins Hawaii, LLC

C Construction Traffic Impact Report - Wilson Okamoto Corporation

D Acoustic Study - Y. Ebisu and Associates

E Air Quality Impact Assessment - ARCADIS U.S. Inc.

F Existing Tree /Palm Inventory and Planting Plan - McCelvey Associates, Inc.

G Arborist Assessment - Steve Nimz and Associates, Inc.

H Archaeological Literature Review and Field Inspection - Cultural Surveys Hawaii, Inc.

I Cultural Impact Assessment - Cultural Surveys Hawaii, Inc.

# EXECUTIVE SUMMARY

# EXECUTIVE SUMMARY

This Environmental Assessment (EA) addresses the environmental impacts of the Proposed Action to construct certain improvements to the City and County of Honolulu (City) wastewater collection system (sewer) along a portion of Kalia Road and within an easement area covering portions of the Fort DeRussy property fronting on Ala Moana Boulevard and Kalakaua Avenue in Waikiki, Oahu, Hawaii.

The purpose of the Proposed Action is to increase the capacity of wastewater collection lines along Kalia Road and portions of Fort DeRussy fronting on Ala Moana Boulevard and Kalakaua Avenue. The improvements are required to reduce the risk of overflows during periods of heavy rain and to accommodate additional flows from future development in the area, including implementation of the Hilton Hawaiian Village (HHV) Master Plan. Completion of these sewer improvements will fulfill a City condition of the Planned Development-Resort (PD-R) and Special Management Area (SMA) Use permits (2011) issued for the HHV Master Plan.

This EA has been developed in accordance with the National Environmental Policy Act (NEPA) of 1969, 42 US Code (USC), Section 4321 et seq.; the Council on Environmental Quality (CEQ) regulations for implementing NEPA, 40 Code of Federal Regulations (CFR) Parts 1500-1508: Environmental Analysis of Army Actions (32 CFR 651) and the State of Hawaii, Environmental Review Process, Chapter 343, Hawaii Revised Statutes (HRS); Hawaii Administrative Rules (HAR), Title 11, Department of Health (DOH). The purpose of the EA is to analyze the environmental impacts of the Proposed Action and project alternatives, present the findings, and solicit public input in order for the City, Department of Environmental Services (ENV) and United States Army Garrison, Hawaii (USAG-HI) to make an informed decision on future action. This EA provides a focused and site-specific analysis of the potential environmental impacts of constructing the proposed sewer improvements. Additionally, the EA considers impacts at this Oahu location that would result from the Proposed Action.

### *Proposed Action (Preferred Alternative): Construct Sewer Improvements along Kalia Road and portions of Fort DeRussy fronting Ala Moana Boulevard and Kalakaua Avenue and make certain other improvements*

The Proposed Action is for the City or its designee to construct the following improvements to the City's sewer system (the "Kalia-Fort DeRussy Wastewater System Improvements" or KDWSI):

1. An existing 12-inch diameter sewer pipe (installed c. 1950s) along Kalia Road will be replaced with a new 21-inch diameter sewer line from a point near Paoa Place to a point near the intersection of Kalia Road, Ena Road and Ala Moana Boulevard. The new line will be located just east of the existing line. A trench will be excavated to accommodate the new line. Following completion of the new line, sewer laterals from HHV that connect to the existing 12-inch diameter sewer line will be connected to the new 21-inch diameter sewer line. The 12-inch diameter sewer line will be removed or grout filled, and abandoned in place. Upon completion, the 21-inch diameter sewer line trench will be backfilled, and existing surface improvements and landscaping will be restored.

2. An existing 24-inch diameter sewer line located within the boundaries of a City easement on federally owned land at Fort DeRussy, will be replaced with a new 30-inch diameter sewer line running along Ala Moana Boulevard from a point near Kalia Road to a point near the intersection of Ala Moana Boulevard and Kalakaua Avenue, and then along Kalakaua Avenue to a point near the existing Fort DeRussy wastewater pumping station (WWPS). The new line will be located in the same easement which contains the existing sewer line. Trenches will be excavated to expose the existing line, which will be bypassed by a temporary line to allow for the removal of the existing line and the installation of the new line. Upon completion of the new line, the new line will be connected to the new 21-inch Kalia Road line (described in item 1 above) and, by way of the new line described in item 3 below, to the Fort DeRussy WWPS. Following this, the bypass will be disconnected and removed, the trench will be backfilled, and existing surface improvements and landscaping in the easement area will be restored.

3. An existing 24-inch diameter sewer line within the Fort DeRussy WWPS, between sewer manhole (9004) and sewer manhole (9003) and between sewer manhole (9003) and the Fort DeRussy WWPS wet well (0000), will be replaced with a new 30-inch diameter sewer line.

4. In addition, an existing 16-inch diameter sewer line crossing Fort DeRussy from the intersection of Kalia Road and Ala Moana Boulevard intersection to the Fort DeRussy WWPS will be cut and plugged with grout.

The KDWSI will expand the capacity of the City's wastewater system in a portion of the service area between the Ala Wai Canal, Kalakaua Avenue, and Fort DeRussy (the "Kalia-Fort DeRussy Wastewater Service Area" or simply the "Service Area"), which includes the Hale Koa Hotel (HKH) and the HHV.

The construction of the KDWSI will be scheduled to meet the development timeline for the completion of the new HHV Timeshare Tower 1 (which is currently scheduled for late 2015). Where potentially significant impacts might result from the Proposed Action, mitigation measures will be taken to reduce the impact to less-than-significant levels.

In addition to providing additional capacity to serve existing and future development within the Service Area, including implementation of the HHV Master Plan, installation of the KDWSI may help the City satisfy the strict mandates set under the 2010 Wastewater Consent Decree agreed upon by the United States (U.S.) Environmental Protection Agency (EPA), the State of Hawaii and the City.

The environmental impact of the Proposed Action (Preferred Alternative) is expected to be less than the impact of the No Action Alternative, as described below.

### *No Action Alternative*

The No Action Alternative is a benchmark against which the Preferred Alternative can be evaluated. Under the No Action Alternative, the existing sewer system servicing the HHV, HKH, and other parts of the Service Area would remain unchanged and unimproved. The existing system is intended to provide capacity for existing peak wet weather flows, which is a combination of the maximum flow and the wet weather infiltration/inflow. Without improvements such as the KDWSI, the City's wastewater system will not be sufficient to accommodate the increased flows that will be produced from implementation of the approved HHV Master Plan, including the construction of the new Timeshare Tower 1.

The No Action Alternative is evaluated in the environmental consequences section of this EA and addresses the potential impacts of the No Action Alternative on the baseline conditions identified in the affected environment section of the document.

### *Summary of Environmental and Socioeconomic Impacts*

Under the Proposed Action, less than significant impacts are identified for most categories of environmental and socioeconomic impact, as summarized in the following table.

| SUMMARY OF POTENTIAL IMPACTS FOR NO ACTION ALTERNATIVE AND PROPOSED ACTION (PREFERRED ALTERNATIVE) | | | |
|---|---|---|---|
| **Impact Area** | **No Action Alternative** | **Cumulative** | **Proposed Action (Preferred Alternative)** |
| Land Use | No impact | No impact | No impact |
| Socioeconomic | No impact | Beneficial | Beneficial |
| Traffic and Roadways | No impact | Significant impact but mitigable to less than significant | Significant impact but mitigable to less than significant |
| Noise | No impact | Significant impact but mitigable to less than significant | Significant impact but mitigable to less than significant |
| Air Quality | No impact | Less than significant impact | Less than significant impact |
| Geology, Soils and Seismicity | No impact | Less than significant impact | Less than significant impact |
| Natural Hazards | No impact | No impact | No impact |
| Water Resources | No impact | Beneficial/ Less than significant impact | Beneficial/ Less than significant impact |
| Hazardous Materials | No impact | No impact | No impact |
| Public Facilities, Services, and Utilities | No impact | Beneficial/ Less than significant impact | Beneficial/ Less than significant impact |
| Biological Resources | No impact | Less than significant impact | Less than significant impact |
| Cultural Resources | No impact | Significant impact but mitigable to less than significant | Significant impact but mitigable to less than significant |
| Visual Resources | No impact | Less than significant impact | Less than significant impact |
| Environmental Justice | No impact | Beneficial | Beneficial |
| Note: In cases when there would be both beneficial and adverse impacts, both are shown on this table. | | | |

*Proposed Action (Preferred Alternative): Construct the Kalia-Fort DeRussy Wastewater System Improvements*

Under the Proposed Action, beneficial impacts can be expected for socioeconomics, water resources, public facilities, services and utilities, and environmental justice.

The Proposed Action will have short-term and long-term beneficial effects on the local economy. There will be short-term increases in employment, income and tax revenue during the construction period. In addition, construction of the proposed sewer line improvements will allow for the development of improvements and expansion projects under the approved HHV Master Plan. These projects will result in beneficial long-term indirect economic and fiscal impacts relating to employment, income, taxes, and additional consumer expenditures.

Implementation of the Proposed Action will have beneficial impacts on water quality since the sewer improvements will serve to minimize problems that occur from wet weather infiltration/inflow to the system. The project will not increase the volume of peak stormwater runoff or contribute additional contaminants to stormwater runoff. Upon completion of the sewer improvements, pavements, groundcover and landscaping disturbed during construction will be repaired to model pre-construction conditions, eliminating discernible long-term adverse impact.

By increasing the capacity of the City's sewer collection system along Kalia Road and the portions of Fort DeRussy fronting Ala Moana Boulevard and Kalakaua Avenue, the KDWSI may help the City comply with the mandates of the 2010 Wastewater Consent Decree with the EPA. The Proposed Action will have a long-term beneficial impact on public utilities by improving the existing wastewater system, and a long-term beneficial impact to surface water quality.

The Proposed Action will directly result in beneficial short-term and long-term impacts through the creation of jobs opportunities for low-income or minority groups. Temporary new jobs will be created during the construction period of the Proposed Action. The sewer expansion will also allow for construction jobs associated with the new Timeshare Tower 1 and various Master Plan projects. By allowing for completion of Timeshare Tower 1 and other elements of the HHV Master Plan, the Proposed Action will aid in the creation of additional long-term jobs associated with those projects.

The Proposed Action will have no impacts on Land Use and Hazardous Materials. Less than significant impacts are expected for air quality, geology, soils and seismicity, water resources, public facilities, services and utilities, biological resources, and visual resources, all of which will be temporary and limited to the period during and immediately following construction.

The Proposed Action will have less than significant adverse impacts on air quality from air pollutants or greenhouse gases. The air quality issues are related to construction activities, and include fugitive dust and emissions from construction equipment engine exhaust. Impacts will be temporary and mitigated through the implementation of best management practices (BMPs), such as dust minimization, to ensure that air quality standards are met.

Short-term adverse impacts from erosion will be mitigated during construction and during the period immediately after construction, through the implementation of erosion and sediment control BMPs. The Proposed Action will not increase impervious area at the project areas. The potential for water quality degradation due to sediment-laden runoff from disturbed areas during construction will be mitigated through the implementation of BMPs for erosion and sediment control (construction) and stormwater management. As a result, the Proposed Action is expected to temporarily generate less than significant impacts to geology, soils, and water quality.

Construction of the Proposed Action will have a less than significant impact on public services (police protection, solid waste management, etc.) and existing utility infrastructure located near the project areas. The Proposed Action will not directly increase energy and potable water consumption, wastewater generation, stormwater generation, or demands on communication systems (except to a limited and less-than-significant degree during construction). Therefore, impacts on all of these are anticipated to be less than significant.

There will be less than significant impacts on biological resources. The Proposed Action may affect the manuoku (White Fairy Tern, *Gygis alba*) particularly during the construction period. However, impacts to this seabird are considered to be less than significant because there is abundant alternative tree canopy habitat for this species in the adjacent areas. The adverse effects from construction are expected to be temporary and minor. Temporary site clearing in Fort DeRussy will have a less than significant impact on biological resources. Upon completion of the sewer improvements, the affected area will be repaired and landscaped to model pre-construction conditions.

During construction, there will be short-term adverse impacts on the visual character of the site and surroundings resulting from a visible increase in traffic from project vehicles, the operation and storage of equipment and materials during demolition and construction, and a decrease in visibility from fugitive dust. These short-term adverse impacts on the visual landscape of the project areas will be limited and temporary, and are expected to be less than significant.

Significant impacts but mitigable to less than significant are expected for traffic and circulation, noise and cultural resources, all of which will be temporary and limited to the period during and immediately following construction.

Under the Proposed Action, there will be short-term impacts to traffic and roadways during construction of the sewer improvements. Lane closures and potential traffic diversions will be required. However, construction work areas will be phased along the project alignment to minimize impact to vehicular and pedestrian traffic. The traffic control plans will include phased work areas and detours for lane and sidewalk closures. Construction scheduling will be coordinated with the City Department of Planning and Permitting (DPP), City Department of Transportation Services (DTS), and State Department of Transportation (DOT) Highways Division in an effort to minimize these impacts. While the potential impacts on traffic and roadways could be significant in the absence of mitigating action, the impacts can be mitigated, and it is anticipated that coordination with City and State agencies will result in mitigation measures that will reduce these impacts to a level that is below what would be considered significant.

The Proposed Action will introduce temporary noise from construction of the sewer improvements. However, these noise levels will not exceed applicable regulatory standards. In addition, typical construction noise mitigation measures will be utilized to reduce the adverse noise impact to a level that is below what would be considered less than significant.

Based on historic documents and archaeological investigations, the Proposed Action may have a significant impact on archaeological resources; however, compensatory mitigation will be included to reduce the level of impact to below significant levels. The project team has engaged and is working closely with cultural and lineal descendants of the Kalia area to learn about the area's history, build relationships, promote dialogue among the parties, and address potential impacts on cultural resources. This collaboration is leading to the formulation of a Plan of Action (POA) to protect cultural resources. In addition, an archaeological monitoring program will be implemented as an appropriate mitigation measure for ground disturbance conducted within the study area. Trenching for the Proposed Action will be within or adjacent to areas that were previously trenched to install or repair the existing lines. Nonetheless, expansion of the trench areas to accommodate the larger pipes presents some risk that human remains or other culturally sensitive items not previously identified will be disturbed. Should human remains (iwi kupuna), cultural sites, or artifacts be uncovered during construction; actions will be undertaken for either preservation in place or relocation, under a plan of action following respective cultural protocol. With these measures in place to mitigate project actions, it is anticipated that the Proposed Action will not have a significant cumulative impact on cultural resources.

It is anticipated that the owner of the HHV will fund, design and construct the KDWSI, which will allow it to construct Timeshare Tower 1 and other additions and improvements to the HHV property contemplated by the recently approved HHV Master Plan. This investment in the City's infrastructure is expected to have an overall beneficial impact, not only for the HHV, but also for the Waikiki community and the visitors and general public that it serves. The construction timetable for the sewer improvements is planned to meet the programmed completion of the HHV Master Plan Timeshare Tower 1 in late 2015. The impacts of the Proposed Action are analyzed in this EA. The project details described in this EA may change as technical requirements and designs are refined, and this EA may be revised, if appropriate, to address material changes. Additionally, unanticipated issues may delay the construction schedule.

*No Action Alternative*

Under the No Action Alternative, the existing conditions would not change and improvements to the sewer lines serving HHV, HKH and other parts of the Service Area would not occur. The HHV Timeshare Towers would not be built because the existing sewer system would not be able to accommodate additional flows. Development and operations employment related to the HHV Master Plan project and Proposed Action would also not be available. The City would need to expend additional public funds to make improvements to the existing wastewater system to meet the requirements of the 2010 Wastewater Consent Decree with the U.S. EPA. Without improvements to the existing system, the risk of wastewater system overflows would not be reduced. While sewer improvements under the Consent Decree may still take place without the Proposed Action, it would occur at a later point.

The No Action Alternative would have no significant impact on land use, socioeconomic characteristics, traffic and roadways, noise, air quality, geology, soils, and seismicity, natural hazards, water resources, hazardous materials, public, facilities, services and utilities, biological resources, cultural resources, visual resources and environmental justice. However, the No Action Alternative would not mitigate potential adverse impacts on water resources, resulting from the lack of wastewater system improvements, and would not result in any improvement to public services and utilities. The benefits to socio-economic and environmental justice resources would also not occur.

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## ABBREVIATIONS/ACRONYMS

| Abbreviation | Definition |
|---|---|
| BMPs | Best Management Practices |
| BWS | Board of Water Supply |
| CAA | Clean Air Act |
| CEQ | Council on Environmental Quality |
| CERCLA | Comprehensive Environmental Response, Compensation, and Liability |
| CFR | Code of Federal Regulations |
| CIA | Cultural Impact Assessment |
| City | City and County of Honolulu |
| CO | Carbon Monoxide |
| CZM | Coastal Zone Management |
| CZMA | Coastal Zone Management Act |
| dBA | A-Weighted Decibels |
| DBEDT | Department of Business, Economic Development, and Tourism |
| DOH | Department of Health |
| DPP | Department of Planning and Permitting |
| DTS | Department of Transportation Services |
| EA | Environmental Assessment |
| EIS | Environmental Impact Statement |
| EMS | Emergency Medical Services |
| ENV | Department of Environmental Services |
| EPA | Environmental Protection Agency |
| FONSI | Finding of No Significant Impact |
| GHG | Greenhouse Gases |
| $H_2S$ | Hydrogen Sulfide |
| HAR | Hawaii Administrative Rules |
| HFD | Honolulu Fire Department |
| HHV | Hilton Hawaiian Village |
| Hilton | Hilton Hawaiian Village Beach Resort and Spa |
| HKH | Hale Koa Hotel |
| HPD | Honolulu Police Department |
| HRS | Hawaii Revised Statutes |
| HTCO | Hawaiian Telcom |
| JaC | Jaucas Sand |
| KDWSI | Kalia-Fort DeRussy Wastewater System Improvements |
| LCA | Land Commission Award |
| LOS | Level of Service |
| LUC | Land Use Commission |
| LUO | Land Use Ordnance |
| MBR | Membrane Bioreactors |
| mgd | Million Gallons per Day |
| NAAQS | National Ambient Air Quality Standards |
| NAGPRA | Native American Graves Protection and Repatriation Act |
| NEPA | National Environmental Policy Act |

| | |
|---|---|
| NHPA | National Historic Preservation Act |
| $NO_2$ | Nitrogen Dioxide |
| NPDES | National Pollutant Discharge Elimination System |
| NRHP | National Registry of Historic Places |
| $O_3$ | Ozone |
| OEQC | Office of Environmental Quality Control |
| Pb | Lead |
| PM | Particulate Matter |
| PUC | Primary Urban Center |
| PUCDP | Primary Urban Center Development Plan |
| ROH | Revised Ordinances of Honolulu |
| ROI | Region of Influence |
| SAAQS | State Ambient Air Quality Standards |
| SHPD | State Historic Preservation Division |
| SMA | Special Management Area |
| $SO_2$ | Sulfur Dioxide |
| tpy | Tons per Year |
| U.S. | United States |
| USAG-HI | United States Army Garrison Hawaii |
| USC | United States Code |
| UST | Underground Storage Tank |
| VECs | Valued Environmental Components |
| WSD | Waikiki Special District |
| WWPS | Wastewater Pump Station |

# 1.0 PURPOSE, NEED, AND SCOPE

# SECTION 1.0
# PURPOSE, NEED AND SCOPE

## 1.1 INTRODUCTION

On behalf of the City and County of Honolulu (City), Department of Environmental Services (ENV), in coordination with the United States Army Garrison, Hawaii (USAG-HI) and Hilton Hawaiian Village Beach Resort and Spa (Hilton), an Environmental Assessment (EA) is being prepared. This EA addresses the environmental impacts of constructing the proposed sewer improvements along Kalia Road and portions of Fort DeRussy fronting Ala Moana Boulevard and Kalakaua Avenue in Waikiki, Oahu, Hawaii.

This EA has been prepared in accordance with the requirements of the National Environmental Policy Act (NEPA) of 1969, 42 United States Code (USC), Section 4321 et seq.; the Council on Environmental Quality (CEQ) regulations for implementing NEPA, 40 Code of Federal Regulations (CFR), Parts 1500-1508, and Environmental Analysis of Army Actions (32 CFR, Part 651). This EA has also been prepared in accordance with the requirements of Chapter 343, Hawaii Revised Statutes (HRS) and Hawaii Administrative Rules (HAR), Title 11, Department of Health (DOH), which set forth the requirements for the preparation of State EAs.

The purposes of the EA are to analyze the environmental impacts of the Proposed Action (described below) and certain alternative actions, including the No Action Alternative, to present findings, and to solicit public input in order for the USAG-HI and City ENV to determine if the Proposed Action would produce significant impacts that necessitate an Environmental Impact Statement (EIS). This EA provides a focused and site-specific analysis of the potential environmental impacts of the Proposed Action.

## 1.2 PROJECT INFORMATION SUMMARY

**Project Name:** Kalia-Fort DeRussy Wastewater System Improvements (KDWSI)

**Involved Parties:**

City and County of Honolulu,
Department of Environmental Services
1000 Uluohia Street, Suite 308
Kapolei, Hawaii 96707
Contact: Jack Pobuk, CIP Program Coordinator
(808) 768-3464

Hilton Hawaiian Village® Beach Resort & Spa (Applicant)
2005 Kalia Road
Honolulu, Hawaii 96815
Contact: Gerard C. Gibson, Area Vice President
(808) 949-4321

| | |
|---|---|
| | United States Army Garrison, Hawaii<br>851 Wright Avenue<br>Schofield Barracks, Hawaii 96857<br>Contact: Dale Kanehisa-Lam, Environmental Protection Specialist<br>(808) 656-5670 |
| **Agent:** | Group 70 International, Inc.<br>925 Bethel Street, 5th Floor<br>Honolulu, Hawaii 96813<br>Contact: Jeffrey H. Overton, AICP, LEED AP<br>(808) 523-5866 |
| **Approving Agency NEPA:** | United States Army Garrison, Hawaii |
| **Approving Agency Ch. 343, HRS:** | City and County of Honolulu, Department of Environmental Services |
| **Class of Action NEPA:** | Use of Federal Lands |
| **Class of Action Ch. 343, HRS:** | Use of State Lands, Use of Historic Site or District, Use of Land in the Waikiki District |
| **Project Location:** | Waikiki, Oahu, Hawaii (*Figure 1-1*) |
| **Tax Map Key:** | (1) 2-6-005:001 (por.), Kalia Road, Ala Moana Boulevard, Kalakaua Avenue (*Figure 1-2*) |
| **Landowner:** | United States of America ((1) 2-6-005:001 por.)<br>City and County of Honolulu (various roadways) |
| **Project Area:** | Approximately 2,600 linear feet of land along or adjacent to Kalia Road, Ala Moana Boulevard and Kalakau Avenue |
| **State Land Use District:** | Urban District (*Figure 1-3*) |
| **City Zoning:** | Waikiki Special District (WSD), Resort Mixed Use Precinct and Public Precinct (*Figure 1-4*) |
| **Primary Urban Center Development Plan (PUCDP):** | Resort and Major Parks and Open Space (*Figure 1-5)* |
| **Special Management Area (SMA):** | Not in the SMA (*Figure 1-6*) |
| **Flood Zone:** | Zone AO and AE (*Figure 1-7*) |
| **Anticipated Determination:** | Finding of No Significant Impact (FONSI) |

## 1.3 PURPOSE AND NEED OF THE PROPOSED ACTION

The purpose of the Proposed Action is to make necessary upgrades to existing sewer lines in the project area to reduce the risk of wastewater system overflow in periods of wet weather conditions and to accommodate additional wastewater flows anticipated to result from future development in the nearby community, including the construction of new timeshare towers and additional retail space contemplated by the recently approved Hilton Hawaiian Village (HHV) Master Plan. The need for the Proposed Action is that HHV Master Plan improvements, and in particular, Timeshare Tower 1, cannot be built until these wastewater improvements are made. The Proposed Action will fulfill a City condition to the HHV Master Plan approval. The HHV Master Plan contemplates the construction of two new timeshare towers and the addition of approximately 14,359 square feet of retail space to the HHV campus. Timeshare Tower 1, with 418 units, is proposed over the existing HHV bus loading area adjacent to Tapa Tower at the corner of Kalia Road and Paoa Place. Timeshare Tower 2, with 132 units and 14,359 square feet of retail space, is proposed over the existing Rainbow Bazaar. Timeshare Tower 1 is scheduled to be completed in late 2015. Timeshare Tower 2 is scheduled to be completed in 2020.

The increased capacity of the City's sewer system will also serve the needs of the broader area bounded by the Ala Wai Canal, Kalakaua Avenue, and Fort DeRussy (the "Kalia-Fort DeRussy Wastewater Service Area" or "Service Area"). Completion of the Proposed Action may help support the City's compliance with the Wastewater Consent Decree entered into in 2010 between the U.S. Environmental Protection Agency (EPA), the City and the State of Hawaii. Once constructed, the upgraded sewer line improvements will be dedicated to the City.

The Proposed Action is for the City or its designee to construct the following improvements to the City's sewer system (KDWSI):

1. An existing 12-inch diameter sewer pipe (installed c. 1950s) along Kalia Road will be replaced with a new 21-inch diameter sewer line from a point near Paoa Place to a point near the intersection of Kalia Road, Ena Road and Ala Moana Boulevard. The new line will be located just east of the existing line. A trench will be excavated to accommodate the new line. Following completion of the new line, sewer laterals from HHV that connect to the existing 12-inch diameter sewer line will be connected to the new 21-inch diameter sewer line. The 12-inch diameter sewer line will be removed or grout filled, and abandoned in place. Upon completion, the 21-inch diameter sewer line trench will be backfilled, and existing surface improvements and landscaping will be restored.

2. An existing 24-inch diameter sewer line located within the boundaries of a City easement on federally owned land at Fort DeRussy, will be replaced with a new 30-inch diameter sewer line running along Ala Moana Boulevard from a point near Kalia Road to a point near the intersection of Ala Moana Boulevard and Kalakaua Avenue, and then along Kalakaua Avenue to a point near the existing Fort DeRussy wastewater pumping station (WWPS). The new line will be located in the same easement which contains the existing sewer line. Trenches will be excavated to expose the existing line, which will be bypassed by a temporary line to allow for the removal of the existing line and the installation of the new line. Upon completion of the new line, the new line will be connected to the new 21-inch Kalia Road line (described in item 1 above) and, by way of the new line described in item 3 below, to the Fort DeRussy WWPS.

Following this, the bypass will be disconnected and removed, the trench will be backfilled, and existing surface improvements and landscaping in the easement area will be restored.

3. An existing 24-inch diameter sewer line within the Fort DeRussy WWPS, between sewer manhole (9004) and sewer manhole (9003) and between sewer manhole (9003) and the Fort DeRussy WWPS wet well (0000), will be replaced with a new 30-inch diameter sewer line.

4. In addition, an existing 16-inch diameter sewer line crossing Fort DeRussy from the intersection of Kalia Road and Ala Moana Boulevard to the Fort DeRussy WWPS will be cut and plugged with grout.

After considering alternate routes and construction methods (which are discussed in the "Alternatives Considered" portion of this report), the City ENV and Department of Planning and Permitting (DPP) has selected the KDWSI as their preferred alternative for improving the wastewater system in this portion of the Service Area and to accommodate the additional wastewater needs of the HHV Master Plan development. The new Kalia Road sewer line is expected to accommodate 3.07 million gallons per day (mgd), and the new sewer line along Ala Moana Boulevard and Kalakaua Avenue is expected to provide capacity of 8.1 mgd. The City has determined that the capacity of these two (2) sewer lines will accommodate existing improvements, Hale Koa Hotel (HKH), the HHV Master Plan improvements, potential future development capacity of HHV, plus 15 percent excess capacity. Replacing the two sewer lines between the manholes at the Fort DeRussy WWPS is expected accommodate 9.11 mgd and 9.33 mgd, respectively.

In addition, the City will design and construct the certain upgrades to the Fort DeRussy WWPS and Kalakaua Avenue sewer force main, to be conducted as required repair and maintenance activities. These repairs are planned to be completed in the same timetable as the KDWSI.

Hilton is required to make the sewer line upgrades along Kalia Road, Ala Moana Boulevard and Kalakaua Avenue to support the HHV Master Plan improvements. It is anticipated that Hilton will fund, design and construct the KDWSI as a condition to obtaining Building Permits and a Sewer Connection Permit for the construction of Timeshare Tower 1 and other improvements contemplated by the HHV Master Plan. This significant investment in the City's infrastructure will have a beneficial impact, not only for HHV, but also for the wider Waikiki community and the visitors and general public that it serves.

## 1.4 SCOPE AND ORGANIZATION OF THE DOCUMENT

In accordance with the requirements of NEPA and Chapter 343, HRS, this EA is being prepared because the project: (a) is located on Federal and County lands, (b) increases the capacity of the City sewer system, and (c) is located within Waikiki. This Draft EA will be published in the Office of Environmental Quality Control (OEQC) Environmental Notice, which will commence a 30-day public review period. Upon acceptance of the Final EA, a FONSI is anticipated.

This EA analyzes the anticipated impact of two primary alternatives: the Proposed Action (which is the "Preferred Alternative" and is described in *Section 1.7.3*) and the No Action Alternative. The No Action Alternative serves as a benchmark against which the Preferred Alternative and other alternatives considered can be evaluated. Other alternatives considered and eliminated through the application of screening criteria are discussed in *Section 1.7.5*.

The EA describes the existing conditions of valued environmental components (VECs) within the project area at Kalia Road, Fort DeRussy (fronting Ala Moana Boulevard), and Kalakaua Avenue. The EA analyzes the environmental impacts on VECs that would result from the Proposed Action (Preferred Alternative) and the No Action Alternative, as described in *Section 2.0*, *Affected Environment and Environmental Consequences*. Along with information presented for the No Action Alternative, existing conditions of the VECs constitute the baseline against which the impacts of the Proposed Action are evaluated. The VECs described in *Section 2.0* are as follows:

- Land Use;
- Socioeconomics Characteristics;
- Traffic and Roadways;
- Noise;
- Air Quality;
- Geology, Soils and Seismicity;
- Natural Hazards
- Water Resources
- Hazardous Materials
- Public Facilities, Services and Utilities;
- Biological Resources;
- Cultural Resources;
- Visual Resources;
- Environmental Justice.

*Section 3.0* describes the cumulative impacts of the Proposed Action, when considered in the context of other past, present, and reasonably foreseeable future actions, regardless of whether they are Federal or not. Actions and measures that can be taken to mitigate impacts are identified, where appropriate.

*Section 4.0* provides a discussion of the project's relationship to Federal, State and County land use designations and regulations. The anticipated determination and reasons for the anticipated outcome (a FONSI) are detailed in *Section 5.0.* References cited or used in developing the EA, a list of preparers, and an updated list of agencies, organizations, and individuals that participated in the preparation or review of the EA are detailed in *Section 6.0, 7.0 and 8.0*, respectively.

## 1.5 PUBLIC INVOLVEMENT

In accordance with 32 CFR, Part 651, and Chapter 343, HRS, opportunities for the public to participate in the NEPA and State Environmental Review process are provided to promote open communication and to improve the decision making process. All persons and organizations having potential interest in the Proposed Action are encouraged to participate in the environmental analysis process. The formal opportunity to comment involves a 30-day period for public review of the Draft EA and draft FONSI. A notice of availability of the Draft EA and draft FONSI will be published in the State of Hawai'i's OEQC Bulletin, *The Environmental Notice*. Also, a notice will be published in the local newspaper to ensure that interested persons and organizations are notified.

In addition, copies of the EA will be provided to libraries in the vicinity of the project, selected Federal, State, and City government agencies and, on request, copies will be mailed to interested individuals, organizations and Native Hawaiian organizations. Comments received during the public comment period will be reviewed, considered and reflected in the draft FONSI (Final EA). Through the EA process, the USAG-HI and ENV will determine whether the Proposed Action may have potentially significant impacts that could not be reduced to less than significant levels with appropriate mitigation.

If impacts are found to have the potential to be significant after the application of mitigation, the USAG-HI would publish a notice of intent in the *Federal Register* to prepare an EIS. Similarly, the ENV, as the approving agency, would not issue a FONSI and would request that an EIS be prepared. If it were determined that no significant impacts would result from implementing the Proposed Action, the USAG-HI and ENV will prepare and sign a FONSI, and the Proposed Action will be permitted to proceed.

A Pre-Consultation Memo and Participant Letter were sent in June 2012 to a variety of agencies and other parties to initiate the environmental review process. These are included as *Appendix A.* A list of agencies and other parties that were presented notice of the proposed project or were contacted during the pre-consultation period of the Draft EA is provided in *Section 8.0* of this document. A listing of those agencies that will be provided an opportunity to review the EA is also provided in *Section 8.0*.

## 1.6 LISTING OF REQUIRED GOVERNMENT PERMITS AND APPROVALS

*Table 1-1* identifies the major State and County permits and approvals that are anticipated to be required to implement the Proposed Action.

**Table 1-1 LISTING OF REQUIRED GOVERNMENT PERMITS AND APPROVALS**

| Approving Authorities | Permit or Approval |
|---|---|
| **Federal** | |
| Department of the Army | Jurisdictional Determination and Section 10 permit, Rivers and Harbors Act of 1899 (if required) |
| Department of the Army | Archaeological Resources Protection Act Permit |
| **State** | |
| Department of Health | National Pollutant Discharge Elimination System Permit |
| Department of Health | Community Noise Permit for Construction activities |
| Department of Health | National Pollutant Discharge Elimination System Construction Dewatering Permit |
| Department of Health | National Pollutant Discharge Elimination System Construction Stormwater Discharge |
| Department of Land and Natural Resources, State Historic Preservation Division | Archaeological Inventory Survey Plan, Conclusion of Historic Preservation Review Process (HRS 6E-42) |
| **City and County of Honolulu** | |
| Department of Planning and Permitting | Building Permit |
| Department of Planning and Permitting | Grubbing, Grading and Stockpiling Permit |
| Department of Planning and Permitting | Trenching Permit |
| Department of Planning and Permitting | Permit to Excavate Public Right-of-Way |
| Department of Planning and Permitting | Construction within a Flood Hazard District approval |
| Department of Transportation Services | Street Usage Permit |

## 1.7 DESCRIPTION OF THE PROPOSED ACTION AND ALTERNATIVES

Two alternatives are fully examined in this EA: the Proposed Action (construction of the Kalia-Fort DeRussy Wastewater System Improvements) and the No Action Alternative.

### 1.7.1 Project Description

The City ENV has identified the KDWSI as necessary and appropriate to improve the wastewater sewer system serving the Kalia-Fort DeRussy Wastewater Service Area and to accommodate future sewer flows expected from the HKH and implementation of the HHV Master Plan (*Figure 1-8*). Completion of the KDWSI has been established as a condition to HHV's ability to obtain Building Permits and a Sewer Connection Permit for Timeshare Tower 1. The KDWSI includes: 1) a new 21-inch diameter sewer line in Kalia Road (945 linear feet) and 2) a new 30-inch diameter sewer line inside the Fort DeRussy property within a City easement area that runs along Ala Moana Boulevard and Kalakaua Avenue (a total of 1,618 linear feet). In addition to the two new lines, an existing 16-inch diameter sewer line traversing diagonally across Fort DeRussy from a point near the intersection of Kalia Road and Ala Moana Boulevard to the Fort DeRussy WWPS will be cut and plugged at Kalia Road, and the line will be abandoned in place. Finally, the pipe replacements between the existing manholes described in part 1.3 above will be completed. Refer to *Figure 1-9*.

1. The existing 1950s 12-inch diameter sewer line in Kalia Road will be replaced with a new 21-inch diameter sewer line to accommodate peak wet weather flow rate of 3.07 mgd. The required flow rate includes capacity for the HKH, HHV Master Plan improvements (including Timeshare Tower 1), the future development capacity of HHV property, and 15 percent excess capacity. The replacement sewer line will begin at the intersection of Paoa Place and Kalia Road and end at the intersection of Ala Moana Boulevard and Kalia Road. The new line will be located just east of the existing line. A trench will be excavated to accommodate the new line. Following completion of the new line, the existing sewer laterals from HHV that connect to the existing 12-inch diameter sewer line will be connected to the new 21-inch diameter sewer line. The 12-inch diameter sewer line will be removed or grout filled, and abandoned in place. Upon completion, the 21-inch diameter sewer line trench will be backfilled, and existing surface improvements and landscaping will be restored.

2. An existing 1960s 24-inch diameter sewer line located within the boundaries of a City easement on federally owned land at Fort DeRussy, will be replaced with a new 30-inch diameter sewer line running along Ala Moana Boulevard from a point near Kalia Road to a point near the intersection of Ala Moana Boulevard and Kalakaua Avenue, and then along Kalakaua Avenue to a point near the existing Fort DeRussy WWPS. The new line will be located in the same easement which contains the existing sewer line. This system will provide capacity for the HKH, HHV Master Plan improvements (including Timeshare Tower 1), the future development capacity of HHV property, other projects known by the City to be planned in the area, and 15 percent excess capacity. The new 30-inch diameter sewer line will accommodate a peak wet weather flow of 8.1 mgd. Trenches will be excavated to expose the existing line, which will be bypassed by a temporary line to allow for the removal of the existing line and the installation of the new line. Upon completion of the new line, the new line will be connected to the new 21-inch Kalia Road line (described in item 1 above) and, by way of the new line (described in item 3 below), to the Fort DeRussy WWPS. Following this, the bypass will be disconnected and

removed, the trench will be backfilled, and existing surface improvements and landscaping in the easement area will be restored.

3. An existing 24-inch diameter sewer line within the Fort DeRussy WWPS, between sewer manhole (9004) and sewer manhole (9003) and between sewer manhole (9003) and the Fort DeRussy WWPS wet well (0000), will be replaced with a new 30-inch diameter sewer line.

4. In addition, an existing 16-inch diameter sewer line crossing Fort DeRussy from the intersection of Kalia Road and Ala Moana Boulevard intersection to the Fort DeRussy WWPS will be cut and plugged with grout.

The work within the Fort DeRussy property will be contained within a sewer line easement granted to the City (1958). See *Table 1-2* for sewer line capacities.

**Table 1-2 SEWER LINE CAPACITIES**

| Location | Pipe Diameter (Inches) | Slope (minimum) | Full Flow Q (mgd) | Required Q (mgd) |
|---|---|---|---|---|
| Kalia Road | 21 | 0.0092 | 3.07 | 2.70 |
| Ala Moana Blvd/ Kalakaua Avenue | 30 | 0.0092 | 8.10 | 8.10 |
| Fort DeRussy WWPS | 30 | 0.00118 | 9.11 | 9.11 |
| Fort DeRussy WWPS | 30 | 0.00124 | 9.34 | 9.33 |

#### 1.7.1.1 Project Location

The project area in which the KDWSI will be completed includes land owned by the State and City within the Kalia Road right-of-way between Ena Road and Paoa Place, federally-owned land inside Fort DeRussy within an easement granted to the City. The easement runs along and adjacent to Ala Moana Boulevard and Kalakaua Avenue, and City-owned land within the Kalakaua Avenue right-of-way. These areas are located in Waikiki, on the Island of Oahu, State of Hawaii (*Figure 1-1*). Access to the area will be modified temporarily during construction. Long-term access will not change.

#### 1.7.1.2 Project Utilities and Infrastructure

***Off-Site Sewer Lines***

Wastewater flow from the majority of the HHV campus flows in a northerly direction toward the Ala Moana Boulevard and Kalia Road intersection through a 15-inch diameter sewer line. At this intersection, wastewater from the 15-inch diameter sewer line is combined with flows from other properties north of the HHV through a 24-inch diameter sewer line (c.1960), which extends from the intersection, along Ala Moana Boulevard and Kalakaua Avenue, to the Fort DeRussy WWPS through an easement just inside the Fort DeRussy Property. A second 24-inch diameter sewer line (2004) located in Ala Moana Boulevard and Kalakaua Avenue, parallels the 24-inch diameter sewer line (c.1960), and conveys wastewater from areas north-east of the HHV to the Fort DeRussy WWPS. The older 24-inch pipe is to be replaced with a new 30-inch pipe pursuant to the Proposed Action. The newer 24-inch diameter sewer line (2004) will not be altered or replaced by the Proposed Action. The locations of the existing sewer lines are shown in *Appendix B*.

Wastewater from the south side of the HHV campus is conveyed through sewer laterals to 8- and 10-inch diameter sewer lines running under Paoa Place, which connects to a 12-inch diameter sewer line in Kalia Road. Wastewater from the east side of the HHV campus is conveyed through sewer laterals to the 12-inch diameter sewer line in Kalia Road. Wastewater from the HKH, including Ilima Tower, restaurants and banquet facilities, also discharges into the 12-inch diameter sewer line in Kalia Road. This combined wastewater from HKH and the south and east sides of HHV flows through the 12-inch diameter sewer line in Kalia Road, to a point of connection with an existing 16-inch diameter sewer line, which carries the combined flow to the Fort DeRussy WWPS through an easement which traverses diagonally through Fort DeRussy from the Ala Moana Boulevard and Kalia Road intersection to the Fort DeRussy WWPS. Portions of the 16-inch diameter sewer line are located under existing structures on Fort DeRussy.

The existing 12-inch diameter sewer line will be replaced with a new 21-inch diameter sewer line as part of the Proposed Action. Instead of connecting to the existing 16-inch diameter sewer line, the new line will connect to the new 30-inch diameter sewer line referred to above, and the 16-inch diameter sewer line will be plugged with grout at the current point of connection. As a result, flow from HKH and the south and east sides of HHV will be carried to the Fort DeRussy WWPS through the new 30-inch diameter sewer line, in the easement that runs along Ala Moana Boulevard and Kalakaua Avenue, instead of through the easement currently occupied by the 16-inch diameter sewer pipe.

Downstream of the Fort DeRussy WWPS, within Kalakaua Avenue, a 12-inch diameter relief sewer line connects the 24-inch diameter sewer line (2004) to the Waikiki Relief Sewer, a 24-inch diameter sewer line. The invert elevation of the 12-inch diameter relief sewer line is at elevation -6.10, and the capacity of the 12-inch diameter relief sewer line is 1.93 mgd. The Waikiki Relief Sewer 24-inch diameter sewer line flows eastward along Kuhio Avenue and connects to the Beach Walk Wastewater Pump Station.

***Fort DeRussy Wastewater Pump Station and Force Main***

The Fort DeRussy WWPS is located near Kalakaua Avenue in a City easement area on the Fort DeRussy property. The Fort DeRussy WWPS was constructed in 1967 and houses three (3) pumps, two (2) for peak flow operations and one (1) for standby. The pumps are 2,755 gallons per minute Morris pumps with 20-inch diameter impellers. Two (2) motors are 75 horsepower variable speed motors, and one (1) motor is a 50 horsepower constant speed motor.

In 2012, R.M. Towill Corporation calculated the operating capacity of the Fort DeRussy WWPS, based on the pump curves and two pumps operating, as 6.95 mgd. The theoretical capacity of the Fort DeRussy WWPS is 7.6 mgd if all three pumps are operating. In November 2011, the City conducted a verification pump flow test at the Fort DeRussy WWPS and determined a flow of approximately 4.77 mgd with a single pump running during the test. Refer to *Appendix B* for the pump, alarm settings and overflow for the Fort DeRussy WWPS.

Within the Fort DeRussy WWPS site, wastewater is discharged from the pump station in a 16-inch diameter force main, then through a 12-inch venturi flow tube which connects to a 20-inch diameter force main (*Appendix B)*. The 20-inch diameter force main extends north along Kalakaua Avenue, crossing the Ala Wai Canal in three 10-inch diameter pipes. After Ala Wai Canal, the three 10-inch diameter pipes merge back into a 20-inch diameter force main, which increases to a 24-inch diameter force main that extends to Kanunu Street, where it discharges into a gravity sewer system.

In April 2012, V&A Consulting Engineers conducted field tests to assess the condition of the sewer force main within the Fort DeRussy WWPS site at the request of the City ENV (*Appendix B*). ENV requested three (3) locations of the force main pipe to be tested; 1) at the discharge pipe within the pump station building, 2) within the venturi meter vault located between the pump station building and Kalakaua Avenue, and 3) at a point between the pump station and the venturi meter vault. Based on the condition of the force main, the City is proceeding with improvements to the Fort DeRussy WWPS and force main. The improvements at the Fort DeRussy WWPS and force main will be designed to include the wastewater flows from the proposed HHV improvements.

#### 1.7.1.3 Construction Characteristics

The construction of the KDWSI will be completed using an open trench method. In general, open cut trenching involves excavation of earth along the entire proposed sewer line alignment. The trench width extends approximately 1.0 feet on either side of the pipe or manhole, and extends about 1.0 feet below the bottom of the pipe. An excavator or backhoe is used to dig the trench, assist in pipe installation and backfilling the trench. Open cut trenching allows a visual inspection of material removed from the trench as construction progresses.

For Kalia Road, a new trench will be excavated parallel to the existing sewer line. New pipe will be installed and existing manholes will be re-channelized and connected to the new pipe. This open trench construction method allows for the installed sewer line to be inspected, resulting in the detection of defects and better grade control.

For the alignment in Fort DeRussy fronting Ala Moana Boulevard and Kalakaua Avenue, the existing trench that houses the 24-inch sewer line will be opened. The 24-inch sewer line will be bypassed and removed and the trench will be widened to accommodate the new 30-inch sewer line. New pipe will be installed and either new manholes installed or existing manholes will be re-channelized and connected to the new pipe, following which the bypass will be removed and the trench will be backfilled.

#### 1.7.1.4 Project Implementation

Due to the development timeline for Timeshare Tower 1 of the HHV Master Plan, the proposed sewer improvements are scheduled to be completed prior to operations and occupancy of the tower in late 2015. Construction of the sewer improvements is expected to commence in 2013.

As shown in *Table 1-3*, the project is expected to cost approximately $13.6 million.

**Table 1-3 SEWER LINE COSTS**

| Sewer Line | Length (LF) | Cost |
|---|---|---|
| 21-inch diameter in Kalia Road | 945 | $4,808,000 |
| 30-inch diameter in Ala Moana Boulevard/Kalakaua Avenue | 1,618 | $8,837,000 |
| **Total Estimated Costs** | | **$13,645,000** |

### 1.7.2 Alternatives Development

In accordance with NEPA and HRS, Chapter 343, the USAG-HI, City ENV, and Hilton have evaluated the following scenarios for improving the existing sewer collection system to accommodate flows from the HHV Master Plan, HKH, and the service area between the Ala Wai Canal, Kalakaua Avenue and Fort DeRussy.

- Proposed alignment and open trench construction for sewer improvements at Kalia Road and Fort DeRussy fronting Ala Moana Boulevard and Kalakaua Avenue (Preferred Alternative);
- Alternate alignments for the sewer improvements; and
- Alternate construction methods for the sewer improvements.

To determine which scenario would best achieve the purpose and need for the project improvements, the project team considered potential methods and alignments that would provide the most efficient and cost-effective method that would meet applicable City design standards. It was determined that the sewer improvements should also be implemented in a manner that is culturally sensitive to the historic nature of the Kalia, Waikiki area.

The USAG-HI, City, and Hilton applied the following screening criteria to the potential alternatives:

- Meets City ENV flow requirements and accommodates the approved HHV Master Plan project, and other contributing sources in the service area.
- Ensures construction of the sewer improvements does not result in significant adverse environmental, cultural, and socioeconomic impacts.
- Meets the development timeline for the construction for occupancy of the HHV Master Plan Timeshare Tower 1 by late 2015.

### 1.7.3 Proposed Action – Construct Sewer Improvements at Kalia Road and Fort DeRussy Fronting Ala Moana Boulevard and Kalakaua Avenue (Preferred Alternative)

Under the Proposed Action, the sewer improvements would be constructed at Kalia Road and on portions of the Fort DeRussy property fronting Ala Moana Boulevard and Kalakaua Avenue to accommodate flows from the HHV Master Plan, HKH, and the service area between the Ala Wai Canal, Kalakaua Avenue and Fort DeRussy. The existing 12-inch diameter sewer line in Kalia Road would be replaced with a new 21-inch diameter sewer line, the existing 16-inch diameter sewer line traversing across Fort DeRussy would be cut and plugged at the Ala Moana Boulevard and Kalia Road intersection, and the existing 24-inch diameter sewer line installed on the Fort DeRussy property in the 1960s along Ala Moana Boulevard and Kalakaua Avenue (but not the 2004 sewer line in the streets) will be replaced by a 30-inch diameter sewer line. Open cut trenching would be used for construction of the sewer line improvements.

Construction of the sewer improvements would be scheduled to meet the development timeline for the completion of the HHV Master Plan Timeshare Tower 1 in late 2015. There is the potential that the project schedule could change, or the project could be abandoned or replaced with a different project. The impacts of the Proposed Action as described in *Section 1.7.1* are analyzed in this EA. Some project details presented in this EA may be changed as the technical system requirements and designs are refined.

USAG-HI, City, and Hilton could make changes in the Proposed Action in response to relevant environmental concerns, or could identify new circumstances or information relevant to environmental concerns that bear on the Proposed Action and its impacts. If either were to happen, USAG-HI, City and Hilton would review the changes and new circumstances to determine if supplemental NEPA or State EA documentation must be completed, as required by 32 CFR, Part 651 and Chapter 343, HRS.

### 1.7.4 No Action Alternative

The No-Action Alternative is the baseline against which other alternatives are measured. "No Action" is not considered a feasible alternative. The existing sewer system servicing the Kalia-Fort DeRussy Wastewater Service Area currently lacks the capacity necessary to accommodate Timeshare Tower 1 or other elements of the approved HHV Master Plan. Under the No-Action Alternative, the existing wastewater system in the vicinity of the project would continue to operate near capacity.

Although the No-Action alternative would eliminate short-term construction related impacts in the project area, a system failure may be more likely to occur which would result in adverse impacts to coastal resources and public health that are considered far greater than the temporary and limited impact of the Preferred Alternative.

### 1.7.5 Alternatives Considered but Eliminated from Further Analysis

Other alternatives were initially considered but were abandoned as infeasible, or because they failed to meet all screening criteria, or because they posed greater environmental, social or cultural impact than the Proposed Action, or because they required greater cost without significantly reducing environmental, cultural or social impact when compared to the Proposed Action. The rejected alternatives include: (a) constructing alternate sewer lines in other locations, (b) employing alternate construction techniques (pipe bursting, microtunneling, horizontal directional drilling) for the KDWSI; and (c) employing alternative technology, such as on-site wastewater treatment and reuse disposal. The reasons for dismissing these alternatives are discussed in further detail below.

***Use Alternate Alignments for Sewer Improvements***

Various on-site and off-site sewer line routing alternatives were considered in this EA, as summarized below.

Routing wastewater flows within the HHV campus from Timeshare Tower 1 was considered as an alternative that would limit the need to make sewer line improvements in Kalia Road. Routing wastewater flows within the HHV campus to the north end, along Ala Moana Boulevard would have required installation of a wastewater holding tank and pump station within the basement of Timeshare Tower 1 (or another building) and construction of a new sewer force main through the campus. The costs and complexities of maintaining the pump station, and the risk of pump failure and wastewater release in an occupied building, were determined to present a far greater risk to Hilton and the community than placing a less complicated, new gravity sewer line in Kalia Road. Moreover, the limited space available on the HHV campus presented considerable challenges to routing a new sewer force main that would not disrupt operations.

Off-site sewer line routes were considered through Fort DeRussy to the WWPS, including (1) replacement of the 16-inch diameter sewer line that runs diagonally through Fort DeRussy from a point near the intersection of Kalia Road and Ala Moana Boulevard to the existing Fort DeRussy WWPS , (2) a new sewer line running south of the existing HKH parking structure, (3) a new sewer line adjacent to the existing 24-inch diameter sewer line (1960) on either the north or south side of the existing easement and sewer line, and (4) a new sewer line running north of the existing HKH parking structure, positioned between the existing 16-inch diameter sewer line and the 24-inch diameter sewer line that is to be replaced as part of the KDWSI.

Installing a new sewer line through Fort DeRussy would require an approval by the U.S. Congress in order to grant the City a new easement over the Fort DeRussy property. The time required to obtain such an easement posed challenges to the project schedule. In addition, it was determined that the risk of impact to areas of archaeological or cultural significance from installing one or more new lines in locations that had not previously been trenched was significantly greater than the impact that would be expected from trenching on land that had already been disturbed, and there would likely be no savings in cost, effort, or impact in terms of dust, noise, visual impairment or risk to natural resources when compared to the Proposed Action. Trenching over existing lines was determined to be superior to trenching in new locations, and trenching over the existing 16-inch diameter sewer line running diagonally through Fort DeRussy was determined to be impractical because that line runs under one or more existing buildings.

In short, construction of these alignments would have resulted in one or more of the following: (1) complexities that would significantly disrupt the existing HHV campus and pose a significant risk to public health if the technologies failed, (2) significantly greater risks of adverse impacts to cultural and archaeological resources, (3) the uncertainty of obtaining Congressional approval and an easement for new sewer lines within the Fort DeRussy property (and the challenge of obtaining such an easement within the development timeline for Timeshare Tower 1) and (4) increased costs due to the need to work around existing buildings or other improvements.

For these reasons, the alternatives described above were dismissed.

***Use Alternate Construction Method for Sewer Improvements***

Various construction methods were considered for constructing the KDWSI in the project area. These include pipe bursting, micro-tunneling, and horizontal directional drilling.

Pipe bursting is a trenchless method of construction which involves an expander head which is pulled through the pipe to be replaced and breaks the existing pipe into small pieces. The new pipe is pulled behind the expander head, replacing the existing pipe. This method of construction is typically used to replace old pipe with new pipe of the same diameter or one size larger. This construction method was determined to be unfeasible for this project because the existing 24-inch diameter sewer line is reinforced concrete pipe, which cannot be easily burst due to the reinforcing steel, and because replacement of the existing 12-inch diameter pipe in Kalia Road with a 21-inch diameter pipe is too large of an expansion, which would cause upheaval of the ground.

Microtunneling is another trenchless method of construction that utilizes a laser-guided steerable boring machine. A cutting and crusher head is pushed forward from a jacking unit located within an excavated jacking shaft to an excavated receiving shaft. As the head moves forward, lengths of pipe are pushed behind the boring machine, while liquefied excavated material is pumped from the microtunneled alignment to an above ground separation plant. Excavated material is removed as the cutting head advances using a “slurry system” that liquefies the excavated material into a slurry form for pumping to an above ground separation plant, where the excavated spoils are removed and dewatered for disposal. The jacking and receiving shafts are typically located at or adjacent to existing manholes. Microtunneling also requires a jet grout silo, approximately ten (10) feet wide by 120 feet long. Jet grouting would create three (3) feet diameter earth grout columns spaced approximately two and one-half (2.5) feet apart. The contractor would jet grout the shafts, install sheet piles and open cut excavate the pits. The jet grouting and sheet piles would cut off water from the excavation and allow the construction to proceed without dewatering.

Horizontal directional drilling is a trenchless method of construction where a pilot hole is drilled from the ground surface down to the design depth and along the proposed alignment. A larger cutting head (a back reamer) is passed through the pilot hole to enlarge the hole. The pipe is pulled behind the reamer. During the drilling a viscous fluid of water and bentonite or polymer is pumped to the drilling head to facilitate removal of cuttings. Drill cuttings are pumped to a reclaimer for separation from the fluid.

Several alternative construction methods were considered for sewer line improvements along Kalia Road and Fort DeRussy, including trenchless construction methods. While there are many advantages for utilizing trenchless construction, these alternative methods were deemed unacceptable for the Proposed Action because of the potential for significant adverse impacts to archaeological/cultural resources. Using trenchless technologies, such as pipe bursting, microtunneling, or horizontal directional drilling, would require major excavation areas at either end of the alignment to create jacking and receiving work pits. For this project, these work pit excavations would affect areas shown in studies to have very high potential for undisturbed archaeological/cultural resources, and possibly including human burials. Additionally, the trenchless alternative would also require trenching across Kalia Road in three (3) locations to allow for the extension of Hilton’s lateral service connections to the current 12-inch sewer. Jet grouting would also be required along the alignment, which involves vertical drilling and grout placement every 10-15 feet, which would also pose additional potential for adverse impacts to cultural resources.

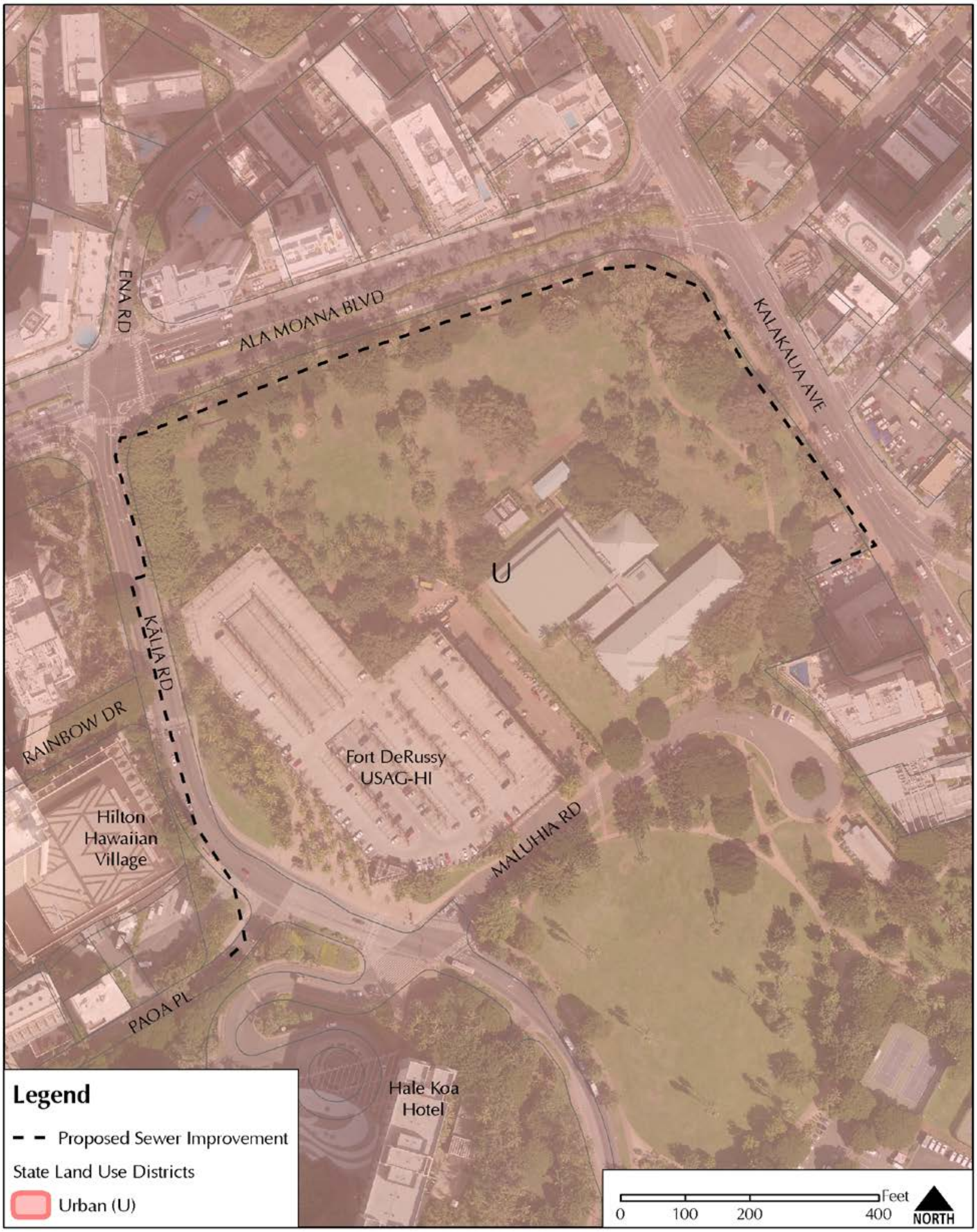
***Use Alternate On-site Wastewater Treatment and Reuse Disposal System***

Another alternative for collecting, treating and re-using wastewater in this portion of the Service Area would be the use of membrane bioreactor (MBR) technology. MBR wastewater treatment facilities are potentially applicable to projects that have large areas of land available for the construction of an on-site treatment facility, and for storage and disposal (reuse) of treated wastewater via landscape irrigation. MBR systems have been shown to provide treatment levels that satisfy State DOH requirements for irrigation disposal. The MBR system alternative could also produce irrigation water savings for HHV, the City and Fort DeRussy. The only nearby area large enough to develop the MBR system, however, would be the open space area within the Fort DeRussy property. The new MBR system would require project teaming of the Army with Hilton and the City for the long-term wastewater treatment and disposal use. In addition, it would require a new multi-year process to obtain Congressional approval for the new easement. Several acres of land would be committed to this long-term wastewater treatment function, at a site located in the middle of Waikiki and very near the beach and ocean. The MBR facility would exclude future uses of a portion of Fort DeRussy and create new environmental risks.

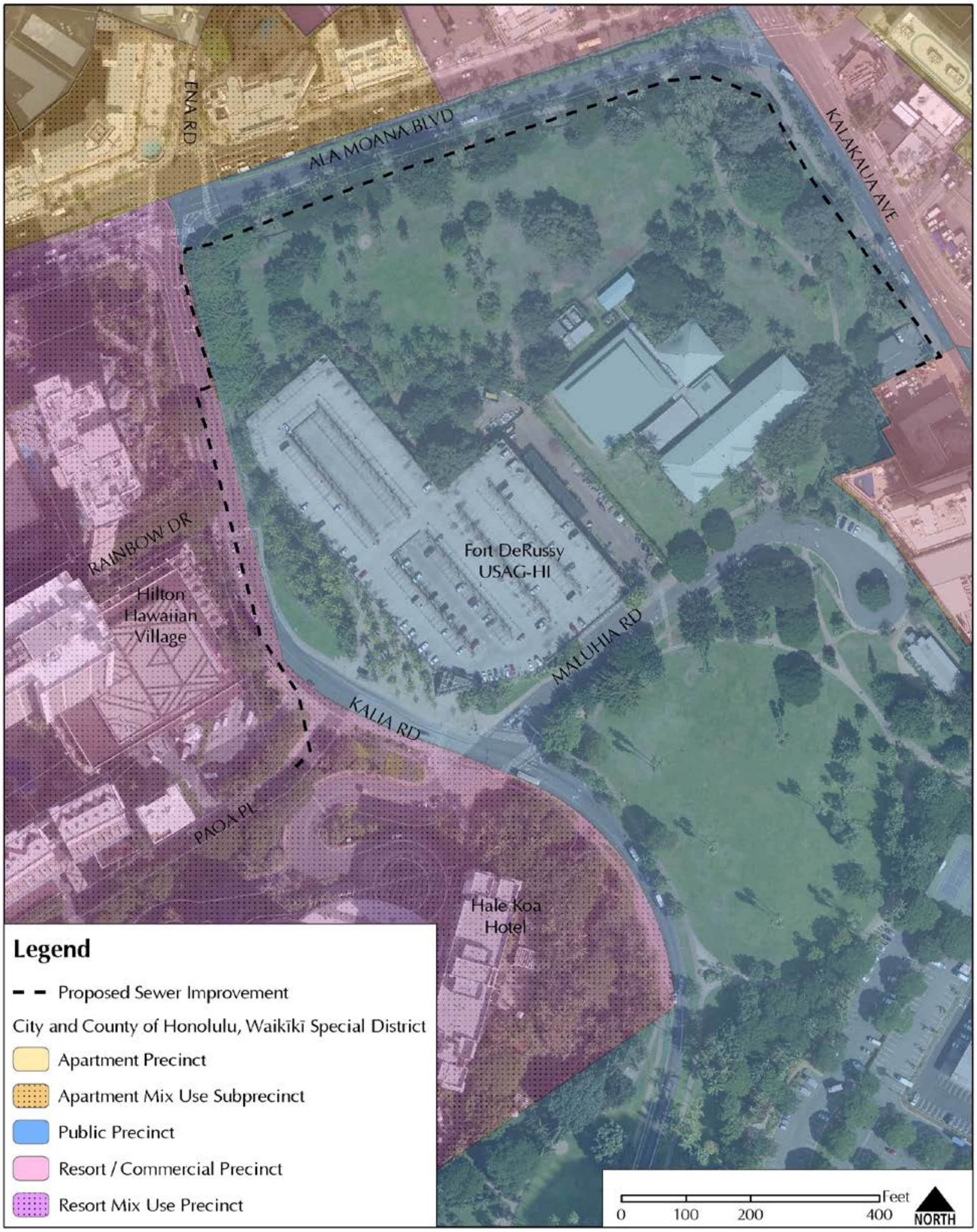
Other drawbacks to this alternative would be the increased subsurface disturbance involved with the new treatment facility, along with excavation for sewer lines leading to this new facility. Further, an effluent disposal system would need to be provided, involving the installation of new subsurface lines for an irrigation system serving the Fort DeRussy grounds. The State DOH would also require 30 days of effluent storage and backup disposal system, likely an injection well. These systems would require more land to be affected, posing new risks to subsurface cultural resources, and the injection disposal system could pose the potential for affecting near shore water quality in Waikiki. Aside from land area limitations, this alternative would not avoid the need to replace the existing pipe under Kalia Road, nor would it eliminate the need to upgrade the 1960s era 24-inch diameter sewer line around Fort DeRussy. The alternative would also impair the government’s ability to use the affected land for other purposes (making approval of the necessary easement more challenging). Because of the cost and uncertainty of implementing this alternative within the project timeline, this alternative was dismissed.


**PROJECT LOCATION**
**KALIA-FORT DERUSSY WASTEWATER SYSTEM IMPROVEMENTS** **FIGURE 1-1**

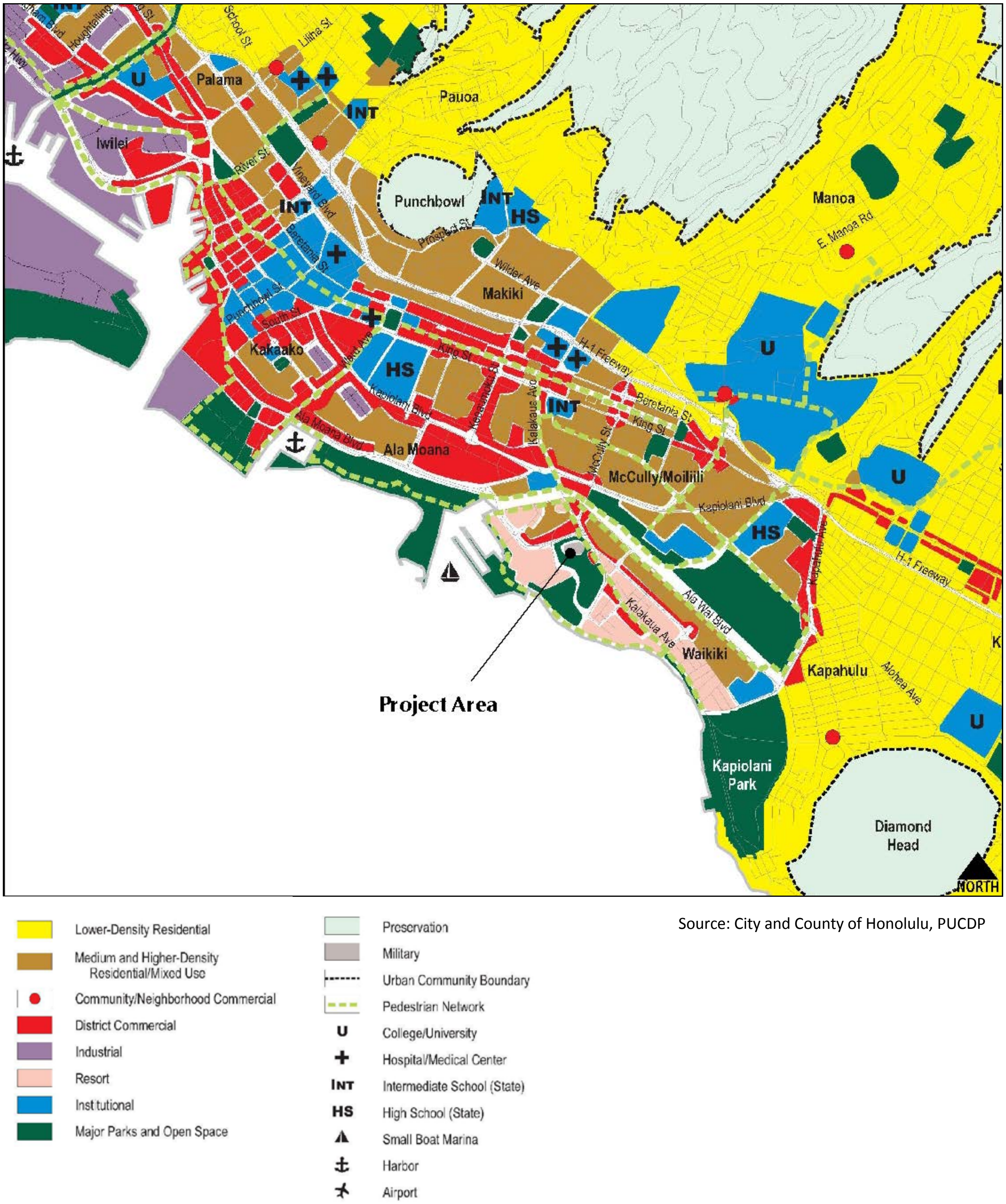

CITY AND COUNTY OF HONOLULU, TAX MAP KEY PARCELS
KALIA-FORT DERUSSY WASTEWATER SYSTEM IMPROVEMENTS FIGURE 1-2




**STATE LAND USE DISTRICTS DESIGNATION**
**KALIA-FORT DERUSSY WASTEWATER SYSTEM SEWER IMPROVEMENTS** **FIGURE 1-3**



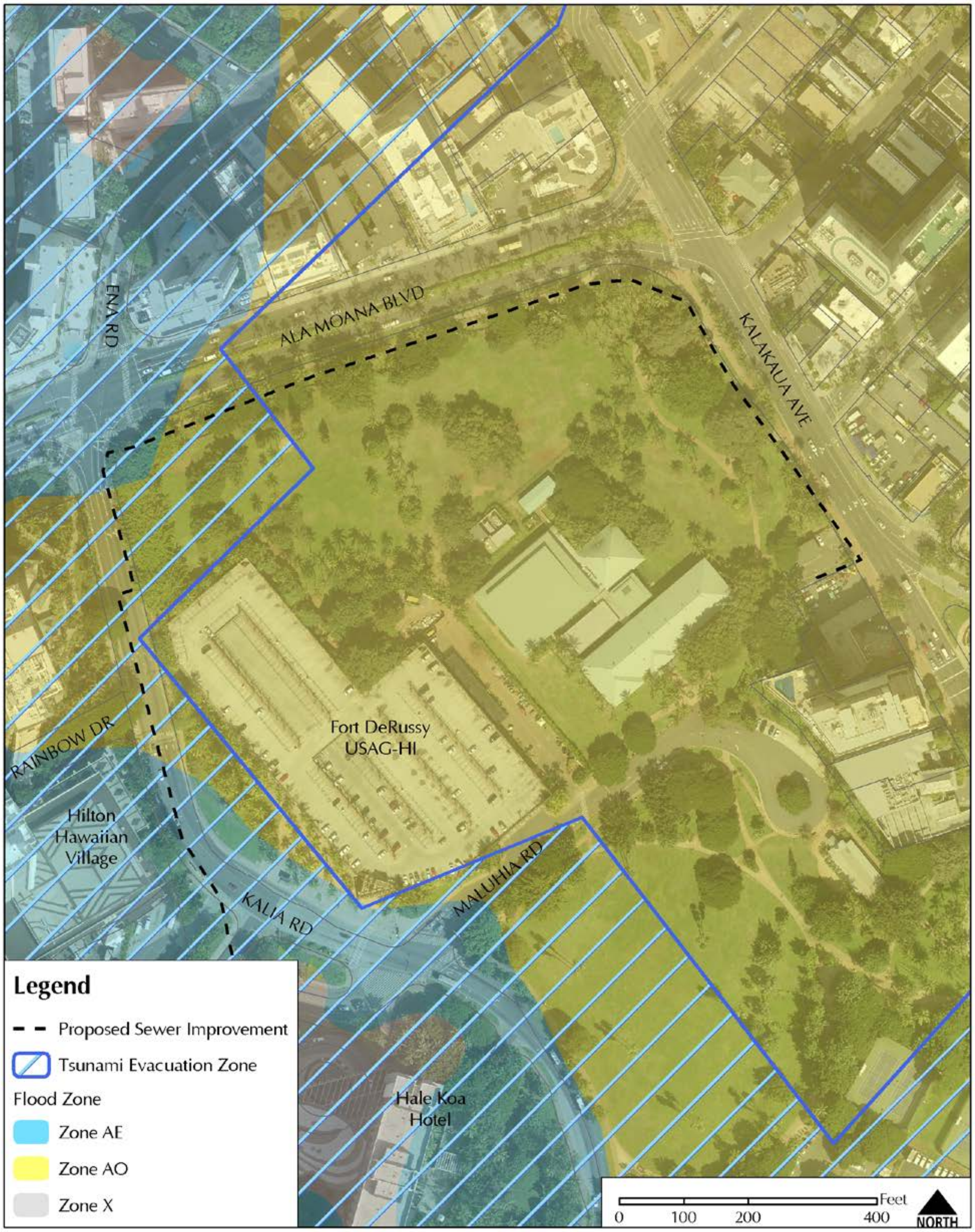

**CITY AND COUNTY OF HONOLULU ZONING AND WAIKIKI SPECIAL DISTRICT DESIGNATIONS**
**KALIA-FORT DERUSSY WASTEWATER SYSTEM IMPROVEMENTS** **FIGURE 1-4**




Source: City and County of Honolulu, PUCDP

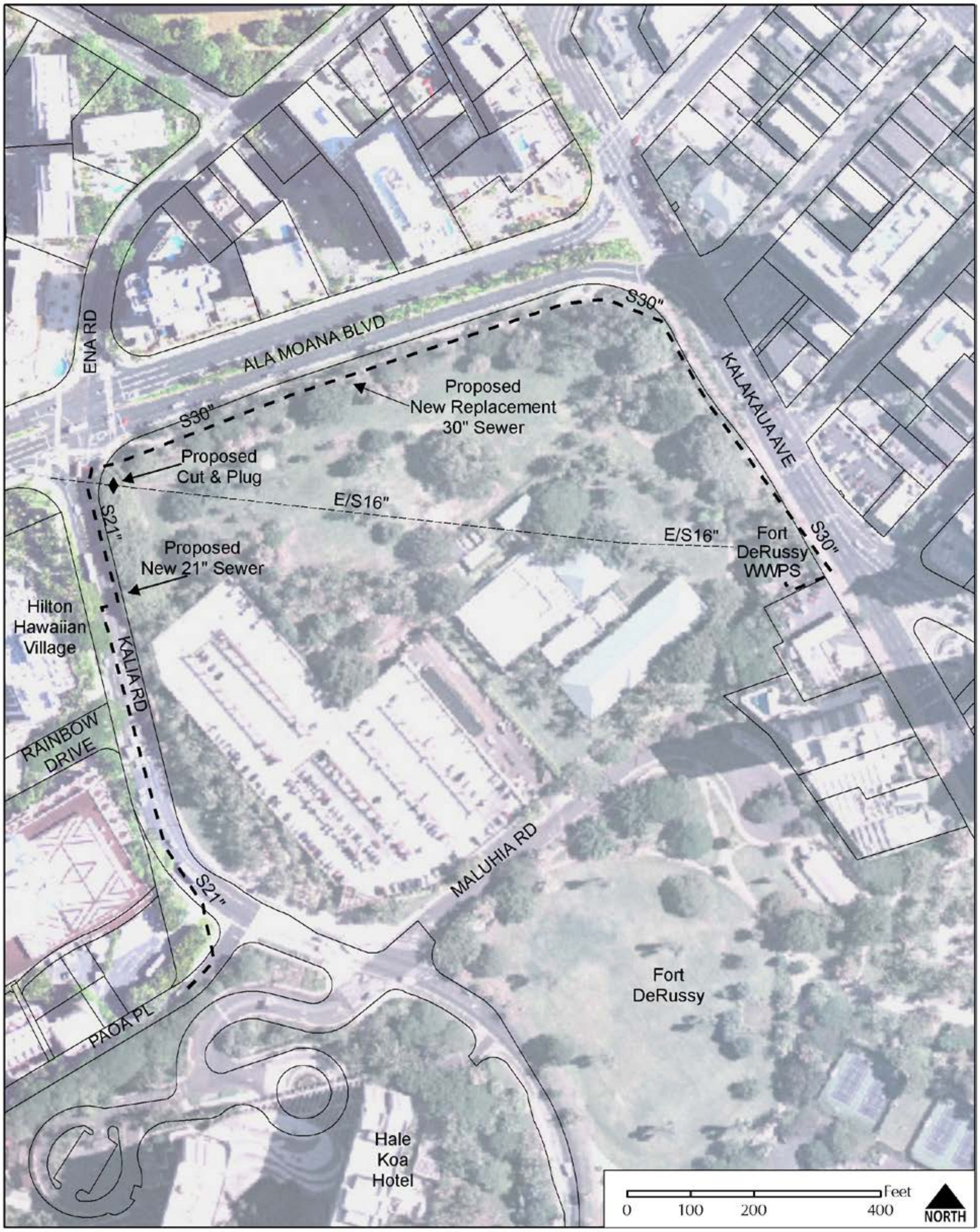
**CITY AND COUNTY OF HONOLULU, PRIMARY URBAN CENTER LAND USE DESIGNATION**
**KALIA-FORT DERUSSY WASTEWATER SYSTEM IMPROVEMENTS** **FIGURE 1-5**


**CITY AND COUNTY OF HONOLULU, SPECIAL MANAGEMENT AREA**
**KALIA-FORT DERUSSY WASTEWATER SYSTEM IMPROVEMENTS** **FIGURE 1-6**




**FEDERAL EMERGENCY MANAGEMENT AGENCY FLOOD ZONE AND TSUNAMI EVACUATION ZONE**
**KALIA-FORT DERUSSY WASTEWATER SYSTEM IMPROVEMENTS** **FIGURE 1-7**


KALIA-FORT DERUSSY WASTEWATER SERVICE DISTRICT
KALIA-FORT DERUSSY WASTEWATER SYSTEM IMPROVEMENTS FIGURE 1-8




**CONCEPTUAL SEWER LINE ALIGNMENT**
**KALIA-FORT DERUSSY WASTEWATER SYSTEM IMPROVEMENTS** **FIGURE 1-9**

# 2.0 AFFECTED ENVIRONMENT AND ENVIRONMENTAL CONSEQUENCES

# SECTION 2.0
# AFFECTED ENVIRONMENT AND ENVIRONMENTAL CHARACTERISTICS

## 2.1 INTRODUCTION

This chapter provides an overview of the baseline physical, biological, social, and economic conditions of VECs that occur within the region of influence (ROI) of the Proposed Action. This chapter also contains the evaluation of the potential impacts on the VECs of the Proposed Action and No Action Alternatives. Relevant environmental and socioe-conomic conditions to the Proposed Action are described, including the following resource or condition categories:

2.2 Land Use
2.3 Socioeconomics Characteristics
2.4 Traffic and Roadways
2.5 Noise
2.6 Air Quality
2.7 Geology, Soils and Seismicity
2.8 Natural Hazards
2.9 Water Resources
2.10 Hazardous Materials
2.11 Public, Facilities, Services and Utilities
2.12 Biological Resources
2.13 Cultural Resources
2.14 Visual Resources
2.15 Environmental Justice

The impact analysis includes beneficial and adverse impacts on the human environment, including short-term and long-term impacts, direct and indirect impacts, and cumulative impacts. The analysis of impacts on resources focuses on environmental issues in proportion to their potential effects. Detailed consideration is given to resources or areas that have a potential for environmental impacts. Impacts under the No Action Alternative are compared against the baseline condition of each resource or condition category.

### 2.1.1 Chapter Organization

Each section details the methods used for impact analysis and those factors used to determine the significance of impacts (40 CFR 1508.8). Impacts are described where they occur for each resource or condition, including both direct and indirect impacts (direct impacts are caused by the Proposed Action and occur at the same time and place, while indirect impacts are caused by the Proposed Action and occur later or at a distance from the Proposed Action). *Section 3.0* discusses cumulative effects and examines whether the Proposed Action will contribute to cumulative impacts on each resource or condition category.

### 2.1.2 Terminology

To determine whether an impact is major, CEQ regulations require the consideration of context and intensity of impacts (40 CFR 1508.27). Context typically refers to the setting, whether the impact is local or regional, and intensity refers to the severity and duration of the impact. The potential conflicts between the Proposed Action and the objectives of Federal, State, and Local plans and policies for the area concerned (40 CFR 1502.16 C) are also discussed.

Impacts are described by the following levels of significance:

- Significant impact;
- Significant impact but mitigable to less than significant;
- Less than significant impact; or
- No impact.

An impact may be described as beneficial or adverse. There may be both adverse (defined as significant, significant but mitigable, and less than significant) and beneficial impacts within a single resource category. Where there are adverse and beneficial impacts, both are described. Mitigation is identified where it may reduce the significance of an impact.

### 2.1.3 Summary of Impacts

*Table 2-1* presents the environmental, cultural, and socio-economic impacts of the No Action Alternative and the Proposed Action. Less than significant impacts were identified for most resource areas.

**Table 2-1 SUMMARY OF POTENTIAL IMPACTS FOR NO ACTION ALTERNATIVE AND PROPOSED ACTION (PREFERRED ALTERNATIVE)**

| Impact Area | No Action Alternative | Proposed Action (Preferred Alternative) |
|---|---|---|
| Land Use | No impact | No impact |
| Socioeconomic | No impact | Beneficial |
| Traffic and Roadways | No impact | Significant impact but mitigable to less than significant |
| Noise | No impact | Significant impact but mitigable to less than significant |
| Air Quality | No impact | Less than significant impact |
| Geology, Soils and Seismicity | No impact | Less than significant impact |
| Natural Hazards | No impact | No impact |
| Water Resources | No impact | Beneficial/Less than significant impact |
| Hazardous Materials | No impact | No impact |
| Public Facilities, Services and Utilities | No impact | Beneficial/Less than significant impact |
| Biological Resources | No impact | Less than significant impact |
| Cultural Resources | No impact | Significant impact but mitigable to less than significant |
| Visual Resources | No impact | Less than significant impact |
| Environmental Justice | No impact | Beneficial |
| Note: In cases when there would be both beneficial and adverse impacts, both are shown on this table. | | |

## 2.2 LAND USE

### 2.2.1 Affected Environment

***Introduction and Region of Influence***

This section summarizes the affected environment in the context of the Proposed Action. For the purpose of this evaluation, the ROI is defined as Kalia Road and the portions of Fort DeRussy fronting Ala Moana Boulevard and Kalakaua Avenue, in Waikiki, Oahu.

Additional discussion relating to the Proposed Action's consistency with applicable land use policies set forth in the Hawaii State Plan, State Land Use Law, State Coastal Zone Management (CZM) Program, Hawaii 2050 Sustainable Plan, City and County of Honolulu General Plan, PUCDP), WSD, and SMA is provided in *Section 4.0* of this EA.

***Regulatory Framework***

The following laws and governmental policies affect the analysis of the Proposed Action and No Action Alternative:

<u>Coastal Zone Management Act</u>

The Coastal Zone Management Act of 1972 (CZMA), as amended (16 USC, Section 145 et seq.), encourages coastal states to manage and conserve the coastal area as a unique irreplaceable resource. Federal activities that affect land or water uses or natural resources of the coastal zone must be carried out in compliance with the enforceable policies of federally approved state coastal zone management programs. For the Proposed Action, a Federal consistency determination is not required because the Proposed Action is not located in the City designated SMA and will have no potential adverse impacts on coastal resources. However, the sewer system will connect with existing laterals located within the SMA to serve approved developments. In addition, the CZMA states that land subject solely to the discretion of the Federal government, such as federally owned or leased property like Fort DeRussy, is excluded from the State and County's coastal zone.

<u>Hawaii State Plan</u>

Under HRS Chapter 226 (Hawaii State Planning Act), the Hawaii State Plan serves as a guide for the future long-range development of the State. The Hawaii State Plan identifies the goals, objectives, policies, and priorities for the State; provides a basis for determining priorities and allocating limited resources, such as public funds, services, human resources, land, energy, water, and other resources; improves coordination of Federal, State, and County plans, policies, programs, projects, and regulatory activities; and establishes a system for plan formulation and program coordination to provide for an integration of all major State and County activities. Act 181, Session Laws of Hawaii 2011, was signed into law on July 5, 2011. Act 181 provides an update to HRS, Chapter 226 by adding a new section to Part III.

The State shall strive to improve the quality of life for Hawaii's present and future population through the pursuit of desirable courses of action in six major areas of statewide concern which merit priority attention: economic development, population growth and land resource management, affordable housing, crime and criminal justice, quality education, and principles of sustainability.

*City and County of Honolulu General Plan*

Adopted in 1977, the 1992 revised edition of the General Plan for the City sets forth the long-range objectives for the general welfare and prosperity of the people of Oahu and broad policies to attain those objectives. The General Plan provides objectives and policies intended to guide and coordinate City land use planning and regulation, and budgeting for operations and capital improvements.

*Primary Urban Center Development Plan*

The PUCDP was developed by the City's DPP in 2004 as a way to shape the growth and development of the Honolulu Primary Urban Center (PUC) over 20 years. The planning goal of the PUCDP is to enhance the livability of the PUC while accommodating a moderate amount of growth. The PUCDP establishes the region's role in Oahu's development pattern by establishing policies in the following areas:

- Natural, historic, cultural and scenic resources
- Parks and recreation areas
- Lower- and higher-density residential neighborhoods
- Commercial and visitor industry facilities
- Military installations, transportation centers and industrial areas
- Design of streets and buildings
- Neighborhood planning
- Transportation networks and systems

*Waikiki Special District*

As a recognized resort destination, Waikiki continues to attract visitors from all parts of the world, serving as the foundation for the state's tourist industry, identified as a major and vital employment sector, and home for thousands of full-time residents. As such, in the City's commitment to maintain the socio-economic vitality of Waikiki, the area is designated as a Special District, with specific design standards and guidelines established to direct its future growth (Land Use Ordnance [LUO], Sec. 21-9.80). The establishment of the WSD was largely a response to the rapid development of the 1960s and 1970s, and the physical and social changes attributed to that development. The LUO's WSD Guidelines are a planning tool aimed at restoring the basic appeal of Waikiki as a pedestrian-friendly environment. To complement the strong urban image that Waikiki possesses, emphasis is placed on developing creative and functional uses of the ground-level open space. The focus of open space helps to define a "Hawaiian sense of place" as stated in the objectives of the WSD Guidelines that are enumerated in Section 7.80-1 of the LUO.

***Overview of Valued Environmental Component***

The proposed project area is located in Waikiki, Oahu. The existing land uses within the ROI are public streets, sidewalks, and landscaped areas, along with urban development, defined as a mix of buildings that vary in height, mass and use. This built landscape is complemented by open space areas, such as Fort DeRussy Park.

The land uses bordering the project sites are all classified by the State Land Use Commission (LUC) as State Land Use Urban District (*Figure 1-3*). Land uses to the west and southeast include the HHV campus and HKH, respectively. Various apartment buildings, condominiums, hotels and retail areas are located to the north and east of the project areas. These adjacent land areas are designated as

Apartment Precinct, Apartment Mixed Use Sub-precinct, Resort/Commercial Precinct, and Resort Mixed Use Precinct by the City (*Figure 1-4*). The proposed sewer alignment also borders Fort DeRussy Armed Services Recreation Center which is designated as Public Precinct (*Figure 1-8*). The Proposed Action and use of the site for the wastewater system improvements is consistent with the existing zoning of the property and surrounding area.

### 2.2.2 Environmental Consequences

***Impact Methodology***

Impacts on land use were assessed based on review and analysis of applicable Federal, State and City land use plans, ordinances, and regulations. Policies applicable to the Proposed Action were identified to determine the potential impacts the Proposed Action would have on policies and regulations. Compliance with regulatory and environmental regulations and policies was analyzed, as required by the NEPA of 1969, AR 200-1: Environmental Protection and Enhancement, and by 32 CFR 651, Environmental Analysis of Army Actions. In addition, potential impacts on surrounding land uses and land use policies and provisions were analyzed.

***Factors Considered for Impacts Analysis***

The evaluation of potential impacts on land use was based on the following:

- Existing land uses at the project area;
- Consistency with adopted Federal, State, and City ordinances and land use plans; and
- Unique characteristics of the geographical area (40 CFR, Section 1508.27), such as parks, reserves, or prime farmlands.

***Summary of Impacts***

*Table 2-2* is a summary of land use impacts of the Proposed Action and the No Action Alternative.

| Table 2-2 SUMMARY OF POTENTIAL IMPACTS ON LAND USE | | |
|---|---|---|
| **Impact Issues** | **No Action Alternative** | **Proposed Action (Preferred Alternative)** |
| Land use | No impact | No impact |

***Proposed Action (Preferred Alternative)***

The Proposed Action will not result in significant impacts to land use. The proposed uses of these areas are consistent with designated Federal, State and County SMA, land use and zoning districts. *Section 4.0* of this EA provides additional discussions on the Proposed Action and its consistency with applicable land use plans and policies.

Based on the parameters of this project, a Federal consistency determination is not required because potential impacts on the coastal zone are negligible. The Proposed Action is not located in the City's designated SMA, but roughly parallels the SMA boundary along the Kalia Road alignment. The project will affect lands within the SMA boundary by replacing existing sewer laterals to serve approved developments. Furthermore, the CZMA states that land subject solely to the discretion of the Federal government, such as Federal-owned or leased property like Fort DeRussy, is excluded from the State and County's coastal zone.

As classified by the State LUC, the project areas are situated within the State Urban District. The proposed uses are consistent with permitted uses for the Urban District, and will not require district reclassification or boundary amendment. The project areas are located in the WSD's Resort Mixed Use Precinct and Public Precinct. The proposed sewer improvements are consistent with permitted uses of these precincts. No change in the existing land use designation will be required for the Proposed Action. The Proposed Action is also consistent with the Hawaii State Plan, City and County of Honolulu General Plan and City's PUCDP. The project is consistent with the surrounding properties and will improve wastewater the service area between the Ala Wai Canal, Kalakaua Avenue and Fort DeRussy, and sewer flows from the HKH and the HHV Master Plan.

***No Action Alternative***

The No Action Alternative would result in no change to the land uses at Kalia Road, Fort DeRussy fronting Ala Moana Boulevard, and Kalakaua Avenue. There would be no impacts on the land use goals and policies of the Federal CZMA or State and County land plans. However, the No Action Alternative would not support plan goals relating to maintaining and implementing wastewater collection system improvements to provide adequate service and sound facilities to existing neighborhoods and timely increases in system capacity to areas planned to undergo improvement or change in use. Without replacement of the existing sewer lines, the City's sewer collection system for the Kalia-DeRussy Service District may require additional costly maintenance, or otherwise experience failure over time.

## 2.3 SOCIO-ECONOMIC CHARACTERISTICS

### 2.3.1 Affected Environment

***Introduction and Region of Influence***

The Proposed Action is located in the Waikiki community of Honolulu. Waikiki is a densely populated area located on the south shore of the island of Oahu. The project area is located in Waikiki Neighborhood Board No. 9, comprised of six census tracts: 18.01, 18.03, 18.04, 19.01, 19.02, 19.03, 20.03, 20.04, 20.05, and 20.6. Waikiki is considered to be both a residential and resort community where visitors and residents interact as they carry out their respective activities.

The ROI for socio-economic conditions is the Waikiki community of Honolulu. The Proposed Action and the No Action are reviewed and evaluated to identify potential beneficial or adverse impacts in the ROI. The socio-economic indicators used for this study are population, employment levels, income, housing, and quality of life. These indicators characterize the ROI.

***Overview of Valued Environmental and Social Component***

<u>*Population and Demographics*</u>

In 2010, Waikiki had a residential population of approximately 20,095, which was approximately 2.1% of Oahu's total population. The average daily visitor population of Waikiki consists of approximately 72,000 visitors and 56,000 visitor industry jobs (Department of Business, Economic Development, and Tourism [DBEDT], 2003). As shown in *Table 2-3*, Waikiki's population is generally older than the Oahu population; and has a racial mix with proportionately more Caucasians and Asians and fewer Native Hawaiian or Pacific Islanders in comparison to the rest of Oahu's population. Proportionately, homeownership rates were higher and vacancy rates lower than the island-wide rates. Many vacant units in Waikiki are held for occasional use as timeshares or second homes. Most Waikiki residents are apartment dwellers, almost half of which are single occupants.

| Table 2-3 WAIKIKI VS. OAHU POPULATION AND DEMOGRAPHICS, 2010 | | |
|---|---|---|
| | **Waikiki** | **Oahu** |
| **Total Population** | **20,095** | **953,207** |
| **Age (% of Total Population)** | | |
| Under 5 Years | 3.3% | 6.4% |
| 5-19 Years | 8.2% | 18.3% |
| 20-64 Years | 70.3% | 60.8% |
| 65 Years and Older | 18.0% | 14.5% |
| **Median Age** | **43.2 yr** | **37.8 yr** |
| **Race (% of Total Population)** | | |
| White (alone) | 41.2% | 20.8% |
| Asian (alone) | 37.9% | 43.9% |
| Native Hawaiian and other Pacific Islander (alone) | 4.5% | 9.5% |
| Other Races (alone) | 1.2% | 1.1% |
| Two or More Races | 12.8% | 22.3% |
| **Housing Occupancy and Tenure** | | |
| **Total Housing Units** | **22,750** | **336,899** |
| Occupied Units | 72.1% | 92.3% |
| By Owner (% of all occupied units) | 38.6% | 56.1% |
| By Renter | 61.4% | 43.9% |
| Vacant Units | 27.9% | 7.7% |
| For Rent | 8.3% | 2.6% |
| For Sale Only | 0.8% | 0.6% |
| For Seasonal, Recreational, or Occasional Use | 17.0% | 2.6% |
| Other Vacant | 1.4% | 1.5% |
| **Household Type** | | |
| Total Occupied Households | 16,393 | 311,047 |
| Family Households | 39.8% | 70.0% |
| Married Couple Family (% of All Family Households) | 29.5% | 51.8% |
| With Own Children Under 18 (% of All Married) | 7.4% | 21.2% |
| Other Family (% of All Family Households) | 10.4% | 18.2% |
| Male householder, no Wife Present (% of All Other Family) | 3.2% | 5.5% |
| Female Householder, No Husband Present | 7.1% | 12.7% |
| Non-family Households | 60.2% | 30.0% |
| **Average Persons per Household** | **1.87** | **2.95** |
| Source: US Census Bureau. 2010 Decennial Census | | |

Over the last 40 years, Waikiki's residential population growth rate increased sharply in the 1970's and 1980's and leveled off in the 1990's (*Table 2-4*). Following the 1990's, the residential population growth rate in Waikiki essentially stopped and decreased slightly. From 2000 to 2010, Waikiki's population began to grow again, increasing by 1.90%.

| Table 2-4 POPULATION TRENDS, 1970-2010 | | | | | |
|---|---|---|---|---|---|
| **Total Population** | **1970** | **1980** | **1990** | **2000** | **2010** |
| Waikiki | 13,124 | 17,384 | 19,768 | 19,720 | 20,095 |
| *Percent Growth* | - | *32.45%* | *13.71%* | *-0.24%* | *1.90%* |
| Oahu | 630,528 | 762,565 | 836,231 | 876,156 | 953,207 |
| *Percent Growth* | - | *20.94%* | *9.66%* | *4.77%* | *8.79%* |
| Source: DBEDT Data Book, 2010 | | | | | |

*Housing Characteristics*

The total occupied housing units in Waikiki experienced a steady rise between 1970 and 1990 as indicated in *Table 2-5*. Housing units generally grew faster than the overall population in Waikiki which reflects a decline in average household size. This trend is particularly noticeable in the 1970s, when much of the earlier single-family housing stock was cleared and replaced by condo and apartment units. Rates of ownership rose steadily in Waikiki into the early 1990s, which leveled off through this decade. From 2000 to 2010, the total number of occupied housing units in Waikiki grew significantly by about 44%, reflecting a large increase in timeshare units in Waikiki.

| Table 2-5 OCCUPIED HOUSING UNITS, 1960-2010 | | | | | |
|---|---|---|---|---|---|
| **Total Occupied Housing Units** | **1970** | **1980** | **1990** | **2000** | **2010** |
| Waikiki | 6,830 | 9,852 | 11,408 | 11,397 | 16,393 |
| *Percent Growth* | *N/A* | *44.25%* | *15.79%* | *-0.1%* | *43.83%* |
| Oahu | 164,763 | 230,214 | 265,304 | 286,450 | 311,047 |
| *Percent Growth* | *N/A* | *39.72%* | *15.24%* | *7.97%* | *8.58%* |
| Source: US Census Bureau. 2010 Decennial Census | | | | | |

*Economic Characteristics*

Waikiki is a significant asset to the State, as it supports around 10% of all State civilian jobs, as well as 12% of Hawaii's State and local taxes. Approximately $3.6 billion (or 46%) of tourism's statewide economic contribution comes from Waikiki -based visitor activity. Tourism related activities in Waikiki account for an estimated 8% or Hawaii's Gross State Product. Waikiki is the most important tourist destination in the State, with around 72,000 visitors per day, accounting for 45% of the state's total yearly visitors (DBEDT, 2010). Visitor industry firms account for more than 122,000 jobs statewide, with nearly half (an estimated 56,000) in Waikiki. Jobs related either directly or indirectly to the visitor industry accounted for nearly 161,000 jobs statewide, with an estimated 73,000 jobs around the State due to activities in Waikiki alone. It is estimated that more than $432 million in tax revenue (a substantial portion from property taxes) are generated by the businesses associated with Waikiki-based visitor industry (DBEDT, 2010).

### 2.3.2 Environmental Consequences

***Impact Methodology***

The No Action Alternative and Proposed Action are reviewed and evaluated to identify potential beneficial or adverse impacts on conditions in the ROI. For the Proposed Action, impacts on population, housing, employment, and quality of life were evaluated.

***Factors Considered for Impacts Analysis***

Factors considered in determining if an alternative would have a significant impact on socio-economics include the extent to which its implementation would change the following:

- Population;
- Economics, including employment, income and tourism,
- Fiscal, including taxes and government revenues.

***Summary of Impacts***

*Table 2-6* is a summary of the potential impacts on socio-economics.

**Table 2-6 SUMMARY OF POTENTIAL SOCIO-ECONOMIC IMPACTS**

| Impact Issues | No Action Alternative | Proposed Action (Preferred Alternative) |
|---|---|---|
| Population | No impact | No impact |
| Economics: Employment, Income, and Tourism | No impact | Beneficial |
| Fiscal: Taxes and Government Revenues | No impact | Beneficial |

***Proposed Action (Preferred Alternative)***

The total estimated cost for the Proposed Action is approximately $13.6 million. Long-term and short-term beneficial impacts will occur by implementing the Proposed Action. Direct benefits will result from materials procurement for construction of the proposed wastewater system improvements and associated state excise tax on those materials. The projected construction expenditures for the new sewer lines will increase employment and income in the ROI during the construction period, and will have a short-term beneficial economic impact. Local communities, such as Waikiki and the greater Honolulu, may benefit from economic activity generated by the purchase of services, manufactured goods, and equipment from local business during the construction period.

Construction of the proposed sewer line improvements may help the City comply with the 2010 EPA Wastewater Consent Decree. This will also allow for the development of the approved HHV Master Plan (which includes 550 new timeshare units and 14,359 square feet of retail space). The HHV Master Plan project will generate significant on-going economic and fiscal benefits, including long term employment and consequent income and taxes. Additionally, by attracting new visitors to Oahu, the new Timeshare Tower and HHV Master Plan will create long-term beneficial impacts to socio-economic conditions, including additional consumer expenditures, employment opportunities, personal income, and government revenue enhancement as detailed below.

***No Action Alternative***

Under the No Action Alternative, no impacts would occur because the existing conditions would not change. Improvements to the sewer lines serving HHV, HKH and the service area between the Ala Wai Canal, Kalakaua Avenue and Fort DeRussy would not occur. The HHV Timeshare Towers would not be built because the existing sewer system would not be able to accommodate additional flow, meaning the socio-economic benefits from the Timeshare Towers would not be produced. Development and operations employment related to the HHV Master Plan project and Proposed Action would not be available. In addition, the City may need to make improvements to the existing wastewater system to meet the requirements of the 2010 Wastewater Consent Decree, requiring the use of City funds.

## 2.4 TRAFFIC AND ROADWAYS

A Construction Traffic Impact Report was prepared by Wilson Okamoto Corporation to identify and assess potential impacts of the Proposed Action on roadways and traffic conditions (*Appendix C*).

### 2.4.1 Affected Environment

***Introduction and Region of Influence***

This section examines the movement of vehicles and pedestrians along existing roadways. The ROI includes the roadways next to and in the vicinity of the Proposed Action sites.

The installation of the proposed sewer lines will require a minimum closure of two (2) travel lanes on Kalia Road to accommodate construction activities. In addition, due to the alignment of the sewer line along the centerline of that roadway, a third lane may be required periodically during construction. As such, this report includes an analysis of both a two (2)-lane and a three (3)-lane closure on Kalia Road. Lane closures are not anticipated to be required along Ala Moana Boulevard and Kalakaua Avenue.

***Overview of Valued Environmental Component***

Kalia Road is a predominantly four (4)-lane, two (2)-way roadway that extends from Ala Moana Boulevard to approximately 450 feet south of Lewers Street. Currently, the roadway carries approximately 10,000 vehicles per day in the project vicinity with heavy northbound and southbound traffic volumes of about 950 vehicles and 1,100 vehicles observed during the AM and PM peak periods, respectively. The posted speed limit on Kalia Road is 25 miles per hour.

Ala Moana Boulevard is a predominantly five-lane (two lanes eastbound, three lanes westbound), two-way roadway in the vicinity of the proposed project extending from downtown Honolulu to Kalakaua Avenue. Currently the roadway carries approximately 18,000 vehicles per day in the project vicinity with heavy through volumes of about 1,800 vehicles per hour observed in the AM peak hour. The posted speed on Ala Moana Boulevard is 35 miles per hour in the project vicinity.

Rainbow Drive is a predominantly two-lane, two-way local roadway that provides access to the HHV. The roadway currently carries approximately 3,300 vehicles per day with volumes of about 400 vehicles per hour observed in the PM peak hour. The speed limit on Rainbow Drive is 15 miles per hour.

Kahanamoku Street is a two (2)-lane, two (2)-way roadway that provides access to the HHV and Rainbow Drive via Lagoon Drive. Currently the roadway carries approximately 2,800 vehicles per day with volumes of about 300 vehicles per hour observed in the AM peak hour. The posted speed limit on Kahanamoku Street is 15 miles per hour.

<u>*Existing Traffic Volumes and Levels of Service*</u>

Traffic counts were conducted in January and June 2012 during the midday peak hours of 11:00 AM and 1:00 PM, and between the afternoon peak hours of 2:00 PM and 5:00 PM at each of the eight (8) intersections:

- Ala Moana Boulevard, Ena Road and Kalia Road
- Ala Moana Boulevard and Kahanamoku Street
- Ala Moana Boulevard, Kalakaua Avenue, and Niu Street
- Ala Moana Boulevard, Kalakaua Avenue, and Pau Street
- Kalakaua Avenue, Saratoga Road and Kalaimoku Street
- Kalia Road and Rainbow Drive
- Kalia Road and Maluhia Road
- Kalia Road and Saratoga Road

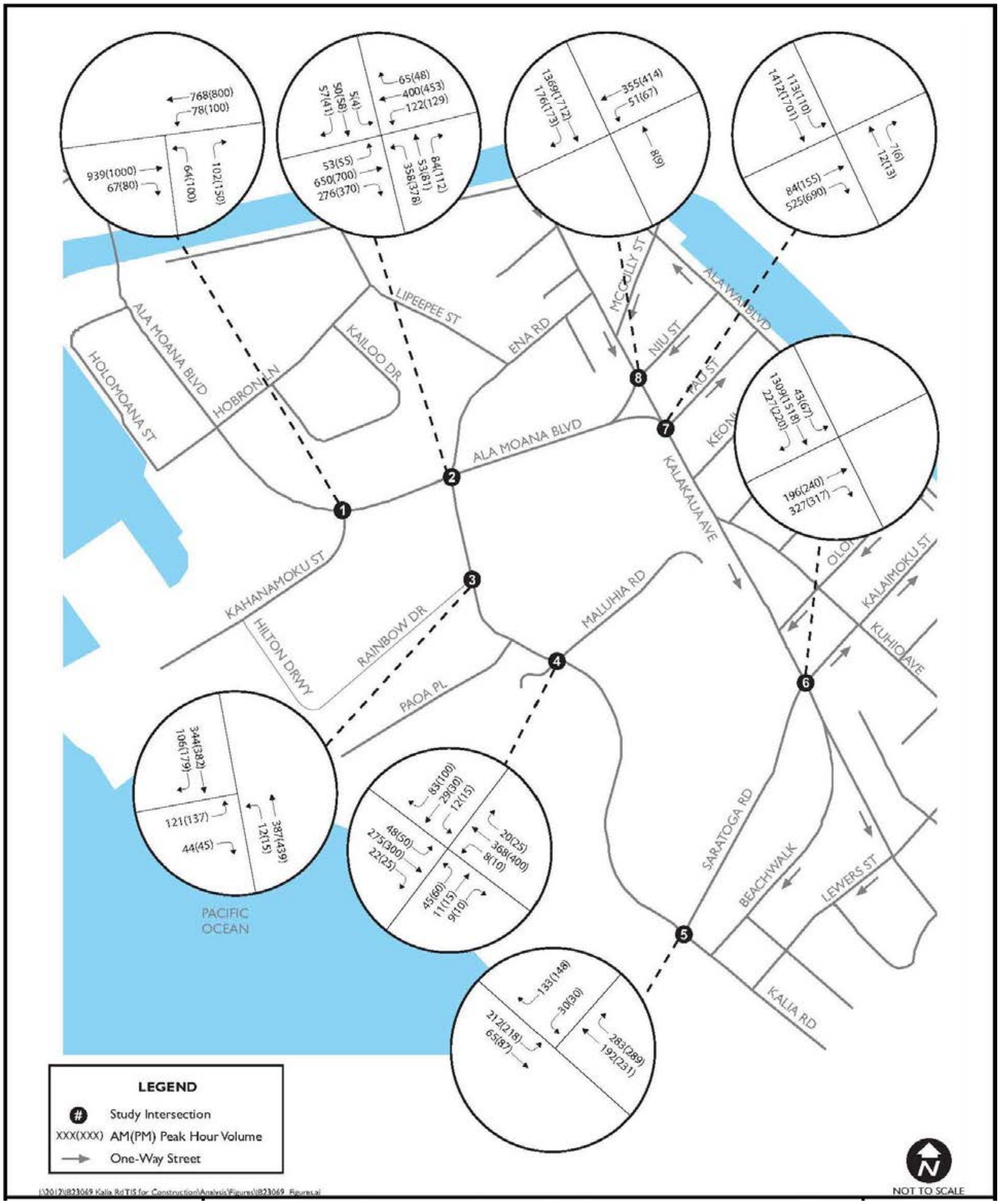
Level of service (LOS) is a qualitative measure describing the condition of traffic flow, ranging from ideal or free-flow traffic operating conditions at LOS “A” to unacceptable or potentially congested traffic operating conditions at LOS “F”. The City has established LOS “D”, which is typically recognized as the minimum satisfactory LOS in most urban areas, as the minimum acceptable LOS for its intersections.

The existing midday and afternoon non-commuter (referred to as PM) peak period traffic volumes and traffic operating conditions are shown in *Figure 2-1* and summarized in *Table 2-7*. The midday peak hour of traffic generally occurs between the hours of II:00 AM and 12:00 PM. During the afternoon, the PM peak hour of traffic generally occurs between the hours of 2:30 PM and 3:30 PM. The analysis is based on these peak hour time periods for each intersection to identify the construction traffic impacts resulting from the proposed project. It should be noted, construction activities are generally not expected to overlap with commuter peak periods with work hours most likely being designated as between 8:30 AM and 3:30 PM. LOS calculations are included in *Appendix C*.

**Table 2-7 EXISTING INTERSECTION LOS TRAFFIC OPERATING CONDITIONS**

| Intersection | Midday | | PM | |
|---|---|---|---|---|
| | Delay* | LOS | Delay* | LOS |
| Ala Moana Blvd/Kahanamoku St | 7.2 | A | 7.8 | A |
| Ala Moana Blvd/Ena Rd/Kalia Rd | 42.4 | D | 44.5 | D |
| Kalia Rd/Rainbow Dr | 4.7 | A | 4.6 | A |
| Kalia Rd/Maluhia Dr | 13.4 | B | 15.2 | B |
| Kalia Rd/Saratoga Rd | 4.8 | A | 4.0 | A |
| Kalakaua Ave/Saratoga Rd/Kalaimoku St | 9.8 | A | 9.4 | A |
| Ala Moana Blvd/Kalakaua Ave/Pau St | 9.4 | A | 11.3 | B |
| Ala Moana Blvd/Kalakaua Ave/Niu St | 14.3 | B | 16.7 | B |

*Seconds per vehicle




**EXISTING MIDDAY AND PM PEAK HOUR TRAFFIC**
**(SOURCE: WILSON OKAMOTO CORPORATION)** **FIGURE 2-1**

*Public Transit Service: TheBus*

The project areas are serviced by several transit lines operated by the City Department of Transportation Services (DTS). The following 11 bus routes serve the study area:

- Route E (Country Express) - Ewa Beach to the Honolulu Zoo.
- Route 8 - Ala Moana Shopping Center to Kapiolani Park/Honolulu Zoo
- Route 19 - Hickam Air Force Base to Kapiolani Park/Honolulu Zoo
- Route 20 - Pearlridge Shopping Center to Kapiolani Park/Honolulu Zoo.
- Route 23 - Ala Moana Shopping Center to Sea Life Park.
- Route 24 - Ala Moana Shopping Center to Aina Haina.
- Route 42 - Kapahulu area to the Ewa area.
- Route 98A - Kunia Drive to Kapiolani Park/Honolulu Zoo in Waikiki.
- Route 201 & 202 (Express) - Ewa area to the Waikiki area.
- Route 203 (Express) - Kalihi area to the Waikiki area.

*Public Transit Service: TheHandi-Van*

TheHandi-Van is a public transit service provided by DTS for persons with disabilities who are unable to use the City's bus service. TheHandi-Van provides comfortable, safe, and reliable curb-to-curb service. Coordination of its operations is handled by trained Mobility Coordinators who help identify public transit options. Individuals interested in using the TheHandi-Van service must participate in an in-person interview. Service is generally available island-wide from approximately 4:00 AM to 1:00 AM daily. 24-hour service is available in areas within three-quarters of a mile of TheBus Routes 2 and 40.

*Pedestrian and Bicycle Facilities*

The proposed sewer improvements are located near the HHV campus in a park-like setting accented by an urban fringe that leads in to the central core of Waikiki. Most pedestrian foot traffic along and through Kalia Road and Fort DeRussy fronting Ala Moana Boulevard and Kalakaua Avenue emanates from various hotel, retail, dining, and recreational activities from nearby hotels, parks, beaches, and commercial establishments. These roadways do not have designated bike paths, however, bicyclist typically use either the roadways or the sidewalk/landscaped area in Fort DeRussy.

### 2.4.2 Environmental Consequences

***Impact Methodology***

Impacts on roadways, pedestrian and bicycle safety in the ROI of the Proposed Action were evaluated.

***Factors Considered for Impacts Analysis***

Factors considered in determining whether an alternative would have a significant impact include the extent to which its implementation would cause or result in the following:

- Increases in vehicle trips on local roads that would disrupt local circulation patterns;
- Lane closures or impediments that would disrupt local circulation patterns;
- Activities that would create potential traffic safety hazards;
- Conflicts with pedestrian and bicycle routes or fixed-route transit;
- Increases in demand on public transportation;

***Summary of Impacts***

*Table 2-8* summarizes transportation impacts from the Proposed Action and the No Action Alternatives.

**Table 2-8 SUMMARY OF POTENTIAL TRAFFIC IMPACTS**

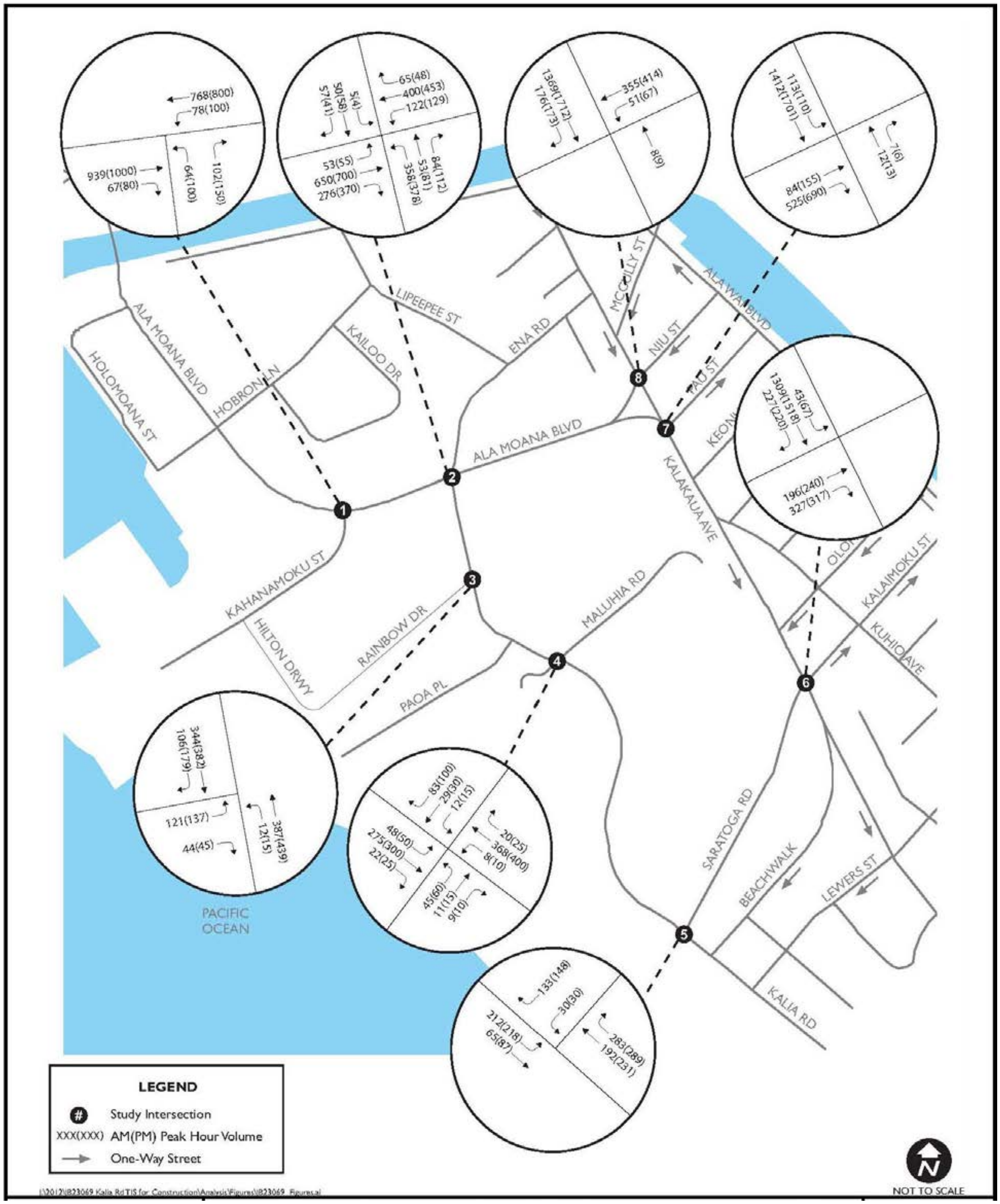
| Impact Issues | No Action Alternative | Proposed Action (Preferred Alternative) |
|---|---|---|
| Increases in vehicle trips | No impact | Less than significant impact |
| Intersection operations | No impact | Significant impact but mitigable to less than significant |
| Lane closures | No impact | Significant impact but mitigable to less than significant |
| Conflicts with pedestrian or bicycle facilities | No impact | Less than significant impact |
| Public transportation | No impact | Less than significant impact |

***Proposed Action (Preferred Alternative)***

During the construction period, there will be short-term, less than significant impacts from an increase in construction-related vehicles and activities near the project areas. The construction of the proposed project will require a minimum closure of two (2) lanes with the potential for an occasional closure of a third lane. As such, this traffic analysis assesses the following scenarios:

- Two (2)-lane closure on Kalia Road (with and without the traffic diversion)
- Three (3)-lane closure on Kalia Road (with and without the traffic diversion)

The anticipated lane closures along Kalia Road during construction are anticipated to cause congestion along that roadway even with the restriction of construction activities to off-peak periods. A potential management strategy to alleviate anticipated congestion is the closure of Rainbow Drive to minimize traffic volumes along Kalia Road. The existing traffic along Rainbow Drive will be diverted along internal roadways within the HHV to Kahanamoku Street. Traffic will be diverted from Rainbow Drive to Kahanamoku Street based on the existing distribution of traffic at the intersections of Kalia Road with Ala Moana Boulevard and Rainbow Drive. The diverted midday and PM peak hour traffic conditions are shown on *Figure 2-2* and the traffic diversion calculation worksheets are included in *Appendix C*.




**PROJECTED MIDDAY AND PM PEAK HOUR WITH TRAFFIC DIVERSION**
**(SOURCE: WILSON OKAMOTO CORPORATION)** **FIGURE 2-2**

***Kalia Road Two (2)-Lane Closure***

*Without Traffic Diversion*

The projected midday and PM peak period traffic volumes and traffic operating conditions with the proposed two (2)-lane closure are summarized in *Tables 2-9*.

**Table 2-9 EXISTING AND PROJECTED (2-LANE CLOSURE) MIDDAY AND PM INTERSECTION LOS TRAFFIC OPERATING CONDITIONS**

| Intersection | Midday Intersection | | | | PM Intersection | | | |
|---|---|---|---|---|---|---|---|---|
| | Existing | | 2-Lane | | Existing | | 2-Lane | |
| | Delay* | LOS | Delay* | LOS | Delay* | LOS | Delay* | LOS |
| Ala Moana Blvd/Kahanamoku St | 7.2 | A | 7.2 | A | 7.8 | A | 7.8 | A |
| Ala Moana Blvd/Ena Rd/Kalia Rd | 42.4 | D | 43.9 | D | 44.5 | D | 47.0 | D |
| Kalia Rd/Rainbow Dr | 4.7 | A | 5.2 | A | 4.6 | A | 6.2 | A |
| Kalia Rd/Maluhia Dr | 13.4 | B | 13.4 | B | 15.2 | B | 15.2 | B |
| Kalia Rd/Saratoga Rd | 4.8 | A | 4.8 | A | 4.0 | A | 4.0 | A |
| Kalakaua Ave/Saratoga Rd/Kalaimoku St | 9.8 | A | 9.8 | A | 9.4 | A | 9.4 | A |
| Ala Moana Blvd/Kalakaua Ave/Pau St | 9.4 | A | 9.4 | A | 11.3 | B | 11.3 | B |
| Ala Moana Blvd/Kalakaua Ave/Niu St | 14.3 | B | 14.3 | B | 16.7 | B | 16.7 | B |
| *Seconds per vehicle | | | | | | | | |

The proposed closure will reduce the number of lanes along Kalia Road to one (1) northbound lane and one (1) southbound lane. At the intersection of Kalia Road with Ala Moana Boulevard, the northbound approach is assumed to have an exclusive left-turn lane and a shared all-way lane. As shown in *Table 2-9*, the study intersections are expected to operate at levels of service similar to existing conditions during the midday and PM peak hours with the proposed two (2)-lane closure along Kalia Road between the weekday hours of 8:30 AM and 3:30 PM. As such, the proposed two (2)-lane closure along Kalia Road is not expected to have a significant impact on traffic operations in the project vicinity.

*With Traffic Diversion*

The projected midday and PM peak period traffic volumes and traffic operating conditions with the proposed two (2)-lane closure and traffic diversion are summarized in *Table 2-10*.

**Table 2-10 EXISTING AND PROJECTED (2-LANE CLOSURE WITH TRAFFIC DIVERSION) MIDDAY AND PM INTERSECTION LOS TRAFFIC OPERATING CONDITIONS**

| Intersection | Midday Intersection | | | | PM Intersection | | | |
|---|---|---|---|---|---|---|---|---|
| | Existing | | 2-Lane w/Div | | Existing | | 2-Lane w/Div | |
| | Delay* | LOS | Delay* | LOS | Delay* | LOS | Delay* | LOS |
| Ala Moana Blvd/Kahanamoku St | 7.2 | A | 9.1 | A | 7.8 | A | 11.9 | B |
| Ala Moana Blvd/Ena Rd/Kalia Rd | 42.4 | D | 39.7 | D | 44.5 | D | 41.6 | D |
| Kalia Rd/Rainbow Dr | 4.7 | A | 3.4 | A | 4.6 | A | 3.4 | A |
| Kalia Rd/Maluhia Dr | 13.4 | B | 13.4 | B | 15.2 | B | 15.2 | B |
| Kalia Rd/Saratoga Rd | 4.8 | A | 4.8 | A | 4.0 | A | 4.0 | A |
| Kalakaua Ave/Saratoga Rd/Kalaimoku St | 9.8 | A | 9.8 | A | 9.4 | A | 9.4 | A |
| Ala Moana Blvd/Kalakaua Ave/Pau St | 9.4 | A | 9.4 | A | 11.3 | B | 11.3 | B |
| Ala Moana Blvd/Kalakaua Ave/Niu St | 14.3 | B | 14.3 | B | 16.7 | B | 16.7 | B |
| *Seconds per vehicle | | | | | | | | |

The proposed closure will reduce the number of lanes along Kalia Road to one (1) northbound lane and one (1) southbound lane. At the intersection of Kalia Road with Ala Moana Boulevard, the northbound approach is assumed to have an exclusive left-tum lane and a shared all-way lane. As shown in *Table 2-10*, with the two (2)-lane closure and the internal diversion of traffic from Rainbow Drive to Kahanamoku Street, the study intersections are expected to operate at levels of service similar to existing conditions with the exception of the intersection of Ala Moana Boulevard and Kahanamoku Street, which is expected to operate at LOS "B" during the PM peak period. As such, the proposed two (2)-lane closure along Kalia Road with traffic diversion is not expected to have a significant impact on traffic operations in the project vicinity.

### *Kalia Road Three (3)-Lane Closure*

<u>*Without Traffic Diversion*</u>

The projected midday and PM peak period traffic volumes and traffic operating conditions with the proposed three (3)-lane closure are summarized in *Tables 2-11*.

**Table 2-11 EXISTING AND PROJECTED (3-LANE CLOSURE) MIDDAY AND PM INTERSECTION LOS TRAFFIC OPERATING CONDITIONS**

| Intersection | Midday Intersection | | | | PM Intersection | | | |
|---|---|---|---|---|---|---|---|---|
| | Existing | | 3-Lane | | Existing | | 3-Lane | |
| | Delay* | LOS | Delay* | LOS | Delay* | LOS | Delay* | LOS |
| Ala Moana Blvd/Kahanamoku St | 7.2 | A | 7.2 | A | 7.8 | A | 7.8 | A |
| Ala Moana Blvd/Ena Rd/Kalia Rd | 42.4 | D | 59.8 | E | 44.5 | D | 66.5 | E |
| Kalia Rd/Rainbow Dr | 4.7 | A | 5.7 | A | 4.6 | A | 6.8 | A |
| Kalia Rd/Maluhia Dr | 13.4 | B | 13.4 | B | 15.2 | B | 15.2 | B |
| Kalia Rd/Saratoga Rd | 4.8 | A | 4.8 | A | 4.0 | A | 4.0 | A |
| Kalakaua Ave/Saratoga Rd/Kalaimoku St | 9.8 | A | 9.8 | A | 9.4 | A | 9.4 | A |
| Ala Moana Blvd/Kalakaua Ave/Pau St | 9.4 | A | 9.4 | A | 11.3 | B | 11.3 | B |
| Ala Moana Blvd/Kalakaua Ave/Niu St | 14.3 | B | 14.3 | B | 16.7 | B | 16.7 | B |
| *Seconds per vehicle | | | | | | | | |

The proposed three (3)-lane closure reduces the number of lanes on Kalia Road to one (1) northbound lane. At the intersection of Kalia Road with Ala Moana Boulevard, the northbound approach is assumed to have one shared all-way lane. As shown above in *Table 2-11*, the study intersections are expected to operate at levels of service similar to existing conditions with the exception of the intersection of Kalia Road with Ala Moana Boulevard. Due to the reduction in lanes along Kalia Road, this intersection is expected to deteriorate to LOS "E" during both peak periods. In addition, an assessment of the projected queuing along Kalia Road as a result of these lane reductions indicates that the proposed three (3)-lane closure will result in significantly longer queue lengths on the Kalia Road approach of that intersection. As such, the proposed closure may impact traffic operations along Kalia Road and at the intersection with Ala Moana Boulevard during the construction period. This significant impact would be mitigated to less than significant by the reduction of traffic volumes along Kalia Road by diverting traffic accessing the HHV.

*With Traffic Diversion*

The projected midday and PM peak period traffic volumes and traffic operating conditions with the proposed three (3)-lane closure and traffic diversion are summarized in *Table 2-12*.

**Table 2-12 EXISTING AND PROJECTED (3-LANE CLOSURE WITH TRAFFIC DIVERSION) MIDDAY AND PM INTERSECTION LOS TRAFFIC OPERATING CONDITIONS**

| Intersection | Midday Intersection | | | | PM Intersection | | | |
|---|---|---|---|---|---|---|---|---|
| | Existing | | 3-Lane w/Div | | Existing | | 3-Lane w/Div | |
| | Delay* | LOS | Delay* | LOS | Delay* | LOS | Delay* | LOS |
| Ala Moana Blvd/Kahanmoku St | 7.2 | A | 9.1 | A | 7.8 | A | 11.9 | B |
| Ala Moana Blvd/Ena Rd/Kalia Rd | 42.4 | D | 45.0 | D | 44.5 | D | 52.3 | D |
| Kalia Rd/Rainbow Dr | 4.7 | A | 3.7 | A | 4.6 | A | 3.9 | A |
| Kalia Rd/Maluhia Dr | 13.4 | B | 13.4 | B | 15.2 | B | 15.2 | B |
| Kalia Rd/Saratoga Rd | 4.8 | A | 4.8 | A | 4.0 | A | 4.0 | A |
| Kalakaua Ave/Saratoga Rd/Kalaimoku St | 9.8 | A | 9.8 | A | 9.4 | A | 9.4 | A |
| Ala Moana Blvd/Kalakaua Ave/Pau St | 9.4 | A | 9.4 | A | 11.3 | B | 11.3 | B |
| Ala Moana Blvd/Kalakaua Ave/Niu St | 14.3 | B | 14.3 | B | 16.7 | B | 16.7 | B |

*Seconds per vehicle

The proposed three (3)-lane closure reduces the number of lanes on Kalia Road to one (1) northbound lane and one (1) southbound lane. At the intersection of Kalia Road with Ala Moana Boulevard, the northbound approach is assumed to have one (1) shared all-way lane. As shown above in *Table 2-12*, the study intersections are expected to operate at levels of service similar to existing conditions with the exception of the intersection of Kalia Road with Ala Moana Boulevard, which is expected to operate at LOS "D" during the PM peak period. Therefore, the proposed three (3)-lane closure along Kalia Road with traffic diversion is not expected to have a significant impact on traffic operations in the project vicinity.

*Public Transit Service*

Less than significant impacts to the existing public transit operations will occur during the construction phase of the project. The Contractor will coordinate with the City DTS, Public Transit Division and Oahu Transit Services, Inc., prior to construction, to minimize impacts on bus routes, bus stops and paratransit operations. The Contractor will identify the scope of work, location, duration and proposed closure of any street, traffic lane and bus stop.

*Pedestrian and Bicycle Facilities*

Existing sidewalks, particularly at Fort DeRussy fronting Ala Moana Boulevard and Kalakaua Avenue, will be impacted by during the construction phase of the project. Prior to construction, the Contractor will coordinate with the City DTS to minimize impacts on sidewalks and walkway areas. There will be rerouting of pedestrian traffic during construction periods along Kalia Road, Ala Moana Boulevard and Kalakaua Avenue. The Contractor will identify the scope of work, location, duration and proposed closure of any sidewalks or pedestrian facilities that may be affected by the project, and offsetting mitigation, as practical.

Proposed Traffic Impact Mitigation

The Proposed Action will likely result in impacts to existing traffic conditions. An impact is considered significant but mitigable if the result of the Proposed Action will have a significant impact on traffic and roadways but compensatory mitigation is included to reduce the level of impact to below significant levels. Based on the analysis of the traffic data and scenarios above, the following mitigation measures are recommended for the construction of the Kalia-DeRussy Wastewater System Improvements:

***General Recommendations***

- A Construction Management Plan for the Proposed Action will be prepared and implemented, and will include the anticipated construction schedule and phasing, traffic circulation, traffic control, parking, and conflicts with public transportation and pedestrian/bicycle facilities during the construction period.
- In general, lane closures along Kalia Road will be limited to two (2)-lane closures wherever possible to minimize the impacts on traffic operations in the project vicinity.
- Bus stops are located along both sides of Kalia Road. The contractor will coordinate with the City DTS to ensure continued transit service along that roadway. Temporary relocation of the bus stops may be required to accommodate the anticipated work areas.

***2-Lane Closure Recommendations***

- Provide one northbound and one southbound lane along Kalia Road.
- At the intersection of Kalia Road with Ala Moana Boulevard, provide an exclusive left-turn lane and a shared all-way lane on the northbound approach of Kalia Road.

***3-Lane Closure Recommendations***

- Provide one northbound lane along Kalia Road.
- At the intersection of Kalia Road with Ala Moana Boulevard, provide one (1) shared all-way lane the northbound approach of Kalia Road.
- Reduce traffic volumes along Kalia Road by diverting traffic accessing the HHV from Rainbow Drive to Kahanamoku Street. A special duty officer may need to be stationed at the intersection of Kahanamoku Street with Ala Moana Boulevard to assist pedestrians and vehicular traffic.

The construction of the Proposed Action will require a minimum closure of two (2) travel lanes on Kalia Road with the occasional closure of a third lane due to the proposed sewer line alignment. The proposed two (2)-lane closure along Kalia Road is not expected to have a significant impact on traffic operations or pedestrian/bicycle facilities in the project vicinity. However, if the closure of a third lane is needed, additional mitigation measures will be implemented to reduce traffic volumes along Kalia Road. Therefore, the Proposed Action is expected to have a significant impact but mitigable to less than significant on traffic and roadways.

***No Action Alternative***

Under the No Action Alternative, there would be no wastewater system improvements and thus no construction that would impact traffic on existing roadways.

## 2.5 NOISE

### 2.5.1 Affected Environment

A study of current and projected noise conditions was conducted by Y. Ebisu & Associates and is included in *Appendix D*.

***Introduction and Region of Influence***

Noise is defined as unwanted sound. Sound may be classified as noise when it damages hearing ability, causes other bodily effects detrimental to health and safety, disturbs sleep and rest, interferes with conversation or other forms of communication, or is simply annoying or irritating. The ROI for the noise includes the areas surrounding Kalia Road, the portions of the Fort DeRussy property fronting Ala Moana Boulevard and Kalakaua Avenue, and other areas where sound generated by the Proposed Action is audible. Generally, the ROI extends no more than a half mile to a mile from the project area, depending on the sound source.

***Overview of the Valued Environmental Component***

The State DOH regulates noise from construction activities under Chapter 46, Community Noise Control, Title 11, Administrative Rules, DOH. Within the ROI, the applicable daytime and nighttime noise limits are 60 and 50 A-Weighted decibels (dBA), respectively. Diesel-powered construction equipment cannot be expected to emit noise levels below 60 to 50 dBA at a 50 foot distance, which will be required to fully comply with the daytime and nighttime DOH noise limits for hotel, commercial, and apartment zones along the project corridor. Typical diesel-powered equipment and trucks will exceed these DOH noise limits by 20 to 40 dBA as shown in *Table 2-13*.

**Table 2-13 RANGES OF A-WEIGHTED SOUND LEVELS OF CONSTRUCTION EQUIPMENT AT 50-FOOT DISTANCE**

| Equipment | Sound Levels (dBA) Minimum/Maximum |
|---|---|
| Hopto, Loader, Trencher | 72/93 |
| Compactors (rollers) | 72/88 |
| Compressors | 68/87 |
| Concrete Mixers | 72/90 |
| Cranes | 65/85 |
| Generators | 60/82 |
| Jackhammers and Drills | 75/98 |
| Pavers | 82/92 |
| Vibrating Hammers | 85/100 |
| Pumps | 70/80 |
| Rollers | 65/90 |
| Saws | 68/93 |
| Scrapers, Graders | 76/95 |
| Tractors | 73/95 |
| Trucks | 70/95 |
| Tampers | 50/80 |
| Welder/Cutting Torches | 65/75 |
| Fans, Pumps, Power Tools | 45/80 |

Recognizing that the 60 dBA daytime limit is difficult to meet for a construction project involving earthwork and the use of heavy equipment, DOH administers a permit system where noisy construction activities are permitted to occur during the following periods: 7:00 am to 6:00 pm, Monday through Friday, excluding holidays; and 9:00 am to 6:00 pm on Saturday. Noisy construction work during other periods, and specifically during the nighttime hours, is not permitted unless a noise variance from the applicable rules is granted by DOH. For projects of this type, DOH will balance the interests of the traveling public and businesses within the ROI with the health and welfare of those residents and hotel guests who may be affected by excessive construction noise.

Major contributions to the existing background ambient noise levels within the ROI is due to local and distant traffic noise. Existing noise levels were measured from Midnight to Midnight (January 2012) as detailed in *Table 2-14*. The noise level range represents the minimum and maximum average noise levels recorded during each period.

**Table 2-14 SUMMARY OF EXISTING AMBIENT NOISE LEVELS**

| Location of Measurement | Average dB Range 6:00 PM - Midnight | Average dB Range Midnight to 6:00 AM | Average dB Range (6:00 AM to 6:00 PM) |
|---|---|---|---|
| Kalakaua Ave. at Luana Waikiki Hotel | 66/74 | 63/70 | 70/75 |
| Ala Moana Blvd. at Alana Waikiki Hotel | 66/69 | 58/62 | 66/72 |
| Kalia Rd. at Tapa Tower | 61/66 | 55/59 | 58/64 |

### 2.5.2 Environmental Consequences

***Impact Methodology***

Potential effects of the Proposed Action and No Action Alternative on noise were evaluated by examining the typical noise generated by construction compared to applicable State DOH regulatory standards regarding noise exposure and distance to nearby sensitive receptors.

***Factors Considered for Impacts Analysis***

Factors considered in determining if an alternative would have a significant impact include the extent to which its implementation would generate temporary noise during construction or long-term noise during operation that would exceed applicable State regulatory standards.

***Summary of Impacts***

*Table 2-15* is a summary of the potential noise impacts.

**Table 2-15 SUMMARY OF POTENTIAL NOISE IMPACTS**

| Impact Issues | No Action Alternative | Proposed Action (Preferred Alternative) |
|---|---|---|
| Construction Noise | No Impact | Significant impact but mitigable to less than significant |
| Operations Noise | No Impact | No impact |

***Proposed Action (Preferred Alternative)***

*Construction Noise*

The ROI consists of noise sensitive structures which are closest to the sewer line improvements: Alana Waikiki Hotel; Inn on the Park Condominium; Canterbury Place Condominium; Kalia Tower of the HHV, and the Diamond Head Apartments on Paoa Place. *Tables 2-16* present the range of anticipated construction noise levels at these and other nearby structures during the noisier phases of construction work. The background noise levels are exceeded approximately ten (10) percent of the time.

| Table 2-16 RANGE OF AMBIENT AND TRENCHING NOISE LEVELS | | | | | | |
|---|---|---|---|---|---|---|
| **Location of Work** | **dBA Range Background Ambient** | | **dBA Range Sheet Pile Construction** | | **dBA Range Sheet Trench Construction** | |
| | **6:00 PM to Midnight** | **Midnight to 6:00 PM** | **6:00 PM to Midnight** | **Midnight to 6:00 PM** | **6:00 PM to Midnight** | **Midnight to 6:00 PM** |
| Along Kalia Rd. from Paoa Pl. to Ala Moana Blvd. | 61 to 74 | 58 to 72 | 62 to 82 | 62 to 82 | 58 to 78 | 58 to 78 |
| Ala Moana Blvd. from Kalia Rd. to Kalakaua Ave. | 65 to 80 | 61 to 82 | 64 to 81 | 64 to 81 | 60 to 77 | 60 to 77 |
| Along Ala Moana Blvd. from Kalia Rd. to Kalakaua Ave. | 65 to 80 | 61 to 82 | 64 to 81 | 64 to 81 | 60 to 77 | 60 to 77 |
| Along Kalakaua Ave. from Ala Moana Blvd. to Ft. DeRussy WWPS | 68 to 80 | 65 to 82 | 55 to 82 | 55 to 82 | 51 to 78 | 51 to 78 |

The Proposed Action is expected to have a significant impact but mitigable to less than significant, on existing noise levels. The risk of noise impacts during the noisier construction activities, such as sheet pile driving and/or trenching, will be lowest along Kalakaua Avenue due to the relatively high background noise levels along this roadway. Risks of noise impacts are higher during construction work along Ala Moana Boulevard, due to the lower background noise levels. Along Kalia Road, risks of potential noise impacts from construction are highest, since construction work during the evening, nighttime, and early morning hours will likely be necessary. In addition, background noise levels are lower along Kalia Road. To minimize the intrusiveness of the construction work along Kalia Road, the noisier construction activities will be scheduled during the daytime and early nighttime hours, and the quieter construction activities will be scheduled during the late night and early morning hours.

Typical construction noise mitigation measures that may be utilized particularly during the nighttime and early morning hours are performing quieter construction activities, such as plate welding, pipe laying, backfilling and use of smaller equipment during the 6:00 pm to 6:00 am time period. Other mitigation measures include the use of quieter equipment (light towers, generators, and bypass pumps with sound attenuation kits); the use of flag men in place of back up beeper alarms; and the scheduling of the noisier activities and equipment (pile driving, saws, jackhammer, etc.) to the evening and early nighttime hours.

<u>Operations Noise</u>

Upon completion of the Proposed Action, noise levels will be reduced back to pre-construction levels. The improved sewer lines will be gravity fed, requiring no operating mechanical equipment, and are not expected to add to ambient noise.

***No Action Alternative***

The No Action Alternative would not change or augment existing noise sources within the ROI. No impacts would result from the No Action Alternative.

## 2.6 AIR QUALITY

An Air Quality Impact Assessment was performed for the Proposed Action by ARCADIS (*Appendix E*). This study identified and evaluated the local, State and Federal regulatory requirements pertaining to Air Emissions.

### 2.6.1 Affected Environment

***Introduction and Region of Influence***

Air quality in Hawaii is generally some of the best in the nation, with ambient air quality concentrations well below federal and state standards. This situation is primarily due to the tendency for pollutants to disperse offshore with the trade winds and the limited number of emission sources on each island. The ROI for this analysis is the location of the Proposed Action and surrounding areas in the vicinity.

***Overview of Valued Environmental Component***

The ambient air quality in an area can be characterized in terms of whether it complies with National Ambient Air Quality Standards (NAAQS) and State Ambient Air Quality Standards (SAAQS), where applicable. The Clean Air Act (CAA) (42 USC 7401 et seq.) requires the EPA to set national standards for emissions that are considered harmful to public health and the environment (criteria pollutants). The seven criteria pollutants are: Carbon Monoxide (CO), Nitrogen Dioxide ($NO_2$), Sulfur Dioxide ($SO_2$), Lead (Pb), Ozone ($O_3$), and particulate matter ($PM_{10}$ and $PM_{2.5}$) less than 10 and 2.5 microns. Hawaii also has a state ambient air standard for Hydrogen Sulfide ($H_2S$).

Areas where air quality is equal to or better than the ambient air quality standards are identified as attainment areas and areas where air quality is worse are identified non-attainment areas. Areas that have been classified as non-attainment in the past but are currently in attainment are called maintenance areas, and areas of uncertain status are designated as unclassifiable. Based on air monitoring data, Hawaii is currently classified as attainment for all Federal and State standards, except for 1-hour $NO_2$, for which attainment status is currently unclassified. *Table 2-17* presents the NAAQS and SAAQS for each criteria pollutant and the 2011 attainment designations for the State of Hawaii.

| Table 2-17 AIR QUALITY STANDARDS ATTAINMENT STATUS FOR HAWAII | | | | | |
|---|---|---|---|---|---|
| **Parameter** | | **State Standard** | | **Federal Standard** | |
| Ozone ($O_3$) | 8-Hour | 0.080 ppm | Attainment | 0.075 ppm | Attainment |
| Carbon Monoxide (CO) | 1-Hour | 9 ppm | Attainment | 35 ppm | Attainment |
| | 8-Hour | 4.4 ppm | Attainment | 9 ppm | Attainment |
| Nitrogen Dioxide ($NO_2$) | 1-Hour | -- | | 0.100 ppm | Unclassified |
| | Annual Arithmetic Mean | 0.040 ppm | Attainment | 0.053 ppm | Attainment |
| Sulfur Dioxide ($SO_2$) | 1-Hour | -- | | 75 ppb | Attainment |
| | 3-Hour | 0.5 ppm | Attainment | -- | |
| | 24-Hour | 0.14 ppm | Attainment | 0.14 ppm | Attainment |
| | Annual Arithmetic Mean | 0.030 ppm | | 0.030 ppm | Attainment |
| Particulate Matter ($PM_{10}$) | 24-Hour | 150 $\mu g/m_3$ | Attainment | 150 $\mu g/m_3$ | Attainment |
| | Annual Arithmetic Mean | 50 $\mu g/m_3$ | Attainment | -- | |
| Particulate Matter Fine ($PM_{2.5}$) | 24-Hour | -- | | 35 $\mu g/m_3$ | Attainment |
| | Annual Arithmetic Mean | -- | | 15 $\mu g/m_3$ | Attainment |
| Lead (Pb) | 30 day Average | 1.5 $\mu g/m_3$ | Attainment | -- | |
| | Rolling 3-Month Avg. | -- | | 0.15 $\mu g/m_3$ | Attainment |
| Hydrogen Sulfide ($H_2S$) | 1-Hour | 0.025 ppm | Attainment | | |

*Existing Air Quality*

The State DOH, Clean Air Branch has been monitoring ambient air quality in the State of Hawaii since 1957. The network is comprised of 14 monitoring stations on the islands of Oahu, Kauai, Maui, and Hawaii. The purpose of the network is to measure ambient air concentrations of the six criteria pollutants that the EPA has promulgated NAAQS.

The DOH Air Monitoring Station nearest Waikiki is located on the roof top of the DOH main building (Kinau Hale) at 1250 Punchbowl Street. This station was established to monitor $SO_2$, CO, and $PM_{10}$ and $PM_{2.5}$. Between 1996 and 1997, Pb concentrations were monitored as well but have since been discontinued. A monitoring station in Kapolei measures $NO_2$ and a station on Sand Island measures $O_3$ concentrations.

Present air quality in the project area is mostly affected by air pollutants from motor vehicles due to the urban setting. Natural sources of air pollution emissions that could affect the project area at times but cannot be quantified very accurately include the ocean (sea spray), plants (aero-allergens), wind-blown dust, and perhaps distant volcanoes on the Hawaii Island. In summary, the State of Hawaii AAQS for $SO_2$, $NO_2$, $PM_{10}$, $PM_{2.5}$, $O_3$ and Pb are currently being met in the project area. While CO measurements at the downtown Honolulu monitoring station suggest that concentrations are within the State and National standards, local "hot spots" may exist near traffic-congested intersections.

Clean Air Act Conformity

Under the authority of the CAA, the EPA has promulgated the general conformity rule, which requires that Federal agencies in nonattainment and maintenance areas perform a general conformity analysis and, where emissions could exceed specified thresholds, prepare a formal conformity determination document. Because Hawaiʻi is in attainment for all pollutants, a general conformity analysis is not required for the Proposed Action.

### 2.6.2 Environmental Consequences

***Impact Methodology***

Emissions were calculated using the URBEMIS 2007 (version 9.2.4) environmental management software. The URBEMIS model provides a platform to calculate construction emissions using equipment emission factors (mass of emissions per unit time) from sources such as EPA, California Air Resources Board and site-specific information. URBEMIS also provides default values when site-specific information is not available.

Construction phases will consist of site mobilization, digging the new pipeline trench, installing the new pipeline, backfilling the trench, and paving, landscaping or concrete laying activities where required. It is assumed the old pipeline will be abandoned in place.

Preliminary estimates are for construction activities to last approximately one year, with construction activities beginning in March 2014. Activities in 2014 will consist of three weeks of site mobilization and staging, six months of trenching, and three months of pipe installation. Activities in 2015 will consist of up to two months of asphalt paving and concrete finishing activities.

To calculate pollutant emissions resulting from soil hauling, it is assumed that earth and material removed from the trench will be hauled to a stockyard located approximately five miles away for temporary storage. This material will be hauled back to the site for backfilling once the new trench is installed. It is also assumed that the trench will be excavated to an average depth of 12 feet and width of four feet, for a length of 2,600 feet. The volume of soil to be removed from the trench will be approximately 4,600 cubic yards.

Paving and concrete finishing activities are expected to be fairly minimal, as it will be restricted to narrow areas along Kalia Road, and short stretches along Paoa Place, Ala Moana Boulevard and Kalakaua Avenue.

The URBEMIS software lets users select pre-programmed “Mitigations” to control certain emissions.

The measures selected and assumed to be implemented are:

- replacing ground cover in disturbed areas quickly
- using water to control dust during loading and unloading activities
- applying water to disturbed surfaces and haul roads three times per day, and reducing speed on unpaved roads to < 15 miles per hour

These measures are all common practices that are required by local and State regulations to control dust and prevent storm water pollution.

***Factors Considered for Impacts Analysis***

Factors considered in determining if the Proposed Action or No Action Alternatives would have a significant impact on air quality are as follows:

- If it were to generate significant quantities of "criteria pollutant" emissions (as defined in Section 2.6.1) in a manner that could contribute to local or regional exceedances of NAAQS or SAAQS, or
- If it were to generate significant quantities of greenhouse gas (GHG) emissions (see below).

***Summary of Impacts***

*Table 2-18* is a summary of the potential impacts on air quality.

| Table 2-18 SUMMARY OF POTENTIAL AIR QUALITY IMPACTS | | |
|---|---|---|
| **Impact Issues** | **No Action Alternative** | **Proposed Action (Preferred Alternative)** |
| Air Pollutants | No impact | Less than significant impact |
| Greenhouse Gases (GHG) | No impact | Less than significant impact |

***Proposed Action (Preferred Alternative)***

<u>Construction Impacts</u>

Under the Proposed Action, air quality impacts will be intermittent and short-term. Construction will generate emissions of the criteria pollutants, as well as $CO_2$. A summary of the site-specific information used in the construction emissions calculations, including activity durations, types of equipment, and shift length are provided in *Appendix E*. Annual emissions calculated from URBEMIS are summarized below (*Table 2-19 and 2-20*). Emissions for the Proposed Action are minimal due to the small scale and low intensity of construction activities. Modeling assumptions and results are presented in *Appendix E*.

| Table 2-19 ESTIMATED PROPOSED CONSTRUCTION EMISSIONS (TONS PER YEAR) | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Construction Year** | **Annual Emissions (tons per year)** | | | | | | |
| | VOCs | $NO_2$ | CO | $SO_2$ | $PM_{10}$ | $PM_{2.5}$ | $CO_2$ |
| 2014 | 0.27 | 2.85 | 1.39 | 0.00 | 9.09 | 1.98 | 433 |
| 2015 | 0.03 | 0.18 | 0.16 | 0.00 | 0.01 | 0.01 | 21.5 |

| Table 2-20 ESTIMATED PROPOSED CONSTRUCTION EMISSIONS (POUNDS PER DAY) | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Construction Year** | **Maximum Emissions (pounds per day)** | | | | | | |
| | VOCs | $NO_2$ | CO | $SO_2$ | $PM_{10}$ | $PM_{2.5}$ | $CO_2$ |
| 2014 | 3.06 | 30.91 | 15.54 | 0.00 | 137 | 29.6 | 4,671 |
| 2015 | 1.23 | 7.37 | 6.20 | 0.00 | 0.59 | 0.54 | 860 |

Potential short-term direct and indirect impacts on air quality are primarily related to project construction. Air pollution emissions that may directly result in short-term air quality impacts during project construction include: (1) fugitive dust from vehicle movement and excavation; and (2) exhaust emissions from on-site construction equipment. Indirectly, there also may be short-term impacts from slow-moving construction equipment traveling to and from the project site, from a temporary increase in local traffic caused by commuting construction workers, and from the disruption of normal traffic flow caused by roadway lane closures.

Fugitive dust emissions may arise from the excavating activities associated with site preparation work. The EPA has an estimated standard for uncontrolled fugitive dust emissions from construction activity in the range of 1.2 tons per acre per month under conditions of "medium" activity, moderate soil silt content (30%), and precipitation/evaporation index of 50. Uncontrolled fugitive dust emissions occurring as a result of the Proposed Action will likely be somewhere near that level or less, depending on the amount of rainfall that occurs. Additionally, State of Hawaii Air Pollution Control Regulations prohibit visible emissions of fugitive dust from construction activities at the property line. Therefore, an effective dust control plan for the project construction phase is essential and will be developed.

Mobile and stationary construction equipment also will emit air pollutants from engine exhausts. The largest emission sources are usually from diesel-powered equipment. Nitrogen oxides emissions from diesel engines can be relatively high compared to gasoline-powered equipment. However, the annual standard for $NO_2$ is not likely to be violated by short-term construction equipment emissions. Also, the new short-term (1-hour) standard for $NO_2$ is based on a three-year average; therefore, it is equally unlikely that relatively short-term construction emissions will exceed the standard CO emissions from diesel engines are low and should be relatively insignificant compared to vehicular emissions on nearby roadways.

Finally, increased vehicular emissions due to disruption of traffic by construction equipment and/or commuting construction workers will be alleviated by moving equipment and personnel to the site during off-peak traffic hours.

The State DOH, Clean Air Branch is the permitting authority for new and existing sources of pollutant emissions. ARCADIS performed a regulatory review of Hawaii Administrative Rules Title 11 Chapters 60.1, 260, 451, and 453, and 40 CFR 52.21, 40 CFR 60, and 40 CFR 63. Based on the type of project and low emissions during construction, the Proposed Action is exempt from any permitting considerations. Further, based on a review of State and Federal Regulations and preliminary emission calculations (*Appendix E*), no significant emissions that will cause or contribute to appreciable impacts to local or regional air quality are anticipated. If significant changes to the proposed construction or operation of the project alter the potential to emit, or if the DOH imparts additional restrictions, the air quality impacts may need to be re-evaluated for compliance.

*Criteria Pollutants*

*Table 2-19* summarizes criteria pollutant emissions from construction and construction-related traffic. CAA conformity analysis criteria do not formally apply to the Proposed Action; nevertheless, the general conformity for maintenance areas of 100 tons per year (tpy) of any criteria pollutant can be a useful indicator of significant emissions that could exceed NAAQS or SAAQS. For each pollutant, the total emissions are an order of magnitude below 100 tpy. The Proposed Action is expected to be in compliance with both NAAQS and SAAQS and will result in a less than significant impact on air quality. This is because the anticipated quantities of construction emissions will be relatively low, temporary, and dispersed throughout the project area by trade winds. In general, Hawaii is in attainment for all criteria pollutants.

<u>*Greenhouse Gas Emissions*</u>

GHG are pollutants of concern for air quality and climate change. GHG include water vapor, $CO_2$, methane, $N_2O$, $O_3$, and several chlorofluorocarbons. Water vapor is a naturally occurring GHG and accounts for the largest percentage of the greenhouse effect. Next to water vapor, $CO_2$ is the second most abundant GHG and is typically produced from human-related activities. The largest source of $CO_2$ emissions globally is the combustion of fossil fuels such as coal, oil, and gas in power plants, automobiles, industrial facilities and other sources. Additionally, a number of specialized industrial production processes and product uses such as mineral production, metal production and the use of petroleum-based products can also lead to $CO_2$ emissions.

Although regulatory agencies are taking actions to address GHG effects, there are no State or Federal standards or regulations limiting $CO_2$ emissions and concentrations in the ambient air. In response to the *FY2008 Consolidated Appropriations Act* (House Resolution 2764; Public Law 110–161), EPA issued the *Final Mandatory Reporting of Greenhouse Gases Rule* (GHG Reporting Rule). The GHG Reporting Rule requires annual reporting of GHG emissions to the EPA from large sources and suppliers in the U.S., including suppliers of fossil fuels or industrial GHGs; manufacturers of vehicles and engines; and facilities that emit greater than 25,000 metric tpy each of $CO_2$ and other GHGs. The intent of the rule is to collect accurate and timely emissions data to inform future policy decisions and programs to reduce emissions, as well as fight against the effects of climate change. Additionally, in September 2009, the EPA proposed, under the CAA, new thresholds for GHG that will require that facilities subjected to the New Source Review and Title V operating permit programs to obtain permits and will cover nearly 70 percent of the nation's largest stationary source GHG emitters—including power plants, refineries, and cement production facilities, while shielding small businesses and farms from permitting requirements. The Final Rule, known as the GHG Tailoring Rule, affects sources with the potential to emit 100,000 tpy or greater of GHGs.

Construction of the proposed project will result in very low, short term emissions of GHGs resulting from the combustion process in fuel-burning construction equipment. As shown in *Table 2-19*, the maximum annual emissions of $CO_2$ are projected to be 433 tons. Methane and other GHGs were not included in the analysis but are expected to be much lower than emissions of $CO_2$.

<u>*Operations*</u>

Upon completion of the Proposed Action, air emission levels will be reduced back to pre-construction levels. The improved sewer lines will operate by gravity flow underground, without the assistance of fuel-burning equipment, and will not result in impacts to ambient air quality.

***No Action Alternative***

Under the No Action Alternative current emissions would continue unchanged within the ROI. Improvements to the existing wastewater system would not occur and the approved HHV Master Plan Timeshare Tower would not be developed. Without replacement of the existing sewer lines, the City's sewer collection system for the Kalia-DeRussy Service District may require additional costly maintenance, or otherwise experience failure over time.

## 2.7 GEOLOGY, SOILS AND SEISMICITY

### 2.7.1 Affected Environment

***Introduction and Region of Influence***

The ROI for the geologic and soil impacts of the project lies where ground disturbing activities would occur under the Proposed Action.

***Overview of Valued Environmental Component***

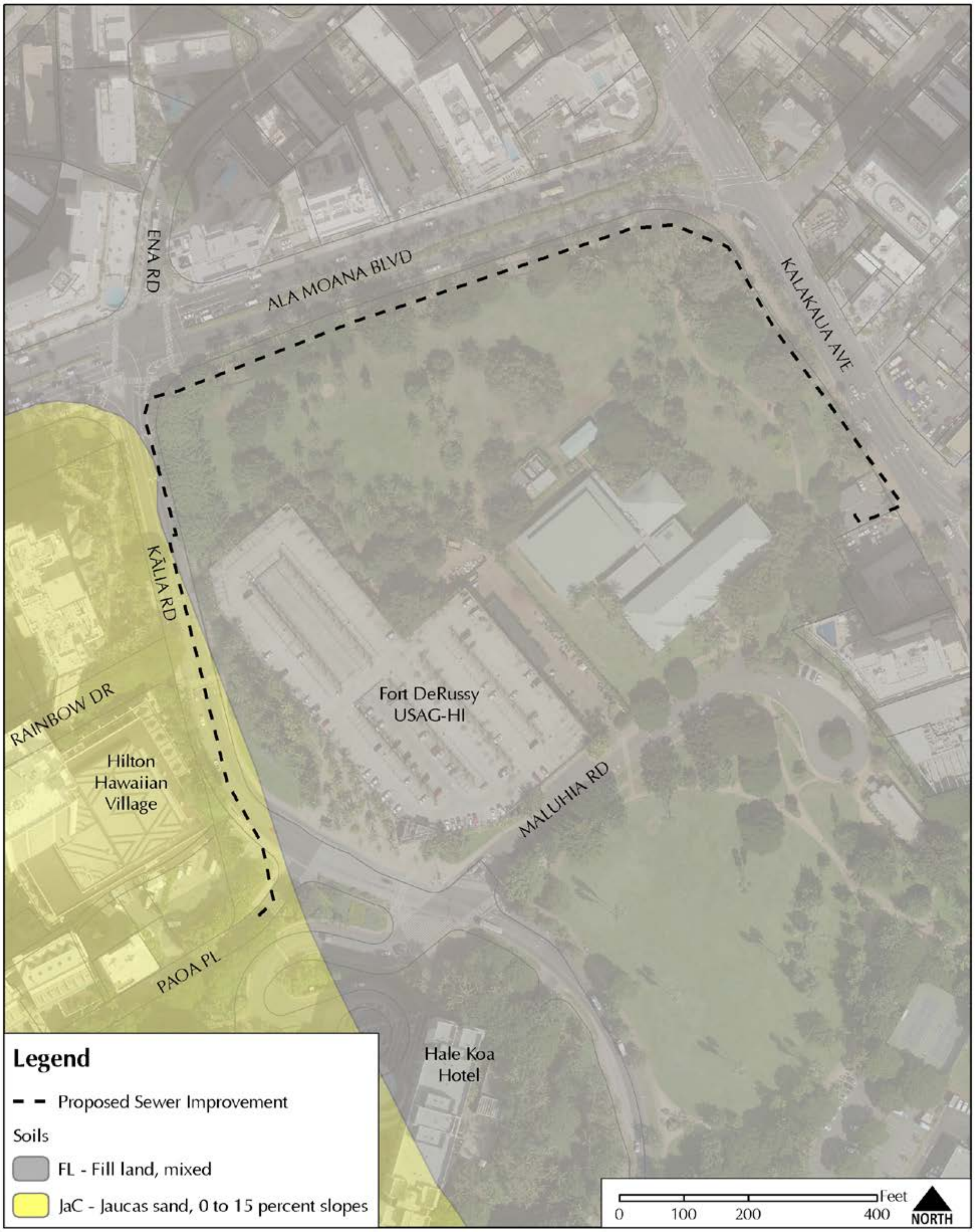
Geology

The geological formation of the Hawaiian archipelago is the result of volcanism. Each island protrusion from the ocean is the summit of a volcanic mountain rising from the ocean floor. The geologic creation of Oahu is a result of the Earth's crust, comprised of irregular rigid segments, known as plates, moving over a hot spot of upwelling lava, which has remained relatively stationary for many millions of years. The plate under which Oahu lies is known as the Pacific plate, which has slowly moved over this span of time towards the northwest. Oahu was created through several stages of activity emanating from two volcanic domes. Through various stages of eruptions, erosion and land movement, the volcanic forms became what are known today as the Waianae and Koolau mountain ranges (Macdonald, 1983).

The project areas are situated on relatively flat land in Waikiki. Waikiki is situated upon a reef formation that extends from Kakaako to the base of Leahi (Diamond Head) crater. Due to its location at the base of a once vast tributary system and in close proximity to Leahi crater, an alluvial mantle on a coral foundation covered the area. As early as 1909, drilling data showed that there is a regular deposition of terrigeneous clay and limestone overlying a substrate layer of coral, coralline algae, and shells. Additionally, the soil contains volcanic ash, olivine, and other lava residue (Carlquist, 1992). The project sites sit on a thick coastal caprock formation comprised of marine (calcareous) sediments, some of which have been imported to fill marshes and other local depressions.

Soils

The project area consists of two soil types (*Figure 2-3*). According to the Oahu soil survey, the underlying site soils consist of Fill land mixed and Jaucas Sand (JaC). Fill land mixed-type soils consist of material dredged from the ocean or hauled from nearby areas. This soil type is typically used for urban development. JaC-type soils consist of excessively drained calcareous soils that occur as narrow strips on coastal plains adjacent to the ocean. This soil type developed in wind- and water-deposited sand from coral and seashells and is generally nearly level to strongly sloping. Permeability is rapid, runoff is slow, water erosion is slight, and wind erosion is severe where areas of vegetation have been removed. (U.S. Department of Agriculture Soil Conservation Service, 1972)




**SOILS**
**KALIA-FORT DERUSSY WASTEWATER SYSTEM IMPROVEMENTS** **FIGURE 2-3**

<u>Seismicity</u>

The majority of earthquakes in Hawaii are directly related to volcanic activity, particularly to the movement of magma beneath Kilauea and Mauna Loa, on the island of Hawaii. Other earthquakes are the result of exerted pressures released by magma that never reaches the surface. The United State Geological Survey conducted a probabilistic seismic-hazards assessment for the State of Hawaii, in 1997. From this assessment, seismic zones were re-assigned for each county.

The entire City lies in a seismic zone designated as Zone 2A. Under the United Building Code seismic provisions, a Zone 2A area could experience seismic activity between .075 and .10 of the earth's gravitational acceleration. In comparison, the County of Hawaii, with its ongoing volcanic activity, is designated as Zone 4, the highest seismic zonation, demonstrating that the island of Hawaii could experience severe seismic activity between .30 and .40 of the earth's gravitational acceleration.

### 2.7.2 Environmental Consequences

***Impact Methodology***

The Proposed Action and No Action Alternatives were evaluated for adverse effects on people and the environment in the context of geologic conditions within the ROI. The Proposed Action and No Action Alternatives were evaluated to determine the significance of the change to the geologic environment with respect to the factors identified below.

***Factors Considered in the Impact Analysis***

Factors considered in determining if the Proposed Action and No Action Alternatives would have a significant impact on geology are the extent to which its implementation would result in the following:

- Increase the exposure of people or structures to geologic hazards;
- Cause a substantial loss of soil; or
- Alter the function of the landscape (i.e. altering drainage patterns through excavation, filling, or leveling).

***Summary of Impacts***

*Table 2-21* provides a summary of the potential impacts on geology, soils, and seismicity.

| Table 2-21 SUMMARY OF POTENTIAL IMPACTS ON GEOLOGICAL RESOURCES | | |
|---|---|---|
| **Impact Issues** | **No Action Alternative** | **Proposed Action (Preferred Alternative)** |
| Erosion | No impact | Less than significant impact |
| Seismicity | No impact | No impact |

***Proposed Action (Preferred Alternative)***

<u>Erosion</u>

During construction, approximately 2,563 linear feet of ground disturbance will occur on existing roadways, sidewalks and landscaped areas for the sewer line improvements. Project construction will involve land disturbing activities that result in soil erosion, such as the removal of existing asphalt, paving and vegetation (clearing and grubbing), grading, excavation, trenching and infilling of soil. During construction, soil erosion will be minimized through compliance with the City's grading ordinance, and the applicable provisions of the DOH's Water Quality Standards (Chapter 11-54, HAR) and Water Pollution Control requirements (Chapter 11-55, HAR). In addition, the effects will temporary and will be reduced by implementing standard Best Management Practices (BMPs). These BMPs will be detailed in subsequent construction plans, and may include phasing of construction activities, stationing water trucks onsite during construction to provide immediate sprinkling in active construction zones if needed, use of temporary screens, and thorough covering open construction areas after activity has ceased for the day and on weekends.

<u>Seismicity</u>

The Proposed Action will be designed according to City's standards for protection from seismic hazards, which will reduce the potential for impacts from seismic events.

***No Action Alternative***

Under the No Action Alternative, the proposed sewer improvements would not occur and no large-scale ground-disturbing activities would occur. No adverse impacts on the geology, soils, and seismicity would occur under the No Action Alternative.

## 2.8 NATURAL HAZARDS

### 2.8.1 Affected Environment

***Introduction and Region of Influence***

The following section addresses natural hazard conditions, such the threat of floods, hurricanes and tsunamis, within the ROI. For the purpose of this evaluation, the ROI is defined as the Proposed Action and areas within the vicinity of the proposed improvements.

***Overview of Valued Environmental Component***

Natural hazards associated with the Proposed Action and its vicinity includes the potential for flooding, hurricanes and tropical storms and tsunamis to occur. These natural hazards are discussed in greater detail below.

<u>Flooding</u>

The proposed sewer improvements areas lie within the areas designated as AO and AE on the National Flood Insurance Rate Maps (#15003 C0370F, 0365F) (*Figure 1-7)*. The AO designation is the 100-year flood zone with a base flood elevation between one (1) and three (3) feet above the geographic elevation. Flooding in these areas is typically shallow and consists of sheet flow on sloping terrain. The AE zone is a special flood area which has the potential to be inundated with a 100-year flood. For AE designations, base flood elevations are determined for each specific geographical area. Within the project site, areas designated as part of the AE zone have a base flood elevation identification of 5 feet above the geographic elevation.

*Hurricanes and Tropical Storms*

Hurricanes and tropical storms are giant whirlwinds in which air moves around a center of low pressure, reaching maximum velocity in a circular band. Tropical storms are categorized as an organized system of strong thunderstorms with defined circulation and maximum sustained winds of 39 to 73 miles per hour. Hurricanes are intense tropical weather systems with well-defined circulation and maximum sustained winds of 74 miles per hour or more. These intense storms are often accompanies by heavy rainfall and flash flooding.

In the Northern Hemisphere, a hurricane's circulation includes low pressure and counter-clockwise inflow at the surface, and high pressure and clockwise outflow at upper levels. The overall diameter of the hurricane circulation is typically between 300 and 600 miles. A hurricane or tropical storm may create hazardous conditions from high winds, torrential rainfall, coastal and inland flooding and erosion, high surf, and storm surge, which may damage or destroy property and/or threaten lives. The general season for these storms is between the months of June to December.

Hurricanes are considered to be relatively rare events in the Hawaiian Islands. Records show that strong wind storms have struck all major Hawaiian Islands. The first officially recognized hurricane in Hawaiian waters was Hurricane Hiki in August 1950. Since that time, five hurricanes have caused serious damage in Hawaii: Nina (1957), Dot (1959), Iwa (1982), Estelle (1986), and Iniki (1992).

*Tsunami Inundation*

Tsunamis are caused by a sudden and typically violent movement of the sea floor that generates a wave or a series of great waves which travel across the ocean until they reach a coast. Sea floor movements may include earthquake faulting, submarine land sliding, or submarine volcanic eruptions. Submarine faulting, often consisting of the vertical movement of a block of oceanic crust, may cause earthquakes.

Tsunamis are characterized by great speeds (up to 590 miles per hour), long wave length (up to 120 miles), long periods between successive crests (ranging from minutes to a few hours), and low height in the open sea. Upon reaching a coastline, a tsunami can become a wall of water reaching heights of 30 feet or more and capable of moving inland several hundred feet.

In Hawaii, tsunamis have accounted for more lost lives than the total of all other local natural disasters. In the 20$^{th}$ century, an estimated 221 people have been killed in Hawaii by tsunami events. Historically, the south shore of Oahu, including Waikiki, has been affected only minimally by tsunamis. Known major tsunami events in Hawaii, per the Pacific Disaster Center, include the areas of Hilo (1946), North Shore Oahu (1952), Laie Point (1957), Hilo (1960), Halape Beach Park, Hawaii Island (1975), Kona Coast, Hawaii Island (2011).

According to the City's tsunami evacuation maps, the proposed sewer improvements along Kalia Road and a portion of the improvements in Fort DeRussy fronting Ala Moana Boulevard is located within the tsunami evacuation zone (*Figure 1-7*).

### 2.8.2 Environmental Consequences

***Impact Methodology***

Numerous federal, state, and local laws exist to help prevent and abate hazardous conditions, and their primary goal is to protect human health and safety. The methods for assessing potential hazardous conditions and related impacts generally include the following:

- Assessing the compliance of the Proposed Action with applicable, site specific, standard operating procedures and health and safety plans in order to avoid potential hazards; and
- Assessing causes and impacts of natural hazards conditions (floods, hurricanes and tsunamis) in conjunction with established management protocols.

***Factors Considered for Impacts Analysis***

Numerous federal, state, and local laws regulate the storage, use, recycling, disposal, and transportation of hazardous materials and waste. Similar laws exist to help prevent and abate hazardous conditions, and their primary goal is to protect human health and safety. The methods for assessing potential hazardous materials and conditions impacts generally include the following:

- Comparing the location of the Proposed Action with data of known natural hazard area (i.e. flood zones, tsunami evacuation zone);
- Assessing the compliance of the Proposed Action with applicable Federal, State and County rules and regulations and standard operating procedures during a natural hazard for the health and safety of the public.

***Summary of Impacts***

*Table 2-22* provides a summary of the potential impacts occurring from natural hazards.

**Table 2-22 SUMMARY OF POTENTIAL IMPACTS FROM NATURAL HAZARDS**

| Impact Issues | No Action Alternative | Proposed Action (Preferred Alternative) |
|---|---|---|
| Location of known natural hazard areas | No impact | No impact |
| Compliance with rules and regulations and standard operating procedures | No impact | No impact |

***Proposed Action (Preferred Alternative)***

<u>*Flooding*</u>

The proposed sewer improvements will meet the flood hazard requirements in accordance with current Federal, State and County standards, including rules and regulations of the National Flood Insurance Program presented in 44 CFR. The project will occur within the City's Flood Hazard District. The area is regulated under by the LUO, Chapter 21, Article 9 Special District Regulation of the Revised Ordinance of Honolulu (ROH). The project will comply with development standards as described in section 21-9.10-4, particularly:

*(h) For new or replacement sanitary sewer system and waste disposal system, be designed, located and constructed so as to minimize impairment to them or contamination from them during and subsequent to flooding by regulatory flood.*

The Flood Fringe District is a lower risk area than the floodway district, allowing uses in the underlying zoning districts, provided such uses, improvements, structures and utilities complies with the provisions of LUO Sections 21-9.10 through 21-9.10-14. To provide flood protection, the Proposed Action will also comply with LUO Section 21-9.10-6. The project contractor will monitor wet weather conditions and prepare the work area to prevent flood damage, prevent sewage overflows and maintain continuity of wastewater services. The contactor will also provide sewage bypass pumps sized for peak wet weather sewage flows and backup bypass pumps. Due to modern collection system design, this replacement sewer system will be much less susceptible to inflow/infiltration than the current system.

In the event of an emergency situation resulting from flood inundation, typically the City designates evacuation shelters to be selectively opened depending upon the severity of the damage. Shelter designations and schedules are broadcast on local radio and television stations.

*Hurricane and Tropical Storm*

Since 1955, five major hurricanes or tropical storms have caused major damage to Hawaii. The effects of these past storm events have caused minimal to no damage in the project area. The future threat of hurricanes in the project area cannot be estimated beyond the fact that hurricanes will probably hit Hawaii as frequently as they have in the past.

*Tsunami Inundation*

In general, all coastal areas of Oahu are vulnerable to impacts resulting from a tsunami. The actual impacts of tsunamis upon a particular area cannot be estimated beyond the possibility of the area sustaining heavy damage. The capacity of a structure to withstand the effects of a tsunami is dependent upon several factors including: the size and speed of the wave as it is transformed while approaching the shore, the type of structure, the site design and orientation of the structure and its surroundings, and the amount of debris that is swept in the movement of the wave. Similar to other natural hazard events, the City has an emergency operations plan for evacuating potentially affected areas. Inland shelters have been identified. Tsunami Warning signals from the State Civil Defense sirens will be audible during a tsunami alert event.

The proposed sewer improvements will be installed underground and will not be impacted by natural hazards such as flooding, hurricanes and tropical storms, and tsunamis. However, during construction in the event of a natural disaster, the contractor will have an evacuation plan to ensure the safety of all workers.

### *No Action Alternative*

Under the No Action Alternative, there would be no change to the conditions affecting natural hazards. No impacts would be anticipated under this alternative.

## 2.9 WATER RESOURCES

### 2.9.1 Affected Environment

***Introduction and Region of Influence***

Water resources include surface water and groundwater. The ROI for surface water and groundwater resources is the watersheds and areas within the vicinity of the proposed improvements, as well as down-gradient areas in hydraulic contact with these places.

***Overview of Valued Environmental Component***

*Surface Water*

There are no natural occurring sources of surface water present near the project areas. Significant land alterations, including the dredging of the Ala Wai Drainage Canal at the turn of the 20th Century, have affected the natural tributary and outflow systems that were once present.

*Groundwater*

Groundwater lies at approximately four feet below grade. Groundwater resources beneath the project areas emanate from in two distinct aquifers within the Palolo Aquifer System. The shallow aquifer is classified as a basal, unconfined, sedimentary aquifer, occurring in non-volcanic lithology. The groundwater protection status is reported as potentially usable, however, it is not considered ecologically important, nor will it be recommended for use as drinking water. The groundwater within this aquifer is described as moderate salinity (1,000-5,000 milligrams per liter of chlorine), replaceable, with a high vulnerability to contamination. The deeper aquifer is classified as a basal, confined, flank aquifer, occurring in horizontally extensive lavas. The groundwater protection status is reported as being currently used for drinking water purposes. The groundwater within this aquifer is described as fresh (<250 milligrams per liter of chlorine), irreplaceable, with a low vulnerability to contamination (Mink and Lau, 1990). The closest potable water wells operated by the City Board of Water Supply (BWS) are located far inland of Waikiki. Potable water sources closest to Waikiki are within the Palolo aquifer unit (5 mgd), 30101 basal aquifer system and Nuuanu aquifer unit (14 mgd, 30102 basal aquifer system) (CWRM, 2008).

### 2.9.2 Environmental Consequences

***Impact Methodology***

The Proposed Action and No Action Alternatives were evaluated for adverse effects on water resources such as water quality, surface water runoff volumes and drainage patterns. Another factor for assessing impacts was if the Proposed Action were evaluated in accordance with the applicable provisions of Federal and State regulations.

***Factors Considered for Impacts Analysis***

Factors considered in determining if the Proposed Action and No Action Alternatives would have a significant impact on water resources are the extent to which its implementation would result in the following:

- Degradation of surface or groundwater quality that will reduce the existing or potential beneficial uses of the water;
- Alteration of the pattern of surface or groundwater flow or drainage that will adversely affect the uses of the water within or outside the project region;
- Noncompliance with existing or proposed water quality standards or with other regulatory requirements related to protecting or managing water resources.

***Summary of Impacts***

*Table 2-23* provides a summary of the potential impacts on water resources.

**Table 2-23 SUMMARY OF POTENTIAL WATER RESOURCE IMPACTS**

| Impact Issues | No Action Alternative | Proposed Action (Preferred Alternative) |
|---|---|---|
| Surface water runoff and erosion | No impact | Beneficial/Less than significant impact |
| Water quality | No impact | Beneficial/Less than significant impact |

***Proposed Action (Preferred Alternative)***

*<u>Surface Water</u>*

The proposed project will not increase the long-term volume of peak stormwater runoff or contribution of contaminants to stormwater runoff. There will be short-term runoff contributions, and the project will restore pavements, groundcover and landscaping disturbed during construction. Implementation of the Proposed Action will have beneficial impacts on water quality since the sewer improvements will serve to minimize problems that may occur from wet water infiltration/inflow.

Materials that may affect surface water quality as the result of the construction work include soils from excavation and material stockpiles, particles from asphalt concrete pavement materials, fuel and oil from construction equipment. Short-term construction related impacts to surface water quality will be mitigated by employing BMPs such as erosion control measures, maintaining the construction to minimize contaminants in stormwater runoff, and treating dewatering effluent discharges. Silt fences and sediment trapping drain inlet filters will be used to minimize the entry of contaminants through storm drain inlets. Construction will be phased to limit the exposure of bare ground and minimize erosion from rainfall and stormwater runoff.

Excavation during construction may require dewatering, which will be managed following the conditions of approval for a National Pollutant Discharge Elimination System (NPDES) Construction Dewatering from the State DOH, Clean Water Branch. The NPDES permit conditions will be administered in association with County permits for Excavation and Grading. The contractor will be required to treat the dewatering effluent using appropriate BMP methods. Water quality testing will be performed as required to comply with requirements of the NPDES general permit. Dewatering effluent contaminated with sewage will be discharged to the sewer system. Accidental sewage spills that occur during construction will be reported in accordance with standard DOH rules and regulations. The contractor will be required to submit a spill mitigation plan prior to commencing work.

Groundwater
The Proposed Action is not expected to significantly impact groundwater quantity or quality within, or down-gradient from, the project sites. Implementation of the Proposed Action will have beneficial impacts on water quality since the sewer improvements will serve to minimize problems that may occur from wet water infiltration/inflow. During construction, contractors will minimize spillage of sewage on the streets to avoid potential groundwater contamination. BMPs that may be implemented include dewatering effluent contaminated with sewage to be discharged to the sewer system and performing groundwater water quality testing during the design phase to verify that hazardous constituents are not present in the discharge. Potential impacts relating to contamination of groundwater in the pipe trenches are not anticipated to be significant, since little or no contamination water will exfiltrate (groundwater will be entering the trench) into the surrounding soil during trench dewatering. BMPs implemented will minimize potentially adverse impacts to groundwater quality. Therefore, mitigation measures are not proposed.

***No Action Alternative***

The No Action Alternative would not result in impacts affecting water resources because they would remain the as they are under existing conditions. However, under this alternative, improvements to the existing sewer lines serving HHV, HKH and portions of the service area between the Ala Wai Canal, Kalakaua Avenue and Fort DeRussy would not occur. The HHV Timeshare Towers would not be built because the existing sewer system would not be able to accommodate additional flows.

## 2.10 HAZARDOUS MATERIALS

### 2.10.1 Affected Environment

***Introduction and Region of Influence***

The following section addresses hazardous materials and conditions, such as the use and storage of hazardous materials and wastes, and the threat of floods, hurricanes and tsunamis, within the ROI. For the purpose of this evaluation, the ROI is defined as the Proposed Action areas within the vicinity of the proposed improvements.

***Overview of Valued Environmental Component***

According to the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), a hazardous substance can be defined as any substance that, due to its quantity, concentration, or physical and chemical characteristics, poses a potential hazard to human health and safety or to the environment. CERCLA has created national policies and procedures to identify and remediate sites contaminated by hazardous substances. Hazardous waste is defined as having a chemical composition or containing other properties that make it capable of causing illness, death, or some other harm to humans and other life forms when mismanaged or released into the environment.

Kalia Road, Ala Moana Boulevard and Kalakaua Avenue has been active roadways for many years. Automotive repair shops and fueling stations have been located in the vicinity of these roadways. Upon examination of the State DOH Underground Storage Tank (UST) Database, there are several USTs located in the vicinity of the project area. The closest active UST is located at 2025 Kalakaua Avenue, where the existing Aloha Petroleum is situated. Two (2) other 12,000-gallon USTs are also located at the HHV. These USTs are located in the tour bus parking area on the eastern corner of the property and were once used for the storage of diesel fuel for the HHV boilers. These USTs are planned for future removal.

Fort DeRussy, and particularly the area fronting Ala Moana Boulevard, is part of a large open park. This area is not known to contain hazardous materials.

### 2.10.2 Environmental Consequences

***Impact Methodology***

Numerous federal, state, and local laws regulate the storage, use, recycling, disposal, and transportation of hazardous materials and waste. Similar laws exist to help prevent and abate hazardous conditions, and their primary goal is to protect human health and safety. The methods for assessing potential hazardous materials and conditions impacts generally include the following:

- Reviewing and evaluating the Proposed Action to identify its potential to use hazardous or toxic materials or to generate hazardous waste, based on the activities proposed;
- Comparing the location of the Proposed Action with baseline data on known or potentially contaminated areas;
- Assessing the compliance of the Proposed Action with applicable Federal, State, and County rules and regulations, standard operating procedures and health, and safety plans in order to avoid potential hazards.

***Factors Considered for Impacts Analysis***

Regulatory standards and guidelines have been applied to determine the significance of each alternative's potential impact from hazardous materials and waste. Factors considered in determining whether an alternative would have a significant hazardous materials and conditions impact include the extent to which its implementation would result in the following:

- Hazardous or acutely hazardous waste, resulting in increased regulatory requirements over the long term;
- A spill or release of a hazardous substance (as defined by 40 CFR, Part 302, of CERCLA, or Sections 110, 112, 116, and 117 of the Clean Water Act);
- Exposure to the environment or public to any hazardous condition through release or disposal;
- The impacts occurring from USTs;
- The accidental release of asbestos during construction demolition.

***Summary of Impacts***

*Table 2-24* provides a summary of the potential impacts from hazardous materials.

**Table 2-24 SUMMARY OF POTENTIAL IMPACTS FROM HAZARDOUS MATERIALS**

| Impact Issues | No Action Alternative | Proposed Action (Preferred Alternative) |
|---|---|---|
| Hazardous waste resulting in increased regulatory requirements | No impact | No impact |
| A spill or release of a hazardous substance | No impact | No impact |
| Exposure to the environment or public to hazardous conditions | No impact | No impact |
| Impacts from USTs | No impact | No impact |
| Accidental release of asbestos | No impact | No impact |

***Proposed Action (Preferred Alternative)***

Based on the project's distance from known sources of hazardous materials, it is unlikely that contaminated soil or groundwater will be encountered during soil disturbance activities. While unlikely, it is possible that contaminated groundwater may be encountered in areas where soil disturbance occurs. Waste generated will be handled in accordance with State solid waste disposal laws. Appropriate worker protection procedures will be implemented during construction of the sewer improvements. This includes wearing proper personal protective equipment, dust and runoff controls, and soil and groundwater handling and disposal procedures. A contingency plan may also be implemented to address contaminated soil or groundwater encountered during excavation activities.

Construction of the Proposed Action will not involve hazardous waste. Some hazardous materials will be used in the course of construction, such as fuels and lubricants. These materials will be managed properly by the contractor to avoid an accidental release to the environment.

***No Action Alternative***

The No Action Alternative would not change the existing conditions within the ROI. Improvements to the existing wastewater system would not occur and the approved HHV Master Plan Timeshare Tower would not be developed, therefore, no impacts relating to hazardous materials would result from the No Action Alternative.

## 2.11 PUBLIC FACILITIES, SERVICES AND UTILITIES

### 2.11.1 Affected Environment

***Introduction and Region of Influence***

This resource is evaluated to determine if the Proposed Action will result in impacts to the existing utility infrastructure. For this evaluation, the ROI is defined as the project areas and its immediate vicinity. Public facilities, services and utilities include educational facilities, recreational facilities, police, fire, emergency medical services and hospital services, solid waste management, and infrastructure for water, wastewater, storm water and drainage, electricity, telephone and natural gas.

***Overview of Valued Environmental Component***

<u>*Public Facilities and Services*</u>

*Schools*

The Waikiki community is part of the State Department of Education's Honolulu school district. The Honolulu School District is comprised of fifty-five elementary, middle, and high schools; two special schools and the Hawaii Center for Deaf and Blind. The public schools closest to the project areas include: Ala Wai Elementary; Jefferson Elementary; Washington Middle School; Kaimuki High School; and McKinley High School.

*Public Parks*

Public parks provide open space and a natural outdoor environment for both residents of Hawaii and tourists to enjoy. The following State and City public parks are within Waikiki and walking distance to the project area: Ainahou Triangle park; Duke Kahanamoku Beach Park; Fort DeRussy Beach Park; Ala Moana Regional Park; Ala Wai Community Park; Ala Wai Neighborhood Park; Ala Wai Promenade, Don Ho Memorial Park (formerly known as Beach Walk Triangle); King Kalakaua Park; Kuhio Avenue Mini Park; Kuhio Beach Park; Honolulu Zoo, Kapiolani Park, and Princess Kaiulani Triangle.

*Police Protection*
The Waikiki region is under the protection of the Honolulu Police Department (HPD). The area is part of HPD District 6, which extends across the Waikiki peninsula from the Ala Wai Canal to Diamond Head and consists of twelve beats (650 to 662). The Village is within District 6, Sector 1, Beat 653, which includes the area makai of Ala Moana Boulevard and Kalakaua Avenue to Saratoga Avenue.

The HPD Waikiki substation is located on Kalakaua Avenue at Prince Kuhio Beach. The district's Burglary-Theft Detail and Crime Reduction Unit occupy office space on the fourth floor of the Royal Hawaiian Center. The Crime Reduction Unit concentrates on drugs, prostitution, violent crimes, and other quality-of-life cases. In addition, the District's Bicycle All-Terrain Vehicle Detail is a detail that provides high visibility and mobility on beaches and in parks. The Beach Detail continues patrols on the beach from the Duke Kahanamoku Lagoon to the Natatorium.

Each year, Waikiki is host to over a hundred events including numerous parades, surfing contests, marathons, Sunset on the Beach, Waikiki Hoolaulea, and other cultural and community events. District officers work with community partners including the Visitor Aloha Society of Hawaii, Business Watch, Hawaii Hotel Security Association, Waikiki Business Improvement District, and others, to create a safe environment for Waikiki residents and guests.

*Fire Protection*
The Waikiki region is in the 2$^{nd}$ Battalion area designated by the Honolulu Fire Department (HFD). The region is served by three fire stations, which include:

- Station 2: The Pawaa Fire Station is located at Makaloa Street near Don Quijote. It has a ladder company, an engine company, and a rescue company.
- Station 7: The Waikiki Fire Station is located at the corner of Kapahulu Avenue and Paki Street. It has a ladder and engine company.
- Station 29: The Moilili Fire Station is located on Date Street, between University Avenue and Kapiolani Boulevard. It has a ladder and engine company.

First response for medical and fire emergencies at the project sites and the surrounding area is provided by HFD Station 2. The other stations will respond in case of a need for additional support for first response or alarm fire. HFD works with the City Emergency Medical Services (EMS) and Emergency Medical Dispatch in providing first response to emergencies.

*Emergency Medical Services and Hospital Services*
EMS provides pre-hospital emergency medical care and emergency ambulance service on Oahu. In 2009, Emergency Medical Dispatch accepted 79,101 calls through the 911 system. This led to 66,047 EMS responses, from which 48,573 patients were transported to hospitals, with the major cause of injury being falls and vehicle accidents. EMS has 19 Advanced Life Support Ambulance units and two (2) Rapid Response Paramedic units on the island, which are assigned to two (2) districts. Waikiki is under District 2 and is covered by an EMS unit at the Waikiki Fire Station.

A Straub Doctors on Call clinic is located on the second floor of the Rainbow Bazaar. Straub Doctors on Call offers a broad range of non-emergency medical care services, including 24-hour physician services, laboratory, and x-ray for visitors and employees. Additionally, the Waikiki Health Clinic is a private non-profit community health center that provides non-emergency comprehensive services. Kapiolani

Medical Center for Women and Children, and the Queen's Medical Center are the two primary main healthcare and emergency facilities that service guests or visitors at the Village. Waikiki Health Clinic is located approximately one mile from the Village in Waikiki on Oahu Avenue; Kapiolani Medical Center for Women and Children is located approximately 1.2 miles on Punahou Street, while Queen's Medical Center is approximately 3 miles on Punchbowl Street near the State Capitol building.

*Solid Waste Management*
Solid waste generated in the vicinity of the Proposed Action is collected and hauled to the City's H-Power waste-to-energy plant and its Waimanalo Gulch landfill, as well as the privately owned PVT Landfill in Nanakuli and various recycling facilities.

*<u>Public Utilities</u>*

*Potable Water Supply*
The BWS provides potable water for most of Oahu. The BWS water system in the vicinity consists of a 12-inch main along the mauka side of Ala Moana Boulevard; a 4-inch service line along the makai side of Ala Moana Boulevard; an 8-inch main in Kalia Road; a 12-inch water main along Kahanamoku Street; and an 8-inch main that reduces to a 4-inch service line within Paoa Place. Fire hydrants are located along the mauka side of Ala Moana Boulevard and Kalia Road, spaced approximately 300-feet apart. Fire hydrants are located along Kahanamoku Street, spaced approximately 250-feet apart. Water for fire protection is serviced from the 12-inch main in Ala Moana Boulevard with a secondary connection to the 8-inch main in Kalia Road.

*Wastewater*
The Proposed Action will improve the existing City wastewater system to accommodate the HHV Master Plan, HKH and surrounding area users. The City wastewater system near HHV consists of 18-inch and 12-inch sewer lines along Ala Moana Boulevard, which connect to a 24-inch sewer line (1960) at the Kalia Road intersection, a 12-inch sewer line in Kalia Road, 8-inch and 12-inch sewer lines in Kahanamoku Street, and a sewer line in Paoa Place that varies in size from 8-inch to 10-inch.

Wastewater from the majority of the HHV campus flows in the mauka direction toward the Ala Moana Boulevard and Kalia Road intersection in a 15-inch diameter sewer line. Wastewater flows through a 24-inch diameter sewer line (1960) in an expired easement through Fort DeRussy along Ala Moana Boulevard and Kalakaua Avenue to the Fort DeRussy WWPS. The City is currently negotiating a renewal of this easement. A second 24-inch diameter sewer line (2004) located in Ala Moana Boulevard and Kalakaua Avenue parallels the 24-inch diameter sewer line (1960) conveying wastewater from areas north of the HHV to the Fort DeRussy WWPS.

Sewer laterals convey wastewater from the south and east sides of the remainder of the HHV campus to 8- and 10-inch diameter sewer lines in Paoa Place, and a12-inch diameter sewer line in Kalia Road, respectively. Wastewater from the HKH, including Ilima Tower (420 rooms), restaurants and banquet facilities, discharges into the 12-inch diameter sewer line in Kalia Road. Wastewater from HHV and HKH flows from the 12-inch diameter sewer line in Kalia Road through a 16-inch diameter sewer line through an easement which traverses diagonally through Fort DeRussy from the Ala Moana Boulevard and Kalia Road intersection to the Fort DeRussy WWPS. Portions of the 16-inch diameter sewer line are located under existing structures on Fort DeRussy.

Within Kalakaua Avenue, a 12-inch diameter relief sewer line connects the 24-inch diameter sewer line (2004) to a “Waikiki Relief Sewer” 24-inch diameter sewer line which traverses along Kuhio Avenue and connects to the Beach Walk Wastewater Pump Station. The capacity of the 12-inch diameter relief sewer line is 1.93 mgd.

The Fort DeRussy WWPS pumps the effluent to the City’s sewage pump station at Ala Moana Beach Park which is conveyed to the Sand Island Treatment Plant, where it is treated and discharged through a deep ocean outfall.

*Storm water and Drainage*
The existing conditions of surface runoff, storm water discharge and drainage are linked to existing infrastructure currently in-place. A 5 feet × 3 feet box drain on the mauka side of Ala Moana Boulevard, which originates at the Kalia Road intersection, conveys storm water in the ewa direction. The drainage system along Kalia Road consists of an 18-inch line from Paoa Place extending to the ewa side of the Rainbow Drive intersection, where the drain system increases to two 18-inch lines and extends to the Ala Moana Boulevard intersection. At this intersection, this drainage system increases to a 24-inch drain line which connects to the 5 feet × 3 feet box drain in Ala Moana Boulevard. Catch basins along Ala Moana Boulevard and Kalia Road capture the roadway storm water runoff for conveyance through the pipes and box drain.

Storm water runoff from the mauka half of Paoa Place is captured in a catch basin near the intersection of Kalia Road that drains to the 18-inch line along Kalia Road to Ala Moana Boulevard. Storm water runoff from the makai half of Paoa Place is captured in inlets and conveyed through a 6-inch line to the makai end of Paoa Place, where the runoff flows through a 3 feet × 1 foot concrete box drain to a 15-inch drain line, and discharges to the ocean at Port Hilton. A catch basin on Kalia Road, ewa of Paoa Place, conveys storm water through an 18-inch drain line that extends across Paoa Place to a 36-inch drain line that runs along the Diamond Head side of Paoa Place. A 5 feet × 3 feet concrete box drain along the ewa side of Kahanamoku Street extends from the mauka side of Ala Moana Boulevard and discharges to the Ala Wai Yacht Harbor.

*Electricity*
The area in the vicinity of the Proposed Action is presently served from Hawaiian Electric Company’s Ena Substation located on Ena Road across from the Hobron Lane intersection.

*Communications*
The area in the vicinity of the Proposed Action is presently serviced from Hawaiian Telcom’s (HTCO) Punahou Central Office located on Young Street, near McCully Street. HTCO’s main duct lines and cables are located along Ala Moana Boulevard. Oceanic Time Warner Cable facilities, in many cases, are collocated with HTCO’s duct system. Since the completion of the Kalia Road Re-alignment project by the Federal Government, there have been on-going discussions regarding the jurisdiction and ownership of the duct system on Kalia Road. The Kalia Road Re-alignment Site Improvements and Utilities Package #1 drawings indicate that the communications duct lines were constructed on the north-east side of Kalia Road within Federal property.

*Natural Gas*
The Gas Company has existing gas lines within Ala Moana Boulevard, Kalia Road, Paoa Place, Kahanamoku Street, and within the site. A 4-inch gas line extends along the mauka sides of Ala Moana

Boulevard and Kalia Road. A 2-inch gas line extends along Paoa Place and Kahanamoku Street. The Gas Company gas lines within the Village are interconnected with gas lines along Kalia Road, Paoa Place and Kahanamoku Street.

### 2.11.2 Environmental Consequences

***Impact Methodology***

The methods used to determine if a project alternative would have a significant impact on public services and utilities are as follows:

- Evaluate existing activities to identify the action's potential to affect public services and utilities;
- Evaluate each project alternative to identify the action's potential to affect public services and utilities; and
- Assess the compliance of the proposed alternative with applicable Federal, State, or County regulations and guidelines.

This section analyzes potential impacts educational facilities, recreational facilities, police, fire, emergency medical services, solid waste management, potable water, wastewater, stormwater and drainage, electricity, communications, and natural gas utilities infrastructure. Potential infrastructure shortfalls, inconsistencies, inadequacies, or deficiencies identified between the infrastructure and the requirements of a project alternative are all characterized as potential effects.

***Factors Considered for Impacts Analysis***

Factors considered in determining if an alternative would have a significant impact on public services and utilities include the extent to which its implementation would result in the following:

- Disrupt public utility service, as a result of physical displacement and subsequent relocation of public utility infrastructure, to the extent that the result would be a direct long-term service interruption or permanent disruption of essential public utilities; or
- Require an increase in demand for public facilities and services or utilities beyond the capacity of the provider, to the extent that additional facilities or increased staffing would be necessary.

***Summary of Impacts***

*Table 2-25* summarizes the potential impacts on public facilities, services and utilities.

**Table 2-25 SUMMARY OF POTENTIAL IMPACTS ON PUBLIC FACILITIES, SERVICES, AND UTILITIES**

| Impact Issues | No Action Alternative | Proposed Action (Preferred Alternative) |
|---|---|---|
| Public facilities and services | No impact | Less than significant impact |
| Potable water supply | No impact | No impact |
| Wastewater | No impact | Beneficial |
| Stormwater and drainage | No impact | Less than significant impact |
| Electricity | No impact | No impact |
| Communications | No impact | No impact |
| Natural Gas | No impact | No impact |

***Proposed Action (Preferred Alternative)***

*Public Facilities and Services*

*Schools and Public Parks*

The Proposed Action is located away from most school facilities and is not expected to result in significant adverse impacts.

Most of the public parks are also located away from the Proposed Action, with the exception of Ainahau Triangle Park. In the short-term, the proposed sewer improvements may have impacts on air quality, noise, and traffic. Construction work areas will be phased along the project alignment to minimize these impacts to the extent possible. Upon completion of the project, no impacts to schools and public parks are anticipated.

*Police Protection, Fire Protection, Emergency Medical Services and Hospital Services*

In the short-term the Proposed Action may have less than significant impacts on public services. These include the use of police officers to manage traffic and construction related accidents that could impact the health care system, and emergency personnel. In addition, a delay in response time relating to police, fire and EMS may occur due to vehicular and pedestrian traffic. These are potential unavoidable impacts can affect all construction activities. During construction, safety requirements and procedures will be implemented during construction to all to reduce the risk of accidents. Traffic control plans will be prepared as part of the construction plans for the sewer line to address vehicular and pedestrian traffic during the construction activities. Construction work areas will be phased along the project alignment to minimize impact to vehicular and pedestrian traffic. Once the construction of the proposed wastewater system improvements is completed, no significant impacts to these services are anticipated. Long-term impacts on existing public services are not anticipated.

*Solid Waste Management*

Solid waste will be generated during the construction of the proposed wastewater system improvements, particularly relating to demolition and opening of the paved areas and removal of the existing sewer line in Fort DeRussy. The existing pipe along Kalia Road will remain below ground and will not require disposal. Solid waste disposal will be carried out in accordance with the established guidelines set forth by the City. Upon completion of the Proposed Action, there will be no net increase in solid waste disposal.

*Public Utilities*

*Potable Water Supply*

Implementation of the Proposed Action will not increase the existing water demand. The project as proposed will improve the integrity of the existing wastewater system. Upon completion of the project, potable water will not be utilized; therefore, no mitigation measures are required.

*Wastewater*

The Proposed Action will increase the capacity of the sewer conveyance system along Kalia Road, Fort DeRussy fronting Ala Moana Boulevard and Kalakaua Avenue. The project is designed to help the City comply with the 2010 Wastewater Consent Decree with the EPA. The installation of the larger capacity sewer pipelines will provide adequate capacity to meet peak wet weather event, as well as meet 2030 peak flows. The project will have a beneficial impact by improving the existing wastewater system; therefore, no mitigation measures are required.

*Stormwater and Drainage*

Drainage problems have been historically reported along Kalia Road due to off-site flow. As part of the HHV Master Plan project, drainage improvements will be made along Kalia Road to alleviate the flooding conditions at the entrance of HHV during high rainfall events. The Proposed Action will not result in long-term impacts on drainage and storm water runoff at the project areas or the nearby vicinity. Upon completion of the sewer improvements, the affected area will be repaired and landscaped to model pre-construction conditions. Therefore, will be no increases in paved areas for existing conditions.

*Electricity, Communications and Natural Gas*

The network of underground utilities could be impacted particularly in the vicinity of the larger capacity pipe and bypass pipe construction areas. The project engineers will coordinate with the various utility companies to ensure service interruption is avoided to the extent possible during construction, and all necessary safety precautions are met. No significant impacts to these systems are anticipated.

***No Action Alternative***

The No Action Alternative would not result in impacts affecting public facilities, services and utilities because they would remain as they are under existing conditions. However, improvements to the sewer lines serving HHV, HKH and the service area between the Ala Wai Canal, Kalakaua Avenue and Fort DeRussy would not occur, which could have a negative impact on public utilities. The HHV Timeshare Towers would not be built because the existing sewer system would not be able to accommodate additional flows.

## 2.12 BIOLOGICAL RESOURCES

A landscaping inventory and description was conducted by McCelvey Associates and is included as *Appendix F*. An arborist assessment was completed by Steve Nimz & Associates, which provides recommendations regarding tree preservation, relocation, removal, and replacement. This report is included as *Appendix G*.

### 2.12.1 Affected Environment

***Introduction and Region of Influence***

This section is a description of the biological resources found in or near the ROI. Biological resources include plant and animal species and the habitats or communities in which they live. The ROI for biological resources is the area of impact for the Proposed Action.

***Overview of Valued Environmental Component***

Flora

The majority of the landscaping in the vicinity of the Proposed Action consists of tropical species. The existing tree and palm inventory calculated 112 trees, palms and shrubs in the designated inventory area. An overview of species type inventoried is provided in *Table 2-26.* Detailed tree disposition plans are provided in *Appendix F.*

| Table 2-26 EXISTING TREE SPECIES | |
|---|---|
| **Common Name** | **No. of Trees Inventoried** |
| Banyan | 5 |
| MacArthur Palm | 3 |
| Shrub | 3 |
| Coconut | 91 |
| Monkeypod | 7 |
| Date Palm | 1 |
| Brassaia | 1 |
| Tree | 1 |
| **TOTAL** | **112** |

*Fauna*

*Common Terrestrial Animals and Birds*

Existing terrestrial fauna within the near vicinity is limited to primarily introduced pests species common to urban environments. These include rats, mice, and feral cats. Birds that flock or reside within the project area include many common introduced species such mynah, cardinals, pigeons, doves, house finches, and rice birds. These common birds are found throughout the urban areas of Honolulu.

*Observations of Indigenous Manuoku within the Vicinity*

In addition to the common species of birds found in the vicinity, the manuoku (White Fairy Tern, *Gygis alba*) has been observed nesting near the project area and within the HHV. The manuoku is indigenous to Hawaii and is on the State threatened list. It is also the official bird of the City. The manuoku is found mainly in the Northwest Hawaiian Islands as well as the island of Oahu. Their flight is buoyant and characterized by erratic changes in direction and speed. Manuoku typically feed by surface diving over the ocean, preying on mostly juvenile goatfish and flying fish.

Estimates are that there are approximately 15,000 breed pairs throughout the Hawaiian Archipelago with over 250 pairs on Oahu, mainly observed between Kapiolani Park and Iolani Palace. Most of the Oahu manuoku population will breed and roost exclusively in large trees, such as banyans, monkeypods, mahogany, or kukui trees. Breeding adults remain close their brooding sites year round.

The manuoku typically remain paired for several seasons and will often return to the same site. Primary threats to the manuoku include introduced predators like rats and feral cats, introduced insects such as big-headed ants (*Pheidole megacephala*) and issues related to areas being overfished, thereby limiting the ability of the manuoku to feed.

### 2.12.2 Environmental Consequences

***Impact Methodology***

Impacts on biological resources were assessed based on whether the Proposed Action is consistent with natural resource protections in the ROI. Another factor for assessing impacts was if the Proposed Action were evaluated in accordance with the applicable provisions of Federal and State regulations.

***Factors Considered for Impacts Analysis***

An action is considered to have a significant adverse impact on biological resources if it would result in the following:

- Result in the impact of a highly sensitive resource, such as a threatened and endangered or special status species;
- Reduce the population of a sensitive species, as designated by Federal and State agencies, or a species with regional and local significance.
- Damage or degrade wetlands or habitat regulated by the local, state, or federal government or another sensitive habitat, such as designated critical habitat, identified in local or regional plans, policies, or regulations or by the USFWS;
- Interfere with the movement of any native resident or migratory wildlife species (including aquatic species) or with established native resident or migratory wildlife corridors;
- Alter or destroy habitat that would prevent biological communities in the area from reestablishing themselves;
- Introduce or increase the prevalence of undesirable nonnative species; or
- Cause long-term loss or impairment of a substantial portion of habitat that species depend on.

An impact is considered significant but mitigable if the result of the Proposed Action would have a significant impact on biological resources but compensatory mitigation is included to reduce the level of impact to below significant levels.

***Summary of Impacts***

*Table 2-27* provides a summary of the potential impacts on biological resources.

**Table 2-27 SUMMARY OF POTENTIAL IMPACTS ON BIOLOGICAL RESOURCES**

| Impact Issues | No Action Alternative | Proposed Action (Preferred Alternative) |
|---|---|---|
| Reduce population or impact sensitive species | No impact | No impact |
| Damage or degrade wetlands habitat | No impact | No impact |
| Interfere with movement of native resident or migratory wildlife species | No impact | Less than significant impact |
| Alter or destroy sensitive species habitat | No impact | Less than significant impact |
| Introduce or increase the prevalence of undesirable nonnative species | No impact | No impact |

***Proposed Action (Preferred Alternative)***

*<u>Flora</u>*

There will be a less than significant impact from the temporary loss of a minimal amount of landscaped area at Fort DeRussy under the Proposed Action. The short-term less than significant impacts from construction will result from demolishing existing sidewalk and removing landscaping and vegetation at Fort DeRussy. Upon completion of the sewer improvements, the affected area will be repaired and landscaped to model pre-construction conditions.

Certified Arborist Steve Nimz reviewed the project area during a site inspection and identified nine (9) Coconut palms that are within the proposed excavation boundaries. The nine (9) Coconut palms are recommended for temporary relocation during the construction period to an appropriate location on the Fort DeRussy site or holding nursery Coconut palms will be replanted as detailed in the proposed Planting Plan when the project improvements are completed (*Appendix F*). Additional conflicts along the sewer alignment include the crown of Ficus growing low over the sidewalk at Kalakaua Avenue which may interfere with construction and the use of excavation equipment. Mitigation for this tree will require crown raising to provide clearance. At the Fort DeRussy WWPS, a Brassaia tree is growing against the wall and the root structure is growing around the manhole covers. It is recommended that this tree be removed due to potential damages that may occur to the wall and conflict with the manholes and excavation.

Large canopy Monkeypod and Ficus trees on Ala Moana Boulevard are located next to the wall and outside the excavation area. Select canopies extend over the excavation site. Roots maybe impacted during excavation. The impact will be minimal to the trees with proper root pruning procedures implemented during excavation. A general Tree Protection Plan, Tree Protection Notes and proposed Planting Plan are provided in *Appendix F and G*.

In general, dust and debris from construction and demolition could also damage vegetation in the vicinity of the project activities. The use of standard BMPs for construction will minimize these potential impacts. BMPs include limiting staging in areas not currently in heavy use, controlling surface water runoff, and implementing BMPs for toxic substances cleanup. Construction staging areas will be in already disturbed areas near the proposed improvements.

Because there are no special status plants or exceptional trees in the ROI, there will be no impacts occurring from the Proposed Action.

*Fauna*

During construction, a portion of the landscaped area in Fort DeRussy fronting Ala Moana Boulevard will be removed to allow for the sewer improvements to be made. Upon completion of the project, the affected area will be repaired and landscaped to pre-construction conditions. Construction and demolition for the Proposed Action will also increase the amount of traffic, noise, and general human activity, which will deter most wildlife in and around the project area. However, since the area is already highly developed, human-tolerant species will not likely be greatly disturbed. Habitat within the ROI is for the most part disturbed natural and introduced landscapes. Activities will mostly affect nonnative species adapted to stressed or nonnative environments.

There will be limited short term-related impacts to the manuoku habitat as a result of the Proposed Action. However, there is abundant alternative habitat for this species in the adjacent areas, and the adverse effects from construction will be temporary and less than significant. Once construction is completed, the manuoku can return to the area. As necessary, measures will be place during to construction to ensure the birds are not significantly impacted. Additionally, ongoing eradication and control measures for pest species such as rats and feral cats will continue to be utilized. Similar conscientious measures have proven successful within other nearby Waikiki development projects.

As described above, there will be less than significant impacts from the Proposed Action on the manuoku, which is on the State threatened list. Other than the manuoku, there are no protected or sensitive wildlife species that are likely to occur in the ROI.

Since there are no designated wetlands within the vicinity of the Proposed Action, there will be no impacts to wetlands from the construction of the sewer improvements. In addition, since there is no federally designated critical habitat or sensitive habitats within the vicinity of the Proposed Action, no impacts on critical habitats are anticipated.

No long-term impacts to biological resources are expected to occur under the Proposed Action. Potential impacts will be short-term, and will last only throughout the project's construction period.

***No Action Alternative***

The No Action Alternative would be a continuation of existing conditions; therefore there would be no construction and no impact on vegetation, wildlife, or habitats.

## 2.13 CULTURAL RESOURCES

Cultural Surveys Hawaii prepared both an Archaeological Literature Review and Field Inspection report and a Cultural Impact Assessment (CIA), which are included as *Appendices H* and *I*, respectively.

### 2.13.1 Affected Environment

***Introduction and Region of Influence***

Cultural resources consist of archaeological resources, Native Hawaiian traditional material, resources and sacred sites, and built environment resources, such as historic buildings, structures, districts, and landscapes. Resources are often categorized by their time period association, with the most prominent reference being either prehistoric (pre-Contact) or historic (post-Contact), indicative of whether a site or documented practice was present prior to or after the arrival of westerners in 1778. The term "historic properties" refers to cultural resources that are eligible for listing on or that are listed on the National Register of Historic Places (NRHP). Traditional resources or sacred sites that are historic properties are referred to as traditional cultural properties. In general cultural resources must be a minimum of 50 years old to be considered historic, but considerations may be made for resources that have achieved national significance in the past 50 years.

There are numerous cultural resource laws and regulations that govern the management of cultural resources. The Proposed Action is subject to Hawai'i State environmental and historic preservation review legislation (HRS Chapter 343 and HRS 6E-8/HAR Chapter 13-275, respectively). Due to the involvement and use of Federal lands (U.S. Army Fort DeRussy military reservation), the Proposed Action is also subject to Federal cultural resource management regulations including Section 106 of the National Historic Preservation Act (NHPA), the Archaeological Resources Protection Act, the American Indian Religious Freedom Act, the Native American Graves Protection and Repatriation Act (NAGPRA), EO 13007 (Indian Sacred Sites), EO 13175 (Consultation and Coordination with Indian Tribal Governments), Curation of Federally Owned and Administered Collections (36 CFR, Part 79), and the Secretary of the Interior's Standards for Treatment of Historic Properties (36 CFR, Part 68), DOD guidelines, including Army regulations.

The ROI for cultural resources is equivalent to the area of potential effect under Section 106 of the NHPA. The ROI for the Proposed Action has been defined as the project area and includes areas immediately subjected to any direct ground disturbance during project implementation. The area of potential effect includes the proposed width of open trench activity, which for the 21 inch diameter sewer line is 3.75 feet and for the 30 inch diameter sewer line is 4.75 feet. The area of potential effect includes the area of anticipated surface level disturbance due to construction related activity and movement, which is estimated to be an area 10 to 15 feet adjacent to the trench. The area of potential effect also includes the construction staging area for personnel and equipment, which for all intents and purposes would be a selected single lane along Kalia Road, Ala Moana Boulevard, or Kalakaua Avenue adjacent to ongoing project construction activity. An off-site baseyard would be utilized to store and transfer construction materials and equipment daily to the construction site.

For the purposes of the CIA, the study area also included the entire modern ahupuaa (land division usually extending from the uplands to the sea) of Waikiki Kai.

***Overview of Valued Environmental Component***

*Archaeological Literature Review and Field Inspection*

While the Archaeological Literature Review and Field Inspection investigation does not fulfill the requirements of an archaeological inventory survey investigation (per HAR Chapter 13-276), it serves as a document to facilitate the Proposed Action's planning and supports historic preservation review compliance by assessing if there are major archaeological concerns within the study area and to develop data on the general nature, density and distribution of archaeological resources.

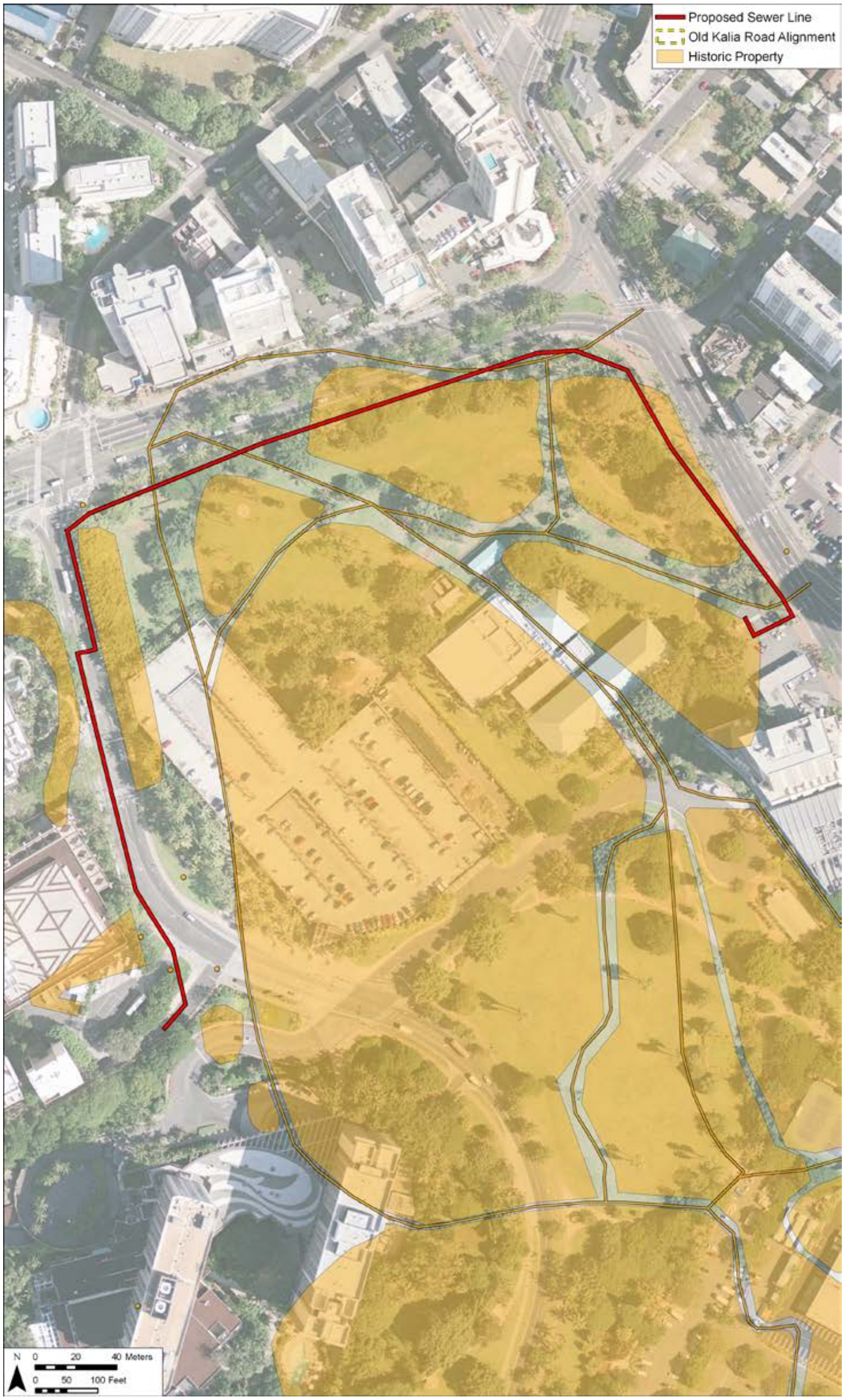
The fieldwork component for this Literature Review and Field Inspection was conducted on January 24, 2012 by Cultural Surveys Hawaii project managers Matt McDermott, M.A. and David Shideler, M.A. Fieldwork consisted of the systematic traverse of the study area to investigate for any surface historic properties and the photographic documentation of the surface landscape and any above-ground structures. Refer to *Appendix H*.

Based on a review of historic documents, the study area, which is located within the ili (land district) of Kalia within the larger ahupuaa (district) of Waikiki, was greatly utilized during the pre-Contact and early post-Contact period as an area of rich wetland resources. The waters of Piinaio Stream and the natural coastal wetlands were modified into a complex system of interlocking fishponds and ‘auwai (irrigation channels) behind the sandy dunes and swales of the coast. During the Mahele, land divisions of the mid-1800s Land Commission Awards (LCAs) dotted the drier lands of the area. Within the study area, only two LCAs were awarded (LCA #2511 and LCA #2083), both described as house lots.

During the post-Contact period, land use patterns began to shift towards residential and commercial development. The early 1900s saw the most dramatic changes to the study area with the development of Fort DeRussy military reservation and the associated in-filling of the Kalia ponds as well as the 1920s Waikiki land reclamation efforts, which filled in the wetlands and streams of Waikiki.

Within the past three decades, numerous previous archaeological investigations have been conducted within the study area and the immediate vicinity (*Figure 2-4 and Table 2-28*). These studies have provided fairly extensive documentation of the subsurface stratigraphy within the study area and indicate that subsurface cultural and historical deposits continue to exist beneath the numerous fill layers associated with modern development.

Archaeological finds documented during these studies include: human burials, pre- and post-Contact cultural layers, buried fishponds, ditches, and other remains of extensive wetland agriculture, historic trash pits, and construction debris. In particular, archaeological deposits documented within the study area or immediate vicinity include remnants of the Loko Kaipuni complex of ponds (SIHP #-4573) along with probable *‘auwai*, historic cultural layers and trash pit features (SIHP #-2780), and human burials, including burial complexes (SIHP #-2780; -4570; -7087).




**PREVIOUS ARCHAEOLOGICAL STUDIES WITHIN THE STUDY AREA OR IMMEDIATE VICINITY (SOURCE: CULTURAL SURVEYS HAWAII)** **FIGURE 2-4**

**Table 2-28 PREVIOUS ARCHAEOLOGICAL STUDIES WITHIN THE STUDY AREA AND IMMEDIATE VICINITY**

| Reference | Nature of Study | SIHP #50-80-14 | Findings |
|---|---|---|---|
| Neller 1980 | Inadvertent Discovery Report | -2780 | Inadvertent burial discovery within the southeastern corner of HHV (area of Tapa Tower). Three (3) disturbed burials postulated as likely of Hawaiian ethnicity and post-1850, SIHP # -2780. |
| Hurlbett et al. 1992 | Archaeological Monitoring | -2780 | Fifteen (15) subsurface pit features associated with post-contact trash disposal were observed. Features were incorporated into SIHP # -2780. |
| Carlson et al. 1994 | Data Recovery | "Burial Area 6" and "Burial Area 7" (no SIHP #s assigned) | Biosystems Analysis excavated human remains found during realignment of Kalia Road. Burial Area six (6) included 27 – 34 individuals in a common pit feature located just SE of the intersection of Paoa Place and Kālia Rd. Burial Area seven (7) included four (4) individuals in association with a cultural layer located in the vicinity of the Army Museum. |
| McMahon 1994 | Inadvertent Discovery Report | | Inadvertent discovery of a single burial of indeterminate ethnicity. |
| Denham and Pantaleo 1997a | Archaeological Monitoring | -4570 ; -4574; -4966 | Three (3) historic properties observed: SIHP #-4574, consisting of fishpond sediments (Loko Paweo I), three (3) historic trash pits, and two (2) burials; SIHP #-4570 consisting of a historic trash pit, four (4) fire pits, an ash lens, and an unknown number of human burials; and SIHP #-4966 comprised of pre-contact features and burials representing at least five (5) individuals found in the Koko Head portion of Fort DeRussy. |
| Denham and Pantaleo 1997b | Data Recovery | -4570; -4575; -4576; -4579; -4970 | Five previously identified sites investigated. |
| Putzi and Cleghorn 2002 | Archaeological Monitoring | -4573, -6399 | Monitoring of force drain line and sewer relief line. Pond sediments, organic sediments, and JaC documented beneath fill layers along Ala Moana Blvd. and Kalakaua Ave. Two (2) features were identified: a portion of Loko Kaipuni (SIHP #-4573) and a basalt alignment of indeterminate date. Five (5) post-contact pit features were documented in HHV grounds (SIHP #-6399). |
| Rasmussen 2005 | Archaeological Monitoring | N/A | No historic properties observed. |
| Mooney et al. 2009 | Archaeological Monitoring | -7086, -7087 | Documented one (1) previously disturbed burial, SIHP # 50-80-14-7087, near the intersection of Kalia Road and Ala Moana Blvd., consisting of a near complete cranium and cranial fragments. The remains were sealed and left in situ. Also documented a large historic trash feature complex, SIHP #-7086, along the north side of the HHV. |
| Tulchin et al. 2011 | Archaeological Inventory Survey | -2780 | Twenty (20) test trenches placed within the area of Rainbow Drive and the bus depot terminal in the southeastern corner of the HHV complex documented a discontinuous A-horizon beneath fill layers. This buried A-horizon (SIHP #-2780) was determined to be the remnants of a stable post-contact historic land surface significantly disturbed by modern development. |

*Cultural Impact Assessment*

A CIA was prepared in accordance with the regulatory requirements of HRS Chapter 343 as amended by H.B. No. 2895, H.D. 1 of the State of Hawaii Twentieth Legislature and approved as Act 50. Act 50 requires consideration of a proposed project's effects on cultural practices and resources as part of a State environmental review. Through document research and ongoing cultural consultation efforts, the CIA (*Appendix I*) provides information pertinent to the assessment of the Proposed Action's impacts to cultural practices and resources which may include Traditional Cultural Properties of ongoing cultural significance that may be eligible for inclusion on the State Register of Historic Places, in accordance with Hawai'i State Historic Preservation Statute (Chapter 6E) guidelines for significance criteria according to HAR §13-275 and §13-284 under Criterion E.

***Background Research***

Research for the Proposed Action yielded the following results:

1. Waikiki was comprised of a vast system of irrigated taro fields which spanned from Waikiki Kai to the valleys of Manoa. The Waikiki marshland was an excellent place to grow taro, even better than the revered areas of Kaneohe and Kahaluu on the windward side of Oahu.

2. The Waikiki area was full of aquatic resources including hundreds of fishponds that dotted the shoreline of the ahupuaa.

3. Six heiau (Hawaiian spiritual and religious structural features) are said to have been associated with the Waikiki area: Papaenaena Heiau, Helumoa Heiau, Kapua Heiau, Kupalaha Heiau, Kamauakapu Heiau, and Kulanihakoi Heiau. The "Wizard Stones of Kapaemahu" at Waikiki was also mentioned as unearthed in the late 1800s on the premises of the Cleghorn family. According to moolelo (oral traditions), four (4) seers from the court of a Tahitian king came to Hawaii and helped to heal many people. Four (4) large stones were gathered from the vicinity of a "bell rock" in Kaimuki and erected in Waikiki to commemorate them–two (2) at their habitation and two (2) at their bathing place in the sea. The chief of these reference "wizards", Kapaemahu, named his stone after himself, and a young chiefess was sacrificed and placed beneath the stone. Today, these stones are located at Kuhio Beach Park. None of these known heiau are within the immediate project area or in close proximity to the project area.

4. During the first decade of the twentieth century, the U.S. War Department acquired more than 70 acres in the Kalia portion of Waikiki for the establishment of a military reservation called Fort DeRussy, named in honor of Brig. Gen. R.E. DeRussy of the Army Corps of Engineers. A hydraulic dredger was used to pump fill from the ocean continuously for nearly a year in order to build up an area on which permanent military structures could be built. This is the beginning of significant landscape transformation within this section of Waikiki.

5. In 1980, three (3) partial sets of human remains (SIHP #50-80-14-2780) and three (3) subsurface features were inadvertently discovered during construction at the southeastern corner of the HHV Tapa Tower. Subsurface features consisted of pit features pre-dating the construction of the Ala Wai Canal. However, two pits had undetermined features, assumed to be filled-in irrigation ditches. The third pit was a trash pit consisting of ceramic and glass artifacts dating to the late 1890s. The burials were reinterred in 1991 on HHV property and remain in long-term curation and stewardship under Hilton management.

6. In 1993, archaeological monitoring was conducted by Biosystems Analysis, Inc. along Kalia Road at Fort DeRussy Military Reservation. Of note, SIHP #50-80-14-4574 consisted of fishpond sediments (Loko Paweo I), three (3) historic trash pits, and two (2) burials. SIHP #50-80-14-4570 consisted of a historic trash pit, four (4) fire pits, an ash lens, and an unknown number of human burials (in six (6) distinct features).

7. In 1992, archaeological data recovery was conducted at Fort DeRussy. Five (5) previously identified sites were investigated (SIHP #50-80-14-4570). SIHP #50-80-14-4970 consisted of an irrigation ditch and bund system. SIHP #50-80-14-4579 revealed numerous features related to permanent historic occupation and possible intermittent prehistoric use (five (5) fire pits, two (2) historic middens, and a human burial). In addition, three (3) fishponds, Loko Paweo I (-4574), Loko Kaihikapu (-4575), and Loko Paweo II (- 4576) were identified.

8. In 2009, Pacific Legacy, Inc. conducted an archaeological monitoring for the HHV Grand Waikikian Development Project. A previously disturbed human burial (- 7087) was found on the mauka side of the intersection of Ala Moana Boulevard and Kalia Road. The remains were sealed and left in situ.

9. An oral history compilation was conducted by the University of Hawaii's Center for Oral History in 1985 to capture the voices of several people with extensive knowledge of the history and culture of Waikiki. These oral histories describe the Kalia area as excellent grounds for aquaculture including fishing and gathering of limu (seaweed). According to Mr. John C. Ernstberg, various limu, including manauea, lipoa, and wawaeiole, could be found in the coastal waters off Waikiki. Mr. Earle "Liko" Vida recalls fishing for opelu (mackerel), ulua (jack), and papio (juvenile jack) in the Kalia area.

***Community Consultation***

Native Hawaiian organizations, agencies and community members were contacted to identify individuals with cultural expertise and/or knowledge of the proposed project areas and the vicinity. The agencies and organizations consulted included the State Historic Preservation Division (SHPD), the Office of Hawaiian Affairs, the Oahu Island Burial Council, Hui Malama I Na Kupuna O Hawaii Nei, the Waikiki Hawaiian Civic Club, and several community members within the Waikiki ahupuaa. Of the 123 community members, cultural descendants, and government agency and community organization representatives contacted, there were 15 responses with five (5) kupuna (elders) and/or kamaaina (Native-born) willing to participate in formal interviews for more in-depth contributions to the CIA. Shared thoughts relative to the immediate Kalia area included the following:

1. Mr. Halealoha Ayau of Hui Malama I Na Kupuna O Hawaiʻi Nei states that the organization has conducted two reburials in the area: one at the HHV and the other at Fort DeRussy. He suggests that both be re-identified so they are not disturbed.

2. Mr. Greg Kashiwa of Kupuna LLC, recalls surfing and fishing in the Kalia and Fort DeRussy area. A platform once existed off shore where swimmers could congregate. After the tsunami of 1946 the platform disappeared. During Mr. Kashiwa's service in the Army, his unit conducted an annual sand replenishment project fronting the HKH. During a routine replenishment, a D9 Cat fell into the ocean causing a coral shelf to collapse. Upon retrieval, a local diver felt fresh

water flowing from the rubble. The diver suggested the coral shelf was actually a lava tube connected to the Moiliili fresh water karst and cave system. The Army did not want to draw attention to the problem and did not pursue investigation. Mr. Kashiwa suggests the area "is worth seeing and archaeological traces may remain" within the karst and cave system.

3. In a written response, Kamana'opono Crabbe, Office of Hawaiian Affairs Administrator, states that "existing documentation from separate projects conducted in the area detail the presence of burials and cultural deposits in the vicinity of the instant project area." Mr. Crabbe recommends archaeological monitoring during all project activities.

4. Mr. Clarence Medeiros, Jr. describes his great-grandfather, Zen Man Sing (also known as "Zane Man Sing"), a Chinese immigrant who arrived in Hawai'i in 1888. Mr. Medeiros' great-grandfather, worked in Waikiki planting rice and taro with relatives. He describes Waikiki being "all water, swampland" and having "all loi [irrigated terrace] kind of land around 1890s."

5. Mr. Richard Paglinawan shares the history behind Na Pohaku Ola Kapaemahu, or the Life-giving Stones or Kapaemahu and Kapuni, commonly referred to as the Wizard Stones. He also traces the royal lineages of alii (chiefs) in Waikiki. Mr. Paglinawan and his family gathered limu and caught hee (octopus), mullet (amaama), papio, uhu (parrotfish), and hinalea (wrasse).

### 2.13.2 Environmental Consequences

***Impact Methodology***

The methods for assessing potential impacts on cultural resources include identifying significant cultural resources in the ROI under the Proposed Action and determining potential direct and indirect impacts on these resources. Identified resources are described above.

Impacts on cultural resources are evaluated in terms of significance. A significant impact on cultural resources is defined as expected and unmitigable impacts on known cultural resources. A significant but mitigable to less than significant impact is defined as impacts on known cultural resources or likely impacts on unknown cultural resources that are mitigable. This category also includes unlikely or unanticipated impacts on known or unknown cultural resources that could be mitigated. A less than significant impact is defined as an impact upon NRHP-ineligible cultural resources or cultural resources not of concern to Native Hawaiians or historical societies or agencies. If during project construction no cultural resources were identified or discovered, then the project would not have any impacts on cultural resources.

***Factors Considered for Impacts Analysis***

The factors that determine the significance of potential impacts on cultural resources in the ROI are determined and based on the Federal and State regulatory controls that set standards for cultural resources protection.

Under NHPA Section 106, Federal agencies must consider the possible effects of their actions on NRHP-eligible properties within their boundaries. Eligible properties include, in addition to archaeological and other cultural sites, those considered significant to Native Hawaiian groups. Under Section 106, an undertaking is considered to have an adverse effect on a historic property when it diminishes the integrity of the property's location, design, setting, materials, workmanship, feeling, or association.

Adverse effects include the following:

- Physical destruction, damage, or alteration of all or part of the property;
- Isolation of the property or alteration of the property's setting when that character contributes to the property's qualifications for the NRHP;
- Introduction of visual, audible, or atmospheric elements that are out of character with the property, or changes that may alter its setting;
- Neglect of a property, resulting in its deterioration or destruction; and
- Transfer, lease, or sale of a property without adequate provisions to protect its historic integrity.

For the project, the protection of known ancestral burial sites within the Kalia corridor, the avoidance and elimination of impacts is the most sensitive and critical issue. This project will require compliance to and completion of Federal and State regulatory controls that ensure the protection and mitigation that leads to the effectual treatment and care of ancestral burials and other cultural and historic resources.

For ancestral burials either identified or encountered along Federally-owned portions of the project, compliance to and completion of NAGPRA will be required; for non-Federal lands, compliance to and completion of HRS 6E-42 and 6E-43 will be required. Under NAGPRA regulations (43 CFR 10, subsection 10.3), the US Army as the Federal proponent must complete necessary consultation with Native Hawaiian Organizations (NHOs) that can establish "cultural affiliation" by means of a "preponderance of evidence". Following consultation, a written Plan of Action (POA) is required, which contains a prescribed set of actions for the planned archaeological recording; treatment, care, and handling; and disposition of ancestral human remains, funerary objects, sacred objects, or objects of cultural patrimony. Concomitantly, the Plan of Action will be referenced under the review and completion of the Section 106 consultation process. In late September 2012, the US Army conducted its first NAGPRA POA meeting with potential cultural descendants whose families could qualify as a NHO with cultural affiliation. Currently, the process is underway to review claims provided to verify NHO qualification. A subsequent meeting is planned for mid-November 2012 with recognized NHO claimants to development the POA for this project.

Under HRS 6E-42, SHPD is to be afforded an opportunity for review and comment on the effect of the proposed project on historic properties, including burials prior to any State or County approval or issuance of a permit, license, certificate, land use change, or any other entitlement for use. Under HRS 6E-42, the State historic preservation review process includes a phase of identification, evaluation of significance, and agreed-to mitigation commitments that either eliminate or minimize known impacts to cultural resources. Under HRS 6E-43, additional guidance and requirements are provided as to the determination of preservation in place or relocation of burials that are discovered or known to exist on non-Federal lands.

The concerns expressed by involved stakeholders such as recognized cultural practitioners; recognized cultural descendants under State burial law; and other Native Hawaiian families, organizations, or individuals during previous analyses emphasized the following needs:

- Continuing access to traditional and religious sites which can include shoreline areas that provide visual alignments and connections for ceremonial purposes as well as maintaining gathering practices of littoral resources.
- Protecting and preserving archaeological sites, with specific emphasis on the long-term stewardship and curation of ancestral burials.
- Interpreting significance based on Native Hawaiian tradition and the knowledge of community elders and community involvement in defining appropriate management of these resources.

***Summary of Impacts***

*Table 2-29* is a summary of the potential impacts on cultural resources.

| Table 2-29 SUMMARY OF POTENTIAL IMPACTS ON CULTURAL RESOURCES | | |
|---|---|---|
| **Impact Issues** | **No Action Alternative** | **Proposed Action (Preferred Alternative)** |
| Archaeological resources | No impact | Significant impact but mitigable to less than significant |
| Traditional Native Hawaiian resources | No impact | Significant impact but mitigable to less than significant |

***Proposed Action (Preferred Alternative)***

Constructing the wastewater system improvements under the Proposed Action will result in significant impacts, but mitigable to less than significant impacts on archaeological and traditional (cultural) resources within the ROI. The City ENV, Hilton, and US Army will continue its consultation requirements to develop and integrate the necessary mitigation steps and BMPS pertaining to cultural resources into the implementation phase of the Proposed Action to minimize and/or eliminate impacts to cultural resources.

<u>Archaeological Resources</u>

The study area has been the focus of numerous previous archaeological studies which have covered almost the entire length of the study corridor or areas immediately adjacent. Accordingly, the previous archaeological documentation provides this EA with an extensive overview of the subsurface stratigraphy within the majority of the study area. For this reason a subsurface archaeological inventory survey is not considered necessary for the majority of the study area. However, due to the concentration of pre-Contact and post-Contact cultural and historical deposits within the immediate area, and in particular the potential for human burials, an archaeological monitoring program has and will continue to be implemented as an appropriate mitigation measure for ground disturbance conducted within the study area. Archaeological monitoring will facilitate the identification and treatment of any burials that might be discovered during project construction, and will mitigate the project's effect on non-burial archaeological deposits. Under State historic preservation administrative rules, "archaeological monitoring may be an identification, mitigation, or post-mitigation contingency measure. Monitoring shall entail the archaeological observation of, and possible intervention with, on-going activities which may adversely affect historic properties" (HAR Chapter 13-279-3). Archaeological monitoring has already commenced with the approval of SHPD and concurrence of OHA for soil boring activities which were recently concluded. There were no finds of iwi kupuna during the course of the soil boring activity and the only cultural resources to note were related with known and anticipated elements of the associated landscape of the area's once predominant fishpond and auwai characteristics. Due to the lack of significant findings, the completed monitoring will be included in an overall archaeological monitoring report for the entire project, upon its completion.

Background research documents a burial reinterment location ("Burial 11") within the southernmost portion of the study area (located at the intersection of Kalia Road and Paoa Place). Since the precise location of this reinterment site is not known and may lie within the proposed path of ground disturbance, as part of the project's archaeological monitoring program, careful subsurface probing in the southernmost portion of the project area is warranted. Both cadaver-sniffing dogs and Ground Penetrating Radar study (March 2012) was utilized within this sensitive zone with no conclusive results verifying or validating this burial's location.

It is very likely that ground disturbance within the study area may affect some other areas that were not previously excavated (i.e. the widening or deepening of extant sewer line trenches), which may expose similar cultural and historic deposits. Therefore, the cultural resources impact of the Proposed Action is considered significant but mitigable. This impact classification is assigned as the result of the Proposed Action results in a significant impact on archaeological resources but the planned courses of action including the development of the POA, a possible need for a memorandum of agreement under NHPA Section 106, and other ongoing consultation under HRS 6E and integration of those recommendations and requirements during project implementation should reduce the level of impact to below significant levels.

_Traditional Native Hawaiian (Cultural) Resources_

Based on the information gathered for the cultural and historic background and community consultation detailed in the CIA, the Proposed Action may potentially impact Native Hawaiian burials and cultural beliefs. There is sufficient documentation of past findings to conclude that iwi kupuna may be present within or near adjacent to the proposed project area, and land-disturbing activities during construction may uncover presently undetected burials or other cultural finds. Additionally, the project area consists of Jaucas sand deposits, which is known as a common soil substrate composition type for traditional burial practices, which thereby increases the likelihood of potential encounters with unmarked or unknown burials. Therefore, the impact of the Proposed Action is considered significant but mitigable on traditional Native Hawaiian (Cultural) resources, but compensatory mitigation will be required and developed in both Federal and State processes of historic preservation review to minimize the level of impact below significant levels or eliminate the impact all together.

Personnel involved in the construction activities of the proposed sewer improvements project will be informed of the possibility of inadvertent cultural finds, including human remains. Should any burials or other cultural finds be identified during ground disturbance, the construction contractor will immediately cease all work and the appropriate agencies will be notified pursuant to applicable law. The agreed-to terms of the NAGPRA Plan of Action and/or findings and implementing actions of a State archaeological monitoring plan will be administered. Consultation with recognized cultural descendants and Native Hawaiian Organizations has and will continue through project development.

### *No Action Alternative*

Under the No Action scenario, improvements to the sewer lines serving HHV, HKH and the service area between the Ala Wai Canal, Kalakaua Avenue and Fort DeRussy would not occur and the HHV Timeshare Towers would not be built because the existing sewer system would not be able to accommodate additional flows. Under the No Action Alternative, no demolition, construction, or ground-disturbing activities would occur in relationship to the Hilton redevelopment and expansion. Eventually, the City may need to increase maintenance activities, respond to an increased possibility of emergency repair, and/or upgrade the sewer collection system at a future date. An established mitigation program to adequately and proactively address the stewardship and curation of unknown but possible iwi kupuna and other cultural resources would not be adopted and in place for any increased maintenance or emergency related activities.

## 2.14 VISUAL RESOURCES

### 2.14.1 Affected Environment

***Introduction and Region of Influence***

This section describes the visual resources associated with the Proposed Action. Visual resources are the visible physical features on a landscape, such as land, water, vegetation, animals, and structures. The ROI for visual resources is the project areas and areas adjacent to these sites.

Designated as a Special District, guidelines and requirements have been established to maintain the vitality of Waikiki. The WSD Design Guidelines provide design standards relating to building design, urban design controls and historic structures, with a focus of maintaining the socio-economic vitality of Waikiki and a “Hawaiian sense of place”.

***Overview of Valued Environmental Component***

The Proposed Action is located in the Waikiki. Within the objectives of the City’s LUO, there is an emphasis placed upon maintaining and improving the mauka views from public viewing areas in Waikiki, especially from public streets. Additional emphasis is placed upon preserving a visual relationship with the ocean from Kalakaua Avenue, Kalia Road, and Ala Moana Boulevard. Further, views of Diamond Head are to also be protected and maintained from the Punchbowl Lookout. The LUO also identifies significant public views of Waikiki landmarks, the ocean, and the mountains from public vantage points.

The following list of streets and locations identify these prominent view corridors:

- Intermittent ocean views from Kalia Road across Fort DeRussy Park from the Ala Wai Bridge on Ala Moana Boulevard.
- Continuous ocean views along Kalakaua Avenue, from Kuhio Beach to Kapahulu Avenue.
- Ocean views from Ala Wai Yacht Harbor.
- Ocean views from Kuhio Beach Park.
- Views of the Ala Wai Yacht Harbor from Ala Moana Park (Magic Island Park).
- Mauka views from portions of the streets ma uka of Kuhio Avenue: Nohonani Street, Nahua Street, Kanekapolei Street, Kaiolu Street, Lewers Street, Walina Street, and Seaside Avenue.
- View of Diamond Head from Ala Wai Boulevard between McCully Street and Kapahulu Avenue.

*Figure 2-5* provides an aerial perspective of the general area. The proposed wastewater system improvements will be located below ground along Kalia Road, Fort DeRussy fronting Ala Moana Boulevard and Kalakaua Avenue (*Figure 2-6A through 2-6D*). The visual landscape is largely characterized by urban development and defined as a balanced mix of buildings that vary in height and mass. This built landscape is complemented by open space areas, such as Fort DeRussy Park that avail various views corridors. Views toward the ocean along Ala Moana Boulevard are restrictive due to the presence of existing structures within and outside the project area and along the shoreline. A limited ocean view is accessible along Kalia Road primarily from the end of Paoa Place. Views of the ocean along Kalia Road open up beyond the HKH in the Diamond Head direction, near Fort DeRussy Park.

### 2.14.2 Environmental Consequences

***Impact Methodology***

Potential impacts on visual resources are based on a review of existing site conditions, of applicable guidelines pertaining to visual resources, and of proposed changes to the visual landscape (described in the description of the Proposed Action). Various actions that may change the basic landscape elements were considered in identifying potential impacts on visual resources. Impacts on visual resources can be either positive or negative, depending on the type and degree of visual contrasts introduced to a landscape. When modifications repeat the general elements of the landscape, the degree of visual contrast is lower, and is therefore perceived less negatively. Where modification introduces significant changes to existing conditions, impacts are often perceived more negatively.

***Factors Considered for Impacts Analysis***

Factors considered in determining whether an alternative would have a significant impact are the extent or degree to which its implementation would cause or result in the following:

- Conflict with established regulations and policies governing visual resources;
- Degrade the visual character or quality of the site and its surroundings;
- Disrupt views or reduce public opportunities to view scenic resources; or
- Create a new source of light or glare.


**SITE PHOTO KEY**
**KALIA-FORT DERUSSY WASTEWATER SYSTEM IMPROVEMENTS** **FIGURE 2-5**


**VIEW OF PAOA PLACE LOOKING EAST TOWARDS KALIA ROAD** **FIGURE 2-6A**

**VIEW OF KALIA ROAD LOOKING NORTH TOWARDS ALA MOANA BOULEVARD** **FIGURE 2-6B**

VIEW OF ALA MOANA BOULEVARD/FORT DERUSSY LOOKING EAST TOWARDS KALAKAUA AVENUE FIGURE 2-6C

VIEW OF KALAKAUA AVENUE/FORT DERUSSY LOOKING SOUTH FIGURE 2-6D

***Summary of Impacts***

*Table 2-30* provides a summary of the potential impacts on visual resources.

**Table 2-30 SUMMARY OF POTENTIAL IMPACTS ON VISUAL RESOURCES**

| Impact Issues | No Action Alternative | Proposed Action (Preferred Alternative) |
|---|---|---|
| Conflict with visual resource regulations | No impact | No impact |
| Degrade the visual character or quality of the site and its surroundings | No impact | Less than significant impact |
| Disrupt views | No impact | No impact |
| Create a new source of light or glare | No impact | Less than significant impact |

***Proposed Action (Preferred Alternative)***

There will be a less than significant impact on visual resources within the ROI. The Proposed Action will create short-term adverse effects during the construction phase, affecting receptors sensitive to visual resources. These receptors are located on the properties that border the sewer line improvement areas and those people who are travel in the vicinity of the project.

Various guidelines and requirements affect the visual resources of the Waikiki. The WSD Design Guidelines provide design standards relating to building design, urban design controls and historic structures, with a focus of maintaining the socio-economic vitality of Waikiki and a "Hawaiian sense of place". There will be no long-term impacts on visual resources from conflicts with visual resource regulations.

During construction, there will be short-term adverse impacts on the visual character of the site and surrounding area. Impacts include a visible construction area on the roadway and Fort DeRussy fronting Ala Moana Boulevard and Kalakaua Avenue, increase in traffic in the vicinity, and an increase in activity and equipment from construction. Temporary staging areas will likely be confined to areas adjacent to the actual project sites. These adverse impacts on the visual landscape of the project sites will be less than significant because they will be limited to the duration of construction. Once the sewer line improvements are constructed underground, the existing roadways, sidewalks, and landscaped areas impacted by the Proposed Action will be returned to pre-disturbance conditions. No long-term impacts to visual resources are anticipated.

If construction takes place during night time hours, there will be increase in light and glare. The degree of adverse impacts will vary, depending on screening objects, such as landscaping, and viewer sensitivity. To minimize short-term impacts from lighting, the Proposed Action will implement BMPs that include using proper outdoor temporary lighting that will keep stray light from illuminating unnecessary areas and provide light only when necessary. Therefore, less than significant impacts from light and glare are anticipated.

The Proposed Action will not disrupt existing views. The sewer improvements will be underground and will not affect prominent view corridors identified in the LUO.

***No Action Alternative***

No impacts would be expected to occur under the No Action Alternative. Construction of the wastewater system improvements would not occur, and the sites for the Proposed Action would remain unchanged.

## 2.15 ENVIRONMENTAL JUSTICE

### 2.15.1 Affected Environment

***Introduction and Region of Influence***

The ROI for issues related to environmental justice is the City on Oahu because this is where potential impacts would most likely be realized. The Proposed Action and No Action Alternative are reviewed and evaluated to identify potential beneficial or adverse impacts on conditions in the ROI. The environmental justice indicators used for this study were minority and low-income populations and the population of children in the ROI. The baseline year for environmental justice data is 2009, the most recent year that data are reasonably available. Information in this analysis was obtained from the U.S. Census Bureau.

***Overview of Valued Environmental Component***

Environmental Justice

Executive Order 12898 was issued in 1194, as Federal Actions to Address Environmental Justice in Minority and Low-Income Populations designed to focus the attention of Federal agencies on the human health and environmental conditions in minority and low-income communities. Environmental Justice analyses are performed to identify potential adverse impacts that may result from Proposed Actions, and to identify alternatives that could mitigate these impacts. Minority populations included in the census are identified as Black or African American, American Indian and Alaska Native, Asian, Native Hawaiian and other Pacific Islander, Hispanic or Latino, Some Other Race, and Two or More Races. Poverty status, used in this analysis to define low-income status, is reported as the number of persons with income below the poverty level. The U.S. Census Bureau calculates annual poverty rates using the sum of family income over the year, divided by the sum of poverty thresholds that can change from month to month if the family composition changes.

Populations

The demographic profiles of the ROI are presented in *Table 2-31*. The ROI has larger Asian and Native Hawaiian and Other Pacific Islander populations. These groups accounted for 41.7 percent and 8.2 percent of the total population of the City in 2009. This represents a slight decrease from 2007 for the Asian group, which comprised 44.2 percent of the population, and about the same representation for the Native Hawaiian and Other Pacific Islander group, which comprised 8.2 percent of the population in 2007. Other increases in ethnic groups between 2007 and 2009 include Black or African American, American Indian and Alaskan Native, Hispanic or Latino, and Two or More Races.

| Table 2-31 RACE, ETHNICITY, AND POVERTY STATUS AND TRENDS FOR HONOLULU COUNTY, HAWAI'I, AND THE UNITED STATES, 2007, 2008 AND 2009 | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Race/Ethnicity** | **City and County of Honolulu** | | | **Hawaii** | | | **United States** | | |
| | **2007** | **2008** | **2009** | **2007** | **2008** | **2009** | **2007** | **2008** | **2009** |
| White | 22.3% | 23.0% | 23.0% | 26.6% | 27.1% | 26.9% | 73.9% | 75.1% | 74.8% |
| Black or African | 2.9% | 3.1% | 3.0% | 2.2% | 2.4% | 2.3% | 12.4% | 12.4% | 12.4% |
| American Indian and Alaska Native | 0.2% | 0.2% | 0.3% | 0.3% | 0.2% | 0.3% | 0.8% | 0.8% | 0.8% |
| Asian | 44.4% | 43.5% | 41.7% | 38.8% | 38.5% | 37.1% | 4.4% | 4.4% | 4.5% |
| Native Hawaiian and Other Pacific Islander | 8.2% | 8.5% | 8.2% | 8.5% | 9.1% | 8.8% | 0.1% | 0.1% | 0.1% |
| Hispanic or Latino (of any race) | 7.4% | 7.9% | 8.1% | 8.2% | 8.7% | 9.0% | 15.1% | 15.4% | 15.8% |
| Some Other Race | 1.5% | 1.1% | 0.8% | 1.3% | 1.4% | 1.0% | 6.2% | 4.9% | 4.9% |
| Two or More Races | 20.6% | 20.5% | 22.9% | 22.3% | 21.3% | 23.6% | 2.2% | 2.3% | 2.4% |
| **Total Population** | **905,601** | **905,034** | **907,574** | **1,283,388** | **1,288,198** | **1,295,178** | **301,621,159** | **304,059,727** | **307,006,556** |
| Source: U.S. Census Bureau, 2010<br>Note: Numbers do not add up to 100 percent because persons of Hispanic origin can be of any race and are also included in categories for Some Other Race and More Races. | | | | | | | | | |

*Poverty Rate*

The Census Bureau bases the poverty status of families and individuals on 48 threshold variables, including income, family size, number of family members under the age of 18 and over 65, and amount spent on food. The poverty rates for City, Hawaii, and the U.S. for the years 2007, 2008, and 2009 are presented in *Table 2-32*. In 2009, approximately 9.9 percent of all people and 7.5 percent for all families with children under the age of 18 residing in the City were classified as living in poverty. This is equivalent to the State's poverty rate and less than the U.S. poverty rate, at 7.5 percent and 10.5 percent, respectively (*Table 2-32*). This is also higher than the poverty rate for City and the State of Hawaii in 2008.

| Table 2-32 POVERTY RATES AND TRENDS FOR CITY AND COUNTY OF HONOLULU, HAWAII AND THE UNITED STATES, 2007, 2008, AND 2009 | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Poverty Rate** | **City and County of Honolulu** | | | **Hawaii** | | | **United States** | | |
| | **2007** | **2008** | **2009** | **2007** | **2008** | **2009** | **2007** | **2008** | **2009** |
| All Families | 4.8% | 5.8% | 7.5% | 5.4% | 5.9% | 7.5% | 9.5% | 9.8% | 10.5% |
| All People | 7.6% | 8.7% | 9.9% | 8.0% | 9.2% | 10.4% | 13.0% | 13.3% | 14.3% |
| Source: U.S. Census Bureau, 2010 | | | | | | | | | |

*Protection of Children*

Executive Order 13045, Protection of Children from Environmental Health and Safety Risks, requires Federal agencies, to the extent permitted by law and mission, to identify and assess environmental health and safety risks that might disproportionately affect children.

Children are often present at Fort DeRussy mostly as visitors to the area. The Fort DeRussy Park is a popular family gathering place. Within the park there is a large grassy area with picnic tables and barbeques, the U.S. Armed Forces HKH, and the U.S. Army Museum of Hawaii. According to the Census Bureau, there are approximately 210,500 children under the age of 18 in the City (U.S. Census, 2010).

### 2.15.2 Environmental Consequences

***Impact Methodology***

The ROI is defined to include the City. The Proposed Action and the No Action Alternative are evaluated to identify potential beneficial or adverse impacts on conditions within the ROI. Potential disproportionate effects on low-income or minority populations and the potential for increased adverse health risks to children have been assessed to evaluate potential environmental justice impacts.

To determine if low-income and minority populations could be disproportionately affected by the Proposed Action, the proportion of low-income people and minorities in the areas surrounding the Proposed Action site were identified. If high percentages of low-income and minority populations were identified, then the potential was assessed for construction or operational activities to cause these populations to be displaced, their income or employment to be lost, or their health or environmental condition to be adversely affected. To evaluate if children would encounter disproportionate environmental health or safety effects, the population under the age of 19 surrounding the Proposed Action area was analyzed. The potential environmental health and public safety risks identified for the Proposed Action and the No Action Alternative was then evaluated for proximity to populations of children.

***Factors Considered for Impacts Analysis***

Factors considered in determining if an alternative would have a significant impact on environmental justice include the extent to which its implementation would result in the following:

- Change any social, economic, physical, environmental, or health conditions to disproportionately affect a particular low-income or minority group, or
- Disproportionately endanger children in areas on or near the installations.

***Summary of Impacts***

*Table 2-33* is a summary of Environmental Justice impacts.

**Table 2-33 SUMMARY OF POTENTIAL ENVIRONMENTAL JUSTICE IMPACTS**

| Impact Issues | No Action Alternative | Proposed Action (Preferred Alternative) |
|---|---|---|
| Low-income or minority groups | No impact | Beneficial |
| Endangerment to children | No impact | No impact |

***Proposed Action (Preferred Alternative)***

*Effects on Low-Income or Minority Groups*

The Proposed Action will not result adverse impacts on low-income or minority populations within the ROI. However, it may result in beneficial short-term and long-term impacts through the creation of jobs if low-income or minority residents within the ROI were hired. New job opportunities will be created during the construction period of the Proposed Action, and subsequent employment related to construction of Hilton's Timeshare Tower 1 and various Master Plan projects. In addition, long-term operation jobs associated with the HHV and Timeshare Tower 1 will also be provided. No long-term impacts on social, economic, physical, environmental, or health-related conditions will occur from the Proposed Action. Therefore, the Proposed Action will not impact low-income or minority groups in the ROI.

*Endangerment of Children*

During construction of the proposed sewer improvements, standard safety measures will be followed and related BMPs implemented, to protect the health and safety of residents, including children. Therefore, the Proposed Action will have no impacts on children.

***No Action Alternative***

Under the No Action Alternative, the existing conditions would not change; therefore, there would be no disproportionate impacts on low-income or minority populations or children. However, with no changes to the existing conditions, improvements to the sewer lines serving HHV, HKH and portions of the service area between the Ala Wai Canal, Kalakaua Avenue and Fort DeRussy would not occur. The HHV Timeshare Towers would not be built because the existing sewer system would not be able to accommodate additional flows. Employment related to the HHV Master Plan project and Proposed Action would not be available, which could eliminate job opportunities for low-income or minority groups.

# 3.0 CUMULATIVE IMPACTS

# SECTION 3.0
# CUMULATIVE IMPACTS

## 3.1 INTRODUCTION

Cumulative impacts are the direct and indirect effects of a proposed project's incremental impacts when they are added to other past, present, and reasonably foreseeable actions, regardless of who carries out the action (40 CFR, 1508.7). Guidance for implementing NEPA recommends that Federal agencies identify the temporal and geographic boundaries of the potential cumulative effects of a proposed action (CEQ 1997). For the purposes of this EA, the temporal boundary of analysis is from approximately 2012 to 2015. This boundary encompasses a range within which data are reasonably available and forecasts can be reasonably made, and corresponds to the current project development timetable.

The geographic boundaries of analysis vary, depending on the resource and potential effects. For most resources, the ROI for cumulative impacts is the same as the ROI used for analyzing the effects from the Proposed Action and No Action Alternatives. Resources with farther-reaching impacts, such as air quality or socioeconomics, are analyzed with a more regional perspective. The analysis area is described under each resource. Specific projects that are similar in size or scope or have the potential to cumulatively affect the resources evaluated for the project are identified below. Some resources would be affected by several or all of the described activities, while others could be affected very little or not at all.

Approximately 108 projects are underway focused on Oahu's wastewater treatment plants, pump stations and collection system. These projects are part of $610 million of ongoing wastewater projects, including planning, designing, construction, project management and equipment project phases. Currently, there are several ongoing projects in Waikiki, and those planned to be developed at the same time as the Proposed Action which include:

- Beachwalk Wastewater Pump Station to Ala Moana Park Sewer Phase I, Force Main System - Installation of a new sewer line along Ala Moana Boulevard (between Atkinson Drive and Ala Wai Canal) and along Ala Wai Boulevard (between Kalakaua Avenue to the dead end of Ala Wai Boulevard.

- Kalakaua Avenue Sewer Rehabilitation – Replacement of 1,500 lineal feet of 6- and 8-inch sewer pipe along Kalakaua Avenue between Philip Street and Kapiolani Boulevard.

- Waikiki Sewer Rehabilitation – Sewer rehabilitation work along Kuhio Avenue between Kuamoo Street and Kaiulani Avenue. HHV Timeshare Tower One (1) – Construction of the new Timeshare Tower, above the existing tour bus/loading area at HHV, will extend from 2014 to 2016.

## 3.2 LAND USE

The Proposed Action will result in the wastewater system improvements consistent with the State and County land use plans and policies. The Proposed Action will not change existing land uses, particularly after construction is completed, or land use impacts on surrounding areas. Therefore, the Proposed Action will have no impact on cumulative land uses.

## 3.3 SOCIO-ECONOMICS

Past, present, and future projects will cumulatively increase economic activity and demand for services within the ROI in the short-term and long-term. The ROI for the cumulative impacts on socio-economics is the overlap of the ROIs of the Proposed Action and the areas affected by the cumulative projects listed in above and any other past, present, or reasonably foreseeable future action.

In the short-term, these projects will contribute to the regional economy through increased income, employment, and increased tax revenue through an increase in sales volume in the ROI during construction. In the long-term, these projects could allow for some modest increase in the resident and visitor population in the ROI by providing increased wastewater capacity. Construction of the proposed sewer line improvement projects will upgrade the City's wastewater system to comply with State of Hawaii and EPA standards, and allow for the development of approved land uses such as the HHV Master Plan. Consequently, this will result in cumulative beneficial long-term economic and fiscal impacts relating to employment, income, taxes, and additional consumer expenditures within the ROI.

## 3.4 TRAFFIC

The construction phase of the projects listed above will have less than significant, short-term impacts on existing vehicular, pedestrian, and bicycle circulation for the duration of each construction period. These projects will implement mitigation measures to minimize impacts to below significant levels. As a result of proposed lane closures during the construction period, the Proposed Action will have a significant impact but will implement mitigation measures to reduce impacts to less than significant. Therefore, past, present, and reasonably foreseeable future actions, combined with the Proposed Action, will have a significant impact but mitigable to less than significant on existing traffic. Upon completion of these projects, traffic will continue to operate at pre-construction levels; therefore, no cumulative long-term impacts on traffic, pedestrian and bicycle circulation are anticipated.

## 3.5 NOISE

The ROI for cumulative impacts is the area surrounding Proposed Action and extending out about a mile from the project areas. Existing noise levels in the ROI are controlled by local and distant traffic. The background noise levels are exceeded approximately ten percent of the time. During construction, significant noise impacts will likely occur; however, typical construction noise mitigation measures will be employed particularly during the nighttime and early morning hours, to reduce impacts to less than significant levels. Therefore, past, present, and reasonably foreseeable future actions, when combined with the Proposed Action, will result in significant impacts but mitigable to less than significant. Upon completion of the construction phase, noise levels will be reduced to pre-construction levels. Therefore, no cumulative long-term impacts existing noise levels in the ROI are anticipated.

## 3.6 AIR QUALITY

***Criteria Pollutants***

Cumulative air quality impacts occur when multiple projects affect the same geographic areas at the same time, or when sequential projects extend the duration of air quality impacts on a given area over a longer period. The air quality impacts of the Proposed Action are primarily due to temporary construction. Temporary construction-related air quality issues include local fugitive dust. More regional air quality issues relate to ozone precursor emissions from construction equipment engine exhaust. Emissions from cumulative projects will affect the local area; however, impacts are expected to be minimal with the implementation of BMPs such as dust minimization to ensure that projects comply with air quality standards. Thus, cumulative air quality impacts from the Proposed Action and other regional projects are considered to be less than significant.

***Greenhouse Gas Emissions***

GHG emissions from sources associated with the Proposed Action will combine with the GHG emissions from other cumulative projects. State and Federal agencies have not yet established impact significance criteria for GHG emissions. However, given the relatively small quantities of criteria pollutant emissions estimated for the Proposed Action, the project's GHG emissions will not significantly contribute to global climate change, and is not expected to contribute considerably to cumulative GHG emissions.

## 3.7 GEOLOGY, SOILS, AND SEISMICITY

The Proposed Action includes erosion and sediment control measures to minimize erosion impacts. Erosion and sediment control measures will be applied, as appropriate, to surrounding project locations where land-disturbing activities will take place to prevent significant erosion impacts from occurring. Less than significant cumulative impacts with respect to geology, topography, and soils are expected.

## 3.8 NATURAL HAZARDS

The Proposed Actions and cumulative projects will comply with applicable regulations relating to flood and other natural hazards. The Proposed Action installed underground and will not be impacted by natural hazards such as flooding, hurricanes and tropical storms, and tsunamis. Therefore, the Proposed Action will have no impact on cumulative natural hazards.

## 3.9 WATER RESOURCES

No significant cumulative impacts on water resources are anticipated. Implementation of the Proposed Action Alternative will have beneficial impacts on water quality since the sewer improvements will serve to minimize problems that may occur from wet water infiltration/inflow. However, during construction of the improvements, there will be a slight increased potential for water quality degradation due to silt runoff from disturbed areas at the construction site. Implementing BMPs for erosion control will minimize localized silt runoff from reaching receiving waters. Similar measures are expected to be used at construction sites for other projects, such as those listed in *Section 3.1,* to prevent significant water quality degradation from construction from occurring.

## 3.10 HAZARDOUS MATERIALS

Cumulative projects will comply with applicable regulations and policies governing the use and storage of hazardous materials. Therefore, no cumulative impacts on hazardous materials from conflicts with applicable regulations are anticipated. While construction of the Proposed Action will not involve hazardous waste, BMPs will be implemented, including appropriate worker protection procedures. No significant short-term or long-term impacts are expected.

## 3.11 PUBLIC FACILITIES, SERVICES, AND UTILITIES

The ROI for the cumulative impacts on public facilities, services and utilities is the overlap of the ROIs of the Proposed Action and the areas affected by the cumulative projects listed in *Section 3.1* and any other past, present, or reasonably foreseeable future action. The Proposed Action and cumulative projects could have a short-term, less than significant impact on public services (police protection, solid waste management, etc.) and existing utility infrastructure located near the project areas during the construction period. However, these projects are not expected to directly increase energy and potable water consumption, wastewater generation, stormwater generation, or demands on communication systems. No significant long-term cumulative impacts are anticipated since these projects will not alter existing public facilities, services and utilities after construction is completed. Indirect cumulative impacts may occur as future projects, such as the approved HHV Master Plan are developed, thereby increasing the demand for public facilities, services and utilities within the ROI. Long-term beneficial impacts to public utilities will result from the improvements to the City's wastewater collection system.

## 3.12 BIOLOGICAL RESOURCES

The Proposed Action and cumulative projects will follow applicable regulations and policies identified to protect biological resources; therefore, there will be no cumulative impacts on biological resources. The cumulative projects will involve construction and an increase in human presence, noise, erosion, dust. However, mitigation measures will be implemented to reduce the level of impact to below significant levels. Construction-related impacts could be adverse for biological resources in the vicinity of the project. With exception of the manuoku, (White Fairy Tern, *Gygis alba*), the ROI does not have special status biological resources. The area is highly disturbed and developed; however, the health of the overall environment and potential increases in degradation of habitat may contribute cumulatively to the impact on biological resources. Impacts will likely be less than significant since the biological resources affected by the Proposed Action alternatives are limited, so its contribution to the overall cumulative impact will be minor.

Cumulative impacts will be greater if the cumulative projects were to involve new activities on high-value habitat, instead of on existing disturbed areas, which will create little change to an area's current habitat. Due to the highly disturbed setting of the cumulative projects, cumulative impacts are expected to be less than significant. The effects of the Proposed Action alternative will not cause the significance level to rise above a less than significant status.

## 3.13 CULTURAL RESOURCES

In general, projects involving construction, demolition, and ground-disturbing activities, have the potential to impact archaeological, traditional Native Hawaiian (cultural) resources. Based on historic documents and past and current archaeological investigations, the Proposed Action will have a significant impact on archaeological resources, but compensatory mitigation will be included to reduce the level of impact to below significant levels. The project team will continue to consult with cultural descendants and/or lineal descendants, to develop a Plan of Action and cultural preservation plan to appropriately treat any findings of human remains, cultural sites, or artifacts during construction. Therefore, cumulative impacts to cultural resources are expected to be significant but mitigable to less than significant. Construction activities for other projects must also comply with Federal and State laws to preclude significant impacts to cultural resources.

## 3.14 VISUAL RESOURCES

Cumulative projects will comply with applicable regulations and policies governing visual resources. Cumulative projects will have cumulative impacts on the visual character of sites and surroundings from construction. Less than significant short-term impacts are expected, as the visual character of the site and surrounding area will be temporarily affected during construction. BMPs will be implemented to reduce associated impacts to visual resources.

Cumulative projects will have cumulative impacts on the visual character of sites and surroundings, and light and glare if construction takes place during night time hours. These impacts are similar to those described above. To minimize short-term impacts from lighting and glare, the Proposed Action will include BMPs, such as using proper outdoor temporary lighting that will keep stray light from illuminating unnecessary areas, and provide light only when necessary. Therefore, less than significant impacts from light and glare are anticipated.

Although short -term adverse cumulative effects could occur, there will be no area-wide cumulative impacts. The cumulative projects do no involve the conversion of undeveloped areas to developed areas, which could more substantially affect local aesthetics and visual resources will be more substantial. The proposed alternatives will not cause the significance level of visual resource impacts to rise above a less than significant status.

## 3.15 ENVIRONMENTAL JUSTICE

When compared to past, present, and reasonably foreseeable actions, the Proposed Action will not impact minority or low-income populations, and will not contribute to a cumulative impact on environmental justice. In fact, the Proposed Action will create new short-term and long-term, direct and indirect job opportunities for low-income or minority groups, thereby contributing to the cumulative beneficial impacts on environmental justice. In addition, the Proposed Action will not contribute to adverse impacts relating to the endangerment of children.

# 4.0 APPLICABLE LAND USE PLANS AND POLICIES

# SECTION 4.0
# APPLICABLE LAND USE PLANS AND POLICIES

## 4.1 INTRODUCTION

In this chapter, the project's consistency with applicable land use policies set forth in the Hawaii State Plan, State Land Use Law, State CZM Program, Hawaii 2050 Sustainable Plan, City and County of Honolulu General Plan, PUCDP, and WSD, and SMA.

## 4.2 HAWAII STATE PLAN

In 1978, the Hawaii State Legislature found a need to improve the planning process in the State, to increase the effectiveness of government and private actions, to improve the coordination among different agencies and levels of government, and to provide for the wise use of Hawaii's resources to guide the future development of the State. Under HRS Chapter 226 (Hawaii State Planning Act), the Hawaii State Plan serves as a guide for the future long-range development of the State. The Hawaii State Plan identifies the goals, objectives, policies, and priorities for the State; provides a basis for determining priorities and allocating limited resources, such as public funds, services, human resources, land, energy, water, and other resources; improves coordination of Federal, State, and County plans, policies, programs, projects, and regulatory activities; and establishes a system for plan formulation and program coordination to provide for an integration of all major State and County activities. Act 181, Session Laws of Hawaii 2011, was signed into law on July 5, 2011. Act 181 provides an update to HRS, Chapter 226 by adding a new section to Part III.

The State shall strive to improve the quality of life for Hawaii's present and future population through the pursuit of desirable courses of action in six major areas of statewide concern which merit priority attention: economic development, population growth and land resource management, affordable housing, crime and criminal justice, quality education, and principles of sustainability. These will be discussed as they relate to the proposed project.

It is the goal of the State, under the Hawaii State Planning Act (Chapter 226, HRS), to achieve the following:

- *A strong, viable economy, characterized by stability, diversity, and growth, that enables the fulfillment of the needs and expectations of Hawaii present and future generations.*
- *A desired physical environment, characterized by beauty, cleanliness, quiet, stable natural systems, and uniqueness, that enhances the mental and physical well-being of the people.*
- *Physical, social, and economic well-being, for individuals and families in Hawaii, that nourishes a sense of community responsibility, of caring, and of participation in community life (Chapter 226-4, HRS).*

Specific objectives and policies of the State Plan that pertain to the project are as follows:

*Section 226-13 Objectives and policies for the physical environment--land, air, and water quality.*

*(a) Planning for the State's physical environment with regard to land, air, and water quality shall be directed towards achievement of the following objectives:*

*(1) Maintenance and pursuit of improved quality in Hawaii's land, air and water resources*

*(b) To achieve the land, air, and water quality objectives, it shall be the policy of this State to:*

*(2) Promote the proper management of Hawaii's land and water resources.*

*(3) Promote effective measures to achieve desired quality in Hawaii's surface, ground and coastal waters.*

**Discussion**

The Proposed Action will be located over 1,200 feet away from the shoreline. BMPs will be implemented during construction to reduce erosion of soils and fugitive dust from occurring. The Proposed Action will protect coastal resources and water quality by improving the existing wastewater system and reducing the potential for future system failures.

*Section 226-15 Objectives and policies for facility systems--solid and liquid wastes.*

*(a) Planning for the State's facility systems with regard to solid and liquid wastes shall be directed towards the achievement of the following objectives:*

*(1) Maintenance of basic public health and sanitation standards relating to treatment and disposal of solid and liquid wastes.*

*(2) Provision of adequate sewerage facilities for physical and economic activities that alleviate problems in housing, employment, mobility, and other areas.*

*(b) To achieve solid and liquid waste objectives, it shall be the policy of this State to:*

*(1) Encourage the adequate development of sewage facilities that complement planned growth.*

**Discussion**

The Proposed Action will decrease the risk of future sewage spills and system failures, thereby providing for the maintenance of public health and sanitation standards. The improvements and expansion made to the existing sewer lines will also accommodate the approved planned growth of the HHV, HKH, and portions of the service area between the Ala Wai Canal, Kalakaua Avenue and Fort DeRussy.

*Section 226-20 Objectives and policies for socio-cultural advancement - health*

*(a) Planning for the State's socio-cultural advancement with regard to health shall be directed towards the achievement of the following objectives:*

*(2) Maintenance of sanitary and environmentally healthful conditions in Hawaii's communities.*

*(b) To achieve the health objectives, it shall be the policy of this State to:*

*(5) Provide programs, services, and activities that ensure environmentally healthful and sanitary conditions.*

**Discussion**

The Proposed Action will meet the needs of the service area between the Ala Wai Canal, Kalakaua Avenue and Fort DeRussy, and will help to support the maintenance of sanitary and environmentally healthful conditions in Hawaii's communities.

## 4.3 HAWAII STATE LAND USE DISTRICT BOUNDARIES

Under the Chapter 205, HRS, all lands of the State are to be classified in one of four categories: urban, rural, agricultural, and conservation lands. The State LUC, an agency of the State DBEDT, is responsible for each district's standards and for determining the boundaries of each district (Chapter 205-2(a), HRS). The LUC is also responsible for administering all requests for district reclassifications and/or amendments to district boundaries, pursuant to Chapter 205-4, HRS, and the HAR, Title 15, Chapter 15 as amended. Under this Chapter, all lands in Hawaii are classified into four land use districts: (1) Conservation, (2) Agricultural; (3) Urban, and (4) Rural.

**Discussion**

As classified by the LUC, the project area is situated within the State Urban District (*Figure 1-3*). The proposed improvements are consistent with permitted uses for the Urban District, and will not require district reclassification or boundary amendment.

## 4.4 HAWAII COASTAL ZONE MANAGEMENT PROGRAM

The CZMA (16 USC, Section 1451), as amended through Public Law 104-150, created the CZM Program and the National Estuarine Research Reserve system. The coastal states are authorized to develop and implement a State CZM program. The Hawaii CZM Program received Federal approval in the late 1970s. The objectives of the CZM Program, as defined in Section 205A-2, HRS, are to protect valuable and vulnerable coastal resources such as coastal ecosystems, special scenic and cultural values and recreational opportunities. The objectives of the program are also to reduce coastal hazards and to improve the review process for activities proposed within the coastal zone. Each County is responsible for designating a SMA that extends inland from the shoreline. Development within the SMA is subject to County approval to ensure the proposal is consistent with the policies and objectives of the Hawaii CZM Program. Program objectives and applicability to the Proposed Action are discussed below.

***Recreational Resources***

*Objective: Provide coastal recreational opportunities accessible to the public.*

*Policy A: Improve coordination and funding of coastal recreational planning and management; and*

*Policy B: Provide adequate, accessible, and diverse recreational opportunities in the coastal zone management area by:*

- *(i) Protecting coastal resources uniquely suited for recreational activities that cannot be provided in other areas;*
- *(ii) Requiring replacement of coastal resources having significant recreational value, including but not limited to surfing sites, fishponds, and sand beaches, when such resources will be unavoidably damaged by development; or requiring reasonable monetary compensation to the State for recreation when replacement is not feasible or desirable;*
- *(iii) Providing and managing adequate public access, consistent with conservation of natural resources, to and along shorelines with recreational value;*
- *(iv) Providing an adequate supply of shoreline parks and other recreational facilities suitable for public recreation;*
- *(v) Ensuring public recreational uses of County, State, and Federally owned or controlled shoreline lands and waters having recreational value consistent with public safety standards and conservation of natural resources;*

*(vi) Adopting water quality standards and regulating point and nonpoint sources of pollution to protect, and where feasible, restore the recreational value of coastal waters;*
*(vii) Developing new shoreline recreational opportunities, where appropriate, such as artificial lagoons, artificial beaches, and artificial reefs for surfing and fishing; and*
*(viii) Encouraging reasonable dedication of shoreline areas with recreational value for public use as part of discretionary approvals or permits by the land use commission, board of land and natural resources, and County authorities; and crediting such dedication against the requirements of section 46-6.*

**Discussion:**

The Proposed Action is not within the SMA as delineated by the City and as such does not require an additional review under State CZM and County SMA rules (*Figure 1-6*). However, the sewer will affect lands within the SMA boundary with the replacement of existing sewer laterals to serve approved developments. The Proposed Action will be located 1,200 feet away from the shoreline; therefore, it is anticipated that there will be no effect on existing coastal recreational resources. The project as proposed is located within the Kalia Road, the Fort DeRussy property along Ala Moana Boulevard and Kalakaua Avenue, and should not impact the recreational resources associated with the Ala Wai Canal, an inland waterway.

***Historic Resources***

*Objective: Protect, preserve and, where desirable, restore those natural and manmade historic and prehistoric resources in the coastal zone management area that are significant in Hawaiian and American history and culture.*

*Policy A: Identify and analyze significant archaeological resources;*
*Policy B: Maximize information retention through preservation of remains and artifacts or salvage operations; and*
*Policy C: Support State goals for protection, restoration, interpretation, and display of historic resources.*

**Discussion:**

On-site archaeological monitoring will be conducted throughout the project area, following an approved Plan of Action and SHPD guidelines. Should archaeological or cultural remains be encountered during construction, work in the immediate vicinity will cease and the SHPD will be contacted in accordance with Chapter 6E, HRS. Contemporary or continuing cultural practices at the project area will not be adversely affected by the Proposed Action.

***Scenic and Open Space Resources***

*Objective: Protect, preserve and, where desirable, restore or improve the quality of coastal scenic and open space resources.*

*Policy A: Identify valued scenic resources in the coastal zone management area;*
*Policy B: Ensure that new developments are compatible with their visual environment by designing and locating such developments to minimize the alteration of natural landforms and existing public views to and along the shoreline;*
*Policy C: Preserve, maintain, and, where desirable, improve and restore shoreline open space and scenic resources; and*
*Policy D: Encourage those developments which are not coastal dependent to locate in inland areas.*

**Discussion:**

The Proposed Action will be located over 1,200 feet away from the shoreline. Additionally, BMPs will be employed to reduce erosion of soils and fugitive dust during construction. No effects on the quality of the coastal scenic resources are anticipated. The project is expected to protect coastal resources by improving the existing City wastewater system and reducing the potential for system failures.

***Coastal Ecosystems***

*Objective: Protect valuable coastal ecosystems, including reefs, from disruption and minimize adverse impacts on all coastal ecosystems.*

*Policy A: Exercise an overall conservation ethic, and practice stewardship in the protection, use, and development of marine and coastal resources;*

*Policy B: Improve the technical basis for natural resource management;*

*Policy C: Preserve valuable coastal ecosystems, including reefs, of significant biological or economic importance;*

*Policy D: Minimize disruption or degradation of coastal water ecosystems by effective regulation of stream diversions, channelization, and similar land and water uses, recognizing competing water needs; and*

*Policy E: Promote water quantity and quality planning and management practices that reflect the tolerance of fresh water and marine ecosystems and maintain and enhance water quality through the development and implementation of point and nonpoint source water pollution control measures.*

**Discussion:**

BMPs will be employed during construction to reduce erosion of soils and fugitive dust from occurring. Sewer system failures in the Waikiki area have occasionally occurred in the past, which resulted in temporary reduction to water quality impacting the coastal ecosystem. The Proposed Action is expected to reduce the potential for sewer system failures to occur. Over the long term, it is anticipated that there will be no adverse effects of the Proposed Action on the quality of the coastal ecosystems.

***Economic Uses***

*Objective: Provide public or private facilities and improvements important to the State's economy in suitable locations.*

*Policy A: Concentrate coastal dependent development in appropriate areas;*

*Policy B: Ensure that coastal dependent development such as harbors and ports, and coastal related development such as visitor industry facilities and energy generating facilities, are located, designed, and constructed to minimize adverse social, visual, and environmental impacts in the coastal zone management area; and*

*Policy C: Direct the location and expansion of coastal dependent developments to areas presently designated and used for such developments and permit reasonable long-term growth at such areas, and permit coastal dependent development outside of presently designated areas when:*

*(i) Use of presently designated locations is not feasible;*
*(ii) Adverse environmental effects are minimized; and*
*(iii) The development is important to the State's economy.*

**Discussion:**
The Proposed Action will have a beneficial impact the State economy. The Proposed Action will result in short-term positive impacts on the local economy by providing new jobs for contractors and construction workers. In addition, the City will gain a well-maintained wastewater system that will require fewer service and traffic disruptions for repairs. This system will also support the economic well-being of the surrounding neighborhood.

***Coastal Hazards***
*Objective: Reduce hazard to life and property from tsunami, storm waves, stream flooding, erosion, subsidence, and pollution.*

*Policy A: Develop and communicate adequate information about storm wave, tsunami, flood, erosion, subsidence, and point and non-point source pollution hazards;*

*Policy B: Control development in areas subject to storm wave, tsunami, flood, erosion, hurricane, wind, subsidence, and point and non-point source pollution hazards;*

*Policy C: Ensure that developments comply with requirements of the Federal Flood Insurance Program; and*

*Policy D: Prevent coastal flooding from inland projects.*

**Discussion:**
Most of the proposed improvements will be located entirely underground. During construction, BMPs will be employed to reduce non-point source pollution caused by the erosion of soils and fugitive dust. The Proposed Action will improve and upgrade part of the existing City wastewater system, thereby reducing the potential for future pollution from sewer system failures.

***Managing Development***
*Objective: Improve the development review process, communication, and public participation in the management of coastal resources and hazards.*

*Policy A: Use, implement, and enforce existing law effectively to the maximum extent possible in managing present and future coastal zone development;*

*Policy B: Facilitate timely processing of applications for development permits and resolve overlapping or conflicting permit requirements; and*

*Policy C: Communicate the potential short and long-term impacts of proposed significant coastal developments early in their life cycle and in terms understandable to the public to facilitate public participation in the planning and review process.*

**Discussion:**
As with all construction projects that cause soil disturbance, there is the potential for the creation of non-point source pollution. The project will include BMPs to reduce potential adverse effects to coastal areas. The project is not considered a “significant coastal development” since it is located inland.

This EA studies the potential short and long-term impacts of the Proposed Action on the environment. Procedurally, this EA conforms to NEPA and HRS Chapter 343. The *OEQC Environmental Notice* publishes notice of the EA availability for public review. The public is allowed up to 30-days to submit comments on the EA. During NEPA consultation and pre-scoping, agencies, organizations, and persons were consulted and will continue to be informed throughout the planning process. In addition, the project development and planning process will include notification of Neighborhood Board No. 9 (Waikiki).

There are numerous County approvals and permits required and processing will be conducted to facilitate timely processing.

***Public Participation***

*Objective: Stimulate public awareness, education, and participation in coastal management.*

*Policy A: Promote public involvement in coastal zone management processes;*

*Policy B: Disseminate information on coastal management issues by means of educational materials, published reports, staff contact, and public workshops for persons and organizations concerned with coastal issues, developments, and government activities; and*

*Policy C: Organize workshops, policy dialogues, and site- specific mediations to respond to coastal issues and conflicts.*

**Discussion:**

This EA provides a means for public input. Copies of the EA were distributed to agencies noted in *Section 8.0*, and were made available at public libraries.

***Beach Protection***

*Objective: Protect beaches for public use and recreation.*

*Policy A: Locate new structures inland from the shoreline setback to conserve open space, minimize interference with natural shoreline processes, and minimize loss of improvements due to erosion;*

*Policy B: Prohibit construction of private erosion-protection structures seaward of the shoreline, except when they result in improved aesthetic and engineering solutions to erosion at the sites and do not interfere with existing recreational and waterline activities; and*

*Policy C: Minimize the construction of public erosion-protection structures seaward of the shoreline.*

**Discussion:**

The proposed improvements are located away from the ocean and public beaches. Due to the distance from the shoreline, no adverse impact to area beaches is anticipated. The Proposed Action will improve and expand the existing wastewater system to reduce the potential for future system failures that could impact beach areas.

***Marine Resources***

*Objective: Promote the protection, use, and development of marine and coastal resources to assure their sustainability.*

*Policy A: Ensure that the use and development of marine and coastal resources are ecologically and environmentally sound and economically beneficial;*

*Policy B: Coordinate the management of marine and coastal resources and activities to improve effectiveness and efficiency;*

*Policy C: Assert and articulate the interests of the State as a partner with Federal agencies in the sound management of ocean resources within the United States exclusive economic zone;*

*Policy D: Promote research, study, and understanding of ocean processes, marine life, and other ocean resources in order to acquire and inventory information necessary to understand how ocean development activities relate to and impact upon ocean and coastal resources; and*

*Policy E: Encourage research and development of new, innovative technologies for exploring, using, or protecting marine and coastal resources.*

**Discussion:**
The proposed project improvements are located away from the coastline. Therefore, impacts to marine resources are not anticipated. By carrying out the Proposed Action, the potential for future sewer system failures within the project area would be reduced, furthering the City's commitment to protect the environment and public health, as well as helping to meet elements of the 2010 EPA Wastewater Consent Decree.

## 4.5 HAWAII 2050 SUSTAINABILITY PLAN

The Hawaii 2050 Sustainability Plan as a long-term strategy has as its main goals and objectives respect for culture, character, beauty, and history of the state's island communities; balance among economic, community, and environmental priorities; and an effort to meet the needs of the present without compromising the ability of future generations to meet their own needs.

The 2050 Plan delineates five goals toward a sustainable Hawaii accompanied by strategic actions for implementation and indicators to measure success or failure. The goals and strategic actions that are pertinent to the project are as follows.

- ***Goal One:*** *Living sustainably is part of our daily practice in Hawaii.*
- ***Goal Two:*** *Our diversified and globally competitive economy enables us to meaningfully live, work, and play in Hawaii.*
- ***Goal Three:*** *Our natural resource are responsibly used, replenished and preserved for future generations.*
- ***Goal Four:*** *Our community is strong, healthy, vibrant and nurturing, providing safety nets for those in need. Strengthen social safety nets.*
- ***Goal Five:*** *Our Kanaka Maoli and island cultures and values are thriving and perpetuated.*

**Discussion:**
Although the Proposed Action does not directly relate to the goals of the 2050 Sustainability Plan, the project improvements will protect coastal resources and water quality by improving the existing sewage conveyance system and reducing the potential for future system failures. BMPs will also be employed to reduce erosion and runoff from occurring during construction.

## 4.6 CITY AND COUNTY OF HONOLULU GENERAL PLAN

Adopted by Resolution in 1977, the 1992 revised edition of the General Plan for the City sets forth the long-range objectives for the general welfare and prosperity of the people of Oahu, and broad policies to attain those objectives. The General Plan provides objectives and policies intended to guide and coordinate City land use planning and regulation, and budgeting for operations and capital improvements.

The project is consistent with the applicable objectives and policies of the City and County of Honolulu General Plan, as described below.

***Natural Environment***
*Objective A: To protect and preserve the natural environment.*
*Policy 7: Protect the natural environment from damaging levels of air, water, and noise pollution.*

***Transportation and Utilities***
*Objective B: To meet the needs of the people of Oahu for an adequate supply of water and for environmentally sensitive waste collection and waste disposal.*
*Policy 5: Provide safe, efficient, and environmentally sensitive wastewater collection and waste disposal services.*

*Objective C: To maintain a high level of services for all utilities.*
*Policy 1: Maintain existing utility systems in order to avoid major breakdowns.*

**Discussion:**
The Proposed Action will upgrade the existing sewer collection lines serving the HHV, HKH and a portion of the service area between the Ala Wai Canal, Kalakaua Avenue and Fort DeRussy. The project supports the General Plan policies above by improving the existing wastewater system, thereby decreasing the risk of sewage spills and water pollution.

## 4.7 CITY AND COUNTY OF HONOLULU – PRIMARY URBAN CENTER DEVELOPMENT PLAN

The PUCDP by the City DPP establishes policy to shape the growth and development of the PUC over the next 20 years. The planning goal of the PUCDP is to enhance the livability of the PUC while accommodating a moderate amount of growth. The PUCDP establishes the region's role in Oahu's development pattern by establishing policies in the following areas:

- Natural, historic, cultural and scenic resources
- *Parks and recreation areas*
- *Lower- and higher-density residential neighborhoods*
- *Commercial and visitor industry facilities*
- *Military installations, transportation centers and industrial areas*
- *Design of streets and buildings*
- *Neighborhood planning*
- *Transportation networks and systems*

A relevant policy is included in Section 4.2.2

- *Implement wastewater collection system improvements to provide adequate service and sound facilities to existing neighborhoods and timely increases in system capacity to areas planned to undergo improvement or change in use.*
- *Implement adequate and timely upgrades/expansion of wastewater treatment facilities to meet the growth demands of the PUC.*

**Discussion:**
The Proposed Action is located in the Resort and Major Parks and Open Space on the PUC Land Use Designation Map (*Figure 1-5).* The proposed project is designated to improve the existing wastewater collection system to ensure adequate service to the HHV, HKH and a portion of the service area between neighborhoods near the Ala Wai Canal, Kalakaua Avenue and Fort DeRussy.

## 4.8 WAIKIKI SPECIAL DISTRICT

The purpose of the LUO is to regulate land use in a manner that will encourage orderly development in accordance with adopted land use policies, including the City and County of Honolulu General Plan and the PUCDP. The LUO also promotes and protects public health, safety, and welfare by:

- Minimizing adverse effects resulting from the inappropriate location, use or design of sites and structures;
- Conserving the city's natural, historic and scenic resources and encouraging design which enhances the physical form of the city; and
- Assisting the public in identifying and understanding regulations affecting the development and use of land.

The LUO also provides reasonable development and design standards that are applicable to the location, height, bulk and size of structures, yard areas, off-street parking facilities, and open spaces, and the use of structures and land for agriculture, industry, business, residences or other purposes (ROH, Chapter 21).

As a recognized resort destination, Waikiki continues to attract visitors from all parts of the world, serving as the foundation for the State's tourist industry, identified as a major and vital employment sector, and home for thousands of full-time residents. As such, in the City's commitment to maintain the socio-economic vitality of Waikiki, the area is designated as a Special District, with specific design standards and guidelines established to direct its future growth (LUO, Sec. 21-9.80).

The establishment of the WSD was largely a response to the rapid development of the 1960s and 1970s, and the physical and social changes attributed to that development. As a sophisticated urban resort, diversity and contrast characterize Waikiki. The LUO's WSD Guidelines are a planning tool aimed at restoring the basic appeal of Waikiki as a pedestrian-friendly environment. To complement the strong urban image that Waikiki possesses, emphasis is placed on developing creative and functional uses of the ground-level open space. The focus of open space helps to define a "Hawaiian sense of place" as stated in the objectives of the WSD Guidelines that are enumerated in Section 7.80-1 of the LUO.

**Discussion:**
The Proposed Action is located in the WSD, Resort Mixed Use Precinct and Public Precinct (*Figure 1-4*). The proposed wastewater system improvements will support the HHV, HKH and a portion of the service area between the Ala Wai Canal, Kalakaua Avenue and Fort DeRussy. Development standards and design guidelines associated with the WSD, Resort Mixed Use Precinct and Public Precinct are not directly applicable to the project.

## 4.9 SPECIAL MANAGEMENT AREA

The SMA for each island was established to preserve, protect, and where possible, to restore the natural resources of the coastal zone of Hawaii. Special controls on developments within the SMA area are necessary to avoid permanent loss of valuable resources and foreclosure of management options. The review guidelines of Section 25-3.2 of the ROH are used by DPP and the City Council for the review of developments proposed in the SMA. These guidelines are derived from Section 205A-26 HRS.

**Discussion:**

The Proposed Action is not located within the County's SMA delineation; therefore approval of an SMA Use Permit is not required (*Figure 1-6*). The project will affect lands within the SMA boundary with the replacement of existing sewer laterals to serve approved developments. These proposed sewer improvements were addressed as part of the EIS and SMA for the HHV Master Plan Improvements project (2011). The Proposed Action is also excluded from consideration as "development" subject to approval of the SMA Use Permit. The ROH Section 25-1.3.2D reads:

*"Development does not include the following: The repair and maintenance of underground utility lines, including but not limited to water, sewer, power and telephone and minor appurtenant structures such as pad mounted transformers and sewer pump stations,"*

# 5.0 OTHER REQUIRED NEPA AND HRS CHAPTER 343 ANALYSIS

# SECTION 5.0
# OTHER REQUIRED NEPA AND HRS CHAPTER 343 ANALYSIS

## 5.1 INTRODUCTION

In addition to the analyses discussed in Chapter 2, NEPA and HRS Chapter 343 also require additional evaluation of the project's impacts.

As detailed in *Section 5.2 and 5.3*, NEPA requires additional analysis with regard to the following:

- *The relationship between local short-term uses of the environment and long-term productivity and*
- *Any irreversible or irretrievable commitment of resources.*

As detailed in *Section 5.5*, HRS Chapter 343 requires additional evaluation of the project with regarding to the 13 significance criteria outlined in Section 11-200-12, HAR:

1. *Involves an irrevocable commitment to loss or destruction of any natural or cultural resources;*

2. *Curtail the range of beneficial uses of the environment;*

3. *Conflicts with the State's long-term environmental policies or goals and guidelines as expressed in Chapter 344, HRS; and any revisions thereof and amendments thereto, court decisions, or executive orders;*

4. *Substantially affects the economic or social welfare of the community or state;*

5. *Substantially affects public health;*

6. *Involves secondary impacts such as population changes or effects on public facilities;*

7. *Involves a substantial degradation of environmental quality;*

8. *Is individually limited but cumulatively has considerable effect upon the environment or involves a commitment for larger actions;*

9. *Substantially affects a rare, threatened, or endangered species or its habitat;*

10. *Detrimentally affects air or water quality or ambient noise levels;*

11. *Affects or is likely to suffer damage by being located in an environmentally sensitive area such as a flood plain, tsunami zone, beach, erosion-prone area, geologically hazardous land, estuary, freshwater, or coastal waters;*

12. *Substantially affects scenic vista and view plane identified in county or state plans or studies;*

13. *Requires substantial energy consumption.*

NEPA and HRS Chapter 343 also require that an EA include a discussion of the agencies consulted during preparation of the document.

## 5.2 RELATIONSHIP BETWEEN LOCAL SHORT-TERM USES OF THE ENVIRONMENT AND LONG-TERM PRODUCTIVITY

Short-term damage to the environment from the Proposed Action will be limited. No significant impacts have been identified. The Proposed Action will involve short-term uses of the environment during the construction phase having both positive and negative impacts. Construction activities associated with the Proposed Action will create temporary adverse impacts, including increased noise, airborne dust and traffic disruptions. The Proposed Action will also provide positive economic benefits resulting from construction expenditures both through the purchase of materials from local suppliers and through the employment of local labor. Indirect economic impacts to local retail businesses from construction activities may also occur as a result of the Proposed Action.

In the long-term, the Proposed Action will have beneficial impacts on the maintenance of the sewer system and enhancement of the environment, including improvements to coastal water quality, ecosystems, public health, and safety. The sewer improvements will improve system reliability and reduce the risk of future wastewater spills. The Proposed Action is designed to help the City meet its current and future infrastructure needs in support of the Waikiki community, its residents, businesses, and its natural environment.

## 5.3 IRREVERSIBLE AND IRRETRIEVABLE COMMITMENTS OF RESOURCES

NEPA requires an analysis of the extent to which the proposed project's primary and secondary effects would commit resources to uses that would be irretrievable in the future. Implementing the Proposed Action will require committing energy and material resources for the construction of the sewer improvements, such as the fuel used by construction vehicles, the materials to construct the improvements, and the resources to maintain and operate the overall infrastructure.

A substantial amount of financial resources also will be required to construct, operate, and maintain the proposed improvements. Hilton will provide the funds for these specific City sewer improvements to support implementation of their HHV Master Plan projects. Once the project is completed, annual operating and maintenance costs associated with the proposed improvements will be provided by the City.

## 5.4 ANTICIPATED DETERMINATION

Based on the information and analysis disclosed in this EA, the project will not have significant adverse impacts to the natural, built, or social environment. As such, it is determined that an EIS is not required and a FONSI is anticipated for this project.

## 5.5 REASONS SUPPORTING THE ANTICIPATED DETERMINATION

In determining whether an action may have significant impact on the environment, the applicant must consider all phases of the project, its expected primary and secondary consequences, the cumulative impacts with other projects, and its short and long-term effects. The potential effects of the proposed project are evaluated based on the significance criteria identified in the Chapter 343, HRS, and Section 11-200-12, HAR. The following is a summary of the potential effects of the project.

1. *Involves an irrevocable commitment to loss or destruction of any natural or cultural resources;*

The proposed sewer improvements will take place within Kalia Road, Fort DeRussy fronting Ala Moana Boulevard and Kalakaua Avenue. There are no significant biological resources within the area where improvements are proposed, including threatened or endangered species or their habitats. No contemporary or continuing cultural practices occur at the project area. On-site archaeological monitoring will be conducted through the entire construction process, with particular attention where excavation occurs near the more sensitive areas of resource concern. Therefore, the Proposed Action will not involve an irrevocable commitment to loss or destruction of any natural or cultural resource.

2. *Curtail the range of beneficial uses of the environment;*

The Proposed Action will not permanently curtail the beneficial uses of the environment. The project improvements will occur within defined utility corridors along Kalia Road, and Fort DeRussy fronting Ala Moana Boulevard and Kalakaua Avenue. The project area involving underground utilities presents no other alternative beneficial uses.

3. *Conflicts with the State's long-term environmental policies or goals and guidelines as expressed in Chapter 344, HRS; and any revisions thereof and amendments thereto, court decisions, or executive orders;*

The Proposed Action will be in conformance with Chapter 344, HRS, which establishes a State policy to encourage productive and enjoyable harmony between people and their environment, promotes efforts to prevent or eliminate damage to the environment, and stimulate community health and welfare. The project will also improve system reliability and reduce the risk of future wastewater spills.

4. *Substantially affects the economic or social welfare of the community or state;*

The Proposed Action is not anticipated to have significant effects on the economic and social welfare of the community or State. Construction will have short-term air, noise, and traffic impacts which will be minor or mitigated to less than significant levels. However, the project will have beneficial long-term impacts to the economic and social environments by providing properly functioning wastewater collection infrastructure, reducing sewer maintenance costs, and providing new construction jobs.

5. *Substantially affects public health;*

The Proposed Action will have a positive impact on public health by reducing the risk of potential wastewater spills into waterways, with direct benefits to public safety and health. Adverse effects on public health are not anticipated to occur as a result of the project.

6. *Involves secondary impacts such as population changes or effects on public facilities;*

The project is not anticipated to result in substantial secondary impacts. The Proposed Action will not result in a population increase or affect the demand for public facilities or utilities.

7. *Involves a substantial degradation of environmental quality;*

The project is not anticipated to involve degradation of environmental quality. Construction impacts related to traffic, noise, and air quality will be temporary. These short-term impacts will be mitigated through phased construction, traffic management, equipment noise attenuation, and the use of BMPs. Completion of the sewer line improvements project will have long-term beneficial impacts on the environmental quality.

8. *Is individually limited but cumulatively has considerable effect upon the environment or involves a commitment for larger actions;*

The Proposed Action is limited in scope to the improvements of the existing sewer lines, and is part of the City's effort to improve Honolulu's sewer system. The project will have a long-term beneficial impact on the environment.

9. *Substantially affects a rare, threatened, or endangered species or its habitat;*

The Proposed Action is not anticipated to affect rare, threatened, or endangered species or habitat. The project areas area urbanized, and there are no significant biological resources located in the area of the sewer system improvements.

10. *Detrimentally affects air or water quality or ambient noise levels;*

The Proposed Action will result in fugitive dust and noise generation during construction. However, BMPs and adherence to applicable controls will be implemented to minimize these short-term impacts. In the long-term, the Proposed Action will have beneficial impacts on air and water quality by reducing the risk of wastewater backups and spills from occurring.

11. *Affects or is likely to suffer damage by being located in an environmentally sensitive area such as a flood plain, tsunami zone, beach, erosion-prone area, geologically hazardous land, estuary, freshwater, or coastal waters;*

The underground utility corridor and the sewer alignment route are not in an environmentally sensitive area. Kalia Road and a portion of Fort DeRussy fronting Ala Moana Boulevard are located in the City's designated tsunami evacuation zone. However, the replacement sewer system will be located underground, and is not anticipated to be directly affected by a tsunami. BMPs will be implemented during construction to minimize potential water quality impacts.

12. *Substantially affects scenic vista and view plane identified in County or State plans or studies;*

The most of the project improvements will be located underground; therefore, impacts to scenic vistas or view planes are not anticipated.

13. *Requires substantial energy consumption.*

The Proposed Action will not require substantial energy consumption. While energy will be consumed during construction of the project, the project improvements will decrease long-term energy consumption associated with ongoing maintenance of the City's sewer facilities.

## 5.6 SUMMARY

Based on the above findings, the Proposed Action will not generate significant adverse socio-economic or environmental impacts. The EA recommends mitigation measures to alleviate potential impacts when such impacts are identified.

The project is consistent with the Hawaii State Land Use District Boundaries; the Hawaii State Plan and Functional Plans; the 2050 Sustainable Plan, the Hawaii CZM Program, the City and County of Honolulu General Plan and Development Plan; the City's Zoning Ordinance, and SMA.

The Proposed Action will help to upgrade and expand the existing sewer lines serving the HHV campus, HKH and portion of the service area between the Ala Wai Canal, Kalakaua Avenue and Fort DeRussy. The sewer improvements will improve system reliability and reduce the risk of future wastewater spills. The Proposed Action is designed to help the City meet its current and future infrastructure needs in support of the Waikiki community, its residents, businesses, and its natural environment. The project will help the City in meeting a portion of their requirements under the 2010 EPA Wastewater Consent Decree.

## 5.7 AGENCY CONSULTATION

The following Federally-recognized Native Hawaiian Organizations will be consulted in compliance with NEPA Section 106 of the NHPA:

- Hawaiʻi State Historic Preservation Officer
- Office of Hawaiian Affairs
- Waikiki Hawaiian Civic Club
- Hui Malama I Na Kupuna O Hawaii Nei
- Oahu Island Burial Council

Copies of the letters and the responses received are included in *Appendix A* of this EA.

Other agencies, organizations, and individuals that will be consulted as part of the project's compliance with NHPA Section 106 and HRS Chapter 343, are detailed in *Section 8.0*.

# 6.0 List of References

# SECTION 6.0
# LIST OF REFERENCES

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### GEOGRAPHICAL INFORMATION SYSTEMS DATA

Maps produced using GIS are based on source data provided from the Federal Government, State of Hawaii and City and County of Honolulu resources. The data layers used to create the maps are used "as is" and are not manipulated or edited for visual improvement. Source map data meet the minimum mapping requirements as set forth by the United States Geological Survey in the National Map Accuracy Standards.

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Zoning Map Height Limit - Information System (HOLIS), C&C of Honolulu, December, 2009

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Oahu TMK - Honolulu Land Information System (HOLIS), C&C of Honolulu, March, 2010

Urban Center
Map from C&C Honolulu, DPP, Primary Urban Center Development Plan, June 2004 Zoning
Zoning - Honolulu Land Information System (HOLIS), C&C of Honolulu, July, 2008

## MAPS

Aerial base - Google Imagery, Sept 28, 2008

Oahu TMK - Honolulu Land Information System (HOLIS), C&C of Honolulu, March, 2010

Oahu Streets - Honolulu Land Information System (HOLIS), C&C of Honolulu, January, 2008

Project Area - Group 70 International, Inc. GIS, January 2010

# 7.0 LIST OF PREPARERS AND PARTICIPANTS

# SECTION 7.0
# LIST OF PREPARERS AND PARTICIPANTS

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| Ms. Laurie Lucking | Chief of the Cultural Resource Section |
| Mr. Richard Davis | Archaeologist |
| **City and County of Honolulu, Department of Environmental Services (Cooperating Agency)** | |
| Mr. Tim Steinberger | Director |
| Mr. David Nagamine | Executive Assistant I |
| Mr. Jack Pobuk | CIP Program Coordinator |
| Ms. Lisa Kimura | Engineer |
| **Hilton Worldwide (Applicant)** | |
| Mr. Gerard Gibson | Area Vice President |
| Mr. Stephen Jacobson | Senior Director, Project Management |
| **Group 70 International, Inc. (Environmental Consultant)** | |
| Mr. Jeffrey Overton | Principal |
| Ms. Tracy Furuya | Planner |
| Mr. Kawika McKeague | Cultural Planner |
| Ms. Stephanie Saephan | GIS Specialist |

| Technical Specialists | Responsibilities |
|---|---|
| **Arcadis U.S., Inc.**<br>Mr. Jeffrey Morrell, Principal Environmental Engineer<br>Mr. Scott Sevadjian, Senior Staff Scientist | Air Impact Analysis |
| **Belt Collins Hawaii, LLC**<br>Ms. Cheryl Palesh, Chairman/Director of Engineering<br>Mr. Alan Kato, Project Manager/Civil Engineer | Preliminary Engineering Report: Water, Sewer, Drainage, Traffic, Electrical |
| **Cultural Surveys Hawaii, Inc.**<br>Mr. David Shideler, Director, Oahu Office<br>Ms. Nicole Ishihara, Cultural Researcher<br>Mr. Matt McDermott, Project Manager | Archaeological Literature Review and Field Inspection and Cultural Impact Assessment |
| **Wilson Okamoto Corporation**<br>Mr. Pete Pascua, Vice-President and Director of Traffic Engineering | Construction Traffic Impact Analysis |

| Technical Specialists (continued) | Responsibilities (continued) |
|---|---|
| **McCelvy Associates, Inc.**<br>Mr. Shelli McCelvey, President | Landscape |
| **Steve Nimz and Associates, Inc.**<br>Mr. Steve Nimz, Consulting Arborist | Arborist Assessment |
| **Geolabs**<br>Mr. Robin Lim, Vice President<br>Mr. Satoshi Tanaka, Senior Project Engineer | Geotechnical Investigation |
| **Control Point**<br>Mr. Ed Yeh, President | Land Survey,<br>Topographic Survey |
| **Y. Ebisu and Associates**<br>Mr. Yoichi Ebisu, Principal | Acoustical Study |
| **Aukahi**<br>Ms. Lani Maa Lapilio, Principal | Cultural Resource Planning and Consultation Services |

# 8.0 LIST OF AGENCIES, ORGANIZATIONS, AND INDIVIDUALS RECEIVING COPIES OF THE EA

# SECTION 8.0
# LIST OF AGENCIES, ORGANIZATIONS, AND INDIVIDUALS RECEIVING COPIES OF THE EA

| Respondents and Distribution | HRS Ch. 343 Pre-Consultation | NEPA Section 106 Consultation | Pre-Consultation Comments Received | Receiving Draft EA | Draft EA Comments Received | Receiving Final EA/ FONSI |
|---|---|---|---|---|---|---|
| **Federal Agencies** | | | | | | |
| Advisory Council on Historic Preservation | | X | | X | | |
| Armed Forces Recreation Center, The Hale Koa Hotel at Fort DeRussy | X | | | X | | |
| United States (U.S.) Army Corps of Engineers, Honolulu District | X | | X | X | | |
| U.S. Army Family & Morale, Welfare & Recreation Army Community Service | X | | | X | | |
| U.S. Army Museum of Hawaii | X | | | X | | |
| U.S. Department of Defense, Asia Pacific Center for Security Studies | X | | | X | | |
| U.S. DOI, Fish and Wildlife | X | | | X | | |
| U.S Environmental Protection Agency, Pacific Islands Contact Office | | | | X | | |
| **State of Hawaii Agencies** | | | | | | |
| Department of Accounting and General Services | | | | X | | |
| Department of Agriculture | | | | X | | |
| Department of Business, Economic Development & Tourism (DBEDT) | | | | X | | |
| DBEDT, Energy Division | | | | X | | |
| DBEDT, Office of Planning | | | | X | | |
| DBEDT, Tourism Liaison | X | | | X | | |
| Department of Defense | X | | | X | | |
| Department of Education | | | | X | | |
| Department of Hawaiian Home Lands | | | | X | | |
| Department of Health, Environmental Planning Office | X | | X | X | | |
| Department of Health, Wastewater Branch | | | X | X | | |
| Department of Human Services | | | | X | | |

| Respondents and Distribution | HRS Ch. 343 Pre-Consultation | NEPA Section 106 Consultation | Pre-Consultation Comments Received | Receiving Draft EA | Draft EA Comments Received | Receiving Final EA/ FONSI |
|---|---|---|---|---|---|---|
| Department of Labor and Industrial Relations | | | | X | | |
| Department of Land and Natural Resources (DLNR) | X | X | X | X | | |
| DLNR, Aquatic Resources Division | | | X | X | | |
| DLNR, Boating and Ocean Recreation Division | | | X | X | | |
| DLNR, Engineering Division | | | X | X | | |
| DLNR, Land Division, Oahu District | | | X | X | | |
| DLNR, State Historic Preservation Division (SHPD) | X | X | | X | | |
| DLNR, SHPD (Kawika Farm, Burial Specialist) | | X | | | | |
| DLNR, SHPD (Nona Naboa, Oahu Archaeologist) | | X | | | | |
| DLNR, SHPD (Susan Lebo, Oahu Archaeologist) | | X | | | | |
| Department of Transportation | X | | X | X | | |
| Hawaii Housing Finance & Development Corporation | | | | X | | |
| Hawaii Visitors and Convention Bureau | X | | | X | | |
| Hawaii Tourism Authority | X | | | X | | |
| Oahu Island Burial Council (OIBC) (Hinaleimoana Kalu, Chair) | X | X | X | X | | |
| OIBC (Jonathan Scheuer, Vice-Chair) | | X | X | | | |
| Oahu Visitors Bureau | X | | | X | | |
| Office of Environmental Quality Control | X | | | X | | |
| Office of Hawaiian Affairs (OHA) | X | X | X | X | | |
| OHA (Keola Lindsey) | | X | X | | | |
| University of Hawaii, Environmental Center | | | | X | | |
| **City and County of Honolulu** | | | | | | |
| Board of Water Supply | X | | X | X | | |
| Department of Community Services | | | | X | | |
| Department of Design and Construction | X | | X | X | | |
| Department of Environmental Services | X | | | X | | |

| Respondents and Distribution | HRS Ch. 343 Pre-Consultation | NEPA Section 106 Consultation | Pre-Consultation Comments Received | Receiving Draft EA | Draft EA Comments Received | Receiving Final EA/ FONSI |
|---|---|---|---|---|---|---|
| Department of Facility Maintenance | X | | X | X | | |
| Department of Planning and Permitting | X | | X | X | | |
| Department of Parks and Recreation | | | | X | | |
| Department of Transportation Services | X | | X | X | | |
| Department of Wastewater Management | X | | | X | | |
| Fire Department | X | | X | X | | |
| Managing Director's Office | X | | | X | | |
| Police Department | X | | X | X | | |
| Waikiki Neighborhood Board (No. 9) | X | | | X | | |
| **Elected Officials** | | | | | | |
| Governor Neil Abercrombie, Office of the Governor | X | | | X | | |
| State Senator Brickwood Galuteria, 12th Senatorial District | X | | | X | | |
| State Senator Maile Shimabukuro, 21st Senatorial District | X | | | X | | |
| State House of Representative Calvin Say, 20th Representative District | X | | | X | | |
| State House of Representative Tom Brower, 23rd Representative District | X | | | X | | |
| State House of Representative Joey Manahan, 29th Representative Dist. | X | | | X | | |
| Mayor Peter Carlisle, Office of the Mayor | X | | | X | | |
| Councilmember Stanley Chang, District 4 | X | | | X | | |
| **Libraries** | | | | | | |
| Hawaii State Library | | | | X | | |
| **Public Utilities** | | | | | | |
| Hawaiian Electric Company | X | | X | X | | |
| **Community Interest Groups and Individuals** | | | | | | |
| Hawaii Building and Construction Trades Council | X | | | X | | |
| The Outdoor Circle | X | | X | X | | |
| Waikiki Improvement Association | X | | | X | | |

| Respondents and Distribution | HRS Ch. 343 Pre-Consultation | NEPA Section 106 Consultation | Pre-Consultation Comments Received | Receiving Draft EA | Draft EA Comments Received | Receiving Final EA/ FONSI |
|---|---|---|---|---|---|---|
| Waikiki Residents Association | X | | | X | | |
| **Cultural Community Consultation** | | | | | | |
| A. Van Horn Diamond | X | | X | | | |
| Adam Hai, Jr. | | X | | | | |
| Adrian Kealoha Keohokalole | X | X | | X | | |
| Alika Luka | | X | | | | |
| Amelia Gora | | X | | | | |
| Angela Malo | | X | | | | |
| Ashford Kekaula | X | X | | X | | |
| Betty Keanaaina | X | X | | X | | |
| Carolyn Keala Norman | X | X | | X | | |
| Chase Keliipaakaua | X | X | | X | | |
| Clarence Medeiros, Jr. | | X | | | | |
| Clarence Medeiros, Sr. | X | X | | X | | |
| Clarence Moses Hukiku | | X | | | | |
| Cy K. Harris | X | X | | X | | |
| Cynthia Ku | | X | | | | |
| Dana Hall | X | X | | X | | |
| Darren Hukiku Lopes | | X | | | | |
| David Medeiros | | X | | | | |
| Debbie Norman Kini | X | X | | X | | |
| Dennis Kaiminaauao Keohokalole | | X | | | | |
| Eileen Norman | | X | | | | |
| Emalia Keohokalole | X | X | | X | | |
| Haumea Lew | | X | | | | |
| Hui Malama I Na Kupuna O Hawaii Nei (Edward Halealoha Ayau) | X | X | | X | | |
| Hui Malama I Na Kupuna O Hawaii Nei (Kihei Nahale-a) | X | X | | X | | |
| Julia Puaala Romero | | X | | | | |
| Kaimana Gasper | | X | | | | |
| Kaleo Norman | X | X | | X | | |

| Respondents and Distribution | HRS Ch. 343 Pre-Consultation | NEPA Section 106 Consultation | Pre-Consultation Comments Received | Receiving Draft EA | Draft EA Comments Received | Receiving Final EA/ FONSI |
|---|---|---|---|---|---|---|
| Kanaloa Koko | X | X | | X | | |
| Kapiolani Ku Naiwi | | X | | | | |
| Kareen Medeiros | | X | | | | |
| Kealoha Kuhea | | X | | | | |
| Kehaulani Souza | | X | | | | |
| Keliinui Norman | | X | | | | |
| Kepoo Keliipaakaua | | X | | | | |
| Kihei Keanaaina | | X | | | | |
| Kolomana Wilson Ku | X | X | | X | | |
| Jacob and Trina Ku, Jr. | | X | | | | |
| Jacob Medeiros | | X | | | | |
| Jacqueline & Thomas Shirai, Jr. | X | X | | X | | |
| Jacquelyn Ku | X | X | | X | | |
| Jaimison Medeiros | | X | | | | |
| Jaycine Hicks Ku | | X | | | | |
| Jayla Medeiros | | X | | | | |
| Jim Medeiros | X | X | | X | | |
| Julie Romero | | X | | | | |
| Justin Kepoo Keliipaakaua | | X | | | | |
| Lachelle Kapunani Ku | | X | | | | |
| Lauren-Stephanie Mapuana Ku | | X | | | | |
| LeeAnna Roberts | | X | | | | |
| Leinaala & Poonui Lopes | X | X | | X | | |
| Lena Estaban Ku | | X | | | | |
| Lincoln Medeiros | | X | | | | |
| Lowens Kapu Ku | | X | | | | |
| Luther Keanaaina | X | X | | X | | |
| Manuel Kuloloio | X | X | | X | | |
| Marshall Paul Ku Robinson | | X | | | | |
| Mary Keanaaina | | X | | | | |

| Respondents and Distribution | HRS Ch. 343 Pre-Consultation | NEPA Section 106 Consultation | Pre-Consultation Comments Received | Receiving Draft EA | Draft EA Comments Received | Receiving Final EA/ FONSI |
|---|---|---|---|---|---|---|
| Michelle Keanaaina | | X | | | | |
| Miles and Tracy Takaki | | X | | | | |
| Moani Soares | | X | | | | |
| Moses Takaki | | X | | | | |
| Nalani Kini | | X | | | | |
| Nalani Olds | X | X | | X | | |
| Nalani Wilson Ku | | X | | | | |
| Napua Alvina Puaoi | | X | | | | |
| Nicole Kotrys Ku | | | | | | |
| Noelani Keanaaina | | X | | | | |
| Norman Miyasato | | X | | | | |
| Ohana Kaleikini | X | X | | X | | |
| Ohana Keliinoi | X | X | | X | | |
| Paula Ku | | X | | | | |
| Richard Likeke Papa, Jr. | X | X | | X | | |
| Regina Keanaaina | | X | | | | |
| Regina Rash | | X | | | | |
| Roland Medeiros | | X | | | | |
| Ruby Keanaaina McDonald | X | | | | | |
| Ryan Fenton Koma-Waikenekona | | X | | | | |
| Ted Kekua Norman | | X | | | | |
| Tercia Ku | | X | | | | |
| Vicky Keanaaina | | X | | | | |
| Violet Medeiros Mamac | | X | | | | |
| Waikiki Hawaiian Civic Club (Malia Nobrega, President) | X | X | | X | | |
| William Haole | X | X | | X | | |
| William Hoohuli | | X | | | | |
| William Keanaaina | | X | | | | |

# APPENDIX A
# AGENCY CONSULTATION: COMMENT LETTERS AND RESPONSES

# NEPA Section 106 Consultation

**NHPA Section 106 Consultation**

In compliance with the NEPA and the National Historic Preservation Act, the U.S. Army Garrison, Hawaii's letter initiating the Section 106 consultation process will be sent to agencies, organizations and individuals noted in Section 8.0 of this Draft Environmental Assessment. Copies of the letter and responses received will be included in the Final Environmental Assessment.

# PRE-CONSULTATION MEMO AND PARTICIPANT LETTER

GROUP 70
INTERNATIONAL

June 8, 2012

**Subject**: Pre-Consultation for Chapter 343, HRS Environmental Assessment
Kālia-Fort DeRussy Wastewater System Improvements
TMK: (1) 2-6-005:001 por., Kālia Road, Ala Moana Blvd., Kalakaua Avenue
(Waikīkī, Oʻahu, Hawaiʻi)

PRINCIPALS

Francis S. Oda, Arch.D., FAIA, AICP, LEED AP
Norman G.Y. Hong AIA
Sheryl B. Seaman AIA, ASID, LEED AP
Hitoshi Hida AIA
Roy H. Nihei AIA, CSI, LEED AP
James I. Nishimoto AIA
Stephen Yuen AIA
Linda C. Miki AIA
George I. Atta AICP, LEED AP
Charles Y. Kaneshiro AIA, LEED AP
Jeffrey H. Overton AICP, LEED AP
Christine Mendes Ruotola AICP, LEED AP
James L. Stone, Arch.D., AIA, LEED AP
Katherine M. MacNeil AIA, LEED AP
Tom Young, MBA AIA
Paul T. Matsuda PE, LEED AP

OF COUNSEL

Ralph E. Portmore FAICP

Dear Participant:

On behalf of the City and County of Honolulu, Department of Environmental Services, United States Army Garrison–Hawaiʻi and Hilton Worldwide, Group 70 International is currently undertaking the preparation of an Environmental Assessment (EA) pursuant to the National Environmental Policy Act (NEPA) and Chapter 343, Hawaiʻi Revised Statutes (HRS), for the proposed Kālia-Fort DeRussy Wastewater System Improvements, located in Waikīkī, Oʻahu, Hawaiʻi.

A pre-consultation process is being conducted to engage agencies and interested parties in the environmental review process. Enclosed, for your review and comment, is a project information summary and overview of the proposed action.

Please provide comments via telephone, email, fax, or U.S. Mail regarding the scope of this EA. We would like to receive these comments no later than July 9, 2012. Comments received subsequent to this deadline will still be considered.


Group 70 International, Inc.
925 Bethel Street, Fifth Floor
Honolulu, HI 96813-4307
Attn: Jeff Overton
Email: KaliaDeRussyWW@Group70int.com
Tel: (808) 523-5866 Ext. 104
Fax: (808) 523-5874


Thank you for participating in pre-consultation for this environmental review process.

Sincerely,
GROUP 70 INTERNATIONAL, INC.

Jeffrey H. Overton, AICP, LEED AP
Principal, Environmental Planner

Enclosed: Pre-Consultation Handout

# PROJECT INFORMATION SUMMARY

| | |
|---|---|
| **Project Name:** | Kālia Road-Fort DeRussy Wastewater System Improvements |
| **Applicant:** | Hilton Hawaiian Village® Beach Resort & Spa<br>2005 Kālia Road<br>Honolulu, Hawaiʻi 96815<br>Contact: Gerard C. Gibson, Area Vice President |
| **Approving Agency NEPA:** | United States Army Garrison, Hawaiʻi (USAG-HI)<br>947 Wright Avenue<br>Schofield Barracks, Hawaiʻi 96857<br>Contact: Douglas S. Mulbury, Colonel |
| **Approving Agency Ch. 343, HRS:** | City and County of Honolulu<br>Department of Environmental Services<br>1000 Uluohia Street, Suite 308<br>Kapolei, Hawaiʻi 96707<br>Contact: Jack Pobuk, CIP Program Coordinator |
| **Class of Action NEPA**: | Use of Federal Lands |
| **Class of Action Ch 343, HRS:** | Use of State Lands |
| **Project Location:** | Waikīkī, Oʻahu, Hawaiʻi |
| **Tax Map Key:** | (1) 2-6-005:001 por., Kālia Rd., Ala Moana Blvd., Kalakaua Ave. |
| **Landowner:** | United States of America ((1) 2-6-005:001 por.)<br>City and County of Honolulu (various roadways) |
| **Project Area:** | 2,600 linear feet alignment |
| **State Land Use District:** | Urban District |
| **City & County of Honolulu Zoning:** | Waikīkī Special District, Resort Mixed Use Precinct and Public Precinct |
| **Primary Urban Center Development Plan:** | Resort and Major Parks and Open Space |
| **Special Management Area (SMA):** | Not in SMA |
| **Flood Zone:** | Zone AO and AE |
| **Ch. 343, HRS:** | Finding of No Significant Impact (FONSI) |

## PROJECT SITE

The proposed Kālia-Fort DeRussy Wastewater System Improvements project is located within the City and County of Honolulu's Kālia Road right-of-way between Ena Road and Paoa Place, and adjacent to Ala Moana Boulevard and Kalakaua Avenue, fronting the Fort DeRussy property. These areas are located in Waikīkī, on the Island of Oʻahu, State of Hawaiʻi (*Figure 1*).

The project consists of replacement of approximately 2,600 linear feet of gravity sewer line, which connects to the Fort DeRussy Wastewater Pump Station. The wastewater line alignment is bounded by Fort DeRussy on the south, the Hilton Hawaiian Village to the west and Ala Moana Boulevard to the north, and Kalakaua Avenue to the east. Various hotels and residential condominiums lie beyond Ala Moana Boulevard and Kalakaua Avenue to north and east of the gravity sewer alignment.

## OVERVIEW OF PLANNED PROJECT

The City and County of Honolulu, Department of Environmental Services has identified sewer system improvements to accommodate the Hilton Hawaiian Village Master Plan and Hale Koa Hotel and sewer flows from the service area between the Ala Wai Canal, Kalakaua Avenue and Fort DeRussy. The proposed system improvements include:

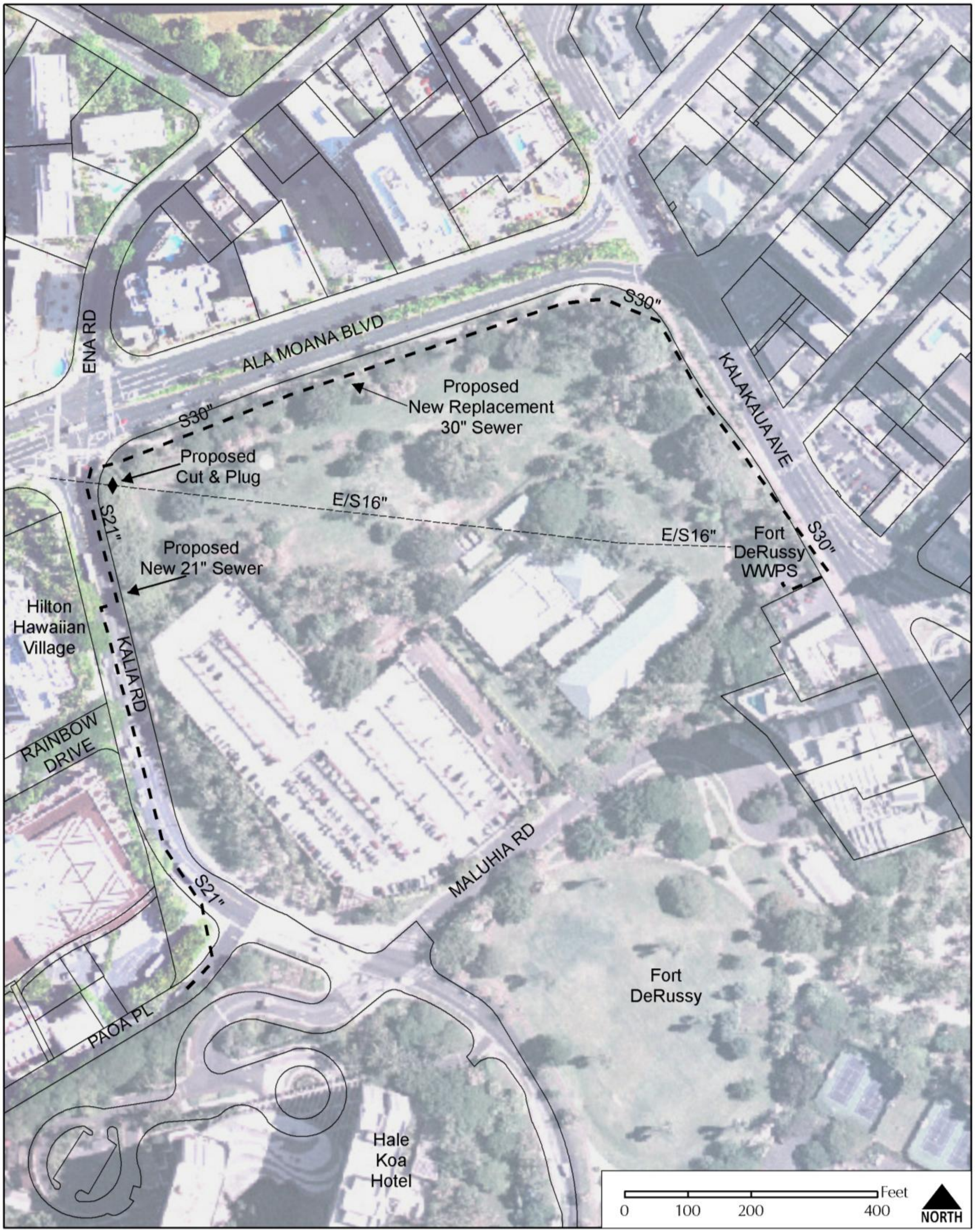
- The existing 1950's 12-inch diameter sewer line in Kālia Road will be replaced with a new 21-inch diameter sewer line. The replacement sewer line will begin at the intersection of Paoa Place and Kālia Road and end at the intersection of Ala Moana Boulevard and Kālia Road. The existing 16-inch diameter sewer line, which traverses across Fort DeRussy in a sewer line easement, would be cut and plugged at the Ala Moana Boulevard and Kālia Road intersection.

- The existing 1960's 24-inch diameter sewer line on Ala Moana Boulevard and Kalakaua Avenue will be replaced by a 30-inch diameter sewer line. The replacement sewer line will begin at the intersection of Kālia Road and Ala Moana Boulevard and end at the Fort DeRussy WWPS. Work at Fort DeRussy will be contained within a City sewer line easement.

The Kālia-Fort DeRussy Wastewater System Improvements project will help the City to meet the 2010 Wastewater Consent Decree with U.S. Environmental Protection Agency to upgrade the wastewater system by 2020 to accommodate projected 2030 peak wet weather flows. The project will provide capacity for the Hilton Hawaiian Hawaiian Village Master Plan improvements, including a new Timeshare Tower.

## PURPOSE OF ENVIRONMENTAL ASSESSMENT

This Environmental Assessment (EA) is being prepared pursuant to State and Federal laws. The EA will comply with Hawaiʻi's Environmental Review Process, Hawaiʻi Revised Statutes (HRS), Chapter 343, which requires that any project that proposes the use of State land must undergo an environmental review. Since a portion of the Kālia-Fort DeRussy Wastewater System Improvements project is also located on Federal land (Fort DeRussy), this document also meets the requirements of a National Environmental Policy Act (NEPA) EA. The EA examines the potential environmental impacts of the project and seeks agency and public comment on subject areas that should be addressed.




**Project Location**
**Kālia-Fort DeRussy Wastewater System Improvements**
**(Source: Belt Collins, 2012)**

# PRE-CONSULTATION COMMENT LETTERS AND RESPONSES

**DEPARTMENT OF THE ARMY**
**U.S. ARMY CORPS OF ENGINEERS, HONOLULU DISTRICT**
**FORT SHAFTER, HAWAII 96858-5440**

REPLY TO
ATTENTION OF:

June 26, 2012

Regulatory Branch

RECEIVED

JUN 28 2012

GROUP 70 INTL

File Number **POH-2012-00164**

Group 70 International, Inc.
Attn: Jeffrey H. Overton
925 Bethel Street, Fifth Floor
Honolulu, HI 96813

Dear Mr. Overton:

This responds to your letter dated June 8, 2012 requesting review comments for the proposed Kalia-Fort DeRussy Wastewater System Improvements, located in Waikiki, Island of Oahu, Hawaii. We have assigned this project the reference number **POH-2012-00164**. Please cite this reference number in any future communications with this office regarding this project.

We have completed our review of the submitted documents pursuant to Section 10 of the Rivers and Harbors Act of 1899 (Section 10) and Section 404 of the Clean Water Act (Section 404). For your information, Section 10 requires that a Department of the Army (DA) permit be obtained from the U.S. Army Corps of Engineers (Corps) prior to undertaking any construction, dredging, or other activity occurring in, over, or under or affecting navigable waters of the U.S. For tidal waters, the shoreward limit of the Corps jurisdiction extends to the Mean High Water Mark. Section 404 requires that a DA permit be obtained for the discharge (placement) of dredged and/or fill material into waters of the U.S., including wetlands. For tidally influenced waters, in the absence of adjacent wetlands, the shoreward limit of the Corps jurisdiction extends to the High Tide Line, which in Hawai'i may be approximated by reference to the Mean Higher High Water Mark. For non-tidal waters, the lateral limits of the Corps jurisdiction extend to the Ordinary High Water Mark or the approved delineated boundary of any adjacent wetlands.

Based on the information provided, the project site appears to be absent of navigable waters subject to the Corps jurisdiction. Therefore, Section 10 authorization may not be required. However, there is insufficient information provided to determine if the proposed project will involve activities under Section 404. Fill material, permanent or temporary, may include, but is not limited to: rock, dirt, sandbags, silt fences or concrete. To avoid unintentional violation to federal regulation and law, we advise you to contact our office prior to conducting any activity that may result in the discharge of dredged and/or fill material. Section 404 authorization may be required for this action.

When developing the Environmental Assessment, we recommend you conduct a thorough aquatic resource survey, describing information regarding any potential water bodies, including wetlands, drainage ditchers, gulches, stream, etc., on-site, especially those that may be impacted by the proposed project. The survey should include descriptions of aquatic features proposed for impact, flow, duration and the flow path of each feature into navigable waters.

We recommend you contact the Corps to determine if any of the proposed work constitutes a "discharge of fill" and submit an application with associated drawings that meet our drawing recommendations found at *http://www.poh.usace.army.mil/EC-R/EC-R.htm*. Click on "Apply for Permit" on the right-hand side, and then click on "Rec – Sect 404 Clean Water Act Drawings." Providing photographs of the parcel would also expedite our review. As a reminder, only the Corps has the authority to determine if any of these features are or are not waters of the U.S. and, potentially subject to regulations. A request for an approved JD can be submitted prior to, or concurrently with, an application for the proposed work.

Thank you for giving us the opportunity to review this proposal and providing us with the opportunity to comment. Should you have any questions, please contact Ms. Michelle Lazaro at (808) 835-4307, or through email at *Michelle.K.Lazaro@usace.army.mil*. You are encouraged to provide comments on your experience with the Honolulu District Regulatory Branch by accessing our web-based customer survey form at *http://per2.nwp.usace.army.mil/survey.html*.

Sincerely,

George P. Young, P.E.
Chief, Regulatory Branch

GROUP 70
INTERNATIONAL

PRINCIPALS

Francis S. Oda, Arch.D., FAIA, AICP, LEED AP
Norman G.Y. Hong AIA
Sheryl B. Seaman AIA, ASID, LEED AP
Hitoshi Hida AIA
Roy H. Nihei AIA, CSI, LEED AP
Ralph E. Portmore AICP
James I. Nishimoto AIA
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Linda C. Miki AIA
George I. Atta AICP, LEED AP
Charles Y. Kaneshiro AIA, LEED AP
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Christine Mendes Ruotola AICP, LEED AP
James L. Stone, Arch.D., AIA, LEED AP
Katherine M. MacNeil AIA, LEED AP
Tom Young, MBA AIA
Paul T. Matsuda PE, LEED AP

October 26, 2012

Mr. George P. Young, P.E.
Chief, Regulatory Branch
Department of the Army
U.S. Army Corps of Engineers, Honolulu District
Fort Shafter, Hawaii 96858-5440

**Subject**: Pre-Consultation for Chapter 343, HRS Environmental Assessment
Kalia-Fort DeRussy Wastewater System Improvements
TMK: (1) 2-6-005:001 por., Kalia Road, Ala Moana Blvd., Kalakaua Avenue
(Waikiki, Oahu, Hawaii)

Dear Mr. Young:

Thank you for your comment letter dated June 26, 2012 concerning the Pre-Consultation for Chapter 343, HRS Environmental Assessment (EA) for the Kalia-Fort DeRussy Wastewater System Improvements project (File No. POH-2012-00164). The following responses are offered to your comments.

We appreciate your determination that the proposed action will not require a Department of Army (DA) Section 10 permit authorization since it is absent of navigable waters subject to the Corps jurisdiction.

Construction of the proposed project improvements will not result in the discharge of dredged material into waters of the U.S., including wetlands. Excess materials from the project's construction will be disposed of off-site by the contractor at an appropriate location.

There are no water bodies in the vicinity of the proposed improvements, including wetlands, drainage ditchers, gulches, stream, etc. The project will upgrade existing sewer lines in Kalia Road, Fort DeRussy fronting Ala Moana Boulevard and Kalauaka Avenue. No aquatic features will be impacted; therefore an aquatic resource survey is not applicable.

We appreciate your participation in the environmental review process. Please contact us if you have questions or require additional information.

Sincerely,
GROUP 70 INTERNATIONAL, INC.

Jeffrey H. Overton, AICP, LEED AP
Principal, Chief Environmental Planner

cc: Jack Pobuk, ENV
Dale Kahehisa-Lam, USAG-HI

NEIL ABERCROMBIE
GOVERNOR OF HAWAII

**STATE OF HAWAII**
**DEPARTMENT OF HEALTH**
P. O. BOX 3378
HONOLULU, HI 96801-3378

LORETTA J. FUDDY, A.C.S.W., M.P.H.
DIRECTOR OF HEALTH

In reply, please refer to:
File:

12-109
Kalia-Fort DeRussv

RECEIVED

JUN 21 2012

GROUP 70 INTL

June 13, 2012

Mr. Jeffrey H. Overton, AICP
Group 70 International
925 Bethel Street, 5th Floor
Honolulu, Hawaii 96813-4307

Dear Mr. Overton:

**SUBJECT: Pre-Consultation for Chapter 343, HRF Environmental Assessment**
**Kalia-Fort DeRussy Wastewater System Improvements**
**TMK: (1) 2-6-005: 001 por., Kalia Road, Ala Moana Blvd., Kalakaua Avenue**
(Waikiki, Oahu, Hawaii)

The Department of Health (DOH), Environmental Planning Office (EPO), acknowledges receipt of your letter, dated **June 8, 2012.** Thank you for allowing us to review and comment on the subject document. The document was routed to the various branches of the Environmental Health Administration. We have no comments at this time, but reserve the right to future comments. We strongly recommend that you review all of the Standard Comments on our website: www.hawaii.gov/health/environmental/env-planning/landuse/landuse.html. Any comments specifically applicable to this application should be adhered to.

The United States Environmental Protection Agency (EPA) provides a wealth of information on their website including strategies to help protect our natural environment and build sustainable communities at: http://water.epa.gov/infrastructure/sustain/ . The DOH encourages State and county planning departments, developers, planners, engineers and other interested parties to apply these strategies and environment principles whenever they plan or review new developments or redevelopments projects. We also ask you to share this information with others to increase community awareness on healthy, sustainable community design. If there are any questions about these comments please contact me.

Sincerely,

Laura Leialoha Phillips McIntyre, AICP
Environmental Planning Office Manager
Environmental Health Administration
Department of Heath
919 Ala Moana Blvd., Ste. 312
Honolulu, Hawaii 96814
Phone: 586-4337
Fax: 586-4370
laura.mcintyre@doh.hawaii.gov

GROUP 70
INTERNATIONAL

PRINCIPALS

Francis S. Oda, Arch.D., FAIA, AICP, LEED AP
Norman G.Y. Hong AIA
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Katherine M. MacNeil AIA, LEED AP
Tom Young, MBA AIA
Paul T. Matsuda PE, LEED AP

October 26, 2012

Ms. Laura Leialoha Philips McIntyre, Office Manager
State of Hawaii
Department of Health
Environmental Health Administration
Environmental Planning Office
P.O. Box 3378
Honolulu, HI 96801-3378

**Subject:** Pre-Consultation for Chapter 343, HRS Environmental Assessment
Kalia-Fort DeRussy Wastewater System Improvements
TMK: (1) 2-6-005:001 por., Kalia Road, Ala Moana Blvd., Kalakaua Avenue
(Waikiki, Oahu, Hawaii)

Dear Ms. Mclyntyre:

Thank you for your comment letter dated June 13, 2012 concerning the Pre-Consultation for Chapter 343, HRS Environmental Assessment (EA) for the Kalia-Fort DeRussy Wastewater System Improvements project.

We appreciate the resources you have provided relating to Standard Comments and the Environmental Protection Agency's strategies and principals relating to Water Infrastructure and Moving Toward Sustainability.

We appreciate your participation in the environmental review process. Please contact us if you have questions or require additional information.

Sincerely,
GROUP 70 INTERNATIONAL, INC.

Jeffrey H. Overton, AICP, LEED AP
Principal, Chief Environmental Planner

cc: Jack Pobuk, ENV
Dale Kahehisa-Lam, USAG-HI

NEIL ABERCROMBIE
GOVERNOR OF HAWAII

LORETTA J. FUDDY, A.C.S.W., M.P.H.
DIRECTOR OF HEALTH

**STATE OF HAWAII**
**DEPARTMENT OF HEALTH**
P. O. BOX 3378
HONOLULU, HI 96801-3378

In reply, please refer to:
File:

LUD-1 2 6 005 001-ID1015
Pre-Cons Kalia Road WW Sys Impr

July 6, 2012

RECEIVED

JUL 11 2012

GROUP 70 INTL

Mr. Jeffrey H. Overton, AICP, LEED AP
Principal, Environmental Planner
Group 70 International
925 Bethel Street 5th Floor
Honolulu, Hawaii 96813-4307

Dear Mr. Overton:

Subject: Pre-Consultation for Chapter 343, HRS Environmental Assessment
Kalia-Fort DeRussy Wastewater System Improvements
Kalia Road, Ala Moana Blvd., Kalakaua Avenue, Waikiki, Oahu, Hawaii 96815
TMK (1) 2-6-005: 001

Thank you for allowing us the opportunity to provide comments on the Environmental Assessment that will be prepared for the subject project.

We have no comments to provide at this time since the proposed project involves improvements to the City and County of Honolulu sewer system.

Should you have any questions, please contact the Planning & Design Section of the Wastewater Branch at 586-4294 or fax to 586-4300.

Sincerely,

SINA PRUDER, P.E., ACTING CHIEF
Wastewater Branch

LM:cle

c: DOH-Environmental Planning Office (12-109), Ms. Laura McIntyre
City & County of Honolulu Planning & Permitting Office, Mr. David Tanoue
Hilton Hawaiian Village Beach Resort Spa, Mr. Gerard C. Gibson
United States Army Garrison, Colonel Douglas S. Mulbury

GROUP 70
INTERNATIONAL



October 26, 2012

Ms. Sina Pruder, Acting Chief
State of Hawaii
Department of Health
Wastewater Branch
P.O. Box 3378
Honolulu, HI 96801-3378

**Subject**: Pre-Consultation for Chapter 343, HRS Environmental Assessment
Kalia-Fort DeRussy Wastewater System Improvements
TMK: (1) 2-6-005:001 por., Kalia Road, Ala Moana Blvd., Kalakaua Avenue
(Waikiki, Oahu, Hawaii)

Dear Ms. Pruder:

Thank you for your comment letter dated July 6, 2012 concerning the Pre-Consultation for Chapter 343, HRS Environmental Assessment (EA) for the Kalia-Fort DeRussy Wastewater System Improvements project.

We acknowledge that the Department of Health, Wastewater Branch has no comments on the project since it involves improvements to the City and County of Honolulu sewer system.

We appreciate your participation in the environmental review process. Please contact us if you have questions or require additional information.

Sincerely,
GROUP 70 INTERNATIONAL, INC.

Jeffrey H. Overton, AICP, LEED AP
Principal, Chief Environmental Planner

cc: Jack Pobuk, ENV
Dale Kahehisa-Lam, USAG-HI

NEIL ABERCROMBIE
GOVERNOR OF HAWAII

WILLIAM J. AILA, JR.
CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES
COMMISSION ON WATER RESOURCE MANAGEMENT

**STATE OF HAWAII**
**DEPARTMENT OF LAND AND NATURAL RESOURCES**
**LAND DIVISION**

POST OFFICE BOX 621
HONOLULU, HAWAII 96809

July 6, 2012

Group 70 International, Inc.
Attention: Mr. Jeffrey H. Overton
925 Bethel Street, 5th Floor
Honolulu, Hawaii 96813

via email: KaliaDeRussyWW@Group70int.com

Dear Mr. Overton,

SUBJECT: Pre-Consultation for Chapter 343 Environmental Assessment, Kalia-Fort DeRussy Wastewater System Improvements

Thank you for the opportunity to review and comment on the subject matter. The Department of Land and Natural Resources' (DLNR) Land Division distributed or made available a copy of your report pertaining to the subject matter to DLNR Divisions for their review and comments.

At this time, enclosed are comments from (1) Land Division – Oahu District; (2) Engineering Division; (3) Division of Boating & Ocean Recreation; and (4) Division of Aquatic Resources, on the subject matter. No other comments were received as of our suspense date. The State Historic Preservation Division may be responding to you separately. Should you have any questions, please feel free to call Supervising Land Agent Steve Molmen at 587-0439. Thank you.

Sincerely,

Russell Y. Tsuji
Land Administrator

Enclosure(s)

7206

GROUP 70
INTERNATIONAL





June 8, 2012

**Subject:** Pre-Consultation for Chapter 343, HRS Environmental Assessment
Kālia-Fort DeRussy Wastewater System Improvements
TMK: (1) 2-6-005:001 por., Kālia Road, Ala Moana Blvd., Kalakaua Avenue
(Waikīkī, O'ahu, Hawai'i)



Dear Participant:

On behalf of the City and County of Honolulu, Department of Environmental Services, United States Army Garrison–Hawai'i and Hilton Worldwide, Group 70 International is currently undertaking the preparation of an Environmental Assessment (EA) pursuant to the National Environmental Policy Act (NEPA) and Chapter 343, Hawai'i Revised Statutes (HRS), for the proposed Kālia-Fort DeRussy Wastewater System Improvements, located in Waikīkī, O'ahu, Hawai'i.

A pre-consultation process is being conducted to engage agencies and interested parties in the environmental review process. Enclosed, for your review and comment, is a project information summary and overview of the proposed action.

Please provide comments via telephone, email, fax, or U.S. Mail regarding the scope of this EA. We would like to receive these comments no later than July 9, 2012. Comments received subsequent to this deadline will still be considered.

Group 70 International, Inc.
925 Bethel Street, Fifth Floor
Honolulu, HI 96813-4307
Attn: Jeff Overton
Email: KaliaDeRussyWW@Group70int.com
Tel: (808) 523-5866 Ext. 104
Fax: (808) 523-5874

Thank you for participating in pre-consultation for this environmental review process.

Sincerely,
GROUP 70 INTERNATIONAL, INC.

Jeffrey H. Overton, AICP, LEED AP
Principal, Environmental Planner

Enclosed: Pre-Consultation Handout

NEIL ABERCROMBIE
GOVERNOR OF HAWAII

WILLIAM J. AILA, JR.
CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES
COMMISSION ON WATER RESOURCE MANAGEMENT

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
LAND DIVISION

POST OFFICE BOX 621
HONOLULU, HAWAII 96809

June 13, 2012

**MEMORANDUM**

TO: **DLNR Agencies:**
_X_ Div. of Aquatic Resources
_X_ Div. of Boating & Ocean Recreation
_X_ Engineering Division
___ Div. of Forestry & Wildlife
___ Div. of State Parks
_X_ Commission on Water Resource Management
_X_ Office of Conservation & Coastal Lands
_X_ Land Division – Oahu District
_X_ Historic Preservation

FROM: Russell Y. Tsuji, Land Administrator
SUBJECT: Pre-Consultation for Chapter 343 HRS Environmental Assessment, Kalia-Fort DeRussy Wastewater System Improvements
LOCATION: Kalia Road, Ala Moana Blvd., Kalakaua Avenue (Waikiki, O`ahu, Hawai`i); TMK (1) 2-6-005:001 por.
APPLICANT: Group 70 International, Inc. on behalf of the City and County of Honolulu, Department of Environmental Services, United States Army Garrison-Hawai`i and Hilton Worldwide

Transmitted for your review and comment on the above referenced document. We would appreciate your comments on this document. Please submit any comments by July 5, 2011.

If no response is received by this date, we will assume your agency has no comments. If you have any questions about this request, please contact Supervising Land Agent Steve Molmen at (808) 587-0439. Thank you.

Attachments

( ✓ ) We have no objections.
( ✓ ) We have no comments.
( ) Comments are attached.

Signed: T. Ohye
Date: 6/15/2012

NEIL ABERCROMBIE
GOVERNOR OF HAWAII

2 JUN 15 PM03:09 ENGINEERING

WILLIAM J. AILA, JR.
CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES
COMMISSION ON WATER RESOURCE MANAGEMENT

Department of Land and Natural Resources
State of Hawaii

**STATE OF HAWAII**
**DEPARTMENT OF LAND AND NATURAL RESOURCES**
**LAND DIVISION**

POST OFFICE BOX 621
HONOLULU, HAWAII 96809

June 13, 2012

**MEMORANDUM**

TO: **DLNR Agencies:**
_X_ Div. of Aquatic Resources
_X_ Div. of Boating & Ocean Recreation
_X_ Engineering Division
___ Div. of Forestry & Wildlife
___ Div. of State Parks
_X_ Commission on Water Resource Management
_X_ Office of Conservation & Coastal Lands
_X_ Land Division – Oahu District
_X_ Historic Preservation

FROM: Russell Y. Tsuji, Land Administrator
SUBJECT: Pre-Consultation for Chapter 343 HRS Environmental Assessment, Kalia-Fort DeRussy Wastewater System Improvements
LOCATION: Kalia Road, Ala Moana Blvd., Kalakaua Avenue (Waikiki, O`ahu, Hawai`i); TMK (1) 2-6-005:001 por.
APPLICANT: Group 70 International, Inc. on behalf of the City and County of Honolulu, Department of Environmental Services, United States Army Garrison-Hawai`i and Hilton Worldwide

Transmitted for your review and comment on the above referenced document. We would appreciate your comments on this document. Please submit any comments by July 5, 2011.

If no response is received by this date, we will assume your agency has no comments. If you have any questions about this request, please contact Supervising Land Agent Steve Molmen at (808) 587-0439. Thank you.

Attachments

( ) We have no objections.
( ) We have no comments.
( X ) Comments are attached.

Signed: ____________
Date: 4/20/16

**DEPARTMENT OF LAND AND NATURAL RESOURCES**
**ENGINEERING DIVISION**

**LD/SteveMolmen**
**Ref.: PreConEAKaliaFortDeRussy**
**Oahu.898**

**COMMENTS**

(X) **We confirm that the project site, according to the Flood Insurance Rate Map (FIRM), is located in Flood Zones AE and AO. The National Flood Insurance Program does regulate developments within Zones AE and AO as indicated in bold letters below.**

( ) Please take note that the project site, according to the Flood Insurance Rate Map (FIRM), is located in Zone ___.

( ) Please note that the correct Flood Zone Designation for the project site according to the Flood Insurance Rate Map (FIRM) is ___.

(X) **Please note that the project site must comply with the rules and regulations of the National Flood Insurance Program (NFIP) presented in Title 44 of the Code of Federal Regulations (44CFR), whenever development within a Special Flood Hazard Area is undertaken. If there are any questions, please contact the State NFIP Coordinator, Ms. Carol Tyau-Beam, of the Department of Land and Natural Resources, Engineering Division at (808) 587-0267.**

**Please be advised that 44CFR indicates the minimum standards set forth by the NFIP. Your Community's local flood ordinance may prove to be more restrictive and thus take precedence over the minimum NFIP standards. If there are questions regarding the local flood ordinances, please contact the applicable County NFIP Coordinators below:**

(X) **Mr. Mario Siu Li at (808) 768-8098 or Ms. Ardis Shaw-Kim at (808) 768-8296 of the City and County of Honolulu, Department of Planning and Permitting.**

( ) Mr. Frank DeMarco at (808) 961-8042 of the County of Hawaii, Department of Public Works.

( ) Mr. Francis Cerizo at (808) 270-7771 of the County of Maui, Department of Planning.

( ) Mr. Wynne Ushigome at (808) 241-4890 of the County of Kauai, Department of Public Works.

( ) The applicant should include project water demands and infrastructure required to meet water demands. Please note that the projects requiring water service from the Honolulu Board of Water Supply system will be required to pay a resource development charge, in addition to Water Facilities Charges for transmission and daily storage.

( ) The applicant should provide the water demands and calculations to the Engineering Division so it can be included in the State Water Projects Plan Update.

( ) Additional Comments: ______________________________

( ) Other: ______________________________

Should you have any questions, please call Ms. Suzie S. Agraan the Planning Branch at 587-0258.

Signed: ______________________________
CARTY S. CHANG, CHIEF ENGINEER

Date: 6/20/12

NEIL ABERCROMBIE
GOVERNOR OF HAWAII

WILLIAM J. AILA, JR.
CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES
COMMISSION ON WATER RESOURCE MANAGEMENT

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LAND DIVISION

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DEPT. OF LAND &
NATURAL RESOURCES
STATE OF HAWAII

**STATE OF HAWAII**
**DEPARTMENT OF LAND AND NATURAL RESOURCES**
**LAND DIVISION**

POST OFFICE BOX 621
HONOLULU, HAWAII 96809

June 13, 2012

**MEMORANDUM**

TO: **DLNR Agencies:**
- _X_ Div. of Aquatic Resources
- _X_ Div. of Boating & Ocean Recreation
- _X_ Engineering Division
- __ Div. of Forestry & Wildlife
- __ Div. of State Parks
- _X_ Commission on Water Resource Management
- _X_ Office of Conservation & Coastal Lands
- _X_ Land Division – Oahu District
- _X_ Historic Preservation

FROM: Russell Y. Tsuji, Land Administrator

SUBJECT: Pre-Consultation for Chapter 343 HRS Environmental Assessment, Kalia-Fort DeRussy Wastewater System Improvements

LOCATION: Kalia Road, Ala Moana Blvd., Kalakaua Avenue (Waikiki, O`ahu, Hawai`i); TMK (1) 2-6-005:001 por.

APPLICANT: Group 70 International, Inc. on behalf of the City and County of Honolulu, Department of Environmental Services, United States Army Garrison-Hawai`i and Hilton Worldwide

Transmitted for your review and comment on the above referenced document. We would appreciate your comments on this document. Please submit any comments by July 5, 2011.

If no response is received by this date, we will assume your agency has no comments. If you have any questions about this request, please contact Supervising Land Agent Steve Molmen at (808) 587-0439. Thank you.

Attachments

( ) We have no objections.
(X) We have no comments.
( ) Comments are attached.

Signed: [signature]
Date: 6/21/12

AMX

NEIL ABERCROMBIE
GOVERNOR OF HAWAII

WILLIAM J. AILA, JR.
CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES
COMMISSION ON WATER RESOURCE MANAGEMENT

**STATE OF HAWAII**
**DEPARTMENT OF LAND AND NATURAL RESOURCES**
**LAND DIVISION**

POST OFFICE BOX 621
HONOLULU, HAWAII 96809

June 13, 2012

## MEMORANDUM

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RECEIVED
LAND DIVISION
2012 JUN 21 A 10:25
DEPT. OF LAND & NATURAL RESOURCES STATE OF HAWAII

RECEIVED
JUN 18 2012
AQUATIC RESOURCES

TO: **DLNR Agencies:**
_X_ Div. of Aquatic Resources
_X_ Div. of Boating & Ocean Recreation
_X_ Engineering Division
___ Div. of Forestry & Wildlife
___ Div. of State Parks
_X_ Commission on Water Resource Management
_X_ Office of Conservation & Coastal Lands
_X_ Land Division – Oahu District
_X_ Historic Preservation

FROM: Russell Y. Tsuji, Land Administrator
SUBJECT: Pre-Consultation for Chapter 343 HRS Environmental Assessment, Kalia-Fort DeRussy Wastewater System Improvements
LOCATION: Kalia Road, Ala Moana Blvd., Kalakaua Avenue (Waikiki, O`ahu, Hawai`i); TMK (1) 2-6-005:001 por.
APPLICANT: Group 70 International, Inc. on behalf of the City and County of Honolulu, Department of Environmental Services, United States Army Garrison-Hawai`i and Hilton Worldwide

Transmitted for your review and comment on the above referenced document. We would appreciate your comments on this document. Please submit any comments by July 5, 2011.

If no response is received by this date, we will assume your agency has no comments. If you have any questions about this request, please contact Supervising Land Agent Steve Molmen at (808) 587-0439. Thank you.

Attachments

( ) We have no objections.
( X ) We have no comments.
( ) Comments are attached.

Signed: [signature]
Date: 26 June 2012

GROUP 70
INTERNATIONAL

PRINCIPALS

Francis S. Oda, Arch.D., FAIA, AICP, LEED AP
Norman G.Y. Hong AIA
Sheryl B. Seaman AIA, ASID, LEED AP
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Paul T. Matsuda PE, LEED AP

October 26, 2012

Russell Y. Tsuji, Land Administrator
State of Hawaii
Department of Land and Natural Resources
Land Division
Post Office Box 621
Honolulu, HI 96809

**Subject**: Pre-Consultation for Chapter 343, HRS Environmental Assessment
Kalia-Fort DeRussy Wastewater System Improvements
TMK: (1) 2-6-005:001 por., Kalia Road, Ala Moana Blvd., Kalakaua Avenue
(Waikiki, Oahu, Hawaii)

Dear Mr. Tsuji:

Thank you for your comment letter dated July 6, 2012 concerning the Pre-Consultation for Chapter 343, HRS Environmental Assessment (EA) for the Kalia-Fort DeRussy Wastewater System Improvements project.

We acknowledge that the Department of Land and Natural Resources, Land Division, has no comments on the subject matter other than comments from the Land Division – Oahu District, Engineering Division, Division of Boating & Ocean Recreation, and Division of Aquatic Resources. We will respond to the comments of each division in separate correspondences.

We appreciate your participation in the environmental review process. Please contact us if you have questions or require additional information.

Sincerely,
GROUP 70 INTERNATIONAL, INC.

Jeffrey H. Overton, AICP, LEED AP
Principal, Chief Environmental Planner

cc: Jack Pobuk, ENV
Dale Kahehisa-Lam, USAG-HI

GROUP 70
INTERNATIONAL

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Tom Young, MBA AIA
Paul T. Matsuda PE, LEED AP

October 26, 2012

Mr. Timothy Chee
State of Hawaii
Department of Land and Natural Resources
Land Division – Oahu District
Post Office Box 621
Honolulu, HI 96809

**Subject**: Pre-Consultation for Chapter 343, HRS Environmental Assessment
Kalia-Fort DeRussy Wastewater System Improvements
TMK: (1) 2-6-005:001 por., Kalia Road, Ala Moana Blvd., Kalakaua Avenue
(Waikiki, Oahu, Hawaii)

Dear Mr. Chee:

Thank you for your comment letter dated June 13, 2012 concerning the Pre-Consultation for Chapter 343, HRS Environmental Assessment (EA) for the Kalia-Fort DeRussy Wastewater System Improvements project.

We acknowledge that the Department of Land and Natural Resources, Land Division – Oahu District has no comments to offer at this time.

We appreciate your participation in the environmental review process. Please contact us if you have questions or require additional information.

Sincerely,
GROUP 70 INTERNATIONAL, INC.

Jeffrey H. Overton, AICP, LEED AP
Principal, Chief Environmental Planner

cc: Jack Pobuk, ENV
Dale Kahehisa-Lam, USAG-HI

Group 70 International • 925 Bethel Street, 5th Floor • Honolulu, HI 96813-4307 • tel. 808.523.5866 • fax. 808.523.5874 • www.group70int.com

GROUP 70
INTERNATIONAL

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Paul T. Matsuda PE, LEED AP

October 26, 2012

Mr. Carty Chang, Chief Engineer
State of Hawaii
Department of Land and Natural Resources
Engineering Division
Post Office Box 621
Honolulu, HI 96809

**Subject**: Pre-Consultation for Chapter 343, HRS Environmental Assessment
Kalia-Fort DeRussy Wastewater System Improvements
TMK: (1) 2-6-005:001 por., Kalia Road, Ala Moana Blvd., Kalakaua Avenue
(Waikiki, Oahu, Hawaii)

Dear Mr. Chee:

Thank you for your comment letter dated June 13, 2012 concerning the Pre-Consultation for Chapter 343, HRS Environmental Assessment (EA) for the Kalia-Fort DeRussy Wastewater System Improvements project.

We are aware that according to the Flood Insurance Rate Map (FIRM), the project site is located in Zones AE and AO, area which are regulated by the National Flood Insurance Program (NFIP). The project improvements will be comply with the rules and regulations of the NFIP presented in Title 44 of the Code of Federal Regulations (44CFR) as noted in *Section 3.8* of the Draft EA.

We appreciate your participation in the environmental review process. Please contact us if you have questions or require additional information.

Sincerely,
GROUP 70 INTERNATIONAL, INC.

Jeffrey H. Overton, AICP, LEED AP
Principal, Chief Environmental Planner

cc: Jack Pobuk, ENV
Dale Kahehisa-Lam, USAG-HI

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Katherine M. MacNeil AIA, LEED AP
Tom Young, MBA AIA
Paul T. Matsuda PE, LEED AP

October 26, 2012

Mr. Edward Underwood, Administrator
State of Hawaii
Department of Land and Natural Resources
Division of Boating & Ocean Recreation
Post Office Box 621
Honolulu HI 96809

**Subject**: Pre-Consultation for Chapter 343, HRS Environmental Assessment
Kalia-Fort DeRussy Wastewater System Improvements
TMK: (1) 2-6-005:001 por., Kalia Road, Ala Moana Blvd., Kalakaua Avenue
(Waikiki, Oahu, Hawaii)

Dear Mr. Underwood:

Thank you for your comment letter dated June 13, 2012 concerning the Pre-Consultation for Chapter 343, HRS Environmental Assessment (EA) for the Kalia-Fort DeRussy Wastewater System Improvements project.

We acknowledge that the Department of Land and Natural Resources, Division of Boating & Ocean Recreation has no comments to offer at this time.

We appreciate your participation in the environmental review process. Please contact us if you have questions or require additional information.

Sincerely,
GROUP 70 INTERNATIONAL, INC.

Jeffrey H. Overton, AICP, LEED AP
Principal, Chief Environmental Planner

cc: Jack Pobuk, ENV
Dale Kahehisa-Lam, USAG-HI

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Paul T. Matsuda PE, LEED AP

October 26, 2012

Administrator
State of Hawaii
Department of Land and Natural Resources
Division of Aquatic Resources
Post Office Box 621
Honolulu, HI 96809

**Subject**: Pre-Consultation for Chapter 343, HRS Environmental Assessment
Kalia-Fort DeRussy Wastewater System Improvements
TMK: (1) 2-6-005:001 por., Kalia Road, Ala Moana Blvd., Kalakaua Avenue
(Waikiki, Oahu, Hawaii)

Dear Administrator:

Thank you for your comment letter dated June 13, 2012 concerning the Pre-Consultation for Chapter 343, HRS Environmental Assessment (EA) for the Kalia-Fort DeRussy Wastewater System Improvements project.

We acknowledge that the Department of Land and Natural Resources, Division of Aquatic Resources has no comments to offer at this time.

We appreciate your participation in the environmental review process. Please contact us if you have questions or require additional information.

Sincerely,
GROUP 70 INTERNATIONAL, INC.

Jeffrey H. Overton, AICP, LEED AP
Principal, Chief Environmental Planner

cc: Jack Pobuk, ENV
Dale Kahehisa-Lam, USAG-HI

NEIL ABERCROMBIE
GOVERNOR

GLENN M. OKIMOTO
DIRECTOR

Deputy Directors
JADE T. BUTAY
FORD N. FUCHIGAMI
RANDY GRUNE
JADINE URASAKI

STATE OF HAWAII
DEPARTMENT OF TRANSPORTATION
869 PUNCHBOWL STREET
HONOLULU, HAWAII 96813-5097

IN REPLY REFER TO:

STP 8.0893

June 25, 2012

Group 70 International
925 Bethel Street, Fifth Floor
Honolulu, Hawaii 96813-4307

RECEIVED
JUL - 5 2012
GROUP 70 INTL

Attn: Jeff Overton

Dear Mr. Overton:

Subject: Kalia-Fort DeRussy Wastewater System Improvements Pre-Consultation for Environmental Assessment (EA) TMK: (1) 2-6-005:001

Thank you for requesting State Department of Transportation's (DOT) review of the subject project. DOT understands the City and County of Honolulu, Department of Environmental Services, United States Army Garrison-Hawaii and Hilton Worldwide propose to replace approximately 2,600 linear feet of gravity sewer line. The subject project will help the City meet the 2010 Wastewater Consent Decree by upgrading the wastewater system by 2020 to accommodate projected 2030 peak wet weather flows. The project will also provide capacity for the Hilton Hawaiian Village Master Plan improvements.

Given that the subject project could impact nearby State highways, such as Ala Moana Boulevard, DOT offers the following comments:

The use of construction vehicles and heavy equipment that will be used at the job site will require a permit from the DOT Highways Division to transport oversized and overweight equipment and loads within the State highway facilities.

Construction plans for all work done within the State highway right-of-way is required to be submitted to the DOT Highways Division for review and approval.

DOT appreciates the opportunity to provide comments. If there are any questions, including the need to meet with DOT Highways Division staffs, please contact Mr. Garrett Smith of the DOT Statewide Transportation Planning Office at telephone number (808) 831-7976.

Very truly yours,

GLENN M. OKIMOTO, Ph.D.
Director of Transportation

GROUP 70
INTERNATIONAL



October 26, 2012

Glenn Okimoto, Ph.D.
Director of Transportation
State of Hawaii
Department of Transportation
869 Punchbowl Street
Honolulu, HI 96813-5097

**Subject**: Pre-Consultation for Chapter 343, HRS Environmental Assessment
Kalia-Fort DeRussy Wastewater System Improvements
TMK: (1) 2-6-005:001 por., Kalia Road, Ala Moana Blvd., Kalakaua Avenue
(Waikiki, Oahu, Hawaii)

Dear Dr. Okimoto:

Thank you for your comment letter dated June 25, 2012 concerning the Pre-Consultation for Chapter 343, HRS Environmental Assessment (EA) for the Kalia-Fort DeRussy Wastewater System Improvements project. The following responses are offered to your comments.

The contractor will obtain the proper permits required for the transport of oversized/overweight equipment and loads within State highway facilities. The contractor will adhere to the individual permit conditions relating to State Highway operations.

At the appropriate time, construction plans will be submitted to the Department of Transportation, Highways Division for work done within the State highway right-of-way.

We appreciate your participation in the environmental review process. Please contact us if you have questions or require additional information.

Sincerely,
GROUP 70 INTERNATIONAL, INC.

Jeffrey H. Overton, AICP, LEED AP
Principal, Chief Environmental Planner

cc: Jack Pobuk, ENV
Dale Kahehisa-Lam, USAG-HI

PHONE (808) 594-1888

FAX (808) 594-1865

**STATE OF HAWAI'I**
**OFFICE OF HAWAIIAN AFFAIRS**
711 KAPI'OLANI BOULEVARD, SUITE 500
HONOLULU, HAWAI'I 96813

HRD12_6311B

June 26, 2012

Jeffrey H. Overton, Principal
Group 70 International, Inc.
925 Bethal Street, 5th Floor
Honolulu, Hawai'i 96813-4307

RECEIVED

JUL - 3 2012

GROUP 70 INTL

Re: Pre-Environmental Assessment consultation
Fort DeRussy Wastewater System Improvements Project
Waikīkī, Island of O'ahu

Dear Jeffrey H. Overton:

The Office of Hawaiian Affairs (OHA) is in receipt of your June 8, 2012 letter with enclosures seeking comments ahead of an environmental assessment (EA) that will be prepared to support a wastewater system improvements project (project) that is proposed by the Hilton Hawaiian Village Beach Resort and Spa in Waikīkī on the Island of O'ahu. Project activities will replace approximately 2, 600 linear feet of existing gravity sewer line extending along Kālia Road, Ala Moana Boulevard and Kalākaua Avenue. Equipment upgrades at the Fort DeRussy Wastewater Pump Station will also be completed. The project will contribute to meeting a 2010 Environmental Protection Agency Consent Decree to upgrade the Fort DeRussy Wastewater System (system) to accommodate 2030 projected peak flows.

A portion of the project extends over lands that are currently under the control of the Department of the Army-United States Army Garrison, Hawai'i (USAG-HI). This Federal nexus serves as the "trigger" for applicable Federal laws including, but not necessarily limited to the National Environmental Policy Act (NEPA) and the National Historic Preservation Act (NHPA). It is our understanding the forthcoming EA will be in compliance with the applicable requirements of the NEPA and Chapter 343, Hawaii Revised Statutes.

Existing documentation from separate projects conducted in the area detail the presence of burials and cultural deposits in the vicinity of the instant project area. Thus, it appears that archaeological monitoring of all project activities is warranted.

In the event iwi kūpuna, cultural items, or sub-surface cultural deposits are encountered during any ground disturbing activities associated with this project, OHA will expect all work in the immediate vicinity of the discovery to immediately cease and the appropriate agencies, organizations or individuals notified and afforded the opportunity to participate in consultation to determine appropriate treatment pursuant to the requirements of applicable Federal or State law.

Overall, OHA recognizes that the intent of this project is the complete necessary improvements and upgrades to the system to ensure adequate protections for both natural and cultural resources (which in traditional Hawaiian thinking are one and the same). We look forward to seeing the project completed. Thank you for seeking comments at this early stage and we look forward to reviewing the EA and providing additional comments at that time. Should you have any questions, please contact Keola Lindsey at 594-0244 or keolal@oha.org.

ʻO wau iho nō me ka ʻoiaʻiʻo,

Kamana'opono M. Crabbe, Ph.D.
Ka Pouhana, Chief Executive Officer

KM:kl

GROUP 70
INTERNATIONAL



October 26, 2012

Kamanaopono M. Crabbe, Ph.D.
Ka Pouhana, Chief Executive Officer
State of Hawaii
Office of Hawaiian Affairs
711 Kapiolani Boulevard, Suite 500
Honolulu, HI 96813

**Subject**: Pre-Consultation for Chapter 343, HRS Environmental Assessment
Kalia-Fort DeRussy Wastewater System Improvements
TMK: (1) 2-6-005:001 por., Kalia Road, Ala Moana Blvd., Kalakaua Avenue
(Waikiki, Oahu, Hawaii)

Dear Dr. Crabbe:

Thank you for your comment letter dated June 26, 2012 concerning the Pre-Consultation for Chapter 343, HRS Environmental Assessment (EA) for the Kalia-Fort DeRussy Wastewater System Improvements project.

The forth coming EA will be incompliance with the applicable requirements of the National Environmental Policy Act (NEPA) and Chapter 343, Hawaii Revised Statues. The presence of historic, cultural and archaeological resources has been evaluated for proposed project, and is addressed in Draft EA, *Section 2.13* and *Appendix H and I*. As detailed in existing documentation, the proposed project improvements are located in a sensitive cultural area. Therefore, archeological monitoring will be carried out during construction of the sewer line improvements. Representatives of the City, Army, and Hilton have worked closely with cultural community and lineal descendants of the Kalia area to formulate a Plan of Action for the treatment of cultural resources that may be affected by the construction of this sewer system improvement. In the event that iwi kupuna, cultural items, or sub-surface cultural deposits are encountered during ground disturbing activities associated with the project, work in the immediate vicinity of the discovery will immediately cease and the appropriate agencies, organizations and/ or individuals will be notified.

We appreciate your participation in the environmental review process. Please contact us if you have questions or require additional information.

Sincerely,
GROUP 70 INTERNATIONAL, INC.

Jeffrey H. Overton, AICP, LEED AP
Principal, Chief Environmental Planner

cc: Jack Pobuk, ENV
Dale Kahehisa-Lam, USAG-HI

**BOARD OF WATER SUPPLY**

CITY AND COUNTY OF HONOLULU
630 SOUTH BERETANIA STREET
HONOLULU, HI 96843

June 28, 2012



RECEIVED

JUL - 3 2012

GROUP 70 INTL

Mr. Jeffrey H. Overton, AICP, LEED AP
Group 70 International, Inc.
925 Bethel Street, Fifth Floor
Honolulu, Hawaii 96813-4307

Dear Mr. Overton:

Subject: Your Letter Dated June 8, 2012 Requesting Comments on the Environmental Assessment for Kalia-Fort DeRussy Wastewater System Improvements, TMK: 2-6-5:1

Thank you for the opportunity to comment on the proposed wastewater system improvements project.

The construction drawings should be submitted for our review.

The construction schedule should be coordinated to minimize impact to the water system.

If you have any questions, please contact Robert Chun at 748-5443.

Very truly yours,

Susan Uyesugi

SUSAN UYESUGI
Program Administrator
Customer Care Division

GROUP 70
INTERNATIONAL



October 26, 2012

Susan Uyesugi, Program Administrator
City and County of Honolulu
Board of Water Supply
630 South Beretania Street
Honolulu, HI 96843

**Subject**: Pre-Consultation for Chapter 343, HRS Environmental Assessment
Kalia-Fort DeRussy Wastewater System Improvements
TMK: (1) 2-6-005:001 por., Kalia Road, Ala Moana Blvd., Kalakaua Avenue
(Waikiki, Oahu, Hawaii)

Dear Ms. Uyesugi:

Thank you for your comment letter dated June 28, 2012 concerning the Pre-Consultation for Chapter 343, HRS Environmental Assessment (EA) for the Kalia-Fort DeRussy Wastewater System Improvements project.

Construction drawings will be submitted for your review at the appropriate time. A construction schedule will also be coordinated to minimize impacts to the water system.

We appreciate your participation in the environmental review process. Please contact us if you have questions or require additional information.

Sincerely,
GROUP 70 INTERNATIONAL, INC.

Jeffrey H. Overton, AICP, LEED AP
Principal, Chief Environmental Planner

cc: Jack Pobuk, ENV
Dale Kahehisa-Lam, USAG-HI

DEPARTMENT OF DESIGN AND CONSTRUCTION
CITY AND COUNTY OF HONOLULU
650 SOUTH KING STREET, 11TH FLOOR
HONOLULU, HAWAII 96813
Phone: (808) 768-8480 • Fax: (808) 768-4567
Web site: www.honolulu.gov

PETER B. CARLISLE
MAYOR

LORI M.K. KAHIKINA, P.E.
DIRECTOR

CHRIS TAKASHIGE, P.E.
DEPUTY DIRECTOR

RECEIVED

JUL - 9 2012

GROUP 70 INTL

July 6, 2012

Jeffrey Overton, AICP, LEED AP
Group 70 International, INC.
925 Bethel Street, 5th Floor
Honolulu, Hawaii 96813-4307

Dear Mr. Overton:

Pre- Consultation for Chapter 343, HRS Environmental Assessment
Kalia- Fort DeRussy Wastewater System Improvements
TMK: (1) 2-6-005:001 por., Kalia Road, Ala Maona Blvd., Kalakaua Ave.

Thank you for the opportunity to review and comment.

The Department of Design and Construction has no comments on this project. Should you have any questions, please contact me at 768-8480.

Sincerely,

Lori M. K. Kahikina P.E.
Director

LMKK:pg(470700)

GROUP 70
INTERNATIONAL

PRINCIPALS

Francis S. Oda, Arch.D., FAIA, AICP, LEED AP
Norman G.Y. Hong AIA
Sheryl B. Seaman AIA, ASID, LEED AP
Hitoshi Hida AIA
Roy H. Nihei AIA, CSI, LEED AP
Ralph E. Portmore AICP
James I. Nishimoto AIA
Stephen Yuen AIA
Linda C. Miki AIA
George I. Atta AICP, LEED AP
Charles Y. Kaneshiro AIA, LEED AP
Jeffrey H. Overton AICP, LEED AP
Christine Mendes Ruotola AICP, LEED AP
James L. Stone, Arch.D., AIA, LEED AP
Katherine M. MacNeil AIA, LEED AP
Tom Young, MBA AIA
Paul T. Matsuda PE, LEED AP

October 26, 2012

Lori M. K. Kahikina P.E., Director
City and County of Honolulu
Department of Design and Construction
650 South King Street, 11th Floor
Honolulu, HI 96813

**Subject**: Pre-Consultation for Chapter 343, HRS Environmental Assessment
Kalia-Fort DeRussy Wastewater System Improvements
TMK: (1) 2-6-005:001 por., Kalia Road, Ala Moana Blvd., Kalakaua Avenue
(Waikiki, Oahu, Hawaii)

Dear Ms. Kahikina:

Thank you for your comment letter dated July 6, 2012 concerning the Pre-Consultation for Chapter 343, HRS Environmental Assessment (EA) for the Kalia-Fort DeRussy Wastewater System Improvements project.

We acknowledge the Department of Design and Construction has no comments on the project.

We appreciate your participation in the environmental review process. Please contact us if you have questions or require additional information.

Sincerely,
GROUP 70 INTERNATIONAL, INC.

Jeffrey H. Overton, AICP, LEED AP
Principal, Chief Environmental Planner

cc: Jack Pobuk, ENV
Dale Kahehisa-Lam, USAG-HI

DEPARTMENT OF FACILITY MAINTENANCE

**CITY AND COUNTY OF HONOLULU**

1000 ULUOHIA STREET, KAPOLEI HALE, SUITE 215, KAPOLEI, HAWAII 96707
TELEPHONE: (808) 768-3343 FAX: (808) 768-3381
Website: www.honolulu.gov

PETER B. CARLISLE
MAYOR

WESTLEY K.C. CHUN, Ph.D., P.E., BCEE
DIRECTOR & CHIEF ENGINEER

KENNETH A. SHIMIZU
DEPUTY DIRECTOR

IN REPLY REFER TO:
DRM 12-535

RECEIVED

JUL - 2 2012

GROUP 70 INTL

June 28, 2012

Group 70 International, Inc.
925 Bethel Street, Fifth Floor
Honolulu, HI 96813-4307

Attention: Jeff Overton

Subject: Pre-Consultation for Chapter 343, HRS Environmental Assessment for Kalia-Fort DeRussy Wastewater System Improvements TMK: 2-6-005:001 por., Kalia Road, Ala Moana Boulevard, Kalakaua Avenue, Waikiki.

Thank you very much for allowing us the opportunity to review the pre-consultation for the subject project assessment. Our only comment is that you be aware of the 18-inch and 24-inch drain lines in Kalia Road, between Ala Moana Boulevard and Paoa Place.

Should you have any questions, please contact Thomas Takeuchi of the Division of Road Maintenance, at 768-3608.

Sincerely,

Westley K.C. Chun, Ph.D., P.E., BCEE
Director and Chief Engineer

GROUP 70
INTERNATIONAL



October 26, 2012

Westley K.C. Chun, Ph.D., P.E., BCEE
Director and Chief Engineer
City and County of Honolulu
Department of Facility Maintenance
1000 Uluohia Street
Kapolei Hale, Suite 215
Kapolei, HI 96707

**Subject**: Pre-Consultation for Chapter 343, HRS Environmental Assessment
Kalia-Fort DeRussy Wastewater System Improvements
TMK: (1) 2-6-005:001 por., Kalia Road, Ala Moana Blvd., Kalakaua Avenue
(Waikiki, Oahu, Hawaii)

Dear Dr. Chun:

Thank you for your comment letter dated June 28, 2012 concerning the Pre-Consultation for Chapter 343, HRS Environmental Assessment (EA) for the Kalia-Fort DeRussy Wastewater System Improvements project.

The project team is aware of the 18-inch and 24-inch drain lines in Kalia Road, between Ala Moana Boulevard and Paoa Place. We have engaged Belt Collins to conduct the Preliminary Engineering assessment and design for the proposed wastewater system improvements. The design and construction activities will take measures to avoid impacts to the City's drainage infrastructure during construction.

We appreciate your participation in the environmental review process. Please contact us if you have questions or require additional information.

Sincerely,
GROUP 70 INTERNATIONAL, INC.

Jeffrey H. Overton, AICP, LEED AP
Principal, Chief Environmental Planner

cc: Jack Pobuk, ENV
Dale Kahehisa-Lam, USAG-HI

DEPARTMENT OF PLANNING AND PERMITTING
**CITY AND COUNTY OF HONOLULU**
650 SOUTH KING STREET, 7TH FLOOR • HONOLULU, HAWAII 96813
TELEPHONE: (808) 768-8000 • FAX: (808) 768-6041
DEPT. WEB SITE: www.honoluludpp.org • CITY WEB SITE: www.honolulu.gov

PETER B. CARLISLE
MAYOR

DAVID K. TANOUE
DIRECTOR

JIRO A. SUMADA
DEPUTY DIRECTOR

RECEIVED 2012/ELOG-1167(JS)

JUN 26 2012

GROUP 70 INTL

June 25, 2012

Mr. Jeffrey H. Overton
Group 70 International, Inc.
925 Bethel Street, Fifth Floor
Honolulu, Hawaii 96813

Dear Mr. Overton:

Subject: Pre-Assessment Consultation for Chapter 343, Hawaii Revised Statutes (HRS)
Kalia-Fort DeRussy Wastewater System Improvements
Fort DeRussy, Kalia Road, Ala Moana Boulevard and Kalakaua Avenue - Waikiki
Tax Map Key 2-6-5: por. of 1

Thank you for the opportunity to comment on the above proposed project. The project area is located within the Public and Resort Mixed Use Precincts of the Waikiki Special District. Based on your brief project description and conceptual site plan, we have the following comments:

1. The Fort DeRussy site is designated as the "Artillery District of Honolulu" and is listed on the National Register of Historic Places. The proposal shall be reviewed by the Advisory Council on Historic Preservation and State Historic Preservation Officer.

2. Indicate whether Federal funds will be utilized.

3. A portion of the project area is located in a "High Cultural Sensitivity" area as determined by the State Historic Preservation Division. The Draft Environmental Assessment shall include a discussion on the identification and treatment of historic burials and findings.

4. The entire project area is within the Waikiki Special District. A special district permit will be required for the removal or relocation of any trees with a trunk diameter of six inches or greater.

5. The Class of Action for Chapter 343, HRS shall include "use of historic site or district" and "use of land in the Waikiki district."

6. The project information indicates that the project area is not within the Special Management Area (SMA). Show the limits of the SMA to confirm that the project is not subject to the provisions of Chapter 25 of the Revised Ordinances of Honolulu, related to the SMA.

If you have any questions, please contact Joyce Shoji of our Urban Design Branch at 768-8032.

Very truly yours,

Anthony X. Ching

for David K. Tanoue, Director
Department of Planning and Permitting

DKT:nw

Doc. 944193

GROUP 70
INTERNATIONAL



October 26, 2012

Mr. Jiro A. Sumada, Acting Director
City and County of Honolulu
Department of Planning and Permitting
650 South King Street, 7th Floor
Honolulu, HI 96813

**Subject**: Pre-Consultation for Chapter 343, HRS Environmental Assessment
Kalia-Fort DeRussy Wastewater System Improvements
TMK: (1) 2-6-005:001 por., Kalia Road, Ala Moana Blvd., Kalakaua Avenue
(Waikiki, Oahu, Hawaii)

Dear Mr. Sumada:

Thank you for your comment letter dated June 25, 2012 concerning the Pre-Consultation for Chapter 343, HRS Environmental Assessment (EA) for the Kalia-Fort DeRussy Wastewater System Improvements project. The following responses are offered to your comments.

1. **Artillery District of Honolulu**. As you have noted, a portion of the proposed improvements are located in the "Artillery District of Honolulu" as listed on the National Register of Historic Places. The project will be reviewed by the Advisory Council on Historic Preservation and the State Historic Preservation Officer.

2. **Federal Funds**. Federal funding will not be used for this sewer project. Hilton will fund the design and construction costs of the project and transfer the completed project to the City and County of Honolulu.

3. **"High Cultural Sensitivity" area**. We understand the proposed project improvements are located in a "High Cultural Sensitivity" area as determined by SHPD. The presence of cultural resources as well as Native Hawaiian burials has been evaluated for the proposed project, and addressed in the Draft EA, *Section 2.13* and *Appendix I*. Please note that Hilton, the U.S. Army Garrison-Hawaii (USAG-HI), the County ENV, and its consultants have been closely coordinating and consulting with the State Historic Preservation Division (SHPD), the Oahu Island Burial Council, and State-recognized cultural descendants to Kalia and the greater Waikiki ahupuaa. As this project traverses across Federal and non-Federal lands, the fulfillment of consultation and mitigation commitments under applicable cultural resource management regulations will be met. These applicable regulations include: Section 106 consultation under the National Historic Preservation Act; consultation and development of a Plan of Action regarding the treatment and disposition of cultural resources, including ancestral human remains, as identified under the Native American Graves Protection and Repatriations Act; if necessary, permit acquisition to conduct an archaeological investigation under the Archaeological Resources Protection Act; the completion of the State historic preservation review process as outlined under HRS 6E-42 (review of proposed projects);

and if applicable, compliance to 6E-43 (prehistoric and historic burial sites), and 6E-43.6 (inadvertent discovery of burial sites).

4. **Special District Permit.** Your comment has been noted. An inventory of trees in the vicinity of the project was completed by Landscape Architect Shelli McCelvey. We have also engaged Steve Nimz, Certified Arborist, to conduct a tree assessment to addresses major trees and palms that may be affected by the project improvements. A Special District Permit will be obtained for the removal or relocation of trees with a trunk diameter of six (6) inches or greater.

5. **Class of Action**. Your comment has been noted. The Class of Action for Chapter 343, HRS will include "use of historic site or district" and "use of land in the Waikiki district" in the Draft EA.

6. **Special Management Area**. The proposed sewer line improvements are not located in the Special Management Area as designated by the City and County of Honolulu. Please refer to *Figure 1-6* of the Draft EA. There are existing laterals extending along Kalia Road from Hilton Hawaiian Village to the Kalia Road gravity sewers which cross through the SMA. These services laterals will be replaced in this project.

We appreciate the efforts of your review and input during the environmental review process. Please contact us if you have questions or require additional information.

Sincerely,
GROUP 70 INTERNATIONAL, INC.

Jeffrey H. Overton, AICP, LEED AP
Principal, Chief Environmental Planner

cc: Jack Pobuk, ENV
Dale Kahehisa-Lam, USAG-HI

DEPARTMENT OF TRANSPORTATION SERVICES

**CITY AND COUNTY OF HONOLULU**

650 SOUTH KING STREET, 3RD FLOOR
HONOLULU, HAWAII 96813
Phone: (808) 768-8305 • Fax: (808) 768-4730 • Internet: www.honolulu.gov

PETER B. CARLISLE
MAYOR

WAYNE Y. YOSHIOKA
DIRECTOR

KAI NANI KRAUT, P.E.
DEPUTY DIRECTOR

TP6/12-470554R

June 29, 2012

RECEIVED

JUL - 3 2012

GROUP 70 INTL

Mr. Jeffrey H. Overton, AICP, LEED AP
Principal, Environmental Planner
Group 70 International, Inc.
925 Bethel Street, 5th Floor
Honolulu, Hawaii 96813-4307

Dear Mr. Overton:

Subject: Pre-Consultation for Draft Environmental Assessment (DEA)
Kalia-Fort DeRussy Wastewater System Improvements
Tax Map Key (TMK): 2-6-005:001 (portion); Waikiki, Oahu, Hawaii

This responds to your letter of June 8, 2012, requesting our comments concerning this proposed project.

Our Traffic Engineering Division (TED) has the following comments:

- The DEA should include a Traffic Impact Assessment Report (TIAR). Field work should be phased to have minimal impact to traffic and pedestrian activity. The DEA should discuss transportation impacts as a result of the project, including short-term impacts during construction and propose mitigating measures.

- The area Neighborhood Board, residents, businesses, etc., should be kept apprised of the details of the proposed project and impacts they may have on the adjoining local street area network.

- A street usage permit from the City's Department of Transportation Services (DTS) must be obtained for work that impacts a City street.

- Construction equipment and materials should be transported to and from the project site during off-peak traffic hours (i.e., 9 a.m. to 3 p.m., and 8 p.m. to 4 a.m.).

Our Public Transit Division (PTD) has the following comments:

- Your DEA should include a description of Public Transit services and operations, the impact of your project on Public Transit bus and paratransit operations during construction.

- The City has two bus stops along the affected portion of Kalia Road near Paoa Place and one bus stop on Kalakaua Avenue at Pau Street which cover many bus routes. The bus stops at Kalia Road and Paoa Place (southbound) and at Kalia Road and Maluhia Street (northbound) specifically service routes 8, 19, 20, 23, 24, 42, 98A. Kalia Road and Paoa Place additionally services routes W1, W2, and W3. The Stop at Kalakaua Avenue and Pau Street (northbound only) specifically serves routes 2, 4, 13, and 22. This project will affect bus service at these bus stops, or other bus traffic along the roads affected by this project, you should contact our staff at 768-8370.

- Basic information is available on our websites: www.thebus.org and www.honolulu.gov/dts. For more details, you may contact our staff at 768-8370.

- Construction notes should include the following note regarding transit services:

  "This project may affect bus routes, bus stops, and paratransit operations, therefore, the Contractor shall notify at the earliest possible date the Department of Transportation Services, Public Transit Division at 768-8396 and Oahu Transit Services, Inc. (bus operations: 848-4578 or 852-6016 and paratransit operations: 454-5041 or 454-5020) of the scope of work, location, proposed closure of any street, traffic lane, sidewalk, or bus stop and duration of project."

We reserve further comment pending submission of the DEA and TIAR.

Thank you for the opportunity to review this matter. Should you have any further questions, please contact Michael Murphy of my staff at 768-8359.

Very truly yours,

WAYNE Y. YOSHIOKA
Director

GROUP 70
INTERNATIONAL

PRINCIPALS

Francis S. Oda, Arch.D., FAIA, AICP, LEED AP
Norman G.Y. Hong AIA
Sheryl B. Seaman AIA, ASID, LEED AP
Hitoshi Hida AIA
Roy H. Nihei AIA, CSI, LEED AP
Ralph E. Portmore AICP
James I. Nishimoto AIA
Stephen Yuen AIA
Linda C. Miki AIA
George I. Atta AICP, LEED AP
Charles Y. Kaneshiro AIA, LEED AP
Jeffrey H. Overton AICP, LEED AP
Christine Mendes Ruotola AICP, LEED AP
James L. Stone, Arch.D., AIA, LEED AP
Katherine M. MacNeil AIA, LEED AP
Tom Young, MBA AIA
Paul T. Matsuda PE, LEED AP

October 26, 2012

Mr. Wayne Yoshioka, Director
City and County of Honolulu
Department of Transportation Services
650 South King Street, 3rd Floor
Honolulu, HI 96813

**Subject**: Pre-Consultation for Chapter 343, HRS Environmental Assessment
Kalia-Fort DeRussy Wastewater System Improvements
TMK: (1) 2-6-005:001 por., Kalia Road, Ala Moana Blvd., Kalakaua Avenue
(Waikiki, Oahu, Hawaii)

Dear Mr. Yoshioka:

Thank you for your comment letter dated June 29, 2012 concerning the Pre-Consultation for Chapter 343, HRS Environmental Assessment (EA) for the Kalia-Fort DeRussy Wastewater System Improvements project. The following responses are offered to your comments.

- **Traffic Impact Assessment Report.** *Section 2.4* of the Draft EA addresses potential construction-related traffic impacts on the roadway system within the project vicinity, and identifies appropriate mitigation measures to address adverse traffic impacts to the immediate roadway system during construction. Field work for the proposed sewer improvements will be phased to minimize impacts to traffic and pedestrian activity. A construction traffic impact analysis report was prepared by Wilson Okamoto Corporation and is included as *Appendix C* of the Draft EA.

  Traffic control plans will be prepared as part of the construction plans for the sewer line to address vehicular and pedestrian traffic during the construction activities. Construction work areas will be phased along the project alignment to minimize impact to vehicular and pedestrian traffic. The traffic control plans will include the phased work areas and detours for lane and sidewalk closures. The traffic control plans will be reviewed and approved by the City and County of Honolulu Department of Planning and Permitting and the State Department of Transportation Highways Division, for the City and State streets, respectively.

- **Neighborhood Board.** Hilton has met with the Waikiki Neighborhood Board No. 9 and provided presentations on the Village Master Plan throughout the entitlements process for the project. The Neighborhood Board was also included as a consulted party for the Kaila-Fort DeRussy Wastewater System Improvements EA Pre-Consultation process. The Waikiki Neighborhood Board No. 9 will continue to be informed of the project, and particularly potential impacts to adjoining streets in the area.

Group 70 International • 925 Bethel Street, 5th Floor • Honolulu, HI 96813-4307 • tel. 808.523.5866 • fax. 808.523.5874 • www.group70int.com

- **Street Usage Permit.** At the appropriate time, a street usage permit will be obtained from your Department for work that impacts City streets.

- **Construction Equipment.** Construction equipment and materials will be transported to and from the project site during off-peak hours between 9:00 AM to 3:00 PM and between 8:00 PM to 4:00 AM to minimize traffic impacts.

- **Public Transit Services.** The Draft EA provides information on Public Transit services and operations in the vicinity of the project and potential impacts on the Public Transit bus and paratransit operations during construction. Please refer to *Section 2.4* of the Draft EA.

- **Bus Stops/Routes.** We understand the City has two bus stops along the affected portion of Kalia Road near Paoa Place and another located on Kalakaua Avenue at Pau Street. These stops service many bus routes. The Contractor will coordinate with the City Department of Transportation Services, Public Transit Division and Oahu Transit Services, Inc. at the earliest possible date, prior to construction, to minimize impacts on bus routes, bus stops and paratransit operations. The Contractor will identify the scope of work, location, duration and proposed closure of any street, traffic lane, sidewalk and bus stop.

- **Website for Basic Information.** We appreciate you providing the website address reference to obtain Public Transit Service information.

- **Construction Notes.** Construction notes will include the note you reference in your letter regarding transit services.

We appreciate the efforts of your review and input during the environmental review process. Please contact us if you have questions or require additional information.

Sincerely,
GROUP 70 INTERNATIONAL, INC.

Jeffrey H. Overton, AICP, LEED AP
Principal, Chief Environmental Planner

cc: Jack Pobuk, ENV
Dale Kahehisa-Lam, USAG-HI

HONOLULU FIRE DEPARTMENT

**CITY AND COUNTY OF HONOLULU**

636 South Street
Honolulu, Hawaii 96813-5007
Phone: 808-723-7139 Fax: 808-723-7111 Internet: www.honolulu.gov/hfd

PETER B. CARLISLE
MAYOR

KENNETH G. SILVA
FIRE CHIEF

EMMIT A. KANE
DEPUTY FIRE CHIEF

RECEIVED

JUL - 6 2012

GROUP 70 INTL

July 3, 2012

Mr. Jeffrey Overton, AICP, LEED AP
Principal Environmental Planner
Group 70 International
925 Bethel Street, 5th Floor
Honolulu, Hawaii 96813-4307

Dear Mr. Overton:

Subject: Preconsultation for Environmental Assessment
Kalia-Fort DeRussy Wastewater System Improvements
Tax Map Key: 2-6-005: 001 Portion
Waikiki, Oahu, Hawaii

In response to your letter of June 8, 2012, regarding the above-mentioned subject, the Honolulu Fire Department reviewed the information provided and determined that there will be no significant impact to our fire services.

Should you have questions, please contact Battalion Chief Socrates Bratakos of our Fire Prevention Bureau at 723-7151 or sbratakos@honolulu.gov.

Sincerely,

KENNETH G. SILVA
Fire Chief

KGS/SY:bh

GROUP 70
INTERNATIONAL

PRINCIPALS

Francis S. Oda, Arch.D., FAIA, AICP, LEED AP
Norman G.Y. Hong, AIA
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Linda C. Miki, AIA
George I. Atta, AICP, LEED AP
Charles Y. Kaneshiro, AIA, LEED AP
Jeffrey H. Overton, AICP, LEED AP
Christine Mendes Ruotola, AICP, LEED AP
James L. Stone, Arch.D., AIA, LEED AP
Katherine M. MacNeil, AIA, LEED AP
Tom Young, MBA, AIA
Paul T. Matsuda, PE, LEED AP

October 26, 2012

Kenneth G. Silva, Fire Chief
City and County of Honolulu
Honolulu Fire Department
636 South Street
Honolulu, HI 96813-5007

**Subject**: Pre-Consultation for Chapter 343, HRS Environmental Assessment
Kalia-Fort DeRussy Wastewater System Improvements
TMK: (1) 2-6-005:001 por., Kalia Road, Ala Moana Blvd., Kalakaua Avenue
(Waikiki, Oahu, Hawaii)

Dear Chief Silva:

Thank you for your comment letter dated July 3, 2012 concerning the Pre-Consultation for Chapter 343, HRS Environmental Assessment (EA) for the Kalia-Fort DeRussy Wastewater System Improvements project.

We acknowledge that the Fire Department has no comments to offer on the project at this time since no significant impacts to fire services are anticipated.

We appreciate your participation in the environmental review process. Please contact us if you have questions or require additional information.

Sincerely,
GROUP 70 INTERNATIONAL, INC.

Jeffrey H. Overton, AICP, LEED AP
Principal, Chief Environmental Planner

cc: Jack Pobuk, ENV
Dale Kahehisa-Lam, USAG-HI

POLICE DEPARTMENT

# CITY AND COUNTY OF HONOLULU

801 SOUTH BERETANIA STREET · HONOLULU, HAWAII 96813
TELEPHONE: (808) 529-3111 · INTERNET: www.honolulupd.org

PETER B. CARLISLE
MAYOR

LOUIS M. KEALOHA
CHIEF

DAVE M. KAJIHIRO
MARIE A. McCAULEY
DEPUTY CHIEFS

OUR REFERENCE EO-LKA

July 2, 2012

RECEIVED

JUL - 5 2012

GROUP 70 INTL

Mr. Jeffrey H. Overton, AICP, LEED AP
Principal, Environmental Planner
Group 70 International
925 Bethel Street, Fifth Floor
Honolulu, Hawaii 96813-4307

Dear Mr. Overton:

This is in response your letter dated June 8, 2012, requesting comments on the Pre-Consultation, Environmental Assessment, for the Kalia-Fort DeRussy Wastewater System Improvements project.

This project may cause an increase in calls for police service and a delay in response time during the construction phase due to vehicular and pedestrian traffic.

The project should have no significant impact on the facilities or services of the Honolulu Police Department once it is completed.

If there are any questions, please call Major Ron Bode of District 6 (Waikiki) at 723-3345.

Sincerely,

LOUIS M. KEALOHA
Chief of Police

By
BART S. HUBER
Assistant Chief
Support Services Bureau

GROUP 70 INTERNATIONAL



October 26, 2012

Louis M. Kealoha, Chief of Police
City and County of Honolulu
Police Department
801 South Beretania Street
Honolulu, HI 96813

**Subject**: Pre-Consultation for Chapter 343, HRS Environmental Assessment
Kalia-Fort DeRussy Wastewater System Improvements
TMK: (1) 2-6-005:001 por., Kalia Road, Ala Moana Blvd., Kalakaua Avenue
(Waikiki, Oahu, Hawaii)

Dear Chief Kealoha:

Thank you for your comment letter dated July 2, 2012 concerning the Pre-Consultation for Chapter 343, HRS Environmental Assessment (EA) for the Kalia-Fort DeRussy Wastewater System Improvements project.

We understand that during the construction phase of the project, there is potential for delays in police response time due to vehicular and pedestrian traffic. Traffic control plans will be prepared as part of the construction plans for the sewer line to address vehicular and pedestrian traffic during the construction activities. Construction work areas will be phased along the project alignment to minimize impact to vehicular and pedestrian traffic.

Once the construction of the proposed wastewater system improvements is completed, no significant impacts to the facilities or services of the Honolulu Police Department are anticipated.

We appreciate your participation in the environmental review process. Please contact us if you have questions or require additional information.

Sincerely,
GROUP 70 INTERNATIONAL, INC.

Jeffrey H. Overton, AICP, LEED AP
Principal, Chief Environmental Planner

cc: Jack Pobuk, ENV
Dale Kahehisa-Lam, USAG-HI

**Hawaiian Electric Company**
Engineering Department
PO Box 2750 • Honolulu, HI 96840

RECEIVED

JUL 11 2012

GROUP 70 INTL

July 10, 2012

Mr. Jeffrey H. Overton, AICP, LEED AP
Principal, Environmental Planner
Group 70 International, Inc.
925 Bethel Street, Fifth Floor
Honolulu, Hawaii 96813-4307

Dear Mr. Overton:

Subject: **Pre-Consultation for Chapter 343, HRS Environmental Assessment**
**Kalia-Fort DeRussy Wastewater System Improvements**
**TMK: (1) 2-6-005:001 por., Kalia Road, Ala Moana Blvd., Kalakaua Ave.**

Thank you for the opportunity to comment on the subject project. Hawaiian Electric Company (HECO) has no objections to the project. Should HECO have existing easements and facilities on the subject property, we will need continued access for maintenance of our facilities.

We appreciate your efforts to keep us apprised of the subject project in the planning process. As the Wastewater System Improvements project comes to fruition, please continue to keep us informed. Further along in the design, we will be better able to evaluate the effects on our system facilities.

If you have any questions, please call me at 543-7245.

Sincerely,

Rouen Q. W. Liu

Rouen Q. W. Liu
Permits Engineer

GROUP 70
INTERNATIONAL



October 26, 2012

Mr. Rouen Q. Q. Liu, Permits Engineer
Hawaiian Electric Company
Engineering Department
P.O. Box 2750
Honolulu, HI 96840

**Subject**: Pre-Consultation for Chapter 343, HRS Environmental Assessment
Kalia-Fort DeRussy Wastewater System Improvements
TMK: (1) 2-6-005:001 por., Kalia Road, Ala Moana Blvd., Kalakaua Avenue
(Waikiki, Oahu, Hawaii)

Dear Mr. Liu:

Thank you for your comment letter dated July 10, 2012 concerning the Pre-Consultation for Chapter 343, HRS Environmental Assessment (EA) for the Kalia-Fort DeRussy Wastewater System Improvements project.

We acknowledge that Hawaiian Electric Company has no objections to the project, and will require continuous access to HECO facilities during the construction period.

We appreciate your participation in the environmental review process. Please contact us if you have questions or require additional information.

Sincerely,
GROUP 70 INTERNATIONAL, INC.

Jeffrey H. Overton, AICP, LEED AP
Principal, Chief Environmental Planner

cc: Jack Pobuk, ENV
Dale Kahehisa-Lam, USAG-HI

## Tracy Furuya

**From:** Bob <bobloy@outdoorcircle.org>
**Sent:** Thursday, June 21, 2012 3:05 PM
**To:** KaliaDeRussyWW
**Subject:** Kalia-Fort DeRussy Wastewater System Improvements

**To: Jeff Overton and Tracy Furuya**

Aloha Jeff and Tracy,

I am writing to request that The Outdoor Circle become a consulting party on the Kalia-Fort DeRussy Wastewater System Improvement project.

This project is located at essentially the gateway to Waikiki and as such is one of the island's most visually sensitive areas. As you know, through years of effort and considerable expense the project area has been turned into one of the most beautifully landscaped parcels in our community. The trees and other landscape features at this location make Ft. DeRussy a treasure that must be vigilantly preserved.

We strongly believe that any damage or altering of this area that might occur as a result of this project must be fully disclosed and vetted through all required approval processes. All damage or altering of the landscaped area must be countered with mitigation that has the approval of community stakeholders. As Hawaii's strongest and longest-standing advocate for protection of the visual environment of our islands we humbly request that The Outdoor Circle be included in all phases of all approval processes. Our voice represents a constituency of thousands of residents who expect The Outdoor Circle to protect their interest in preserving the landscape of the project area.

We look forward to working with you and the other parties on a plan that meets the needs this project is intended to address, while preserving this priceless gateway to the most important economic engine in the State of Hawaii—Waikiki.

Bob Loy
Director of Environmental Programs
1314 South King St. Ste 306
808.593.0300 work
386.6588 mobile
593.0525 fax

GROUP 70
INTERNATIONAL

PRINCIPALS

Francis S. Oda, Arch.D., FAIA, AICP, LEED AP
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Hitoshi Hida AIA
Roy H. Nihei AIA, CSI, LEED AP
Ralph E. Portmore AICP
James I. Nishimoto AIA
Stephen Yuen AIA
Linda C. Miki AIA
George I. Atta AICP, LEED AP
Charles Y. Kaneshiro AIA, LEED AP
Jeffrey H. Overton AICP, LEED AP
Christine Mendes Ruotola AICP, LEED AP
James L. Stone, Arch.D., AIA, LEED AP
Katherine M. MacNeil AIA, LEED AP
Tom Young, MBA AIA
Paul T. Matsuda PE, LEED AP

October 26, 2012

Mr. Bob Loy, Director of Environmental Program
The Outdoor Circle
1314 South King Street, Suite 306
Honolulu, HI 96814

**Subject**: Pre-Consultation for Chapter 343, HRS Environmental Assessment
Kalia-Fort DeRussy Wastewater System Improvements
TMK: (1) 2-6-005:001 por., Kalia Road, Ala Moana Blvd., Kalakaua Avenue
(Waikiki, Oahu, Hawaii)

Dear Mr. Loy:

Thank you for your comment letter dated June 21, 2012 concerning the Pre-Consultation for Chapter 343, HRS Environmental Assessment (EA) for the Kalia-Fort DeRussy Wastewater System Improvements project.

We acknowledge your request that The Outdoor Circle be a consulted party on the proposed project. We have engaged Steve Nimz, Certified Arborist, to conduct a tree assessment to addresses major trees and palms that may be impacted by the proposed project improvements. Please refer to *Section 2.12* of the Draft EA and *Appendix G* for additional details.

We appreciate your participation in the environmental review process. Please contact us if you have questions or require additional information.

Sincerely,

GROUP 70 INTERNATIONAL, INC.

Jeffrey H. Overton, AICP, LEED AP
Principal, Chief Environmental Planner

cc: Jack Pobuk, ENV
Dale Kahehisa-Lam, USAG-HI

# CONFERENCE REPORT

**Group 70 International, Inc.** • Sustainable Development • Architecture • Planning & Environmental Services • Interior Design • Assets Management
925 Bethel Street, Fifth Floor • Honolulu, Hawai'i 96813-4307 • PH: (808) 523-5866 • FAX: (808) 523-5874



| | | | |
|---|---|---|---|
| **TO:** | Files | | |
| **FROM:** | Jeff Overton | | |
| **DATE:** | June 12, 2012 | | |
| **PROJECT:** | Kalia-Fort DeRussy Wastewater System Improvements | **PROJECT NO:** | 201001-02 |
| **SUBJECT:** | Record of Conversation for EA | | |
| **LOCATION:** | Via telephone | **NO. OF PAGES:** | 1 |
| **THOSE PRESENT:** | Jeff Overton (Group 70)<br>A. Vanhorn Diamond | | |

**SUMMARY:**

A. Vanhorn Diamond phoned Jeff Overton at Group 70 to comment on the proposed Kalia-Fort DeRussy Wastewater System Improvements project. He asked questions about the scope of the project and what is being ascertained to guarantee that ancient remains found along the sewer pipelines are treated in a culturally appropriate manner. Mr. Overton described the mitigation planning for cultural resources. Mr. Diamond stated that he has no problem with the planning sewer improvements project.

# APPENDIX B
# PRELIMINARY ENGINEERING REPORT
# (BELT COLLINS HAWAII, LLC)

# KALIA–FORT DERUSSY
# WASTEWATER SYSTEM IMPROVEMENTS

# PRELIMINARY ENGINEERING REPORT

Prepared by:

Belt Collins Hawaii LLC
2153 North King Street, Suite 200
Honolulu, Hawaii 96819

September 2012

ALAN M. KATO
LICENSED
PROFESSIONAL
ENGINEER
No.7552-C
HAWAII, U.S.A.

THIS WORK WAS PREPARED BY ME
OR UNDER MY SUPERVISION

April 30, 2014
EXPIRATION DATE OF THE LICENSE

## 1. Purpose

The purpose of this Kalia–Fort DeRussy Wastewater System Improvements Preliminary Engineering Report (PER) is to address existing sewer system conditions, proposed sewer system improvements, alternatives considered, the potential impacts, and mitigations to accommodate the master plan improvements at the Hilton Hawaiian Village (HHV) by the year 2020.[1]

The HHV master plan improvements include two timeshare towers and retail spaces. Timeshare Tower 1, with 418 units, is proposed over the existing HHV bus loading area adjacent to Tapa Tower at the corner of Kalia Road and Paoa Place. Timeshare Tower 2, with 132 units and 14,359 square feet of retail space, is proposed over the existing Rainbow Bazaar. Timeshare Tower 1 is scheduled to be completed in late 2015. Timeshare Tower 2 is scheduled to be completed in 2020. 350 future timeshare units, located off of Paoa Place, are also considered for construction after 2020.

A sewer connection application for the HHV Master Plan improvements, including 550 new timeshare units (300 units Tower 1 and 250 units Tower 2) and 14,359 square feet of retail space, was submitted to the City Department of Planning and Permitting (DPP) in 2010. Subsequent development of the project resulted in a redistribution of the timeshare units to 418 units for Tower 1 and 132 units for Tower 1. In addition, DPP Wastewater Branch was informed of 350 future timeshare units, off of Paoa Place.

The City Department of Environmental Services (ENV) and DPP identified the following required off-site sewer system improvements. These improvements were determined after various alternate routes and construction methods were considered. The routes and construction methods are discussed in the Alternatives Considered portion of this report.

1. A new Kalia Road sewer line to replace the existing 1950's 12-inch diameter sewer line to accommodate 2.7 million gallons per day (mgd). The required flow rate includes capacity for the master plan improvements (Tower 1), the 350 future timeshare units, and 15 percent excess capacity.

2. The 16-inch diameter sewer line crossing Fort DeRussy from the Kalia Road and Ala Moana Boulevard intersection to the Fort DeRussy Wastewater pump station (FDWWPS) should be cut and plugged.

[1] The City and County of Honolulu's Global Consent Decree with the U.S. Environmental Protection Agency and the State Department of Health requires the City to upgrade the Fort DeRussy Wastewater Pump Station by June 20, 2020 to accommodate the projected year 2030 peak wet weather flow.

3. Replace the existing 1960's 24-inch diameter sewer line in Ala Moana Boulevard and Kalakaua Avenue to accommodate 8.1 mgd. The required flow rate includes capacity for the master plan improvements, the 350 future timeshare units, other area projects known by the City to be planned in the area, and 15 percent excess capacity.

4. Replace the 24-inch diameter sewer line within the FDWWPS between sewer manhole (9004) and sewer manhole (9003) and between sewer manhole (9003) and the FDWWPS wet well (0000) to accommodate 9.11 mgd and 9.33 mgd, respectively.

5. FDWWPS and sewer force main upgrades are required to accommodate the HHV improvements. Due to the deteriorated condition of the force main, the City will design and construct the required upgrades to the pump station and sewer force main as an emergency repair activity.

Hilton is required to make the sewer line upgrades along Kalia Road, Ala Moana Boulevard and Kalakaua Avenue to support the proposed master plan improvements and the 350 future timeshare units.

## 2. Existing Sewer System Conditions

### 2.1. Off-Site Sewer Lines

Wastewater from the majority of the HHV campus flows in a northerly direction toward the Ala Moana Boulevard and Kalia Road intersection through a 15-inch diameter sewer line. See figure 1 – Existing Sewer System following the text of this report. At this intersection, wastewater from the 15-inch diameter sewer line is combined with flows from other properties north of the HHV through a 24-inch diameter sewer line (c. 1960) in an expired easement[2] through Fort DeRussy along Ala Moana Boulevard and Kalakaua Avenue to the FDWWPS. A second 24-inch diameter sewer line (2004) located in Ala Moana Boulevard and Kalakaua Avenue parallels the 24-inch diameter sewer line (c. 1960) and conveys wastewater from areas north-east of the HHV to the FDWWPS.

Wastewater from the south side of the HHV campus is conveyed through sewer laterals to 8- and 10-inch diameter sewer lines running under Paoa Place, which connects to a 12-inch diameter sewer line in Kalia Road. Wastewater from the east side of the HHV campus is conveyed through sewer laterals to the 12-inch diameter sewer line in Kalia Road. Wastewater from the Hale Koa Hotel (HKH), including Ilima Tower (420 rooms),

[2] The City ENV is in the process of renewing the easement with the Army at the time of the writing of this report.

restaurants and banquet facilities, also discharges into the 12-inch diameter sewer line in Kalia Road. This combined wastewater from HKH and the south and east sides of HHV flows through the 12-inch diameter sewer line in Kalia Road, to a point of connection with the an existing 16-inch diameter sewer line, which carries the combined flow to the FDWWPS through an easement which traverses diagonally through Fort DeRussy from the Ala Moana Boulevard and Kalia Road intersection to the FDWWPS. Portions of the 16-inch diameter sewer line are located under existing structures on Fort DeRussy.

Outside the FDWWPS, within Kalakaua Avenue, a 12-inch diameter relief sewer line connects the 24-inch diameter sewer line (2004) to a "Waikiki Relief Sewer" 24-inch diameter sewer line. The invert elevation of the 12-inch diameter relief sewer line is (-)6.10, and the capacity of the 12-inch diameter relief sewer line is 1.93 mgd. The "Waikiki Relief Sewer" 24-inch diameter sewer line traverses along Kuhio Avenue and connects to the Beach Walk Wastewater Pump Station.

## 2.2. Fort DeRussy Wastewater Pump Station and Force Main

The FDWWPS is located along Kalakaua Avenue in an easement on the Fort DeRussy property. The FDWWPS was constructed in 1967 and houses three (3) pumps, two (2) for peak flow operations and one (1) for standby. The pumps are 2,755 gallon per minute (gpm) Morris pumps with 20-inch diameter impellers. Two (2) motors are 75 horsepower (hp) variable speed motors, and one (1) motor is a 50 hp constant speed motor.

R.M. Towill Corporation calculated the operating capacity of the FDWWPS, based on the pump curves and two pumps operating, as 6.95 million gallons per day (mgd) in the *Memorandum Hilton Hawaiian Village – Fort DeRussy WWPS Study* dated April 24, 2011. The theoretical capacity of the FDWWPS is 7.6 mgd if all three pumps are operating. On November 4, 2011, the City conducted a verification pump flow test at the FDWWPS and determined a flow of about 4.77 mgd[3] with a single pump running during the test.

The pump, alarm settings and overflow for the FDWWPS are shown in Table 1:

[3] The Technical Services Branch, Division of Wastewater Treatment and Disposal, ENV, City and County of Honolulu advised that the actual capacity of the FDWWPS may be more than the tested 4.77 mgd based on the liquid level within the wet well, which when at higher levels provides additional head and pumping capacity.

| Table 1 - FDWWPS Pump and Alarm Settings | | | | |
|---|---|---|---|---|
| Alarms | Pump 1 (Lead) | Pump 2 | Pump 3 | Overflow |
| -3.16 – High Level Alarm<br>-4.60 – Off | | | -4.08 – On | |
| | | | | |
| | -5.39 – On | -5.40 – On | -6.60 - Off | -6.1 |
| -6.74 – Off<br>-7.88 – Low Level Alarm | -7.54 - Off | -7.10 – Off | | |

Within the FDWWPS site, wastewater is discharged from the pump station in a 16-inch diameter force main, then through a 12-inch venturi flow tube which connects to a 20-inch diameter force main. The 20-inch diameter force main extends north along Kalakaua Avenue to the Ala Wai Canal where it crosses the Ala Wai Canal in three 10-inch diameter pipes. After Ala Wai Canal, the three 10-inch diameter pipes merge back into a 20-inch diameter force main, which increases in size to a 24-inch diameter force main that extends to Kanunu Street, where it discharges into a gravity sewer system.

On April 18, 2012, V&A Consulting Engineers, under contract through Hilton, conducted field tests to assess the condition of the sewer force main within the FDWWPS site at the request of the City ENV. ENV requested three locations of the force main pipe to be tested; 1) at the discharge pipe within the pump station building, 2) within the venturi meter vault located between the pump station building and Kalakaua Avenue, and 3) a point between the pump station and the venturi meter vault. Ultrasonic thickness testing of the pipe at the pump station building and the venturi meter vault indicated the force main pipe to have lost up to 92% of the wall thickness. ENV staff excavated for the force main pipe between the pump station building and the venturi meter, but would not allow testing of the pipe due to the corroded condition of the pipe. Based on the deteriorated condition of the force main, the City is proceeding with emergency improvements to the FDWWPS and force main. The improvements at the FDWWPS and force main will be designed to include the wastewater flows from the proposed HHV improvements.

## 3. Proposed Sewer System Improvements

To accommodate the HHV development, the proposed off-site sewer lines are 1) 945 linear feet of new 21-inch diameter sewer line in Kalia Road and 2)

1,618 linear feet of new 30-inch diameter sewer line along Ala Moana Boulevard and Kalakaua Avenue. See Figure 2 – Proposed Sewer System following the text of this report. The existing 16-inch diameter sewer line traversing diagonally across Fort DeRussy will be cut and plugged at Kalia Road.

The Kalia Road 21-inch diameter sewer line, with a minimum slope of 0.00092[4] feet per feet, will accommodate 3.07 mgd, which exceeds the required 2.7 mgd. The 21-inch diameter sewer line at the Kalia Road and Paoa Place intersection will be relocated east of the existing 12-inch diameter sewer line to accommodate the new Timeshare Tower 1 foundation. The new 21-inch diameter sewer line will be constructed adjacent to the existing 12-inch diameter sewer line along Kalia Road. After completion of the new 21-inch diameter sewer line, sewer laterals from HHV which connect to the existing 12-inch diameter sewer line will be connected to the new 21-inch diameter sewer line and the 12-inch diameter sewer line will be demolished and removed or abandoned in place.

The Ala Moana Boulevard and Kalakakaua Avenue 30-inch diameter sewer line, with a minimum slope of 0.00093 feet per feet, will accommodate the required 8.1 mgd. The new 30-inch diameter sewer line will be constructed along the existing (c. 1960) 24-inch diameter sewer line alignment. A 30-inch diameter sewer line in the FDWWPS site with minimum slopes of 0.00118 and 0.00124 feet per feet, will accommodate the required 9.11 mgd and 9.33 mgd, respectively. Wastewater in the existing 24-inch diameter sewer line will have to be by-passed during construction to allow the removal of the existing 24-inch diameter sewer line and installation of the new 30-inch diameter sewer line. See Table 2 for sewer line capacities and Table 3 for sewer line cost.

**Table 2 – Sewer Line Capacities**

| Location | Pipe Diameter (Inches) | n | Slope (minimum) | Full Flow Q (mgd) | Required Q (mgd) |
|---|---|---|---|---|---|
| Kalia Road | 21 | 0.013 | 0.0092 | 3.07 | 2.7 |
| Ala Moana Blvd and Kalakaua Avenue | 30 | 0.013 | 0.0092 | 8.10 | 8.1 |
| FDWWPS | 30 | 0.013 | 0.00118 | 9.11 | 9.11 |
| FDWWPS | 30 | 0.013 | 0.00124 | 9.34 | 9.33 |

[4] Sewer line minimum full flow velocity is 2.0 feet per second. For a 21-inch diameter sewer line, the minimum pipe slope to meet the minimum velocity is 0.00092 feet per feet.

| Table 3 – Sewer Line Cost | |
|---|---|
| Sewer Line | Cost |
| 945 LF of 21-inch diameter in Kalia Road | $4,808,000 |
| 1,618 LF of 30-inch diameter in Ala Moana Boulevard and Kalakaua Avenue | $8,837,000 |
| TOTAL | $13,645,000 |

Note: Cost includes construction, design, permitting, project management, escalation to January 2014 and contingency.

# 4. Alternatives Considered

## 4.1. Sewer Line Routing

Various on-site and off-site sewer line routing alternatives were considered to minimize sewer system improvements and potential impacts from the project.

Routing wastewater flows within the HHV campus from Timeshare Tower 1 was considered to limit sewer line improvements in Kalia Road. Routing wastewater flows within the HHV campus to the north end would require a pump station within the basement of the tower and a new sewer force main through the campus. Maintenance of a pump station and the limited space to route a sewer force main through the campus were determined unacceptable in comparison with a gravity sewer line connection to the sewer line in Kalia Road.

Off-site sewer line routes considered through Fort DeRussy to the FDWWPS included 1) the existing 16-inch diameter sewer line alignment diagonally through Fort DeRussy, 2) a new sewer line south of the existing Hale Koa parking structure, 3) a new sewer line adjacent to the existing 24-inch diameter sewer line (c. 1960) on either the north or south side and 4) a new sewer line north of the existing Hale Koa parking structure between the existing 16-inch diameter sewer line and the existing 24-inch diameter sewer line (c. 1960). Any new sewer line routing through Fort DeRussy would require an easement and approval by the United States Congress. Archaeological concerns also deemed any new sewer line route through Fort DeRussy unacceptable by the Directorate of Public Works U.S. Army Garrison Hawaii Environmental Division. The only acceptable sewer line routing through Fort DeRussy, from an archaeological perspective, was determined to be the replacement of existing sewer lines. The replacement of the 16-inch diameter sewer line diagonally through Fort DeRussy was determined unfeasible due to existing buildings over the line. The remaining acceptable alignment was the replacement of the existing 24-inch diameter sewer line (c. 1960) along Ala Moana Boulevard and Kalakaua Avenue.

Along Kalia Road, the new 21-inch diameter sewer line will follow the existing 12-inch diameter sewer line alignment, from Paoa Place to Ala Moana Boulevard. The exact location and alignment will be determined after field topographic surveys are completed and the sewer line will have to be designed to conform to clearance requirements from other existing utilities.

### 4.2. Construction Methods

Various construction methods were considered in addition to alignments, including open cut trenching and trenchless construction. Trenchless construction methods considered included pipe bursting, microtunneling, and horizontal directional drilling.

Open cut trenching involves excavating the ground along the entire proposed sewer line alignment. The trench width extends approximately a foot on either side of the pipe or manhole and extends about a foot below the bottom of the pipe. An excavator or backhoe is typically used to dig the trench, assist in pipe installation and backfilling the trench. Open cut trenching disturbs the largest area of the various construction methods. Open cut trenching allows a visual inspection of material removed from the trench as construction progresses. Due to the construction required along the entire alignment, open cut trenching has the greatest surface area impact. However, the majority of the construction will occur along existing sewer alignments which have previously been disturbed and excavated.

Pipe bursting is a trenchless method of construction which involves an expander head which is pulled through the pipe to be replaced and breaks the existing pipe into small pieces. The new pipe is pulled behind the expander head, replacing the existing pipe. This method of construction is typically used to replace old pipe with new pipe of the same diameter or one size larger. This construction method was determined to be unfeasible due to the existing pipe material and the large increase in pipe size. The existing 24-inch diameter sewer line is reinforced concrete pipe, which cannot be easily burst due to the reinforcing steel. The replacement of the existing 12-inch diameter pipe with a 21-inch diameter pipe is too large of an expansion, which would cause upheaval of the ground.

Microtunneling is another trenchless method of construction which utilizes a laser-guided steerable boring machine. A cutting and crusher head is pushed forward by a jacking unit located within an excavated jacking shaft to an excavated receiving shaft. Lengths of pipe are pushed behind the boring machine, while liquefied excavated material is pumped from the microtunneled alignment to an above ground separation plant. The excavated material is dewatered and disposed. The jacking and receiving shafts are typically located at or adjacent to the locations of manholes.

Horizontal directional drilling is a trenchless method of construction where a pilot hole is drilled from the ground surface down to the design depth and along the proposed alignment. A larger cutting head, back reamer, is passed through the pilot hole to enlarge the hole. The pipe is pulled behind the reamer. During the drilling a viscous fluid of water and bentonite or polymer is pumped to the drilling head to facilitate removal of cuttings. Drill cuttings are pumped back to a reclaimer for separation from the fluid.

Any cultural or archaeological resources along a microtunneled or horizontal directional drilled alignment would be pulverized during the construction. The potential loss of cultural and archaeological resources using these two methods of construction deemed these methods unacceptable.

## 5. Potential Impacts

Potential impacts due to the sewer system improvements project will occur during construction and include impacts to 1) surface water and drainage, 2) potential subsurface archaeological/cultural resources, 3) landscape trees, plants and public area hardscape, 4) vehicular and pedestrian traffic, 5) noise and 6) air quality. No long term impacts are anticipated as the sewer line alignment follows previously disturbed and excavated alignments, and the site areas will be restored after construction

## 6. Mitigation Measures

To mitigate the potential impacts during construction of the project the following measures will be taken:

### 6.1. Surface Water and Drainage

Erosion controls and best management practices will be included in the construction plans and implemented during construction. A National Pollutant Discharge Elimination System (NPDES) General Permit coverage authorizing discharges of storm water associated with construction activities will be obtained for the project from the State of Hawaii Department of Health and the conditions of the permit will be complied with to minimize impacts on surface water and drainage during construction. Existing pavement and landscaping will be restored after the construction is completed.

### 6.2. Potential Subsurface Archaeological/Cultural Resources

Open cut trench excavation is proposed to allow visual observation of material removed during construction. The majority of the construction will occur along existing sewer alignments which have previously been disturbed and excavated. A predetermined action plan will be prepared to address any archaeological/cultural resources that may be encountered during construction.

### 6.3. Landscape Trees/Plants and Public Area Hardscape

There will be trees and plants affected by the sewer line construction, in some cases requiring trimming, relocation or replacement. A certified arborist has been consulted to address affected trees along the project route. Public area hardscape affected by the construction will be restored.

### 6.4. Vehicular and Pedestrian Traffic

Traffic control plans will be prepared as part of the construction plans for the sewer line to address vehicular and pedestrian traffic during the construction activities. Construction work areas will be phased along the project alignment to minimize impact to vehicular and pedestrian traffic. The traffic control plans will include the phased work areas and detours for lane and sidewalk closures. The traffic control plans will be reviewed and approved by the City and County of Honolulu Department of Planning and Permitting and the State Department of Transportation Highways Division, for the City and State streets, respectively.

Construction equipment and materials will be transported to and from the project site during off-peak traffic hours, between 9 am to 3 pm and between 8 pm to 4 am.

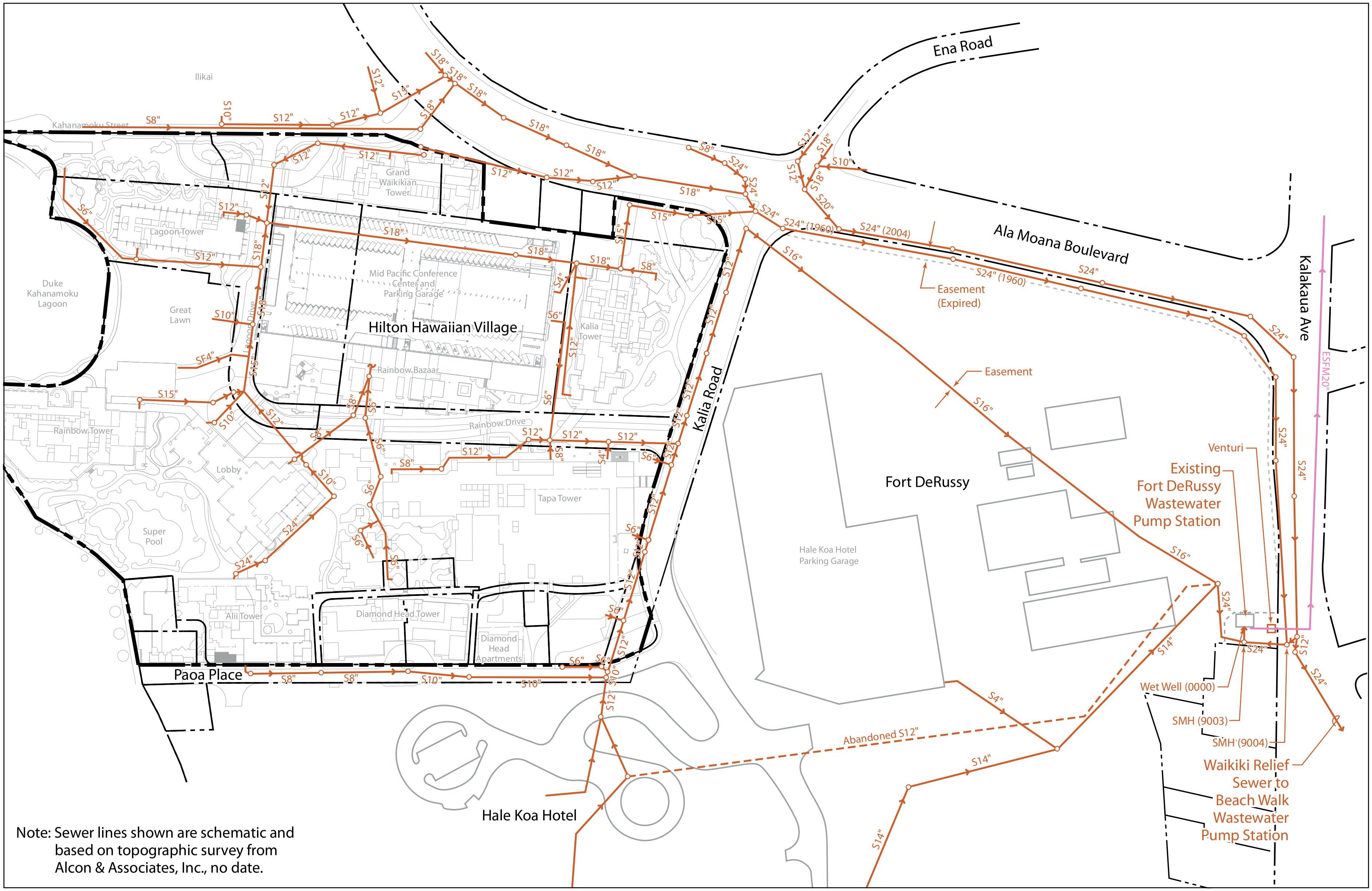
The Contractor will coordinate with the City Department of Transportation Services, Public Transit Division and Oahu Transit Services, Inc. at the earliest possible date, prior to construction, to minimize impacts on bus routes, bus stops and paratransit operations. The Contractor will identify the scope of work, location, duration and proposed closure of any street, traffic lane, sidewalk and bus stop.

### 6.5. Noise

Short–term temporary noise impacts would occur during construction. Construction work will be conducted in compliance with applicable State Department of Health noise regulations.

### 6.6. Air Quality

Short-term potential impacts to air quality will be mitigated by complying with State of Hawaii Air Pollution Control regulations during construction.




Note: Sewer lines shown are schematic and based on topographic survey from Alcon & Associates, Inc., no date.

BELT COLLINS

NORTH

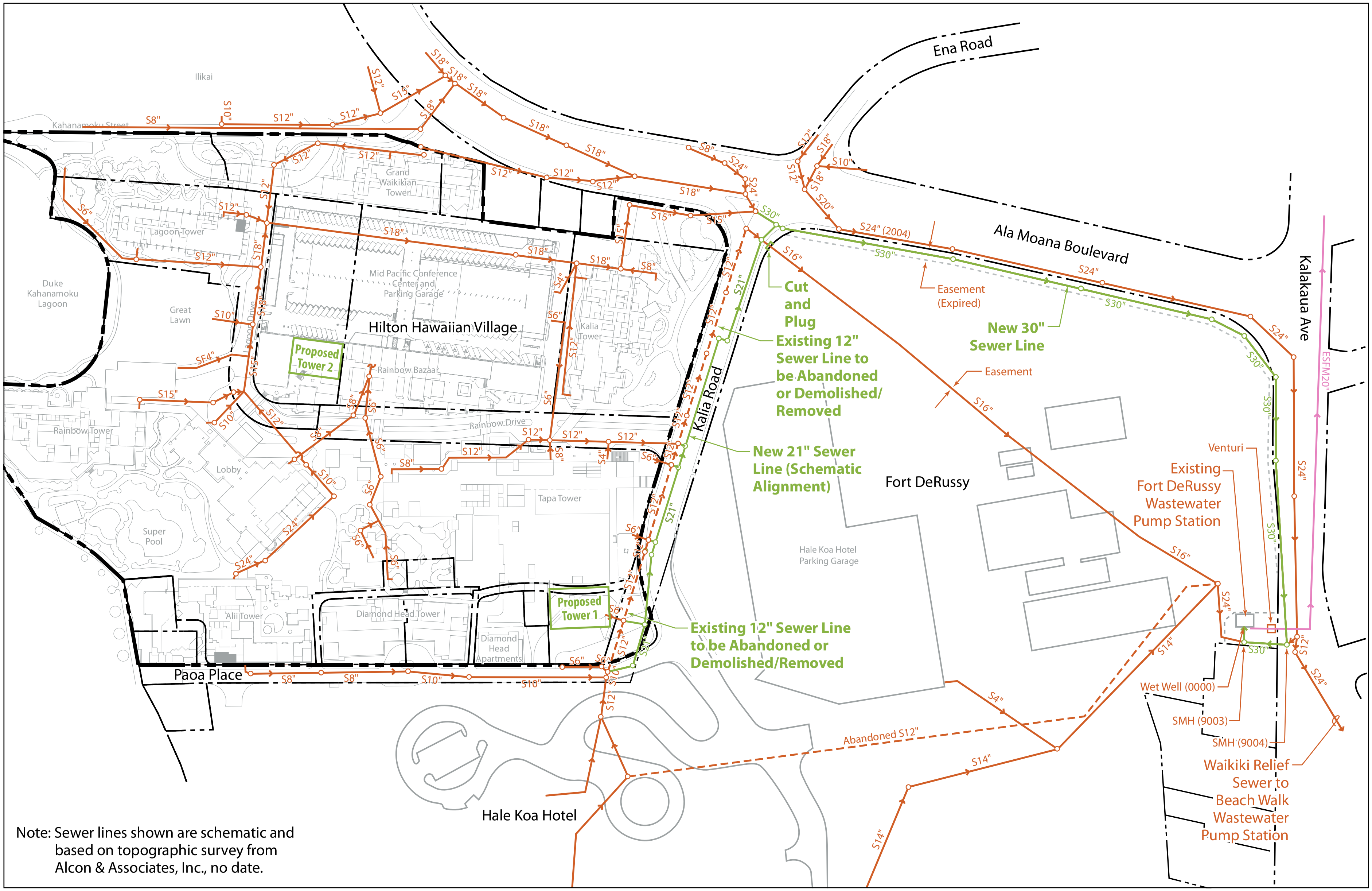
0 125 250
SCALE IN FEET

**LEGEND**

- S12" Sewer Line/Size/Direction
- Sewer Manhole
- ESFM20" Sewer Force Main/Size/Direction

# Figure 1
# EXISTING SEWER SYSTEM

Kalia-Fort DeRussy Wastewater System Improvements
Preliminary Engineering Report
August 2012




**LEGEND**

- S12" — Sewer Line/Size/Direction
- Sewer Manhole
- ESFM20" — Sewer Force Main/Size/Direction
- S21" — New Sewer Line/Size Direction
- New Sewer Manhole

NORTH

SCALE IN FEET: 0, 125, 250

BELT COLLINS

# Figure 2
## PROPOSED SEWER SYSTEM

Kalia-Fort DeRussy Wastewater System Improvements
Preliminary Engineering Report
August 2012

# APPENDIX C
# CONSTRUCTION TRAFFIC IMPACT REPORT
# (WILSON OKAMOTO CORPORATION)

# Construction Traffic Impact Report

## *Kalia-Fort DeRussy Wastewater System Improvements*

Prepared for:
Group 70 International

Prepared by:
Wilson Okamoto Corporation

July 2012
Updated August 2012

***CONSTRUCTION TRAFFIC IMPACT REPORT***

***for***

# *Kalia-Fort DeRussy*
# *Wastewater System Improvements*

*Prepared for*:

Group 70 International
925 Bethel Street, 5th Floor
Honolulu, HI  96813

*Prepared by*:

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1907 South Beretania Street, Suite 400
Honolulu, Hawaii 96826
WOC Ref: 8088-03

July 2012
Updated August 2012

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# I. INTRODUCTION

## A. Purpose of Study

The purpose of this study is to identify and assess the traffic impacts resulting from the construction of the proposed City Kalia-Fort DeRussy Wastewater System Improvements project in Waikiki on the island of Oahu. The proposed project entails the replacement of gravity sewer lines in the vicinity of the resort to accommodate the proposed renovations at the Hilton Hawaiian Village and other uses in the service area.

## B. Scope of Study

This report presents the findings and conclusions of the traffic study, the scope of which includes:

1. Description of the proposed project.
2. Evaluation of existing roadway and traffic operations in the vicinity.
3. Analysis of projected roadway and traffic conditions with the proposed project.
4. The identification and analysis of construction traffic impacts resulting from the proposed project.
5. Recommendations of improvements, if appropriate, that would mitigate the construction traffic impacts resulting from the proposed project.

# II. PROJECT DESCRIPTION

The existing Hilton Hawaiian Village is located adjacent to Kalia Road between Ala Moana Boulevard and Paoa Place in Waikiki on the island of Oahu. The Master Plan for the resort includes improvements to the main entry, retail areas, recreational areas, and existing towers, as well as, the development of new timeshare towers. To support the planned improvements and upgrade the capacity and integrity of the system, the proposed project entails the replacement of approximately 2,600 linear feet of gravity sewer line connecting to the Fort DeRussy Wastewater Pump Station including the following:

- Replacement of the existing 1950's 12-inch diameter sewer line along Kalia Road with a new 21-inch diameter sewer line. The replacement sewer line will begin at the intersection of Kalia Road and Paoa Place and end at the intersection of Ala Moana Boulevard and Kalia Road. The existing 16-inch diameter sewer line, which traverses across Fort DeRussy in a sewer line easement, would be cut and plugged at the intersection of Kalia Road and Ala Moana Boulevard.

- Replacement of the existing 1960's 24-inch diameter sewer line along Ala Moana Boulevard and Kalakaua Avenue with a 30-inch diameter sewer line. The replacement sewer line will begin at the intersection of Kalia Road and Ala Moana Boulevard and end at the Fort DeRussy WWPS. Work at Fort DeRussy will be contained within a City and County of Honolulu sewer line easement.

Location and vicinity maps are shown in Figures 1 and 2, and a schematic alignment of the proposed sewer project is shown in Figure 3.

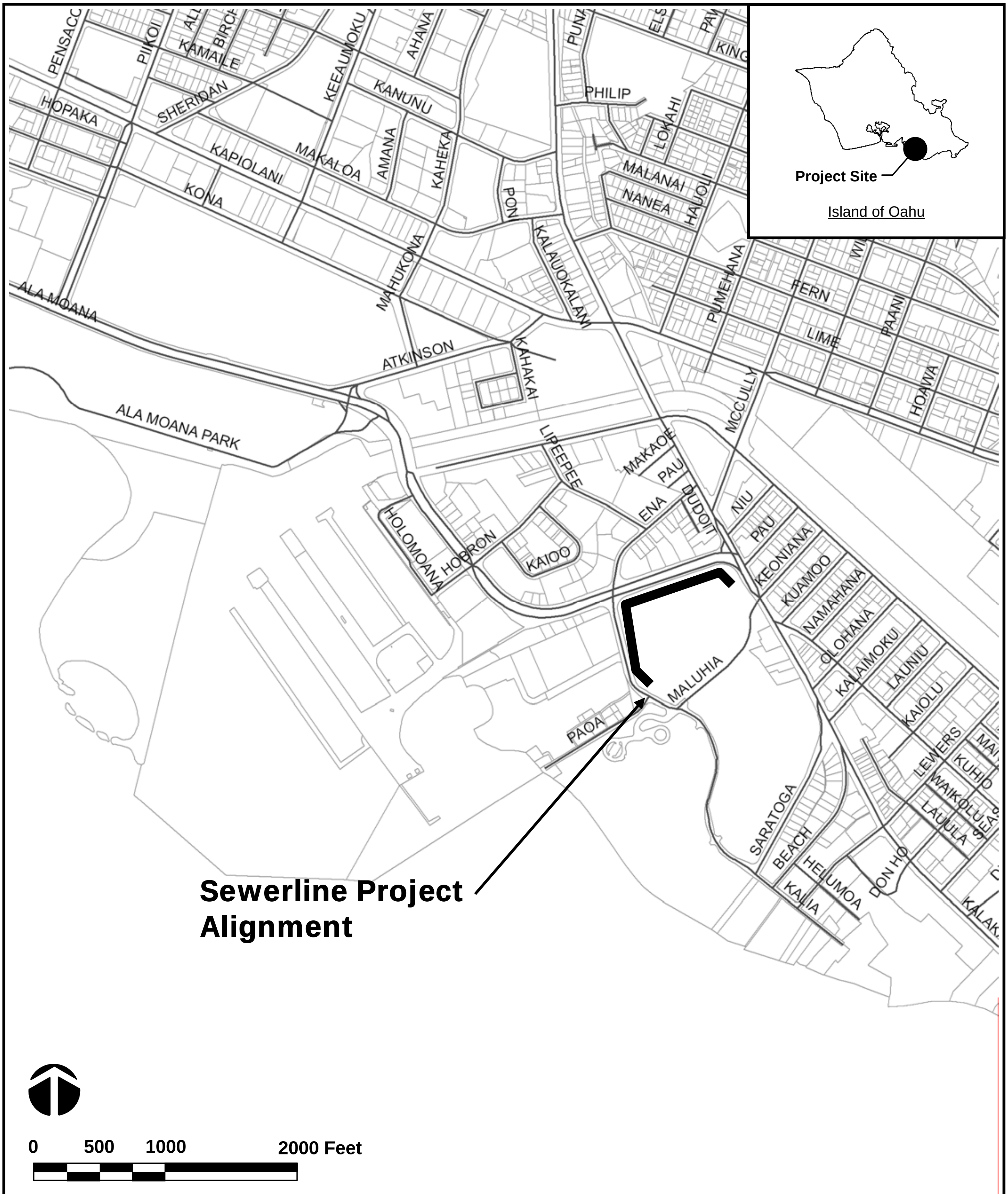
The installation of the proposed sewer lines will require a minimum closure of two travel lanes on Kalia Road to accommodate construction activities between the weekday hours of 8:30 AM and 3:30 PM. Lane closures are not anticipated along Ala Moana Boulevard and Kalakaua Avenue. In addition, due to the alignment of the sewer line along the centerline of that roadway, a third lane may be required periodically during construction. As such, this report includes an analysis both a two-lane and a three-lane closure on Kalia Road.

## III. EXISTING TRAFFIC CONDITIONS

### A. Area Roadway System

Kalia Road is a predominantly four-lane, two-way roadway that extends from Ala Moana Boulevard to approximately 450 feet south of Lewers Street. Currently, the roadway carries approximately 10,000 vehicles per day in the project vicinity with heavy northbound and southbound traffic volumes of about 950 vehicles and 1,100 vehicles observed during the AM and PM peak periods, respectively. The posted speed limit on Kalia Road is 25 miles per hour.

Ala Moana Boulevard is a predominantly five-lane (two lanes eastbound, three lanes westbound), two-way roadway in the vicinity of the proposed project extending from downtown Honolulu to Kalakaua Avenue. Currently the roadway carries approximately 18,000 vehicles per day in the project vicinity with heavy through volumes of about 1,800 vehicles per hour observed in the AM peak hour. The posted speed on Ala Moana Boulevard is 35 miles per hour in the project vicinity.

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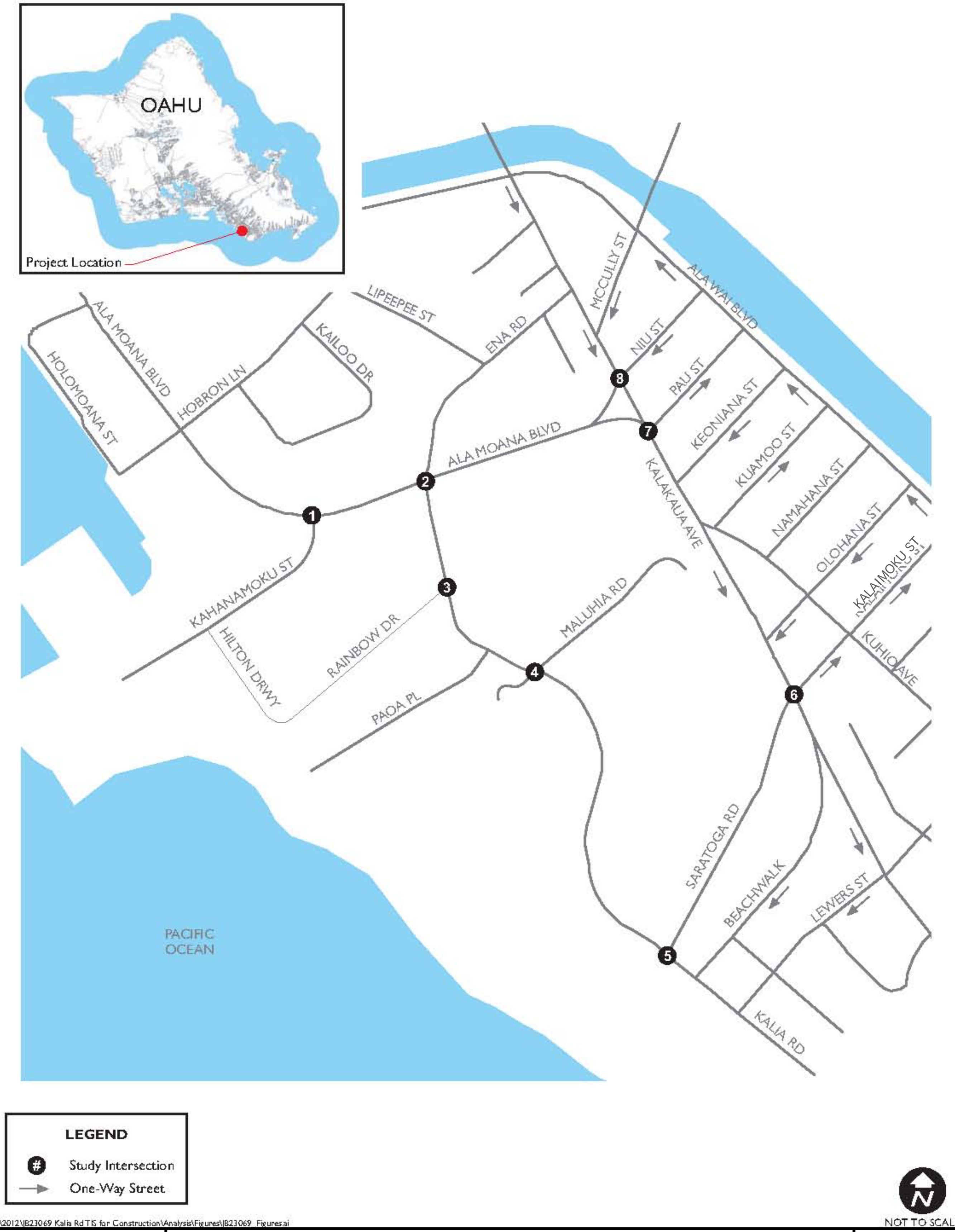
KALIA – FORT DERUSSY WASTEWATER SYSTEM IMPROVEMENTS

LOCATION MAP

FIGURE 1

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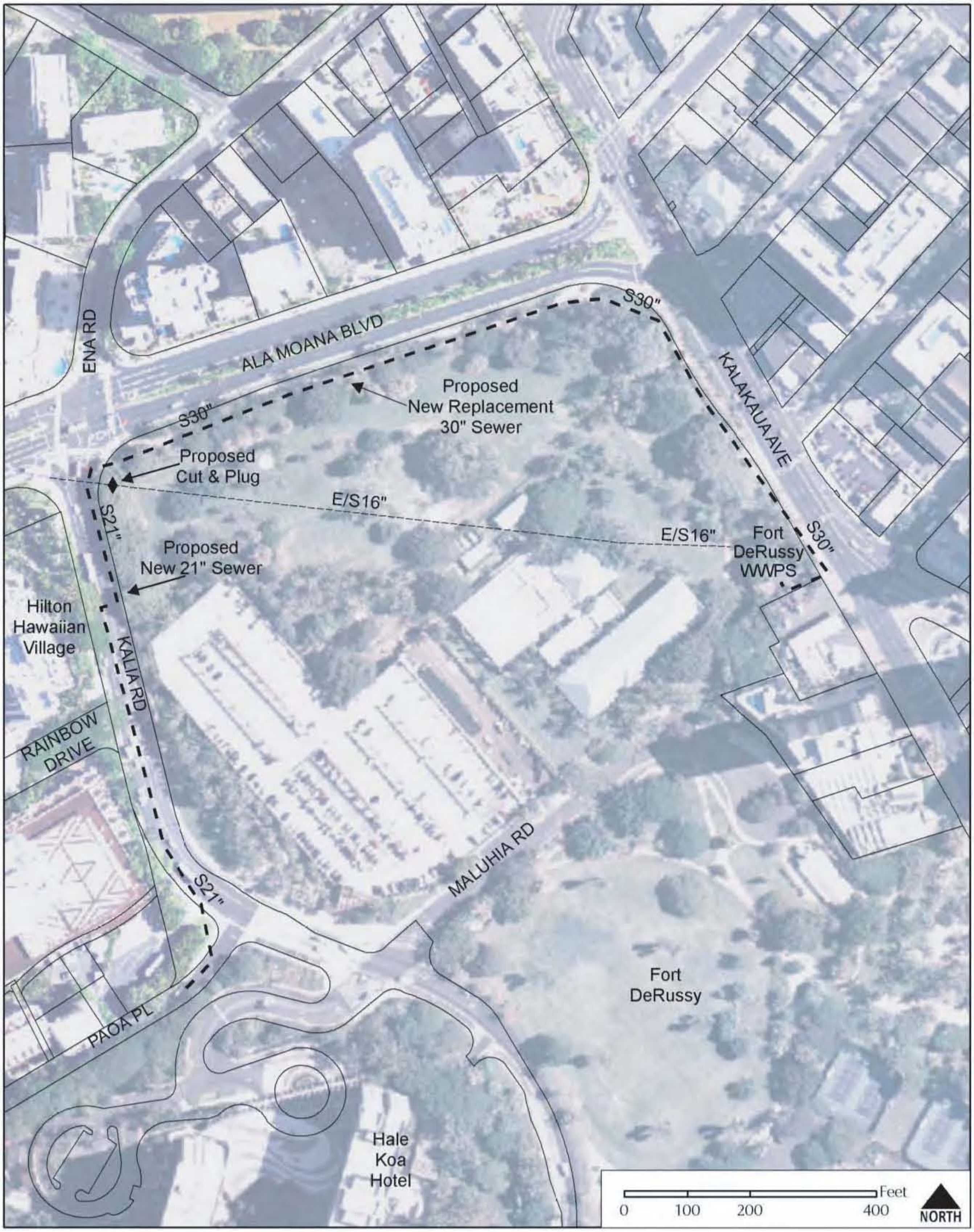
| WILSON OKAMOTO CORPORATION ENGINEERS - PLANNERS | KALIA – FORT DERUSSY WASTEWATER SYSTEM IMPROVEMENTS | FIGURE |
|---|---|---|
| | VICINITY MAP | 2 |




| WILSON OKAMOTO CORPORATION<br>ENGINEERS - PLANNERS | KALIA – FORT DERUSSY WASTEWATER SYSTEM IMPROVEMENTS<br><br>PROJECT SITE PLAN | FIGURE<br>3 |
|---|---|---|

Rainbow Drive is a predominantly two-lane, two-way local roadway that provides access to the Hilton Hawaiian Village. The roadway currently carries approximately 3,300 vehicles per day with volumes of about 400 vehicles per hour observed in the PM peak hour. The speed limit on Rainbow Drive is 15 miles per hour.

Kahanamoku Street is a two-lane, two-way roadway that provides access to the Hilton Hawaiian Village and Rainbow Drive via Lagoon Drive. Currently the roadway carries approximately 2,800 vehicles per day with volumes of about 300 vehicles per hour observed in the AM peak hour. The posted speed limit on Kahanamoku Street is 15 miles per hour.

Figure 4 shows the existing intersection configurations for the intersections within the study area.

## B. Traffic Volumes and Conditions

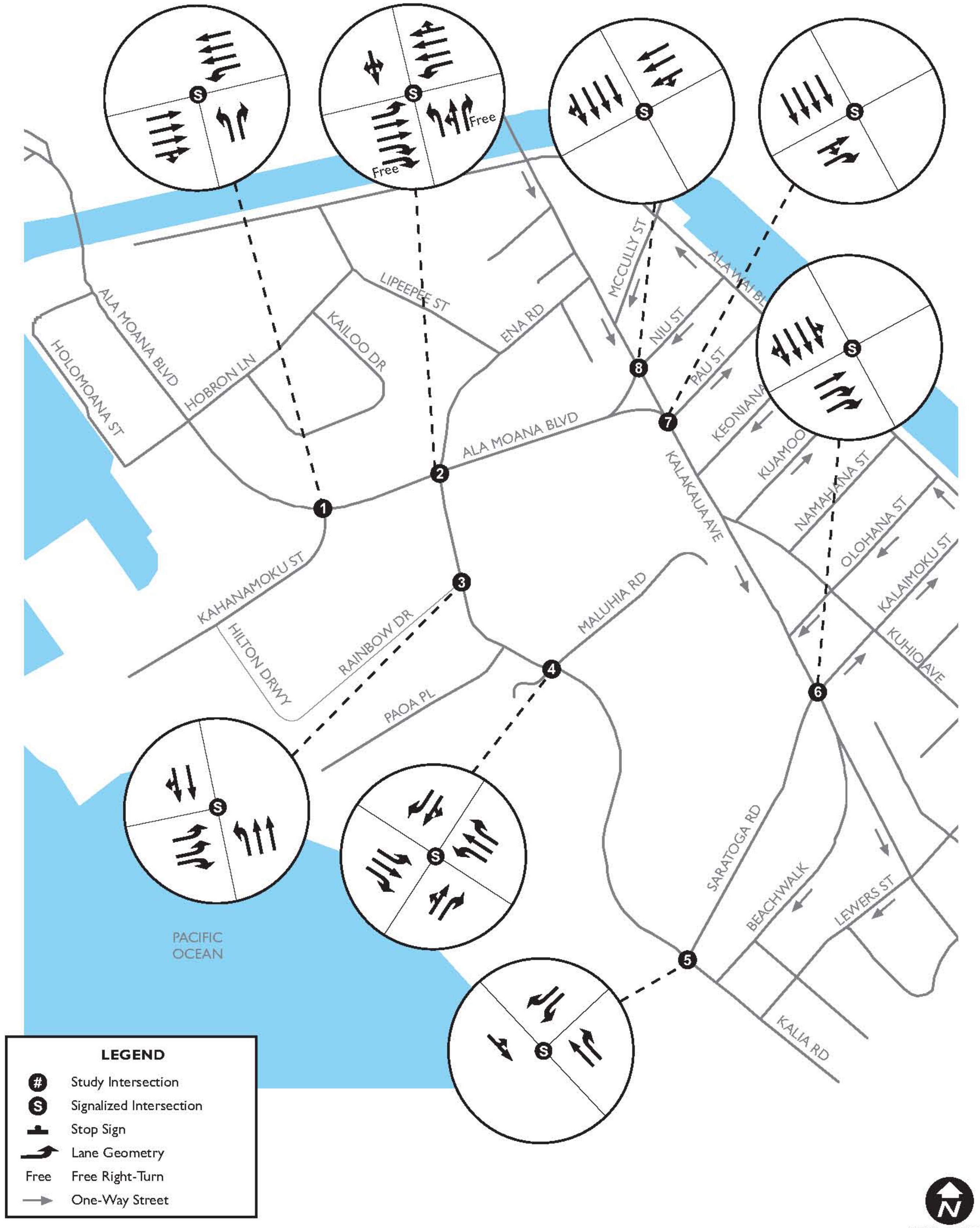
### 1. General

#### a. Field Investigation

Field investigations were conducted during January and June 2012 and consisted of manual turning movement count surveys and traffic flow assessments during the midday peak hours of 11:00 AM and 1:00 PM, and between the afternoon peak hours of 2:00 PM and 5:00 PM at the following intersections:

- Ala Moana Boulevard, Ena Road, and Kalia Road
- Ala Moana Boulevard and Kahanamoku Street
- Ala Moana Boulevard, Kalakaua Avenue, and Niu Street
- Ala Moana Boulevard, Kalakaua Avenue, and Pau Street
- Kalakaua Avenue, Saratoga Road, and Kalaimoku Street
- Kalia Road and Rainbow Drive
- Kalia Road and Maluhia Road
- Kalia Road and Saratoga Road

Appendix A includes the existing traffic count data.

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| WILSON OKAMOTO CORPORATION ENGINEERS - PLANNERS | KALIA-FORT DERUSSY WASTEWATER SYSTEM IMPROVEMENTS | FIGURE |
|---|---|---|
| | EXISTING LANE CONFIGURATIONS | 4 |

**b. Capacity Analysis Methodology**

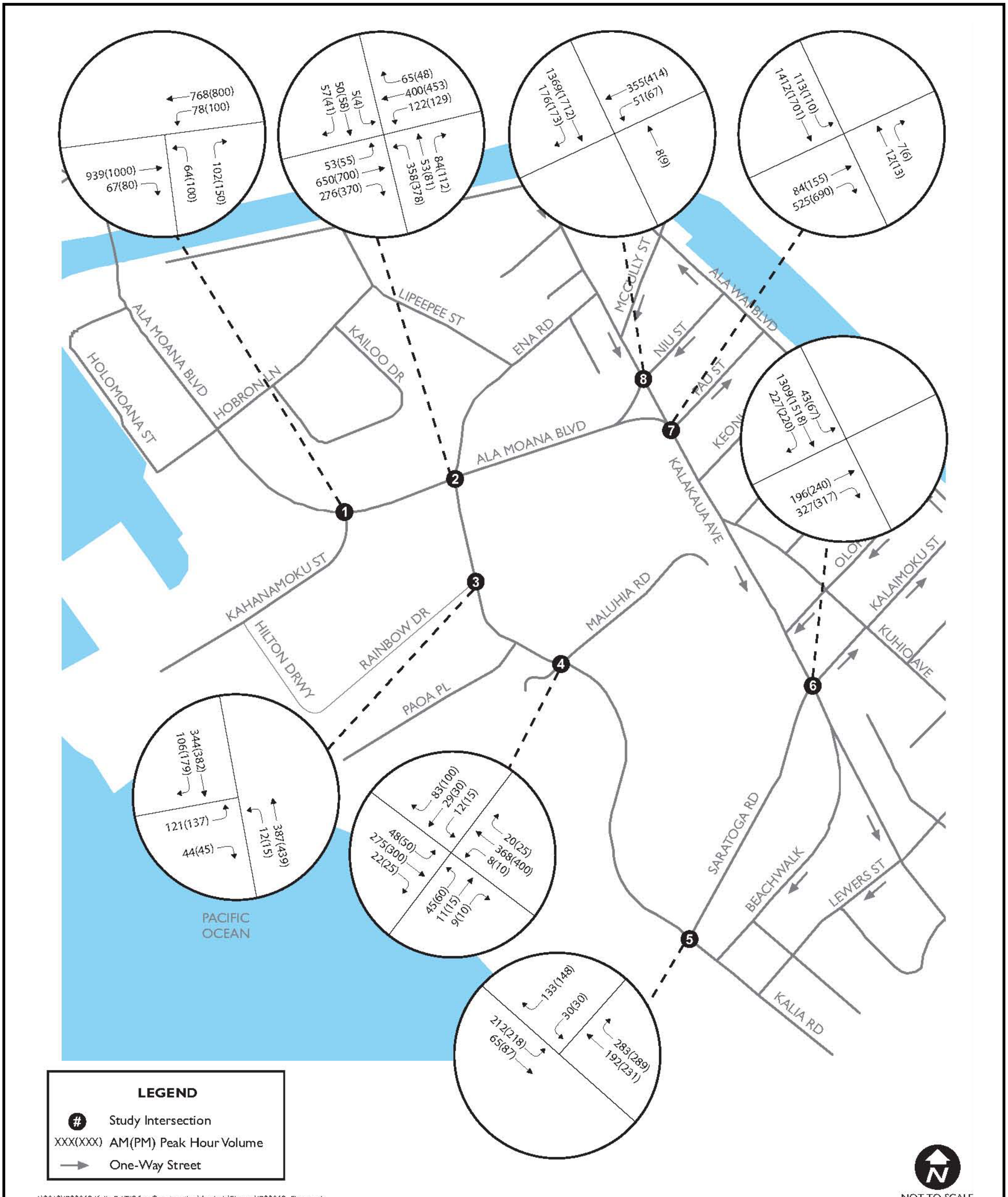
The highway capacity analysis performed in this study is based upon procedures presented in the "Highway Capacity Manual", Transportation Research Board, 2000, and the "Synchro", developed by Trafficware. The analysis is based on the concept of Level of Service (LOS).

LOS is a quantitative and qualitative assessment of traffic operations. Levels of Service are defined by LOS "A" through "F"; LOS "A" representing ideal or free-flow traffic operating conditions and LOS "F" representing unacceptable or potentially congested traffic operating conditions.

"Volume-to-Capacity" (v/c) ratio is another measure indicating the relative traffic demand to the roadway carrying capacity. A v/c ratio of one (1.00) indicates that the roadway is operating at or near capacity. A v/c ratio of greater than 1.00 generally indicates that the traffic demand exceeds the road's carrying capacity. The LOS definitions are included in Appendix B.

**2. Existing Peak Hour Traffic**

The existing midday and afternoon non-commuter (hereinafter referred to as PM) peak period traffic volumes and traffic operating conditions are shown in Figure 5 and summarized in Table 1. The midday peak hour of traffic generally occurs between the hours of 11:00 AM and 12:00 PM. During the afternoon, the PM peak hour of traffic generally occurs between the hours of 2:30 PM and 3:30 PM. The analysis is based on these peak hour time periods for each intersection to identify the construction traffic impacts resulting from the proposed project. It should be noted, construction activities are generally not expected to overlap with commuter peak periods with work hours most likely being designated as between 8:30 AM and 3:30 PM. LOS calculations are included in Appendix C.

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**KALIA – FORT DERUSSY WASTEWATER SYSTEM IMPROVEMENTS**

EXISTING MIDDAY AND PM PEAK HOUR

FIGURE 5

**Table 1: Existing Intersection LOS Traffic Operating Conditions**

| Intersection | Midday | | PM | |
|---|---|---|---|---|
| | **Delay*** | **LOS** | **Delay*** | **LOS** |
| Ala Moana Blvd/Kahanamoku St | 7.2 | A | 7.8 | A |
| Ala Moana Blvd/Ena Rd/Kalia Rd | 42.4 | D | 44.5 | D |
| Kalia Rd/Rainbow Dr | 4.7 | A | 4.6 | A |
| Kalia Rd/Maluhia Dr | 13.4 | B | 15.2 | B |
| Kalia Rd/Saratoga Rd | 4.8 | A | 4.0 | A |
| Kalakaua Rd/Saratoga Rd/Kalaimoku St | 9.8 | A | 9.4 | A |
| Ala Moana Blvd/Kalakaua Ave/Pau St | 9.4 | A | 11.3 | B |
| Ala Moana Blvd/Kalakaua Ave/Niu St | 14.3 | B | 16.7 | B |

*Seconds per vehicle

## IV. PROJECTED TRAFFIC CONDITIONS

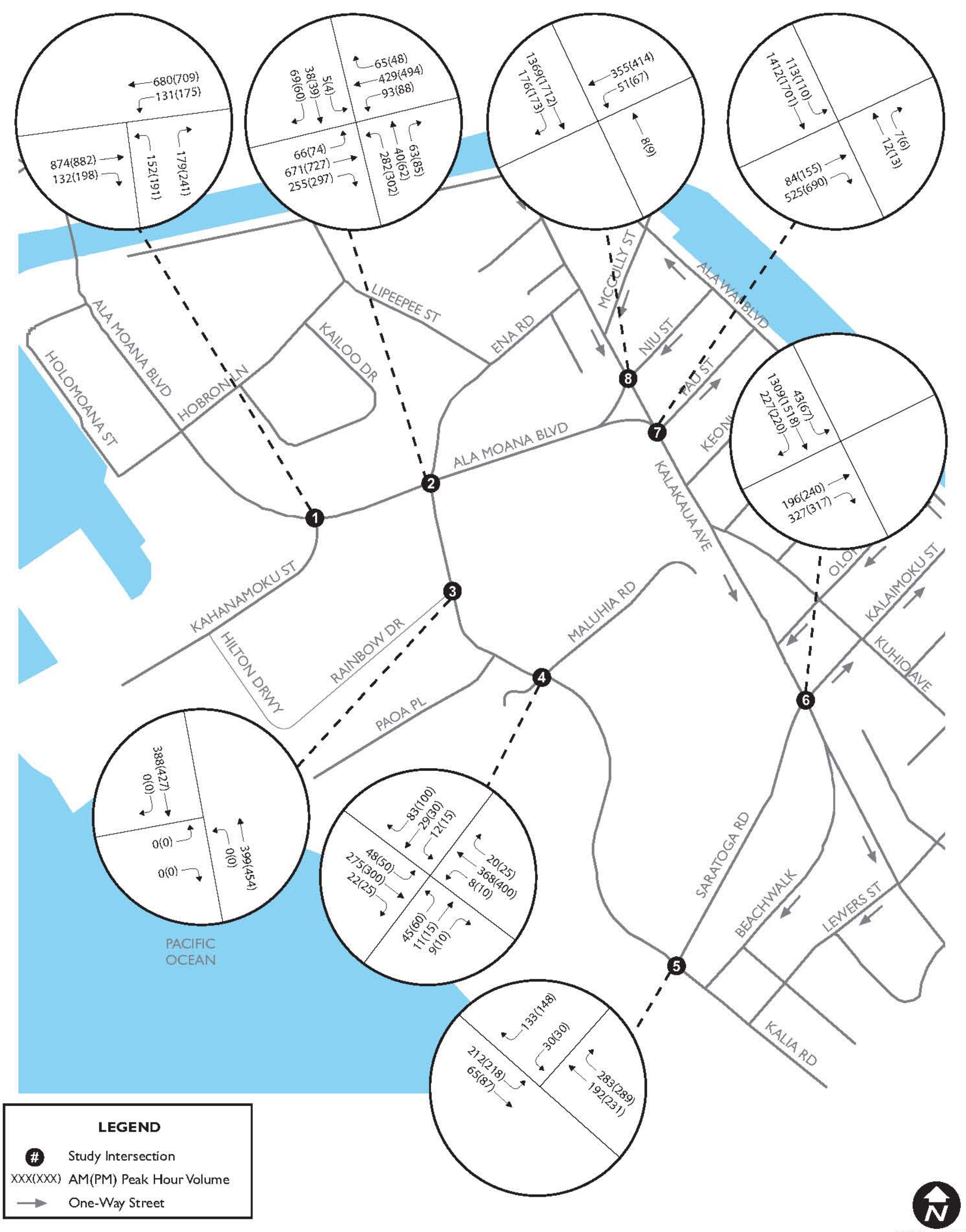
### A. General

The construction of the proposed project will require a minimum closure of two lanes with the potential for an occasional closure of a third lane. As such, the traffic analysis included in this report assesses the following scenarios:

- 2-lane closure on Kalia Road (with and without the traffic diversion)
- 3-lane closure on Kalia Road (with and without the traffic diversion)

### B. Traffic Diversion

The anticipated lane closures along Kalia Road during construction area anticipated to cause congestion along that roadway even with the restriction of construction activities to off-peak periods. A potential management strategy that could be implemented to alleviate this anticipated congestion is the closure of Rainbow Drive to minimize traffic volumes along Kalia Road. The existing traffic along Rainbow Drive would be diverted along internal roadways within the Hilton Hawaiian Village to Kahanamoku Street. Traffic was diverted from Rainbow Drive to Kahanamoku Street based on the existing distribution of traffic at the intersections of Kalia Road with Ala Moana Boulevard and Rainbow Drive. The diverted midday and PM peak hour traffic conditions are shown on Figure 6 and the traffic diversion calculation worksheets are included in Appendix D.

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**KALIA – FORT DERUSSY WASTEWATER SYSTEM IMPROVEMENTS**

PROJECTED MIDDAY AND PM PEAK HOUR WITH TRAFFIC DIVERSION

FIGURE 6

## C. Kalia Road 2-Lane Closure

### 1. Without Traffic Diversion

The projected midday and PM peak period traffic volumes and traffic operating conditions with the proposed 2-lane closure are summarized in Tables 2 and 3. The existing conditions are provided for comparison purposes. LOS calculations are included in Appendix E.

**Table 2: Existing and Projected (2-Lane Closure) Midday Intersection LOS Traffic Operating Conditions**

| Intersection | Exist | | 2-Lane | |
|---|---|---|---|---|
| | Delay* | LOS | Delay* | LOS |
| Ala Moana Blvd/Kahanamoku St | 7.2 | A | 7.2 | A |
| Ala Moana Blvd/Ena Rd/Kalia Rd | 42.4 | D | 43.9 | D |
| Kalia Rd/Rainbow Dr | 4.7 | A | 5.2 | A |
| Kalia Rd/Maluhia Dr | 13.4 | B | 13.4 | B |
| Kalia Rd/Saratoga Rd | 4.8 | A | 4.8 | A |
| Kalakaua Rd/Saratoga Rd/Kalaimoku St | 9.8 | A | 9.8 | A |
| Ala Moana Blvd/Kalakaua Ave/Pau St | 9.4 | A | 9.4 | A |
| Ala Moana Blvd/Kalakaua Ave/Niu St | 14.3 | B | 14.3 | B |

*Seconds per vehicle

**Table 3: Existing and Projected (2-Lane Closure) PM Intersection LOS Traffic Operating Conditions**

| Intersection | Exist | | 2-Lane | |
|---|---|---|---|---|
| | Delay* | LOS | Delay* | LOS |
| Ala Moana Blvd/Kahanamoku St | 7.8 | A | 7.8 | A |
| Ala Moana Blvd/Ena Rd/Kalia Rd | 44.5 | D | 47.0 | D |
| Kalia Rd/Rainbow Dr | 4.6 | A | 6.2 | A |
| Kalia Rd/Maluhia Dr | 15.2 | B | 15.2 | B |
| Kalia Rd/Saratoga Rd | 4.0 | A | 4.0 | A |
| Kalakaua Rd/Saratoga Rd/Kalaimoku St | 9.4 | A | 9.4 | A |
| Ala Moana Blvd/Kalakaua Ave/Pau St | 11.3 | B | 11.3 | B |
| Ala Moana Blvd/Kalakaua Ave/Niu St | 16.7 | B | 16.7 | B |

*Seconds per vehicle

The proposed closure would reduce the number of lanes along Kalia Road to two northbound lanes and one southbound lane. At the intersection of Kalia Road with Ala Moana Boulevard, the northbound approach is assumed to have an exclusive left-turn lane and a shared all-way lane. As shown in the above tables, the study intersections are expected to operate at levels of service similar to existing conditions during the midday and PM peak hours with the proposed 2-lane closure along Kalia Road between the weekday hours of 8:30 AM and 3:30 PM. As such, the proposed 2-lane closure along Kalia Road is not expected to have a significant impact on traffic operations in the project vicinity.

**2. With Traffic Diversion**

The projected midday and PM peak period traffic volumes and traffic operating conditions with the proposed 2-lane closure and traffic diversion are summarized in Tables 4 and 5. The existing conditions are provided for comparison purposes. LOS calculations are included in Appendix E.

**Table 4: Existing and Projected (2-Lane Closure with Traffic Diversion) Midday Intersection LOS Traffic Operating Conditions**

| Intersection | Exist | | 2-Lane w/ Div | |
|---|---|---|---|---|
| | Delay* | LOS | Delay* | LOS |
| Ala Moana Blvd/Kahanamoku St | 7.2 | A | 9.1 | A |
| Ala Moana Blvd/Ena Rd/Kalia Rd | 42.4 | D | 39.7 | D |
| Kalia Rd/Rainbow Dr | 4.7 | A | 3.4 | A |
| Kalia Rd/Maluhia Dr | 13.4 | B | 13.4 | B |
| Kalia Rd/Saratoga Rd | 4.8 | A | 4.8 | A |
| Kalakaua Rd/Saratoga Rd/Kalaimoku St | 9.8 | A | 9.8 | A |
| Ala Moana Blvd/Kalakaua Ave/Pau St | 9.4 | A | 9.4 | A |
| Ala Moana Blvd/Kalakaua Ave/Niu St | 14.3 | B | 14.3 | B |

*Seconds per vehicle

**Table 5: Existing and Projected (2--Lane Closure with Traffic Diversion) PM Intersection LOS Traffic Operating Conditions**

| Intersection | Exist | | 2-Lane w/ Div | |
|---|---|---|---|---|
| | Delay* | LOS | Delay* | LOS |
| Ala Moana Blvd/Kahanamoku St | 7.8 | A | 11.9 | B |
| Ala Moana Blvd/Ena Rd/Kalia Rd | 44.5 | D | 41.6 | D |
| Kalia Rd/Rainbow Dr | 4.6 | A | 3.4 | A |
| Kalia Rd/Maluhia Dr | 15.2 | B | 15.2 | B |
| Kalia Rd/Saratoga Rd | 4.0 | A | 4.0 | A |
| Kalakaua Rd/Saratoga Rd/Kalaimoku St | 9.4 | A | 9.4 | A |
| Ala Moana Blvd/Kalakaua Ave/Pau St | 11.3 | B | 11.3 | B |
| Ala Moana Blvd/Kalakaua Ave/Niu St | 16.7 | B | 16.7 | B |

*Seconds per vehicle

The proposed closure would reduce the number of lanes along Kalia Road to two northbound lanes and one southbound lane. At the intersection of Kalia Road with Ala Moana Boulevard, the northbound approach is assumed to have an exclusive left-turn lane and a shared all-way lane. As shown in the above tables, with the 2-lane closure and the internal diversion of traffic from Rainbow Drive to Kahanamoku Street, the study intersections are expected to operate at levels of service similar to existing conditions with the exception of the intersection of Ala Moana Boulevard and Kahanamoku Street which is expected to operate at LOS “B” during the PM peak period. As such, the proposed 2-lane closure along Kalia Road with traffic diversion is not expected to have a significant impact on traffic operations in the project vicinity.

## D. Kalia Road 3-Lane Closure

### 1. Without Traffic Diversion

The projected midday and PM peak period traffic volumes and traffic operating conditions with the proposed 3-lane closure are summarized in Tables 6 and 7. The existing conditions are provided for comparison purposes. LOS calculations are included in Appendix F.

**Table 6: Existing and Projected (3-Lane Closure) Midday Intersection LOS Traffic Operating Conditions**

| Intersection | Exist | | 3-Lane | |
|---|---|---|---|---|
| | Delay* | LOS | Delay* | LOS |
| Ala Moana Blvd/Kahanamoku St | 7.2 | A | 7.2 | A |
| Ala Moana Blvd/Ena Rd/Kalia Rd | 42.4 | D | 59.8 | E |
| Kalia Rd/Rainbow Dr | 4.7 | A | 5.7 | A |
| Kalia Rd/Maluhia Dr | 13.4 | B | 13.4 | B |
| Kalia Rd/Saratoga Rd | 4.8 | A | 4.8 | A |
| Kalakaua Rd/Saratoga Rd/Kalaimoku St | 9.8 | A | 9.8 | A |
| Ala Moana Blvd/Kalakaua Ave/Pau St | 9.4 | A | 9.4 | A |
| Ala Moana Blvd/Kalakaua Ave/Niu St | 14.3 | B | 14.3 | B |

*Seconds per vehicle

**Table 7: Existing and Projected (3-Lane Closure) PM Intersection LOS Traffic Operating Conditions**

| Intersection | Exist | | 3-Lane | |
|---|---|---|---|---|
| | Delay* | LOS | Delay* | LOS |
| Ala Moana Blvd/Kahanamoku St | 7.8 | A | 7.8 | A |
| Ala Moana Blvd/Ena Rd/Kalia Rd | 44.5 | D | 66.5 | E |
| Kalia Rd/Rainbow Dr | 4.6 | A | 6.8 | A |
| Kalia Rd/Maluhia Dr | 15.2 | B | 15.2 | B |
| Kalia Rd/Saratoga Rd | 4.0 | A | 4.0 | A |
| Kalakaua Rd/Saratoga Rd/Kalaimoku St | 9.4 | A | 9.4 | A |
| Ala Moana Blvd/Kalakaua Ave/Pau St | 11.3 | B | 11.3 | B |
| Ala Moana Blvd/Kalakaua Ave/Niu St | 16.7 | B | 16.7 | B |

*Seconds per vehicle

The proposed 3-lane closure reduces the number of lanes on Kalia Road to one northbound lane and one southbound lane. At the intersection of Kalia Road with Ala Moana Boulevard, the northbound approach is assumed to have one shared all-way lane. As shown in the above tables, the study intersections are expected to operate at levels of service similar to existing conditions with the exception of the intersection of Kalia Road with Ala Moana Boulevard. Due to the reduction in lanes along Kalia Road, the intersection with Ala Moana Boulevard is expected to deteriorate to LOS “E” during both peak periods. In addition, an assessment of the projected queuing along Kalia Road as a result of these lane reductions indicates that the proposed 3-lane closure will result in significantly longer queue lengths on the Kalia Road approach of that intersection. As such, the proposed closure is expected to impact traffic operations along Kalia Road and at the intersection with Ala Moana Boulevard. This impact could be mitigated by the reduction of traffic volumes along Kalia Road by diverting traffic accessing the Hilton Hawaiian Village.

**2. With Traffic Diversion**

The projected midday and PM peak period traffic volumes and traffic operating conditions with the proposed 3-lane closure and traffic diversion are summarized in Tables 8 and 9. The existing conditions are provided for comparison purposes. LOS calculations are included in Appendix F.

**Table 8: Existing and Projected (3-Lane Closure with Traffic Diversion) Midday Intersection LOS Traffic Operating Conditions**

| Intersection | Exist | | 3-Lane w/ Div | |
|---|---|---|---|---|
| | Delay* | LOS | Delay* | LOS |
| Ala Moana Blvd/Kahanamoku St | 7.2 | A | 9.1 | A |
| Ala Moana Blvd/Ena Rd/Kalia Rd | 42.4 | D | 45.0 | D |
| Kalia Rd/Rainbow Dr | 4.7 | A | 3.7 | A |
| Kalia Rd/Maluhia Dr | 13.4 | B | 13.4 | B |
| Kalia Rd/Saratoga Rd | 4.8 | A | 4.8 | A |
| Kalakaua Rd/Saratoga Rd/Kalaimoku St | 9.8 | A | 9.8 | A |
| Ala Moana Blvd/Kalakaua Ave/Pau St | 9.4 | A | 9.4 | A |
| Ala Moana Blvd/Kalakaua Ave/Niu St | 14.3 | B | 14.3 | B |

*Seconds per vehicle

**Table 9: Existing and Projected (3--Lane Closure with Traffic Diversion) PM Intersection LOS Traffic Operating Conditions**

| Intersection | Exist | | 3-Lane w/ Div | |
|---|---|---|---|---|
| | Delay* | LOS | Delay* | LOS |
| Ala Moana Blvd/Kahanamoku St | 7.8 | A | 11.9 | B |
| Ala Moana Blvd/Ena Rd/Kalia Rd | 44.5 | D | 52.3 | D |

*Seconds per vehicle

**Table 9: Existing and Projected (3--Lane Closure with Traffic Diversion) PM Intersection LOS Traffic Operating Conditions (Cont'd)**

| Intersection | Exist | | 3-Lane w/ Div | |
|---|---|---|---|---|
| | Delay* | LOS | Delay* | LOS |
| Kalia Rd/Rainbow Dr | 4.6 | A | 3.9 | A |
| Kalia Rd/Maluhia Dr | 15.2 | B | 15.2 | B |
| Kalia Rd/Saratoga Rd | 4.0 | A | 4.0 | A |
| Kalakaua Rd/Saratoga Rd/Kalaimoku St | 9.4 | A | 9.4 | A |
| Ala Moana Blvd/Kalakaua Ave/Pau St | 11.3 | B | 11.3 | B |
| Ala Moana Blvd/Kalakaua Ave/Niu St | 16.7 | B | 16.7 | B |

*Seconds per vehicle

The proposed 3-lane closure reduces the number of lanes on Kalia Road to one northbound lane and one southbound lane. At the intersection of Kalia Road with Ala Moana Boulevard, the northbound approach is assumed to have one shared all-way lane. As shown in the above tables, the study intersections are expected to operate at levels of service similar to existing conditions with the exception of the intersection of Kalia Road with Ala Moana Boulevard which is expected to operate at LOS "B" during the PM peak period. As such, the proposed 3-lane closure along Kalia Road with traffic diversion is not expected to have a significant impact on traffic operations in the project vicinity.

## V. RECOMMENDATIONS

Based on the analysis of the traffic data, the following are the recommendations of this study associated with the construction of the Hilton Hawaiian Village Wastewater System Improvements:

*General Recommendations*

1. Prepare a Construction Management Plan (CMP) for the proposed Wastewater System Improvements project which includes discussions regarding the anticipated construction schedule and phasing, as well as, traffic circulation, traffic control, parking, and conflicts with public transportation during the construction period.

2. In general, lane closures along Kalia Road should be limited to 2-lane closures wherever possible to minimize the impact of the project on traffic operations in the project vicinity.

3. There are bus stops located along both sides of Kalia Road in the vicinity of the Hilton Hawaiian Village. The contractor should coordinate with the City and County of Honolulu Department of Transportation Services to ensure continued transit service along that roadway. Temporary relocation of the bus stops may be required to accommodate the anticipated work areas.

*2-Lane Closure Recommendations*

1. Provide two northbound and one southbound lane along Kalia Road.

2. At the intersection of Kalia Road with Ala Moana Boulevard, provide an exclusive left-turn lane and a shared all-way lane on the northbound approach of Kalia Road.

*3-Lane Closure Recommendations*

1. Provide one northbound and one southbound lane along Kalia Road.

2. At the intersection of Kalia Road with Ala Moana Boulevard, provide one shared all-way lane the northbound approach of Kalia Road.

3. Reduce traffic volumes along Kalia Road by diverting traffic accessing the Hilton Hawaiian Village from Rainbow Drive to Kahanamoku Street. A special duty officer may need to be stationed at the intersection of Kahanamoku Street with Ala Moana Boulevard to assist pedestrians and vehicular traffic at that intersection due to the anticipated increases in traffic volumes.

## VI. CONCLUSION

The proposed project involves the upgrade of the City sewer system to support existing and planned uses in the service district, including Hilton Hawaiian Village, Hale Koa Hotel and surrounding areas. The construction of the improvements will require a minimum closure of two travel lanes on Kalia Road with the occasional closure of a third lane due to the proposed sewer line alignment. The proposed 2-lane closure along Kalia Road is not expected to have a significant impact on traffic operations in the project vicinity. However, the closure of a third lane will require additional mitigative measures to reduce traffic volumes along Kalia Road.

# APPENDIX A

# EXISTING TRAFFIC COUNT DATA

# Wilson Okamoto Corporation

1907 S. Beretania Street, Suite 400
Honolulu, Hawaii

Counter:TU-0649
Counted By:TO
Weather:Clear

File Name : AlaKah Midday
Site Code : 00000001
Start Date : 6/13/2012
Page No : 1

Groups Printed- Unshifted

| | Southbound | Ala Moana Boulevard Westbound | | | | | Kahanamoku Street Northbound | | | | | Ala Moana Boulevard Eastbound | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Start Time | App. Total | Left | Thru | Right | Peds | App. Total | Left | Thru | Right | Peds | App. Total | Left | Thru | Right | Peds | App. Total | Int. Total |
| 11:00 AM | 0 | 10 | 200 | 0 | 0 | 210 | 5 | 0 | 26 | 60 | 91 | 0 | 202 | 13 | 0 | 215 | 516 |
| 11:15 AM | 0 | 17 | 195 | 0 | 0 | 212 | 21 | 0 | 34 | 56 | 111 | 0 | 187 | 11 | 0 | 198 | 521 |
| 11:30 AM | 0 | 12 | 191 | 0 | 0 | 203 | 26 | 0 | 24 | 39 | 89 | 0 | 195 | 16 | 0 | 211 | 503 |
| 11:45 AM | 0 | 19 | 226 | 0 | 0 | 245 | 23 | 0 | 18 | 58 | 99 | 0 | 215 | 8 | 0 | 223 | 567 |
| Total | 0 | 58 | 812 | 0 | 0 | 870 | 75 | 0 | 102 | 213 | 390 | 0 | 799 | 48 | 0 | 847 | 2107 |
| 12:00 PM | 0 | 13 | 193 | 0 | 0 | 206 | 15 | 0 | 22 | 51 | 88 | 0 | 194 | 14 | 0 | 208 | 502 |
| 12:15 PM | 0 | 17 | 226 | 0 | 0 | 243 | 13 | 0 | 27 | 47 | 87 | 0 | 225 | 13 | 0 | 238 | 568 |
| 12:30 PM | 0 | 17 | 185 | 0 | 0 | 202 | 22 | 0 | 21 | 78 | 121 | 0 | 229 | 14 | 0 | 243 | 566 |
| 12:45 PM | 0 | 18 | 185 | 0 | 0 | 203 | 8 | 0 | 22 | 53 | 83 | 0 | 255 | 10 | 0 | 265 | 551 |
| Total | 0 | 65 | 789 | 0 | 0 | 854 | 58 | 0 | 92 | 229 | 379 | 0 | 903 | 51 | 0 | 954 | 2187 |
| 01:00 PM | 0 | 19 | 178 | 0 | 0 | 197 | 20 | 0 | 24 | 50 | 94 | 0 | 203 | 18 | 0 | 221 | 512 |
| 01:15 PM | 0 | 15 | 204 | 0 | 0 | 219 | 16 | 0 | 27 | 61 | 104 | 0 | 267 | 21 | 0 | 288 | 611 |
| 01:30 PM | 0 | 16 | 172 | 0 | 0 | 188 | 16 | 0 | 20 | 52 | 88 | 0 | 222 | 9 | 0 | 231 | 507 |
| 01:45 PM | 0 | 28 | 214 | 0 | 0 | 242 | 12 | 0 | 31 | 57 | 100 | 0 | 247 | 19 | 0 | 266 | 608 |
| Total | 0 | 78 | 768 | 0 | 0 | 846 | 64 | 0 | 102 | 220 | 386 | 0 | 939 | 67 | 0 | 1006 | 2238 |
| Grand Total | 0 | 201 | 2369 | 0 | 0 | 2570 | 197 | 0 | 296 | 662 | 1155 | 0 | 2641 | 166 | 0 | 2807 | 6532 |
| Apprch % | | 7.8 | 92.2 | 0 | 0 | | 17.1 | 0 | 25.6 | 57.3 | | 0 | 94.1 | 5.9 | 0 | | |
| Total % | 0 | 3.1 | 36.3 | 0 | 0 | 39.3 | 3 | 0 | 4.5 | 10.1 | 17.7 | 0 | 40.4 | 2.5 | 0 | 43 | |

| | Southbound | Ala Moana Boulevard Westbound | | | | Kahanamoku Street Northbound | | | | Ala Moana Boulevard Eastbound | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Start Time | App. Total | Left | Thru | Right | App. Total | Left | Thru | Right | App. Total | Left | Thru | Right | App. Total | Int. Total |
| Peak Hour Analysis From 11:00 AM to 01:45 PM - Peak 1 of 1 | | | | | | | | | | | | | | |
| Peak Hour for Entire Intersection Begins at 01:00 PM | | | | | | | | | | | | | | |
| 01:00 PM | 0 | 19 | 178 | 0 | 197 | 20 | 0 | 24 | **44** | 0 | 203 | 18 | 221 | 462 |
| 01:15 PM | 0 | 15 | 204 | 0 | 219 | 16 | 0 | 27 | 43 | 0 | **267** | **21** | **288** | 550 |
| 01:30 PM | 0 | **16** | 172 | 0 | 188 | 16 | 0 | 20 | 36 | 0 | 222 | 9 | 231 | 455 |
| 01:45 PM | 0 | **28** | **214** | 0 | **242** | 12 | 0 | **31** | 43 | 0 | 247 | 19 | 266 | **551** |
| Total Volume | 0 | 78 | 768 | 0 | 846 | 64 | 0 | 102 | 166 | 0 | 939 | 67 | 1006 | 2018 |
| % App. Total | | 9.2 | 90.8 | 0 | | 38.6 | 0 | 61.4 | | 0 | 93.3 | 6.7 | | |
| PHF | .000 | .696 | .897 | .000 | .874 | .800 | .000 | .823 | .943 | .000 | .879 | .798 | .873 | .916 |

# Wilson Okamoto Corporation

1907 S. Beretana Street, Suite 400
Honolulu, HI 96826

Counter:TU-0649, T-1841
Counted By:RJ, GC
Weather:Clear

File Name : alakalena
Site Code : 00000001
Start Date : 1/18/2012
Page No : 1

Groups Printed- Unshifted

| | Ala Moana Blvd Southbound | | | | | Kalia Rd Westbound | | | | | Kalia Road Northbound | | | | | Ena Rd Eastbound | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Start Time | Left | Thru | Right | Peds | App. Total | Left | Thru | Right | Peds | App. Total | Left | Thru | Right | Peds | App. Total | Left | Thru | Right | Peds | App. Total | Int. Total |
| 11:00 AM | 26 | 78 | 7 | 17 | 128 | 92 | 16 | 24 | 20 | 152 | 9 | 102 | 63 | 95 | 269 | 2 | 9 | 18 | 35 | 64 | 613 |
| 11:15 AM | 27 | 123 | 15 | 12 | 177 | 80 | 20 | 19 | 40 | 159 | 13 | 168 | 84 | 88 | 353 | 1 | 11 | 20 | 28 | 60 | 749 |
| 11:30 AM | 34 | 101 | 13 | 11 | 159 | 111 | 5 | 26 | 18 | 160 | 4 | 106 | 57 | 138 | 305 | 2 | 20 | 15 | 53 | 90 | 714 |
| 11:45 AM | 18 | 84 | 17 | 14 | 133 | 99 | 16 | 22 | 22 | 159 | 9 | 138 | 75 | 123 | 345 | 2 | 11 | 9 | 25 | 47 | 684 |
| Total | 105 | 386 | 52 | 54 | 597 | 382 | 57 | 91 | 100 | 630 | 35 | 514 | 279 | 444 | 1272 | 7 | 51 | 62 | 141 | 261 | 2760 |
| 12:00 PM | 33 | 92 | 20 | 25 | 170 | 68 | 12 | 17 | 29 | 126 | 11 | 123 | 60 | 96 | 290 | 0 | 8 | 13 | 44 | 65 | 651 |
| 12:15 PM | 33 | 123 | 8 | 14 | 178 | 92 | 20 | 15 | 31 | 158 | 11 | 116 | 53 | 133 | 313 | 1 | 11 | 14 | 44 | 70 | 719 |
| 12:30 PM | 28 | 88 | 6 | 14 | 136 | 96 | 16 | 18 | 12 | 142 | 4 | 131 | 73 | 76 | 284 | 2 | 11 | 19 | 12 | 44 | 606 |
| 12:45 PM | 36 | 122 | 6 | 11 | 175 | 80 | 6 | 18 | 30 | 134 | 11 | 166 | 75 | 82 | 334 | 0 | 9 | 11 | 43 | 63 | 706 |
| Total | 130 | 425 | 40 | 64 | 659 | 336 | 54 | 68 | 102 | 560 | 37 | 536 | 261 | 387 | 1221 | 3 | 39 | 57 | 143 | 242 | 2682 |
| 02:00 PM | 30 | 93 | 13 | 7 | 143 | 80 | 13 | 24 | 36 | 153 | 8 | 169 | 72 | 67 | 316 | 1 | 12 | 16 | 46 | 75 | 687 |
| 02:15 PM | 38 | 85 | 9 | 10 | 142 | 75 | 13 | 27 | 18 | 133 | 9 | 192 | 96 | 124 | 421 | 4 | 15 | 10 | 36 | 65 | 761 |
| 02:30 PM | 21 | 76 | 14 | 6 | 117 | 105 | 22 | 21 | 4 | 152 | 7 | 152 | 108 | 100 | 367 | 0 | 20 | 7 | 10 | 37 | 673 |
| 02:45 PM | 35 | 129 | 7 | 14 | 185 | 69 | 17 | 22 | 13 | 121 | 11 | 193 | 99 | 88 | 391 | 2 | 14 | 9 | 41 | 66 | 763 |
| Total | 124 | 383 | 43 | 37 | 587 | 329 | 65 | 94 | 71 | 559 | 35 | 706 | 375 | 379 | 1495 | 7 | 61 | 42 | 133 | 243 | 2884 |
| 03:00 PM | 37 | 110 | 10 | 19 | 176 | 103 | 24 | 39 | 34 | 200 | 9 | 170 | 73 | 76 | 328 | 2 | 12 | 14 | 14 | 42 | 746 |
| 03:15 PM | 28 | 138 | 17 | 23 | 206 | 101 | 18 | 30 | 38 | 187 | 10 | 185 | 90 | 117 | 402 | 0 | 12 | 11 | 26 | 49 | 844 |
| 03:30 PM | 40 | 111 | 5 | 17 | 173 | 109 | 17 | 34 | 34 | 194 | 10 | 211 | 90 | 108 | 419 | 1 | 11 | 19 | 33 | 64 | 850 |
| 03:45 PM | 19 | 104 | 13 | 17 | 153 | 122 | 16 | 25 | 40 | 203 | 4 | 159 | 77 | 94 | 334 | 2 | 23 | 9 | 34 | 68 | 758 |
| Total | 124 | 463 | 45 | 76 | 708 | 435 | 75 | 128 | 146 | 784 | 33 | 725 | 330 | 395 | 1483 | 5 | 58 | 53 | 107 | 223 | 3198 |
| 04:00 PM | 25 | 118 | 8 | 17 | 168 | 91 | 25 | 38 | 48 | 202 | 12 | 207 | 111 | 84 | 414 | 3 | 14 | 13 | 37 | 67 | 851 |
| 04:15 PM | 37 | 143 | 7 | 25 | 212 | 112 | 28 | 23 | 24 | 187 | 21 | 185 | 102 | 98 | 406 | 2 | 16 | 13 | 41 | 72 | 877 |
| 04:30 PM | 19 | 151 | 16 | 17 | 203 | 100 | 15 | 33 | 37 | 185 | 8 | 196 | 113 | 105 | 422 | 2 | 27 | 9 | 30 | 68 | 878 |
| 04:45 PM | 30 | 137 | 8 | 16 | 191 | 97 | 12 | 35 | 37 | 181 | 11 | 230 | 99 | 128 | 468 | 2 | 17 | 11 | 54 | 84 | 924 |
| Total | 111 | 549 | 39 | 75 | 774 | 400 | 80 | 129 | 146 | 755 | 52 | 818 | 425 | 415 | 1710 | 9 | 74 | 46 | 162 | 291 | 3530 |
| Grand Total | 594 | 2206 | 219 | 306 | 3325 | 1882 | 331 | 510 | 565 | 3288 | 192 | 3299 | 1670 | 2020 | 7181 | 31 | 283 | 260 | 686 | 1260 | 15054 |
| Apprch % | 17.9 | 66.3 | 6.6 | 9.2 | | 57.2 | 10.1 | 15.5 | 17.2 | | 2.7 | 45.9 | 23.3 | 28.1 | | 2.5 | 22.5 | 20.6 | 54.4 | | |
| Total % | 3.9 | 14.7 | 1.5 | 2 | 22.1 | 12.5 | 2.2 | 3.4 | 3.8 | 21.8 | 1.3 | 21.9 | 11.1 | 13.4 | 47.7 | 0.2 | 1.9 | 1.7 | 4.6 | 8.4 | |

**Wilson Okamoto Corporation**
1907 S. Beretana Street, Suite 400
Honolulu, HI 96826

File Name : alakalena
Site Code : 00000001
Start Date : 1/18/2012


| | Ala Moana Blvd Southbound | | | | Kalia Rd Westbound | | | | Kalia Road Northbound | | | | Ena Rd Eastbound | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Start Time | Left | Thru | Right | App. Total | Left | Thru | Right | App. Total | Left | Thru | Right | App. Total | Left | Thru | Right | App. Total | Int. Total |
| Peak Hour Analysis From 11:00 AM to 12:45 PM - Peak 1 of 1 | | | | | | | | | | | | | | | | | |
| Peak Hour for Entire Intersection Begins at 11:15 AM | | | | | | | | | | | | | | | | | |
| 11:15 AM | 27 | 123 | 15 | 165 | 80 | 20 | 19 | 119 | 13 | 168 | 84 | 265 | 1 | 11 | 20 | 32 | 581 |
| 11:30 AM | 34 | 101 | 13 | 148 | 111 | 5 | 26 | 142 | 4 | 106 | 57 | 167 | 2 | 20 | 15 | 37 | 494 |
| 11:45 AM | 18 | 84 | 17 | 119 | 99 | 16 | 22 | 137 | 9 | 138 | 75 | 222 | 2 | 11 | 9 | 22 | 500 |
| 12:00 PM | 33 | 92 | 20 | 145 | 68 | 12 | 17 | 97 | 11 | 123 | 60 | 194 | 0 | 8 | 13 | 21 | 457 |
| Total Volume | 112 | 400 | 65 | 577 | 358 | 53 | 84 | 495 | 37 | 535 | 276 | 848 | 5 | 50 | 57 | 112 | 2032 |
| % App. Total | 19.4 | 69.3 | 11.3 | | 72.3 | 10.7 | 17 | | 4.4 | 63.1 | 32.5 | | 4.5 | 44.6 | 50.9 | | |
| PHF | .824 | .813 | .813 | .874 | .806 | .663 | .808 | .871 | .712 | .796 | .821 | .800 | .625 | .625 | .713 | .757 | .874 |
| Peak Hour Analysis From 02:00 PM to 03:15 PM - Peak 1 of 1 | | | | | | | | | | | | | | | | | |
| Peak Hour for Entire Intersection Begins at 02:30 PM | | | | | | | | | | | | | | | | | |
| 02:30 PM | 21 | 76 | 14 | 111 | 105 | 22 | 21 | 148 | 7 | 152 | 108 | 267 | 0 | 20 | 7 | 27 | 553 |
| 02:45 PM | 35 | 129 | 7 | 171 | 69 | 17 | 22 | 108 | 11 | 193 | 99 | 303 | 2 | 14 | 9 | 25 | 607 |
| 03:00 PM | 37 | 110 | 10 | 157 | 103 | 24 | 39 | 166 | 9 | 170 | 73 | 252 | 2 | 12 | 14 | 28 | 603 |
| 03:15 PM | 28 | 138 | 17 | 183 | 101 | 18 | 30 | 149 | 10 | 185 | 90 | 285 | 0 | 12 | 11 | 23 | 640 |
| Total Volume | 121 | 453 | 48 | 622 | 378 | 81 | 112 | 571 | 37 | 700 | 370 | 1107 | 4 | 58 | 41 | 103 | 2403 |
| % App. Total | 19.5 | 72.8 | 7.7 | | 66.2 | 14.2 | 19.6 | | 3.3 | 63.2 | 33.4 | | 3.9 | 56.3 | 39.8 | | |
| PHF | .818 | .821 | .706 | .850 | .900 | .844 | .718 | .860 | .841 | .907 | .856 | .913 | .500 | .725 | .732 | .920 | .939 |

# Wilson Okamoto Corporation

1907 S. Beretana Street, Suite 400
Honolulu, HI 96826

Counter:TU-0649, T-1841
Counted By:RJ, GC
Weather:Clear

File Name : Kalena Uturns
Site Code : 00000001
Start Date : 1/18/2012
Page No : 1

Groups Printed- Unshifted

| | Ala Moana Blvd Southbound | | | | | Kalia Rd Westbound | | | | | Kalia Road Northbound | | | | | Ena Rd Eastbound | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Start Time | Left | Thru | Right | Peds | App. Total | Left | Thru | Right | Peds | App. Total | Left | Thru | Right | Peds | App. Total | Left | Thru | Right | Peds | App. Total | Int. Total |
| 11:00 AM | 3 | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 5 |
| 11:15 AM | 4 | 0 | 0 | 0 | 4 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 5 |
| 11:30 AM | 3 | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 7 | 0 | 0 | 0 | 7 | 0 | 0 | 0 | 0 | 0 | 10 |
| 11:45 AM | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 3 |
| Total | 11 | 0 | 0 | 0 | 11 | 0 | 0 | 0 | 0 | 0 | 12 | 0 | 0 | 0 | 12 | 0 | 0 | 0 | 0 | 0 | 23 |
| 12:00 PM | 2 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 5 | 0 | 0 | 0 | 5 | 0 | 0 | 0 | 0 | 0 | 7 |
| 12:15 PM | 4 | 0 | 0 | 0 | 4 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 6 |
| 12:30 PM | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 2 |
| 12:45 PM | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 8 | 0 | 0 | 0 | 8 | 0 | 0 | 0 | 0 | 0 | 9 |
| Total | 8 | 0 | 0 | 0 | 8 | 0 | 0 | 0 | 0 | 0 | 16 | 0 | 0 | 0 | 16 | 0 | 0 | 0 | 0 | 0 | 24 |
| 02:00 PM | 2 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 5 |
| 02:15 PM | 2 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 4 | 0 | 0 | 0 | 4 | 0 | 0 | 0 | 0 | 0 | 6 |
| 02:30 PM | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 4 |
| 02:45 PM | 3 | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 4 | 0 | 0 | 0 | 4 | 0 | 0 | 0 | 0 | 0 | 7 |
| Total | 8 | 0 | 0 | 0 | 8 | 0 | 0 | 0 | 0 | 0 | 14 | 0 | 0 | 0 | 14 | 0 | 0 | 0 | 0 | 0 | 22 |
| 03:00 PM | 3 | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 5 | 0 | 0 | 0 | 5 | 0 | 0 | 0 | 0 | 0 | 8 |
| 03:15 PM | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 6 | 0 | 0 | 0 | 6 | 0 | 0 | 0 | 0 | 0 | 7 |
| 03:30 PM | 2 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 9 | 0 | 0 | 0 | 9 | 0 | 0 | 0 | 0 | 0 | 11 |
| 03:45 PM | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 4 |
| Total | 7 | 0 | 0 | 0 | 7 | 0 | 0 | 0 | 0 | 0 | 23 | 0 | 0 | 0 | 23 | 0 | 0 | 0 | 0 | 0 | 30 |
| 04:00 PM | 3 | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 5 | 0 | 0 | 0 | 5 | 0 | 0 | 0 | 0 | 0 | 8 |
| 04:15 PM | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 4 | 0 | 0 | 0 | 4 | 0 | 0 | 0 | 0 | 0 | 5 |
| 04:30 PM | 2 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 11 | 0 | 0 | 0 | 11 | 0 | 0 | 0 | 0 | 0 | 13 |
| 04:45 PM | 2 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 4 | 0 | 0 | 0 | 4 | 0 | 0 | 0 | 0 | 0 | 6 |
| Total | 8 | 0 | 0 | 0 | 8 | 0 | 0 | 0 | 0 | 0 | 24 | 0 | 0 | 0 | 24 | 0 | 0 | 0 | 0 | 0 | 32 |
| Grand Total | 42 | 0 | 0 | 0 | 42 | 0 | 0 | 0 | 0 | 0 | 89 | 0 | 0 | 0 | 89 | 0 | 0 | 0 | 0 | 0 | 131 |
| Apprch % | 100 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | | 100 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | | |
| Total % | 32.1 | 0 | 0 | 0 | 32.1 | 0 | 0 | 0 | 0 | 0 | 67.9 | 0 | 0 | 0 | 67.9 | 0 | 0 | 0 | 0 | 0 | |

## Wilson Okamoto Corporation

1907 S. Beretana Street, Suite 400
Honolulu, HI 96826

File Name : Kalena Uturns
Site Code : 00000001
Start Date : 1/18/2012
Page No : 2

| | Ala Moana Blvd Southbound | | | | Kalia Rd Westbound | | | | Kalia Road Northbound | | | | Ena Rd Eastbound | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Start Time | Left | Thru | Right | App. Total | Left | Thru | Right | App. Total | Left | Thru | Right | App. Total | Left | Thru | Right | App. Total | Int. Total |
| Peak Hour Analysis From 11:00 AM to 12:45 PM - Peak 1 of 1 | | | | | | | | | | | | | | | | | |
| Peak Hour for Entire Intersection Begins at 11:30 AM | | | | | | | | | | | | | | | | | |
| 11:30 AM | 3 | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 7 | 0 | 0 | 7 | 0 | 0 | 0 | 0 | 10 |
| 11:45 AM | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 3 |
| 12:00 PM | 2 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 5 | 0 | 0 | 5 | 0 | 0 | 0 | 0 | 7 |
| 12:15 PM | 4 | 0 | 0 | 4 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 6 |
| Total Volume | 10 | 0 | 0 | 10 | 0 | 0 | 0 | 0 | 16 | 0 | 0 | 16 | 0 | 0 | 0 | 0 | 26 |
| % App. Total | 100 | 0 | 0 | | 0 | 0 | 0 | | 100 | 0 | 0 | | 0 | 0 | 0 | | |
| PHF | .625 | .000 | .000 | .625 | .000 | .000 | .000 | .000 | .571 | .000 | .000 | .571 | .000 | .000 | .000 | .000 | .650 |
| Peak Hour Analysis From 02:00 PM to 03:15 PM - Peak 1 of 1 | | | | | | | | | | | | | | | | | |
| Peak Hour for Entire Intersection Begins at 02:30 PM | | | | | | | | | | | | | | | | | |
| 02:30 PM | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 4 |
| 02:45 PM | 3 | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 4 | 0 | 0 | 4 | 0 | 0 | 0 | 0 | 7 |
| 03:00 PM | 3 | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 5 | 0 | 0 | 5 | 0 | 0 | 0 | 0 | 8 |
| 03:15 PM | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 6 | 0 | 0 | 6 | 0 | 0 | 0 | 0 | 7 |
| Total Volume | 8 | 0 | 0 | 8 | 0 | 0 | 0 | 0 | 18 | 0 | 0 | 18 | 0 | 0 | 0 | 0 | 26 |
| % App. Total | 100 | 0 | 0 | | 0 | 0 | 0 | | 100 | 0 | 0 | | 0 | 0 | 0 | | |
| PHF | .667 | .000 | .000 | .667 | .000 | .000 | .000 | .000 | .750 | .000 | .000 | .750 | .000 | .000 | .000 | .000 | .813 |

# Wilson Okamoto Corporation

1907 S. Beretana Street, Suite 400
Honolulu, HI 96826

Counter:TU-0653, T-1839
Counted By:EV, JI
Weather:Clear

File Name : kalrai
Site Code : 00000002
Start Date : 1/18/2012
Page No : 1

Groups Printed- Unshifted

| | Southbound | Kalia Road Westbound | | | | | Rainbow Drive Northbound | | | | | Kalia Road Eastbound | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Start Time | App. Total | Left | Thru | Right | Peds | App. Total | Left | Thru | Right | Peds | App. Total | Left | Thru | Right | Peds | App. Total | Int. Total |
| 11:00 AM | 0 | 2 | 100 | 0 | 27 | 129 | 26 | 0 | 10 | 92 | 128 | 0 | 74 | 19 | 0 | 93 | 350 |
| 11:15 AM | 0 | 3 | 92 | 0 | 38 | 133 | 27 | 0 | 14 | 80 | 121 | 0 | 99 | 28 | 0 | 127 | 381 |
| 11:30 AM | 0 | 4 | 101 | 0 | 46 | 151 | 31 | 0 | 8 | 65 | 104 | 0 | 80 | 32 | 0 | 112 | 367 |
| 11:45 AM | 0 | 3 | 94 | 0 | 33 | 130 | 37 | 0 | 12 | 61 | 110 | 0 | 91 | 27 | 0 | 118 | 358 |
| Total | 0 | 12 | 387 | 0 | 144 | 543 | 121 | 0 | 44 | 298 | 463 | 0 | 344 | 106 | 0 | 450 | 1456 |
| 12:00 PM | 0 | 6 | 71 | 0 | 29 | 106 | 27 | 0 | 6 | 60 | 93 | 0 | 81 | 25 | 0 | 106 | 305 |
| 12:15 PM | 0 | 4 | 98 | 0 | 31 | 133 | 25 | 0 | 13 | 75 | 113 | 0 | 64 | 31 | 0 | 95 | 341 |
| 12:30 PM | 0 | 3 | 100 | 0 | 44 | 147 | 25 | 0 | 13 | 60 | 98 | 0 | 82 | 28 | 0 | 110 | 355 |
| 12:45 PM | 0 | 4 | 74 | 0 | 19 | 97 | 22 | 0 | 18 | 55 | 95 | 0 | 88 | 28 | 0 | 116 | 308 |
| Total | 0 | 17 | 343 | 0 | 123 | 483 | 99 | 0 | 50 | 250 | 399 | 0 | 315 | 112 | 0 | 427 | 1309 |
| 02:00 PM | 0 | 3 | 89 | 0 | 44 | 136 | 31 | 0 | 13 | 71 | 115 | 0 | 96 | 29 | 0 | 125 | 376 |
| 02:15 PM | 0 | 2 | 73 | 0 | 51 | 126 | 39 | 0 | 12 | 67 | 118 | 0 | 102 | 38 | 0 | 140 | 384 |
| 02:30 PM | 0 | 1 | 114 | 0 | 46 | 161 | 34 | 0 | 9 | 73 | 116 | 0 | 100 | 40 | 0 | 140 | 417 |
| 02:45 PM | 0 | 6 | 95 | 0 | 26 | 127 | 26 | 0 | 13 | 91 | 130 | 0 | 93 | 57 | 0 | 150 | 407 |
| Total | 0 | 12 | 371 | 0 | 167 | 550 | 130 | 0 | 47 | 302 | 479 | 0 | 391 | 164 | 0 | 555 | 1584 |
| 03:00 PM | 0 | 4 | 120 | 0 | 44 | 168 | 42 | 0 | 14 | 56 | 112 | 0 | 89 | 41 | 0 | 130 | 410 |
| 03:15 PM | 0 | 4 | 110 | 0 | 39 | 153 | 35 | 0 | 9 | 97 | 141 | 0 | 100 | 41 | 0 | 141 | 435 |
| 03:30 PM | 0 | 3 | 115 | 0 | 55 | 173 | 46 | 0 | 16 | 87 | 149 | 0 | 83 | 52 | 0 | 135 | 457 |
| 03:45 PM | 0 | 2 | 111 | 0 | 51 | 164 | 45 | 0 | 19 | 47 | 111 | 0 | 87 | 50 | 0 | 137 | 412 |
| Total | 0 | 13 | 456 | 0 | 189 | 658 | 168 | 0 | 58 | 287 | 513 | 0 | 359 | 184 | 0 | 543 | 1714 |
| 04:00 PM | 0 | 4 | 93 | 0 | 44 | 141 | 64 | 0 | 15 | 74 | 153 | 0 | 101 | 43 | 0 | 144 | 438 |
| 04:15 PM | 0 | 4 | 43 | 0 | 24 | 71 | 49 | 0 | 11 | 64 | 124 | 0 | 109 | 60 | 0 | 169 | 364 |
| 04:30 PM | 0 | 3 | 114 | 0 | 43 | 160 | 37 | 0 | 16 | 76 | 129 | 0 | 118 | 42 | 0 | 160 | 449 |
| 04:45 PM | 0 | 2 | 108 | 0 | 51 | 161 | 33 | 0 | 13 | 77 | 123 | 0 | 96 | 53 | 0 | 149 | 433 |
| Total | 0 | 13 | 358 | 0 | 162 | 533 | 183 | 0 | 55 | 291 | 529 | 0 | 424 | 198 | 0 | 622 | 1684 |
| Grand Total | 0 | 67 | 1915 | 0 | 785 | 2767 | 701 | 0 | 254 | 1428 | 2383 | 0 | 1833 | 764 | 0 | 2597 | 7747 |
| Apprch % | | 2.4 | 69.2 | 0 | 28.4 | | 29.4 | 0 | 10.7 | 59.9 | | 0 | 70.6 | 29.4 | 0 | | |
| Total % | 0 | 0.9 | 24.7 | 0 | 10.1 | 35.7 | 9 | 0 | 3.3 | 18.4 | 30.8 | 0 | 23.7 | 9.9 | 0 | 33.5 | |

# Wilson Okamoto Corporation

1907 S. Beretana Street, Suite 400
Honolulu, HI 96826


File Name : kalrai
Site Code : 00000002
Start Date : 1/18/2012
Page No : 2

| | Southbound | Kalia Road Westbound | | | | Rainbow Drive Northbound | | | | Kalia Road Eastbound | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Start Time | App. Total | Left | Thru | Right | App. Total | Left | Thru | Right | App. Total | Left | Thru | Right | App. Total | Int. Total |
| Peak Hour Analysis From 11:00 AM to 12:45 PM - Peak 1 of 1 | | | | | | | | | | | | | | |
| Peak Hour for Entire Intersection Begins at 11:00 AM | | | | | | | | | | | | | | |
| 11:00 AM | 0 | 2 | 100 | 0 | 102 | 26 | 0 | 10 | 36 | 0 | 74 | 19 | 93 | 231 |
| 11:15 AM | 0 | 3 | 92 | 0 | 95 | 27 | 0 | **14** | 41 | 0 | **99** | 28 | **127** | 263 |
| 11:30 AM | 0 | 4 | **101** | 0 | **105** | 31 | 0 | 8 | 39 | 0 | 80 | **32** | 112 | 256 |
| 11:45 AM | 0 | 3 | 94 | 0 | 97 | **37** | 0 | 12 | **49** | 0 | 91 | 27 | 118 | **264** |
| Total Volume | 0 | 12 | 387 | 0 | 399 | 121 | 0 | 44 | 165 | 0 | 344 | 106 | 450 | 1014 |
| % App. Total | | 3 | 97 | 0 | | 73.3 | 0 | 26.7 | | 0 | 76.4 | 23.6 | | |
| PHF | .000 | .750 | .958 | .000 | .950 | .818 | .000 | .786 | .842 | .000 | .869 | .828 | .886 | .960 |
| Peak Hour Analysis From 02:00 PM to 03:15 PM - Peak 1 of 1 | | | | | | | | | | | | | | |
| Peak Hour for Entire Intersection Begins at 02:30 PM | | | | | | | | | | | | | | |
| 02:30 PM | 0 | 1 | 114 | 0 | 115 | 34 | 0 | 9 | 43 | 0 | **100** | 40 | 140 | 298 |
| 02:45 PM | 0 | **6** | 95 | 0 | 101 | 26 | 0 | 13 | 39 | 0 | 93 | **57** | **150** | 290 |
| 03:00 PM | 0 | 4 | **120** | 0 | **124** | **42** | 0 | **14** | **56** | 0 | 89 | 41 | 130 | **310** |
| 03:15 PM | 0 | 4 | 110 | 0 | 114 | 35 | 0 | 9 | 44 | 0 | 100 | 41 | 141 | 299 |
| Total Volume | 0 | 15 | 439 | 0 | 454 | 137 | 0 | 45 | 182 | 0 | 382 | 179 | 561 | 1197 |
| % App. Total | | 3.3 | 96.7 | 0 | | 75.3 | 0 | 24.7 | | 0 | 68.1 | 31.9 | | |
| PHF | .000 | .625 | .915 | .000 | .915 | .815 | .000 | .804 | .813 | .000 | .955 | .785 | .935 | .965 |

# Wilson Okamoto Corporation

1907 S. Beretania Street, Suite 400
Honolulu, Hawaii

Counter:TU-0650
Counted By:TO
Weather:Clear

File Name : KalMal Midday
Site Code : 00000001
Start Date : 6/19/2012
Page No : 1

Groups Printed- Unshifted

| | Kalia Road Southbound | | | | | Maluhia Road Westbound | | | | | Kalia Road Northbound | | | | | Maluhia Road Eastbound | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Start Time | Left | Thru | Right | Peds | App. Total | Left | Thru | Right | Peds | App. Total | Left | Thru | Right | Peds | App. Total | Left | Thru | Right | Peds | App. Total | Int. Total |
| 11:00 AM | 16 | 75 | 5 | 80 | 176 | 3 | 9 | 14 | 32 | 58 | 0 | 66 | 1 | 6 | 73 | 12 | 5 | 3 | 93 | 113 | 420 |
| 11:15 AM | 6 | 69 | 1 | 54 | 130 | 1 | 9 | 14 | 21 | 45 | 2 | 99 | 5 | 25 | 131 | 7 | 2 | 2 | 71 | 82 | 388 |
| 11:30 AM | 10 | 76 | 4 | 50 | 140 | 4 | 5 | 22 | 10 | 41 | 1 | 93 | 7 | 22 | 123 | 16 | 2 | 1 | 118 | 137 | 441 |
| 11:45 AM | 18 | 64 | 8 | 41 | 131 | 3 | 9 | 29 | 16 | 57 | 3 | 92 | 4 | 23 | 122 | 9 | 3 | 2 | 93 | 107 | 417 |
| Total | 50 | 284 | 18 | 225 | 577 | 11 | 32 | 79 | 79 | 201 | 6 | 350 | 17 | 76 | 449 | 44 | 12 | 8 | 375 | 439 | 1666 |
| 12:00 PM | 14 | 66 | 9 | 57 | 146 | 4 | 6 | 18 | 36 | 64 | 2 | 84 | 4 | 37 | 127 | 13 | 4 | 4 | 128 | 149 | 486 |
| 12:15 PM | 11 | 65 | 13 | 56 | 145 | 4 | 4 | 8 | 24 | 40 | 2 | 74 | 2 | 17 | 95 | 8 | 2 | 7 | 70 | 87 | 367 |
| 12:30 PM | 18 | 83 | 8 | 59 | 168 | 6 | 7 | 14 | 12 | 39 | 2 | 66 | 4 | 17 | 89 | 10 | 6 | 2 | 109 | 127 | 423 |
| 12:45 PM | 12 | 63 | 7 | 59 | 141 | 4 | 5 | 8 | 10 | 27 | 1 | 76 | 2 | 10 | 89 | 8 | 4 | 1 | 51 | 64 | 321 |
| Total | 55 | 277 | 37 | 231 | 600 | 18 | 22 | 48 | 82 | 170 | 7 | 300 | 12 | 81 | 400 | 39 | 16 | 14 | 358 | 427 | 1597 |
| 01:00 PM | 17 | 86 | 4 | 56 | 163 | 0 | 3 | 13 | 14 | 30 | 0 | 80 | 1 | 8 | 89 | 6 | 2 | 0 | 99 | 107 | 389 |
| 01:15 PM | 21 | 83 | 4 | 44 | 152 | 4 | 5 | 18 | 33 | 60 | 5 | 77 | 6 | 28 | 116 | 9 | 5 | 2 | 81 | 97 | 425 |
| 01:30 PM | 28 | 90 | 5 | 56 | 179 | 4 | 3 | 11 | 20 | 38 | 3 | 80 | 5 | 21 | 109 | 6 | 4 | 2 | 93 | 105 | 431 |
| 01:45 PM | 27 | 70 | 9 | 61 | 167 | 3 | 1 | 18 | 11 | 33 | 2 | 73 | 3 | 32 | 110 | 6 | 3 | 1 | 98 | 108 | 418 |
| Total | 93 | 329 | 22 | 217 | 661 | 11 | 12 | 60 | 78 | 161 | 10 | 310 | 15 | 89 | 424 | 27 | 14 | 5 | 371 | 417 | 1663 |
| Grand Total | 198 | 890 | 77 | 673 | 1838 | 40 | 66 | 187 | 239 | 532 | 23 | 960 | 44 | 246 | 1273 | 110 | 42 | 27 | 1104 | 1283 | 4926 |
| Apprch % | 10.8 | 48.4 | 4.2 | 36.6 | | 7.5 | 12.4 | 35.2 | 44.9 | | 1.8 | 75.4 | 3.5 | 19.3 | | 8.6 | 3.3 | 2.1 | 86 | | |
| Total % | 4 | 18.1 | 1.6 | 13.7 | 37.3 | 0.8 | 1.3 | 3.8 | 4.9 | 10.8 | 0.5 | 19.5 | 0.9 | 5 | 25.8 | 2.2 | 0.9 | 0.5 | 22.4 | 26 | |

| | Kalia Road Southbound | | | | Maluhia Road Westbound | | | | Kalia Road Northbound | | | | Maluhia Road Eastbound | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Start Time | Left | Thru | Right | App. Total | Left | Thru | Right | App. Total | Left | Thru | Right | App. Total | Left | Thru | Right | App. Total | Int. Total |
| Peak Hour Analysis From 11:00 AM to 01:45 PM - Peak 1 of 1 | | | | | | | | | | | | | | | | | |
| Peak Hour for Entire Intersection Begins at 11:15 AM | | | | | | | | | | | | | | | | | |
| 11:15 AM | 6 | 69 | 1 | 76 | 1 | **9** | 14 | 24 | 2 | **99** | 5 | **106** | 7 | 2 | 2 | 11 | 217 |
| 11:30 AM | 10 | **76** | 4 | **90** | **4** | 5 | 22 | 31 | 1 | 93 | **7** | 101 | **16** | 2 | 1 | 19 | 241 |
| 11:45 AM | **18** | 64 | 8 | 90 | 3 | 9 | **29** | **41** | 3 | 92 | 4 | 99 | 9 | 3 | 2 | 14 | **244** |
| 12:00 PM | 14 | 66 | **9** | 89 | 4 | 6 | 18 | 28 | 2 | 84 | 4 | 90 | 13 | **4** | **4** | **21** | 228 |
| Total Volume | 48 | 275 | 22 | 345 | 12 | 29 | 83 | 124 | 8 | 368 | 20 | 396 | 45 | 11 | 9 | 65 | 930 |
| % App. Total | 13.9 | 79.7 | 6.4 | | 9.7 | 23.4 | 66.9 | | 2 | 92.9 | 5.1 | | 69.2 | 16.9 | 13.8 | | |
| PHF | .667 | .905 | .611 | .958 | .750 | .806 | .716 | .756 | .667 | .929 | .714 | .934 | .703 | .688 | .563 | .774 | .953 |

# Wilson Okamoto Corporation

1907 S. Beretana Street, Suite 400
Honolulu, HI 96826

Counter:TU-0651, TU-0652
Counted By:DY, CY
Weather:Clear

File Name : kalisar
Site Code : 00000002
Start Date : 1/19/2012
Page No : 1

Groups Printed- Unshifted

| | Saratoga Road Southbound | | | | | Kalia Road Westbound | | | | | Northbound | Kalia Road Eastbound | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Start Time | Left | Thru | Right | Peds | App. Total | Left | Thru | Right | Peds | App. Total | App. Total | Left | Thru | Right | Peds | App. Total | Int. Total |
| 11:00 AM | 8 | 0 | 37 | 52 | 97 | 0 | 51 | 60 | 0 | 111 | 0 | 51 | 23 | 0 | 67 | 141 | 349 |
| 11:15 AM | 4 | 0 | 37 | 31 | 72 | 0 | 47 | 69 | 0 | 116 | 0 | 59 | 20 | 0 | 33 | 112 | 300 |
| 11:30 AM | 3 | 0 | 39 | 44 | 86 | 0 | 58 | 82 | 0 | 140 | 0 | 48 | 14 | 0 | 34 | 96 | 322 |
| 11:45 AM | 9 | 0 | 19 | 30 | 58 | 0 | 42 | 70 | 0 | 112 | 0 | 44 | 13 | 0 | 31 | 88 | 258 |
| Total | 24 | 0 | 132 | 157 | 313 | 0 | 198 | 281 | 0 | 479 | 0 | 202 | 70 | 0 | 165 | 437 | 1229 |
| 12:00 PM | 6 | 0 | 38 | 49 | 93 | 0 | 46 | 69 | 0 | 115 | 0 | 60 | 17 | 0 | 40 | 117 | 325 |
| 12:15 PM | 12 | 0 | 37 | 50 | 99 | 0 | 46 | 62 | 0 | 108 | 0 | 60 | 21 | 0 | 27 | 108 | 315 |
| 12:30 PM | 5 | 0 | 39 | 35 | 79 | 0 | 60 | 57 | 0 | 117 | 0 | 54 | 14 | 0 | 47 | 115 | 311 |
| 12:45 PM | 8 | 0 | 25 | 49 | 82 | 0 | 44 | 59 | 0 | 103 | 0 | 52 | 9 | 0 | 65 | 126 | 311 |
| Total | 31 | 0 | 139 | 183 | 353 | 0 | 196 | 247 | 0 | 443 | 0 | 226 | 61 | 0 | 179 | 466 | 1262 |
| 02:00 PM | 6 | 0 | 33 | 41 | 80 | 0 | 53 | 67 | 0 | 120 | 0 | 62 | 22 | 0 | 56 | 140 | 340 |
| 02:15 PM | 11 | 0 | 37 | 23 | 71 | 0 | 66 | 62 | 0 | 128 | 0 | 61 | 29 | 0 | 45 | 135 | 334 |
| 02:30 PM | 5 | 0 | 32 | 27 | 64 | 0 | 64 | 73 | 0 | 137 | 0 | 48 | 20 | 0 | 40 | 108 | 309 |
| 02:45 PM | 9 | 0 | 40 | 47 | 96 | 0 | 41 | 67 | 0 | 108 | 0 | 53 | 23 | 0 | 57 | 133 | 337 |
| Total | 31 | 0 | 142 | 138 | 311 | 0 | 224 | 269 | 0 | 493 | 0 | 224 | 94 | 0 | 198 | 516 | 1320 |
| 03:00 PM | 11 | 0 | 35 | 59 | 105 | 0 | 61 | 80 | 0 | 141 | 0 | 46 | 20 | 0 | 64 | 130 | 376 |
| 03:15 PM | 5 | 0 | 41 | 38 | 84 | 0 | 65 | 69 | 0 | 134 | 0 | 71 | 24 | 0 | 71 | 166 | 384 |
| 03:30 PM | 9 | 0 | 42 | 31 | 82 | 0 | 72 | 57 | 0 | 129 | 0 | 65 | 16 | 0 | 83 | 164 | 375 |
| 03:45 PM | 5 | 0 | 49 | 22 | 76 | 0 | 53 | 80 | 0 | 133 | 0 | 70 | 22 | 0 | 36 | 128 | 337 |
| Total | 30 | 0 | 167 | 150 | 347 | 0 | 251 | 286 | 0 | 537 | 0 | 252 | 82 | 0 | 254 | 588 | 1472 |
| 04:00 PM | 8 | 0 | 40 | 34 | 82 | 0 | 71 | 106 | 0 | 177 | 0 | 89 | 23 | 0 | 79 | 191 | 450 |
| 04:15 PM | 8 | 0 | 46 | 70 | 124 | 0 | 56 | 95 | 0 | 151 | 0 | 78 | 24 | 0 | 57 | 159 | 434 |
| 04:30 PM | 6 | 0 | 48 | 40 | 94 | 0 | 53 | 90 | 0 | 143 | 0 | 83 | 30 | 0 | 81 | 194 | 431 |
| 04:45 PM | 3 | 0 | 40 | 48 | 91 | 0 | 52 | 84 | 0 | 136 | 0 | 78 | 35 | 0 | 47 | 160 | 387 |
| Total | 25 | 0 | 174 | 192 | 391 | 0 | 232 | 375 | 0 | 607 | 0 | 328 | 112 | 0 | 264 | 704 | 1702 |
| Grand Total | 141 | 0 | 754 | 820 | 1715 | 0 | 1101 | 1456 | 0 | 2559 | 0 | 1232 | 419 | 0 | 1060 | 2711 | 6985 |
| Apprch % | 8.2 | 0 | 44 | 47.8 | | 0 | 43 | 57 | 0 | | | 45.4 | 15.5 | 0 | 39.1 | | |
| Total % | 2 | 0 | 10.8 | 11.7 | 24.6 | 0 | 15.8 | 20.9 | 0 | 36.6 | 0 | 17.6 | 6 | 0 | 15.2 | 38.8 | |

# Wilson Okamoto Corporation

1907 S. Beretana Street, Suite 400
Honolulu, HI 96826

File Name : kalisar
Site Code : 00000002
Start Date : 1/19/2012
Page No : 2

| | Saratoga Road Southbound | | | | Kalia Road Westbound | | | | Northbound | Kalia Road Eastbound | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Start Time | Left | Thru | Right | App. Total | Left | Thru | Right | App. Total | App. Total | Left | Thru | Right | App. Total | Int. Total |
| Peak Hour Analysis From 11:00 AM to 12:45 PM - Peak 1 of 1 | | | | | | | | | | | | | | |
| Peak Hour for Entire Intersection Begins at 11:30 AM | | | | | | | | | | | | | | |
| 11:30 AM | 3 | 0 | **39** | 42 | 0 | **58** | **82** | **140** | 0 | 48 | 14 | 0 | 62 | **244** |
| 11:45 AM | 9 | 0 | 19 | 28 | 0 | 42 | 70 | 112 | 0 | 44 | 13 | 0 | 57 | 197 |
| 12:00 PM | 6 | 0 | 38 | 44 | 0 | 46 | 69 | 115 | 0 | **60** | 17 | 0 | 77 | 236 |
| 12:15 PM | **12** | 0 | 37 | **49** | 0 | 46 | 62 | 108 | 0 | 60 | **21** | 0 | **81** | 238 |
| Total Volume | 30 | 0 | 133 | 163 | 0 | 192 | 283 | 475 | 0 | 212 | 65 | 0 | 277 | 915 |
| % App. Total | 18.4 | 0 | 81.6 | | 0 | 40.4 | 59.6 | | | 76.5 | 23.5 | 0 | | |
| PHF | .625 | .000 | .853 | .832 | .000 | .828 | .863 | .848 | .000 | .883 | .774 | .000 | .855 | .938 |
| Peak Hour Analysis From 02:00 PM to 03:15 PM - Peak 1 of 1 | | | | | | | | | | | | | | |
| Peak Hour for Entire Intersection Begins at 02:30 PM | | | | | | | | | | | | | | |
| 02:30 PM | 5 | 0 | 32 | 37 | 0 | 64 | 73 | 137 | 0 | 48 | 20 | 0 | 68 | 242 |
| 02:45 PM | 9 | 0 | 40 | **49** | 0 | 41 | 67 | 108 | 0 | 53 | 23 | 0 | 76 | 233 |
| 03:00 PM | **11** | 0 | 35 | 46 | 0 | 61 | **80** | **141** | 0 | 46 | 20 | 0 | 66 | 253 |
| 03:15 PM | 5 | 0 | **41** | 46 | 0 | **65** | 69 | 134 | 0 | **71** | **24** | 0 | **95** | **275** |
| Total Volume | 30 | 0 | 148 | 178 | 0 | 231 | 289 | 520 | 0 | 218 | 87 | 0 | 305 | 1003 |
| % App. Total | 16.9 | 0 | 83.1 | | 0 | 44.4 | 55.6 | | | 71.5 | 28.5 | 0 | | |
| PHF | .682 | .000 | .902 | .908 | .000 | .888 | .903 | .922 | .000 | .768 | .906 | .000 | .803 | .912 |

# Wilson Okamoto Corporation

1907 S. Beretana Street, Suite 400
Honolulu, HI 96826

Counter:TU-0649, T-1841
Counted By:RJ, GC
Weather:Clear

File Name : kalsar
Site Code : 00000001
Start Date : 1/19/2012
Page No : 1

Groups Printed- Unshifted

| | Kalaimoku Street Southbound | | | | | Westbound | Saratoga Rd Northbound | | | | | Kalakaua Avenue Eastbound | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Start Time | Left | Thru | Right | Peds | App. Total | App. Total | Left | Thru | Right | Peds | App. Total | Left | Thru | Right | Peds | App. Total | Int. Total |
| 11:00 AM | 0 | 0 | 0 | 60 | 60 | 0 | 0 | 44 | 82 | 82 | 208 | 11 | 303 | 55 | 84 | 453 | 721 |
| 11:15 AM | 0 | 0 | 0 | 56 | 56 | 0 | 0 | 57 | 81 | 59 | 197 | 18 | 313 | 51 | 34 | 416 | 669 |
| 11:30 AM | 0 | 0 | 0 | 74 | 74 | 0 | 0 | 48 | 80 | 89 | 217 | 15 | 306 | 56 | 36 | 413 | 704 |
| 11:45 AM | 0 | 0 | 0 | 60 | 60 | 0 | 0 | 46 | 83 | 88 | 217 | 14 | 339 | 50 | 34 | 437 | 714 |
| Total | 0 | 0 | 0 | 250 | 250 | 0 | 0 | 195 | 326 | 318 | 839 | 58 | 1261 | 212 | 188 | 1719 | 2808 |
| 12:00 PM | 0 | 0 | 0 | 35 | 35 | 0 | 0 | 43 | 90 | 82 | 215 | 11 | 308 | 69 | 49 | 437 | 687 |
| 12:15 PM | 0 | 0 | 0 | 60 | 60 | 0 | 0 | 63 | 79 | 85 | 227 | 7 | 295 | 58 | 32 | 392 | 679 |
| 12:30 PM | 0 | 0 | 0 | 57 | 57 | 0 | 0 | 44 | 75 | 77 | 196 | 11 | 367 | 50 | 40 | 468 | 721 |
| 12:45 PM | 0 | 0 | 0 | 56 | 56 | 0 | 0 | 52 | 77 | 80 | 209 | 6 | 352 | 43 | 39 | 440 | 705 |
| Total | 0 | 0 | 0 | 208 | 208 | 0 | 0 | 202 | 321 | 324 | 847 | 35 | 1322 | 220 | 160 | 1737 | 2792 |
| 02:00 PM | 0 | 0 | 0 | 46 | 46 | 0 | 0 | 46 | 99 | 94 | 239 | 14 | 347 | 47 | 49 | 457 | 742 |
| 02:15 PM | 0 | 0 | 0 | 43 | 43 | 0 | 0 | 56 | 76 | 127 | 259 | 15 | 341 | 61 | 40 | 457 | 759 |
| 02:30 PM | 0 | 0 | 0 | 40 | 40 | 0 | 0 | 45 | 72 | 104 | 221 | 20 | 420 | 44 | 36 | 520 | 781 |
| 02:45 PM | 0 | 0 | 0 | 61 | 61 | 0 | 0 | 51 | 81 | 84 | 216 | 19 | 363 | 64 | 38 | 484 | 761 |
| Total | 0 | 0 | 0 | 190 | 190 | 0 | 0 | 198 | 328 | 409 | 935 | 68 | 1471 | 216 | 163 | 1918 | 3043 |
| 03:00 PM | 0 | 0 | 0 | 97 | 97 | 0 | 0 | 67 | 80 | 62 | 209 | 12 | 319 | 60 | 56 | 447 | 753 |
| 03:15 PM | 0 | 0 | 0 | 55 | 55 | 0 | 0 | 77 | 84 | 128 | 289 | 16 | 416 | 52 | 59 | 543 | 887 |
| 03:30 PM | 0 | 0 | 0 | 82 | 82 | 0 | 0 | 62 | 89 | 117 | 268 | 7 | 409 | 58 | 69 | 543 | 893 |
| 03:45 PM | 0 | 0 | 0 | 57 | 57 | 0 | 0 | 54 | 92 | 107 | 253 | 17 | 487 | 54 | 33 | 591 | 901 |
| Total | 0 | 0 | 0 | 291 | 291 | 0 | 0 | 260 | 345 | 414 | 1019 | 52 | 1631 | 224 | 217 | 2124 | 3434 |
| 04:00 PM | 0 | 0 | 0 | 44 | 44 | 0 | 0 | 91 | 122 | 92 | 305 | 12 | 446 | 66 | 62 | 586 | 935 |
| 04:15 PM | 0 | 0 | 0 | 61 | 61 | 0 | 0 | 104 | 87 | 123 | 314 | 16 | 393 | 56 | 44 | 509 | 884 |
| 04:30 PM | 0 | 0 | 0 | 68 | 68 | 0 | 0 | 86 | 88 | 115 | 289 | 18 | 463 | 45 | 68 | 594 | 951 |
| 04:45 PM | 0 | 0 | 0 | 89 | 89 | 0 | 0 | 73 | 91 | 97 | 261 | 12 | 436 | 40 | 54 | 542 | 892 |
| Total | 0 | 0 | 0 | 262 | 262 | 0 | 0 | 354 | 388 | 427 | 1169 | 58 | 1738 | 207 | 228 | 2231 | 3662 |
| Grand Total | 0 | 0 | 0 | 1201 | 1201 | 0 | 0 | 1209 | 1708 | 1892 | 4809 | 271 | 7423 | 1079 | 956 | 9729 | 15739 |
| Apprch % | 0 | 0 | 0 | 100 | | | 0 | 25.1 | 35.5 | 39.3 | | 2.8 | 76.3 | 11.1 | 9.8 | | |
| Total % | 0 | 0 | 0 | 7.6 | 7.6 | 0 | 0 | 7.7 | 10.9 | 12 | 30.6 | 1.7 | 47.2 | 6.9 | 6.1 | 61.8 | |

# Wilson Okamoto Corporation

1907 S. Beretana Street, Suite 400
Honolulu, HI 96826

File Name : kalsar
Site Code : 00000001
Start Date : 1/19/2012
Page No : 2

| | Kalaimoku Street Southbound | | | | Westbound | Saratoga Rd Northbound | | | | Kalakaua Avenue Eastbound | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Start Time | Left | Thru | Right | App. Total | App. Total | Left | Thru | Right | App. Total | Left | Thru | Right | App. Total | Int. Total |
| Peak Hour Analysis From 11:00 AM to 12:45 PM - Peak 1 of 1 | | | | | | | | | | | | | | |
| Peak Hour for Entire Intersection Begins at 11:45 AM | | | | | | | | | | | | | | |
| 11:45 AM | 0 | 0 | 0 | 0 | 0 | 0 | 46 | 83 | 129 | **14** | 339 | 50 | 403 | 532 |
| 12:00 PM | 0 | 0 | 0 | 0 | 0 | 0 | 43 | **90** | 133 | 11 | 308 | **69** | 388 | 521 |
| 12:15 PM | 0 | 0 | 0 | 0 | 0 | 0 | **63** | 79 | **142** | 7 | 295 | 58 | 360 | 502 |
| 12:30 PM | 0 | 0 | 0 | 0 | 0 | 0 | 44 | 75 | 119 | 11 | **367** | 50 | **426** | **547** |
| Total Volume | 0 | 0 | 0 | 0 | 0 | 0 | 196 | 327 | 523 | 43 | 1309 | 227 | 1579 | 2102 |
| % App. Total | 0 | 0 | 0 | | | 0 | 37.5 | 62.5 | | 2.7 | 82.9 | 14.4 | | |
| PHF | .000 | .000 | .000 | .000 | .000 | .000 | .778 | .908 | .921 | .768 | .892 | .822 | .922 | .961 |

| | Kalaimoku Street Southbound | | | | Westbound | Saratoga Rd Northbound | | | | Kalakaua Avenue Eastbound | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Start Time | Left | Thru | Right | App. Total | App. Total | Left | Thru | Right | App. Total | Left | Thru | Right | App. Total | Int. Total |
| Peak Hour Analysis From 02:00 PM to 03:15 PM - Peak 1 of 1 | | | | | | | | | | | | | | |
| Peak Hour for Entire Intersection Begins at 02:30 PM | | | | | | | | | | | | | | |
| 02:30 PM | 0 | 0 | 0 | 0 | 0 | 0 | 45 | 72 | 117 | **20** | **420** | 44 | **484** | 601 |
| 02:45 PM | 0 | 0 | 0 | 0 | 0 | 0 | 51 | 81 | 132 | 19 | 363 | **64** | 446 | 578 |
| 03:00 PM | 0 | 0 | 0 | 0 | 0 | 0 | 67 | 80 | 147 | 12 | 319 | 60 | 391 | 538 |
| 03:15 PM | 0 | 0 | 0 | 0 | 0 | 0 | **77** | **84** | **161** | 16 | 416 | 52 | 484 | **645** |
| Total Volume | 0 | 0 | 0 | 0 | 0 | 0 | 240 | 317 | 557 | 67 | 1518 | 220 | 1805 | 2362 |
| % App. Total | 0 | 0 | 0 | | | 0 | 43.1 | 56.9 | | 3.7 | 84.1 | 12.2 | | |
| PHF | .000 | .000 | .000 | .000 | .000 | .000 | .779 | .943 | .865 | .838 | .904 | .859 | .932 | .916 |

# Wilson Okamoto Corporation

1907 S. Beretana Street, Suite 400
Honolulu, HI 96826

Counter:TU-0652, TU-0653
Counted By:DY, CY
Weather:Clear

File Name : kalpao
Site Code : 00000004
Start Date : 1/18/2012
Page No : 1

Groups Printed- Unshifted

| | Pao Street Southbound | | | | | Kalakaua Ave Westbound | | | | | Ala Moana Blvd Northbound | | | | | Kalakaua Ave Eastbound | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Start Time | Left | Thru | Right | Peds | App. Total | Left | Thru | Right | Peds | App. Total | Left | Thru | Right | Peds | App. Total | Left | Thru | Right | Peds | App. Total | Int. Total |
| 11:00 AM | 0 | 0 | 0 | 51 | 51 | 0 | 3 | 2 | 0 | 5 | 0 | 26 | 113 | 57 | 196 | 31 | 295 | 0 | 22 | 348 | 600 |
| 11:15 AM | 0 | 0 | 0 | 42 | 42 | 0 | 3 | 0 | 0 | 3 | 0 | 17 | 152 | 52 | 221 | 32 | 390 | 0 | 19 | 441 | 707 |
| 11:30 AM | 0 | 0 | 0 | 20 | 20 | 0 | 3 | 3 | 0 | 6 | 0 | 19 | 113 | 56 | 188 | 28 | 314 | 0 | 14 | 356 | 570 |
| 11:45 AM | 0 | 0 | 0 | 25 | 25 | 0 | 3 | 4 | 0 | 7 | 0 | 29 | 140 | 66 | 235 | 19 | 370 | 0 | 24 | 413 | 680 |
| Total | 0 | 0 | 0 | 138 | 138 | 0 | 12 | 9 | 0 | 21 | 0 | 91 | 518 | 231 | 840 | 110 | 1369 | 0 | 79 | 1558 | 2557 |
| 12:00 PM | 0 | 0 | 0 | 41 | 41 | 0 | 3 | 0 | 0 | 3 | 0 | 19 | 120 | 47 | 186 | 34 | 338 | 0 | 15 | 387 | 617 |
| 12:15 PM | 0 | 0 | 0 | 33 | 33 | 0 | 2 | 1 | 0 | 3 | 0 | 16 | 105 | 56 | 177 | 28 | 327 | 0 | 24 | 379 | 592 |
| 12:30 PM | 0 | 0 | 0 | 35 | 35 | 0 | 4 | 1 | 0 | 5 | 0 | 23 | 151 | 62 | 236 | 16 | 351 | 0 | 28 | 395 | 671 |
| 12:45 PM | 0 | 0 | 0 | 49 | 49 | 0 | 4 | 4 | 0 | 8 | 0 | 22 | 134 | 53 | 209 | 30 | 396 | 0 | 20 | 446 | 712 |
| Total | 0 | 0 | 0 | 158 | 158 | 0 | 13 | 6 | 0 | 19 | 0 | 80 | 510 | 218 | 808 | 108 | 1412 | 0 | 87 | 1607 | 2592 |
| 02:00 PM | 0 | 0 | 0 | 31 | 31 | 0 | 0 | 1 | 0 | 1 | 0 | 24 | 160 | 43 | 227 | 36 | 375 | 0 | 14 | 425 | 684 |
| 02:15 PM | 0 | 0 | 0 | 42 | 42 | 0 | 3 | 0 | 0 | 3 | 0 | 40 | 151 | 49 | 240 | 24 | 390 | 0 | 17 | 431 | 716 |
| 02:30 PM | 0 | 0 | 0 | 35 | 35 | 0 | 3 | 2 | 0 | 5 | 0 | 27 | 184 | 64 | 275 | 23 | 427 | 0 | 9 | 459 | 774 |
| 02:45 PM | 0 | 0 | 0 | 37 | 37 | 0 | 3 | 2 | 0 | 5 | 0 | 32 | 148 | 46 | 226 | 31 | 441 | 0 | 16 | 488 | 756 |
| Total | 0 | 0 | 0 | 145 | 145 | 0 | 9 | 5 | 0 | 14 | 0 | 123 | 643 | 202 | 968 | 114 | 1633 | 0 | 56 | 1803 | 2930 |
| 03:00 PM | 0 | 0 | 0 | 45 | 45 | 0 | 4 | 1 | 0 | 5 | 0 | 44 | 183 | 40 | 267 | 24 | 411 | 0 | 12 | 447 | 764 |
| 03:15 PM | 0 | 0 | 0 | 33 | 33 | 0 | 3 | 1 | 0 | 4 | 0 | 52 | 175 | 84 | 311 | 32 | 422 | 0 | 16 | 470 | 818 |
| 03:30 PM | 0 | 0 | 0 | 45 | 45 | 0 | 2 | 2 | 0 | 4 | 0 | 44 | 179 | 65 | 288 | 36 | 453 | 0 | 23 | 512 | 849 |
| 03:45 PM | 0 | 0 | 0 | 48 | 48 | 0 | 3 | 2 | 0 | 5 | 0 | 35 | 171 | 83 | 289 | 34 | 451 | 0 | 28 | 513 | 855 |
| Total | 0 | 0 | 0 | 171 | 171 | 0 | 12 | 6 | 0 | 18 | 0 | 175 | 708 | 272 | 1155 | 126 | 1737 | 0 | 79 | 1942 | 3286 |
| 04:00 PM | 0 | 0 | 0 | 57 | 57 | 0 | 5 | 2 | 0 | 7 | 0 | 46 | 167 | 57 | 270 | 38 | 451 | 0 | 33 | 522 | 856 |
| 04:15 PM | 0 | 0 | 0 | 64 | 64 | 0 | 6 | 3 | 0 | 9 | 0 | 36 | 205 | 81 | 322 | 41 | 483 | 0 | 30 | 554 | 949 |
| 04:30 PM | 0 | 0 | 0 | 51 | 51 | 0 | 3 | 2 | 0 | 5 | 0 | 31 | 223 | 61 | 315 | 31 | 445 | 0 | 26 | 502 | 873 |
| 04:45 PM | 0 | 0 | 0 | 47 | 47 | 0 | 5 | 2 | 0 | 7 | 0 | 41 | 198 | 72 | 311 | 41 | 410 | 0 | 20 | 471 | 836 |
| Total | 0 | 0 | 0 | 219 | 219 | 0 | 19 | 9 | 0 | 28 | 0 | 154 | 793 | 271 | 1218 | 151 | 1789 | 0 | 109 | 2049 | 3514 |
| Grand Total | 0 | 0 | 0 | 831 | 831 | 0 | 65 | 35 | 0 | 100 | 0 | 623 | 3172 | 1194 | 4989 | 609 | 7940 | 0 | 410 | 8959 | 14879 |
| Apprch % | 0 | 0 | 0 | 100 | | 0 | 65 | 35 | 0 | | 0 | 12.5 | 63.6 | 23.9 | | 6.8 | 88.6 | 0 | 4.6 | | |
| Total % | 0 | 0 | 0 | 5.6 | 5.6 | 0 | 0.4 | 0.2 | 0 | 0.7 | 0 | 4.2 | 21.3 | 8 | 33.5 | 4.1 | 53.4 | 0 | 2.8 | 60.2 | |

# Wilson Okamoto Corporation

1907 S. Beretana Street, Suite 400
Honolulu, HI 96826

File Name : kalpao
Site Code : 00000004
Start Date : 1/18/2012
Page No : 2

| | Pao Street Southbound | | | | Kalakaua Ave Westbound | | | | Ala Moana Blvd Northbound | | | | Kalakaua Ave Eastbound | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Start Time | Left | Thru | Right | App. Total | Left | Thru | Right | App. Total | Left | Thru | Right | App. Total | Left | Thru | Right | App. Total | Int. Total |
| Peak Hour Analysis From 11:00 AM to 12:45 PM - Peak 1 of 1 | | | | | | | | | | | | | | | | | |
| Peak Hour for Entire Intersection Begins at 11:15 AM | | | | | | | | | | | | | | | | | |
| 11:15 AM | 0 | 0 | **0** | **0** | 0 | 3 | 0 | 3 | 0 | 17 | **152** | **169** | 32 | **390** | 0 | **422** | **594** |
| 11:30 AM | 0 | 0 | 0 | 0 | 0 | 3 | 3 | 6 | 0 | 19 | 113 | 132 | 28 | 314 | 0 | 342 | 480 |
| 11:45 AM | 0 | 0 | 0 | 0 | 0 | 3 | **4** | **7** | 0 | **29** | 140 | 169 | 19 | 370 | 0 | 389 | 565 |
| 12:00 PM | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 3 | 0 | 19 | 120 | 139 | **34** | 338 | 0 | 372 | 514 |
| Total Volume | 0 | 0 | 0 | 0 | 0 | 12 | 7 | 19 | 0 | 84 | 525 | 609 | 113 | 1412 | 0 | 1525 | 2153 |
| % App. Total | 0 | 0 | 0 | | 0 | 63.2 | 36.8 | | 0 | 13.8 | 86.2 | | 7.4 | 92.6 | 0 | | |
| PHF | .000 | .000 | .000 | .000 | .000 | 1.00 | .438 | .679 | .000 | .724 | .863 | .901 | .831 | .905 | .000 | .903 | .906 |
| Peak Hour Analysis From 02:00 PM to 03:15 PM - Peak 1 of 1 | | | | | | | | | | | | | | | | | |
| Peak Hour for Entire Intersection Begins at 02:30 PM | | | | | | | | | | | | | | | | | |
| 02:30 PM | 0 | 0 | 0 | 0 | 0 | 3 | **2** | **5** | 0 | 27 | **184** | 211 | 23 | 427 | 0 | 450 | 666 |
| 02:45 PM | 0 | 0 | 0 | 0 | 0 | 3 | 2 | 5 | 0 | 32 | 148 | 180 | **31** | **441** | 0 | **472** | 657 |
| 03:00 PM | 0 | 0 | 0 | 0 | 0 | **4** | 1 | 5 | 0 | 44 | 183 | **227** | 24 | 411 | 0 | 435 | 667 |
| 03:15 PM | 0 | 0 | 0 | 0 | 0 | 3 | 1 | 4 | 0 | **52** | 175 | 227 | **32** | 422 | 0 | 454 | **685** |
| Total Volume | 0 | 0 | 0 | 0 | 0 | 13 | 6 | 19 | 0 | 155 | 690 | 845 | 110 | 1701 | 0 | 1811 | 2675 |
| % App. Total | 0 | 0 | 0 | | 0 | 68.4 | 31.6 | | 0 | 18.3 | 81.7 | | 6.1 | 93.9 | 0 | | |
| PHF | .000 | .000 | .000 | .000 | .000 | .813 | .750 | .950 | .000 | .745 | .938 | .931 | .859 | .964 | .000 | .959 | .976 |

## Wilson Okamoto Corporation

1907 S. Beretana Street, Suite 400
Honolulu, HI 96826

Counter:TU-0650, TU-0651
Counted By:MM, PA
Weather:Clear

File Name : kalniu
Site Code : 00000003
Start Date : 1/18/2012
Page No : 1

Groups Printed- Unshifted

| | Niu Street Southbound | | | | | Kalakaua Ave Westbound | | | | | Ala Moana Blvd Northbound | | | | | Kalakaua Ave Eastbound | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Start Time | Left | Thru | Right | Peds | App. Total | Left | Thru | Right | Peds | App. Total | Left | Thru | Right | Peds | App. Total | Left | Thru | Right | Peds | App. Total | Int. Total |
| 11:00 AM | 17 | 81 | 0 | 40 | 138 | 0 | 3 | 0 | 0 | 3 | 0 | 0 | 0 | 55 | 55 | 0 | 321 | 37 | 25 | 383 | 579 |
| 11:15 AM | 10 | 103 | 0 | 27 | 140 | 0 | 2 | 0 | 0 | 2 | 0 | 0 | 0 | 51 | 51 | 0 | 395 | 46 | 12 | 453 | 646 |
| 11:30 AM | 11 | 91 | 0 | 22 | 124 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 58 | 58 | 0 | 317 | 37 | 16 | 370 | 553 |
| 11:45 AM | 13 | 80 | 0 | 21 | 114 | 0 | 2 | 0 | 0 | 2 | 0 | 0 | 0 | 65 | 65 | 0 | 336 | 56 | 23 | 415 | 596 |
| Total | 51 | 355 | 0 | 110 | 516 | 0 | 8 | 0 | 0 | 8 | 0 | 0 | 0 | 229 | 229 | 0 | 1369 | 176 | 76 | 1621 | 2374 |
| 12:00 PM | 17 | 81 | 0 | 31 | 129 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 48 | 48 | 0 | 319 | 39 | 29 | 387 | 565 |
| 12:15 PM | 11 | 85 | 0 | 27 | 123 | 0 | 3 | 0 | 0 | 3 | 0 | 0 | 0 | 56 | 56 | 0 | 329 | 68 | 11 | 408 | 590 |
| 12:30 PM | 13 | 77 | 0 | 16 | 106 | 0 | 4 | 0 | 0 | 4 | 0 | 0 | 0 | 62 | 62 | 0 | 336 | 41 | 20 | 397 | 569 |
| 12:45 PM | 16 | 81 | 0 | 39 | 136 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 53 | 53 | 0 | 366 | 57 | 17 | 440 | 630 |
| Total | 57 | 324 | 0 | 113 | 494 | 0 | 9 | 0 | 0 | 9 | 0 | 0 | 0 | 219 | 219 | 0 | 1350 | 205 | 77 | 1632 | 2354 |
| 02:00 PM | 18 | 78 | 0 | 15 | 111 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 39 | 39 | 0 | 378 | 46 | 20 | 444 | 595 |
| 02:15 PM | 16 | 73 | 0 | 34 | 123 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 49 | 49 | 0 | 389 | 46 | 29 | 464 | 637 |
| 02:30 PM | 17 | 84 | 0 | 37 | 138 | 0 | 4 | 0 | 0 | 4 | 0 | 0 | 0 | 64 | 64 | 0 | 418 | 37 | 22 | 477 | 683 |
| 02:45 PM | 18 | 110 | 0 | 32 | 160 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 44 | 44 | 0 | 446 | 50 | 26 | 522 | 727 |
| Total | 69 | 345 | 0 | 118 | 532 | 0 | 7 | 0 | 0 | 7 | 0 | 0 | 0 | 196 | 196 | 0 | 1631 | 179 | 97 | 1907 | 2642 |
| 03:00 PM | 13 | 107 | 0 | 30 | 150 | 0 | 3 | 0 | 0 | 3 | 0 | 0 | 0 | 42 | 42 | 0 | 420 | 41 | 12 | 473 | 668 |
| 03:15 PM | 19 | 113 | 0 | 29 | 161 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 84 | 84 | 0 | 428 | 45 | 25 | 498 | 744 |
| 03:30 PM | 21 | 96 | 0 | 21 | 138 | 0 | 2 | 0 | 0 | 2 | 0 | 0 | 0 | 65 | 65 | 0 | 450 | 41 | 26 | 517 | 722 |
| 03:45 PM | 17 | 102 | 0 | 22 | 141 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 81 | 81 | 0 | 456 | 54 | 9 | 519 | 742 |
| Total | 70 | 418 | 0 | 102 | 590 | 0 | 7 | 0 | 0 | 7 | 0 | 0 | 0 | 272 | 272 | 0 | 1754 | 181 | 72 | 2007 | 2876 |
| 04:00 PM | 24 | 87 | 0 | 28 | 139 | 0 | 3 | 0 | 0 | 3 | 0 | 0 | 0 | 59 | 59 | 0 | 478 | 41 | 24 | 543 | 744 |
| 04:15 PM | 24 | 123 | 0 | 35 | 182 | 0 | 6 | 0 | 0 | 6 | 0 | 0 | 0 | 81 | 81 | 0 | 470 | 32 | 38 | 540 | 809 |
| 04:30 PM | 14 | 131 | 0 | 29 | 174 | 0 | 3 | 0 | 0 | 3 | 0 | 0 | 0 | 61 | 61 | 0 | 423 | 49 | 28 | 500 | 738 |
| 04:45 PM | 11 | 129 | 0 | 36 | 176 | 0 | 4 | 0 | 0 | 4 | 0 | 0 | 0 | 72 | 72 | 0 | 410 | 41 | 20 | 471 | 723 |
| Total | 73 | 470 | 0 | 128 | 671 | 0 | 16 | 0 | 0 | 16 | 0 | 0 | 0 | 273 | 273 | 0 | 1781 | 163 | 110 | 2054 | 3014 |
| Grand Total | 320 | 1912 | 0 | 571 | 2803 | 0 | 47 | 0 | 0 | 47 | 0 | 0 | 0 | 1189 | 1189 | 0 | 7885 | 904 | 432 | 9221 | 13260 |
| Apprch % | 11.4 | 68.2 | 0 | 20.4 | | 0 | 100 | 0 | 0 | | 0 | 0 | 0 | 100 | | 0 | 85.5 | 9.8 | 4.7 | | |
| Total % | 2.4 | 14.4 | 0 | 4.3 | 21.1 | 0 | 0.4 | 0 | 0 | 0.4 | 0 | 0 | 0 | 9 | 9 | 0 | 59.5 | 6.8 | 3.3 | 69.5 | |

**Wilson Okamoto Corporation**
1907 S. Beretana Street, Suite 400
Honolulu, HI 96826

File Name : kalniu
Site Code : 00000003
Start Date : 1/18/2012
Page No : 2

| | Niu Street Southbound | | | | Kalakaua Ave Westbound | | | | Ala Moana Blvd Northbound | | | | Kalakaua Ave Eastbound | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Start Time | Left | Thru | Right | App. Total | Left | Thru | Right | App. Total | Left | Thru | Right | App. Total | Left | Thru | Right | App. Total | Int. Total |
| Peak Hour Analysis From 11:00 AM to 12:45 PM - Peak 1 of 1 | | | | | | | | | | | | | | | | | |
| Peak Hour for Entire Intersection Begins at 11:00 AM | | | | | | | | | | | | | | | | | |
| 11:00 AM | 17 | 81 | 0 | 98 | 0 | 3 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 321 | 37 | 358 | 459 |
| 11:15 AM | 10 | 103 | 0 | 113 | 0 | 2 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 395 | 46 | 441 | 556 |
| 11:30 AM | 11 | 91 | 0 | 102 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 317 | 37 | 354 | 457 |
| 11:45 AM | 13 | 80 | 0 | 93 | 0 | 2 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 336 | 56 | 392 | 487 |
| Total Volume | 51 | 355 | 0 | 406 | 0 | 8 | 0 | 8 | 0 | 0 | 0 | 0 | 0 | 1369 | 176 | 1545 | 1959 |
| % App. Total | 12.6 | 87.4 | 0 | | 0 | 100 | 0 | | 0 | 0 | 0 | | 0 | 88.6 | 11.4 | | |
| PHF | .750 | .862 | .000 | .898 | .000 | .667 | .000 | .667 | .000 | .000 | .000 | .000 | .000 | .866 | .786 | .876 | .881 |

| | Niu Street Southbound | | | | Kalakaua Ave Westbound | | | | Ala Moana Blvd Northbound | | | | Kalakaua Ave Eastbound | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Start Time | Left | Thru | Right | App. Total | Left | Thru | Right | App. Total | Left | Thru | Right | App. Total | Left | Thru | Right | App. Total | Int. Total |
| Peak Hour Analysis From 02:00 PM to 03:15 PM - Peak 1 of 1 | | | | | | | | | | | | | | | | | |
| Peak Hour for Entire Intersection Begins at 02:30 PM | | | | | | | | | | | | | | | | | |
| 02:30 PM | 17 | 84 | 0 | 101 | 0 | 4 | 0 | 4 | 0 | 0 | 0 | 0 | 0 | 418 | 37 | 455 | 560 |
| 02:45 PM | 18 | 110 | 0 | 128 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 446 | 50 | 496 | 625 |
| 03:00 PM | 13 | 107 | 0 | 120 | 0 | 3 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 420 | 41 | 461 | 584 |
| 03:15 PM | 19 | 113 | 0 | 132 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 428 | 45 | 473 | 606 |
| Total Volume | 67 | 414 | 0 | 481 | 0 | 9 | 0 | 9 | 0 | 0 | 0 | 0 | 0 | 1712 | 173 | 1885 | 2375 |
| % App. Total | 13.9 | 86.1 | 0 | | 0 | 100 | 0 | | 0 | 0 | 0 | | 0 | 90.8 | 9.2 | | |
| PHF | .882 | .916 | .000 | .911 | .000 | .563 | .000 | .563 | .000 | .000 | .000 | .000 | .000 | .960 | .865 | .950 | .950 |

# APPENDIX B

# LEVEL OF SERVICE DEFINITIONS

## LEVEL OF SERVICE DEFINITIONS

### LEVEL-OF-SERVICE CRITERIA FOR SIGNALIZED INTERSECTIONS

**Level of Service (LOS)** for signalized intersections is defined in terms of delay, which is a measure of driver discomfort, frustration, fuel consumption, and increased travel time. Specifically, level-of-service (LOS) criteria are stated in terms of the average control delay per vehicle, typically a 15-min analysis period. The criteria are given in the following table.

**Table 1: Level-of-Service Criteria for Signalized Intersections**

| Level of Service | Control Delay per Vehicle (sec/veh) |
|---|---|
| A | ≤10.0 |
| B | >10.0 and ≤20.0 |
| C | >20.0 and ≤35.0 |
| D | >35.0 and ≤55.0 |
| E | >55.0 and ≤80.0 |
| F | >80.0 |

Delay is a complex measure and depends on a number of variables, including the quality of progression, the cycle length, the green ratio, and the v/c ratio for the lane group.

**Level of Service A** describes operations with low control delay, up to 10 sec per vehicle. This level of service occurs when progression is extremely favorable and most vehicles arrive during the green phase. Many vehicles do not stop at all. Short cycle lengths may tend to contribute to low delay values.

**Level of Service B** describes operations with control delay greater than 10 and up to 20 sec per vehicle. This level generally occurs with good progression, short cycle lengths, or both. More vehicles stop than with LOS A, causing higher levels of delay.

**Level of Service C** describes operations with control delay greater than 20 and up to 35 sec per vehicle. These higher delays may result from only fair progression, longer cycle lengths, or both. Individual cycle failures may begin to appear at this level. Cycle failure occurs when a given green phase does not serve queued vehicles and overflows occur. The number of vehicles stopping is significant at this level, though many still pass through the intersection without stopping.

**Level of Service D** describes operations with control delay greater than 35 and up to 55 sec per vehicle. At level of service D, the influence of congestion becomes more noticeable. Longer delays may result from some combination of unfavorable progression, long cycle lengths, or high v/c ratios. Many vehicles stop, and the proportion of vehicles not stopping declines. Individual cycle failures are noticeable.

"Highway Capacity Manual," Transportation Research Board, 2000.

**Level of Service E** describes operation with control delay greater than 55 and up to 80 sec per vehicle. These high delay values generally indicate poor progression, long cycle lengths, and high v/c ratios. Individual cycle failures are frequent.

**Level of Service F** describes operations with control delay in excess of 80 sec per vehicle. This level, considered to be unacceptable to most drivers, often occurs with oversaturation, that is, when arrival flow rates exceed the capacity lane groups. It may also occur at high v/c ratios with many individual cycle failures. Poor progression and long cycle lengths may also contribute significantly to high delay levels.

"Highway Capacity Manual," Transportation Research Board, 2000.

# APPENDIX C

## CAPACITY ANALYSIS CALCULATIONS
## EXISTING PEAK HOUR TRAFFIC ANALYSIS

| Movement | EBT | EBR | WBL | WBT | NBL | NBR |
|---|---|---|---|---|---|---|
| Lane Configurations | ↑↑↑↱ | | ↰ | ↑↑↑ | ↰ | ↱ |
| Volume (vph) | 939 | 67 | 78 | 768 | 64 | 102 |
| 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 | 0.86 | | 1.00 | 0.91 | 1.00 | 1.00 |
| Frt | 0.99 | | 1.00 | 1.00 | 1.00 | 0.85 |
| Flt Protected | 1.00 | | 0.95 | 1.00 | 0.95 | 1.00 |
| Satd. Flow (prot) | 6344 | | 1770 | 5085 | 1770 | 1583 |
| Flt Permitted | 1.00 | | 0.95 | 1.00 | 0.95 | 1.00 |
| Satd. Flow (perm) | 6344 | | 1770 | 5085 | 1770 | 1583 |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 1021 | 73 | 85 | 835 | 70 | 111 |
| RTOR Reduction (vph) | 17 | 0 | 0 | 0 | 0 | 95 |
| Lane Group Flow (vph) | 1077 | 0 | 85 | 835 | 70 | 16 |
| Turn Type | | | Prot | | | Perm |
| Protected Phases | 4 | | 3 | 8 | 2 | |
| Permitted Phases | | | | | | 2 |
| Actuated Green, G (s) | 17.7 | | 2.3 | 24.0 | 5.4 | 5.4 |
| Effective Green, g (s) | 17.7 | | 2.3 | 24.0 | 5.4 | 5.4 |
| Actuated g/C Ratio | 0.47 | | 0.06 | 0.64 | 0.14 | 0.14 |
| 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) | 3002 | | 109 | 3263 | 256 | 229 |
| v/s Ratio Prot | c0.17 | | c0.05 | 0.16 | c0.04 | |
| v/s Ratio Perm | | | | | | 0.01 |
| v/c Ratio | 0.36 | | 0.78 | 0.26 | 0.27 | 0.07 |
| Uniform Delay, d1 | 6.2 | | 17.3 | 2.9 | 14.3 | 13.8 |
| Progression Factor | 1.00 | | 1.00 | 1.00 | 1.00 | 1.00 |
| Incremental Delay, d2 | 0.1 | | 28.9 | 0.0 | 0.6 | 0.1 |
| Delay (s) | 6.3 | | 46.2 | 2.9 | 14.8 | 14.0 |
| Level of Service | A | | D | A | B | B |
| Approach Delay (s) | 6.3 | | | 6.9 | 14.3 | |
| Approach LOS | A | | | A | B | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 7.2 | HCM Level of Service | A |
| HCM Volume to Capacity ratio | 0.38 | | |
| Actuated Cycle Length (s) | 37.4 | 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) | 53 | 650 | 276 | 122 | 400 | 65 | 358 | 53 | 84 | 5 | 50 | 57 |
| Ideal Flow (vphpl) | 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 | 0.88 | 1.00 | 0.91 | | 0.95 | 0.95 | 1.00 | | 1.00 | |
| Frt | 1.00 | 1.00 | 0.85 | 1.00 | 0.98 | | 1.00 | 1.00 | 0.85 | | 0.93 | |
| Flt Protected | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | | 0.95 | 0.96 | 1.00 | | 1.00 | |
| Satd. Flow (prot) | 1770 | 3539 | 2787 | 1770 | 4978 | | 1681 | 1706 | 1583 | | 1730 | |
| Flt Permitted | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | | 0.95 | 0.96 | 1.00 | | 1.00 | |
| Satd. Flow (perm) | 1770 | 3539 | 2787 | 1770 | 4978 | | 1681 | 1706 | 1583 | | 1730 | |
| 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) | 58 | 707 | 300 | 133 | 435 | 71 | 389 | 58 | 91 | 5 | 54 | 62 |
| RTOR Reduction (vph) | 0 | 0 | 138 | 0 | 15 | 0 | 0 | 0 | 67 | 0 | 31 | 0 |
| Lane Group Flow (vph) | 58 | 707 | 162 | 133 | 491 | 0 | 222 | 225 | 24 | 0 | 90 | 0 |
| Turn Type | Prot | | pt+ov | Prot | | | Split | | Perm | Split | | |
| Protected Phases | 7 | 4 | 4 2 | 3 | 8 | | 2 | 2 | | 6 | 6 | |
| Permitted Phases | | | | | | | | | 2 | | | |
| Actuated Green, G (s) | 6.3 | 28.7 | 63.0 | 8.7 | 31.1 | | 30.3 | 30.3 | 30.3 | | 32.9 | |
| Effective Green, g (s) | 6.3 | 28.7 | 63.0 | 8.7 | 31.1 | | 30.3 | 30.3 | 30.3 | | 32.9 | |
| Actuated g/C Ratio | 0.05 | 0.25 | 0.54 | 0.07 | 0.27 | | 0.26 | 0.26 | 0.26 | | 0.28 | |
| 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) | 96 | 871 | 1506 | 132 | 1328 | | 437 | 443 | 411 | | 488 | |
| v/s Ratio Prot | 0.03 | c0.20 | 0.06 | c0.08 | 0.10 | | c0.13 | 0.13 | | | c0.05 | |
| v/s Ratio Perm | | | | | | | | | 0.01 | | | |
| v/c Ratio | 0.60 | 0.81 | 0.11 | 1.01 | 0.37 | | 0.51 | 0.51 | 0.06 | | 0.18 | |
| Uniform Delay, d1 | 53.9 | 41.4 | 13.1 | 54.0 | 34.8 | | 36.8 | 36.8 | 32.4 | | 31.7 | |
| Progression Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | | 1.00 | 1.00 | 1.00 | | 1.00 | |
| Incremental Delay, d2 | 10.3 | 5.8 | 0.0 | 80.4 | 0.2 | | 0.9 | 0.9 | 0.1 | | 0.2 | |
| Delay (s) | 64.2 | 47.2 | 13.1 | 134.3 | 34.9 | | 37.7 | 37.7 | 32.5 | | 31.9 | |
| Level of Service | E | D | B | F | C | | D | D | C | | C | |
| Approach Delay (s) | | 38.5 | | | 55.6 | | | 36.8 | | | 31.9 | |
| Approach LOS | | D | | | E | | | D | | | C | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 42.4 | HCM Level of Service | D |
| HCM Volume to Capacity ratio | 0.52 | | |
| Actuated Cycle Length (s) | 116.6 | 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 | EBL | EBR | NBL | NBT | SBT | SBR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Volume (vph) | 121 | 44 | 12 | 387 | 344 | 106 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 4.0 | 4.0 | | 4.0 | 4.0 | |
| Lane Util. Factor | 0.97 | 1.00 | | 0.91 | 0.95 | |
| Frt | 1.00 | 0.85 | | 1.00 | 0.96 | |
| Flt Protected | 0.95 | 1.00 | | 1.00 | 1.00 | |
| Satd. Flow (prot) | 3433 | 1583 | | 5078 | 3414 | |
| Flt Permitted | 0.95 | 1.00 | | 0.92 | 1.00 | |
| Satd. Flow (perm) | 3433 | 1583 | | 4700 | 3414 | |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 132 | 48 | 13 | 421 | 374 | 115 |
| RTOR Reduction (vph) | 0 | 38 | 0 | 0 | 59 | 0 |
| Lane Group Flow (vph) | 132 | 10 | 0 | 434 | 430 | 0 |
| Turn Type | | Perm | Perm | | | |
| Protected Phases | 4 | | | 2 | 6 | |
| Permitted Phases | | 4 | 2 | | | |
| Actuated Green, G (s) | 5.5 | 5.5 | | 13.0 | 13.0 | |
| Effective Green, g (s) | 5.5 | 5.5 | | 13.0 | 13.0 | |
| Actuated g/C Ratio | 0.21 | 0.21 | | 0.49 | 0.49 | |
| 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) | 713 | 329 | | 2306 | 1675 | |
| v/s Ratio Prot | c0.04 | | | | c0.13 | |
| v/s Ratio Perm | | 0.01 | | 0.09 | | |
| v/c Ratio | 0.19 | 0.03 | | 0.19 | 0.26 | |
| Uniform Delay, d1 | 8.7 | 8.4 | | 3.8 | 3.9 | |
| Progression Factor | 1.00 | 1.00 | | 1.00 | 1.00 | |
| Incremental Delay, d2 | 0.1 | 0.0 | | 0.0 | 0.1 | |
| Delay (s) | 8.8 | 8.4 | | 3.8 | 4.0 | |
| Level of Service | A | A | | A | A | |
| Approach Delay (s) | 8.7 | | | 3.8 | 4.0 | |
| Approach LOS | A | | | A | A | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 4.7 | HCM Level of Service | A |
| HCM Volume to Capacity ratio | 0.24 | | |
| Actuated Cycle Length (s) | 26.5 | Sum of lost time (s) | 8.0 |
| Intersection Capacity Utilization | 26.3% | 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) | 45 | 11 | 9 | 12 | 29 | 83 | 8 | 368 | 20 | 48 | 275 | 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 | 4.0 | 4.0 | 4.0 |
| Lane Util. Factor | | 1.00 | 1.00 | | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Frt | | 1.00 | 0.85 | | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 |
| Flt Protected | | 0.96 | 1.00 | | 0.99 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 |
| Satd. Flow (prot) | | 1791 | 1583 | | 1836 | 1583 | 1770 | 1863 | 1583 | 1770 | 1863 | 1583 |
| Flt Permitted | | 0.79 | 1.00 | | 0.93 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 |
| Satd. Flow (perm) | | 1470 | 1583 | | 1735 | 1583 | 1770 | 1863 | 1583 | 1770 | 1863 | 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) | 49 | 12 | 10 | 13 | 32 | 90 | 9 | 400 | 22 | 52 | 299 | 24 |
| RTOR Reduction (vph) | 0 | 0 | 7 | 0 | 0 | 66 | 0 | 0 | 12 | 0 | 0 | 13 |
| Lane Group Flow (vph) | 0 | 61 | 3 | 0 | 45 | 24 | 9 | 400 | 10 | 52 | 299 | 11 |
| Turn Type | Perm | | Perm | Perm | | Perm | Prot | | Perm | Prot | | Perm |
| Protected Phases | | 4 | | | 8 | | 5 | 2 | | 1 | 6 | |
| Permitted Phases | 4 | | 4 | 8 | | 8 | | | 2 | | | 6 |
| Actuated Green, G (s) | | 11.9 | 11.9 | | 11.9 | 11.9 | 0.5 | 19.4 | 19.4 | 1.6 | 20.5 | 20.5 |
| Effective Green, g (s) | | 11.9 | 11.9 | | 11.9 | 11.9 | 0.5 | 19.4 | 19.4 | 1.6 | 20.5 | 20.5 |
| Actuated g/C Ratio | | 0.27 | 0.27 | | 0.27 | 0.27 | 0.01 | 0.43 | 0.43 | 0.04 | 0.46 | 0.46 |
| Clearance Time (s) | | 4.0 | 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 | 3.0 |
| Lane Grp Cap (vph) | | 390 | 420 | | 460 | 420 | 20 | 805 | 684 | 63 | 851 | 723 |
| v/s Ratio Prot | | | | | | | 0.01 | c0.21 | | c0.03 | 0.16 | |
| v/s Ratio Perm | | c0.04 | 0.00 | | 0.03 | 0.02 | | | 0.01 | | | 0.01 |
| v/c Ratio | | 0.16 | 0.01 | | 0.10 | 0.06 | 0.45 | 0.50 | 0.01 | 0.83 | 0.35 | 0.02 |
| Uniform Delay, d1 | | 12.7 | 12.1 | | 12.4 | 12.3 | 22.1 | 9.2 | 7.3 | 21.5 | 7.9 | 6.7 |
| 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 | | 0.2 | 0.0 | | 0.1 | 0.1 | 15.3 | 0.5 | 0.0 | 56.1 | 0.3 | 0.0 |
| Delay (s) | | 12.8 | 12.2 | | 12.5 | 12.4 | 37.3 | 9.7 | 7.3 | 77.6 | 8.1 | 6.7 |
| Level of Service | | B | B | | B | B | D | A | A | E | A | A |
| Approach Delay (s) | | 12.7 | | | 12.4 | | | 10.2 | | | 17.7 | |
| Approach LOS | | B | | | B | | | B | | | B | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 13.4 | HCM Level of Service | B |
| HCM Volume to Capacity ratio | 0.39 | | |
| Actuated Cycle Length (s) | 44.9 | Sum of lost time (s) | 12.0 |
| Intersection Capacity Utilization | 42.4% | 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) | 0 | 196 | 327 | 0 | 0 | 0 | 0 | 0 | 0 | 43 | 1309 | 227 |
| Ideal 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 | | 1.00 | 0.88 | | | | | | | | 0.86 | |
| Frt | | 1.00 | 0.85 | | | | | | | | 0.98 | |
| Flt Protected | | 1.00 | 1.00 | | | | | | | | 1.00 | |
| Satd. Flow (prot) | | 1863 | 2787 | | | | | | | | 6261 | |
| Flt Permitted | | 1.00 | 1.00 | | | | | | | | 1.00 | |
| Satd. Flow (perm) | | 1863 | 2787 | | | | | | | | 6261 | |
| 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 | 213 | 355 | 0 | 0 | 0 | 0 | 0 | 0 | 47 | 1423 | 247 |
| RTOR Reduction (vph) | 0 | 0 | 42 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 29 | 0 |
| Lane Group Flow (vph) | 0 | 213 | 313 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1688 | 0 |
| Turn Type | | | Prot | | | | | | | Perm | | |
| Protected Phases | | 4 | 4 | | | | | | | | 6 | |
| Permitted Phases | | | | | | | | | | 6 | | |
| Actuated Green, G (s) | | 17.2 | 17.2 | | | | | | | | 54.8 | |
| Effective Green, g (s) | | 17.2 | 17.2 | | | | | | | | 54.8 | |
| Actuated g/C Ratio | | 0.22 | 0.22 | | | | | | | | 0.68 | |
| Clearance Time (s) | | 4.0 | 4.0 | | | | | | | | 4.0 | |
| Vehicle Extension (s) | | 3.0 | 3.0 | | | | | | | | 3.0 | |
| Lane Grp Cap (vph) | | 401 | 599 | | | | | | | | 4289 | |
| v/s Ratio Prot | | c0.11 | 0.11 | | | | | | | | | |
| v/s Ratio Perm | | | | | | | | | | | 0.27 | |
| v/c Ratio | | 0.53 | 0.52 | | | | | | | | 0.39 | |
| Uniform Delay, d1 | | 27.8 | 27.8 | | | | | | | | 5.4 | |
| Progression Factor | | 1.00 | 1.00 | | | | | | | | 0.61 | |
| Incremental Delay, d2 | | 1.4 | 0.8 | | | | | | | | 0.2 | |
| Delay (s) | | 29.2 | 28.6 | | | | | | | | 3.5 | |
| Level of Service | | C | C | | | | | | | | A | |
| Approach Delay (s) | | 28.8 | | | 0.0 | | | 0.0 | | | 3.5 | |
| Approach LOS | | C | | | A | | | A | | | A | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 9.8 | HCM Level of Service | A |
| HCM Volume to Capacity ratio | 0.43 | | |
| Actuated Cycle Length (s) | 80.0 | 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 | EBR | NBL | NBT | NBR | SBL | SBT | SBR | SWL | SWR |
|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | |
| Volume (vph) | 84 | 525 | 0 | 12 | 7 | 113 | 1412 | 0 | 0 | 0 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Lane Width | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 16 |
| Total Lost time (s) | 5.0 | 5.0 | | 5.0 | | | 5.0 | | | |
| Lane Util. Factor | 1.00 | 0.95 | | 1.00 | | | 0.86 | | | |
| Frt | 0.89 | 0.85 | | 0.95 | | | 1.00 | | | |
| Flt Protected | 0.99 | 1.00 | | 1.00 | | | 1.00 | | | |
| Satd. Flow (prot) | 1637 | 1504 | | 1767 | | | 6384 | | | |
| Flt Permitted | 0.99 | 1.00 | | 1.00 | | | 0.90 | | | |
| Satd. Flow (perm) | 1637 | 1504 | | 1767 | | | 5787 | | | |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 91 | 571 | 0 | 13 | 8 | 123 | 1535 | 0 | 0 | 0 |
| RTOR Reduction (vph) | 8 | 8 | 0 | 4 | 0 | 0 | 0 | 0 | 0 | 0 |
| Lane Group Flow (vph) | 329 | 317 | 0 | 17 | 0 | 0 | 1658 | 0 | 0 | 0 |
| Turn Type | | Prot | | | | Perm | | | | |
| Protected Phases | 4 | 4 | | 2 | | | 6 | | | |
| Permitted Phases | | | | | | 6 | | | | |
| Actuated Green, G (s) | 28.8 | 28.8 | | 41.2 | | | 41.2 | | | |
| Effective Green, g (s) | 28.8 | 28.8 | | 41.2 | | | 41.2 | | | |
| Actuated g/C Ratio | 0.36 | 0.36 | | 0.52 | | | 0.52 | | | |
| Clearance Time (s) | 5.0 | 5.0 | | 5.0 | | | 5.0 | | | |
| Vehicle Extension (s) | 2.0 | 2.0 | | 5.0 | | | 5.0 | | | |
| Lane Grp Cap (vph) | 589 | 541 | | 910 | | | 2980 | | | |
| v/s Ratio Prot | 0.20 | c0.21 | | 0.01 | | | | | | |
| v/s Ratio Perm | | | | | | | c0.29 | | | |
| v/c Ratio | 0.56 | 0.59 | | 0.02 | | | 0.56 | | | |
| Uniform Delay, d1 | 20.5 | 20.8 | | 9.5 | | | 13.2 | | | |
| Progression Factor | 1.00 | 1.00 | | 1.00 | | | 0.30 | | | |
| Incremental Delay, d2 | 0.7 | 1.0 | | 0.0 | | | 0.7 | | | |
| Delay (s) | 21.2 | 21.8 | | 9.5 | | | 4.6 | | | |
| Level of Service | C | C | | A | | | A | | | |
| Approach Delay (s) | 21.5 | | | 9.5 | | | 4.6 | | 0.0 | |
| Approach LOS | C | | | A | | | A | | A | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 9.4 | HCM Level of Service | A |
| HCM Volume to Capacity ratio | 0.57 | | |
| Actuated Cycle Length (s) | 80.0 | Sum of lost time (s) | 10.0 |
| Intersection Capacity Utilization | 52.2% | 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) | 0 | 0 | 0 | 51 | 355 | 0 | 0 | 8 | 0 | 0 | 1369 | 176 |
| 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 | |
| Lane Util. Factor | | | | | 0.91 | | | 1.00 | | | 0.86 | |
| Frt | | | | | 1.00 | | | 1.00 | | | 0.98 | |
| Flt Protected | | | | | 0.99 | | | 1.00 | | | 1.00 | |
| Satd. Flow (prot) | | | | | 5054 | | | 1863 | | | 6299 | |
| Flt Permitted | | | | | 0.99 | | | 1.00 | | | 1.00 | |
| Satd. Flow (perm) | | | | | 5054 | | | 1863 | | | 6299 | |
| 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 | 55 | 386 | 0 | 0 | 9 | 0 | 0 | 1488 | 191 |
| RTOR Reduction (vph) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 27 | 0 |
| Lane Group Flow (vph) | 0 | 0 | 0 | 0 | 441 | 0 | 0 | 9 | 0 | 0 | 1652 | 0 |
| Turn Type | | | | Perm | | | | | | | | |
| Protected Phases | | | | | 4 | | | 2 | | | 6 | |
| Permitted Phases | | | | 4 | | | | | | | | |
| Actuated Green, G (s) | | | | | 28.8 | | | 41.2 | | | 41.2 | |
| Effective Green, g (s) | | | | | 28.8 | | | 41.2 | | | 41.2 | |
| Actuated g/C Ratio | | | | | 0.36 | | | 0.52 | | | 0.52 | |
| Clearance Time (s) | | | | | 5.0 | | | 5.0 | | | 5.0 | |
| Vehicle Extension (s) | | | | | 2.0 | | | 5.0 | | | 5.0 | |
| Lane Grp Cap (vph) | | | | | 1819 | | | 959 | | | 3244 | |
| v/s Ratio Prot | | | | | | | | 0.00 | | | c0.26 | |
| v/s Ratio Perm | | | | | 0.09 | | | | | | | |
| v/c Ratio | | | | | 0.24 | | | 0.01 | | | 0.51 | |
| Uniform Delay, d1 | | | | | 18.0 | | | 9.5 | | | 12.8 | |
| Progression Factor | | | | | 1.00 | | | 0.41 | | | 1.00 | |
| Incremental Delay, d2 | | | | | 0.0 | | | 0.0 | | | 0.6 | |
| Delay (s) | | | | | 18.0 | | | 3.9 | | | 13.3 | |
| Level of Service | | | | | B | | | A | | | B | |
| Approach Delay (s) | | 0.0 | | | 18.0 | | | 3.9 | | | 13.3 | |
| Approach LOS | | A | | | B | | | A | | | B | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 14.3 | HCM Level of Service | B |
| HCM Volume to Capacity ratio | 0.40 | | |
| Actuated Cycle Length (s) | 80.0 | Sum of lost time (s) | 10.0 |
| Intersection Capacity Utilization | 39.0% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

| Movement | EBL | EBT | WBT | WBR | SBL | SBR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Volume (vph) | 212 | 65 | 192 | 283 | 30 | 133 |
| 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 | | 1.00 | 1.00 | 0.85 | 1.00 | 0.85 |
| Flt Protected | | 0.96 | 1.00 | 1.00 | 0.95 | 1.00 |
| Satd. Flow (prot) | | 1794 | 1863 | 1583 | 1770 | 1583 |
| Flt Permitted | | 0.65 | 1.00 | 1.00 | 0.95 | 1.00 |
| Satd. Flow (perm) | | 1205 | 1863 | 1583 | 1770 | 1583 |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 230 | 71 | 209 | 308 | 33 | 145 |
| RTOR Reduction (vph) | 0 | 0 | 0 | 0 | 0 | 118 |
| Lane Group Flow (vph) | 0 | 301 | 209 | 308 | 33 | 27 |
| Turn Type | Perm | | | Free | | Perm |
| Protected Phases | | 4 | 8 | | 6 | |
| Permitted Phases | 4 | | | Free | | 6 |
| Actuated Green, G (s) | | 6.5 | 6.5 | 17.8 | 3.3 | 3.3 |
| Effective Green, g (s) | | 6.5 | 6.5 | 17.8 | 3.3 | 3.3 |
| Actuated g/C Ratio | | 0.37 | 0.37 | 1.00 | 0.19 | 0.19 |
| 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) | | 440 | 680 | 1583 | 328 | 293 |
| v/s Ratio Prot | | | 0.11 | | 0.02 | |
| v/s Ratio Perm | | c0.25 | | c0.19 | | 0.02 |
| v/c Ratio | | 0.68 | 0.31 | 0.19 | 0.10 | 0.09 |
| Uniform Delay, d1 | | 4.8 | 4.0 | 0.0 | 6.0 | 6.0 |
| Progression Factor | | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Incremental Delay, d2 | | 4.4 | 0.3 | 0.3 | 0.1 | 0.1 |
| Delay (s) | | 9.1 | 4.3 | 0.3 | 6.2 | 6.1 |
| Level of Service | | A | A | A | A | A |
| Approach Delay (s) | | 9.1 | 1.9 | | 6.1 | |
| Approach LOS | | A | A | | A | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 4.8 | HCM Level of Service | A |
| HCM Volume to Capacity ratio | 0.43 | | |
| Actuated Cycle Length (s) | 17.8 | Sum of lost time (s) | 4.0 |
| Intersection Capacity Utilization | 38.6% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

| Movement | EBT | EBR | WBL | WBT | NBL | NBR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Volume (vph) | 1000 | 80 | 100 | 800 | 100 | 150 |
| 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 | 0.86 | | 1.00 | 0.91 | 1.00 | 1.00 |
| Frt | 0.99 | | 1.00 | 1.00 | 1.00 | 0.85 |
| Flt Protected | 1.00 | | 0.95 | 1.00 | 0.95 | 1.00 |
| Satd. Flow (prot) | 6337 | | 1770 | 5085 | 1770 | 1583 |
| Flt Permitted | 1.00 | | 0.95 | 1.00 | 0.95 | 1.00 |
| Satd. Flow (perm) | 6337 | | 1770 | 5085 | 1770 | 1583 |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 1087 | 87 | 109 | 870 | 109 | 163 |
| RTOR Reduction (vph) | 20 | 0 | 0 | 0 | 0 | 138 |
| Lane Group Flow (vph) | 1154 | 0 | 109 | 870 | 109 | 25 |
| Turn Type | | | Prot | | | Perm |
| Protected Phases | 4 | | 3 | 8 | 2 | |
| Permitted Phases | | | | | | 2 |
| Actuated Green, G (s) | 18.8 | | 3.5 | 26.3 | 6.1 | 6.1 |
| Effective Green, g (s) | 18.8 | | 3.5 | 26.3 | 6.1 | 6.1 |
| Actuated g/C Ratio | 0.47 | | 0.09 | 0.65 | 0.15 | 0.15 |
| 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) | 2949 | | 153 | 3310 | 267 | 239 |
| v/s Ratio Prot | c0.18 | | c0.06 | 0.17 | c0.06 | |
| v/s Ratio Perm | | | | | | 0.02 |
| v/c Ratio | 0.39 | | 0.71 | 0.26 | 0.41 | 0.10 |
| Uniform Delay, d1 | 7.1 | | 18.0 | 3.0 | 15.5 | 14.8 |
| Progression Factor | 1.00 | | 1.00 | 1.00 | 1.00 | 1.00 |
| Incremental Delay, d2 | 0.1 | | 14.5 | 0.0 | 1.0 | 0.2 |
| Delay (s) | 7.1 | | 32.5 | 3.0 | 16.5 | 15.0 |
| Level of Service | A | | C | A | B | B |
| Approach Delay (s) | 7.1 | | | 6.3 | 15.6 | |
| Approach LOS | A | | | A | B | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 7.8 | HCM Level of Service | A |
| HCM Volume to Capacity ratio | 0.43 | | |
| Actuated Cycle Length (s) | 40.4 | Sum of lost time (s) | 12.0 |
| 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) | 55 | 700 | 370 | 129 | 453 | 48 | 378 | 81 | 112 | 4 | 58 | 41 |
| Ideal Flow (vphpl) | 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 | 0.88 | 1.00 | 0.91 | | 0.95 | 0.95 | 1.00 | | 1.00 | |
| Frt | 1.00 | 1.00 | 0.85 | 1.00 | 0.99 | | 1.00 | 1.00 | 0.85 | | 0.95 | |
| Flt Protected | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | | 0.95 | 0.97 | 1.00 | | 1.00 | |
| Satd. Flow (prot) | 1770 | 3539 | 2787 | 1770 | 5012 | | 1681 | 1714 | 1583 | | 1759 | |
| Flt Permitted | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | | 0.95 | 0.97 | 1.00 | | 1.00 | |
| Satd. Flow (perm) | 1770 | 3539 | 2787 | 1770 | 5012 | | 1681 | 1714 | 1583 | | 1759 | |
| 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) | 60 | 761 | 402 | 140 | 492 | 52 | 411 | 88 | 122 | 4 | 63 | 45 |
| RTOR Reduction (vph) | 0 | 0 | 183 | 0 | 9 | 0 | 0 | 0 | 90 | 0 | 20 | 0 |
| Lane Group Flow (vph) | 60 | 761 | 219 | 140 | 535 | 0 | 247 | 252 | 32 | 0 | 92 | 0 |
| Turn Type | Prot | | pt+ov | Prot | | | Split | | Perm | Split | | |
| Protected Phases | 7 | 4 | 4 2 | 3 | 8 | | 2 | 2 | | 6 | 6 | |
| Permitted Phases | | | | | | | | | 2 | | | |
| Actuated Green, G (s) | 6.9 | 29.2 | 64.1 | 8.6 | 30.9 | | 30.9 | 30.9 | 30.9 | | 33.2 | |
| Effective Green, g (s) | 6.9 | 29.2 | 64.1 | 8.6 | 30.9 | | 30.9 | 30.9 | 30.9 | | 33.2 | |
| Actuated g/C Ratio | 0.06 | 0.25 | 0.54 | 0.07 | 0.26 | | 0.26 | 0.26 | 0.26 | | 0.28 | |
| 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) | 104 | 876 | 1515 | 129 | 1314 | | 441 | 449 | 415 | | 495 | |
| v/s Ratio Prot | 0.03 | c0.22 | 0.08 | c0.08 | 0.11 | | 0.15 | c0.15 | | | c0.05 | |
| v/s Ratio Perm | | | | | | | | | 0.02 | | | |
| v/c Ratio | 0.58 | 0.87 | 0.14 | 1.09 | 0.41 | | 0.56 | 0.56 | 0.08 | | 0.19 | |
| Uniform Delay, d1 | 54.1 | 42.5 | 13.3 | 54.6 | 35.9 | | 37.6 | 37.6 | 32.8 | | 32.1 | |
| Progression Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | | 1.00 | 1.00 | 1.00 | | 1.00 | |
| Incremental Delay, d2 | 7.5 | 9.1 | 0.0 | 103.9 | 0.2 | | 1.6 | 1.6 | 0.1 | | 0.2 | |
| Delay (s) | 61.6 | 51.7 | 13.4 | 158.6 | 36.1 | | 39.3 | 39.2 | 32.8 | | 32.3 | |
| Level of Service | E | D | B | F | D | | D | D | C | | C | |
| Approach Delay (s) | | 39.6 | | | 61.2 | | | 38.0 | | | 32.3 | |
| Approach LOS | | D | | | E | | | D | | | C | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 44.5 | HCM Level of Service | D |
| HCM Volume to Capacity ratio | 0.57 | | |
| Actuated Cycle Length (s) | 117.9 | Sum of lost time (s) | 16.0 |
| Intersection Capacity Utilization | 55.8% | ICU Level of Service | B |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

| Movement | EBL | EBR | NBL | NBT | SBT | SBR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Volume (vph) | 137 | 45 | 15 | 439 | 382 | 179 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 4.0 | 4.0 | | 4.0 | 4.0 | |
| Lane Util. Factor | 0.97 | 1.00 | | 0.91 | 0.95 | |
| Frt | 1.00 | 0.85 | | 1.00 | 0.95 | |
| Flt Protected | 0.95 | 1.00 | | 1.00 | 1.00 | |
| Satd. Flow (prot) | 3433 | 1583 | | 5077 | 3370 | |
| Flt Permitted | 0.95 | 1.00 | | 0.92 | 1.00 | |
| Satd. Flow (perm) | 3433 | 1583 | | 4680 | 3370 | |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 149 | 49 | 16 | 477 | 415 | 195 |
| RTOR Reduction (vph) | 0 | 40 | 0 | 0 | 86 | 0 |
| Lane Group Flow (vph) | 149 | 9 | 0 | 493 | 524 | 0 |
| Turn Type | | Perm | Perm | | | |
| Protected Phases | 4 | | | 2 | 6 | |
| Permitted Phases | | 4 | 2 | | | |
| Actuated Green, G (s) | 5.5 | 5.5 | | 17.1 | 17.1 | |
| Effective Green, g (s) | 5.5 | 5.5 | | 17.1 | 17.1 | |
| Actuated g/C Ratio | 0.18 | 0.18 | | 0.56 | 0.56 | |
| 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) | 617 | 285 | | 2615 | 1883 | |
| v/s Ratio Prot | c0.04 | | | | c0.16 | |
| v/s Ratio Perm | | 0.01 | | 0.11 | | |
| v/c Ratio | 0.24 | 0.03 | | 0.19 | 0.28 | |
| Uniform Delay, d1 | 10.8 | 10.4 | | 3.3 | 3.5 | |
| Progression Factor | 1.00 | 1.00 | | 1.00 | 1.00 | |
| Incremental Delay, d2 | 0.2 | 0.0 | | 0.0 | 0.1 | |
| Delay (s) | 11.0 | 10.4 | | 3.4 | 3.6 | |
| Level of Service | B | B | | A | A | |
| Approach Delay (s) | 10.8 | | | 3.4 | 3.6 | |
| Approach LOS | B | | | A | A | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 4.6 | HCM Level of Service | A |
| HCM Volume to Capacity ratio | 0.27 | | |
| Actuated Cycle Length (s) | 30.6 | Sum of lost time (s) | 8.0 |
| 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) | 60 | 15 | 10 | 15 | 30 | 100 | 10 | 400 | 25 | 50 | 300 | 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 | 4.0 | 4.0 | 4.0 |
| Lane Util. Factor | | 1.00 | 1.00 | | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Frt | | 1.00 | 0.85 | | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 |
| Flt Protected | | 0.96 | 1.00 | | 0.98 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 |
| Satd. Flow (prot) | | 1791 | 1583 | | 1833 | 1583 | 1770 | 1863 | 1583 | 1770 | 1863 | 1583 |
| Flt Permitted | | 0.79 | 1.00 | | 0.92 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 |
| Satd. Flow (perm) | | 1468 | 1583 | | 1723 | 1583 | 1770 | 1863 | 1583 | 1770 | 1863 | 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) | 65 | 16 | 11 | 16 | 33 | 109 | 11 | 435 | 27 | 54 | 326 | 27 |
| RTOR Reduction (vph) | 0 | 0 | 7 | 0 | 0 | 73 | 0 | 0 | 17 | 0 | 0 | 16 |
| Lane Group Flow (vph) | 0 | 81 | 4 | 0 | 49 | 36 | 11 | 435 | 10 | 54 | 326 | 11 |
| Turn Type | Perm | | Perm | Perm | | Perm | Prot | | Perm | Prot | | Perm |
| Protected Phases | | 4 | | | 8 | | 5 | 2 | | 1 | 6 | |
| Permitted Phases | 4 | | 4 | 8 | | 8 | | | 2 | | | 6 |
| Actuated Green, G (s) | | 15.2 | 15.2 | | 15.2 | 15.2 | 0.6 | 17.3 | 17.3 | 1.7 | 18.4 | 18.4 |
| Effective Green, g (s) | | 15.2 | 15.2 | | 15.2 | 15.2 | 0.6 | 17.3 | 17.3 | 1.7 | 18.4 | 18.4 |
| Actuated g/C Ratio | | 0.33 | 0.33 | | 0.33 | 0.33 | 0.01 | 0.37 | 0.37 | 0.04 | 0.40 | 0.40 |
| Clearance Time (s) | | 4.0 | 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 | 3.0 |
| Lane Grp Cap (vph) | | 483 | 521 | | 567 | 521 | 23 | 698 | 593 | 65 | 742 | 630 |
| v/s Ratio Prot | | | | | | | 0.01 | c0.23 | | c0.03 | 0.18 | |
| v/s Ratio Perm | | c0.06 | 0.00 | | 0.03 | 0.02 | | | 0.01 | | | 0.01 |
| v/c Ratio | | 0.17 | 0.01 | | 0.09 | 0.07 | 0.48 | 0.62 | 0.02 | 0.83 | 0.44 | 0.02 |
| Uniform Delay, d1 | | 11.0 | 10.4 | | 10.7 | 10.6 | 22.6 | 11.8 | 9.1 | 22.1 | 10.1 | 8.4 |
| 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 | 0.0 | | 0.1 | 0.1 | 14.8 | 1.7 | 0.0 | 56.7 | 0.4 | 0.0 |
| Delay (s) | | 11.2 | 10.4 | | 10.8 | 10.7 | 37.5 | 13.5 | 9.1 | 78.8 | 10.6 | 8.4 |
| Level of Service | | B | B | | B | B | D | B | A | E | B | A |
| Approach Delay (s) | | 11.1 | | | 10.7 | | | 13.8 | | | 19.5 | |
| Approach LOS | | B | | | B | | | B | | | B | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 15.2 | HCM Level of Service | B |
| HCM Volume to Capacity ratio | 0.43 | | |
| Actuated Cycle Length (s) | 46.2 | 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 | WBT | WBR | SBL | SBR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Sign Control | | Stop | Stop | | Stop | |
| Volume (vph) | 218 | 87 | 231 | 289 | 30 | 148 |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Hourly flow rate (vph) | 237 | 95 | 251 | 314 | 33 | 161 |

| Direction, Lane # | EB 1 | WB 1 | WB 2 | SB 1 | SB 2 |
|---|---|---|---|---|---|
| Volume Total (vph) | 332 | 251 | 314 | 33 | 161 |
| Volume Left (vph) | 237 | 0 | 0 | 33 | 0 |
| Volume Right (vph) | 0 | 0 | 314 | 0 | 161 |
| Hadj (s) | 0.18 | 0.03 | -0.57 | 0.23 | -0.57 |
| Departure Headway (s) | 4.4 | 4.4 | 3.2 | 5.4 | 3.2 |
| Degree Utilization, x | 0.41 | 0.31 | 0.28 | 0.05 | 0.14 |
| Capacity (veh/h) | 797 | 800 | 1112 | 596 | 1121 |
| Control Delay (s) | 10.5 | 9.3 | 7.4 | 8.7 | 6.7 |
| Approach Delay (s) | 10.5 | 8.3 | | 7.1 | |
| Approach LOS | B | A | | A | |

| Intersection Summary | | | |
|---|---|---|---|
| Delay | 8.7 | | |
| HCM Level of Service | A | | |
| Intersection Capacity Utilization | 42.1% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | ↑ | ↱↱ | | | | | | | | ↰↑↑↑↱ | |
| Volume (vph) | 0 | 240 | 317 | 0 | 0 | 0 | 0 | 0 | 0 | 67 | 1518 | 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 | | 1.00 | 0.88 | | | | | | | | 0.86 | |
| Frt | | 1.00 | 0.85 | | | | | | | | 0.98 | |
| Flt Protected | | 1.00 | 1.00 | | | | | | | | 1.00 | |
| Satd. Flow (prot) | | 1863 | 2787 | | | | | | | | 6279 | |
| Flt Permitted | | 1.00 | 1.00 | | | | | | | | 1.00 | |
| Satd. Flow (perm) | | 1863 | 2787 | | | | | | | | 6279 | |
| 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 | 261 | 345 | 0 | 0 | 0 | 0 | 0 | 0 | 73 | 1650 | 239 |
| RTOR Reduction (vph) | 0 | 0 | 25 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 28 | 0 |
| Lane Group Flow (vph) | 0 | 261 | 320 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1934 | 0 |
| Turn Type | | | Prot | | | | | | | Perm | | |
| Protected Phases | | 4 | 4 | | | | | | | | 6 | |
| Permitted Phases | | | | | | | | | | 6 | | |
| Actuated Green, G (s) | | 18.6 | 18.6 | | | | | | | | 53.4 | |
| Effective Green, g (s) | | 18.6 | 18.6 | | | | | | | | 53.4 | |
| Actuated g/C Ratio | | 0.23 | 0.23 | | | | | | | | 0.67 | |
| Clearance Time (s) | | 4.0 | 4.0 | | | | | | | | 4.0 | |
| Vehicle Extension (s) | | 3.0 | 3.0 | | | | | | | | 3.0 | |
| Lane Grp Cap (vph) | | 433 | 648 | | | | | | | | 4191 | |
| v/s Ratio Prot | | c0.14 | 0.11 | | | | | | | | | |
| v/s Ratio Perm | | | | | | | | | | | 0.31 | |
| v/c Ratio | | 0.60 | 0.49 | | | | | | | | 0.46 | |
| Uniform Delay, d1 | | 27.4 | 26.6 | | | | | | | | 6.4 | |
| Progression Factor | | 1.00 | 1.00 | | | | | | | | 0.52 | |
| Incremental Delay, d2 | | 2.4 | 0.6 | | | | | | | | 0.3 | |
| Delay (s) | | 29.8 | 27.2 | | | | | | | | 3.6 | |
| Level of Service | | C | C | | | | | | | | A | |
| Approach Delay (s) | | 28.3 | | | 0.0 | | | 0.0 | | | 3.6 | |
| Approach LOS | | C | | | A | | | A | | | A | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 9.4 | HCM Level of Service | A |
| HCM Volume to Capacity ratio | 0.50 | | |
| Actuated Cycle Length (s) | 80.0 | 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 | EBL | EBR | NBL | NBT | NBR | SBL | SBT | SBR | SWL | SWR |
|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | |
| Volume (vph) | 155 | 690 | 0 | 13 | 6 | 110 | 1701 | 0 | 0 | 0 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Lane Width | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 16 |
| Total Lost time (s) | 5.0 | 5.0 | | 5.0 | | | 5.0 | | | |
| Lane Util. Factor | 1.00 | 0.95 | | 1.00 | | | 0.86 | | | |
| Frt | 0.90 | 0.85 | | 0.96 | | | 1.00 | | | |
| Flt Protected | 0.98 | 1.00 | | 1.00 | | | 1.00 | | | |
| Satd. Flow (prot) | 1654 | 1504 | | 1779 | | | 6388 | | | |
| Flt Permitted | 0.98 | 1.00 | | 1.00 | | | 0.91 | | | |
| Satd. Flow (perm) | 1654 | 1504 | | 1779 | | | 5818 | | | |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 168 | 750 | 0 | 14 | 7 | 120 | 1849 | 0 | 0 | 0 |
| RTOR Reduction (vph) | 2 | 2 | 0 | 4 | 0 | 0 | 0 | 0 | 0 | 0 |
| Lane Group Flow (vph) | 466 | 448 | 0 | 17 | 0 | 0 | 1969 | 0 | 0 | 0 |
| Turn Type | | Prot | | | | Perm | | | | |
| Protected Phases | 4 | 4 | | 2 | | | 6 | | | |
| Permitted Phases | | | | | | 6 | | | | |
| Actuated Green, G (s) | 31.2 | 31.2 | | 38.8 | | | 38.8 | | | |
| Effective Green, g (s) | 31.2 | 31.2 | | 38.8 | | | 38.8 | | | |
| Actuated g/C Ratio | 0.39 | 0.39 | | 0.48 | | | 0.48 | | | |
| Clearance Time (s) | 5.0 | 5.0 | | 5.0 | | | 5.0 | | | |
| Vehicle Extension (s) | 2.0 | 2.0 | | 5.0 | | | 5.0 | | | |
| Lane Grp Cap (vph) | 645 | 587 | | 863 | | | 2822 | | | |
| v/s Ratio Prot | 0.28 | c0.30 | | 0.01 | | | | | | |
| v/s Ratio Perm | | | | | | | c0.34 | | | |
| v/c Ratio | 0.72 | 0.76 | | 0.02 | | | 0.70 | | | |
| Uniform Delay, d1 | 20.7 | 21.2 | | 10.7 | | | 16.0 | | | |
| Progression Factor | 1.00 | 1.00 | | 1.00 | | | 0.23 | | | |
| Incremental Delay, d2 | 3.4 | 5.3 | | 0.0 | | | 1.1 | | | |
| Delay (s) | 24.1 | 26.4 | | 10.8 | | | 4.9 | | | |
| Level of Service | C | C | | B | | | A | | | |
| Approach Delay (s) | 25.2 | | | 10.8 | | | 4.9 | | 0.0 | |
| Approach LOS | C | | | B | | | A | | A | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 11.3 | HCM Level of Service | B |
| HCM Volume to Capacity ratio | 0.73 | | |
| Actuated Cycle Length (s) | 80.0 | Sum of lost time (s) | 10.0 |
| 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 | 0 | 0 | 67 | 414 | 0 | 0 | 9 | 0 | 0 | 1712 | 173 |
| 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 | |
| Lane Util. Factor | | | | | 0.91 | | | 1.00 | | | 0.86 | |
| Frt | | | | | 1.00 | | | 1.00 | | | 0.99 | |
| Flt Protected | | | | | 0.99 | | | 1.00 | | | 1.00 | |
| Satd. Flow (prot) | | | | | 5050 | | | 1863 | | | 6320 | |
| Flt Permitted | | | | | 0.99 | | | 1.00 | | | 1.00 | |
| Satd. Flow (perm) | | | | | 5050 | | | 1863 | | | 6320 | |
| 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 | 73 | 450 | 0 | 0 | 10 | 0 | 0 | 1861 | 188 |
| RTOR Reduction (vph) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 20 | 0 |
| Lane Group Flow (vph) | 0 | 0 | 0 | 0 | 523 | 0 | 0 | 10 | 0 | 0 | 2029 | 0 |
| Turn Type | | | | Perm | | | | | | | | |
| Protected Phases | | | | | 4 | | | 2 | | | 6 | |
| Permitted Phases | | | | 4 | | | | | | | | |
| Actuated Green, G (s) | | | | | 31.2 | | | 38.8 | | | 38.8 | |
| Effective Green, g (s) | | | | | 31.2 | | | 38.8 | | | 38.8 | |
| Actuated g/C Ratio | | | | | 0.39 | | | 0.48 | | | 0.48 | |
| Clearance Time (s) | | | | | 5.0 | | | 5.0 | | | 5.0 | |
| Vehicle Extension (s) | | | | | 2.0 | | | 5.0 | | | 5.0 | |
| Lane Grp Cap (vph) | | | | | 1970 | | | 904 | | | 3065 | |
| v/s Ratio Prot | | | | | | | | 0.01 | | | c0.32 | |
| v/s Ratio Perm | | | | | 0.10 | | | | | | | |
| v/c Ratio | | | | | 0.27 | | | 0.01 | | | 0.66 | |
| Uniform Delay, d1 | | | | | 16.6 | | | 10.7 | | | 15.6 | |
| Progression Factor | | | | | 1.00 | | | 0.37 | | | 1.00 | |
| Incremental Delay, d2 | | | | | 0.0 | | | 0.0 | | | 1.1 | |
| Delay (s) | | | | | 16.6 | | | 4.0 | | | 16.8 | |
| Level of Service | | | | | B | | | A | | | B | |
| Approach Delay (s) | | 0.0 | | | 16.6 | | | 4.0 | | | 16.8 | |
| Approach LOS | | A | | | B | | | A | | | B | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 16.7 | HCM Level of Service | B |
| HCM Volume to Capacity ratio | 0.49 | | |
| Actuated Cycle Length (s) | 80.0 | Sum of lost time (s) | 10.0 |
| Intersection Capacity Utilization | 45.4% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

| Lane Group | EBL | EBT | EBR | WBL | WBT | NBL | NBT | NBR | SBT |
|---|---|---|---|---|---|---|---|---|---|
| Lane Group Flow (vph) | 58 | 707 | 300 | 133 | 506 | 222 | 225 | 91 | 121 |
| v/c Ratio | 0.45 | 0.86 | 0.19 | 1.00 | 0.38 | 0.51 | 0.51 | 0.19 | 0.23 |
| Control Delay | 70.2 | 58.5 | 2.1 | 138.2 | 41.7 | 42.4 | 42.2 | 8.1 | 22.1 |
| Queue Delay | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Total Delay | 70.2 | 58.5 | 2.1 | 138.2 | 41.7 | 42.4 | 42.2 | 8.1 | 22.1 |
| Queue Length 50th (ft) | 48 | 316 | 0 | ~138 | 135 | 163 | 165 | 0 | 46 |
| Queue Length 95th (ft) | 95 | #450 | 24 | #272 | 175 | 247 | 250 | 42 | 94 |
| Internal Link Dist (ft) | | 590 | | | 238 | | 431 | | 189 |
| Turn Bay Length (ft) | 155 | | | 80 | | | | | |
| Base Capacity (vph) | 149 | 861 | 1816 | 133 | 1344 | 581 | 591 | 608 | 722 |
| Starvation Cap Reductn | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Spillback Cap Reductn | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Storage Cap Reductn | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Reduced v/c Ratio | 0.39 | 0.82 | 0.17 | 1.00 | 0.38 | 0.38 | 0.38 | 0.15 | 0.17 |

Intersection Summary

~ Volume exceeds capacity, queue is theoretically infinite.
Queue shown is maximum after two cycles.

\# 95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

| Lane Group | EBL | EBT | EBR | WBL | WBT | NBL | NBT | NBR | SBT |
|---|---|---|---|---|---|---|---|---|---|
| Lane Group Flow (vph) | 60 | 761 | 402 | 140 | 544 | 247 | 252 | 122 | 112 |
| v/c Ratio | 0.45 | 0.91 | 0.24 | 1.09 | 0.41 | 0.56 | 0.56 | 0.24 | 0.22 |
| Control Delay | 68.9 | 63.4 | 1.9 | 158.4 | 43.5 | 43.8 | 43.7 | 7.5 | 24.8 |
| Queue Delay | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Total Delay | 68.9 | 63.4 | 1.9 | 158.4 | 43.5 | 43.8 | 43.7 | 7.5 | 24.8 |
| Queue Length 50th (ft) | 49 | ~375 | 0 | ~150 | 151 | 184 | 188 | 0 | 50 |
| Queue Length 95th (ft) | 96 | #503 | 27 | #286 | 193 | 275 | 280 | 47 | 97 |
| Internal Link Dist (ft) | | 590 | | | 238 | | 431 | | 189 |
| Turn Bay Length (ft) | 155 | | | 80 | | | | | |
| Base Capacity (vph) | 161 | 837 | 1856 | 129 | 1325 | 566 | 577 | 614 | 706 |
| Starvation Cap Reductn | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Spillback Cap Reductn | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Storage Cap Reductn | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Reduced v/c Ratio | 0.37 | 0.91 | 0.22 | 1.09 | 0.41 | 0.44 | 0.44 | 0.20 | 0.16 |

**Intersection Summary**

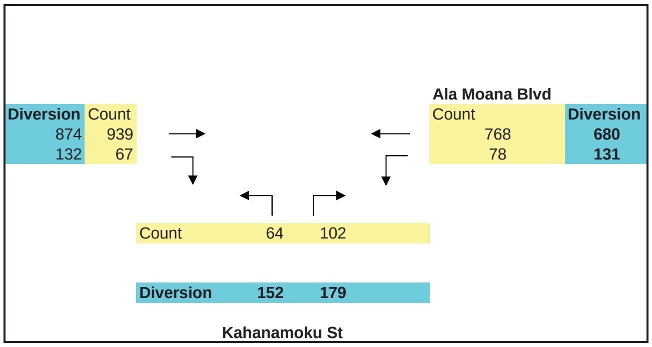
~ Volume exceeds capacity, queue is theoretically infinite.
Queue shown is maximum after two cycles.

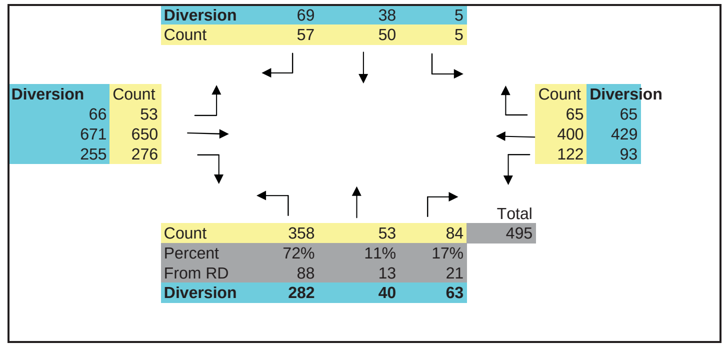
# 95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

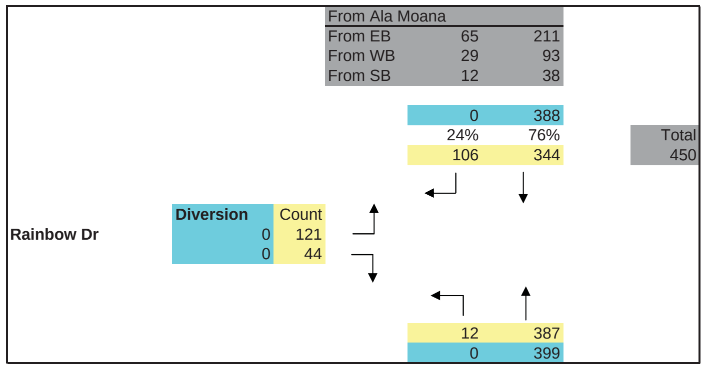
# APPENDIX D

# TRAFFIC DIVERSION

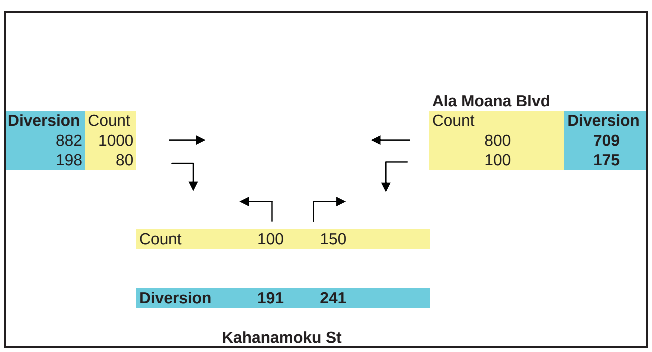
**AM Hour**

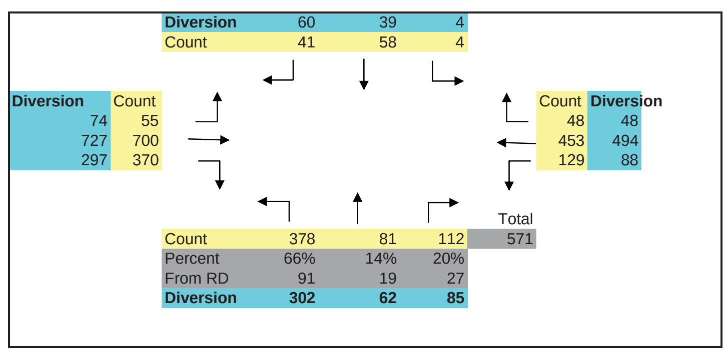


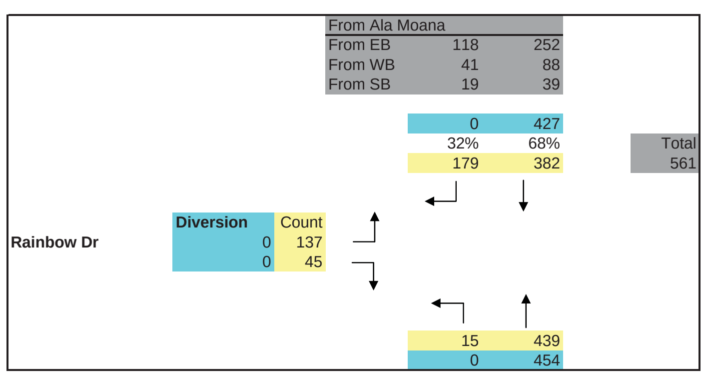




**PM Hour**



# APPENDIX E

## CAPACITY ANALYSIS CALCULATIONS
## PROJECTED PEAK HOUR TRAFFIC ANALYSIS
## 2-LANE CLOSURE

| Movement | EBT | EBR | WBL | WBT | NBL | NBR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Volume (vph) | 939 | 67 | 78 | 768 | 64 | 102 |
| 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 | 0.86 | | 1.00 | 0.91 | 1.00 | 1.00 |
| Frt | 0.99 | | 1.00 | 1.00 | 1.00 | 0.85 |
| Flt Protected | 1.00 | | 0.95 | 1.00 | 0.95 | 1.00 |
| Satd. Flow (prot) | 6344 | | 1770 | 5085 | 1770 | 1583 |
| Flt Permitted | 1.00 | | 0.95 | 1.00 | 0.95 | 1.00 |
| Satd. Flow (perm) | 6344 | | 1770 | 5085 | 1770 | 1583 |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 1021 | 73 | 85 | 835 | 70 | 111 |
| RTOR Reduction (vph) | 17 | 0 | 0 | 0 | 0 | 95 |
| Lane Group Flow (vph) | 1077 | 0 | 85 | 835 | 70 | 16 |
| Turn Type | | | Prot | | | Perm |
| Protected Phases | 4 | | 3 | 8 | 2 | |
| Permitted Phases | | | | | | 2 |
| Actuated Green, G (s) | 17.7 | | 2.3 | 24.0 | 5.4 | 5.4 |
| Effective Green, g (s) | 17.7 | | 2.3 | 24.0 | 5.4 | 5.4 |
| Actuated g/C Ratio | 0.47 | | 0.06 | 0.64 | 0.14 | 0.14 |
| 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) | 3002 | | 109 | 3263 | 256 | 229 |
| v/s Ratio Prot | c0.17 | | c0.05 | 0.16 | c0.04 | |
| v/s Ratio Perm | | | | | | 0.01 |
| v/c Ratio | 0.36 | | 0.78 | 0.26 | 0.27 | 0.07 |
| Uniform Delay, d1 | 6.2 | | 17.3 | 2.9 | 14.3 | 13.8 |
| Progression Factor | 1.00 | | 1.00 | 1.00 | 1.00 | 1.00 |
| Incremental Delay, d2 | 0.1 | | 28.9 | 0.0 | 0.6 | 0.1 |
| Delay (s) | 6.3 | | 46.2 | 2.9 | 14.8 | 14.0 |
| Level of Service | A | | D | A | B | B |
| Approach Delay (s) | 6.3 | | | 6.9 | 14.3 | |
| Approach LOS | A | | | A | B | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 7.2 | HCM Level of Service | A |
| HCM Volume to Capacity ratio | 0.38 | | |
| Actuated Cycle Length (s) | 37.4 | 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) | 53 | 650 | 276 | 122 | 400 | 65 | 358 | 53 | 84 | 5 | 50 | 57 |
| Ideal Flow (vphpl) | 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 | 1.00 | 1.00 | 0.91 | | 0.95 | 0.95 | | | 1.00 | |
| Frt | 1.00 | 1.00 | 0.85 | 1.00 | 0.98 | | 1.00 | 0.95 | | | 0.93 | |
| Flt Protected | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | | 0.95 | 0.98 | | | 1.00 | |
| Satd. Flow (prot) | 1770 | 3539 | 1583 | 1770 | 4978 | | 1681 | 1643 | | | 1730 | |
| Flt Permitted | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | | 0.95 | 0.98 | | | 1.00 | |
| Satd. Flow (perm) | 1770 | 3539 | 1583 | 1770 | 4978 | | 1681 | 1643 | | | 1730 | |
| 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) | 58 | 707 | 300 | 133 | 435 | 71 | 389 | 58 | 91 | 5 | 54 | 62 |
| RTOR Reduction (vph) | 0 | 0 | 137 | 0 | 15 | 0 | 0 | 15 | 0 | 0 | 31 | 0 |
| Lane Group Flow (vph) | 58 | 707 | 163 | 133 | 491 | 0 | 272 | 251 | 0 | 0 | 90 | 0 |
| Turn Type | Prot | | pt+ov | Prot | | | Split | | | Split | | |
| Protected Phases | 7 | 4 | 4 2 | 3 | 8 | | 2 | 2 | | 6 | 6 | |
| Permitted Phases | | | | | | | | | | | | |
| Actuated Green, G (s) | 6.3 | 28.6 | 63.8 | 8.6 | 30.9 | | 31.2 | 31.2 | | | 33.0 | |
| Effective Green, g (s) | 6.3 | 28.6 | 63.8 | 8.6 | 30.9 | | 31.2 | 31.2 | | | 33.0 | |
| Actuated g/C Ratio | 0.05 | 0.24 | 0.54 | 0.07 | 0.26 | | 0.27 | 0.27 | | | 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) | 95 | 862 | 860 | 130 | 1310 | | 447 | 437 | | | 486 | |
| v/s Ratio Prot | 0.03 | c0.20 | 0.10 | c0.08 | 0.10 | | c0.16 | 0.15 | | | c0.05 | |
| v/s Ratio Perm | | | | | | | | | | | | |
| v/c Ratio | 0.61 | 0.82 | 0.19 | 1.02 | 0.37 | | 0.61 | 0.58 | | | 0.19 | |
| Uniform Delay, d1 | 54.3 | 42.0 | 13.6 | 54.4 | 35.4 | | 37.8 | 37.4 | | | 32.0 | |
| Progression Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | | 1.00 | 1.00 | | | 1.00 | |
| Incremental Delay, d2 | 11.1 | 6.3 | 0.1 | 85.2 | 0.2 | | 2.3 | 1.8 | | | 0.2 | |
| Delay (s) | 65.4 | 48.3 | 13.7 | 139.6 | 35.5 | | 40.1 | 39.2 | | | 32.2 | |
| Level of Service | E | D | B | F | D | | D | D | | | C | |
| Approach Delay (s) | | 39.5 | | | 57.2 | | | 39.6 | | | 32.2 | |
| Approach LOS | | D | | | E | | | D | | | C | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 43.9 | HCM Level of Service | D |
| HCM Volume to Capacity ratio | 0.56 | | |
| Actuated Cycle Length (s) | 117.4 | Sum of lost time (s) | 16.0 |
| Intersection Capacity Utilization | 55.3% | ICU Level of Service | B |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

| Movement | EBL | EBR | NBL | NBT | SBT | SBR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Volume (vph) | 121 | 44 | 12 | 387 | 344 | 106 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 4.0 | 4.0 | | 4.0 | 4.0 | |
| Lane Util. Factor | 0.97 | 1.00 | | 0.95 | 1.00 | |
| Frt | 1.00 | 0.85 | | 1.00 | 0.97 | |
| Flt Protected | 0.95 | 1.00 | | 1.00 | 1.00 | |
| Satd. Flow (prot) | 3433 | 1583 | | 3534 | 1804 | |
| Flt Permitted | 0.95 | 1.00 | | 0.94 | 1.00 | |
| Satd. Flow (perm) | 3433 | 1583 | | 3327 | 1804 | |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 132 | 48 | 13 | 421 | 374 | 115 |
| RTOR Reduction (vph) | 0 | 39 | 0 | 0 | 21 | 0 |
| Lane Group Flow (vph) | 132 | 9 | 0 | 434 | 468 | 0 |
| Turn Type | | Perm | Perm | | | |
| Protected Phases | 4 | | | 2 | 6 | |
| Permitted Phases | | 4 | 2 | | | |
| Actuated Green, G (s) | 5.5 | 5.5 | | 14.5 | 14.5 | |
| Effective Green, g (s) | 5.5 | 5.5 | | 14.5 | 14.5 | |
| Actuated g/C Ratio | 0.20 | 0.20 | | 0.52 | 0.52 | |
| 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) | 674 | 311 | | 1723 | 934 | |
| v/s Ratio Prot | c0.04 | | | | c0.26 | |
| v/s Ratio Perm | | 0.01 | | 0.13 | | |
| v/c Ratio | 0.20 | 0.03 | | 0.25 | 0.50 | |
| Uniform Delay, d1 | 9.4 | 9.1 | | 3.7 | 4.4 | |
| Progression Factor | 1.00 | 1.00 | | 1.00 | 1.00 | |
| Incremental Delay, d2 | 0.1 | 0.0 | | 0.1 | 0.4 | |
| Delay (s) | 9.5 | 9.1 | | 3.8 | 4.8 | |
| Level of Service | A | A | | A | A | |
| Approach Delay (s) | 9.4 | | | 3.8 | 4.8 | |
| Approach LOS | A | | | A | A | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 5.2 | HCM Level of Service | A |
| HCM Volume to Capacity ratio | 0.42 | | |
| Actuated Cycle Length (s) | 28.0 | Sum of lost time (s) | 8.0 |
| Intersection Capacity Utilization | 34.7% | 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) | 45 | 11 | 9 | 12 | 29 | 83 | 8 | 368 | 20 | 48 | 275 | 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 | 4.0 | 4.0 | 4.0 |
| Lane Util. Factor | | 1.00 | 1.00 | | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Frt | | 1.00 | 0.85 | | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 |
| Flt Protected | | 0.96 | 1.00 | | 0.99 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 |
| Satd. Flow (prot) | | 1791 | 1583 | | 1836 | 1583 | 1770 | 1863 | 1583 | 1770 | 1863 | 1583 |
| Flt Permitted | | 0.79 | 1.00 | | 0.93 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 |
| Satd. Flow (perm) | | 1470 | 1583 | | 1735 | 1583 | 1770 | 1863 | 1583 | 1770 | 1863 | 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) | 49 | 12 | 10 | 13 | 32 | 90 | 9 | 400 | 22 | 52 | 299 | 24 |
| RTOR Reduction (vph) | 0 | 0 | 7 | 0 | 0 | 66 | 0 | 0 | 12 | 0 | 0 | 13 |
| Lane Group Flow (vph) | 0 | 61 | 3 | 0 | 45 | 24 | 9 | 400 | 10 | 52 | 299 | 11 |
| Turn Type | Perm | | Perm | Perm | | Perm | Prot | | Perm | Prot | | Perm |
| Protected Phases | | 4 | | | 8 | | 5 | 2 | | 1 | 6 | |
| Permitted Phases | 4 | | 4 | 8 | | 8 | | | 2 | | | 6 |
| Actuated Green, G (s) | | 11.9 | 11.9 | | 11.9 | 11.9 | 0.5 | 19.4 | 19.4 | 1.6 | 20.5 | 20.5 |
| Effective Green, g (s) | | 11.9 | 11.9 | | 11.9 | 11.9 | 0.5 | 19.4 | 19.4 | 1.6 | 20.5 | 20.5 |
| Actuated g/C Ratio | | 0.27 | 0.27 | | 0.27 | 0.27 | 0.01 | 0.43 | 0.43 | 0.04 | 0.46 | 0.46 |
| Clearance Time (s) | | 4.0 | 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 | 3.0 |
| Lane Grp Cap (vph) | | 390 | 420 | | 460 | 420 | 20 | 805 | 684 | 63 | 851 | 723 |
| v/s Ratio Prot | | | | | | | 0.01 | c0.21 | | c0.03 | 0.16 | |
| v/s Ratio Perm | | c0.04 | 0.00 | | 0.03 | 0.02 | | | 0.01 | | | 0.01 |
| v/c Ratio | | 0.16 | 0.01 | | 0.10 | 0.06 | 0.45 | 0.50 | 0.01 | 0.83 | 0.35 | 0.02 |
| Uniform Delay, d1 | | 12.7 | 12.1 | | 12.4 | 12.3 | 22.1 | 9.2 | 7.3 | 21.5 | 7.9 | 6.7 |
| 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 | | 0.2 | 0.0 | | 0.1 | 0.1 | 15.3 | 0.5 | 0.0 | 56.1 | 0.3 | 0.0 |
| Delay (s) | | 12.8 | 12.2 | | 12.5 | 12.4 | 37.3 | 9.7 | 7.3 | 77.6 | 8.1 | 6.7 |
| Level of Service | | B | B | | B | B | D | A | A | E | A | A |
| Approach Delay (s) | | 12.7 | | | 12.4 | | | 10.2 | | | 17.7 | |
| Approach LOS | | B | | | B | | | B | | | B | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 13.4 | HCM Level of Service | B |
| HCM Volume to Capacity ratio | 0.39 | | |
| Actuated Cycle Length (s) | 44.9 | Sum of lost time (s) | 12.0 |
| Intersection Capacity Utilization | 42.4% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

| Movement | EBL | EBT | WBT | WBR | SBL | SBR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Volume (vph) | 212 | 65 | 192 | 283 | 30 | 133 |
| 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 | | 1.00 | 1.00 | 0.85 | 1.00 | 0.85 |
| Flt Protected | | 0.96 | 1.00 | 1.00 | 0.95 | 1.00 |
| Satd. Flow (prot) | | 1794 | 1863 | 1583 | 1770 | 1583 |
| Flt Permitted | | 0.65 | 1.00 | 1.00 | 0.95 | 1.00 |
| Satd. Flow (perm) | | 1205 | 1863 | 1583 | 1770 | 1583 |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 230 | 71 | 209 | 308 | 33 | 145 |
| RTOR Reduction (vph) | 0 | 0 | 0 | 0 | 0 | 118 |
| Lane Group Flow (vph) | 0 | 301 | 209 | 308 | 33 | 27 |
| Turn Type | Perm | | | Free | | Perm |
| Protected Phases | | 4 | 8 | | 6 | |
| Permitted Phases | 4 | | | Free | | 6 |
| Actuated Green, G (s) | | 6.5 | 6.5 | 17.8 | 3.3 | 3.3 |
| Effective Green, g (s) | | 6.5 | 6.5 | 17.8 | 3.3 | 3.3 |
| Actuated g/C Ratio | | 0.37 | 0.37 | 1.00 | 0.19 | 0.19 |
| 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) | | 440 | 680 | 1583 | 328 | 293 |
| v/s Ratio Prot | | | 0.11 | | 0.02 | |
| v/s Ratio Perm | | c0.25 | | c0.19 | | 0.02 |
| v/c Ratio | | 0.68 | 0.31 | 0.19 | 0.10 | 0.09 |
| Uniform Delay, d1 | | 4.8 | 4.0 | 0.0 | 6.0 | 6.0 |
| Progression Factor | | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Incremental Delay, d2 | | 4.4 | 0.3 | 0.3 | 0.1 | 0.1 |
| Delay (s) | | 9.1 | 4.3 | 0.3 | 6.2 | 6.1 |
| Level of Service | | A | A | A | A | A |
| Approach Delay (s) | | 9.1 | 1.9 | | 6.1 | |
| Approach LOS | | A | A | | A | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 4.8 | HCM Level of Service | A |
| HCM Volume to Capacity ratio | 0.43 | | |
| Actuated Cycle Length (s) | 17.8 | Sum of lost time (s) | 4.0 |
| Intersection Capacity Utilization | 38.6% | 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 | 196 | 327 | 0 | 0 | 0 | 0 | 0 | 0 | 43 | 1309 | 227 |
| Ideal 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 | | 1.00 | 0.88 | | | | | | | | 0.86 | |
| Frt | | 1.00 | 0.85 | | | | | | | | 0.98 | |
| Flt Protected | | 1.00 | 1.00 | | | | | | | | 1.00 | |
| Satd. Flow (prot) | | 1863 | 2787 | | | | | | | | 6261 | |
| Flt Permitted | | 1.00 | 1.00 | | | | | | | | 1.00 | |
| Satd. Flow (perm) | | 1863 | 2787 | | | | | | | | 6261 | |
| 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 | 213 | 355 | 0 | 0 | 0 | 0 | 0 | 0 | 47 | 1423 | 247 |
| RTOR Reduction (vph) | 0 | 0 | 42 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 29 | 0 |
| Lane Group Flow (vph) | 0 | 213 | 313 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1688 | 0 |
| Turn Type | | | Prot | | | | | | | Perm | | |
| Protected Phases | | 4 | 4 | | | | | | | | 6 | |
| Permitted Phases | | | | | | | | | | 6 | | |
| Actuated Green, G (s) | | 17.2 | 17.2 | | | | | | | | 54.8 | |
| Effective Green, g (s) | | 17.2 | 17.2 | | | | | | | | 54.8 | |
| Actuated g/C Ratio | | 0.22 | 0.22 | | | | | | | | 0.68 | |
| Clearance Time (s) | | 4.0 | 4.0 | | | | | | | | 4.0 | |
| Vehicle Extension (s) | | 3.0 | 3.0 | | | | | | | | 3.0 | |
| Lane Grp Cap (vph) | | 401 | 599 | | | | | | | | 4289 | |
| v/s Ratio Prot | | c0.11 | 0.11 | | | | | | | | | |
| v/s Ratio Perm | | | | | | | | | | | 0.27 | |
| v/c Ratio | | 0.53 | 0.52 | | | | | | | | 0.39 | |
| Uniform Delay, d1 | | 27.8 | 27.8 | | | | | | | | 5.4 | |
| Progression Factor | | 1.00 | 1.00 | | | | | | | | 0.61 | |
| Incremental Delay, d2 | | 1.4 | 0.8 | | | | | | | | 0.2 | |
| Delay (s) | | 29.2 | 28.6 | | | | | | | | 3.5 | |
| Level of Service | | C | C | | | | | | | | A | |
| Approach Delay (s) | | 28.8 | | | 0.0 | | | 0.0 | | | 3.5 | |
| Approach LOS | | C | | | A | | | A | | | A | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 9.8 | HCM Level of Service | A |
| HCM Volume to Capacity ratio | 0.43 | | |
| Actuated Cycle Length (s) | 80.0 | 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 | EBR | NBL | NBT | NBR | SBL | SBT | SBR | SWL | SWR |
|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | |
| Volume (vph) | 84 | 525 | 0 | 12 | 7 | 113 | 1412 | 0 | 0 | 0 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Lane Width | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 16 |
| Total Lost time (s) | 5.0 | 5.0 | | 5.0 | | | 5.0 | | | |
| Lane Util. Factor | 1.00 | 0.95 | | 1.00 | | | 0.86 | | | |
| Frt | 0.89 | 0.85 | | 0.95 | | | 1.00 | | | |
| Flt Protected | 0.99 | 1.00 | | 1.00 | | | 1.00 | | | |
| Satd. Flow (prot) | 1637 | 1504 | | 1767 | | | 6384 | | | |
| Flt Permitted | 0.99 | 1.00 | | 1.00 | | | 0.90 | | | |
| Satd. Flow (perm) | 1637 | 1504 | | 1767 | | | 5787 | | | |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 91 | 571 | 0 | 13 | 8 | 123 | 1535 | 0 | 0 | 0 |
| RTOR Reduction (vph) | 8 | 8 | 0 | 4 | 0 | 0 | 0 | 0 | 0 | 0 |
| Lane Group Flow (vph) | 329 | 317 | 0 | 17 | 0 | 0 | 1658 | 0 | 0 | 0 |
| Turn Type | | Prot | | | | Perm | | | | |
| Protected Phases | 4 | 4 | | 2 | | | 6 | | | |
| Permitted Phases | | | | | | 6 | | | | |
| Actuated Green, G (s) | 28.8 | 28.8 | | 41.2 | | | 41.2 | | | |
| Effective Green, g (s) | 28.8 | 28.8 | | 41.2 | | | 41.2 | | | |
| Actuated g/C Ratio | 0.36 | 0.36 | | 0.52 | | | 0.52 | | | |
| Clearance Time (s) | 5.0 | 5.0 | | 5.0 | | | 5.0 | | | |
| Vehicle Extension (s) | 2.0 | 2.0 | | 5.0 | | | 5.0 | | | |
| Lane Grp Cap (vph) | 589 | 541 | | 910 | | | 2980 | | | |
| v/s Ratio Prot | 0.20 | c0.21 | | 0.01 | | | | | | |
| v/s Ratio Perm | | | | | | | c0.29 | | | |
| v/c Ratio | 0.56 | 0.59 | | 0.02 | | | 0.56 | | | |
| Uniform Delay, d1 | 20.5 | 20.8 | | 9.5 | | | 13.2 | | | |
| Progression Factor | 1.00 | 1.00 | | 1.00 | | | 0.30 | | | |
| Incremental Delay, d2 | 0.7 | 1.0 | | 0.0 | | | 0.7 | | | |
| Delay (s) | 21.2 | 21.8 | | 9.5 | | | 4.6 | | | |
| Level of Service | C | C | | A | | | A | | | |
| Approach Delay (s) | 21.5 | | | 9.5 | | | 4.6 | | 0.0 | |
| Approach LOS | C | | | A | | | A | | A | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 9.4 | HCM Level of Service | A |
| HCM Volume to Capacity ratio | 0.57 | | |
| Actuated Cycle Length (s) | 80.0 | Sum of lost time (s) | 10.0 |
| Intersection Capacity Utilization | 52.2% | 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) | 0 | 0 | 0 | 51 | 355 | 0 | 0 | 8 | 0 | 0 | 1369 | 176 |
| 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 | |
| Lane Util. Factor | | | | | 0.91 | | | 1.00 | | | 0.86 | |
| Frt | | | | | 1.00 | | | 1.00 | | | 0.98 | |
| Flt Protected | | | | | 0.99 | | | 1.00 | | | 1.00 | |
| Satd. Flow (prot) | | | | | 5054 | | | 1863 | | | 6299 | |
| Flt Permitted | | | | | 0.99 | | | 1.00 | | | 1.00 | |
| Satd. Flow (perm) | | | | | 5054 | | | 1863 | | | 6299 | |
| 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 | 55 | 386 | 0 | 0 | 9 | 0 | 0 | 1488 | 191 |
| RTOR Reduction (vph) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 27 | 0 |
| Lane Group Flow (vph) | 0 | 0 | 0 | 0 | 441 | 0 | 0 | 9 | 0 | 0 | 1652 | 0 |
| Turn Type | | | | Perm | | | | | | | | |
| Protected Phases | | | | | 4 | | | 2 | | | 6 | |
| Permitted Phases | | | | 4 | | | | | | | | |
| Actuated Green, G (s) | | | | | 28.8 | | | 41.2 | | | 41.2 | |
| Effective Green, g (s) | | | | | 28.8 | | | 41.2 | | | 41.2 | |
| Actuated g/C Ratio | | | | | 0.36 | | | 0.52 | | | 0.52 | |
| Clearance Time (s) | | | | | 5.0 | | | 5.0 | | | 5.0 | |
| Vehicle Extension (s) | | | | | 2.0 | | | 5.0 | | | 5.0 | |
| Lane Grp Cap (vph) | | | | | 1819 | | | 959 | | | 3244 | |
| v/s Ratio Prot | | | | | | | | 0.00 | | | c0.26 | |
| v/s Ratio Perm | | | | | 0.09 | | | | | | | |
| v/c Ratio | | | | | 0.24 | | | 0.01 | | | 0.51 | |
| Uniform Delay, d1 | | | | | 18.0 | | | 9.5 | | | 12.8 | |
| Progression Factor | | | | | 1.00 | | | 0.41 | | | 1.00 | |
| Incremental Delay, d2 | | | | | 0.0 | | | 0.0 | | | 0.6 | |
| Delay (s) | | | | | 18.0 | | | 3.9 | | | 13.3 | |
| Level of Service | | | | | B | | | A | | | B | |
| Approach Delay (s) | | 0.0 | | | 18.0 | | | 3.9 | | | 13.3 | |
| Approach LOS | | A | | | B | | | A | | | B | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 14.3 | HCM Level of Service | B |
| HCM Volume to Capacity ratio | 0.40 | | |
| Actuated Cycle Length (s) | 80.0 | Sum of lost time (s) | 10.0 |
| Intersection Capacity Utilization | 39.0% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

| | → | ↘ | ↙ | ← | ↖ | ↗ |
|---|---|---|---|---|---|---|
| Movement | EBT | EBR | WBL | WBT | NBL | NBR |
| Lane Configurations | ↑↑↑↱ | | ↰ | ↑↑↑ | ↰ | ↱ |
| Volume (vph) | 1000 | 80 | 100 | 800 | 100 | 150 |
| 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 | 0.86 | | 1.00 | 0.91 | 1.00 | 1.00 |
| Frt | 0.99 | | 1.00 | 1.00 | 1.00 | 0.85 |
| Flt Protected | 1.00 | | 0.95 | 1.00 | 0.95 | 1.00 |
| Satd. Flow (prot) | 6337 | | 1770 | 5085 | 1770 | 1583 |
| Flt Permitted | 1.00 | | 0.95 | 1.00 | 0.95 | 1.00 |
| Satd. Flow (perm) | 6337 | | 1770 | 5085 | 1770 | 1583 |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 1087 | 87 | 109 | 870 | 109 | 163 |
| RTOR Reduction (vph) | 20 | 0 | 0 | 0 | 0 | 138 |
| Lane Group Flow (vph) | 1154 | 0 | 109 | 870 | 109 | 25 |
| Turn Type | | | Prot | | | Perm |
| Protected Phases | 4 | | 3 | 8 | 2 | |
| Permitted Phases | | | | | | 2 |
| Actuated Green, G (s) | 18.8 | | 3.5 | 26.3 | 6.1 | 6.1 |
| Effective Green, g (s) | 18.8 | | 3.5 | 26.3 | 6.1 | 6.1 |
| Actuated g/C Ratio | 0.47 | | 0.09 | 0.65 | 0.15 | 0.15 |
| 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) | 2949 | | 153 | 3310 | 267 | 239 |
| v/s Ratio Prot | c0.18 | | c0.06 | 0.17 | c0.06 | |
| v/s Ratio Perm | | | | | | 0.02 |
| v/c Ratio | 0.39 | | 0.71 | 0.26 | 0.41 | 0.10 |
| Uniform Delay, d1 | 7.1 | | 18.0 | 3.0 | 15.5 | 14.8 |
| Progression Factor | 1.00 | | 1.00 | 1.00 | 1.00 | 1.00 |
| Incremental Delay, d2 | 0.1 | | 14.5 | 0.0 | 1.0 | 0.2 |
| Delay (s) | 7.1 | | 32.5 | 3.0 | 16.5 | 15.0 |
| Level of Service | A | | C | A | B | B |
| Approach Delay (s) | 7.1 | | | 6.3 | 15.6 | |
| Approach LOS | A | | | A | B | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 7.8 | HCM Level of Service | A |
| HCM Volume to Capacity ratio | 0.43 | | |
| Actuated Cycle Length (s) | 40.4 | Sum of lost time (s) | 12.0 |
| 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) | 55 | 700 | 370 | 129 | 453 | 48 | 378 | 81 | 112 | 4 | 58 | 41 |
| Ideal Flow (vphpl) | 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 | 1.00 | 1.00 | 0.91 | | 0.95 | 0.95 | | | 1.00 | |
| Frt | 1.00 | 1.00 | 0.85 | 1.00 | 0.99 | | 1.00 | 0.94 | | | 0.95 | |
| Flt Protected | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | | 0.95 | 0.98 | | | 1.00 | |
| Satd. Flow (prot) | 1770 | 3539 | 1583 | 1770 | 5012 | | 1681 | 1638 | | | 1759 | |
| Flt Permitted | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | | 0.95 | 0.98 | | | 1.00 | |
| Satd. Flow (perm) | 1770 | 3539 | 1583 | 1770 | 5012 | | 1681 | 1638 | | | 1759 | |
| 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) | 60 | 761 | 402 | 140 | 492 | 52 | 411 | 88 | 122 | 4 | 63 | 45 |
| RTOR Reduction (vph) | 0 | 0 | 182 | 0 | 9 | 0 | 0 | 19 | 0 | 0 | 20 | 0 |
| Lane Group Flow (vph) | 60 | 761 | 220 | 140 | 535 | 0 | 316 | 286 | 0 | 0 | 92 | 0 |
| Turn Type | Prot | | pt+ov | Prot | | | Split | | | Split | | |
| Protected Phases | 7 | 4 | 4 2 | 3 | 8 | | 2 | 2 | | 6 | 6 | |
| Permitted Phases | | | | | | | | | | | | |
| Actuated Green, G (s) | 6.9 | 28.8 | 64.8 | 8.5 | 30.4 | | 32.0 | 32.0 | | | 33.3 | |
| Effective Green, g (s) | 6.9 | 28.8 | 64.8 | 8.5 | 30.4 | | 32.0 | 32.0 | | | 33.3 | |
| Actuated g/C Ratio | 0.06 | 0.24 | 0.55 | 0.07 | 0.26 | | 0.27 | 0.27 | | | 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) | 103 | 859 | 865 | 127 | 1285 | | 454 | 442 | | | 494 | |
| v/s Ratio Prot | 0.03 | c0.22 | 0.14 | c0.08 | 0.11 | | c0.19 | 0.17 | | | c0.05 | |
| v/s Ratio Perm | | | | | | | | | | | | |
| v/c Ratio | 0.58 | 0.89 | 0.25 | 1.10 | 0.42 | | 0.70 | 0.65 | | | 0.19 | |
| Uniform Delay, d1 | 54.4 | 43.3 | 14.2 | 55.0 | 36.7 | | 38.9 | 38.3 | | | 32.4 | |
| Progression Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | | 1.00 | 1.00 | | | 1.00 | |
| Incremental Delay, d2 | 8.1 | 10.9 | 0.2 | 110.0 | 0.2 | | 4.6 | 3.2 | | | 0.2 | |
| Delay (s) | 62.6 | 54.2 | 14.3 | 165.0 | 36.9 | | 43.5 | 41.6 | | | 32.5 | |
| Level of Service | E | D | B | F | D | | D | D | | | C | |
| Approach Delay (s) | | 41.5 | | | 63.2 | | | 42.6 | | | 32.5 | |
| Approach LOS | | D | | | E | | | D | | | C | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 47.0 | HCM Level of Service | D |
| HCM Volume to Capacity ratio | 0.62 | | |
| Actuated Cycle Length (s) | 118.6 | Sum of lost time (s) | 16.0 |
| Intersection Capacity Utilization | 59.2% | ICU Level of Service | B |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

| Movement | EBL | EBR | NBL | NBT | SBT | SBR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Volume (vph) | 137 | 45 | 15 | 439 | 382 | 179 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 4.0 | 4.0 | | 4.0 | 4.0 | |
| Lane Util. Factor | 0.97 | 1.00 | | 0.95 | 1.00 | |
| Frt | 1.00 | 0.85 | | 1.00 | 0.96 | |
| Flt Protected | 0.95 | 1.00 | | 1.00 | 1.00 | |
| Satd. Flow (prot) | 3433 | 1583 | | 3533 | 1782 | |
| Flt Permitted | 0.95 | 1.00 | | 0.94 | 1.00 | |
| Satd. Flow (perm) | 3433 | 1583 | | 3311 | 1782 | |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 149 | 49 | 16 | 477 | 415 | 195 |
| RTOR Reduction (vph) | 0 | 38 | 0 | 0 | 31 | 0 |
| Lane Group Flow (vph) | 149 | 11 | 0 | 493 | 579 | 0 |
| Turn Type | | Perm | Perm | | | |
| Protected Phases | 4 | | | 2 | 6 | |
| Permitted Phases | | 4 | 2 | | | |
| Actuated Green, G (s) | 7.7 | 7.7 | | 19.0 | 19.0 | |
| Effective Green, g (s) | 7.7 | 7.7 | | 19.0 | 19.0 | |
| Actuated g/C Ratio | 0.22 | 0.22 | | 0.55 | 0.55 | |
| 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) | 762 | 351 | | 1813 | 976 | |
| v/s Ratio Prot | c0.04 | | | | c0.32 | |
| v/s Ratio Perm | | 0.01 | | 0.15 | | |
| v/c Ratio | 0.20 | 0.03 | | 0.27 | 0.59 | |
| Uniform Delay, d1 | 11.0 | 10.6 | | 4.2 | 5.3 | |
| Progression Factor | 1.00 | 1.00 | | 1.00 | 1.00 | |
| Incremental Delay, d2 | 0.1 | 0.0 | | 0.1 | 1.0 | |
| Delay (s) | 11.1 | 10.6 | | 4.3 | 6.2 | |
| Level of Service | B | B | | A | A | |
| Approach Delay (s) | 11.0 | | | 4.3 | 6.2 | |
| Approach LOS | B | | | A | A | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 6.2 | HCM Level of Service | A |
| HCM Volume to Capacity ratio | 0.48 | | |
| Actuated Cycle Length (s) | 34.7 | Sum of lost time (s) | 8.0 |
| Intersection Capacity Utilization | 41.6% | 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) | 60 | 15 | 10 | 15 | 30 | 100 | 10 | 400 | 25 | 50 | 300 | 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 | 4.0 | 4.0 | 4.0 |
| Lane Util. Factor | | 1.00 | 1.00 | | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Frt | | 1.00 | 0.85 | | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 |
| Flt Protected | | 0.96 | 1.00 | | 0.98 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 |
| Satd. Flow (prot) | | 1791 | 1583 | | 1833 | 1583 | 1770 | 1863 | 1583 | 1770 | 1863 | 1583 |
| Flt Permitted | | 0.79 | 1.00 | | 0.92 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 |
| Satd. Flow (perm) | | 1468 | 1583 | | 1723 | 1583 | 1770 | 1863 | 1583 | 1770 | 1863 | 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) | 65 | 16 | 11 | 16 | 33 | 109 | 11 | 435 | 27 | 54 | 326 | 27 |
| RTOR Reduction (vph) | 0 | 0 | 7 | 0 | 0 | 73 | 0 | 0 | 17 | 0 | 0 | 16 |
| Lane Group Flow (vph) | 0 | 81 | 4 | 0 | 49 | 36 | 11 | 435 | 10 | 54 | 326 | 11 |
| Turn Type | Perm | | Perm | Perm | | Perm | Prot | | Perm | Prot | | Perm |
| Protected Phases | | 4 | | | 8 | | 5 | 2 | | 1 | 6 | |
| Permitted Phases | 4 | | 4 | 8 | | 8 | | | 2 | | | 6 |
| Actuated Green, G (s) | | 15.2 | 15.2 | | 15.2 | 15.2 | 0.6 | 17.3 | 17.3 | 1.7 | 18.4 | 18.4 |
| Effective Green, g (s) | | 15.2 | 15.2 | | 15.2 | 15.2 | 0.6 | 17.3 | 17.3 | 1.7 | 18.4 | 18.4 |
| Actuated g/C Ratio | | 0.33 | 0.33 | | 0.33 | 0.33 | 0.01 | 0.37 | 0.37 | 0.04 | 0.40 | 0.40 |
| Clearance Time (s) | | 4.0 | 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 | 3.0 |
| Lane Grp Cap (vph) | | 483 | 521 | | 567 | 521 | 23 | 698 | 593 | 65 | 742 | 630 |
| v/s Ratio Prot | | | | | | | 0.01 | c0.23 | | c0.03 | 0.18 | |
| v/s Ratio Perm | | c0.06 | 0.00 | | 0.03 | 0.02 | | | 0.01 | | | 0.01 |
| v/c Ratio | | 0.17 | 0.01 | | 0.09 | 0.07 | 0.48 | 0.62 | 0.02 | 0.83 | 0.44 | 0.02 |
| Uniform Delay, d1 | | 11.0 | 10.4 | | 10.7 | 10.6 | 22.6 | 11.8 | 9.1 | 22.1 | 10.1 | 8.4 |
| 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 | 0.0 | | 0.1 | 0.1 | 14.8 | 1.7 | 0.0 | 56.7 | 0.4 | 0.0 |
| Delay (s) | | 11.2 | 10.4 | | 10.8 | 10.7 | 37.5 | 13.5 | 9.1 | 78.8 | 10.6 | 8.4 |
| Level of Service | | B | B | | B | B | D | B | A | E | B | A |
| Approach Delay (s) | | 11.1 | | | 10.7 | | | 13.8 | | | 19.5 | |
| Approach LOS | | B | | | B | | | B | | | B | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 15.2 | HCM Level of Service | B |
| HCM Volume to Capacity ratio | 0.43 | | |
| Actuated Cycle Length (s) | 46.2 | 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 | WBT | WBR | SBL | SBR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Sign Control | | Stop | Stop | | Stop | |
| Volume (vph) | 218 | 87 | 231 | 289 | 30 | 148 |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Hourly flow rate (vph) | 237 | 95 | 251 | 314 | 33 | 161 |

| Direction, Lane # | EB 1 | WB 1 | WB 2 | SB 1 | SB 2 |
|---|---|---|---|---|---|
| Volume Total (vph) | 332 | 251 | 314 | 33 | 161 |
| Volume Left (vph) | 237 | 0 | 0 | 33 | 0 |
| Volume Right (vph) | 0 | 0 | 314 | 0 | 161 |
| Hadj (s) | 0.18 | 0.03 | -0.57 | 0.23 | -0.57 |
| Departure Headway (s) | 4.4 | 4.4 | 3.2 | 5.4 | 3.2 |
| Degree Utilization, x | 0.41 | 0.31 | 0.28 | 0.05 | 0.14 |
| Capacity (veh/h) | 797 | 800 | 1112 | 596 | 1121 |
| Control Delay (s) | 10.5 | 9.3 | 7.4 | 8.7 | 6.7 |
| Approach Delay (s) | 10.5 | 8.3 | | 7.1 | |
| Approach LOS | B | A | | A | |

| Intersection Summary | | | |
|---|---|---|---|
| Delay | 8.7 | | |
| HCM Level of Service | A | | |
| Intersection Capacity Utilization | 42.1% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | ↑ | ↱↱ | | | | | | | | ↰↑↑↱ | |
| Volume (vph) | 0 | 240 | 317 | 0 | 0 | 0 | 0 | 0 | 0 | 67 | 1518 | 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 | | 1.00 | 0.88 | | | | | | | | 0.86 | |
| Frt | | 1.00 | 0.85 | | | | | | | | 0.98 | |
| Flt Protected | | 1.00 | 1.00 | | | | | | | | 1.00 | |
| Satd. Flow (prot) | | 1863 | 2787 | | | | | | | | 6279 | |
| Flt Permitted | | 1.00 | 1.00 | | | | | | | | 1.00 | |
| Satd. Flow (perm) | | 1863 | 2787 | | | | | | | | 6279 | |
| 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 | 261 | 345 | 0 | 0 | 0 | 0 | 0 | 0 | 73 | 1650 | 239 |
| RTOR Reduction (vph) | 0 | 0 | 25 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 28 | 0 |
| Lane Group Flow (vph) | 0 | 261 | 320 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1934 | 0 |
| Turn Type | | | Prot | | | | | | | Perm | | |
| Protected Phases | | 4 | 4 | | | | | | | | 6 | |
| Permitted Phases | | | | | | | | | | 6 | | |
| Actuated Green, G (s) | | 18.6 | 18.6 | | | | | | | | 53.4 | |
| Effective Green, g (s) | | 18.6 | 18.6 | | | | | | | | 53.4 | |
| Actuated g/C Ratio | | 0.23 | 0.23 | | | | | | | | 0.67 | |
| Clearance Time (s) | | 4.0 | 4.0 | | | | | | | | 4.0 | |
| Vehicle Extension (s) | | 3.0 | 3.0 | | | | | | | | 3.0 | |
| Lane Grp Cap (vph) | | 433 | 648 | | | | | | | | 4191 | |
| v/s Ratio Prot | | c0.14 | 0.11 | | | | | | | | | |
| v/s Ratio Perm | | | | | | | | | | | 0.31 | |
| v/c Ratio | | 0.60 | 0.49 | | | | | | | | 0.46 | |
| Uniform Delay, d1 | | 27.4 | 26.6 | | | | | | | | 6.4 | |
| Progression Factor | | 1.00 | 1.00 | | | | | | | | 0.52 | |
| Incremental Delay, d2 | | 2.4 | 0.6 | | | | | | | | 0.3 | |
| Delay (s) | | 29.8 | 27.2 | | | | | | | | 3.6 | |
| Level of Service | | C | C | | | | | | | | A | |
| Approach Delay (s) | | 28.3 | | | 0.0 | | | 0.0 | | | 3.6 | |
| Approach LOS | | C | | | A | | | A | | | A | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 9.4 | HCM Level of Service | A |
| HCM Volume to Capacity ratio | 0.50 | | |
| Actuated Cycle Length (s) | 80.0 | 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 | EBL | EBR | NBL | NBT | NBR | SBL | SBT | SBR | SWL | SWR |
|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | |
| Volume (vph) | 155 | 690 | 0 | 13 | 6 | 110 | 1701 | 0 | 0 | 0 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Lane Width | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 16 |
| Total Lost time (s) | 5.0 | 5.0 | | 5.0 | | | 5.0 | | | |
| Lane Util. Factor | 1.00 | 0.95 | | 1.00 | | | 0.86 | | | |
| Frt | 0.90 | 0.85 | | 0.96 | | | 1.00 | | | |
| Flt Protected | 0.98 | 1.00 | | 1.00 | | | 1.00 | | | |
| Satd. Flow (prot) | 1654 | 1504 | | 1779 | | | 6388 | | | |
| Flt Permitted | 0.98 | 1.00 | | 1.00 | | | 0.91 | | | |
| Satd. Flow (perm) | 1654 | 1504 | | 1779 | | | 5818 | | | |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 168 | 750 | 0 | 14 | 7 | 120 | 1849 | 0 | 0 | 0 |
| RTOR Reduction (vph) | 2 | 2 | 0 | 4 | 0 | 0 | 0 | 0 | 0 | 0 |
| Lane Group Flow (vph) | 466 | 448 | 0 | 17 | 0 | 0 | 1969 | 0 | 0 | 0 |
| Turn Type | | Prot | | | | Perm | | | | |
| Protected Phases | 4 | 4 | | 2 | | | 6 | | | |
| Permitted Phases | | | | | | 6 | | | | |
| Actuated Green, G (s) | 31.2 | 31.2 | | 38.8 | | | 38.8 | | | |
| Effective Green, g (s) | 31.2 | 31.2 | | 38.8 | | | 38.8 | | | |
| Actuated g/C Ratio | 0.39 | 0.39 | | 0.48 | | | 0.48 | | | |
| Clearance Time (s) | 5.0 | 5.0 | | 5.0 | | | 5.0 | | | |
| Vehicle Extension (s) | 2.0 | 2.0 | | 5.0 | | | 5.0 | | | |
| Lane Grp Cap (vph) | 645 | 587 | | 863 | | | 2822 | | | |
| v/s Ratio Prot | 0.28 | c0.30 | | 0.01 | | | | | | |
| v/s Ratio Perm | | | | | | | c0.34 | | | |
| v/c Ratio | 0.72 | 0.76 | | 0.02 | | | 0.70 | | | |
| Uniform Delay, d1 | 20.7 | 21.2 | | 10.7 | | | 16.0 | | | |
| Progression Factor | 1.00 | 1.00 | | 1.00 | | | 0.23 | | | |
| Incremental Delay, d2 | 3.4 | 5.3 | | 0.0 | | | 1.1 | | | |
| Delay (s) | 24.1 | 26.4 | | 10.8 | | | 4.9 | | | |
| Level of Service | C | C | | B | | | A | | | |
| Approach Delay (s) | 25.2 | | | 10.8 | | | 4.9 | | 0.0 | |
| Approach LOS | C | | | B | | | A | | A | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 11.3 | HCM Level of Service | B |
| HCM Volume to Capacity ratio | 0.73 | | |
| Actuated Cycle Length (s) | 80.0 | Sum of lost time (s) | 10.0 |
| 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 | 0 | 0 | 67 | 414 | 0 | 0 | 9 | 0 | 0 | 1712 | 173 |
| 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 | |
| Lane Util. Factor | | | | | 0.91 | | | 1.00 | | | 0.86 | |
| Frt | | | | | 1.00 | | | 1.00 | | | 0.99 | |
| Flt Protected | | | | | 0.99 | | | 1.00 | | | 1.00 | |
| Satd. Flow (prot) | | | | | 5050 | | | 1863 | | | 6320 | |
| Flt Permitted | | | | | 0.99 | | | 1.00 | | | 1.00 | |
| Satd. Flow (perm) | | | | | 5050 | | | 1863 | | | 6320 | |
| 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 | 73 | 450 | 0 | 0 | 10 | 0 | 0 | 1861 | 188 |
| RTOR Reduction (vph) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 20 | 0 |
| Lane Group Flow (vph) | 0 | 0 | 0 | 0 | 523 | 0 | 0 | 10 | 0 | 0 | 2029 | 0 |
| Turn Type | | | | Perm | | | | | | | | |
| Protected Phases | | | | | 4 | | | 2 | | | 6 | |
| Permitted Phases | | | | 4 | | | | | | | | |
| Actuated Green, G (s) | | | | | 31.2 | | | 38.8 | | | 38.8 | |
| Effective Green, g (s) | | | | | 31.2 | | | 38.8 | | | 38.8 | |
| Actuated g/C Ratio | | | | | 0.39 | | | 0.48 | | | 0.48 | |
| Clearance Time (s) | | | | | 5.0 | | | 5.0 | | | 5.0 | |
| Vehicle Extension (s) | | | | | 2.0 | | | 5.0 | | | 5.0 | |
| Lane Grp Cap (vph) | | | | | 1970 | | | 904 | | | 3065 | |
| v/s Ratio Prot | | | | | | | | 0.01 | | | c0.32 | |
| v/s Ratio Perm | | | | | 0.10 | | | | | | | |
| v/c Ratio | | | | | 0.27 | | | 0.01 | | | 0.66 | |
| Uniform Delay, d1 | | | | | 16.6 | | | 10.7 | | | 15.6 | |
| Progression Factor | | | | | 1.00 | | | 0.37 | | | 1.00 | |
| Incremental Delay, d2 | | | | | 0.0 | | | 0.0 | | | 1.1 | |
| Delay (s) | | | | | 16.6 | | | 4.0 | | | 16.8 | |
| Level of Service | | | | | B | | | A | | | B | |
| Approach Delay (s) | | 0.0 | | | 16.6 | | | 4.0 | | | 16.8 | |
| Approach LOS | | A | | | B | | | A | | | B | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 16.7 | HCM Level of Service | B |
| HCM Volume to Capacity ratio | 0.49 | | |
| Actuated Cycle Length (s) | 80.0 | Sum of lost time (s) | 10.0 |
| Intersection Capacity Utilization | 45.4% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

| Lane Group | EBL | EBT | EBR | WBL | WBT | NBL | NBT | SBT |
|---|---|---|---|---|---|---|---|---|
| Lane Group Flow (vph) | 58 | 707 | 300 | 133 | 506 | 272 | 266 | 121 |
| v/c Ratio | 0.46 | 0.86 | 0.30 | 1.02 | 0.38 | 0.61 | 0.59 | 0.23 |
| Control Delay | 70.6 | 59.1 | 2.7 | 142.8 | 41.8 | 45.4 | 41.6 | 22.0 |
| Queue Delay | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Total Delay | 70.6 | 59.1 | 2.7 | 142.8 | 41.8 | 45.4 | 41.6 | 22.0 |
| Queue Length 50th (ft) | 48 | 316 | 0 | ~138 | 135 | 206 | 185 | 46 |
| Queue Length 95th (ft) | 95 | #450 | 45 | #272 | 175 | 306 | 282 | 94 |
| Internal Link Dist (ft) | | 189 | | | 238 | | 431 | 189 |
| Turn Bay Length (ft) | 155 | | | 80 | | | | |
| Base Capacity (vph) | 147 | 846 | 1074 | 130 | 1327 | 571 | 572 | 710 |
| Starvation Cap Reductn | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Spillback Cap Reductn | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Storage Cap Reductn | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Reduced v/c Ratio | 0.39 | 0.84 | 0.28 | 1.02 | 0.38 | 0.48 | 0.47 | 0.17 |

**Intersection Summary**

~ Volume exceeds capacity, queue is theoretically infinite.
Queue shown is maximum after two cycles.

\# 95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

| Lane Group | EBL | EBT | EBR | WBL | WBT | NBL | NBT | SBT |
|---|---|---|---|---|---|---|---|---|
| Lane Group Flow (vph) | 60 | 761 | 402 | 140 | 544 | 316 | 305 | 112 |
| v/c Ratio | 0.45 | 0.92 | 0.39 | 1.10 | 0.42 | 0.70 | 0.66 | 0.22 |
| Control Delay | 69.2 | 65.4 | 2.7 | 163.6 | 43.6 | 49.0 | 43.7 | 24.7 |
| Queue Delay | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Total Delay | 69.2 | 65.4 | 2.7 | 163.6 | 43.6 | 49.0 | 43.7 | 24.7 |
| Queue Length 50th (ft) | 49 | ~375 | 0 | ~150 | 151 | 247 | 216 | 50 |
| Queue Length 95th (ft) | 96 | #503 | 50 | #286 | 193 | 360 | 324 | 97 |
| Internal Link Dist (ft) | | 189 | | | 238 | | 431 | 189 |
| Turn Bay Length (ft) | 155 | | | 80 | | | | |
| Base Capacity (vph) | 159 | 825 | 1111 | 127 | 1299 | 557 | 561 | 695 |
| Starvation Cap Reductn | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Spillback Cap Reductn | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Storage Cap Reductn | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Reduced v/c Ratio | 0.38 | 0.92 | 0.36 | 1.10 | 0.42 | 0.57 | 0.54 | 0.16 |

Intersection Summary

~ Volume exceeds capacity, queue is theoretically infinite.
Queue shown is maximum after two cycles.

# 95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

| | → | ↘ | ↙ | ← | ↖ | ↗ |
|---|---|---|---|---|---|---|
| Movement | EBT | EBR | WBL | WBT | NBL | NBR |
| Lane Configurations | ↑↑↑↱ | | ↰ | ↑↑↑ | ↰ | ↱ |
| Volume (vph) | 874 | 132 | 131 | 680 | 152 | 179 |
| 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 | 0.86 | | 1.00 | 0.91 | 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) | 6282 | | 1770 | 5085 | 1770 | 1583 |
| Flt Permitted | 1.00 | | 0.95 | 1.00 | 0.95 | 1.00 |
| Satd. Flow (perm) | 6282 | | 1770 | 5085 | 1770 | 1583 |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 950 | 143 | 142 | 739 | 165 | 195 |
| RTOR Reduction (vph) | 48 | 0 | 0 | 0 | 0 | 161 |
| Lane Group Flow (vph) | 1045 | 0 | 142 | 739 | 165 | 34 |
| Turn Type | | | Prot | | | Perm |
| Protected Phases | 4 | | 3 | 8 | 2 | |
| Permitted Phases | | | | | | 2 |
| Actuated Green, G (s) | 17.6 | | 5.4 | 27.0 | 7.5 | 7.5 |
| Effective Green, g (s) | 17.6 | | 5.4 | 27.0 | 7.5 | 7.5 |
| Actuated g/C Ratio | 0.41 | | 0.13 | 0.64 | 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) | 2601 | | 225 | 3230 | 312 | 279 |
| v/s Ratio Prot | c0.17 | | c0.08 | 0.15 | c0.09 | |
| v/s Ratio Perm | | | | | | 0.02 |
| v/c Ratio | 0.40 | | 0.63 | 0.23 | 0.53 | 0.12 |
| Uniform Delay, d1 | 8.7 | | 17.6 | 3.3 | 15.9 | 14.7 |
| Progression Factor | 1.00 | | 1.00 | 1.00 | 1.00 | 1.00 |
| Incremental Delay, d2 | 0.1 | | 5.7 | 0.0 | 1.6 | 0.2 |
| Delay (s) | 8.9 | | 23.3 | 3.3 | 17.5 | 14.9 |
| Level of Service | A | | C | A | B | B |
| Approach Delay (s) | 8.9 | | | 6.6 | 16.1 | |
| Approach LOS | A | | | A | B | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 9.1 | HCM Level of Service | A |
| HCM Volume to Capacity ratio | 0.47 | | |
| Actuated Cycle Length (s) | 42.5 | Sum of lost time (s) | 12.0 |
| Intersection Capacity Utilization | 40.5% | 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) | 66 | 671 | 255 | 93 | 429 | 65 | 282 | 40 | 63 | 5 | 38 | 69 |
| Ideal Flow (vphpl) | 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 | 1.00 | 1.00 | 0.91 | | 0.95 | 0.95 | | | 1.00 | |
| Frt | 1.00 | 1.00 | 0.85 | 1.00 | 0.98 | | 1.00 | 0.95 | | | 0.92 | |
| Flt Protected | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | | 0.95 | 0.98 | | | 1.00 | |
| Satd. Flow (prot) | 1770 | 3539 | 1583 | 1770 | 4984 | | 1681 | 1644 | | | 1703 | |
| Flt Permitted | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | | 0.95 | 0.98 | | | 1.00 | |
| Satd. Flow (perm) | 1770 | 3539 | 1583 | 1770 | 4984 | | 1681 | 1644 | | | 1703 | |
| 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) | 72 | 729 | 277 | 101 | 466 | 71 | 307 | 43 | 68 | 5 | 41 | 75 |
| RTOR Reduction (vph) | 0 | 0 | 127 | 0 | 14 | 0 | 0 | 14 | 0 | 0 | 48 | 0 |
| Lane Group Flow (vph) | 72 | 729 | 150 | 101 | 523 | 0 | 212 | 192 | 0 | 0 | 73 | 0 |
| Turn Type | Prot | | pt+ov | Prot | | | Split | | | Split | | |
| Protected Phases | 7 | 4 | 4 2 | 3 | 8 | | 2 | 2 | | 6 | 6 | |
| Permitted Phases | | | | | | | | | | | | |
| Actuated Green, G (s) | 7.5 | 29.5 | 63.6 | 8.6 | 30.6 | | 30.1 | 30.1 | | | 32.9 | |
| Effective Green, g (s) | 7.5 | 29.5 | 63.6 | 8.6 | 30.6 | | 30.1 | 30.1 | | | 32.9 | |
| Actuated g/C Ratio | 0.06 | 0.25 | 0.54 | 0.07 | 0.26 | | 0.26 | 0.26 | | | 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) | 113 | 892 | 860 | 130 | 1302 | | 432 | 423 | | | 478 | |
| v/s Ratio Prot | 0.04 | c0.21 | 0.10 | c0.06 | 0.10 | | c0.13 | 0.12 | | | c0.04 | |
| v/s Ratio Perm | | | | | | | | | | | | |
| v/c Ratio | 0.64 | 0.82 | 0.17 | 0.78 | 0.40 | | 0.49 | 0.45 | | | 0.15 | |
| Uniform Delay, d1 | 53.5 | 41.3 | 13.5 | 53.3 | 35.7 | | 37.0 | 36.6 | | | 31.6 | |
| Progression Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | | 1.00 | 1.00 | | | 1.00 | |
| Incremental Delay, d2 | 11.2 | 5.9 | 0.1 | 24.7 | 0.2 | | 0.9 | 0.8 | | | 0.1 | |
| Delay (s) | 64.7 | 47.1 | 13.6 | 78.0 | 35.9 | | 37.9 | 37.4 | | | 31.8 | |
| Level of Service | E | D | B | E | D | | D | D | | | C | |
| Approach Delay (s) | | 39.7 | | | 42.6 | | | 37.6 | | | 31.8 | |
| Approach LOS | | D | | | D | | | D | | | C | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 39.7 | HCM Level of Service | D |
| HCM Volume to Capacity ratio | 0.50 | | |
| Actuated Cycle Length (s) | 117.1 | Sum of lost time (s) | 16.0 |
| Intersection Capacity Utilization | 51.1% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

| Movement | EBL | EBR | NBL | NBT | SBT | SBR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Volume (vph) | 0 | 0 | 0 | 399 | 388 | 0 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | | | | 4.0 | 4.0 | |
| Lane Util. Factor | | | | 0.95 | 1.00 | |
| Frt | | | | 1.00 | 1.00 | |
| Flt Protected | | | | 1.00 | 1.00 | |
| Satd. Flow (prot) | | | | 3539 | 1863 | |
| Flt Permitted | | | | 1.00 | 1.00 | |
| Satd. Flow (perm) | | | | 3539 | 1863 | |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 0 | 0 | 0 | 434 | 422 | 0 |
| RTOR Reduction (vph) | 0 | 0 | 0 | 0 | 0 | 0 |
| Lane Group Flow (vph) | 0 | 0 | 0 | 434 | 422 | 0 |
| Turn Type | | Perm | Perm | | | |
| Protected Phases | 4 | | | 2 | 6 | |
| Permitted Phases | | 4 | 2 | | | |
| Actuated Green, G (s) | | | | 13.6 | 13.6 | |
| Effective Green, g (s) | | | | 13.6 | 13.6 | |
| Actuated g/C Ratio | | | | 0.54 | 0.54 | |
| Clearance Time (s) | | | | 4.0 | 4.0 | |
| Vehicle Extension (s) | | | | 3.0 | 3.0 | |
| Lane Grp Cap (vph) | | | | 1918 | 1009 | |
| v/s Ratio Prot | | | | 0.12 | c0.23 | |
| v/s Ratio Perm | | | | | | |
| v/c Ratio | | | | 0.23 | 0.42 | |
| Uniform Delay, d1 | | | | 3.0 | 3.4 | |
| Progression Factor | | | | 1.00 | 1.00 | |
| Incremental Delay, d2 | | | | 0.1 | 0.3 | |
| Delay (s) | | | | 3.1 | 3.7 | |
| Level of Service | | | | A | A | |
| Approach Delay (s) | 0.0 | | | 3.1 | 3.7 | |
| Approach LOS | A | | | A | A | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 3.4 | HCM Level of Service | A |
| HCM Volume to Capacity ratio | 0.42 | | |
| Actuated Cycle Length (s) | 25.1 | Sum of lost time (s) | 11.5 |
| Intersection Capacity Utilization | 23.8% | 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) | 45 | 11 | 9 | 12 | 29 | 83 | 8 | 368 | 20 | 48 | 275 | 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 | 4.0 | 4.0 | 4.0 |
| Lane Util. Factor | | 1.00 | 1.00 | | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Frt | | 1.00 | 0.85 | | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 |
| Flt Protected | | 0.96 | 1.00 | | 0.99 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 |
| Satd. Flow (prot) | | 1791 | 1583 | | 1836 | 1583 | 1770 | 1863 | 1583 | 1770 | 1863 | 1583 |
| Flt Permitted | | 0.79 | 1.00 | | 0.93 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 |
| Satd. Flow (perm) | | 1470 | 1583 | | 1735 | 1583 | 1770 | 1863 | 1583 | 1770 | 1863 | 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) | 49 | 12 | 10 | 13 | 32 | 90 | 9 | 400 | 22 | 52 | 299 | 24 |
| RTOR Reduction (vph) | 0 | 0 | 7 | 0 | 0 | 66 | 0 | 0 | 12 | 0 | 0 | 13 |
| Lane Group Flow (vph) | 0 | 61 | 3 | 0 | 45 | 24 | 9 | 400 | 10 | 52 | 299 | 11 |
| Turn Type | Perm | | Perm | Perm | | Perm | Prot | | Perm | Prot | | Perm |
| Protected Phases | | 4 | | | 8 | | 5 | 2 | | 1 | 6 | |
| Permitted Phases | 4 | | 4 | 8 | | 8 | | | 2 | | | 6 |
| Actuated Green, G (s) | | 11.9 | 11.9 | | 11.9 | 11.9 | 0.5 | 19.4 | 19.4 | 1.6 | 20.5 | 20.5 |
| Effective Green, g (s) | | 11.9 | 11.9 | | 11.9 | 11.9 | 0.5 | 19.4 | 19.4 | 1.6 | 20.5 | 20.5 |
| Actuated g/C Ratio | | 0.27 | 0.27 | | 0.27 | 0.27 | 0.01 | 0.43 | 0.43 | 0.04 | 0.46 | 0.46 |
| Clearance Time (s) | | 4.0 | 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 | 3.0 |
| Lane Grp Cap (vph) | | 390 | 420 | | 460 | 420 | 20 | 805 | 684 | 63 | 851 | 723 |
| v/s Ratio Prot | | | | | | | 0.01 | c0.21 | | c0.03 | 0.16 | |
| v/s Ratio Perm | | c0.04 | 0.00 | | 0.03 | 0.02 | | | 0.01 | | | 0.01 |
| v/c Ratio | | 0.16 | 0.01 | | 0.10 | 0.06 | 0.45 | 0.50 | 0.01 | 0.83 | 0.35 | 0.02 |
| Uniform Delay, d1 | | 12.7 | 12.1 | | 12.4 | 12.3 | 22.1 | 9.2 | 7.3 | 21.5 | 7.9 | 6.7 |
| 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 | | 0.2 | 0.0 | | 0.1 | 0.1 | 15.3 | 0.5 | 0.0 | 56.1 | 0.3 | 0.0 |
| Delay (s) | | 12.8 | 12.2 | | 12.5 | 12.4 | 37.3 | 9.7 | 7.3 | 77.6 | 8.1 | 6.7 |
| Level of Service | | B | B | | B | B | D | A | A | E | A | A |
| Approach Delay (s) | | 12.7 | | | 12.4 | | | 10.2 | | | 17.7 | |
| Approach LOS | | B | | | B | | | B | | | B | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 13.4 | HCM Level of Service | B |
| HCM Volume to Capacity ratio | 0.39 | | |
| Actuated Cycle Length (s) | 44.9 | Sum of lost time (s) | 12.0 |
| Intersection Capacity Utilization | 42.4% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

| Movement | EBL | EBT | WBT | WBR | SBL | SBR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Volume (vph) | 212 | 65 | 192 | 283 | 30 | 133 |
| 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 | | 1.00 | 1.00 | 0.85 | 1.00 | 0.85 |
| Flt Protected | | 0.96 | 1.00 | 1.00 | 0.95 | 1.00 |
| Satd. Flow (prot) | | 1794 | 1863 | 1583 | 1770 | 1583 |
| Flt Permitted | | 0.65 | 1.00 | 1.00 | 0.95 | 1.00 |
| Satd. Flow (perm) | | 1205 | 1863 | 1583 | 1770 | 1583 |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 230 | 71 | 209 | 308 | 33 | 145 |
| RTOR Reduction (vph) | 0 | 0 | 0 | 0 | 0 | 118 |
| Lane Group Flow (vph) | 0 | 301 | 209 | 308 | 33 | 27 |
| Turn Type | Perm | | | Free | | Perm |
| Protected Phases | | 4 | 8 | | 6 | |
| Permitted Phases | 4 | | | Free | | 6 |
| Actuated Green, G (s) | | 6.5 | 6.5 | 17.8 | 3.3 | 3.3 |
| Effective Green, g (s) | | 6.5 | 6.5 | 17.8 | 3.3 | 3.3 |
| Actuated g/C Ratio | | 0.37 | 0.37 | 1.00 | 0.19 | 0.19 |
| 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) | | 440 | 680 | 1583 | 328 | 293 |
| v/s Ratio Prot | | | 0.11 | | 0.02 | |
| v/s Ratio Perm | | c0.25 | | c0.19 | | 0.02 |
| v/c Ratio | | 0.68 | 0.31 | 0.19 | 0.10 | 0.09 |
| Uniform Delay, d1 | | 4.8 | 4.0 | 0.0 | 6.0 | 6.0 |
| Progression Factor | | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Incremental Delay, d2 | | 4.4 | 0.3 | 0.3 | 0.1 | 0.1 |
| Delay (s) | | 9.1 | 4.3 | 0.3 | 6.2 | 6.1 |
| Level of Service | | A | A | A | A | A |
| Approach Delay (s) | | 9.1 | 1.9 | | 6.1 | |
| Approach LOS | | A | A | | A | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 4.8 | HCM Level of Service | A |
| HCM Volume to Capacity ratio | 0.43 | | |
| Actuated Cycle Length (s) | 17.8 | Sum of lost time (s) | 4.0 |
| Intersection Capacity Utilization | 38.6% | 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 | 196 | 327 | 0 | 0 | 0 | 0 | 0 | 0 | 43 | 1309 | 227 |
| Ideal 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 | | 1.00 | 0.88 | | | | | | | | 0.86 | |
| Frt | | 1.00 | 0.85 | | | | | | | | 0.98 | |
| Flt Protected | | 1.00 | 1.00 | | | | | | | | 1.00 | |
| Satd. Flow (prot) | | 1863 | 2787 | | | | | | | | 6261 | |
| Flt Permitted | | 1.00 | 1.00 | | | | | | | | 1.00 | |
| Satd. Flow (perm) | | 1863 | 2787 | | | | | | | | 6261 | |
| 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 | 213 | 355 | 0 | 0 | 0 | 0 | 0 | 0 | 47 | 1423 | 247 |
| RTOR Reduction (vph) | 0 | 0 | 42 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 29 | 0 |
| Lane Group Flow (vph) | 0 | 213 | 313 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1688 | 0 |
| Turn Type | | | Prot | | | | | | | Perm | | |
| Protected Phases | | 4 | 4 | | | | | | | | 6 | |
| Permitted Phases | | | | | | | | | | 6 | | |
| Actuated Green, G (s) | | 17.2 | 17.2 | | | | | | | | 54.8 | |
| Effective Green, g (s) | | 17.2 | 17.2 | | | | | | | | 54.8 | |
| Actuated g/C Ratio | | 0.22 | 0.22 | | | | | | | | 0.68 | |
| Clearance Time (s) | | 4.0 | 4.0 | | | | | | | | 4.0 | |
| Vehicle Extension (s) | | 3.0 | 3.0 | | | | | | | | 3.0 | |
| Lane Grp Cap (vph) | | 401 | 599 | | | | | | | | 4289 | |
| v/s Ratio Prot | | c0.11 | 0.11 | | | | | | | | | |
| v/s Ratio Perm | | | | | | | | | | | 0.27 | |
| v/c Ratio | | 0.53 | 0.52 | | | | | | | | 0.39 | |
| Uniform Delay, d1 | | 27.8 | 27.8 | | | | | | | | 5.4 | |
| Progression Factor | | 1.00 | 1.00 | | | | | | | | 0.61 | |
| Incremental Delay, d2 | | 1.4 | 0.8 | | | | | | | | 0.2 | |
| Delay (s) | | 29.2 | 28.6 | | | | | | | | 3.5 | |
| Level of Service | | C | C | | | | | | | | A | |
| Approach Delay (s) | | 28.8 | | | 0.0 | | | 0.0 | | | 3.5 | |
| Approach LOS | | C | | | A | | | A | | | A | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 9.8 | HCM Level of Service | A |
| HCM Volume to Capacity ratio | 0.43 | | |
| Actuated Cycle Length (s) | 80.0 | 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 | EBR | NBL | NBT | NBR | SBL | SBT | SBR | SWL | SWR |
|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | |
| Volume (vph) | 84 | 525 | 0 | 12 | 7 | 113 | 1412 | 0 | 0 | 0 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Lane Width | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 16 |
| Total Lost time (s) | 5.0 | 5.0 | | 5.0 | | | 5.0 | | | |
| Lane Util. Factor | 1.00 | 0.95 | | 1.00 | | | 0.86 | | | |
| Frt | 0.89 | 0.85 | | 0.95 | | | 1.00 | | | |
| Flt Protected | 0.99 | 1.00 | | 1.00 | | | 1.00 | | | |
| Satd. Flow (prot) | 1637 | 1504 | | 1767 | | | 6384 | | | |
| Flt Permitted | 0.99 | 1.00 | | 1.00 | | | 0.90 | | | |
| Satd. Flow (perm) | 1637 | 1504 | | 1767 | | | 5787 | | | |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 91 | 571 | 0 | 13 | 8 | 123 | 1535 | 0 | 0 | 0 |
| RTOR Reduction (vph) | 8 | 8 | 0 | 4 | 0 | 0 | 0 | 0 | 0 | 0 |
| Lane Group Flow (vph) | 329 | 317 | 0 | 17 | 0 | 0 | 1658 | 0 | 0 | 0 |
| Turn Type | | Prot | | | | Perm | | | | |
| Protected Phases | 4 | 4 | | 2 | | | 6 | | | |
| Permitted Phases | | | | | | 6 | | | | |
| Actuated Green, G (s) | 28.8 | 28.8 | | 41.2 | | | 41.2 | | | |
| Effective Green, g (s) | 28.8 | 28.8 | | 41.2 | | | 41.2 | | | |
| Actuated g/C Ratio | 0.36 | 0.36 | | 0.52 | | | 0.52 | | | |
| Clearance Time (s) | 5.0 | 5.0 | | 5.0 | | | 5.0 | | | |
| Vehicle Extension (s) | 2.0 | 2.0 | | 5.0 | | | 5.0 | | | |
| Lane Grp Cap (vph) | 589 | 541 | | 910 | | | 2980 | | | |
| v/s Ratio Prot | 0.20 | c0.21 | | 0.01 | | | | | | |
| v/s Ratio Perm | | | | | | | c0.29 | | | |
| v/c Ratio | 0.56 | 0.59 | | 0.02 | | | 0.56 | | | |
| Uniform Delay, d1 | 20.5 | 20.8 | | 9.5 | | | 13.2 | | | |
| Progression Factor | 1.00 | 1.00 | | 1.00 | | | 0.30 | | | |
| Incremental Delay, d2 | 0.7 | 1.0 | | 0.0 | | | 0.7 | | | |
| Delay (s) | 21.2 | 21.8 | | 9.5 | | | 4.6 | | | |
| Level of Service | C | C | | A | | | A | | | |
| Approach Delay (s) | 21.5 | | | 9.5 | | | 4.6 | | 0.0 | |
| Approach LOS | C | | | A | | | A | | A | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 9.4 | HCM Level of Service | A |
| HCM Volume to Capacity ratio | 0.57 | | |
| Actuated Cycle Length (s) | 80.0 | Sum of lost time (s) | 10.0 |
| Intersection Capacity Utilization | 52.2% | 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) | 0 | 0 | 0 | 51 | 355 | 0 | 0 | 8 | 0 | 0 | 1369 | 176 |
| 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 | |
| Lane Util. Factor | | | | | 0.91 | | | 1.00 | | | 0.86 | |
| Frt | | | | | 1.00 | | | 1.00 | | | 0.98 | |
| Flt Protected | | | | | 0.99 | | | 1.00 | | | 1.00 | |
| Satd. Flow (prot) | | | | | 5054 | | | 1863 | | | 6299 | |
| Flt Permitted | | | | | 0.99 | | | 1.00 | | | 1.00 | |
| Satd. Flow (perm) | | | | | 5054 | | | 1863 | | | 6299 | |
| 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 | 55 | 386 | 0 | 0 | 9 | 0 | 0 | 1488 | 191 |
| RTOR Reduction (vph) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 27 | 0 |
| Lane Group Flow (vph) | 0 | 0 | 0 | 0 | 441 | 0 | 0 | 9 | 0 | 0 | 1652 | 0 |
| Turn Type | | | | Perm | | | | | | | | |
| Protected Phases | | | | | 4 | | | 2 | | | 6 | |
| Permitted Phases | | | | 4 | | | | | | | | |
| Actuated Green, G (s) | | | | | 28.8 | | | 41.2 | | | 41.2 | |
| Effective Green, g (s) | | | | | 28.8 | | | 41.2 | | | 41.2 | |
| Actuated g/C Ratio | | | | | 0.36 | | | 0.52 | | | 0.52 | |
| Clearance Time (s) | | | | | 5.0 | | | 5.0 | | | 5.0 | |
| Vehicle Extension (s) | | | | | 2.0 | | | 5.0 | | | 5.0 | |
| Lane Grp Cap (vph) | | | | | 1819 | | | 959 | | | 3244 | |
| v/s Ratio Prot | | | | | | | | 0.00 | | | c0.26 | |
| v/s Ratio Perm | | | | | 0.09 | | | | | | | |
| v/c Ratio | | | | | 0.24 | | | 0.01 | | | 0.51 | |
| Uniform Delay, d1 | | | | | 18.0 | | | 9.5 | | | 12.8 | |
| Progression Factor | | | | | 1.00 | | | 0.41 | | | 1.00 | |
| Incremental Delay, d2 | | | | | 0.0 | | | 0.0 | | | 0.6 | |
| Delay (s) | | | | | 18.0 | | | 3.9 | | | 13.3 | |
| Level of Service | | | | | B | | | A | | | B | |
| Approach Delay (s) | | 0.0 | | | 18.0 | | | 3.9 | | | 13.3 | |
| Approach LOS | | A | | | B | | | A | | | B | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 14.3 | HCM Level of Service | B |
| HCM Volume to Capacity ratio | 0.40 | | |
| Actuated Cycle Length (s) | 80.0 | Sum of lost time (s) | 10.0 |
| Intersection Capacity Utilization | 39.0% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

| Movement | EBT | EBR | WBL | WBT | NBL | NBR |
|---|---|---|---|---|---|---|
| Lane Configurations | ↑↑↑↱ | | ↰ | ↑↑↑ | ↰ | ↱ |
| Volume (vph) | 882 | 198 | 175 | 709 | 191 | 241 |
| 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 | 0.86 | | 1.00 | 0.91 | 1.00 | 1.00 |
| Frt | 0.97 | | 1.00 | 1.00 | 1.00 | 0.85 |
| Flt Protected | 1.00 | | 0.95 | 1.00 | 0.95 | 1.00 |
| Satd. Flow (prot) | 6232 | | 1770 | 5085 | 1770 | 1583 |
| Flt Permitted | 1.00 | | 0.95 | 1.00 | 0.95 | 1.00 |
| Satd. Flow (perm) | 6232 | | 1770 | 5085 | 1770 | 1583 |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 959 | 215 | 190 | 771 | 208 | 262 |
| RTOR Reduction (vph) | 66 | 0 | 0 | 0 | 0 | 201 |
| Lane Group Flow (vph) | 1108 | 0 | 190 | 771 | 208 | 61 |
| Turn Type | | | Prot | | | Perm |
| Protected Phases | 4 | | 3 | 8 | 2 | |
| Permitted Phases | | | | | | 2 |
| Actuated Green, G (s) | 19.0 | | 7.1 | 30.1 | 11.5 | 11.5 |
| Effective Green, g (s) | 19.0 | | 7.1 | 30.1 | 11.5 | 11.5 |
| Actuated g/C Ratio | 0.38 | | 0.14 | 0.61 | 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) | 2387 | | 253 | 3086 | 410 | 367 |
| v/s Ratio Prot | c0.18 | | c0.11 | 0.15 | c0.12 | |
| v/s Ratio Perm | | | | | | 0.04 |
| v/c Ratio | 0.46 | | 0.75 | 0.25 | 0.51 | 0.17 |
| Uniform Delay, d1 | 11.5 | | 20.4 | 4.5 | 16.6 | 15.2 |
| Progression Factor | 1.00 | | 1.00 | 1.00 | 1.00 | 1.00 |
| Incremental Delay, d2 | 0.1 | | 11.8 | 0.0 | 1.0 | 0.2 |
| Delay (s) | 11.6 | | 32.2 | 4.6 | 17.6 | 15.4 |
| Level of Service | B | | C | A | B | B |
| Approach Delay (s) | 11.6 | | | 10.0 | 16.4 | |
| Approach LOS | B | | | B | B | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 11.9 | HCM Level of Service | B |
| HCM Volume to Capacity ratio | 0.53 | | |
| Actuated Cycle Length (s) | 49.6 | 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) | 74 | 727 | 297 | 88 | 494 | 48 | 302 | 62 | 85 | 4 | 39 | 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 | | | 4.0 | |
| Lane Util. Factor | 1.00 | 0.95 | 1.00 | 1.00 | 0.91 | | 0.95 | 0.95 | | | 1.00 | |
| Frt | 1.00 | 1.00 | 0.85 | 1.00 | 0.99 | | 1.00 | 0.94 | | | 0.92 | |
| Flt Protected | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | | 0.95 | 0.98 | | | 1.00 | |
| Satd. Flow (prot) | 1770 | 3539 | 1583 | 1770 | 5018 | | 1681 | 1640 | | | 1712 | |
| Flt Permitted | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | | 0.95 | 0.98 | | | 1.00 | |
| Satd. Flow (perm) | 1770 | 3539 | 1583 | 1770 | 5018 | | 1681 | 1640 | | | 1712 | |
| 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) | 80 | 790 | 323 | 96 | 537 | 52 | 328 | 67 | 92 | 4 | 42 | 65 |
| RTOR Reduction (vph) | 0 | 0 | 144 | 0 | 8 | 0 | 0 | 18 | 0 | 0 | 42 | 0 |
| Lane Group Flow (vph) | 80 | 790 | 179 | 96 | 581 | 0 | 246 | 223 | 0 | 0 | 69 | 0 |
| Turn Type | Prot | | pt+ov | Prot | | | Split | | | Split | | |
| Protected Phases | 7 | 4 | 4 2 | 3 | 8 | | 2 | 2 | | 6 | 6 | |
| Permitted Phases | | | | | | | | | | | | |
| Actuated Green, G (s) | 7.7 | 30.4 | 65.2 | 7.5 | 30.2 | | 30.8 | 30.8 | | | 33.0 | |
| Effective Green, g (s) | 7.7 | 30.4 | 65.2 | 7.5 | 30.2 | | 30.8 | 30.8 | | | 33.0 | |
| Actuated g/C Ratio | 0.07 | 0.26 | 0.55 | 0.06 | 0.26 | | 0.26 | 0.26 | | | 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) | 116 | 914 | 877 | 113 | 1288 | | 440 | 429 | | | 480 | |
| v/s Ratio Prot | 0.05 | c0.22 | 0.11 | c0.05 | 0.12 | | c0.15 | 0.14 | | | c0.04 | |
| v/s Ratio Perm | | | | | | | | | | | | |
| v/c Ratio | 0.69 | 0.86 | 0.20 | 0.85 | 0.45 | | 0.56 | 0.52 | | | 0.14 | |
| Uniform Delay, d1 | 53.8 | 41.7 | 13.2 | 54.5 | 36.8 | | 37.6 | 37.1 | | | 31.8 | |
| Progression Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | | 1.00 | 1.00 | | | 1.00 | |
| Incremental Delay, d2 | 15.7 | 8.5 | 0.1 | 41.5 | 0.3 | | 1.5 | 1.1 | | | 0.1 | |
| Delay (s) | 69.6 | 50.2 | 13.3 | 96.0 | 37.0 | | 39.1 | 38.3 | | | 31.9 | |
| Level of Service | E | D | B | F | D | | D | D | | | C | |
| Approach Delay (s) | | 41.5 | | | 45.3 | | | 38.7 | | | 31.9 | |
| Approach LOS | | D | | | D | | | D | | | C | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 41.6 | HCM Level of Service | D |
| HCM Volume to Capacity ratio | 0.52 | | |
| Actuated Cycle Length (s) | 117.7 | Sum of lost time (s) | 12.0 |
| Intersection Capacity Utilization | 54.2% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

| Movement | EBL | EBR | NBL | NBT | SBT | SBR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Volume (vph) | 0 | 0 | 0 | 454 | 427 | 0 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | | | | 4.0 | 4.0 | |
| Lane Util. Factor | | | | 0.95 | 1.00 | |
| Frt | | | | 1.00 | 1.00 | |
| Flt Protected | | | | 1.00 | 1.00 | |
| Satd. Flow (prot) | | | | 3539 | 1863 | |
| Flt Permitted | | | | 1.00 | 1.00 | |
| Satd. Flow (perm) | | | | 3539 | 1863 | |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 0 | 0 | 0 | 493 | 464 | 0 |
| RTOR Reduction (vph) | 0 | 0 | 0 | 0 | 0 | 0 |
| Lane Group Flow (vph) | 0 | 0 | 0 | 493 | 464 | 0 |
| Turn Type | | Perm | Perm | | | |
| Protected Phases | 4 | | | 2 | 6 | |
| Permitted Phases | | 4 | 2 | | | |
| Actuated Green, G (s) | | | | 13.8 | 13.8 | |
| Effective Green, g (s) | | | | 13.8 | 13.8 | |
| Actuated g/C Ratio | | | | 0.55 | 0.55 | |
| Clearance Time (s) | | | | 4.0 | 4.0 | |
| Vehicle Extension (s) | | | | 3.0 | 3.0 | |
| Lane Grp Cap (vph) | | | | 1930 | 1016 | |
| v/s Ratio Prot | | | | 0.14 | c0.25 | |
| v/s Ratio Perm | | | | | | |
| v/c Ratio | | | | 0.26 | 0.46 | |
| Uniform Delay, d1 | | | | 3.0 | 3.5 | |
| Progression Factor | | | | 1.00 | 1.00 | |
| Incremental Delay, d2 | | | | 0.1 | 0.3 | |
| Delay (s) | | | | 3.1 | 3.8 | |
| Level of Service | | | | A | A | |
| Approach Delay (s) | 0.0 | | | 3.1 | 3.8 | |
| Approach LOS | A | | | A | A | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 3.4 | HCM Level of Service | A |
| HCM Volume to Capacity ratio | 0.46 | | |
| Actuated Cycle Length (s) | 25.3 | Sum of lost time (s) | 11.5 |
| Intersection Capacity Utilization | 25.8% | 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) | 60 | 15 | 10 | 15 | 30 | 100 | 10 | 400 | 25 | 50 | 300 | 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 | 4.0 | 4.0 | 4.0 |
| Lane Util. Factor | | 1.00 | 1.00 | | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Frt | | 1.00 | 0.85 | | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 |
| Flt Protected | | 0.96 | 1.00 | | 0.98 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 |
| Satd. Flow (prot) | | 1791 | 1583 | | 1833 | 1583 | 1770 | 1863 | 1583 | 1770 | 1863 | 1583 |
| Flt Permitted | | 0.79 | 1.00 | | 0.92 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 |
| Satd. Flow (perm) | | 1468 | 1583 | | 1723 | 1583 | 1770 | 1863 | 1583 | 1770 | 1863 | 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) | 65 | 16 | 11 | 16 | 33 | 109 | 11 | 435 | 27 | 54 | 326 | 27 |
| RTOR Reduction (vph) | 0 | 0 | 7 | 0 | 0 | 73 | 0 | 0 | 17 | 0 | 0 | 16 |
| Lane Group Flow (vph) | 0 | 81 | 4 | 0 | 49 | 36 | 11 | 435 | 10 | 54 | 326 | 11 |
| Turn Type | Perm | | Perm | Perm | | Perm | Prot | | Perm | Prot | | Perm |
| Protected Phases | | 4 | | | 8 | | 5 | 2 | | 1 | 6 | |
| Permitted Phases | 4 | | 4 | 8 | | 8 | | | 2 | | | 6 |
| Actuated Green, G (s) | | 15.2 | 15.2 | | 15.2 | 15.2 | 0.6 | 17.3 | 17.3 | 1.7 | 18.4 | 18.4 |
| Effective Green, g (s) | | 15.2 | 15.2 | | 15.2 | 15.2 | 0.6 | 17.3 | 17.3 | 1.7 | 18.4 | 18.4 |
| Actuated g/C Ratio | | 0.33 | 0.33 | | 0.33 | 0.33 | 0.01 | 0.37 | 0.37 | 0.04 | 0.40 | 0.40 |
| Clearance Time (s) | | 4.0 | 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 | 3.0 |
| Lane Grp Cap (vph) | | 483 | 521 | | 567 | 521 | 23 | 698 | 593 | 65 | 742 | 630 |
| v/s Ratio Prot | | | | | | | 0.01 | c0.23 | | c0.03 | 0.18 | |
| v/s Ratio Perm | | c0.06 | 0.00 | | 0.03 | 0.02 | | | 0.01 | | | 0.01 |
| v/c Ratio | | 0.17 | 0.01 | | 0.09 | 0.07 | 0.48 | 0.62 | 0.02 | 0.83 | 0.44 | 0.02 |
| Uniform Delay, d1 | | 11.0 | 10.4 | | 10.7 | 10.6 | 22.6 | 11.8 | 9.1 | 22.1 | 10.1 | 8.4 |
| 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 | 0.0 | | 0.1 | 0.1 | 14.8 | 1.7 | 0.0 | 56.7 | 0.4 | 0.0 |
| Delay (s) | | 11.2 | 10.4 | | 10.8 | 10.7 | 37.5 | 13.5 | 9.1 | 78.8 | 10.6 | 8.4 |
| Level of Service | | B | B | | B | B | D | B | A | E | B | A |
| Approach Delay (s) | | 11.1 | | | 10.7 | | | 13.8 | | | 19.5 | |
| Approach LOS | | B | | | B | | | B | | | B | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 15.2 | HCM Level of Service | B |
| HCM Volume to Capacity ratio | 0.43 | | |
| Actuated Cycle Length (s) | 46.2 | 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 | WBT | WBR | SBL | SBR |
|---|---|---|---|---|---|---|
| Lane Configurations | | ↰↑ | ↑ | ↱ | ↰ | ↱ |
| Sign Control | | Stop | Stop | | Stop | |
| Volume (vph) | 218 | 87 | 231 | 289 | 30 | 148 |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Hourly flow rate (vph) | 237 | 95 | 251 | 314 | 33 | 161 |

| Direction, Lane # | EB 1 | WB 1 | WB 2 | SB 1 | SB 2 |
|---|---|---|---|---|---|
| Volume Total (vph) | 332 | 251 | 314 | 33 | 161 |
| Volume Left (vph) | 237 | 0 | 0 | 33 | 0 |
| Volume Right (vph) | 0 | 0 | 314 | 0 | 161 |
| Hadj (s) | 0.18 | 0.03 | -0.57 | 0.23 | -0.57 |
| Departure Headway (s) | 4.4 | 4.4 | 3.2 | 5.4 | 3.2 |
| Degree Utilization, x | 0.41 | 0.31 | 0.28 | 0.05 | 0.14 |
| Capacity (veh/h) | 797 | 800 | 1112 | 596 | 1121 |
| Control Delay (s) | 10.5 | 9.3 | 7.4 | 8.7 | 6.7 |
| Approach Delay (s) | 10.5 | 8.3 | | 7.1 | |
| Approach LOS | B | A | | A | |

| Intersection Summary | | | |
|---|---|---|---|
| Delay | 8.7 | | |
| HCM Level of Service | A | | |
| Intersection Capacity Utilization | 42.1% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | ↑ | ↱↱ | | | | | | | | ↰↑↑↑↱ | |
| Volume (vph) | 0 | 240 | 317 | 0 | 0 | 0 | 0 | 0 | 0 | 67 | 1518 | 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 | | 1.00 | 0.88 | | | | | | | | 0.86 | |
| Frt | | 1.00 | 0.85 | | | | | | | | 0.98 | |
| Flt Protected | | 1.00 | 1.00 | | | | | | | | 1.00 | |
| Satd. Flow (prot) | | 1863 | 2787 | | | | | | | | 6279 | |
| Flt Permitted | | 1.00 | 1.00 | | | | | | | | 1.00 | |
| Satd. Flow (perm) | | 1863 | 2787 | | | | | | | | 6279 | |
| 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 | 261 | 345 | 0 | 0 | 0 | 0 | 0 | 0 | 73 | 1650 | 239 |
| RTOR Reduction (vph) | 0 | 0 | 25 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 28 | 0 |
| Lane Group Flow (vph) | 0 | 261 | 320 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1934 | 0 |
| Turn Type | | | Prot | | | | | | | Perm | | |
| Protected Phases | | 4 | 4 | | | | | | | | 6 | |
| Permitted Phases | | | | | | | | | | 6 | | |
| Actuated Green, G (s) | | 18.6 | 18.6 | | | | | | | | 53.4 | |
| Effective Green, g (s) | | 18.6 | 18.6 | | | | | | | | 53.4 | |
| Actuated g/C Ratio | | 0.23 | 0.23 | | | | | | | | 0.67 | |
| Clearance Time (s) | | 4.0 | 4.0 | | | | | | | | 4.0 | |
| Vehicle Extension (s) | | 3.0 | 3.0 | | | | | | | | 3.0 | |
| Lane Grp Cap (vph) | | 433 | 648 | | | | | | | | 4191 | |
| v/s Ratio Prot | | c0.14 | 0.11 | | | | | | | | | |
| v/s Ratio Perm | | | | | | | | | | | 0.31 | |
| v/c Ratio | | 0.60 | 0.49 | | | | | | | | 0.46 | |
| Uniform Delay, d1 | | 27.4 | 26.6 | | | | | | | | 6.4 | |
| Progression Factor | | 1.00 | 1.00 | | | | | | | | 0.52 | |
| Incremental Delay, d2 | | 2.4 | 0.6 | | | | | | | | 0.3 | |
| Delay (s) | | 29.8 | 27.2 | | | | | | | | 3.6 | |
| Level of Service | | C | C | | | | | | | | A | |
| Approach Delay (s) | | 28.3 | | | 0.0 | | | 0.0 | | | 3.6 | |
| Approach LOS | | C | | | A | | | A | | | A | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 9.4 | HCM Level of Service | A |
| HCM Volume to Capacity ratio | 0.50 | | |
| Actuated Cycle Length (s) | 80.0 | 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 | EBL | EBR | NBL | NBT | NBR | SBL | SBT | SBR | SWL | SWR |
|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | |
| Volume (vph) | 155 | 690 | 0 | 13 | 6 | 110 | 1701 | 0 | 0 | 0 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Lane Width | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 16 |
| Total Lost time (s) | 5.0 | 5.0 | | 5.0 | | | 5.0 | | | |
| Lane Util. Factor | 1.00 | 0.95 | | 1.00 | | | 0.86 | | | |
| Frt | 0.90 | 0.85 | | 0.96 | | | 1.00 | | | |
| Flt Protected | 0.98 | 1.00 | | 1.00 | | | 1.00 | | | |
| Satd. Flow (prot) | 1654 | 1504 | | 1779 | | | 6388 | | | |
| Flt Permitted | 0.98 | 1.00 | | 1.00 | | | 0.91 | | | |
| Satd. Flow (perm) | 1654 | 1504 | | 1779 | | | 5818 | | | |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 168 | 750 | 0 | 14 | 7 | 120 | 1849 | 0 | 0 | 0 |
| RTOR Reduction (vph) | 2 | 2 | 0 | 4 | 0 | 0 | 0 | 0 | 0 | 0 |
| Lane Group Flow (vph) | 466 | 448 | 0 | 17 | 0 | 0 | 1969 | 0 | 0 | 0 |
| Turn Type | | Prot | | | | Perm | | | | |
| Protected Phases | 4 | 4 | | 2 | | | 6 | | | |
| Permitted Phases | | | | | | 6 | | | | |
| Actuated Green, G (s) | 31.2 | 31.2 | | 38.8 | | | 38.8 | | | |
| Effective Green, g (s) | 31.2 | 31.2 | | 38.8 | | | 38.8 | | | |
| Actuated g/C Ratio | 0.39 | 0.39 | | 0.48 | | | 0.48 | | | |
| Clearance Time (s) | 5.0 | 5.0 | | 5.0 | | | 5.0 | | | |
| Vehicle Extension (s) | 2.0 | 2.0 | | 5.0 | | | 5.0 | | | |
| Lane Grp Cap (vph) | 645 | 587 | | 863 | | | 2822 | | | |
| v/s Ratio Prot | 0.28 | c0.30 | | 0.01 | | | | | | |
| v/s Ratio Perm | | | | | | | c0.34 | | | |
| v/c Ratio | 0.72 | 0.76 | | 0.02 | | | 0.70 | | | |
| Uniform Delay, d1 | 20.7 | 21.2 | | 10.7 | | | 16.0 | | | |
| Progression Factor | 1.00 | 1.00 | | 1.00 | | | 0.23 | | | |
| Incremental Delay, d2 | 3.4 | 5.3 | | 0.0 | | | 1.1 | | | |
| Delay (s) | 24.1 | 26.4 | | 10.8 | | | 4.9 | | | |
| Level of Service | C | C | | B | | | A | | | |
| Approach Delay (s) | 25.2 | | | 10.8 | | | 4.9 | | 0.0 | |
| Approach LOS | C | | | B | | | A | | A | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 11.3 | HCM Level of Service | B |
| HCM Volume to Capacity ratio | 0.73 | | |
| Actuated Cycle Length (s) | 80.0 | Sum of lost time (s) | 10.0 |
| 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 | 0 | 0 | 67 | 414 | 0 | 0 | 9 | 0 | 0 | 1712 | 173 |
| 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 | |
| Lane Util. Factor | | | | | 0.91 | | | 1.00 | | | 0.86 | |
| Frt | | | | | 1.00 | | | 1.00 | | | 0.99 | |
| Flt Protected | | | | | 0.99 | | | 1.00 | | | 1.00 | |
| Satd. Flow (prot) | | | | | 5050 | | | 1863 | | | 6320 | |
| Flt Permitted | | | | | 0.99 | | | 1.00 | | | 1.00 | |
| Satd. Flow (perm) | | | | | 5050 | | | 1863 | | | 6320 | |
| 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 | 73 | 450 | 0 | 0 | 10 | 0 | 0 | 1861 | 188 |
| RTOR Reduction (vph) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 20 | 0 |
| Lane Group Flow (vph) | 0 | 0 | 0 | 0 | 523 | 0 | 0 | 10 | 0 | 0 | 2029 | 0 |
| Turn Type | | | | Perm | | | | | | | | |
| Protected Phases | | | | | 4 | | | 2 | | | 6 | |
| Permitted Phases | | | | 4 | | | | | | | | |
| Actuated Green, G (s) | | | | | 31.2 | | | 38.8 | | | 38.8 | |
| Effective Green, g (s) | | | | | 31.2 | | | 38.8 | | | 38.8 | |
| Actuated g/C Ratio | | | | | 0.39 | | | 0.48 | | | 0.48 | |
| Clearance Time (s) | | | | | 5.0 | | | 5.0 | | | 5.0 | |
| Vehicle Extension (s) | | | | | 2.0 | | | 5.0 | | | 5.0 | |
| Lane Grp Cap (vph) | | | | | 1970 | | | 904 | | | 3065 | |
| v/s Ratio Prot | | | | | | | | 0.01 | | | c0.32 | |
| v/s Ratio Perm | | | | | 0.10 | | | | | | | |
| v/c Ratio | | | | | 0.27 | | | 0.01 | | | 0.66 | |
| Uniform Delay, d1 | | | | | 16.6 | | | 10.7 | | | 15.6 | |
| Progression Factor | | | | | 1.00 | | | 0.37 | | | 1.00 | |
| Incremental Delay, d2 | | | | | 0.0 | | | 0.0 | | | 1.1 | |
| Delay (s) | | | | | 16.6 | | | 4.0 | | | 16.8 | |
| Level of Service | | | | | B | | | A | | | B | |
| Approach Delay (s) | | 0.0 | | | 16.6 | | | 4.0 | | | 16.8 | |
| Approach LOS | | A | | | B | | | A | | | B | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 16.7 | HCM Level of Service | B |
| HCM Volume to Capacity ratio | 0.49 | | |
| Actuated Cycle Length (s) | 80.0 | Sum of lost time (s) | 10.0 |
| Intersection Capacity Utilization | 45.4% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

| Lane Group | EBL | EBT | EBR | WBL | WBT | NBL | NBT | SBT |
|---|---|---|---|---|---|---|---|---|
| Lane Group Flow (vph) | 72 | 729 | 277 | 101 | 537 | 212 | 206 | 121 |
| v/c Ratio | 0.49 | 0.86 | 0.28 | 0.77 | 0.41 | 0.49 | 0.47 | 0.23 |
| Control Delay | 69.4 | 58.5 | 2.7 | 95.2 | 43.5 | 42.0 | 37.8 | 16.6 |
| Queue Delay | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Total Delay | 69.4 | 58.5 | 2.7 | 95.2 | 43.5 | 42.0 | 37.8 | 16.6 |
| Queue Length 50th (ft) | 59 | ~345 | 0 | 86 | 148 | 154 | 134 | 31 |
| Queue Length 95th (ft) | 111 | #472 | 43 | #201 | 190 | 235 | 214 | 78 |
| Internal Link Dist (ft) | | 189 | | | 238 | | 431 | 189 |
| Turn Bay Length (ft) | 155 | | | 80 | | | | |
| Base Capacity (vph) | 180 | 849 | 1077 | 131 | 1319 | 573 | 573 | 716 |
| Starvation Cap Reductn | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Spillback Cap Reductn | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Storage Cap Reductn | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Reduced v/c Ratio | 0.40 | 0.86 | 0.26 | 0.77 | 0.41 | 0.37 | 0.36 | 0.17 |

Intersection Summary

~ Volume exceeds capacity, queue is theoretically infinite.
Queue shown is maximum after two cycles.

\# 95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

| Lane Group | EBL | EBT | EBR | WBL | WBT | NBL | NBT | SBT |
|---|---|---|---|---|---|---|---|---|
| Lane Group Flow (vph) | 80 | 790 | 323 | 96 | 589 | 246 | 241 | 111 |
| v/c Ratio | 0.54 | 0.91 | 0.32 | 0.85 | 0.45 | 0.56 | 0.54 | 0.21 |
| Control Delay | 71.5 | 62.0 | 2.6 | 112.2 | 45.0 | 43.8 | 39.1 | 17.5 |
| Queue Delay | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Total Delay | 71.5 | 62.0 | 2.6 | 112.2 | 45.0 | 43.8 | 39.1 | 17.5 |
| Queue Length 50th (ft) | 66 | ~389 | 0 | ~83 | 168 | 183 | 161 | 31 |
| Queue Length 95th (ft) | 120 | #518 | 45 | #202 | 212 | 274 | 250 | 75 |
| Internal Link Dist (ft) | | 189 | | | 238 | | 431 | 189 |
| Turn Bay Length (ft) | 155 | | | 80 | | | | |
| Base Capacity (vph) | 178 | 872 | 1102 | 113 | 1299 | 568 | 570 | 707 |
| Starvation Cap Reductn | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Spillback Cap Reductn | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Storage Cap Reductn | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Reduced v/c Ratio | 0.45 | 0.91 | 0.29 | 0.85 | 0.45 | 0.43 | 0.42 | 0.16 |

Intersection Summary

~ Volume exceeds capacity, queue is theoretically infinite.
Queue shown is maximum after two cycles.

# 95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

# APPENDIX F

# CAPACITY ANALYSIS CALCULATIONS
# PROJECTED PEAK HOUR TRAFFIC ANALYSIS
# 3-LANE CLOSURE

| | → | ↘ | ↙ | ← | ↖ | ↗ |
|---|---|---|---|---|---|---|
| Movement | EBT | EBR | WBL | WBT | NBL | NBR |
| Lane Configurations | ↑↑↑↱ | | ↰ | ↑↑↑ | ↰ | ↱ |
| Volume (vph) | 939 | 67 | 78 | 768 | 64 | 102 |
| 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 | 0.86 | | 1.00 | 0.91 | 1.00 | 1.00 |
| Frt | 0.99 | | 1.00 | 1.00 | 1.00 | 0.85 |
| Flt Protected | 1.00 | | 0.95 | 1.00 | 0.95 | 1.00 |
| Satd. Flow (prot) | 6344 | | 1770 | 5085 | 1770 | 1583 |
| Flt Permitted | 1.00 | | 0.95 | 1.00 | 0.95 | 1.00 |
| Satd. Flow (perm) | 6344 | | 1770 | 5085 | 1770 | 1583 |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 1021 | 73 | 85 | 835 | 70 | 111 |
| RTOR Reduction (vph) | 17 | 0 | 0 | 0 | 0 | 95 |
| Lane Group Flow (vph) | 1077 | 0 | 85 | 835 | 70 | 16 |
| Turn Type | | | Prot | | | Perm |
| Protected Phases | 4 | | 3 | 8 | 2 | |
| Permitted Phases | | | | | | 2 |
| Actuated Green, G (s) | 17.7 | | 2.3 | 24.0 | 5.4 | 5.4 |
| Effective Green, g (s) | 17.7 | | 2.3 | 24.0 | 5.4 | 5.4 |
| Actuated g/C Ratio | 0.47 | | 0.06 | 0.64 | 0.14 | 0.14 |
| 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) | 3002 | | 109 | 3263 | 256 | 229 |
| v/s Ratio Prot | c0.17 | | c0.05 | 0.16 | c0.04 | |
| v/s Ratio Perm | | | | | | 0.01 |
| v/c Ratio | 0.36 | | 0.78 | 0.26 | 0.27 | 0.07 |
| Uniform Delay, d1 | 6.2 | | 17.3 | 2.9 | 14.3 | 13.8 |
| Progression Factor | 1.00 | | 1.00 | 1.00 | 1.00 | 1.00 |
| Incremental Delay, d2 | 0.1 | | 28.9 | 0.0 | 0.6 | 0.1 |
| Delay (s) | 6.3 | | 46.2 | 2.9 | 14.8 | 14.0 |
| Level of Service | A | | D | A | B | B |
| Approach Delay (s) | 6.3 | | | 6.9 | 14.3 | |
| Approach LOS | A | | | A | B | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 7.2 | HCM Level of Service | A |
| HCM Volume to Capacity ratio | 0.38 | | |
| Actuated Cycle Length (s) | 37.4 | 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) | 53 | 650 | 276 | 122 | 400 | 65 | 358 | 53 | 84 | 5 | 50 | 57 |
| Ideal Flow (vphpl) | 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 | 0.95 | 1.00 | 1.00 | 0.91 | | | 1.00 | | | 1.00 | |
| Frt | 1.00 | 1.00 | 0.85 | 1.00 | 0.98 | | | 0.98 | | | 0.93 | |
| Flt Protected | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | | | 0.97 | | | 1.00 | |
| Satd. Flow (prot) | 1770 | 3539 | 1583 | 1770 | 4978 | | | 1757 | | | 1730 | |
| Flt Permitted | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | | | 0.97 | | | 1.00 | |
| Satd. Flow (perm) | 1770 | 3539 | 1583 | 1770 | 4978 | | | 1757 | | | 1730 | |
| 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) | 58 | 707 | 300 | 133 | 435 | 71 | 389 | 58 | 91 | 5 | 54 | 62 |
| RTOR Reduction (vph) | 0 | 0 | 131 | 0 | 16 | 0 | 0 | 6 | 0 | 0 | 31 | 0 |
| Lane Group Flow (vph) | 58 | 707 | 169 | 133 | 490 | 0 | 0 | 532 | 0 | 0 | 90 | 0 |
| Turn Type | Prot | | pt+ov | Prot | | | Split | | | Split | | |
| Protected Phases | 7 | 4 | 4 2 | 3 | 8 | | 2 | 2 | | 6 | 6 | |
| Permitted Phases | | | | | | | | | | | | |
| Actuated Green, G (s) | 6.6 | 27.6 | 69.3 | 8.1 | 29.1 | | | 37.7 | | | 33.9 | |
| Effective Green, g (s) | 6.6 | 27.6 | 69.3 | 8.1 | 29.1 | | | 37.7 | | | 33.9 | |
| Actuated g/C Ratio | 0.05 | 0.22 | 0.56 | 0.07 | 0.24 | | | 0.31 | | | 0.27 | |
| 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) | 95 | 792 | 890 | 116 | 1175 | | | 537 | | | 476 | |
| v/s Ratio Prot | 0.03 | c0.20 | 0.11 | c0.08 | 0.10 | | | c0.30 | | | c0.05 | |
| v/s Ratio Perm | | | | | | | | | | | | |
| v/c Ratio | 0.61 | 0.89 | 0.19 | 1.15 | 0.42 | | | 0.99 | | | 0.19 | |
| Uniform Delay, d1 | 57.1 | 46.4 | 13.2 | 57.6 | 39.9 | | | 42.6 | | | 34.2 | |
| Progression Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | | | 1.00 | | | 1.00 | |
| Incremental Delay, d2 | 11.1 | 12.4 | 0.1 | 128.3 | 0.2 | | | 36.5 | | | 0.2 | |
| Delay (s) | 68.2 | 58.8 | 13.3 | 185.9 | 40.2 | | | 79.1 | | | 34.4 | |
| Level of Service | E | E | B | F | D | | | E | | | C | |
| Approach Delay (s) | | 46.5 | | | 70.5 | | | 79.1 | | | 34.4 | |
| Approach LOS | | D | | | E | | | E | | | C | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 59.8 | HCM Level of Service | E |
| HCM Volume to Capacity ratio | 0.72 | | |
| Actuated Cycle Length (s) | 123.3 | Sum of lost time (s) | 16.0 |
| Intersection Capacity Utilization | 69.1% | ICU Level of Service | C |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

| Movement | EBL | EBR | NBL | NBT | SBT | SBR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Volume (vph) | 121 | 44 | 12 | 387 | 344 | 106 |
| 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 | 1.00 | 0.85 | | 1.00 | 0.97 | |
| Flt Protected | 0.95 | 1.00 | | 1.00 | 1.00 | |
| Satd. Flow (prot) | 1770 | 1583 | | 1860 | 1804 | |
| Flt Permitted | 0.95 | 1.00 | | 0.98 | 1.00 | |
| Satd. Flow (perm) | 1770 | 1583 | | 1831 | 1804 | |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 132 | 48 | 13 | 421 | 374 | 115 |
| RTOR Reduction (vph) | 0 | 38 | 0 | 0 | 21 | 0 |
| Lane Group Flow (vph) | 132 | 10 | 0 | 434 | 468 | 0 |
| Turn Type | | Perm | Perm | | | |
| Protected Phases | 4 | | | 2 | 6 | |
| Permitted Phases | | 4 | 2 | | | |
| Actuated Green, G (s) | 5.7 | 5.7 | | 14.7 | 14.7 | |
| Effective Green, g (s) | 5.7 | 5.7 | | 14.7 | 14.7 | |
| Actuated g/C Ratio | 0.20 | 0.20 | | 0.52 | 0.52 | |
| 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) | 355 | 318 | | 948 | 934 | |
| v/s Ratio Prot | c0.07 | | | | c0.26 | |
| v/s Ratio Perm | | 0.01 | | 0.24 | | |
| v/c Ratio | 0.37 | 0.03 | | 0.46 | 0.50 | |
| Uniform Delay, d1 | 9.8 | 9.1 | | 4.3 | 4.5 | |
| Progression Factor | 1.00 | 1.00 | | 1.00 | 1.00 | |
| Incremental Delay, d2 | 0.7 | 0.0 | | 0.4 | 0.4 | |
| Delay (s) | 10.5 | 9.2 | | 4.7 | 4.9 | |
| Level of Service | B | A | | A | A | |
| Approach Delay (s) | 10.1 | | | 4.7 | 4.9 | |
| Approach LOS | B | | | A | A | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 5.7 | HCM Level of Service | A |
| HCM Volume to Capacity ratio | 0.46 | | |
| Actuated Cycle Length (s) | 28.4 | Sum of lost time (s) | 8.0 |
| Intersection Capacity Utilization | 43.4% | 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) | 45 | 11 | 9 | 12 | 29 | 83 | 8 | 368 | 20 | 48 | 275 | 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 | 4.0 | 4.0 | 4.0 |
| Lane Util. Factor | | 1.00 | 1.00 | | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Frt | | 1.00 | 0.85 | | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 |
| Flt Protected | | 0.96 | 1.00 | | 0.99 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 |
| Satd. Flow (prot) | | 1791 | 1583 | | 1836 | 1583 | 1770 | 1863 | 1583 | 1770 | 1863 | 1583 |
| Flt Permitted | | 0.79 | 1.00 | | 0.93 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 |
| Satd. Flow (perm) | | 1470 | 1583 | | 1735 | 1583 | 1770 | 1863 | 1583 | 1770 | 1863 | 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) | 49 | 12 | 10 | 13 | 32 | 90 | 9 | 400 | 22 | 52 | 299 | 24 |
| RTOR Reduction (vph) | 0 | 0 | 7 | 0 | 0 | 66 | 0 | 0 | 12 | 0 | 0 | 13 |
| Lane Group Flow (vph) | 0 | 61 | 3 | 0 | 45 | 24 | 9 | 400 | 10 | 52 | 299 | 11 |
| Turn Type | Perm | | Perm | Perm | | Perm | Prot | | Perm | Prot | | Perm |
| Protected Phases | | 4 | | | 8 | | 5 | 2 | | 1 | 6 | |
| Permitted Phases | 4 | | 4 | 8 | | 8 | | | 2 | | | 6 |
| Actuated Green, G (s) | | 11.9 | 11.9 | | 11.9 | 11.9 | 0.5 | 19.4 | 19.4 | 1.6 | 20.5 | 20.5 |
| Effective Green, g (s) | | 11.9 | 11.9 | | 11.9 | 11.9 | 0.5 | 19.4 | 19.4 | 1.6 | 20.5 | 20.5 |
| Actuated g/C Ratio | | 0.27 | 0.27 | | 0.27 | 0.27 | 0.01 | 0.43 | 0.43 | 0.04 | 0.46 | 0.46 |
| Clearance Time (s) | | 4.0 | 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 | 3.0 |
| Lane Grp Cap (vph) | | 390 | 420 | | 460 | 420 | 20 | 805 | 684 | 63 | 851 | 723 |
| v/s Ratio Prot | | | | | | | 0.01 | c0.21 | | c0.03 | 0.16 | |
| v/s Ratio Perm | | c0.04 | 0.00 | | 0.03 | 0.02 | | | 0.01 | | | 0.01 |
| v/c Ratio | | 0.16 | 0.01 | | 0.10 | 0.06 | 0.45 | 0.50 | 0.01 | 0.83 | 0.35 | 0.02 |
| Uniform Delay, d1 | | 12.7 | 12.1 | | 12.4 | 12.3 | 22.1 | 9.2 | 7.3 | 21.5 | 7.9 | 6.7 |
| 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 | | 0.2 | 0.0 | | 0.1 | 0.1 | 15.3 | 0.5 | 0.0 | 56.1 | 0.3 | 0.0 |
| Delay (s) | | 12.8 | 12.2 | | 12.5 | 12.4 | 37.3 | 9.7 | 7.3 | 77.6 | 8.1 | 6.7 |
| Level of Service | | B | B | | B | B | D | A | A | E | A | A |
| Approach Delay (s) | | 12.7 | | | 12.4 | | | 10.2 | | | 17.7 | |
| Approach LOS | | B | | | B | | | B | | | B | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 13.4 | HCM Level of Service | B |
| HCM Volume to Capacity ratio | 0.39 | | |
| Actuated Cycle Length (s) | 44.9 | Sum of lost time (s) | 12.0 |
| Intersection Capacity Utilization | 42.4% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

| Movement | EBL | EBT | WBT | WBR | SBL | SBR |
|---|---|---|---|---|---|---|
| Lane Configurations | | ↰↑ | ↑ | ↱ | ↰ | ↱ |
| Volume (vph) | 212 | 65 | 192 | 283 | 30 | 133 |
| 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 | | 1.00 | 1.00 | 0.85 | 1.00 | 0.85 |
| Flt Protected | | 0.96 | 1.00 | 1.00 | 0.95 | 1.00 |
| Satd. Flow (prot) | | 1794 | 1863 | 1583 | 1770 | 1583 |
| Flt Permitted | | 0.65 | 1.00 | 1.00 | 0.95 | 1.00 |
| Satd. Flow (perm) | | 1205 | 1863 | 1583 | 1770 | 1583 |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 230 | 71 | 209 | 308 | 33 | 145 |
| RTOR Reduction (vph) | 0 | 0 | 0 | 0 | 0 | 118 |
| Lane Group Flow (vph) | 0 | 301 | 209 | 308 | 33 | 27 |
| Turn Type | Perm | | | Free | | Perm |
| Protected Phases | | 4 | 8 | | 6 | |
| Permitted Phases | 4 | | | Free | | 6 |
| Actuated Green, G (s) | | 6.5 | 6.5 | 17.8 | 3.3 | 3.3 |
| Effective Green, g (s) | | 6.5 | 6.5 | 17.8 | 3.3 | 3.3 |
| Actuated g/C Ratio | | 0.37 | 0.37 | 1.00 | 0.19 | 0.19 |
| 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) | | 440 | 680 | 1583 | 328 | 293 |
| v/s Ratio Prot | | | 0.11 | | 0.02 | |
| v/s Ratio Perm | | c0.25 | | c0.19 | | 0.02 |
| v/c Ratio | | 0.68 | 0.31 | 0.19 | 0.10 | 0.09 |
| Uniform Delay, d1 | | 4.8 | 4.0 | 0.0 | 6.0 | 6.0 |
| Progression Factor | | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Incremental Delay, d2 | | 4.4 | 0.3 | 0.3 | 0.1 | 0.1 |
| Delay (s) | | 9.1 | 4.3 | 0.3 | 6.2 | 6.1 |
| Level of Service | | A | A | A | A | A |
| Approach Delay (s) | | 9.1 | 1.9 | | 6.1 | |
| Approach LOS | | A | A | | A | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 4.8 | HCM Level of Service | A |
| HCM Volume to Capacity ratio | 0.43 | | |
| Actuated Cycle Length (s) | 17.8 | Sum of lost time (s) | 4.0 |
| Intersection Capacity Utilization | 38.6% | 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 | 196 | 327 | 0 | 0 | 0 | 0 | 0 | 0 | 43 | 1309 | 227 |
| Ideal 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 | | 1.00 | 0.88 | | | | | | | | 0.86 | |
| Frt | | 1.00 | 0.85 | | | | | | | | 0.98 | |
| Flt Protected | | 1.00 | 1.00 | | | | | | | | 1.00 | |
| Satd. Flow (prot) | | 1863 | 2787 | | | | | | | | 6261 | |
| Flt Permitted | | 1.00 | 1.00 | | | | | | | | 1.00 | |
| Satd. Flow (perm) | | 1863 | 2787 | | | | | | | | 6261 | |
| 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 | 213 | 355 | 0 | 0 | 0 | 0 | 0 | 0 | 47 | 1423 | 247 |
| RTOR Reduction (vph) | 0 | 0 | 42 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 29 | 0 |
| Lane Group Flow (vph) | 0 | 213 | 313 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1688 | 0 |
| Turn Type | | | Prot | | | | | | | Perm | | |
| Protected Phases | | 4 | 4 | | | | | | | | 6 | |
| Permitted Phases | | | | | | | | | | 6 | | |
| Actuated Green, G (s) | | 17.2 | 17.2 | | | | | | | | 54.8 | |
| Effective Green, g (s) | | 17.2 | 17.2 | | | | | | | | 54.8 | |
| Actuated g/C Ratio | | 0.22 | 0.22 | | | | | | | | 0.68 | |
| Clearance Time (s) | | 4.0 | 4.0 | | | | | | | | 4.0 | |
| Vehicle Extension (s) | | 3.0 | 3.0 | | | | | | | | 3.0 | |
| Lane Grp Cap (vph) | | 401 | 599 | | | | | | | | 4289 | |
| v/s Ratio Prot | | c0.11 | 0.11 | | | | | | | | | |
| v/s Ratio Perm | | | | | | | | | | | 0.27 | |
| v/c Ratio | | 0.53 | 0.52 | | | | | | | | 0.39 | |
| Uniform Delay, d1 | | 27.8 | 27.8 | | | | | | | | 5.4 | |
| Progression Factor | | 1.00 | 1.00 | | | | | | | | 0.61 | |
| Incremental Delay, d2 | | 1.4 | 0.8 | | | | | | | | 0.2 | |
| Delay (s) | | 29.2 | 28.6 | | | | | | | | 3.5 | |
| Level of Service | | C | C | | | | | | | | A | |
| Approach Delay (s) | | 28.8 | | | 0.0 | | | 0.0 | | | 3.5 | |
| Approach LOS | | C | | | A | | | A | | | A | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 9.8 | HCM Level of Service | A |
| HCM Volume to Capacity ratio | 0.43 | | |
| Actuated Cycle Length (s) | 80.0 | 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 | EBR | NBL | NBT | NBR | SBL | SBT | SBR | SWL | SWR |
|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | |
| Volume (vph) | 84 | 525 | 0 | 12 | 7 | 113 | 1412 | 0 | 0 | 0 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Lane Width | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 16 |
| Total Lost time (s) | 5.0 | 5.0 | | 5.0 | | | 5.0 | | | |
| Lane Util. Factor | 1.00 | 0.95 | | 1.00 | | | 0.86 | | | |
| Frt | 0.89 | 0.85 | | 0.95 | | | 1.00 | | | |
| Flt Protected | 0.99 | 1.00 | | 1.00 | | | 1.00 | | | |
| Satd. Flow (prot) | 1637 | 1504 | | 1767 | | | 6384 | | | |
| Flt Permitted | 0.99 | 1.00 | | 1.00 | | | 0.90 | | | |
| Satd. Flow (perm) | 1637 | 1504 | | 1767 | | | 5787 | | | |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 91 | 571 | 0 | 13 | 8 | 123 | 1535 | 0 | 0 | 0 |
| RTOR Reduction (vph) | 8 | 8 | 0 | 4 | 0 | 0 | 0 | 0 | 0 | 0 |
| Lane Group Flow (vph) | 329 | 317 | 0 | 17 | 0 | 0 | 1658 | 0 | 0 | 0 |
| Turn Type | | Prot | | | | Perm | | | | |
| Protected Phases | 4 | 4 | | 2 | | | 6 | | | |
| Permitted Phases | | | | | | 6 | | | | |
| Actuated Green, G (s) | 28.8 | 28.8 | | 41.2 | | | 41.2 | | | |
| Effective Green, g (s) | 28.8 | 28.8 | | 41.2 | | | 41.2 | | | |
| Actuated g/C Ratio | 0.36 | 0.36 | | 0.52 | | | 0.52 | | | |
| Clearance Time (s) | 5.0 | 5.0 | | 5.0 | | | 5.0 | | | |
| Vehicle Extension (s) | 2.0 | 2.0 | | 5.0 | | | 5.0 | | | |
| Lane Grp Cap (vph) | 589 | 541 | | 910 | | | 2980 | | | |
| v/s Ratio Prot | 0.20 | c0.21 | | 0.01 | | | | | | |
| v/s Ratio Perm | | | | | | | c0.29 | | | |
| v/c Ratio | 0.56 | 0.59 | | 0.02 | | | 0.56 | | | |
| Uniform Delay, d1 | 20.5 | 20.8 | | 9.5 | | | 13.2 | | | |
| Progression Factor | 1.00 | 1.00 | | 1.00 | | | 0.30 | | | |
| Incremental Delay, d2 | 0.7 | 1.0 | | 0.0 | | | 0.7 | | | |
| Delay (s) | 21.2 | 21.8 | | 9.5 | | | 4.6 | | | |
| Level of Service | C | C | | A | | | A | | | |
| Approach Delay (s) | 21.5 | | | 9.5 | | | 4.6 | | 0.0 | |
| Approach LOS | C | | | A | | | A | | A | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 9.4 | HCM Level of Service | A |
| HCM Volume to Capacity ratio | 0.57 | | |
| Actuated Cycle Length (s) | 80.0 | Sum of lost time (s) | 10.0 |
| Intersection Capacity Utilization | 52.2% | 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) | 0 | 0 | 0 | 51 | 355 | 0 | 0 | 8 | 0 | 0 | 1369 | 176 |
| 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 | |
| Lane Util. Factor | | | | | 0.91 | | | 1.00 | | | 0.86 | |
| Frt | | | | | 1.00 | | | 1.00 | | | 0.98 | |
| Flt Protected | | | | | 0.99 | | | 1.00 | | | 1.00 | |
| Satd. Flow (prot) | | | | | 5054 | | | 1863 | | | 6299 | |
| Flt Permitted | | | | | 0.99 | | | 1.00 | | | 1.00 | |
| Satd. Flow (perm) | | | | | 5054 | | | 1863 | | | 6299 | |
| 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 | 55 | 386 | 0 | 0 | 9 | 0 | 0 | 1488 | 191 |
| RTOR Reduction (vph) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 27 | 0 |
| Lane Group Flow (vph) | 0 | 0 | 0 | 0 | 441 | 0 | 0 | 9 | 0 | 0 | 1652 | 0 |
| Turn Type | | | | Perm | | | | | | | | |
| Protected Phases | | | | | 4 | | | 2 | | | 6 | |
| Permitted Phases | | | | 4 | | | | | | | | |
| Actuated Green, G (s) | | | | | 28.8 | | | 41.2 | | | 41.2 | |
| Effective Green, g (s) | | | | | 28.8 | | | 41.2 | | | 41.2 | |
| Actuated g/C Ratio | | | | | 0.36 | | | 0.52 | | | 0.52 | |
| Clearance Time (s) | | | | | 5.0 | | | 5.0 | | | 5.0 | |
| Vehicle Extension (s) | | | | | 2.0 | | | 5.0 | | | 5.0 | |
| Lane Grp Cap (vph) | | | | | 1819 | | | 959 | | | 3244 | |
| v/s Ratio Prot | | | | | | | | 0.00 | | | c0.26 | |
| v/s Ratio Perm | | | | | 0.09 | | | | | | | |
| v/c Ratio | | | | | 0.24 | | | 0.01 | | | 0.51 | |
| Uniform Delay, d1 | | | | | 18.0 | | | 9.5 | | | 12.8 | |
| Progression Factor | | | | | 1.00 | | | 0.41 | | | 1.00 | |
| Incremental Delay, d2 | | | | | 0.0 | | | 0.0 | | | 0.6 | |
| Delay (s) | | | | | 18.0 | | | 3.9 | | | 13.3 | |
| Level of Service | | | | | B | | | A | | | B | |
| Approach Delay (s) | | 0.0 | | | 18.0 | | | 3.9 | | | 13.3 | |
| Approach LOS | | A | | | B | | | A | | | B | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 14.3 | HCM Level of Service | B |
| HCM Volume to Capacity ratio | 0.40 | | |
| Actuated Cycle Length (s) | 80.0 | Sum of lost time (s) | 10.0 |
| Intersection Capacity Utilization | 39.0% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

| | → | ↘ | ↙ | ← | ↖ | ↗ |
|---|---|---|---|---|---|---|
| Movement | EBT | EBR | WBL | WBT | NBL | NBR |
| Lane Configurations | ↑↑↑↱ | | ↰ | ↑↑↑ | ↰ | ↱ |
| Volume (vph) | 1000 | 80 | 100 | 800 | 100 | 150 |
| 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 | 0.86 | | 1.00 | 0.91 | 1.00 | 1.00 |
| Frt | 0.99 | | 1.00 | 1.00 | 1.00 | 0.85 |
| Flt Protected | 1.00 | | 0.95 | 1.00 | 0.95 | 1.00 |
| Satd. Flow (prot) | 6337 | | 1770 | 5085 | 1770 | 1583 |
| Flt Permitted | 1.00 | | 0.95 | 1.00 | 0.95 | 1.00 |
| Satd. Flow (perm) | 6337 | | 1770 | 5085 | 1770 | 1583 |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 1087 | 87 | 109 | 870 | 109 | 163 |
| RTOR Reduction (vph) | 20 | 0 | 0 | 0 | 0 | 138 |
| Lane Group Flow (vph) | 1154 | 0 | 109 | 870 | 109 | 25 |
| Turn Type | | | Prot | | | Perm |
| Protected Phases | 4 | | 3 | 8 | 2 | |
| Permitted Phases | | | | | | 2 |
| Actuated Green, G (s) | 18.8 | | 3.5 | 26.3 | 6.1 | 6.1 |
| Effective Green, g (s) | 18.8 | | 3.5 | 26.3 | 6.1 | 6.1 |
| Actuated g/C Ratio | 0.47 | | 0.09 | 0.65 | 0.15 | 0.15 |
| 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) | 2949 | | 153 | 3310 | 267 | 239 |
| v/s Ratio Prot | c0.18 | | c0.06 | 0.17 | c0.06 | |
| v/s Ratio Perm | | | | | | 0.02 |
| v/c Ratio | 0.39 | | 0.71 | 0.26 | 0.41 | 0.10 |
| Uniform Delay, d1 | 7.1 | | 18.0 | 3.0 | 15.5 | 14.8 |
| Progression Factor | 1.00 | | 1.00 | 1.00 | 1.00 | 1.00 |
| Incremental Delay, d2 | 0.1 | | 14.5 | 0.0 | 1.0 | 0.2 |
| Delay (s) | 7.1 | | 32.5 | 3.0 | 16.5 | 15.0 |
| Level of Service | A | | C | A | B | B |
| Approach Delay (s) | 7.1 | | | 6.3 | 15.6 | |
| Approach LOS | A | | | A | B | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 7.8 | HCM Level of Service | A |
| HCM Volume to Capacity ratio | 0.43 | | |
| Actuated Cycle Length (s) | 40.4 | Sum of lost time (s) | 12.0 |
| 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) | 55 | 700 | 370 | 129 | 453 | 48 | 378 | 81 | 112 | 4 | 58 | 41 |
| Ideal Flow (vphpl) | 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 | 0.95 | 1.00 | 1.00 | 0.91 | | | 1.00 | | | 1.00 | |
| Frt | 1.00 | 1.00 | 0.85 | 1.00 | 0.99 | | | 0.97 | | | 0.95 | |
| Flt Protected | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | | | 0.97 | | | 1.00 | |
| Satd. Flow (prot) | 1770 | 3539 | 1583 | 1770 | 5012 | | | 1755 | | | 1759 | |
| Flt Permitted | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | | | 0.97 | | | 1.00 | |
| Satd. Flow (perm) | 1770 | 3539 | 1583 | 1770 | 5012 | | | 1755 | | | 1759 | |
| 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) | 60 | 761 | 402 | 140 | 492 | 52 | 411 | 88 | 122 | 4 | 63 | 45 |
| RTOR Reduction (vph) | 0 | 0 | 161 | 0 | 8 | 0 | 0 | 6 | 0 | 0 | 17 | 0 |
| Lane Group Flow (vph) | 60 | 761 | 241 | 140 | 536 | 0 | 0 | 615 | 0 | 0 | 95 | 0 |
| Turn Type | Prot | | pt+ov | Prot | | | Split | | | Split | | |
| Protected Phases | 7 | 4 | 4 2 | 3 | 8 | | 2 | 2 | | 6 | 6 | |
| Permitted Phases | | | | | | | | | | | | |
| Actuated Green, G (s) | 7.8 | 31.4 | 86.0 | 11.1 | 34.7 | | | 50.6 | | | 34.5 | |
| Effective Green, g (s) | 7.8 | 31.4 | 86.0 | 11.1 | 34.7 | | | 50.6 | | | 34.5 | |
| Actuated g/C Ratio | 0.05 | 0.22 | 0.60 | 0.08 | 0.24 | | | 0.35 | | | 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) | 96 | 774 | 948 | 137 | 1211 | | | 618 | | | 423 | |
| v/s Ratio Prot | 0.03 | c0.22 | 0.15 | c0.08 | c0.11 | | | c0.35 | | | c0.05 | |
| v/s Ratio Perm | | | | | | | | | | | | |
| v/c Ratio | 0.62 | 0.98 | 0.25 | 1.02 | 0.44 | | | 1.00 | | | 0.22 | |
| Uniform Delay, d1 | 66.5 | 55.8 | 13.6 | 66.2 | 46.2 | | | 46.4 | | | 43.8 | |
| Progression Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | | | 1.00 | | | 1.00 | |
| Incremental Delay, d2 | 12.0 | 28.0 | 0.1 | 82.8 | 0.3 | | | 34.8 | | | 0.3 | |
| Delay (s) | 78.5 | 83.8 | 13.8 | 149.1 | 46.5 | | | 81.2 | | | 44.1 | |
| Level of Service | E | F | B | F | D | | | F | | | D | |
| Approach Delay (s) | | 60.5 | | | 67.5 | | | 81.2 | | | 44.1 | |
| Approach LOS | | E | | | E | | | F | | | D | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 66.5 | HCM Level of Service | E |
| HCM Volume to Capacity ratio | 0.80 | | |
| Actuated Cycle Length (s) | 143.6 | Sum of lost time (s) | 20.0 |
| Intersection Capacity Utilization | 75.2% | ICU Level of Service | D |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

| Movement | EBL | EBR | NBL | NBT | SBT | SBR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Volume (vph) | 137 | 45 | 15 | 439 | 382 | 179 |
| 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 | 1.00 | 0.85 | | 1.00 | 0.96 | |
| Flt Protected | 0.95 | 1.00 | | 1.00 | 1.00 | |
| Satd. Flow (prot) | 1770 | 1583 | | 1860 | 1782 | |
| Flt Permitted | 0.95 | 1.00 | | 0.98 | 1.00 | |
| Satd. Flow (perm) | 1770 | 1583 | | 1823 | 1782 | |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 149 | 49 | 16 | 477 | 415 | 195 |
| RTOR Reduction (vph) | 0 | 38 | 0 | 0 | 31 | 0 |
| Lane Group Flow (vph) | 149 | 11 | 0 | 493 | 579 | 0 |
| Turn Type | | Perm | Perm | | | |
| Protected Phases | 4 | | | 2 | 6 | |
| Permitted Phases | | 4 | 2 | | | |
| Actuated Green, G (s) | 8.1 | 8.1 | | 19.3 | 19.3 | |
| Effective Green, g (s) | 8.1 | 8.1 | | 19.3 | 19.3 | |
| Actuated g/C Ratio | 0.23 | 0.23 | | 0.55 | 0.55 | |
| 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) | 405 | 362 | | 994 | 972 | |
| v/s Ratio Prot | c0.08 | | | | c0.32 | |
| v/s Ratio Perm | | 0.01 | | 0.27 | | |
| v/c Ratio | 0.37 | 0.03 | | 0.50 | 0.60 | |
| Uniform Delay, d1 | 11.5 | 10.6 | | 5.0 | 5.4 | |
| Progression Factor | 1.00 | 1.00 | | 1.00 | 1.00 | |
| Incremental Delay, d2 | 0.6 | 0.0 | | 0.4 | 1.0 | |
| Delay (s) | 12.1 | 10.6 | | 5.4 | 6.4 | |
| Level of Service | B | B | | A | A | |
| Approach Delay (s) | 11.7 | | | 5.4 | 6.4 | |
| Approach LOS | B | | | A | A | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 6.8 | HCM Level of Service | A |
| HCM Volume to Capacity ratio | 0.53 | | |
| Actuated Cycle Length (s) | 35.4 | Sum of lost time (s) | 8.0 |
| Intersection Capacity Utilization | 49.5% | 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) | 60 | 15 | 10 | 15 | 30 | 100 | 10 | 400 | 25 | 50 | 300 | 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 | 4.0 | 4.0 | 4.0 |
| Lane Util. Factor | | 1.00 | 1.00 | | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Frt | | 1.00 | 0.85 | | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 |
| Flt Protected | | 0.96 | 1.00 | | 0.98 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 |
| Satd. Flow (prot) | | 1791 | 1583 | | 1833 | 1583 | 1770 | 1863 | 1583 | 1770 | 1863 | 1583 |
| Flt Permitted | | 0.79 | 1.00 | | 0.92 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 |
| Satd. Flow (perm) | | 1468 | 1583 | | 1723 | 1583 | 1770 | 1863 | 1583 | 1770 | 1863 | 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) | 65 | 16 | 11 | 16 | 33 | 109 | 11 | 435 | 27 | 54 | 326 | 27 |
| RTOR Reduction (vph) | 0 | 0 | 7 | 0 | 0 | 73 | 0 | 0 | 17 | 0 | 0 | 16 |
| Lane Group Flow (vph) | 0 | 81 | 4 | 0 | 49 | 36 | 11 | 435 | 10 | 54 | 326 | 11 |
| Turn Type | Perm | | Perm | Perm | | Perm | Prot | | Perm | Prot | | Perm |
| Protected Phases | | 4 | | | 8 | | 5 | 2 | | 1 | 6 | |
| Permitted Phases | 4 | | 4 | 8 | | 8 | | | 2 | | | 6 |
| Actuated Green, G (s) | | 15.2 | 15.2 | | 15.2 | 15.2 | 0.6 | 17.3 | 17.3 | 1.7 | 18.4 | 18.4 |
| Effective Green, g (s) | | 15.2 | 15.2 | | 15.2 | 15.2 | 0.6 | 17.3 | 17.3 | 1.7 | 18.4 | 18.4 |
| Actuated g/C Ratio | | 0.33 | 0.33 | | 0.33 | 0.33 | 0.01 | 0.37 | 0.37 | 0.04 | 0.40 | 0.40 |
| Clearance Time (s) | | 4.0 | 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 | 3.0 |
| Lane Grp Cap (vph) | | 483 | 521 | | 567 | 521 | 23 | 698 | 593 | 65 | 742 | 630 |
| v/s Ratio Prot | | | | | | | 0.01 | c0.23 | | c0.03 | 0.18 | |
| v/s Ratio Perm | | c0.06 | 0.00 | | 0.03 | 0.02 | | | 0.01 | | | 0.01 |
| v/c Ratio | | 0.17 | 0.01 | | 0.09 | 0.07 | 0.48 | 0.62 | 0.02 | 0.83 | 0.44 | 0.02 |
| Uniform Delay, d1 | | 11.0 | 10.4 | | 10.7 | 10.6 | 22.6 | 11.8 | 9.1 | 22.1 | 10.1 | 8.4 |
| 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 | 0.0 | | 0.1 | 0.1 | 14.8 | 1.7 | 0.0 | 56.7 | 0.4 | 0.0 |
| Delay (s) | | 11.2 | 10.4 | | 10.8 | 10.7 | 37.5 | 13.5 | 9.1 | 78.8 | 10.6 | 8.4 |
| Level of Service | | B | B | | B | B | D | B | A | E | B | A |
| Approach Delay (s) | | 11.1 | | | 10.7 | | | 13.8 | | | 19.5 | |
| Approach LOS | | B | | | B | | | B | | | B | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 15.2 | HCM Level of Service | B |
| HCM Volume to Capacity ratio | 0.43 | | |
| Actuated Cycle Length (s) | 46.2 | 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 | WBT | WBR | SBL | SBR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Sign Control | | Stop | Stop | | Stop | |
| Volume (vph) | 218 | 87 | 231 | 289 | 30 | 148 |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Hourly flow rate (vph) | 237 | 95 | 251 | 314 | 33 | 161 |

| Direction, Lane # | EB 1 | WB 1 | WB 2 | SB 1 | SB 2 |
|---|---|---|---|---|---|
| Volume Total (vph) | 332 | 251 | 314 | 33 | 161 |
| Volume Left (vph) | 237 | 0 | 0 | 33 | 0 |
| Volume Right (vph) | 0 | 0 | 314 | 0 | 161 |
| Hadj (s) | 0.18 | 0.03 | -0.57 | 0.23 | -0.57 |
| Departure Headway (s) | 4.4 | 4.4 | 3.2 | 5.4 | 3.2 |
| Degree Utilization, x | 0.41 | 0.31 | 0.28 | 0.05 | 0.14 |
| Capacity (veh/h) | 797 | 800 | 1112 | 596 | 1121 |
| Control Delay (s) | 10.5 | 9.3 | 7.4 | 8.7 | 6.7 |
| Approach Delay (s) | 10.5 | 8.3 | | 7.1 | |
| Approach LOS | B | A | | A | |

| Intersection Summary | | | |
|---|---|---|---|
| Delay | 8.7 | | |
| HCM Level of Service | A | | |
| Intersection Capacity Utilization | 42.1% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | ↑ | ↱↱ | | | | | | | | ↰↑↑↑↱ | |
| Volume (vph) | 0 | 240 | 317 | 0 | 0 | 0 | 0 | 0 | 0 | 67 | 1518 | 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 | | 1.00 | 0.88 | | | | | | | | 0.86 | |
| Frt | | 1.00 | 0.85 | | | | | | | | 0.98 | |
| Flt Protected | | 1.00 | 1.00 | | | | | | | | 1.00 | |
| Satd. Flow (prot) | | 1863 | 2787 | | | | | | | | 6279 | |
| Flt Permitted | | 1.00 | 1.00 | | | | | | | | 1.00 | |
| Satd. Flow (perm) | | 1863 | 2787 | | | | | | | | 6279 | |
| 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 | 261 | 345 | 0 | 0 | 0 | 0 | 0 | 0 | 73 | 1650 | 239 |
| RTOR Reduction (vph) | 0 | 0 | 25 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 28 | 0 |
| Lane Group Flow (vph) | 0 | 261 | 320 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1934 | 0 |
| Turn Type | | | Prot | | | | | | | Perm | | |
| Protected Phases | | 4 | 4 | | | | | | | | 6 | |
| Permitted Phases | | | | | | | | | | 6 | | |
| Actuated Green, G (s) | | 18.6 | 18.6 | | | | | | | | 53.4 | |
| Effective Green, g (s) | | 18.6 | 18.6 | | | | | | | | 53.4 | |
| Actuated g/C Ratio | | 0.23 | 0.23 | | | | | | | | 0.67 | |
| Clearance Time (s) | | 4.0 | 4.0 | | | | | | | | 4.0 | |
| Vehicle Extension (s) | | 3.0 | 3.0 | | | | | | | | 3.0 | |
| Lane Grp Cap (vph) | | 433 | 648 | | | | | | | | 4191 | |
| v/s Ratio Prot | | c0.14 | 0.11 | | | | | | | | | |
| v/s Ratio Perm | | | | | | | | | | | 0.31 | |
| v/c Ratio | | 0.60 | 0.49 | | | | | | | | 0.46 | |
| Uniform Delay, d1 | | 27.4 | 26.6 | | | | | | | | 6.4 | |
| Progression Factor | | 1.00 | 1.00 | | | | | | | | 0.52 | |
| Incremental Delay, d2 | | 2.4 | 0.6 | | | | | | | | 0.3 | |
| Delay (s) | | 29.8 | 27.2 | | | | | | | | 3.6 | |
| Level of Service | | C | C | | | | | | | | A | |
| Approach Delay (s) | | 28.3 | | | 0.0 | | | 0.0 | | | 3.6 | |
| Approach LOS | | C | | | A | | | A | | | A | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 9.4 | HCM Level of Service | A |
| HCM Volume to Capacity ratio | 0.50 | | |
| Actuated Cycle Length (s) | 80.0 | 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 | EBL | EBR | NBL | NBT | NBR | SBL | SBT | SBR | SWL | SWR |
|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | |
| Volume (vph) | 155 | 690 | 0 | 13 | 6 | 110 | 1701 | 0 | 0 | 0 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Lane Width | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 16 |
| Total Lost time (s) | 5.0 | 5.0 | | 5.0 | | | 5.0 | | | |
| Lane Util. Factor | 1.00 | 0.95 | | 1.00 | | | 0.86 | | | |
| Frt | 0.90 | 0.85 | | 0.96 | | | 1.00 | | | |
| Flt Protected | 0.98 | 1.00 | | 1.00 | | | 1.00 | | | |
| Satd. Flow (prot) | 1654 | 1504 | | 1779 | | | 6388 | | | |
| Flt Permitted | 0.98 | 1.00 | | 1.00 | | | 0.91 | | | |
| Satd. Flow (perm) | 1654 | 1504 | | 1779 | | | 5818 | | | |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 168 | 750 | 0 | 14 | 7 | 120 | 1849 | 0 | 0 | 0 |
| RTOR Reduction (vph) | 2 | 2 | 0 | 4 | 0 | 0 | 0 | 0 | 0 | 0 |
| Lane Group Flow (vph) | 466 | 448 | 0 | 17 | 0 | 0 | 1969 | 0 | 0 | 0 |
| Turn Type | | Prot | | | | Perm | | | | |
| Protected Phases | 4 | 4 | | 2 | | | 6 | | | |
| Permitted Phases | | | | | | 6 | | | | |
| Actuated Green, G (s) | 31.2 | 31.2 | | 38.8 | | | 38.8 | | | |
| Effective Green, g (s) | 31.2 | 31.2 | | 38.8 | | | 38.8 | | | |
| Actuated g/C Ratio | 0.39 | 0.39 | | 0.48 | | | 0.48 | | | |
| Clearance Time (s) | 5.0 | 5.0 | | 5.0 | | | 5.0 | | | |
| Vehicle Extension (s) | 2.0 | 2.0 | | 5.0 | | | 5.0 | | | |
| Lane Grp Cap (vph) | 645 | 587 | | 863 | | | 2822 | | | |
| v/s Ratio Prot | 0.28 | c0.30 | | 0.01 | | | | | | |
| v/s Ratio Perm | | | | | | | c0.34 | | | |
| v/c Ratio | 0.72 | 0.76 | | 0.02 | | | 0.70 | | | |
| Uniform Delay, d1 | 20.7 | 21.2 | | 10.7 | | | 16.0 | | | |
| Progression Factor | 1.00 | 1.00 | | 1.00 | | | 0.23 | | | |
| Incremental Delay, d2 | 3.4 | 5.3 | | 0.0 | | | 1.1 | | | |
| Delay (s) | 24.1 | 26.4 | | 10.8 | | | 4.9 | | | |
| Level of Service | C | C | | B | | | A | | | |
| Approach Delay (s) | 25.2 | | | 10.8 | | | 4.9 | | 0.0 | |
| Approach LOS | C | | | B | | | A | | A | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 11.3 | HCM Level of Service | B |
| HCM Volume to Capacity ratio | 0.73 | | |
| Actuated Cycle Length (s) | 80.0 | Sum of lost time (s) | 10.0 |
| 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 | 0 | 0 | 67 | 414 | 0 | 0 | 9 | 0 | 0 | 1712 | 173 |
| 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 | |
| Lane Util. Factor | | | | | 0.91 | | | 1.00 | | | 0.86 | |
| Frt | | | | | 1.00 | | | 1.00 | | | 0.99 | |
| Flt Protected | | | | | 0.99 | | | 1.00 | | | 1.00 | |
| Satd. Flow (prot) | | | | | 5050 | | | 1863 | | | 6320 | |
| Flt Permitted | | | | | 0.99 | | | 1.00 | | | 1.00 | |
| Satd. Flow (perm) | | | | | 5050 | | | 1863 | | | 6320 | |
| 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 | 73 | 450 | 0 | 0 | 10 | 0 | 0 | 1861 | 188 |
| RTOR Reduction (vph) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 20 | 0 |
| Lane Group Flow (vph) | 0 | 0 | 0 | 0 | 523 | 0 | 0 | 10 | 0 | 0 | 2029 | 0 |
| Turn Type | | | | Perm | | | | | | | | |
| Protected Phases | | | | | 4 | | | 2 | | | 6 | |
| Permitted Phases | | | | 4 | | | | | | | | |
| Actuated Green, G (s) | | | | | 31.2 | | | 38.8 | | | 38.8 | |
| Effective Green, g (s) | | | | | 31.2 | | | 38.8 | | | 38.8 | |
| Actuated g/C Ratio | | | | | 0.39 | | | 0.48 | | | 0.48 | |
| Clearance Time (s) | | | | | 5.0 | | | 5.0 | | | 5.0 | |
| Vehicle Extension (s) | | | | | 2.0 | | | 5.0 | | | 5.0 | |
| Lane Grp Cap (vph) | | | | | 1970 | | | 904 | | | 3065 | |
| v/s Ratio Prot | | | | | | | | 0.01 | | | c0.32 | |
| v/s Ratio Perm | | | | | 0.10 | | | | | | | |
| v/c Ratio | | | | | 0.27 | | | 0.01 | | | 0.66 | |
| Uniform Delay, d1 | | | | | 16.6 | | | 10.7 | | | 15.6 | |
| Progression Factor | | | | | 1.00 | | | 0.37 | | | 1.00 | |
| Incremental Delay, d2 | | | | | 0.0 | | | 0.0 | | | 1.1 | |
| Delay (s) | | | | | 16.6 | | | 4.0 | | | 16.8 | |
| Level of Service | | | | | B | | | A | | | B | |
| Approach Delay (s) | | 0.0 | | | 16.6 | | | 4.0 | | | 16.8 | |
| Approach LOS | | A | | | B | | | A | | | B | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 16.7 | HCM Level of Service | B |
| HCM Volume to Capacity ratio | 0.49 | | |
| Actuated Cycle Length (s) | 80.0 | Sum of lost time (s) | 10.0 |
| Intersection Capacity Utilization | 45.4% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

| Lane Group | EBL | EBT | EBR | WBL | WBT | NBT | SBT |
|---|---|---|---|---|---|---|---|
| Lane Group Flow (vph) | 58 | 707 | 300 | 133 | 506 | 538 | 121 |
| v/c Ratio | 0.49 | 0.92 | 0.30 | 1.13 | 0.42 | 0.99 | 0.24 |
| Control Delay | 73.0 | 67.5 | 2.6 | 174.3 | 42.8 | 79.0 | 21.5 |
| Queue Delay | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 9.0 | 0.0 |
| Total Delay | 73.0 | 67.5 | 2.6 | 174.3 | 42.8 | 88.0 | 21.5 |
| Queue Length 50th (ft) | 48 | 316 | 0 | ~138 | 135 | ~495 | 46 |
| Queue Length 95th (ft) | 95 | #450 | 45 | #272 | 175 | #721 | 94 |
| Internal Link Dist (ft) | | 189 | | | 238 | 431 | 189 |
| Turn Bay Length (ft) | 155 | | | 80 | | | |
| Base Capacity (vph) | 133 | 765 | 1014 | 118 | 1197 | 546 | 646 |
| Starvation Cap Reductn | 0 | 0 | 0 | 0 | 0 | 19 | 0 |
| Spillback Cap Reductn | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Storage Cap Reductn | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Reduced v/c Ratio | 0.44 | 0.92 | 0.30 | 1.13 | 0.42 | 1.02 | 0.19 |

Intersection Summary

~ Volume exceeds capacity, queue is theoretically infinite.
Queue shown is maximum after two cycles.

# 95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

| Lane Group | EBL | EBT | EBR | WBL | WBT | NBT | SBT |
|---|---|---|---|---|---|---|---|
| Lane Group Flow (vph) | 60 | 761 | 402 | 140 | 544 | 621 | 112 |
| v/c Ratio | 0.52 | 1.01 | 0.36 | 1.01 | 0.44 | 0.99 | 0.25 |
| Control Delay | 83.0 | 91.4 | 2.4 | 145.0 | 49.6 | 79.7 | 34.0 |
| Queue Delay | 0.0 | 0.0 | 0.3 | 0.0 | 0.0 | 77.2 | 0.0 |
| Total Delay | 83.0 | 91.4 | 2.6 | 145.0 | 49.6 | 156.9 | 34.0 |
| Queue Length 50th (ft) | 58 | ~434 | 0 | ~152 | 172 | ~655 | 66 |
| Queue Length 95th (ft) | 108 | #566 | 47 | #298 | 216 | #900 | 119 |
| Internal Link Dist (ft) | | 189 | | | 238 | 431 | 189 |
| Turn Bay Length (ft) | 155 | | | 80 | | | |
| Base Capacity (vph) | 138 | 753 | 1105 | 138 | 1226 | 628 | 552 |
| Starvation Cap Reductn | 0 | 0 | 240 | 0 | 0 | 109 | 0 |
| Spillback Cap Reductn | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Storage Cap Reductn | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Reduced v/c Ratio | 0.43 | 1.01 | 0.46 | 1.01 | 0.44 | 1.20 | 0.20 |

Intersection Summary

~ Volume exceeds capacity, queue is theoretically infinite.
Queue shown is maximum after two cycles.

\# 95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

| | → | ↘ | ↙ | ← | ↖ | ↗ |
|---|---|---|---|---|---|---|
| Movement | EBT | EBR | WBL | WBT | NBL | NBR |
| Lane Configurations | ↑↑↑↱ | | ↰ | ↑↑↑ | ↰ | ↱ |
| Volume (vph) | 874 | 132 | 131 | 680 | 152 | 179 |
| 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 | 0.86 | | 1.00 | 0.91 | 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) | 6282 | | 1770 | 5085 | 1770 | 1583 |
| Flt Permitted | 1.00 | | 0.95 | 1.00 | 0.95 | 1.00 |
| Satd. Flow (perm) | 6282 | | 1770 | 5085 | 1770 | 1583 |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 950 | 143 | 142 | 739 | 165 | 195 |
| RTOR Reduction (vph) | 48 | 0 | 0 | 0 | 0 | 161 |
| Lane Group Flow (vph) | 1045 | 0 | 142 | 739 | 165 | 34 |
| Turn Type | | | Prot | | | Perm |
| Protected Phases | 4 | | 3 | 8 | 2 | |
| Permitted Phases | | | | | | 2 |
| Actuated Green, G (s) | 17.6 | | 5.4 | 27.0 | 7.5 | 7.5 |
| Effective Green, g (s) | 17.6 | | 5.4 | 27.0 | 7.5 | 7.5 |
| Actuated g/C Ratio | 0.41 | | 0.13 | 0.64 | 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) | 2601 | | 225 | 3230 | 312 | 279 |
| v/s Ratio Prot | c0.17 | | c0.08 | 0.15 | c0.09 | |
| v/s Ratio Perm | | | | | | 0.02 |
| v/c Ratio | 0.40 | | 0.63 | 0.23 | 0.53 | 0.12 |
| Uniform Delay, d1 | 8.7 | | 17.6 | 3.3 | 15.9 | 14.7 |
| Progression Factor | 1.00 | | 1.00 | 1.00 | 1.00 | 1.00 |
| Incremental Delay, d2 | 0.1 | | 5.7 | 0.0 | 1.6 | 0.2 |
| Delay (s) | 8.9 | | 23.3 | 3.3 | 17.5 | 14.9 |
| Level of Service | A | | C | A | B | B |
| Approach Delay (s) | 8.9 | | | 6.6 | 16.1 | |
| Approach LOS | A | | | A | B | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 9.1 | HCM Level of Service | A |
| HCM Volume to Capacity ratio | 0.47 | | |
| Actuated Cycle Length (s) | 42.5 | Sum of lost time (s) | 12.0 |
| Intersection Capacity Utilization | 40.5% | 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) | 66 | 671 | 255 | 93 | 429 | 65 | 282 | 40 | 63 | 5 | 38 | 69 |
| Ideal Flow (vphpl) | 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 | 0.95 | 1.00 | 1.00 | 0.91 | | | 1.00 | | | 1.00 | |
| Frt | 1.00 | 1.00 | 0.85 | 1.00 | 0.98 | | | 0.98 | | | 0.92 | |
| Flt Protected | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | | | 0.96 | | | 1.00 | |
| Satd. Flow (prot) | 1770 | 3539 | 1583 | 1770 | 4984 | | | 1757 | | | 1703 | |
| Flt Permitted | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | | | 0.96 | | | 1.00 | |
| Satd. Flow (perm) | 1770 | 3539 | 1583 | 1770 | 4984 | | | 1757 | | | 1703 | |
| 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) | 72 | 729 | 277 | 101 | 466 | 71 | 307 | 43 | 68 | 5 | 41 | 75 |
| RTOR Reduction (vph) | 0 | 0 | 125 | 0 | 14 | 0 | 0 | 6 | 0 | 0 | 48 | 0 |
| Lane Group Flow (vph) | 72 | 729 | 152 | 101 | 523 | 0 | 0 | 412 | 0 | 0 | 73 | 0 |
| Turn Type | Prot | | pt+ov | Prot | | | Split | | | Split | | |
| Protected Phases | 7 | 4 | 4 2 | 3 | 8 | | 2 | 2 | | 6 | 6 | |
| Permitted Phases | | | | | | | | | | | | |
| Actuated Green, G (s) | 7.6 | 28.8 | 65.4 | 8.4 | 29.6 | | | 32.6 | | | 33.2 | |
| Effective Green, g (s) | 7.6 | 28.8 | 65.4 | 8.4 | 29.6 | | | 32.6 | | | 33.2 | |
| Actuated g/C Ratio | 0.06 | 0.24 | 0.55 | 0.07 | 0.25 | | | 0.27 | | | 0.28 | |
| 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) | 113 | 856 | 870 | 125 | 1240 | | | 481 | | | 475 | |
| v/s Ratio Prot | 0.04 | c0.21 | 0.10 | c0.06 | 0.10 | | | c0.23 | | | c0.04 | |
| v/s Ratio Perm | | | | | | | | | | | | |
| v/c Ratio | 0.64 | 0.85 | 0.17 | 0.81 | 0.42 | | | 0.86 | | | 0.15 | |
| Uniform Delay, d1 | 54.4 | 43.1 | 13.4 | 54.5 | 37.5 | | | 41.0 | | | 32.3 | |
| Progression Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | | | 1.00 | | | 1.00 | |
| Incremental Delay, d2 | 11.2 | 8.2 | 0.1 | 30.5 | 0.2 | | | 14.0 | | | 0.2 | |
| Delay (s) | 65.6 | 51.2 | 13.5 | 85.0 | 37.7 | | | 55.0 | | | 32.5 | |
| Level of Service | E | D | B | F | D | | | D | | | C | |
| Approach Delay (s) | | 42.5 | | | 45.2 | | | 55.0 | | | 32.5 | |
| Approach LOS | | D | | | D | | | D | | | C | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 45.0 | HCM Level of Service | D |
| HCM Volume to Capacity ratio | 0.62 | | |
| Actuated Cycle Length (s) | 119.0 | Sum of lost time (s) | 16.0 |
| Intersection Capacity Utilization | 61.9% | ICU Level of Service | B |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

| Movement | EBL | EBR | NBL | NBT | SBT | SBR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Volume (vph) | 0 | 0 | 0 | 399 | 388 | 0 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | | | | 4.0 | 4.0 | |
| Lane Util. Factor | | | | 1.00 | 1.00 | |
| Frt | | | | 1.00 | 1.00 | |
| Flt Protected | | | | 1.00 | 1.00 | |
| Satd. Flow (prot) | | | | 1863 | 1863 | |
| Flt Permitted | | | | 1.00 | 1.00 | |
| Satd. Flow (perm) | | | | 1863 | 1863 | |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 0 | 0 | 0 | 434 | 422 | 0 |
| RTOR Reduction (vph) | 0 | 0 | 0 | 0 | 0 | 0 |
| Lane Group Flow (vph) | 0 | 0 | 0 | 434 | 422 | 0 |
| Turn Type | | Perm | Perm | | | |
| Protected Phases | 4 | | | 2 | 6 | |
| Permitted Phases | | 4 | 2 | | | |
| Actuated Green, G (s) | | | | 13.7 | 13.7 | |
| Effective Green, g (s) | | | | 13.7 | 13.7 | |
| Actuated g/C Ratio | | | | 0.54 | 0.54 | |
| Clearance Time (s) | | | | 4.0 | 4.0 | |
| Vehicle Extension (s) | | | | 3.0 | 3.0 | |
| Lane Grp Cap (vph) | | | | 1013 | 1013 | |
| v/s Ratio Prot | | | | c0.23 | 0.23 | |
| v/s Ratio Perm | | | | | | |
| v/c Ratio | | | | 0.43 | 0.42 | |
| Uniform Delay, d1 | | | | 3.4 | 3.4 | |
| Progression Factor | | | | 1.00 | 1.00 | |
| Incremental Delay, d2 | | | | 0.3 | 0.3 | |
| Delay (s) | | | | 3.7 | 3.7 | |
| Level of Service | | | | A | A | |
| Approach Delay (s) | 0.0 | | | 3.7 | 3.7 | |
| Approach LOS | A | | | A | A | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 3.7 | HCM Level of Service | A |
| HCM Volume to Capacity ratio | 0.43 | | |
| Actuated Cycle Length (s) | 25.2 | Sum of lost time (s) | 11.5 |
| Intersection Capacity Utilization | 24.3% | 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) | 45 | 11 | 9 | 12 | 29 | 83 | 8 | 368 | 20 | 48 | 275 | 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 | 4.0 | 4.0 | 4.0 |
| Lane Util. Factor | | 1.00 | 1.00 | | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Frt | | 1.00 | 0.85 | | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 |
| Flt Protected | | 0.96 | 1.00 | | 0.99 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 |
| Satd. Flow (prot) | | 1791 | 1583 | | 1836 | 1583 | 1770 | 1863 | 1583 | 1770 | 1863 | 1583 |
| Flt Permitted | | 0.79 | 1.00 | | 0.93 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 |
| Satd. Flow (perm) | | 1470 | 1583 | | 1735 | 1583 | 1770 | 1863 | 1583 | 1770 | 1863 | 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) | 49 | 12 | 10 | 13 | 32 | 90 | 9 | 400 | 22 | 52 | 299 | 24 |
| RTOR Reduction (vph) | 0 | 0 | 7 | 0 | 0 | 66 | 0 | 0 | 12 | 0 | 0 | 13 |
| Lane Group Flow (vph) | 0 | 61 | 3 | 0 | 45 | 24 | 9 | 400 | 10 | 52 | 299 | 11 |
| Turn Type | Perm | | Perm | Perm | | Perm | Prot | | Perm | Prot | | Perm |
| Protected Phases | | 4 | | | 8 | | 5 | 2 | | 1 | 6 | |
| Permitted Phases | 4 | | 4 | 8 | | 8 | | | 2 | | | 6 |
| Actuated Green, G (s) | | 11.9 | 11.9 | | 11.9 | 11.9 | 0.5 | 19.4 | 19.4 | 1.6 | 20.5 | 20.5 |
| Effective Green, g (s) | | 11.9 | 11.9 | | 11.9 | 11.9 | 0.5 | 19.4 | 19.4 | 1.6 | 20.5 | 20.5 |
| Actuated g/C Ratio | | 0.27 | 0.27 | | 0.27 | 0.27 | 0.01 | 0.43 | 0.43 | 0.04 | 0.46 | 0.46 |
| Clearance Time (s) | | 4.0 | 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 | 3.0 |
| Lane Grp Cap (vph) | | 390 | 420 | | 460 | 420 | 20 | 805 | 684 | 63 | 851 | 723 |
| v/s Ratio Prot | | | | | | | 0.01 | c0.21 | | c0.03 | 0.16 | |
| v/s Ratio Perm | | c0.04 | 0.00 | | 0.03 | 0.02 | | | 0.01 | | | 0.01 |
| v/c Ratio | | 0.16 | 0.01 | | 0.10 | 0.06 | 0.45 | 0.50 | 0.01 | 0.83 | 0.35 | 0.02 |
| Uniform Delay, d1 | | 12.7 | 12.1 | | 12.4 | 12.3 | 22.1 | 9.2 | 7.3 | 21.5 | 7.9 | 6.7 |
| 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 | | 0.2 | 0.0 | | 0.1 | 0.1 | 15.3 | 0.5 | 0.0 | 56.1 | 0.3 | 0.0 |
| Delay (s) | | 12.8 | 12.2 | | 12.5 | 12.4 | 37.3 | 9.7 | 7.3 | 77.6 | 8.1 | 6.7 |
| Level of Service | | B | B | | B | B | D | A | A | E | A | A |
| Approach Delay (s) | | 12.7 | | | 12.4 | | | 10.2 | | | 17.7 | |
| Approach LOS | | B | | | B | | | B | | | B | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 13.4 | HCM Level of Service | B |
| HCM Volume to Capacity ratio | 0.39 | | |
| Actuated Cycle Length (s) | 44.9 | Sum of lost time (s) | 12.0 |
| Intersection Capacity Utilization | 42.4% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

| Movement | EBL | EBT | WBT | WBR | SBL | SBR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Volume (vph) | 212 | 65 | 192 | 283 | 30 | 133 |
| 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 | | 1.00 | 1.00 | 0.85 | 1.00 | 0.85 |
| Flt Protected | | 0.96 | 1.00 | 1.00 | 0.95 | 1.00 |
| Satd. Flow (prot) | | 1794 | 1863 | 1583 | 1770 | 1583 |
| Flt Permitted | | 0.65 | 1.00 | 1.00 | 0.95 | 1.00 |
| Satd. Flow (perm) | | 1205 | 1863 | 1583 | 1770 | 1583 |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 230 | 71 | 209 | 308 | 33 | 145 |
| RTOR Reduction (vph) | 0 | 0 | 0 | 0 | 0 | 118 |
| Lane Group Flow (vph) | 0 | 301 | 209 | 308 | 33 | 27 |
| Turn Type | Perm | | | Free | | Perm |
| Protected Phases | | 4 | 8 | | 6 | |
| Permitted Phases | 4 | | | Free | | 6 |
| Actuated Green, G (s) | | 6.5 | 6.5 | 17.8 | 3.3 | 3.3 |
| Effective Green, g (s) | | 6.5 | 6.5 | 17.8 | 3.3 | 3.3 |
| Actuated g/C Ratio | | 0.37 | 0.37 | 1.00 | 0.19 | 0.19 |
| 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) | | 440 | 680 | 1583 | 328 | 293 |
| v/s Ratio Prot | | | 0.11 | | 0.02 | |
| v/s Ratio Perm | | c0.25 | | c0.19 | | 0.02 |
| v/c Ratio | | 0.68 | 0.31 | 0.19 | 0.10 | 0.09 |
| Uniform Delay, d1 | | 4.8 | 4.0 | 0.0 | 6.0 | 6.0 |
| Progression Factor | | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Incremental Delay, d2 | | 4.4 | 0.3 | 0.3 | 0.1 | 0.1 |
| Delay (s) | | 9.1 | 4.3 | 0.3 | 6.2 | 6.1 |
| Level of Service | | A | A | A | A | A |
| Approach Delay (s) | | 9.1 | 1.9 | | 6.1 | |
| Approach LOS | | A | A | | A | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 4.8 | HCM Level of Service | A |
| HCM Volume to Capacity ratio | 0.43 | | |
| Actuated Cycle Length (s) | 17.8 | Sum of lost time (s) | 4.0 |
| Intersection Capacity Utilization | 38.6% | 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 | 196 | 327 | 0 | 0 | 0 | 0 | 0 | 0 | 43 | 1309 | 227 |
| Ideal 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 | | 1.00 | 0.88 | | | | | | | | 0.86 | |
| Frt | | 1.00 | 0.85 | | | | | | | | 0.98 | |
| Flt Protected | | 1.00 | 1.00 | | | | | | | | 1.00 | |
| Satd. Flow (prot) | | 1863 | 2787 | | | | | | | | 6261 | |
| Flt Permitted | | 1.00 | 1.00 | | | | | | | | 1.00 | |
| Satd. Flow (perm) | | 1863 | 2787 | | | | | | | | 6261 | |
| 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 | 213 | 355 | 0 | 0 | 0 | 0 | 0 | 0 | 47 | 1423 | 247 |
| RTOR Reduction (vph) | 0 | 0 | 42 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 29 | 0 |
| Lane Group Flow (vph) | 0 | 213 | 313 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1688 | 0 |
| Turn Type | | | Prot | | | | | | | Perm | | |
| Protected Phases | | 4 | 4 | | | | | | | | 6 | |
| Permitted Phases | | | | | | | | | | 6 | | |
| Actuated Green, G (s) | | 17.2 | 17.2 | | | | | | | | 54.8 | |
| Effective Green, g (s) | | 17.2 | 17.2 | | | | | | | | 54.8 | |
| Actuated g/C Ratio | | 0.22 | 0.22 | | | | | | | | 0.68 | |
| Clearance Time (s) | | 4.0 | 4.0 | | | | | | | | 4.0 | |
| Vehicle Extension (s) | | 3.0 | 3.0 | | | | | | | | 3.0 | |
| Lane Grp Cap (vph) | | 401 | 599 | | | | | | | | 4289 | |
| v/s Ratio Prot | | c0.11 | 0.11 | | | | | | | | | |
| v/s Ratio Perm | | | | | | | | | | | 0.27 | |
| v/c Ratio | | 0.53 | 0.52 | | | | | | | | 0.39 | |
| Uniform Delay, d1 | | 27.8 | 27.8 | | | | | | | | 5.4 | |
| Progression Factor | | 1.00 | 1.00 | | | | | | | | 0.61 | |
| Incremental Delay, d2 | | 1.4 | 0.8 | | | | | | | | 0.2 | |
| Delay (s) | | 29.2 | 28.6 | | | | | | | | 3.5 | |
| Level of Service | | C | C | | | | | | | | A | |
| Approach Delay (s) | | 28.8 | | | 0.0 | | | 0.0 | | | 3.5 | |
| Approach LOS | | C | | | A | | | A | | | A | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 9.8 | HCM Level of Service | A |
| HCM Volume to Capacity ratio | 0.43 | | |
| Actuated Cycle Length (s) | 80.0 | 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 | EBR | NBL | NBT | NBR | SBL | SBT | SBR | SWL | SWR |
|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | |
| Volume (vph) | 84 | 525 | 0 | 12 | 7 | 113 | 1412 | 0 | 0 | 0 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Lane Width | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 16 |
| Total Lost time (s) | 5.0 | 5.0 | | 5.0 | | | 5.0 | | | |
| Lane Util. Factor | 1.00 | 0.95 | | 1.00 | | | 0.86 | | | |
| Frt | 0.89 | 0.85 | | 0.95 | | | 1.00 | | | |
| Flt Protected | 0.99 | 1.00 | | 1.00 | | | 1.00 | | | |
| Satd. Flow (prot) | 1637 | 1504 | | 1767 | | | 6384 | | | |
| Flt Permitted | 0.99 | 1.00 | | 1.00 | | | 0.90 | | | |
| Satd. Flow (perm) | 1637 | 1504 | | 1767 | | | 5787 | | | |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 91 | 571 | 0 | 13 | 8 | 123 | 1535 | 0 | 0 | 0 |
| RTOR Reduction (vph) | 8 | 8 | 0 | 4 | 0 | 0 | 0 | 0 | 0 | 0 |
| Lane Group Flow (vph) | 329 | 317 | 0 | 17 | 0 | 0 | 1658 | 0 | 0 | 0 |
| Turn Type | | Prot | | | | Perm | | | | |
| Protected Phases | 4 | 4 | | 2 | | | 6 | | | |
| Permitted Phases | | | | | | 6 | | | | |
| Actuated Green, G (s) | 28.8 | 28.8 | | 41.2 | | | 41.2 | | | |
| Effective Green, g (s) | 28.8 | 28.8 | | 41.2 | | | 41.2 | | | |
| Actuated g/C Ratio | 0.36 | 0.36 | | 0.52 | | | 0.52 | | | |
| Clearance Time (s) | 5.0 | 5.0 | | 5.0 | | | 5.0 | | | |
| Vehicle Extension (s) | 2.0 | 2.0 | | 5.0 | | | 5.0 | | | |
| Lane Grp Cap (vph) | 589 | 541 | | 910 | | | 2980 | | | |
| v/s Ratio Prot | 0.20 | c0.21 | | 0.01 | | | | | | |
| v/s Ratio Perm | | | | | | | c0.29 | | | |
| v/c Ratio | 0.56 | 0.59 | | 0.02 | | | 0.56 | | | |
| Uniform Delay, d1 | 20.5 | 20.8 | | 9.5 | | | 13.2 | | | |
| Progression Factor | 1.00 | 1.00 | | 1.00 | | | 0.30 | | | |
| Incremental Delay, d2 | 0.7 | 1.0 | | 0.0 | | | 0.7 | | | |
| Delay (s) | 21.2 | 21.8 | | 9.5 | | | 4.6 | | | |
| Level of Service | C | C | | A | | | A | | | |
| Approach Delay (s) | 21.5 | | | 9.5 | | | 4.6 | | 0.0 | |
| Approach LOS | C | | | A | | | A | | A | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 9.4 | HCM Level of Service | A |
| HCM Volume to Capacity ratio | 0.57 | | |
| Actuated Cycle Length (s) | 80.0 | Sum of lost time (s) | 10.0 |
| Intersection Capacity Utilization | 52.2% | 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) | 0 | 0 | 0 | 51 | 355 | 0 | 0 | 8 | 0 | 0 | 1369 | 176 |
| 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 | |
| Lane Util. Factor | | | | | 0.91 | | | 1.00 | | | 0.86 | |
| Frt | | | | | 1.00 | | | 1.00 | | | 0.98 | |
| Flt Protected | | | | | 0.99 | | | 1.00 | | | 1.00 | |
| Satd. Flow (prot) | | | | | 5054 | | | 1863 | | | 6299 | |
| Flt Permitted | | | | | 0.99 | | | 1.00 | | | 1.00 | |
| Satd. Flow (perm) | | | | | 5054 | | | 1863 | | | 6299 | |
| 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 | 55 | 386 | 0 | 0 | 9 | 0 | 0 | 1488 | 191 |
| RTOR Reduction (vph) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 27 | 0 |
| Lane Group Flow (vph) | 0 | 0 | 0 | 0 | 441 | 0 | 0 | 9 | 0 | 0 | 1652 | 0 |
| Turn Type | | | | Perm | | | | | | | | |
| Protected Phases | | | | | 4 | | | 2 | | | 6 | |
| Permitted Phases | | | | 4 | | | | | | | | |
| Actuated Green, G (s) | | | | | 28.8 | | | 41.2 | | | 41.2 | |
| Effective Green, g (s) | | | | | 28.8 | | | 41.2 | | | 41.2 | |
| Actuated g/C Ratio | | | | | 0.36 | | | 0.52 | | | 0.52 | |
| Clearance Time (s) | | | | | 5.0 | | | 5.0 | | | 5.0 | |
| Vehicle Extension (s) | | | | | 2.0 | | | 5.0 | | | 5.0 | |
| Lane Grp Cap (vph) | | | | | 1819 | | | 959 | | | 3244 | |
| v/s Ratio Prot | | | | | | | | 0.00 | | | c0.26 | |
| v/s Ratio Perm | | | | | 0.09 | | | | | | | |
| v/c Ratio | | | | | 0.24 | | | 0.01 | | | 0.51 | |
| Uniform Delay, d1 | | | | | 18.0 | | | 9.5 | | | 12.8 | |
| Progression Factor | | | | | 1.00 | | | 0.41 | | | 1.00 | |
| Incremental Delay, d2 | | | | | 0.0 | | | 0.0 | | | 0.6 | |
| Delay (s) | | | | | 18.0 | | | 3.9 | | | 13.3 | |
| Level of Service | | | | | B | | | A | | | B | |
| Approach Delay (s) | | 0.0 | | | 18.0 | | | 3.9 | | | 13.3 | |
| Approach LOS | | A | | | B | | | A | | | B | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 14.3 | HCM Level of Service | B |
| HCM Volume to Capacity ratio | 0.40 | | |
| Actuated Cycle Length (s) | 80.0 | Sum of lost time (s) | 10.0 |
| Intersection Capacity Utilization | 39.0% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

| Movement | EBT | EBR | WBL | WBT | NBL | NBR |
|---|---|---|---|---|---|---|
| Lane Configurations | ↑↑↑↱ | | ↰ | ↑↑↑ | ↰ | ↱ |
| Volume (vph) | 882 | 198 | 175 | 709 | 191 | 241 |
| 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 | 0.86 | | 1.00 | 0.91 | 1.00 | 1.00 |
| Frt | 0.97 | | 1.00 | 1.00 | 1.00 | 0.85 |
| Flt Protected | 1.00 | | 0.95 | 1.00 | 0.95 | 1.00 |
| Satd. Flow (prot) | 6232 | | 1770 | 5085 | 1770 | 1583 |
| Flt Permitted | 1.00 | | 0.95 | 1.00 | 0.95 | 1.00 |
| Satd. Flow (perm) | 6232 | | 1770 | 5085 | 1770 | 1583 |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 959 | 215 | 190 | 771 | 208 | 262 |
| RTOR Reduction (vph) | 66 | 0 | 0 | 0 | 0 | 201 |
| Lane Group Flow (vph) | 1108 | 0 | 190 | 771 | 208 | 61 |
| Turn Type | | | Prot | | | Perm |
| Protected Phases | 4 | | 3 | 8 | 2 | |
| Permitted Phases | | | | | | 2 |
| Actuated Green, G (s) | 19.0 | | 7.1 | 30.1 | 11.5 | 11.5 |
| Effective Green, g (s) | 19.0 | | 7.1 | 30.1 | 11.5 | 11.5 |
| Actuated g/C Ratio | 0.38 | | 0.14 | 0.61 | 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) | 2387 | | 253 | 3086 | 410 | 367 |
| v/s Ratio Prot | c0.18 | | c0.11 | 0.15 | c0.12 | |
| v/s Ratio Perm | | | | | | 0.04 |
| v/c Ratio | 0.46 | | 0.75 | 0.25 | 0.51 | 0.17 |
| Uniform Delay, d1 | 11.5 | | 20.4 | 4.5 | 16.6 | 15.2 |
| Progression Factor | 1.00 | | 1.00 | 1.00 | 1.00 | 1.00 |
| Incremental Delay, d2 | 0.1 | | 11.8 | 0.0 | 1.0 | 0.2 |
| Delay (s) | 11.6 | | 32.2 | 4.6 | 17.6 | 15.4 |
| Level of Service | B | | C | A | B | B |
| Approach Delay (s) | 11.6 | | | 10.0 | 16.4 | |
| Approach LOS | B | | | B | B | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 11.9 | HCM Level of Service | B |
| HCM Volume to Capacity ratio | 0.53 | | |
| Actuated Cycle Length (s) | 49.6 | 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) | 74 | 727 | 297 | 88 | 494 | 48 | 302 | 62 | 85 | 4 | 39 | 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 | 0.95 | 1.00 | 1.00 | 0.91 | | | 1.00 | | | 1.00 | |
| Frt | 1.00 | 1.00 | 0.85 | 1.00 | 0.99 | | | 0.97 | | | 0.92 | |
| Flt Protected | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | | | 0.97 | | | 1.00 | |
| Satd. Flow (prot) | 1770 | 3539 | 1583 | 1770 | 5018 | | | 1756 | | | 1712 | |
| Flt Permitted | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | | | 0.97 | | | 1.00 | |
| Satd. Flow (perm) | 1770 | 3539 | 1583 | 1770 | 5018 | | | 1756 | | | 1712 | |
| 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) | 80 | 790 | 323 | 96 | 537 | 52 | 328 | 67 | 92 | 4 | 42 | 65 |
| RTOR Reduction (vph) | 0 | 0 | 140 | 0 | 8 | 0 | 0 | 6 | 0 | 0 | 42 | 0 |
| Lane Group Flow (vph) | 80 | 790 | 183 | 96 | 581 | 0 | 0 | 481 | 0 | 0 | 69 | 0 |
| Turn Type | Prot | | pt+ov | Prot | | | Split | | | Split | | |
| Protected Phases | 7 | 4 | 4 2 | 3 | 8 | | 2 | 2 | | 6 | 6 | |
| Permitted Phases | | | | | | | | | | | | |
| Actuated Green, G (s) | 7.9 | 29.2 | 68.5 | 7.2 | 28.5 | | | 35.3 | | | 33.5 | |
| Effective Green, g (s) | 7.9 | 29.2 | 68.5 | 7.2 | 28.5 | | | 35.3 | | | 33.5 | |
| Actuated g/C Ratio | 0.07 | 0.24 | 0.57 | 0.06 | 0.24 | | | 0.29 | | | 0.28 | |
| 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) | 115 | 853 | 895 | 105 | 1180 | | | 511 | | | 473 | |
| v/s Ratio Prot | 0.05 | c0.22 | 0.12 | c0.05 | 0.12 | | | c0.27 | | | c0.04 | |
| v/s Ratio Perm | | | | | | | | | | | | |
| v/c Ratio | 0.70 | 0.93 | 0.20 | 0.91 | 0.49 | | | 0.94 | | | 0.15 | |
| Uniform Delay, d1 | 55.5 | 44.9 | 13.0 | 56.7 | 40.1 | | | 41.9 | | | 33.1 | |
| Progression Factor | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | | | 1.00 | | | 1.00 | |
| Incremental Delay, d2 | 16.7 | 15.7 | 0.1 | 60.8 | 0.3 | | | 25.7 | | | 0.1 | |
| Delay (s) | 72.2 | 60.6 | 13.1 | 117.5 | 40.4 | | | 67.6 | | | 33.2 | |
| Level of Service | E | E | B | F | D | | | E | | | C | |
| Approach Delay (s) | | 48.5 | | | 51.2 | | | 67.6 | | | 33.2 | |
| Approach LOS | | D | | | D | | | E | | | C | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 52.3 | HCM Level of Service | D |
| HCM Volume to Capacity ratio | 0.66 | | |
| Actuated Cycle Length (s) | 121.2 | Sum of lost time (s) | 12.0 |
| Intersection Capacity Utilization | 66.8% | ICU Level of Service | C |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

| Movement | EBL | EBR | NBL | NBT | SBT | SBR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Volume (vph) | 0 | 0 | 0 | 454 | 427 | 0 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | | | | 4.0 | 4.0 | |
| Lane Util. Factor | | | | 1.00 | 1.00 | |
| Frt | | | | 1.00 | 1.00 | |
| Flt Protected | | | | 1.00 | 1.00 | |
| Satd. Flow (prot) | | | | 1863 | 1863 | |
| Flt Permitted | | | | 1.00 | 1.00 | |
| Satd. Flow (perm) | | | | 1863 | 1863 | |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 0 | 0 | 0 | 493 | 464 | 0 |
| RTOR Reduction (vph) | 0 | 0 | 0 | 0 | 0 | 0 |
| Lane Group Flow (vph) | 0 | 0 | 0 | 493 | 464 | 0 |
| Turn Type | | Perm | Perm | | | |
| Protected Phases | 4 | | | 2 | 6 | |
| Permitted Phases | | 4 | 2 | | | |
| Actuated Green, G (s) | | | | 14.1 | 14.1 | |
| Effective Green, g (s) | | | | 14.1 | 14.1 | |
| Actuated g/C Ratio | | | | 0.55 | 0.55 | |
| Clearance Time (s) | | | | 4.0 | 4.0 | |
| Vehicle Extension (s) | | | | 3.0 | 3.0 | |
| Lane Grp Cap (vph) | | | | 1022 | 1022 | |
| v/s Ratio Prot | | | | c0.26 | 0.25 | |
| v/s Ratio Perm | | | | | | |
| v/c Ratio | | | | 0.48 | 0.45 | |
| Uniform Delay, d1 | | | | 3.6 | 3.5 | |
| Progression Factor | | | | 1.00 | 1.00 | |
| Incremental Delay, d2 | | | | 0.4 | 0.3 | |
| Delay (s) | | | | 3.9 | 3.8 | |
| Level of Service | | | | A | A | |
| Approach Delay (s) | 0.0 | | | 3.9 | 3.8 | |
| Approach LOS | A | | | A | A | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 3.9 | HCM Level of Service | A |
| HCM Volume to Capacity ratio | 0.48 | | |
| Actuated Cycle Length (s) | 25.7 | Sum of lost time (s) | 11.6 |
| Intersection Capacity Utilization | 27.2% | 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) | 60 | 15 | 10 | 15 | 30 | 100 | 10 | 400 | 25 | 50 | 300 | 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 | 4.0 | 4.0 | 4.0 |
| Lane Util. Factor | | 1.00 | 1.00 | | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Frt | | 1.00 | 0.85 | | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 | 1.00 | 1.00 | 0.85 |
| Flt Protected | | 0.96 | 1.00 | | 0.98 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 |
| Satd. Flow (prot) | | 1791 | 1583 | | 1833 | 1583 | 1770 | 1863 | 1583 | 1770 | 1863 | 1583 |
| Flt Permitted | | 0.79 | 1.00 | | 0.92 | 1.00 | 0.95 | 1.00 | 1.00 | 0.95 | 1.00 | 1.00 |
| Satd. Flow (perm) | | 1468 | 1583 | | 1723 | 1583 | 1770 | 1863 | 1583 | 1770 | 1863 | 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) | 65 | 16 | 11 | 16 | 33 | 109 | 11 | 435 | 27 | 54 | 326 | 27 |
| RTOR Reduction (vph) | 0 | 0 | 7 | 0 | 0 | 73 | 0 | 0 | 17 | 0 | 0 | 16 |
| Lane Group Flow (vph) | 0 | 81 | 4 | 0 | 49 | 36 | 11 | 435 | 10 | 54 | 326 | 11 |
| Turn Type | Perm | | Perm | Perm | | Perm | Prot | | Perm | Prot | | Perm |
| Protected Phases | | 4 | | | 8 | | 5 | 2 | | 1 | 6 | |
| Permitted Phases | 4 | | 4 | 8 | | 8 | | | 2 | | | 6 |
| Actuated Green, G (s) | | 15.2 | 15.2 | | 15.2 | 15.2 | 0.6 | 17.3 | 17.3 | 1.7 | 18.4 | 18.4 |
| Effective Green, g (s) | | 15.2 | 15.2 | | 15.2 | 15.2 | 0.6 | 17.3 | 17.3 | 1.7 | 18.4 | 18.4 |
| Actuated g/C Ratio | | 0.33 | 0.33 | | 0.33 | 0.33 | 0.01 | 0.37 | 0.37 | 0.04 | 0.40 | 0.40 |
| Clearance Time (s) | | 4.0 | 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 | 3.0 |
| Lane Grp Cap (vph) | | 483 | 521 | | 567 | 521 | 23 | 698 | 593 | 65 | 742 | 630 |
| v/s Ratio Prot | | | | | | | 0.01 | c0.23 | | c0.03 | 0.18 | |
| v/s Ratio Perm | | c0.06 | 0.00 | | 0.03 | 0.02 | | | 0.01 | | | 0.01 |
| v/c Ratio | | 0.17 | 0.01 | | 0.09 | 0.07 | 0.48 | 0.62 | 0.02 | 0.83 | 0.44 | 0.02 |
| Uniform Delay, d1 | | 11.0 | 10.4 | | 10.7 | 10.6 | 22.6 | 11.8 | 9.1 | 22.1 | 10.1 | 8.4 |
| 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 | 0.0 | | 0.1 | 0.1 | 14.8 | 1.7 | 0.0 | 56.7 | 0.4 | 0.0 |
| Delay (s) | | 11.2 | 10.4 | | 10.8 | 10.7 | 37.5 | 13.5 | 9.1 | 78.8 | 10.6 | 8.4 |
| Level of Service | | B | B | | B | B | D | B | A | E | B | A |
| Approach Delay (s) | | 11.1 | | | 10.7 | | | 13.8 | | | 19.5 | |
| Approach LOS | | B | | | B | | | B | | | B | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 15.2 | HCM Level of Service | B |
| HCM Volume to Capacity ratio | 0.43 | | |
| Actuated Cycle Length (s) | 46.2 | 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 | WBT | WBR | SBL | SBR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Sign Control | | Stop | Stop | | Stop | |
| Volume (vph) | 218 | 87 | 231 | 289 | 30 | 148 |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Hourly flow rate (vph) | 237 | 95 | 251 | 314 | 33 | 161 |

| Direction, Lane # | EB 1 | WB 1 | WB 2 | SB 1 | SB 2 |
|---|---|---|---|---|---|
| Volume Total (vph) | 332 | 251 | 314 | 33 | 161 |
| Volume Left (vph) | 237 | 0 | 0 | 33 | 0 |
| Volume Right (vph) | 0 | 0 | 314 | 0 | 161 |
| Hadj (s) | 0.18 | 0.03 | -0.57 | 0.23 | -0.57 |
| Departure Headway (s) | 4.4 | 4.4 | 3.2 | 5.4 | 3.2 |
| Degree Utilization, x | 0.41 | 0.31 | 0.28 | 0.05 | 0.14 |
| Capacity (veh/h) | 797 | 800 | 1112 | 596 | 1121 |
| Control Delay (s) | 10.5 | 9.3 | 7.4 | 8.7 | 6.7 |
| Approach Delay (s) | 10.5 | 8.3 | | 7.1 | |
| Approach LOS | B | A | | A | |

| Intersection Summary | | | |
|---|---|---|---|
| Delay | 8.7 | | |
| HCM Level of Service | A | | |
| Intersection Capacity Utilization | 42.1% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | ↑ | ↱↱ | | | | | | | | ↰↑↑↱ | |
| Volume (vph) | 0 | 240 | 317 | 0 | 0 | 0 | 0 | 0 | 0 | 67 | 1518 | 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 | | 1.00 | 0.88 | | | | | | | | 0.86 | |
| Frt | | 1.00 | 0.85 | | | | | | | | 0.98 | |
| Flt Protected | | 1.00 | 1.00 | | | | | | | | 1.00 | |
| Satd. Flow (prot) | | 1863 | 2787 | | | | | | | | 6279 | |
| Flt Permitted | | 1.00 | 1.00 | | | | | | | | 1.00 | |
| Satd. Flow (perm) | | 1863 | 2787 | | | | | | | | 6279 | |
| 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 | 261 | 345 | 0 | 0 | 0 | 0 | 0 | 0 | 73 | 1650 | 239 |
| RTOR Reduction (vph) | 0 | 0 | 25 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 28 | 0 |
| Lane Group Flow (vph) | 0 | 261 | 320 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1934 | 0 |
| Turn Type | | | Prot | | | | | | | Perm | | |
| Protected Phases | | 4 | 4 | | | | | | | | 6 | |
| Permitted Phases | | | | | | | | | | 6 | | |
| Actuated Green, G (s) | | 18.6 | 18.6 | | | | | | | | 53.4 | |
| Effective Green, g (s) | | 18.6 | 18.6 | | | | | | | | 53.4 | |
| Actuated g/C Ratio | | 0.23 | 0.23 | | | | | | | | 0.67 | |
| Clearance Time (s) | | 4.0 | 4.0 | | | | | | | | 4.0 | |
| Vehicle Extension (s) | | 3.0 | 3.0 | | | | | | | | 3.0 | |
| Lane Grp Cap (vph) | | 433 | 648 | | | | | | | | 4191 | |
| v/s Ratio Prot | | c0.14 | 0.11 | | | | | | | | | |
| v/s Ratio Perm | | | | | | | | | | | 0.31 | |
| v/c Ratio | | 0.60 | 0.49 | | | | | | | | 0.46 | |
| Uniform Delay, d1 | | 27.4 | 26.6 | | | | | | | | 6.4 | |
| Progression Factor | | 1.00 | 1.00 | | | | | | | | 0.52 | |
| Incremental Delay, d2 | | 2.4 | 0.6 | | | | | | | | 0.3 | |
| Delay (s) | | 29.8 | 27.2 | | | | | | | | 3.6 | |
| Level of Service | | C | C | | | | | | | | A | |
| Approach Delay (s) | | 28.3 | | | 0.0 | | | 0.0 | | | 3.6 | |
| Approach LOS | | C | | | A | | | A | | | A | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 9.4 | HCM Level of Service | A |
| HCM Volume to Capacity ratio | 0.50 | | |
| Actuated Cycle Length (s) | 80.0 | 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 | EBL | EBR | NBL | NBT | NBR | SBL | SBT | SBR | SWL | SWR |
|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | |
| Volume (vph) | 155 | 690 | 0 | 13 | 6 | 110 | 1701 | 0 | 0 | 0 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Lane Width | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 16 |
| Total Lost time (s) | 5.0 | 5.0 | | 5.0 | | | 5.0 | | | |
| Lane Util. Factor | 1.00 | 0.95 | | 1.00 | | | 0.86 | | | |
| Frt | 0.90 | 0.85 | | 0.96 | | | 1.00 | | | |
| Flt Protected | 0.98 | 1.00 | | 1.00 | | | 1.00 | | | |
| Satd. Flow (prot) | 1654 | 1504 | | 1779 | | | 6388 | | | |
| Flt Permitted | 0.98 | 1.00 | | 1.00 | | | 0.91 | | | |
| Satd. Flow (perm) | 1654 | 1504 | | 1779 | | | 5818 | | | |
| Peak-hour factor, PHF | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 168 | 750 | 0 | 14 | 7 | 120 | 1849 | 0 | 0 | 0 |
| RTOR Reduction (vph) | 2 | 2 | 0 | 4 | 0 | 0 | 0 | 0 | 0 | 0 |
| Lane Group Flow (vph) | 466 | 448 | 0 | 17 | 0 | 0 | 1969 | 0 | 0 | 0 |
| Turn Type | | Prot | | | | Perm | | | | |
| Protected Phases | 4 | 4 | | 2 | | | 6 | | | |
| Permitted Phases | | | | | | 6 | | | | |
| Actuated Green, G (s) | 31.2 | 31.2 | | 38.8 | | | 38.8 | | | |
| Effective Green, g (s) | 31.2 | 31.2 | | 38.8 | | | 38.8 | | | |
| Actuated g/C Ratio | 0.39 | 0.39 | | 0.48 | | | 0.48 | | | |
| Clearance Time (s) | 5.0 | 5.0 | | 5.0 | | | 5.0 | | | |
| Vehicle Extension (s) | 2.0 | 2.0 | | 5.0 | | | 5.0 | | | |
| Lane Grp Cap (vph) | 645 | 587 | | 863 | | | 2822 | | | |
| v/s Ratio Prot | 0.28 | c0.30 | | 0.01 | | | | | | |
| v/s Ratio Perm | | | | | | | c0.34 | | | |
| v/c Ratio | 0.72 | 0.76 | | 0.02 | | | 0.70 | | | |
| Uniform Delay, d1 | 20.7 | 21.2 | | 10.7 | | | 16.0 | | | |
| Progression Factor | 1.00 | 1.00 | | 1.00 | | | 0.23 | | | |
| Incremental Delay, d2 | 3.4 | 5.3 | | 0.0 | | | 1.1 | | | |
| Delay (s) | 24.1 | 26.4 | | 10.8 | | | 4.9 | | | |
| Level of Service | C | C | | B | | | A | | | |
| Approach Delay (s) | 25.2 | | | 10.8 | | | 4.9 | | 0.0 | |
| Approach LOS | C | | | B | | | A | | A | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 11.3 | HCM Level of Service | B |
| HCM Volume to Capacity ratio | 0.73 | | |
| Actuated Cycle Length (s) | 80.0 | Sum of lost time (s) | 10.0 |
| 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 | 0 | 0 | 67 | 414 | 0 | 0 | 9 | 0 | 0 | 1712 | 173 |
| 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 | |
| Lane Util. Factor | | | | | 0.91 | | | 1.00 | | | 0.86 | |
| Frt | | | | | 1.00 | | | 1.00 | | | 0.99 | |
| Flt Protected | | | | | 0.99 | | | 1.00 | | | 1.00 | |
| Satd. Flow (prot) | | | | | 5050 | | | 1863 | | | 6320 | |
| Flt Permitted | | | | | 0.99 | | | 1.00 | | | 1.00 | |
| Satd. Flow (perm) | | | | | 5050 | | | 1863 | | | 6320 | |
| 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 | 73 | 450 | 0 | 0 | 10 | 0 | 0 | 1861 | 188 |
| RTOR Reduction (vph) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 20 | 0 |
| Lane Group Flow (vph) | 0 | 0 | 0 | 0 | 523 | 0 | 0 | 10 | 0 | 0 | 2029 | 0 |
| Turn Type | | | | Perm | | | | | | | | |
| Protected Phases | | | | | 4 | | | 2 | | | 6 | |
| Permitted Phases | | | | 4 | | | | | | | | |
| Actuated Green, G (s) | | | | | 31.2 | | | 38.8 | | | 38.8 | |
| Effective Green, g (s) | | | | | 31.2 | | | 38.8 | | | 38.8 | |
| Actuated g/C Ratio | | | | | 0.39 | | | 0.48 | | | 0.48 | |
| Clearance Time (s) | | | | | 5.0 | | | 5.0 | | | 5.0 | |
| Vehicle Extension (s) | | | | | 2.0 | | | 5.0 | | | 5.0 | |
| Lane Grp Cap (vph) | | | | | 1970 | | | 904 | | | 3065 | |
| v/s Ratio Prot | | | | | | | | 0.01 | | | c0.32 | |
| v/s Ratio Perm | | | | | 0.10 | | | | | | | |
| v/c Ratio | | | | | 0.27 | | | 0.01 | | | 0.66 | |
| Uniform Delay, d1 | | | | | 16.6 | | | 10.7 | | | 15.6 | |
| Progression Factor | | | | | 1.00 | | | 0.37 | | | 1.00 | |
| Incremental Delay, d2 | | | | | 0.0 | | | 0.0 | | | 1.1 | |
| Delay (s) | | | | | 16.6 | | | 4.0 | | | 16.8 | |
| Level of Service | | | | | B | | | A | | | B | |
| Approach Delay (s) | | 0.0 | | | 16.6 | | | 4.0 | | | 16.8 | |
| Approach LOS | | A | | | B | | | A | | | B | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 16.7 | HCM Level of Service | B |
| HCM Volume to Capacity ratio | 0.49 | | |
| Actuated Cycle Length (s) | 80.0 | Sum of lost time (s) | 10.0 |
| Intersection Capacity Utilization | 45.4% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

| Lane Group | EBL | EBT | EBR | WBL | WBT | NBT | SBT |
|---|---|---|---|---|---|---|---|
| Lane Group Flow (vph) | 72 | 729 | 277 | 101 | 537 | 418 | 121 |
| v/c Ratio | 0.50 | 0.89 | 0.28 | 0.80 | 0.43 | 0.85 | 0.23 |
| Control Delay | 70.0 | 61.7 | 2.6 | 99.6 | 43.8 | 58.9 | 16.5 |
| Queue Delay | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.4 | 0.0 |
| Total Delay | 70.0 | 61.7 | 2.6 | 99.6 | 43.8 | 59.3 | 16.5 |
| Queue Length 50th (ft) | 59 | ~345 | 0 | 86 | 148 | 325 | 31 |
| Queue Length 95th (ft) | 111 | #472 | 43 | #201 | 190 | #491 | 78 |
| Internal Link Dist (ft) | | 189 | | | 238 | 431 | 189 |
| Turn Bay Length (ft) | 155 | | | 80 | | | |
| Base Capacity (vph) | 174 | 820 | 1056 | 126 | 1259 | 585 | 693 |
| Starvation Cap Reductn | 0 | 0 | 0 | 0 | 0 | 21 | 0 |
| Spillback Cap Reductn | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Storage Cap Reductn | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Reduced v/c Ratio | 0.41 | 0.89 | 0.26 | 0.80 | 0.43 | 0.74 | 0.17 |

Intersection Summary

~ Volume exceeds capacity, queue is theoretically infinite.
Queue shown is maximum after two cycles.

# 95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

| Lane Group | EBL | EBT | EBR | WBL | WBT | NBT | SBT |
|---|---|---|---|---|---|---|---|
| Lane Group Flow (vph) | 80 | 790 | 323 | 96 | 589 | 487 | 111 |
| v/c Ratio | 0.56 | 0.96 | 0.31 | 0.91 | 0.49 | 0.93 | 0.21 |
| Control Delay | 72.8 | 71.9 | 2.5 | 124.9 | 45.8 | 69.4 | 17.2 |
| Queue Delay | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 1.8 | 0.0 |
| Total Delay | 72.8 | 71.9 | 2.5 | 124.9 | 45.8 | 71.2 | 17.2 |
| Queue Length 50th (ft) | 66 | ~389 | 0 | ~83 | 168 | 399 | 31 |
| Queue Length 95th (ft) | 120 | #518 | 45 | #202 | 212 | #622 | 75 |
| Internal Link Dist (ft) | | 189 | | | 238 | 431 | 189 |
| Turn Bay Length (ft) | 155 | | | 80 | | | |
| Base Capacity (vph) | 167 | 820 | 1058 | 106 | 1194 | 563 | 668 |
| Starvation Cap Reductn | 0 | 0 | 0 | 0 | 0 | 20 | 0 |
| Spillback Cap Reductn | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Storage Cap Reductn | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Reduced v/c Ratio | 0.48 | 0.96 | 0.31 | 0.91 | 0.49 | 0.90 | 0.17 |

**Intersection Summary**

~ Volume exceeds capacity, queue is theoretically infinite.
Queue shown is maximum after two cycles.

# 95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

# APPENDIX D
# ACOUSTIC STUDY
# (Y. EBISU AND ASSOCIATES)

**Y. Ebisu & Associates**
Acoustical and Electronic Engineers

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YEA Job #49.050
August 1, 2012



Group 70 International
925 Bethel Street, Fifth Floor
Honolulu, Hawaii 96813

Attention: Mr. Jeffrey H. Overton, AICP, LEED-AP

Subject: Evaluation of Construction Noise Impacts; Kalia-Fort DeRussy Wastewater System Improvements

Dear Mr. Overton:

Purpose: The purpose of this letter report is to describe the potential noise impacts associated with daytime and nighttime construction work on the subject project. The locations of the sewer line corridors and Ft. DeRussy Wastewater Pump Station (WWPS) are shown in Figure 1. The construction work associated with these wastewater system upgrades involve excavation along three major roadways: Kalia Road; Ala Moana Boulevard; and Kalakaua Avenue. Because traffic lane closures will probably be necessary during this type of construction activity along Kalakaua Avenue and Kalia Road, work during the nighttime hours may be required to minimize traffic congestion and traffic delays during the normal daytime working hours. Because of the proximity of existing hotels and multifamily residences along the project corridor, the potential noise impacts from nighttime construction work was also evaluated.

Background: The State Department of Health currently regulates noise from construction activities under Chapter 46, Community Noise Control, Title 11, Administrative Rules, Department of Health. Along the project corridor, the applicable daytime and nighttime noise limits are 60 and 50 dBA (A-Weighted decibels), respectively. Diesel-powered construction equipment cannot be expected to emit noise levels below 60 to 50 dBA at 50 FT distance, which will be required to fully comply with the daytime and nighttime DOH noise limits for hotel, commercial, and apartment zones along the project corridor. Typical diesel-powered equipment and trucks will exceed these DOH noise limits by 20 to 40 dBA as shown in Table 1.

Recognizing that the 60 dBA daytime limit is difficult to meet along a typical boundary line for a construction project involving earthwork and the use of heavy equipment, the Department of Health (DOH) administers a permit system where noisy construction activities are permitted to occur during the following periods: 7:00 am to 6:00 pm, Monday through Friday, excluding holidays; and 9:00 am to 6:00 pm on Saturday. Noisy construction work during other periods, and specifically during the nighttime hours, is normally not permitted unless a noise variance from the applicable rules is granted by the DOH. In granting such a request for a noise variance, the applicant must demonstrate that granting of a noise variance for the construction project is in the public interest and that adverse noise impacts are not severe. Normally, for projects of this type, the DOH attempts to balance the interests of the traveling public and businesses along the project corridor with the health and welfare of those residents and hotel guests who may be impacted by excessive construction noise.

Ft. DeRussy WWPS Improvements. Construction activities at the Ft. DeRussy WWPS are not expected to require extraordinary noise mitigation measures, but may require construction work or operation of construction equipment (bypass pumping) during nighttime periods. The closest noise sensitive buildings to the Ft. DeRussy WWPS are the Asian Pacific Center for Security Studies and the Outrigger Luana Waikiki Hotel. During daytime open trenching operations at the WWPS, construction noise levels at these two noise sensitive receptor locations may intermittently be 2 to 10 dBA greater than existing background noise levels, which are controlled by traffic on Kalakaua Avenue. During renovation work at the WWPS building, construction noise levels should be approximately 13 dBA lower than those associated with open trenching operations, and should not be higher than existing background noise levels at these two receptor locations. During the nighttime and early morning periods, the noisier construction noise levels associated with open trenching operations may be audible above existing background noise, and range from 75 to 78 dBA. The noise sensitive receptors are located in air conditioned buildings, and interior noise levels during construction should be approximately 20 dBA lower than the noise levels outside the buildings.

Sewer Line Project. The proposed sewer line project corridor is shown in Figure 1. The noise sensitive structures which are closest to the sewer line corridor are: Alana Waikiki Hotel; Inn On the Park Condominium; Canterbury Place Condominium; Kalia Tower of the Hilton Hawaiian Village Hotel, and the Diamond Head Apartments on Paoa Place. Tables 2 through 4 present the range of predicted construction noise levels at these and other nearby structures during the noisier phases of the work. In the tables, the L10 values represent the background noise levels which are exceeded ten percent of the time, and the L10 descriptor is the noise metric used in the State DOH regulatory limits. The noise levels for a vibratory pile driver are shown, assuming that sheet piles will be required for shoring and/or dewatering. The noise levels for trenching operations using large equipment, such as a CAT 330L, are also shown. If a smaller Case 580L (backhoe) is used, trenching noise levels shown in the table may be reduced by approximately 8 to 10 dBA.

Background ambient noise levels along the sewer line project corridor are controlled by local and distant traffic noise. Noise levels along Kalakaua Avenue were measured with the microphone situated on the third floor lanai of the Outrigger Luana Waikiki Hotel. Noise levels along Ala Moana Boulevard were measured with the microphone situated on the 9th floor lanai of the Hilton Alana Waikiki Hotel. Noise levels along Kalia Road were measured with the microphone situated on the 23rd floor lanai of the Tapa Tower, Hilton Hawaiian Village. The results of these measurements from Midnight to Midnight are shown in Figures 2 through 4. In the figures, the hourly equivalent noise levels represent the average noise levels recorded during each hour.

Work on the sewer line project during the nighttime and early morning hours may be required along Kalia Road, where the open trenching work on the sewer line will interfere with traffic along Kalia Road. Risks of adverse noise impacts are highest during work along the Kalia Road section of the sewer line, and noise mitigation measures will probably be required during nighttime and early morning work along the Kalia Road section. Similar conditions on Kalakaua Avenue may also require nighttime work near the Ft. DeRussy WWPS. Typical construction noise mitigation measures utilized during the nighttime and early morning hours are: the use of quieter equipment (light towers, generators, and bypass pumps with sound attenuation kits); the use of flag men in place of back up beeper alarms; and the scheduling of the noisier activities and equipment (pile driving, saws, jackhammer, etc.) to the evening and early nighttime hours, with the late night and early morning hours used to schedule the quieter construction activities.

Conclusions. From Tables 2 through 4, it was concluded that risks of noise impacts during the noisier construction activities such as sheet pile driving and/or trenching will be lowest along Kalakaua Avenue due to the relatively high background noise levels along this roadway. Risks of noise impacts are higher during construction work along Ala Moana Boulevard, due to the lower background noise levels along Ala Moana Boulevard. If traffic lane closures can be avoided along Ala Moana Boulevard, construction work during the nighttime and early morning hours may not be necessary. Along Kalia Road, risks of potential noise impacts from construction are highest since construction work during the evening, nighttime, and early morning hours will probably be necessary. In addition, background noise levels are lower along Kalia Road than along Ala Moana Boulevard or Kalakaua Avenue. Scheduling of the noisier construction activities during the daytime and early nighttime hours, and scheduling of the quieter construction activities during the late night and early morning hours will minimize the intrusiveness of the construction work along Kalia Road.

It should be possible to perform some of the quieter construction activities, such as plate welding, pipe laying, backfilling and use of smaller equipment such as the Case 580L loader/backhoe during the 6:00 pm to 6:00 am time period. Use of smaller equipment may be more feasible along the sewer line project if trenches are relatively shallow. The use of quieter equipment (light towers, generators, and bypass pumps with sound attenuation kits), the use of flag men in place of back up beeper alarms, and the use of the evening and early nighttime hours for the noisier construction activities are additional noise mitigation measures which are typically applied.

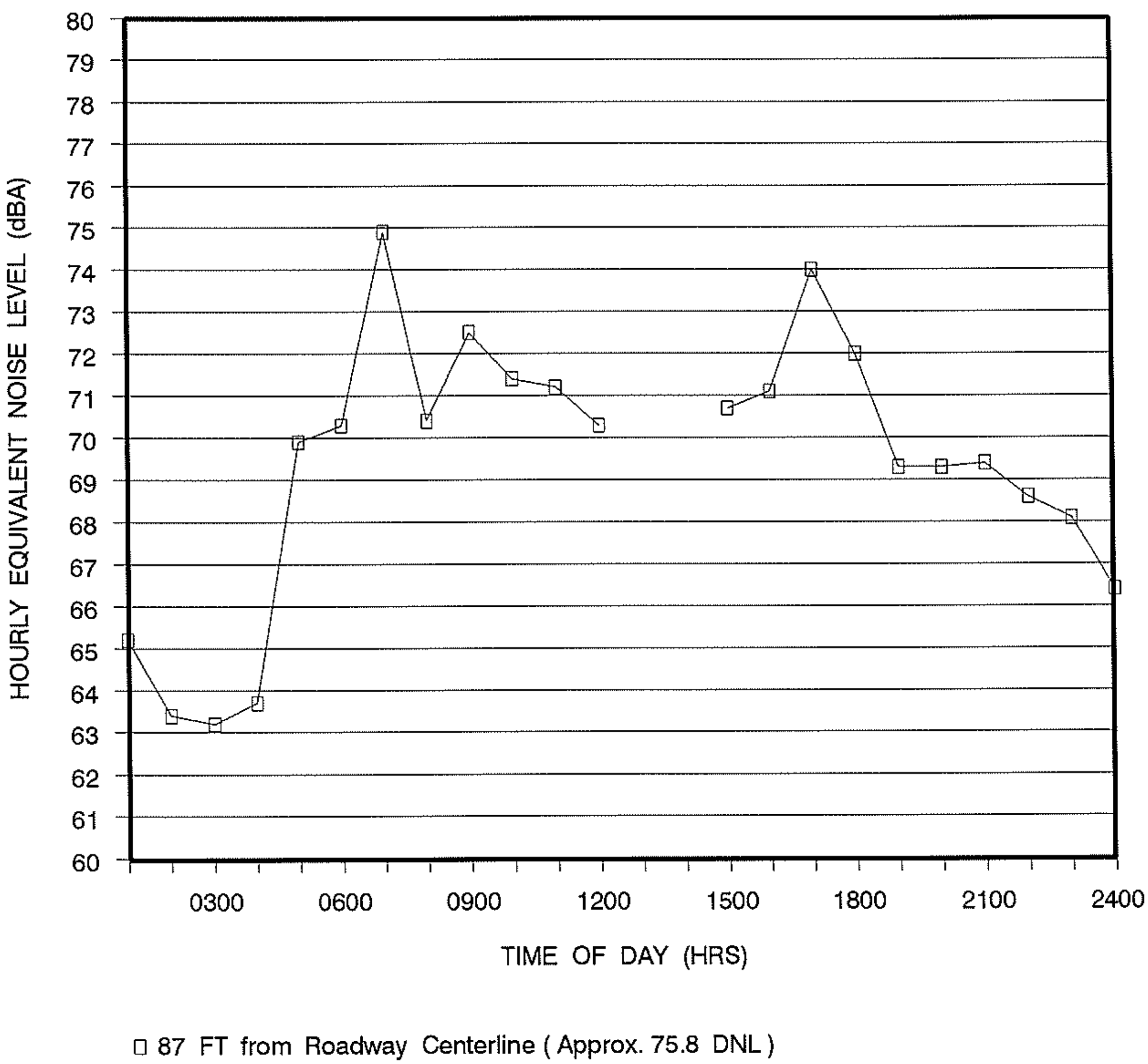
Sincerely,

Yoichi Ebisu, P.E.

encl.

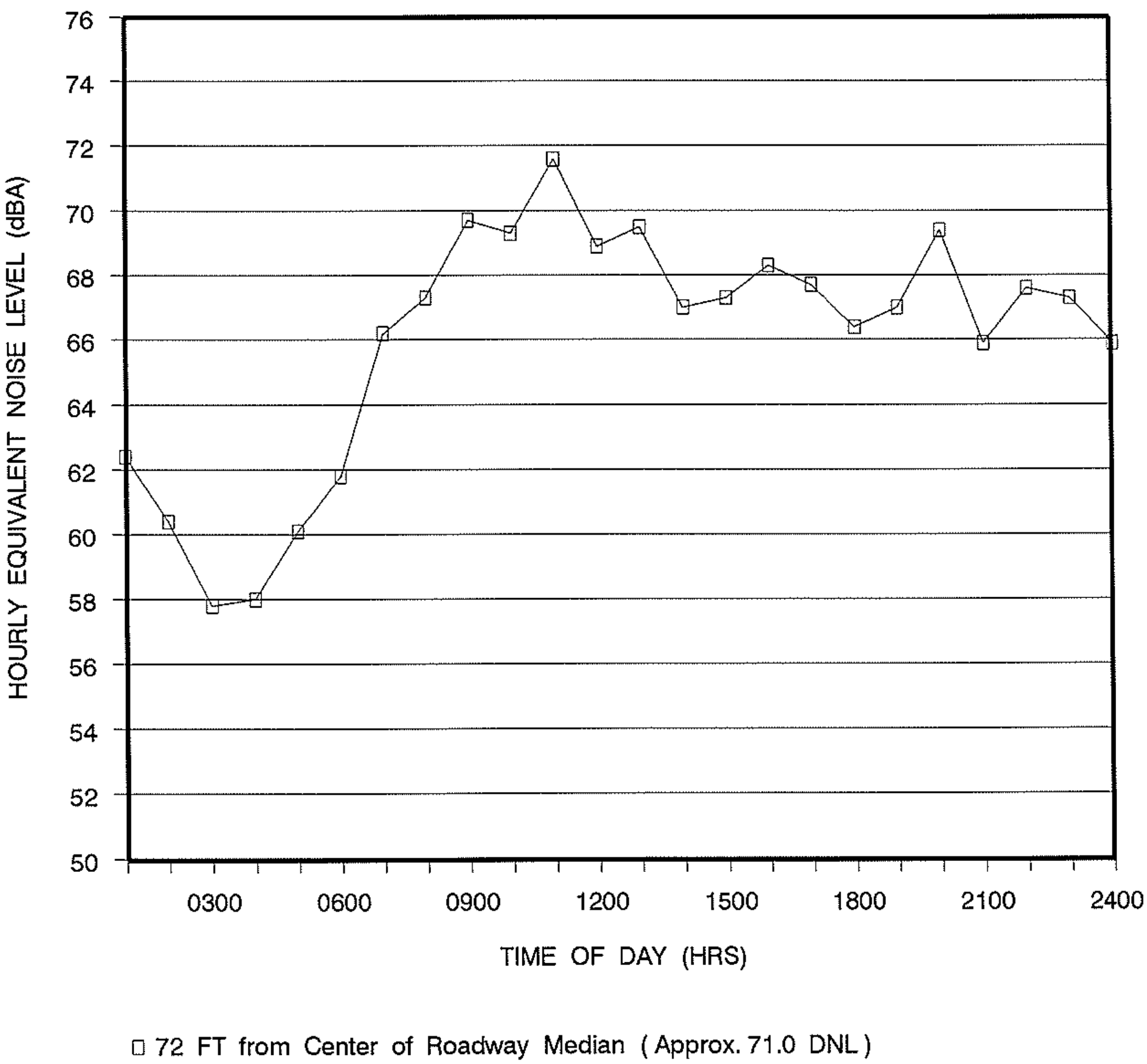
# FIGURE 2

## MEASURED TRAFFIC NOISE LEVELS AT 87 FT SLANT DISTANCE FROM THE CENTERLINE OF KALAKAUA AVENUE AT LUANA WAIKIKI HOTEL (JANUARY 24 – 25, 2012)



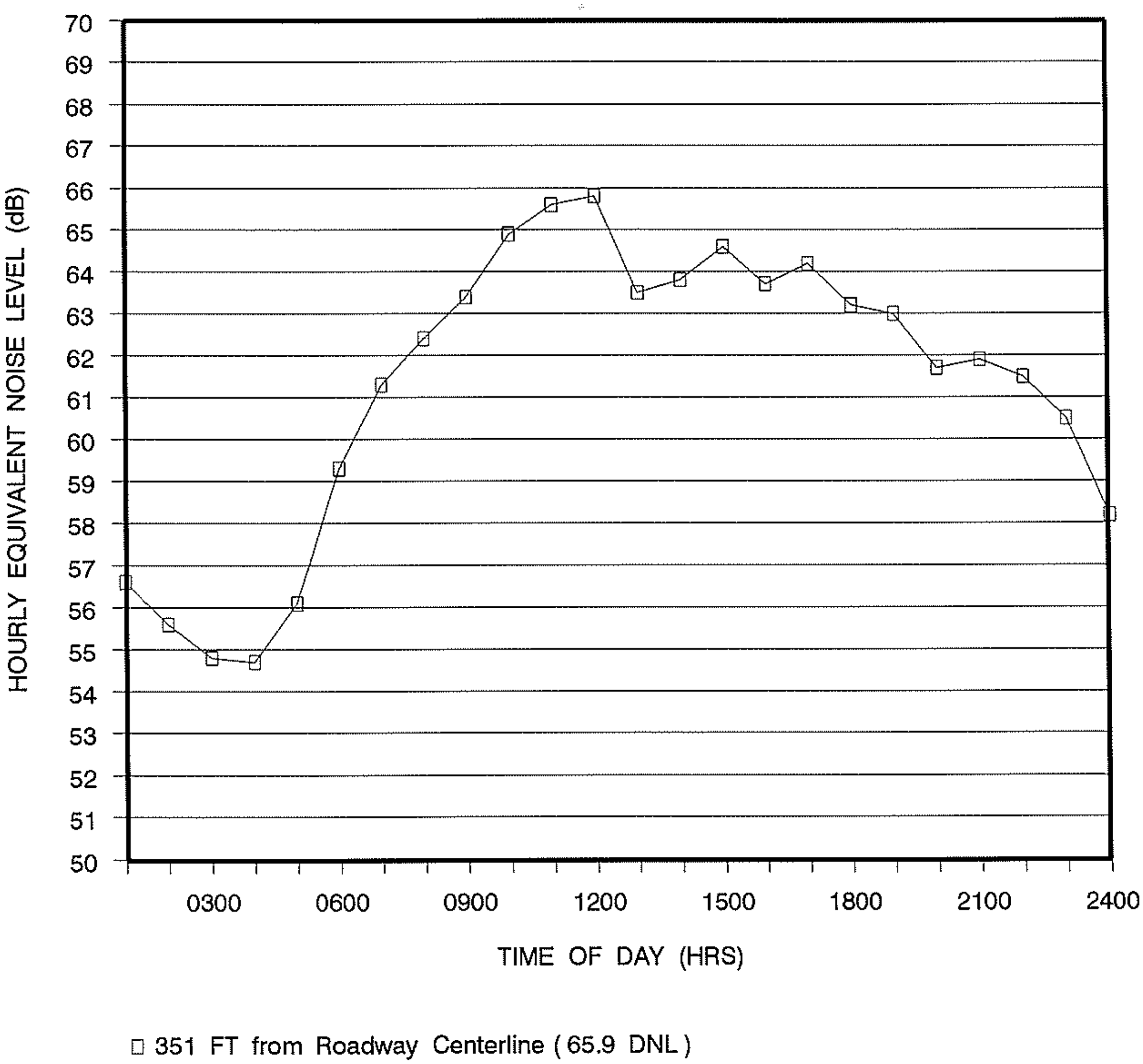
## FIGURE 3

## MEASURED TRAFFIC NOISE LEVELS AT 72 FT SLANT DISTANCE FROM THE CENTER OF THE MEDIAN OF ALA MOANA BOULEVARD AT ALANA WAIKIKI HOTEL ( JANUARY 31 TO FEBRUARY 1, 2012 )



## FIGURE 4

## MEASURED TRAFFIC NOISE LEVELS AT 351 FT SLANT DISTANCE FROM THE CENTERLINE OF KALIA ROAD AT TAPA TOWER, HILTON HAWAIIAN VILLAGE (AUGUST 16 – 17, 2010)



## TABLE 1

## RANGES OF A-WEIGHTED SOUND LEVELS OF CONSTRUCTION EQUIPMENT AT 50 FOOT DISTANCE

| EQUIPMENT | SOUND LEVELS (dBA) (Minimum / Maximum) |
|---|---|
| Hopto, Loader, Trencher | 72 / 93 |
| Compactors (rollers) | 72 / 88 |
| Compressors | 68 / 87 |
| Concrete Mixers | 72 / 90 |
| Cranes | 65 / 85 |
| Generators | 60 / 82 |
| Jackhammers and Drills | 75 / 98 |
| Pavers | 82 / 92 |
| Vibrating Hammers | 85 / 100 |
| Pumps | 70 / 80 |
| Rollers | 65 / 90 |
| Saws | 68 / 93 |
| Scrapers, Graders | 76 / 95 |
| Tractors | 73 / 95 |
| Trucks | 70 / 95 |
| Tampers | 50 / 80 |
| Welder / Cutting Torches | 65 / 75 |
| Fans, Pumps, Power Tools | 45 / 80 |

## TABLE 2

## RANGE OF BACKGROUND AMBIENT AND TRENCHING NOISE LEVELS AT VARIOUS NOISE SENSITIVE LOCATIONS IN THE VICINITY OF THE PROJECT

LOCATION OF WORK: Along Kalia Road. from Paoa Place to Ala Moana Boulevard
INSTALLATION: Sewer Line
PILE DRIVING: Sheet Pile Driving and Trenching

| | --------BACKGROUND AMBIENT------- | | ------ CONSTRUCTION (b) ------- ------ NOISE LEVELS (dBA) ------ | |
|---|---|---|---|---|
| RECEPTOR LOCATION | L10 (dBA) (a) | TIME | SHEET PILES | TRENCHING |
| A. Hale Koa Hotel | 61 to 65 | 6:00 pm to Midnight | 62 to 76 | 58 to 73 |
| A. Hale Koa Hotel | 58 to 66 | Midnight to 6:00 am | 62 to 76 | 58 to 73 |
| B. Tapa Tower, HHV | 62 to 66 | 6:00 pm to Midnight | 68 to 77 | 64 to 73 |
| B. Tapa Tower, HHV | 59 to 67 | Midnight to 6:00 am | 68 to 77 | 64 to 73 |
| C. Kalia Tower, HHV | 62 to 66 | 6:00 pm to Midnight | 69 to 82 | 65 to 78 |
| C. Kalia Tower, HHV | 59 to 67 | Midnight to 6:00 am | 69 to 82 | 65 to 78 |
| D. Wailana | 69 to 74 | 6:00 pm to Midnight | 64 to 80 | 60 to 76 |
| D. Wailana | 65 to 72 | Midnight to 6:00 am | 64 to 80 | 60 to 76 |
| E. Diamond Head Apartments | 62 to 66 | 6:00 pm to Midnight | 65 to 80 | 61 to 76 |
| E. Diamond Head Apartments | 59 to 67 | Midnight to 6:00 am | 65 to 80 | 61 to 76 |

Notes:

(a) L10 is the sound level which was exceeded 10 percent of the time.

(b) Predicted levels are for sheet pile driving (87 dBA at 100 feet distance), and for trenching work (83 dBA at 100 feet distance).

## TABLE 3

### RANGE OF BACKGROUND AMBIENT AND TRENCHING NOISE LEVELS AT VARIOUS NOISE SENSITIVE LOCATIONS IN THE VICINITY OF THE PROJECT

LOCATION OF WORK: Along Ala Moana Blvd. from Kalia Road to Kalakaua Avenue
INSTALLATION: Sewer Line
PILE DRIVING: Sheet Pile Driving and Trenching

| | --------BACKGROUND AMBIENT------- | | ------ CONSTRUCTION (b) ------- ------ NOISE LEVELS (dBA) ------ | |
|---|---|---|---|---|
| RECEPTOR LOCATION | L10 (dBA) (a) | TIME | SHEET PILES | TRENCHING |
| A. Wailana | 69 to 74 | 6:00 pm to Midnight | 64 to 80 | 60 to 76 |
| A. Wailana | 65 to 72 | Midnight to 6:00 am | 64 to 80 | 60 to 76 |
| B. Canterbury Place | 67 to 72 | 6:00 pm to Midnight | 68 to 79 | 64 to 75 |
| B. Canterbury Place | 63 to 70 | Midnight to 6:00 am | 68 to 79 | 64 to 75 |
| C. Inn On the Park | 67 to 72 | 6:00 pm to Midnight | 71 to 81 | 67 to 77 |
| C. Inn On the Park | 63 to 70 | Midnight to 6:00 am | 71 to 81 | 67 to 77 |
| D. Alana Waikiki Hotel | 69 to 74 | 6:00 pm to Midnight | 69 to 81 | 65 to 77 |
| D. Alana Waikiki Hotel | 65 to 72 | Midnight to 6:00 am | 69 to 81 | 65 to 77 |
| E. The Pavillion At Waikiki | 74 to 80 | 6:00 pm to Midnight | 66 to 78 | 62 to 74 |
| E. The Pavillion At Waikiki | 71 to 82 | Midnight to 6:00 am | 66 to 78 | 62 to 74 |
| F. Asian Pac. Center (Future) | 65 to 70 | 6:00 pm to Midnight | 68 to 80 | 64 to 76 |
| F. Asian Pac. Center (Future) | 61 to 68 | Midnight to 6:00 am | 68 to 80 | 64 to 76 |

Notes:

(a) L10 is the sound level which was exceeded 10 percent of the time.

(b) Predicted levels are for sheet pile driving (87 dBA at 100 feet distance), and for trenching work (83 dBA at 100 feet distance).

## TABLE 4

### RANGE OF BACKGROUND AMBIENT AND TRENCHING NOISE LEVELS AT VARIOUS NOISE SENSITIVE LOCATIONS IN THE VICINITY OF THE PROJECT

LOCATION OF WORK: Along Kalakaua Avenue from Ala Moana Boulevard to Ft. DeRussy WWPS
INSTALLATION: Sewer Line
PILE DRIVING: Sheet Pile Driving and Trenching

| RECEPTOR LOCATION | BACKGROUND AMBIENT L10 (dBA) (a) | BACKGROUND AMBIENT TIME | CONSTRUCTION (b) NOISE LEVELS (dBA) SHEET PILES | CONSTRUCTION (b) NOISE LEVELS (dBA) TRENCHING |
|---|---|---|---|---|
| A. The Pavillion At Waikiki | 74 to 80 | 6:00 pm to Midnight | 66 to 78 | 62 to 74 |
| A. The Pavillion At Waikiki | 71 to 82 | Midnight to 6:00 am | 66 to 78 | 62 to 74 |
| B. Keoni Ana Condominium | 70 to 76 | 6:00 pm to Midnight | 70 to 79 | 66 to 75 |
| B. Keoni Ana Condominium | 67 to 78 | Midnight to 6:00 am | 70 to 79 | 66 to 75 |
| C. Oahu Surf One | 68 to 74 | 6:00 pm to Midnight | 72 to 76 | 68 to 72 |
| C. Oahu Surf One | 65 to 76 | Midnight to 6:00 am | 72 to 76 | 68 to 72 |
| D. Asian Pac. Center | 68 to 74 | 6:00 pm to Midnight | 71 to 82 | 67 to 78 |
| D. Asian Pac. Center | 65 to 76 | Midnight to 6:00 am | 71 to 82 | 67 to 78 |
| E. Outrigger Luana Waikiki | 73 to 79 | 6:00 pm to Midnight | 67 to 79 | 63 to 75 |
| E. Outrigger Luana Waikiki | 70 to 81 | Midnight to 6:00 am | 67 to 79 | 63 to 75 |
| F. 4-story Apt, 412 Keoniana St. | 71 to 77 | 6:00 pm to Midnight | 73 to 80 | 69 to 76 |
| F. 4-story Apt, 412 Keoniana St. | 68 to 79 | Midnight to 6:00 am | 73 to 80 | 69 to 76 |
| G. 4-story Apt, Imua | 69 to 75 | 6:00 pm to Midnight | 70 to 78 | 66 to 74 |
| G. 4-story Apt, Imua | 66 to 77 | Midnight to 6:00 am | 70 to 78 | 66 to 74 |
| H. Ambassador Hotel | 70 to 76 | 6:00 pm to Midnight | 67 to 77 | 63 to 73 |
| H. Ambassador Hotel | 67 to 78 | Midnight to 6:00 am | 67 to 77 | 63 to 73 |
| I. 8-Story Condominium | 68 to 74 | 6:00 pm to Midnight | 68 to 79 | 64 to 75 |
| I. 8-Story Condominium | 65 to 76 | Midnight to 6:00 am | 68 to 79 | 64 to 75 |
| J. Waikiki Gateway | 73 to 79 | 6:00 pm to Midnight | 61 to 67 | 57 to 63 |
| J. Waikiki Gateway | 70 to 81 | Midnight to 6:00 am | 61 to 67 | 57 to 63 |
| K. Maile Sky Court | 70 to 76 | 6:00 pm to Midnight | 55 to 72 | 51 to 68 |
| K. Maile Sky Court | 67 to 78 | Midnight to 6:00 am | 55 to 72 | 51 to 68 |

Notes:

(a) L10 is the sound level which was exceeded 10 percent of the time.

(b) Predicted levels are for sheet pile driving (87 dBA at 100 feet distance), and for trenching work (83 dBA at 100 feet distance).

# APPENDIX E
## AIR QUALITY IMPACT ASSESSMENT
## (ARCADIS U.S., INC.)

Imagine the result

**Group 70 International, Inc.**

# Air Quality Impact Assessment

Kalia – Fort DeRussy Wastewater System
Improvements

July 6, 2012

ARCADIS

Scott Sevadjian
Staff Environmental Scientist

Bryan Chen
Senior Environmental Engineer

**Air Quality Impact Assessment**

Kalia – Fort DeRussy Wastewater System Improvements

Prepared for:
Group 70 International, Inc.

Prepared by:
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Our Ref.:
HI011165.0000

Date:
July 6, 2012

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A URBEMIS 2007 Emissions Model Inputs and Results

ARCADIS

## Executive Summary

ARCADIS performed a review of applicable federal, state and local regulations relating to the construction of the proposed Kalia-Fort DeRussy wastewater system improvements project (the project) located in Honolulu, Hawaii. Based on information provided to ARCADIS, the project involves the installation and replacement of approximately 2,600 feet of sewer line which connects to the Fort DeRussy Wastewater Pump Station.

Impacts to air quality during construction will consist of emissions of fugitive dust, including particulate matter less than 10 microns ($PM_{10}$), and less than 2.5 microns ($PM_{2.5}$), and the criteria pollutants carbon monoxide (CO), nitrogen dioxide ($NO_2$), sulfur dioxide ($SO_2$), and volatile organic compounds (VOCs).

ARCADIS has conducted an emissions analysis to quantify the total emissions of criteria pollutants, as well as carbon dioxide ($CO_2$), during construction of the project. Operational, or post-construction emissions, were not considered because they will not change from pre-project levels. Emission sources are assumed to be fugitive dust from soil hauling and handling, construction equipment exhaust, and off-gassing of pollutants from asphalt paving operations.

Emissions of the criteria pollutants were found to be very low. $NO_2$ and $PM_{10}$ accounted for the majority of the emissions. The maximum emissions of $NO_2$ and $PM_{10}$ were estimated to be 2.85 and 9.09 tons, respectively, emitted in 2014. Daily maximum emissions of $NO_2$ were 31 pounds, emitted in March 2014 and daily maximum emissions of $PM_{10}$ were 136 pounds, emitted in the fourth quarter (Q4) of 2014. Emissions of $CO_2$ were also found to be quite low, with an annual maximum total of 433 tons emitted in 2014.

The low levels of pollutant emission emissions during the construction of the proposed project will not result in any significant impacts to air quality or trigger any permit requirements.

## 1. Introduction

The purpose of this Air Quality Impact Assessment is to evaluate whether emissions from the proposed Hilton Hawaiian Village Master Plan sewer line improvement project (the project) would cause or contribute to the deterioration of the air quality in the area. The impacts are evaluated by qualitatively assessing the air pollutant emissions resulting from the construction of the proposed project. Emissions include construction equipment exhaust, fugitive dust associated with soil handling and hauling, and off-gassing from paving activities. The emission rates will be compared to the applicable local, state and federal regulatory requirements pertaining to air quality.

## 2. Project Description

The proposed project consists of the replacement of approximately 2,600 linear feet of gravity sewer line, which connects to the Fort DeRussy Wastewater Pump Station. The wastewater line alignment is bounded by Fort DeRussy on the south, the Hilton Hawaiian Village to the west, and Ala Moana Boulevard to the north, and Kalakaua Avenue to the north and east.

The proposed project will include:

- Replacement of the existing 1950's 12-inch diameter sewer line in Kalia Road with a new 21-inch diameter sewer line beginning at the intersection of Paoa Place and Kalia Road and ending at the intersection of Ala Moana Boulevard and Kalia Road. The existing 16-inch diameter sewer line, which traverses across Fort DeRussy in a sewer line easement, would be cut and plugged at the Ala Moana Boulevard and Kalia Road intersection.

- Replacement of the existing 1960's 24-inch diameter sewer line on Ala Moana Boulevard and Kalakaua Avenue with a 30-inch diameter sewer line beginning at the intersection of Kalia Road and Ala Moana Boulevard and ending at the Fort DeRussy waste water pump station.

The purpose of the improvements is to accommodate the Hilton Hawaiian Village Master Plan and Hale Koa Hotel, and sewer flows from the service area between the Ala Wai Canal, Kalakaua Avenue, and Fort DeRussy.

## 3. Environmental Setting

### 3.1 Project Location

The project site is located along the west, north, and east perimeter of Fort DeRussy, in the Waikiki District of the south shore of Oahu. The site is located approximately 0.5 miles east of the Ala Moana boat harbor. The site is surrounded by high-rise resort hotels, mid-rise apartment buildings, and parks.

The Fort DeRussy wastewater pump station is located at the northern boundary of the project site. Portions of the project are located in the right-of-way of Kalia Road and Kalakaua Avenue.

## 3.2 Climate

### 3.2.1 Regional

Hawaii is comprised of several islands with diverse topography, but is generally classified as mountainous. These factors contribute to a mixture of climate regimes that exist within the island chain. Diverse climates can exist within relatively short distances on the same island due to topographical effects on wind direction and speed and rainfall patterns.

Oahu is the third-largest of the Hawaiian Islands. The Ko'olau Range, at an average elevation of 2,000 feet, parallels the northeastern coast. The Wai'anae Mountains, somewhat higher in elevation, parallel the west coast. Honolulu International Airport, the business and Waikiki districts, and a number of Honolulu's residential areas lie along the southern coastal plain.

The predominant winds that affect the island are the trade winds that generally flow from the northeast, although its average frequency varies from 80 to 90 percent during the summer to only 50 percent in January. Lighter southeasterly winds prevail in the cooler winter months, with occasional strong wind events from winter storms.

The moderate temperature range is associated with the small seasonal variation in energy received from the sun and the tempering effect of the surrounding ocean. Honolulu International Airport has recorded temperatures as high as the lower 90s and as low as the lower 50s.

Heavy mountain rainfall sustains agricultural irrigation and Honolulu's water supply. The high elevations of the Ko'olau Mountains are extremely wet year-round, averaging over 200 inches per year. O'ahu is driest along the coast west of the Wainae Mountains, where rainfall drops to about 20 inches a year. Daytime showers, usually light, often occur while the sun continues to shine.

Intense rains in the October to April winter season sometimes causes serious flash flooding. Thunderstorms are infrequent and usually mild, and hail seldom occurs. Infrequently, a small tornado or waterspout may cause some damage. Only a few tropical cyclones have struck Hawaii, although others have come near enough for their outlying winds, waves, clouds, and rain to affect the islands.

### 3.2.2 Local

The Hilton Hawaiian Village Sewer Line Improvement Project site is located in the highly developed Waikiki district in the City of Honolulu. The Site is flat with an elevation of approximately six feet above mean sea level (MSL), and is located approximately 1,200 feet northeast of the shoreline. The City of Honolulu averages approximately 91 days of rain and 21 inches of rain per year. Light to moderate trade winds typical of the island are common in the Waikiki district.

### 3.3 Ambient Air Quality

The ambient air quality in an area can be characterized in terms of whether it complies with National Ambient Air Quality Standards (NAAQS) and State Ambient Air Quality Standards (SAAQS), where applicable. The Clean Air Act (42 U.S.C. 7401 et seq.) requires the U.S. Environmental Protection Agency (USEPA) to set national standards for emissions that are considered harmful to public health and the environment (criteria pollutants). The seven criteria pollutants are: carbon monoxide (CO), nitrogen dioxide ($NO_2$), sulfur dioxide ($SO_2$), lead (Pb), ozone ($O_3$), and particulate matter ($PM_{10}$ and $PM_{2.5}$). Hawaii also has a state ambient air standard for hydrogen sulfide ($H_2S$). Based on air monitoring data, Hawaii is currently classified as attainment for all Federal and State standards, except for 1-hour $NO_2$, for which attainment status is currently unclassified. Table 3-1 presents the NAAQS and SAAQS for each criteria pollutant and the 2011 attainment designations for the State of Hawaii.

**Table 3-1 Air Quality Standards Attainment Status for Hawaii**

| Parameter | | State Standard | | Federal Standard | |
|---|---|---|---|---|---|
| Ozone | 8-Hour | 0.080 ppm | Attainment | 0.075 ppm | Attainment |
| Carbon Monoxide | 1-Hour | 9 ppm | Attainment | 35 ppm | Attainment |
| | 8-Hour | 4.4 ppm | Attainment | 9 ppm | Attainment |
| Nitrogen Dioxide | 1-Hour | -- | | 0.100 ppm | Unclassified |
| | Annual Arithmetic Mean | 0.040 ppm | Attainment | 0.053 ppm | Attainment |
| Sulfur Dioxide | 1-Hour | -- | | 75 ppb | Attainment |
| | 3-Hour | 0.5 ppm | Attainment | -- | |
| | 24-Hour | 0.14 ppm | Attainment | 0.14 ppm | Attainment |
| | Annual Arithmetic Mean | 0.030 ppm | | 0.030 ppm | Attainment |
| Particulate Matter ($PM_{10}$) | 24-Hour | 150 μg/m$^3$ | Attainment | 150 μg/m$^3$ | Attainment |
| | Annual Arithmetic Mean | 50 μg/m$^3$ | Attainment | -- | |
| Particulate Matter – Fine ($PM_{2.5}$) | 24-Hour | -- | | 35 μg/m$^3$ | Attainment |
| | Annual Arithmetic Mean | -- | | 15 μg/m$^3$ | Attainment |
| Lead | 30 day Average | 1.5 μg/m$^3$ | Attainment | -- | |
| | Rolling 3-Month Avg. | -- | | 0.15 μg/m$^3$ | Attainment |
| Hydrogen Sulfide ($H_2S$) | 1-Hour | 0.025 ppm | Attainment | -- | |

**Notes:**
-- no standard available
μg/m$^3$ = micrograms per cubic meter
ppm = parts per million

*Sources: HAR 11-59; 40 CFR Part 50*

# 4. Emissions Evaluation

## 4.1 Construction Emissions

Under the proposed scenario, air quality impacts would be intermittent and short term. Construction would generate emissions of the criteria pollutants, as well as $CO_2$ (Appendix A). Emissions were calculated using the URBEMIS 2007 v. 9.2.4 environmental management software. The URBEMIS model provides a platform to calculate construction emissions using equipment emission factors (mass of emissions per unit time) from sources such as USEPA, California Air Resources Board (CARB) and site-specific information. URBEMIS also provides default values when site-specific information is not available. Table 4-1 summarizes the site-specific information used in the construction emissions calculations, including activity durations, types of equipment, and shift length.

Construction phases will consist of site mobilization, digging the new pipeline trench, installing the new pipeline and backfilling the trench, and paving or concrete laying activities where required. It was assumed the old pipeline will be abandoned in place.

Preliminary estimates are for construction activities to last one year, with construction activities beginning in March, 2014. Activities in 2014 will consist of three weeks of site mobilization and staging, six months of trenching, and three months of pipe installation. Activities in 2015 will consist of two months of asphalt paving and concrete finishing activities.

To calculate pollutant emissions resulting from soil hauling, it was assumed that trench spoils will need to be hauled to a stockyard located approximately five miles away for temporary storage, and will be hauled back to the site for backfilling once the new trench is installed. It was also assumed that the trench would be excavated to an average depth of 12 feet and width of four feet, for a length of 2,600 feet. The volume of soil to be removed from the trench would thus be approximately 4,600 cubic yards.

Paving and concrete finishing activities are expected to fairly minimal, as it will be restricted to narrow areas along Kalia Road, and short stretches along Paoa Place and Kalakaua Avenue.

The URBEMIS software allows the user to select pre-programmed “Mitigations” to control certain emissions. The measures selected and assumed to be implemented are:

- replacing ground cover in disturbed areas quickly
- using water to control dust during loading and unloading activities
- applying water to disturbed surfaces and haul roads three times per day, and

- reducing speed on unpaved roads to < 15 miles per hour

These measures are all common practices that are required by local and state regulations to control dust and prevent storm water pollution.

**Table 4-1 Construction Details by Activity**

| Activity | Start | Duration | Diesel Construction Equipment | Hours per Day Construction | Daily Workers | Soil Hauling |
|---|---|---|---|---|---|---|
| Site Mobilization | Q2 2014 | 3 weeks | 1 forklift | 8 hours | <10 | None |
| Trenching | Q2 2014 | 6 months | 1 excavator<br>1 loader<br>1 forklift<br>1 portable generator | 8 hours | 10 | 4,600 $yd^3$ exported for storage. 10 $yd^3$ per truck, 10 miles per trip |
| Pipe Installation and Backfilling | Q4 2014 | 3 months | 1 excavator<br>1 loader<br>1 forklift<br>1 air compressor<br>1 compactor<br>1 generator | 8 hours | 10 | 4,600 $yd^3$ imported for backfilling. 10 $yd^3$ per truck, 10 miles per trip |
| Paving/Concrete Finishing | Q1 2015 | 2 months | 1 paver<br>1 roller<br>1 skid-steer loader<br>1 cement mixer | 8 hours | <10 | None |

Annual emissions calculated from URBEMIS are summarized below (Table 4-2 and 4-3). Emissions for the proposed action are minimal due to the relatively small scale and low intensity of construction activities. Modeling assumptions and results are presented in Appendix A.

**Table 4-2 Estimated Proposed Construction Emissions (Tons per Year)**

| Construction Year | Annual Emissions (tons per year) | | | | | | |
|---|---|---|---|---|---|---|---|
| | VOCs | $NO_2$ | CO | $SO_2$ | $PM_{10}$ | $PM_{2.5}$ | $CO_2$ |
| 2014 | 0.27 | 2.85 | 1.39 | 0.00 | 9.09 | 1.98 | 433 |
| 2015 | 0.03 | 0.18 | 0.16 | 0.00 | 0.01 | 0.01 | 21.5 |

Notes: Detailed annual results presented in Appendix A.
Reactive organic gas (ROG) emissions reported in URBEMIS is used as a surrogate for VOCs in this analysis.
Nitrogen oxide (NOx) emissions reported in URBEMIS is used as a surrogate for $NO_2$ in this analysis.

**Table 4-3 Estimated Proposed Construction Emissions (Pounds per Day)**

| Construction Year | Maximum Emissions (pounds per day) | | | | | | |
|---|---|---|---|---|---|---|---|
| | VOCs | $NO_2$ | CO | $SO_2$ | $PM_{10}$ | $PM_{2.5}$ | $CO_2$ |
| 2014 | 3.06 | 30.91 | 15.54 | 0.00 | 137 | 29.6 | 4,671 |
| 2015 | 1.23 | 7.37 | 6.20 | 0.00 | 0.59 | 0.54 | 860 |

Notes: Detailed annual results presented in Appendix A.
Reactive organic gas (ROG) emissions reported in URBEMIS is used as a surrogate for VOCs in this analysis.
Nitrogen oxide (NOx) emissions reported in URBEMIS is used as a surrogate for $NO_2$ in this analysis.

### 4.2 Greenhouse Gas Emissions

Greenhouse gases (GHGs) are pollutants of concern for air quality and climate change. GHGs include water vapor, $CO_2$, methane, $N_2O$, $O_3$, and several chlorofluorocarbons. Water vapor is a naturally occurring GHG and accounts for the largest percentage of the greenhouse effect. Next to water vapor, $CO_2$ is the second-most abundant GHG and is typically produced from human-related activities. The largest source of $CO_2$ emissions globally is the combustion of fossil fuels such as coal, oil, and gas in power plants, automobiles, industrial facilities and other sources. Additionally, a number of specialized industrial production processes and product uses such as mineral production, metal production and the use of petroleum-based products can also lead to $CO_2$ emissions.

Although regulatory agencies are taking actions to address GHG effects, there are currently no state or Federal standards or regulations limiting $CO_2$ emissions and concentrations in the ambient air. In response to the *FY2008 Consolidated Appropriations Act* (House Resolution 2764; Public Law 110–161), USEPA issued the *Final Mandatory Reporting of Greenhouse Gases Rule* (GHG Reporting Rule), which became effective on January 1, 2010. The GHG Reporting Rule requires annual reporting of GHG emissions to the USEPA from large sources and suppliers in the United States, including suppliers of fossil fuels or industrial GHGs; manufacturers of vehicles and engines; and facilities that emit greater than 25,000 metric tons per year (mtpy) (27,558 tons per year [tpy]) each of $CO_2$ and other GHGs. The intent of the rule is to collect accurate and timely emissions data to inform future policy decisions and programs to reduce emissions, as well as fight against the effects of climate change.

Additionally, on September 30, 2009, USEPA proposed, under the Clean Air Act (CAA), new thresholds for GHG that would require that facilities subjected to the New Source Review and Title V operating permit programs to obtain permits and would cover nearly 70 percent of the nation's largest stationary source GHG emitters—including power plants, refineries, and cement production facilities, while shielding small businesses and farms from permitting requirements. The Final Rule, known as the GHG Tailoring Rule, affects sources with the potential to emit 100,000 tpy or greater of GHGs.

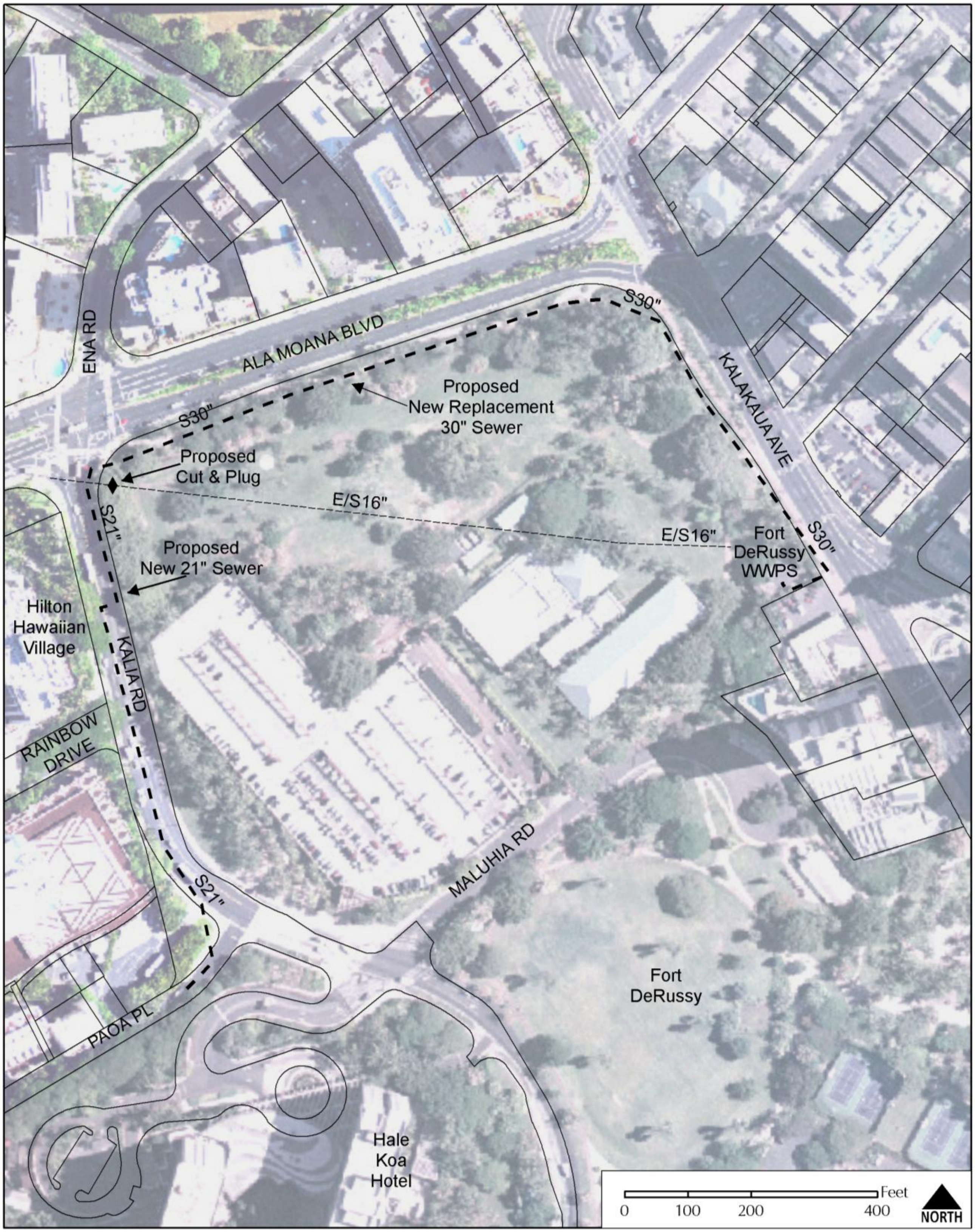
Construction of the proposed project will result in very low, short term emissions of GHGs resulting from the combustion process in fuel-burning construction equipment. As shown in Table 4-2, the maximum annual emissions of $CO_2$ are project to be 433 tons. Methane and other GHGs were not included in the analysis but are expected to be much lower than emissions of $CO_2$.

## 5. Air Permitting Considerations

The State of Hawaii Department of Health (DOH) Clean Air Branch (CAB) is the permitting authority for new and existing sources of pollutant emissions. ARCADIS performed a regulatory review of Hawaii Administrative Rules Title 11 Chapters 60.1, 260, 451, and 453, and Code of Federal Regulations 40 CFR 52.21, 40 CFR 60, and 40 CFR 63. Based on the type of project and low emissions during construction, the project is exempt from any permitting considerations.

## 6. Conclusions

Based on a review of State and Federal Regulations and preliminary emission calculations (Appendix A), there do not appear to be any significant emissions that would cause or contribute to any appreciable impact to local or regional air quality. If any significant changes to the proposed construction or operation of the project alter the potential to emit, or if the DOH imparts additional restrictions, the air quality impacts may need to be re-evaluated for compliance.




**Project Location**
**Kālia-Fort DeRussy Wastewater System Improvements**
**(Source: Belt Collins, 2012)**

GROUP 70 INTERNATIONAL

ARCADIS

Appendix **A**

URBEMIS 2007 Emissions Model
Inputs and Results

Urbemis 2007 Version 9.2.4

Summary Report for Annual Emissions (Tons/Year)

File Name: C:\Users\sasevadj\AppData\Roaming\Urbemis\Version9a\Projects\Hilton Ft DeRussy 7-03-12.urb924

Project Name: Ft. DeRussy Wastewater Improvements

Project Location: California State-wide

On-Road Vehicle Emissions Based on: Version : Emfac2007 V2.3 Nov 1 2006

Off-Road Vehicle Emissions Based on: OFFROAD2007

CONSTRUCTION EMISSION ESTIMATES

| | ROG | NOx | CO | SO2 | PM10 Dust | PM10 Exhaust | Total PM10 | PM2.5 Dust | PM2.5 Exhaust | Total PM2.5 | CO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 2014 TOTALS (tons/year unmitigated) | 0.27 | 2.85 | 1.39 | 0.00 | 28.52 | 0.11 | 28.63 | 5.96 | 0.10 | 6.06 | 432.76 |
| 2014 TOTALS (tons/year mitigated) | 0.27 | 2.85 | 1.39 | 0.00 | 8.98 | 0.11 | 9.09 | 1.87 | 0.10 | 1.98 | 432.76 |
| Percent Reduction | 0.00 | 0.00 | 0.00 | 0.00 | 68.53 | 0.00 | 68.26 | 68.53 | 0.00 | 67.36 | 0.00 |
| | | | | | | | | | | | |
| 2015 TOTALS (tons/year unmitigated) | 0.03 | 0.18 | 0.16 | 0.00 | 0.00 | 0.01 | 0.01 | 0.00 | 0.01 | 0.01 | 21.50 |
| 2015 TOTALS (tons/year mitigated) | 0.03 | 0.18 | 0.16 | 0.00 | 0.00 | 0.01 | 0.01 | 0.00 | 0.01 | 0.01 | 21.50 |
| Percent Reduction | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |

Urbemis 2007 Version 9.2.4

Detail Report for Annual Construction Mitigated Emissions (Tons/Year)

File Name: C:\Users\sasevadj\AppData\Roaming\Urbemis\Version9a\Projects\Hilton Ft DeRussy 7-03-12.urb924

Project Name: Ft. DeRussy Wastewater Improvements

Project Location: California State-wide

On-Road Vehicle Emissions Based on: Version : Emfac2007 V2.3 Nov 1 2006

Off-Road Vehicle Emissions Based on: OFFROAD2007

CONSTRUCTION EMISSION ESTIMATES (Annual Tons Per Year, Mitigated)

| | ROG | NOx | CO | SO2 | PM10 Dust | PM10 Exhaust | PM10 Total | PM2.5 Dust | PM2.5 Exhaust | PM2.5 Total | CO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 2014 | 0.27 | 2.85 | 1.39 | 0.00 | 8.98 | 0.11 | 9.09 | 1.87 | 0.10 | 1.98 | 432.76 |
| Mobilization 03/07/2014-03/28/2014 | 0.00 | 0.01 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 1.25 |
| Mobilization Dust | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Mobilization Off Road Diesel | 0.00 | 0.01 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 1.05 |
| Mobilization On Road Diesel | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Mobilization Worker Trips | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.20 |
| Trenching 03/28/2014-09/28/2014 | 0.17 | 1.82 | 0.86 | 0.00 | 4.49 | 0.07 | 4.56 | 0.94 | 0.06 | 1.00 | 276.50 |
| Trenching Dust | 0.00 | 0.00 | 0.00 | 0.00 | 4.49 | 0.00 | 4.49 | 0.94 | 0.00 | 0.94 | 0.00 |
| Trenching Off Road Diesel | 0.17 | 1.77 | 0.79 | 0.00 | 0.00 | 0.07 | 0.07 | 0.00 | 0.06 | 0.06 | 260.54 |
| Trenching On Road Diesel | 0.00 | 0.04 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 9.26 |
| Trenching Worker Trips | 0.00 | 0.00 | 0.05 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 6.70 |
| Pipe Installation 09/29/2014-12/29/2014 | 0.10 | 1.02 | 0.51 | 0.00 | 4.49 | 0.04 | 4.53 | 0.94 | 0.04 | 0.98 | 154.15 |
| Pipe Installation Dust | 0.00 | 0.00 | 0.00 | 0.00 | 4.49 | 0.00 | 4.49 | 0.94 | 0.00 | 0.94 | 0.00 |
| Pipe Installation Off Road Diesel | 0.10 | 0.98 | 0.46 | 0.00 | 0.00 | 0.04 | 0.04 | 0.00 | 0.04 | 0.04 | 139.83 |
| Pipe Installation On Road Diesel | 0.00 | 0.04 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 9.26 |
| Pipe Installation Worker Trips | 0.00 | 0.00 | 0.04 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 5.06 |
| Asphalt 12/30/2014-03/11/2015 | 0.00 | 0.01 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.86 |
| Paving Off-Gas | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Paving Off Road Diesel | 0.00 | 0.01 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.76 |
| Paving On Road Diesel | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Paving Worker Trips | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.10 |
| 2015 | 0.03 | 0.18 | 0.16 | 0.00 | 0.00 | 0.01 | 0.01 | 0.00 | 0.01 | 0.01 | 21.50 |
| Asphalt 12/30/2014-03/11/2015 | 0.03 | 0.18 | 0.16 | 0.00 | 0.00 | 0.01 | 0.01 | 0.00 | 0.01 | 0.01 | 21.50 |
| Paving Off-Gas | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Paving Off Road Diesel | 0.03 | 0.18 | 0.14 | 0.00 | 0.00 | 0.01 | 0.01 | 0.00 | 0.01 | 0.01 | 18.88 |
| Paving On Road Diesel | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.06 |
| Paving Worker Trips | 0.00 | 0.00 | 0.02 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 2.56 |

## Construction Related Mitigation Measures

The following mitigation measures apply to Phase: Fine Grading 3/7/2014 - 3/28/2014 - Site Mobilization

For Soil Stablizing Measures, the Replace ground cover in disturbed areas quickly mitigation reduces emissions by:

PM10: 5% PM25: 5%

For Soil Stablizing Measures, the Water exposed surfaces 3x daily watering mitigation reduces emissions by:

PM10: 61% PM25: 61%

For Soil Stablizing Measures, the Equipment loading/unloading mitigation reduces emissions by:

PM10: 69% PM25: 69%

For Unpaved Roads Measures, the Reduce speed on unpaved roads to less than 15 mph mitigation reduces emissions by:

PM10: 44% PM25: 44%

For Unpaved Roads Measures, the Manage haul road dust 3x daily watering mitigation reduces emissions by:

PM10: 61% PM25: 61%

The following mitigation measures apply to Phase: Fine Grading 3/28/2014 - 9/28/2014 - Trenching

For Soil Stablizing Measures, the Replace ground cover in disturbed areas quickly mitigation reduces emissions by:

PM10: 5% PM25: 5%

For Soil Stablizing Measures, the Water exposed surfaces 2x daily watering mitigation reduces emissions by:

PM10: 55% PM25: 55%

For Soil Stablizing Measures, the Equipment loading/unloading mitigation reduces emissions by:

PM10: 69% PM25: 69%

The following mitigation measures apply to Phase: Fine Grading 9/29/2014 - 12/29/2014 - Pipe Installation and Backfilling

For Soil Stablizing Measures, the Replace ground cover in disturbed areas quickly mitigation reduces emissions by:

PM10: 5% PM25: 5%

For Soil Stablizing Measures, the Water exposed surfaces 2x daily watering mitigation reduces emissions by:

PM10: 55% PM25: 55%

For Soil Stablizing Measures, the Equipment loading/unloading mitigation reduces emissions by:

PM10: 69% PM25: 69%

## Phase Assumptions

Phase: Fine Grading 3/7/2014 - 3/28/2014 - Site Mobilization

Total Acres Disturbed: 0

Maximum Daily Acreage Disturbed: 0

Fugitive Dust Level of Detail: High

Onsite Haulage: 0 ton-miles/day;  Offsite haulage: 0 ton-mils/day

On Road Truck Travel (VMT): 0

Off-Road Equipment:

1 Forklifts (145 hp) operating at a 0.3 load factor for 8 hours per day

Phase: Fine Grading 3/28/2014 - 9/28/2014 - Trenching
Total Acres Disturbed: 0.36
Maximum Daily Acreage Disturbed: 0.02
Fugitive Dust Level of Detail: High
Onsite Haulage: 0 ton-miles/day;  Offsite haulage: 351 ton-mils/day
On Road Truck Travel (VMT): 35.11
Off-Road Equipment:
1 Excavators (168 hp) operating at a 0.57 load factor for 8 hours per day
1 Forklifts (145 hp) operating at a 0.3 load factor for 8 hours per day
1 Generator Sets (549 hp) operating at a 0.74 load factor for 8 hours per day
1 Tractors/Loaders/Backhoes (108 hp) operating at a 0.55 load factor for 7 hours per day

Phase: Fine Grading 9/29/2014 - 12/29/2014 - Pipe Installation and Backfilling
Total Acres Disturbed: 0.36
Maximum Daily Acreage Disturbed: 0.02
Fugitive Dust Level of Detail: High
Onsite Haulage: 0 ton-miles/day;  Offsite haulage: 697 ton-mils/day
On Road Truck Travel (VMT): 69.7
Off-Road Equipment:
1 Air Compressors (106 hp) operating at a 0.48 load factor for 8 hours per day
1 Excavators (168 hp) operating at a 0.57 load factor for 8 hours per day
1 Forklifts (145 hp) operating at a 0.3 load factor for 8 hours per day
1 Generator Sets (549 hp) operating at a 0.74 load factor for 8 hours per day
1 Plate Compactors (8 hp) operating at a 0.43 load factor for 8 hours per day
1 Tractors/Loaders/Backhoes (108 hp) operating at a 0.55 load factor for 7 hours per day

Phase: Paving 12/30/2014 - 3/11/2015 - Paving/Concrete Finishing
Acres to be Paved: 0.1
Off-Road Equipment:
1 Cement and Mortar Mixers (10 hp) operating at a 0.56 load factor for 6 hours per day
1 Pavers (100 hp) operating at a 0.62 load factor for 7 hours per day
1 Rollers (95 hp) operating at a 0.56 load factor for 7 hours per day
1 Skid Steer Loaders (44 hp) operating at a 0.55 load factor for 8 hours per day

Urbemis 2007 Version 9.2.4

Summary Report for Summer Emissions (Pounds/Day)

File Name: C:\Users\sasevadj\AppData\Roaming\Urbemis\Version9a\Projects\Hilton Ft DeRussy 7-03-12.urb924

Project Name: Ft. DeRussy Wastewater Improvements

Project Location: California State-wide

On-Road Vehicle Emissions Based on: Version  : Emfac2007 V2.3 Nov 1 2006

Off-Road Vehicle Emissions Based on: OFFROAD2007

CONSTRUCTION EMISSION ESTIMATES

| | ROG | NOx | CO | SO2 | PM10 Dust | PM10 Exhaust | Total PM10 | PM2.5 Dust | PM2.5 Exhaust | Total PM2.5 | CO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 2014 TOTALS (lbs/day unmitigated) | 3.06 | 30.91 | 15.54 | 0.00 | 432.18 | 1.29 | 433.47 | 90.26 | 1.19 | 91.45 | 4,671.34 |
| 2014 TOTALS (lbs/day mitigated) | 3.06 | 30.91 | 15.54 | 0.00 | 136.02 | 1.29 | 137.31 | 28.41 | 1.19 | 29.60 | 4,671.34 |
| 2015 TOTALS (lbs/day unmitigated) | 1.23 | 7.37 | 6.20 | 0.00 | 0.01 | 0.58 | 0.59 | 0.00 | 0.53 | 0.54 | 860.00 |
| 2015 TOTALS (lbs/day mitigated) | 1.23 | 7.37 | 6.20 | 0.00 | 0.01 | 0.58 | 0.59 | 0.00 | 0.53 | 0.54 | 860.00 |

Urbemis 2007 Version 9.2.4

Detail Report for Summer Construction Mitigated Emissions (Pounds/Day)

File Name: C:\Users\sasevadj\AppData\Roaming\Urbemis\Version9a\Projects\Hilton Ft DeRussy 7-03-12.urb924

Project Name: Ft. DeRussy Wastewater Improvements

Project Location: California State-wide

On-Road Vehicle Emissions Based on: Version : Emfac2007 V2.3 Nov 1 2006

Off-Road Vehicle Emissions Based on: OFFROAD2007

CONSTRUCTION EMISSION ESTIMATES (Summer Pounds Per Day, Mitigated)

| | ROG | NOx | CO | SO2 | PM10 Dust | PM10 Exhaust | PM10 Total | PM2.5 Dust | PM2.5 Exhaust | PM2.5 Total | CO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Time Slice 3/7/2014-3/27/2014 Active Days: | 0.13 | 0.91 | 0.98 | 0.00 | 0.00 | 0.05 | 0.05 | 0.00 | 0.04 | 0.04 | 156.37 |
| Mobilization 03/07/2014-03/28/2014 | 0.13 | 0.91 | 0.98 | 0.00 | 0.00 | 0.05 | 0.05 | 0.00 | 0.04 | 0.04 | 156.37 |
| Mobilization Dust | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Mobilization Off Road Diesel | 0.12 | 0.90 | 0.77 | 0.00 | 0.00 | 0.05 | 0.05 | 0.00 | 0.04 | 0.04 | 130.80 |
| Mobilization On Road Diesel | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Mobilization Worker Trips | 0.01 | 0.01 | 0.20 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 25.57 |
| Time Slice 3/28/2014-3/28/2014 Active Days: | 2.73 | 28.65 | 14.12 | 0.00 | 68.50 | 1.09 | 69.60 | 14.31 | 1.01 | 15.31 | 4,377.72 |
| Mobilization 03/07/2014-03/28/2014 | 0.13 | 0.91 | 0.98 | 0.00 | 0.00 | 0.05 | 0.05 | 0.00 | 0.04 | 0.04 | 156.37 |
| Mobilization Dust | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Mobilization Off Road Diesel | 0.12 | 0.90 | 0.77 | 0.00 | 0.00 | 0.05 | 0.05 | 0.00 | 0.04 | 0.04 | 130.80 |
| Mobilization On Road Diesel | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Mobilization Worker Trips | 0.01 | 0.01 | 0.20 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 25.57 |
| Trenching 03/28/2014-09/28/2014 | 2.60 | 27.74 | 13.15 | 0.00 | 68.50 | 1.05 | 69.55 | 14.31 | 0.96 | 15.27 | 4,221.35 |
| Trenching Dust | 0.00 | 0.00 | 0.00 | 0.00 | 68.49 | 0.00 | 68.49 | 14.30 | 0.00 | 14.30 | 0.00 |
| Trenching Off Road Diesel | 2.53 | 27.06 | 12.11 | 0.00 | 0.00 | 1.02 | 1.02 | 0.00 | 0.94 | 0.94 | 3,977.68 |
| Trenching On Road Diesel | 0.05 | 0.64 | 0.23 | 0.00 | 0.00 | 0.02 | 0.03 | 0.00 | 0.02 | 0.02 | 141.37 |
| Trenching Worker Trips | 0.02 | 0.04 | 0.81 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 102.29 |
| Time Slice 3/31/2014-9/26/2014 Active Days: | 2.60 | 27.74 | 13.15 | 0.00 | 68.50 | 1.05 | 69.55 | 14.31 | 0.96 | 15.27 | 4,221.35 |
| Trenching 03/28/2014-09/28/2014 | 2.60 | 27.74 | 13.15 | 0.00 | 68.50 | 1.05 | 69.55 | 14.31 | 0.96 | 15.27 | 4,221.35 |
| Trenching Dust | 0.00 | 0.00 | 0.00 | 0.00 | 68.49 | 0.00 | 68.49 | 14.30 | 0.00 | 14.30 | 0.00 |
| Trenching Off Road Diesel | 2.53 | 27.06 | 12.11 | 0.00 | 0.00 | 1.02 | 1.02 | 0.00 | 0.94 | 0.94 | 3,977.68 |
| Trenching On Road Diesel | 0.05 | 0.64 | 0.23 | 0.00 | 0.00 | 0.02 | 0.03 | 0.00 | 0.02 | 0.02 | 141.37 |
| Trenching Worker Trips | 0.02 | 0.04 | 0.81 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 102.29 |
| Time Slice 9/29/2014-12/29/2014 Active Days: | **3.06** | **30.91** | **15.54** | **0.00** | 136.02 | **1.29** | 137.31 | 28.41 | **1.19** | 29.60 | **4,671.34** |
| Fine Grading 09/29/2014-12/29/2014 | 3.06 | 30.91 | 15.54 | 0.00 | 136.02 | 1.29 | 137.31 | 28.41 | 1.19 | 29.60 | 4,671.34 |
| Pipe Installation Dust | 0.00 | 0.00 | 0.00 | 0.00 | 136.00 | 0.00 | 136.00 | 28.40 | 0.00 | 28.40 | 0.00 |
| Pipe Installation Off Road Diesel | 2.93 | 29.58 | 13.87 | 0.00 | 0.00 | 1.24 | 1.24 | 0.00 | 1.14 | 1.14 | 4,237.30 |
| Pipe Installation On Road Diesel | 0.09 | 1.27 | 0.45 | 0.00 | 0.01 | 0.05 | 0.06 | 0.00 | 0.04 | 0.05 | 280.60 |

CONSTRUCTION EMISSION ESTIMATES (Summer Pounds Per Day, Mitigated)

| | ROG | NOx | CO | SO2 | PM10 Dust | PM10 Exhaust | PM10 Total | PM2.5 Dust | PM2.5 Exhaust | PM2.5 Total | CO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Pipe Installation Worker Trips | 0.04 | 0.06 | 1.21 | 0.00 | 0.01 | 0.00 | 0.01 | 0.00 | 0.00 | 0.01 | 153.44 |
| Time Slice 12/30/2014-12/31/2014 Active | 1.34 | 7.84 | 6.33 | 0.00 | 0.01 | 0.63 | 0.64 | 0.00 | 0.58 | 0.59 | 859.97 |
| Asphalt 12/30/2014-03/11/2015 | 1.34 | 7.84 | 6.33 | 0.00 | 0.01 | 0.63 | 0.64 | 0.00 | 0.58 | 0.59 | 859.97 |
| Paving Off-Gas | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Paving Off Road Diesel | 1.31 | 7.79 | 5.52 | 0.00 | 0.00 | 0.63 | 0.63 | 0.00 | 0.58 | 0.58 | 755.39 |
| Paving On Road Diesel | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 2.30 |
| Paving Worker Trips | 0.02 | 0.04 | 0.81 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 102.29 |
| Time Slice 1/1/2015-3/11/2015 Active Days: | 1.23 | 7.37 | 6.20 | 0.00 | 0.01 | 0.58 | 0.59 | 0.00 | 0.53 | 0.54 | 860.00 |
| Asphalt 12/30/2014-03/11/2015 | 1.23 | 7.37 | 6.20 | 0.00 | 0.01 | 0.58 | 0.59 | 0.00 | 0.53 | 0.54 | 860.00 |
| Paving Off-Gas | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Paving Off Road Diesel | 1.20 | 7.33 | 5.45 | 0.00 | 0.00 | 0.58 | 0.58 | 0.00 | 0.53 | 0.53 | 755.39 |
| Paving On Road Diesel | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 2.30 |
| Paving Worker Trips | 0.02 | 0.04 | 0.75 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 102.32 |

## Construction Related Mitigation Measures

The following mitigation measures apply to Phase: Fine Grading 3/7/2014 - 3/28/2014 - Site Mobilization

For Soil Stablizing Measures, the Replace ground cover in disturbed areas quickly mitigation reduces emissions by:

PM10: 5% PM25: 5%

For Soil Stablizing Measures, the Water exposed surfaces 3x daily watering mitigation reduces emissions by:

PM10: 61% PM25: 61%

For Soil Stablizing Measures, the Equipment loading/unloading mitigation reduces emissions by:

PM10: 69% PM25: 69%

For Unpaved Roads Measures, the Reduce speed on unpaved roads to less than 15 mph mitigation reduces emissions by:

PM10: 44% PM25: 44%

For Unpaved Roads Measures, the Manage haul road dust 3x daily watering mitigation reduces emissions by:

PM10: 61% PM25: 61%

The following mitigation measures apply to Phase: Fine Grading 3/28/2014 - 9/28/2014 - Trenching

For Soil Stablizing Measures, the Replace ground cover in disturbed areas quickly mitigation reduces emissions by:

PM10: 5% PM25: 5%

For Soil Stablizing Measures, the Water exposed surfaces 2x daily watering mitigation reduces emissions by:

PM10: 55% PM25: 55%

For Soil Stablizing Measures, the Equipment loading/unloading mitigation reduces emissions by:

PM10: 69% PM25: 69%

The following mitigation measures apply to Phase: Fine Grading 9/29/2014 - 12/29/2014 - Pipe Installation and Backfilling

For Soil Stablizing Measures, the Replace ground cover in disturbed areas quickly mitigation reduces emissions by:

PM10: 5% PM25: 5%

For Soil Stablizing Measures, the Water exposed surfaces 2x daily watering mitigation reduces emissions by:

PM10: 55% PM25: 55%

For Soil Stablizing Measures, the Equipment loading/unloading mitigation reduces emissions by:

PM10: 69% PM25: 69%

Phase Assumptions

Phase: Fine Grading 3/7/2014 - 3/28/2014 - Site Mobilization
Total Acres Disturbed: 0
Maximum Daily Acreage Disturbed: 0
Fugitive Dust Level of Detail: High
Onsite Haulage: 0 ton-miles/day;  Offsite haulage: 0 ton-mils/day
On Road Truck Travel (VMT): 0
Off-Road Equipment:
1 Forklifts (145 hp) operating at a 0.3 load factor for 8 hours per day

Phase: Fine Grading 3/28/2014 - 9/28/2014 - Trenching
Total Acres Disturbed: 0.36
Maximum Daily Acreage Disturbed: 0.02
Fugitive Dust Level of Detail: High
Onsite Haulage: 0 ton-miles/day;  Offsite haulage: 351 ton-mils/day
On Road Truck Travel (VMT): 35.11
Off-Road Equipment:
1 Excavators (168 hp) operating at a 0.57 load factor for 8 hours per day
1 Forklifts (145 hp) operating at a 0.3 load factor for 8 hours per day
1 Generator Sets (549 hp) operating at a 0.74 load factor for 8 hours per day
1 Tractors/Loaders/Backhoes (108 hp) operating at a 0.55 load factor for 7 hours per day

Phase: Fine Grading 9/29/2014 - 12/29/2014 - Pipe Installation and Backfilling
Total Acres Disturbed: 0.36
Maximum Daily Acreage Disturbed: 0.02
Fugitive Dust Level of Detail: High
Onsite Haulage: 0 ton-miles/day;  Offsite haulage: 697 ton-mils/day
On Road Truck Travel (VMT): 69.7
Off-Road Equipment:
1 Air Compressors (106 hp) operating at a 0.48 load factor for 8 hours per day
1 Excavators (168 hp) operating at a 0.57 load factor for 8 hours per day
1 Forklifts (145 hp) operating at a 0.3 load factor for 8 hours per day
1 Generator Sets (549 hp) operating at a 0.74 load factor for 8 hours per day
1 Plate Compactors (8 hp) operating at a 0.43 load factor for 8 hours per day
1 Tractors/Loaders/Backhoes (108 hp) operating at a 0.55 load factor for 7 hours per day

Phase: Paving 12/30/2014 - 3/11/2015 - Paving/Concrete Finishing

Acres to be Paved: 0.1

Off-Road Equipment:

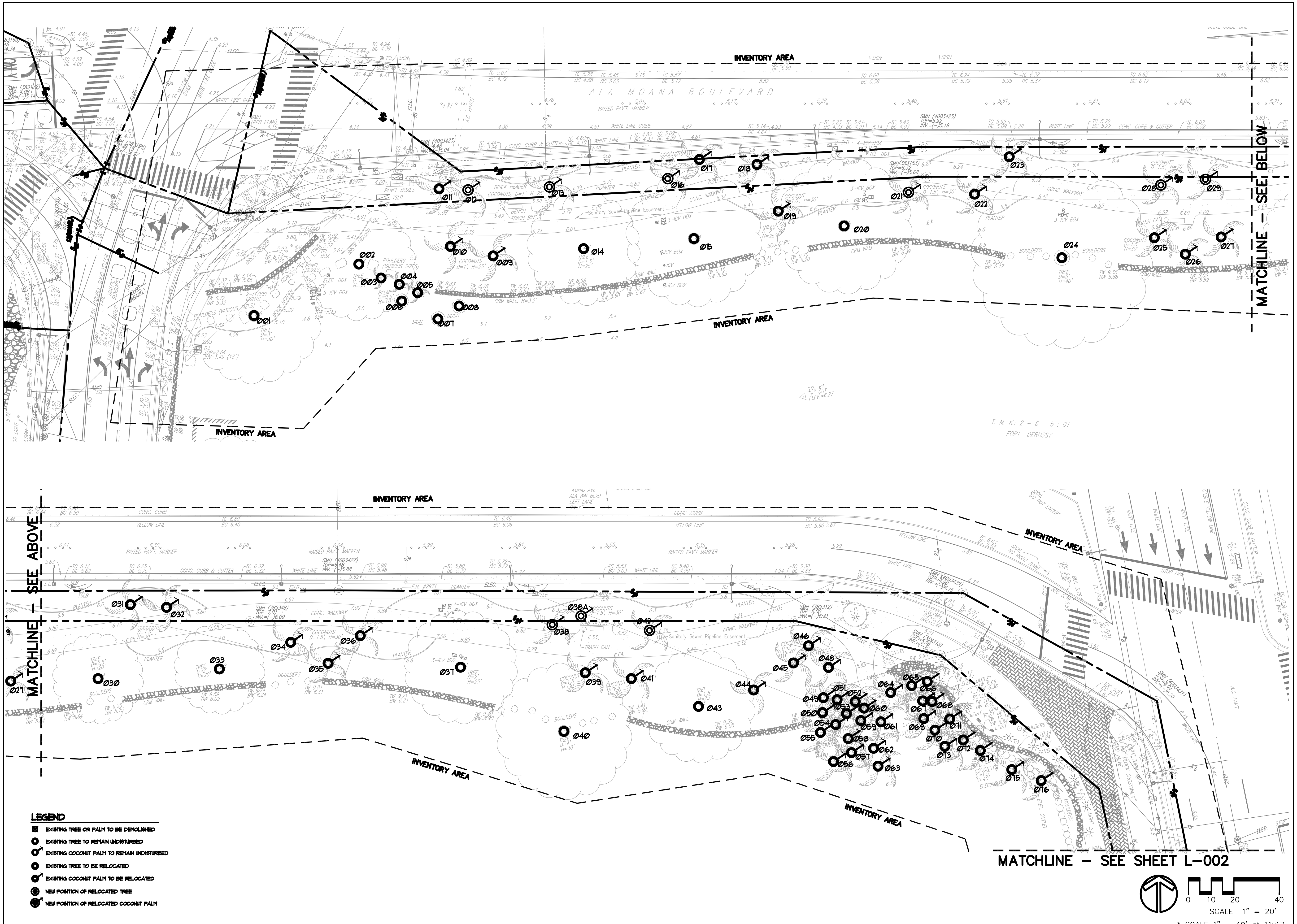
1 Cement and Mortar Mixers (10 hp) operating at a 0.56 load factor for 6 hours per day

1 Pavers (100 hp) operating at a 0.62 load factor for 7 hours per day

1 Rollers (95 hp) operating at a 0.56 load factor for 7 hours per day

1 Skid Steer Loaders (44 hp) operating at a 0.55 load factor for 8 hours per day

# APPENDIX F
# EXISTING TREE/PALM INVENTORY AND PLANTING PLAN
# (MCCELVEY ASSOCIATES, INC.)





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**Consultant**

**Project**
KALIA–FORT DERUSSY WASTEWATER SYSTEM IMPROVEMENTS

**Sheet Title**
TREE DISPOSITION PLAN 1

**Revisions**

**Drawing Date** August 2012
**AutoCad File** mai-tree-disp.dwg

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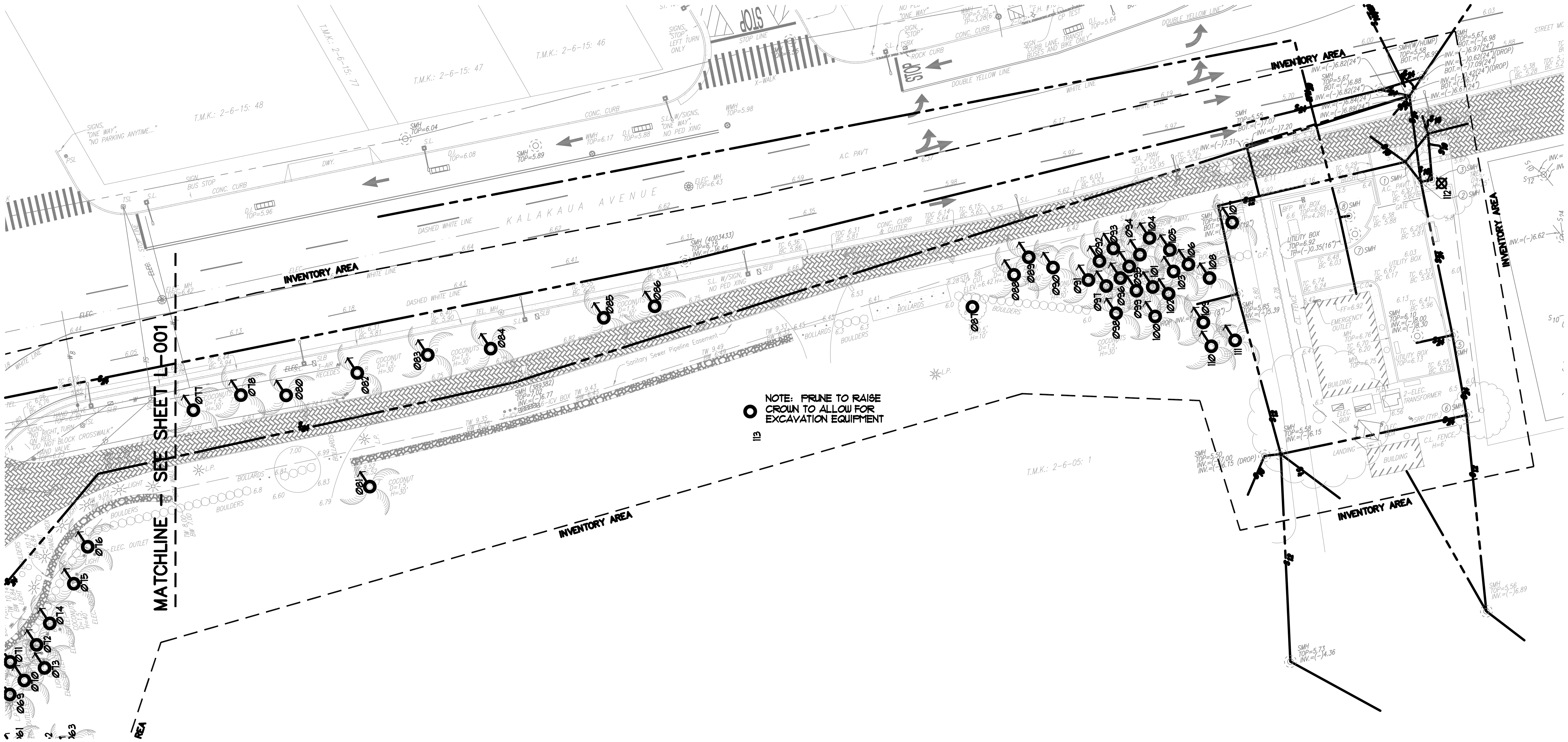
SHELLI A. McCELVEY LICENSED PROFESSIONAL LANDSCAPE ARCHITECT No. 7119 HAWAII, U.S.A.

**Sheet Number**
L-001

1 of 3 sheets




**LEGEND**

- EXISTING TREE OR PALM TO BE DEMOLISHED
- EXISTING TREE TO REMAIN UNDISTURBED
- EXISTING COCONUT PALM TO REMAIN UNDISTURBED
- EXISTING TREE TO BE RELOCATED
- EXISTING COCONUT PALM TO BE RELOCATED
- NEW POSITION OF RELOCATED TREE
- NEW POSITION OF RELOCATED COCONUT PALM

0 10 20 40

SCALE 1" = 20'

* SCALE 1" = 40' at 11x17

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**Project**
KALIA–FORT DERUSSY WASTEWATER SYSTEM IMPROVEMENTS

**Sheet Title**
TREE DISPOSITION PLAN 2

**Revisions**

**Drawing Date** August 2012
**AutoCad File** mai-tree-disp.dwg

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SHELLI A. McCELVEY LICENSED PROFESSIONAL LANDSCAPE ARCHITECT No. 7119 HAWAII, U.S.A.

**Sheet Number**
L-002

2 of 3 sheets

| Status | Plan # | General Location | Common Name | Height | Spread | Caliper | Condition |
|---|---|---|---|---|---|---|---|
| E | | | Existing Tree to Remain | | | | |
| R | | | Relocate Tree | | | | |
| D | | | Demolish and Replace | | | | |
| | | | | | | | |
| E | 001 | Kalia Road | Banyan | 30' | | 36" | Good Condition, Nice Tree |
| E | 002 | Kalia Road | Banyan | 30' | | 42" | Good Condition, Nice Tree |
| E | 003 | Kalia Road | MacArthur Palm | 10' | | | Weak, Spindly |
| E | 004 | Kalia Road | MacArthur Palm | 10' | | | Weak, Spindly |
| E | 005 | Ala Moana Blvd | MacArthur Palm | 25' | | | Weak, Spindly |
| E | 006 | Kalia Road | Shrub | | | | |
| E | 007 | Kalia Road | Shrub | | | | |
| E | 008 | Kalia Road | Shrub | | | | |
| E | 009 | Ala Moana Blvd | Coconut | 25' | | 12" | Fair |
| E | 010 | Ala Moana Blvd | Coconut | 25' | | 12" | Fair |
| E | 011 | Ala Moana Blvd | Coconut | 20' | | 10" | Slight Hourglassing |
| R | 012 | Ala Moana Blvd | Coconut | 22' | | 12" | Good |
| R | 013 | Ala Moana Blvd | Coconut | 30' | | 18" | Good |
| E | 014 | Ala Moana Blvd | Monkeypod | 25' | 45' | 18" | Good, Nice Tree |
| E | 015 | Ala Moana Blvd | Monkeypod | 25' | 50' | 24" | Fair |
| R | 016 | Ala Moana Blvd | Coconut | 25' | | 14" | Good |
| E | 017 | Ala Moana Blvd | Coconut | 25' | | 18" | Good |
| E | 018 | Ala Moana Blvd | Coconut | 30' | | 16" | Good |
| E | 019 | Ala Moana Blvd | Coconut | 35' | | 16" | Slight Hourglassing |
| E | 020 | Ala Moana Blvd | Monkeypod | 25' | 60' | 24" | Good, Nice Tree |
| R | 021 | Ala Moana Blvd | Coconut | 35' | | 18" | Good |
| E | 022 | Ala Moana Blvd | Coconut | 25' | | 14" | Good |
| E | 023 | Ala Moana Blvd | Coconut | 25' | | 14" | Good |
| E | 024 | Ala Moana Blvd | Banyan | 40' | 75' | 60" | Good, Multitrunk |
| E | 025 | Ala Moana Blvd | Coconut | 30' | | 18" | Slight Hourglassing |
| E | 026 | Ala Moana Blvd | Coconut | 30' | | 18" | Slight Hourglassing |
| E | 027 | Ala Moana Blvd | Coconut | 30' | | 18" | Slight Hourglassing |
| R | 028 | Ala Moana Blvd | Coconut | 20' | | 14" | Good |
| R | 029 | Ala Moana Blvd | Coconut | 25' | | 16" | Good |
| E | 030 | Ala Moana Blvd | Monkeypod | 20' | 35' | 30" | Fair, Poorly Pruned in Past |
| E | 031 | Ala Moana Blvd | Coconut | 35' | | 15" | Good |
| E | 032 | Ala Moana Blvd | Coconut | 30' | | 16" | Good |
| E | 033 | Ala Moana Blvd | Monkeypod | 20' | 50' | 24" | Good, Nice Tree |
| E | 034 | Ala Moana Blvd | Coconut | 25' | | 18" | Good |
| E | 035 | Ala Moana Blvd | Coconut | 30' | | 18" | Hourglassing at top |
| E | 036 | Ala Moana Blvd | Coconut | 25' | | 14" | Slight Hourglassing |
| E | 037 | Ala Moana Blvd | Monkeypod | 25' | 55' | 24" | Good, on mound |
| R | 038 | Ala Moana Blvd | Coconut | 30' | | 14" | Good |
| R | 038A | Ala Moana Blvd | Coconut | 30' | | 15" | Stressed, Replace |
| E | 039 | Ala Moana Blvd | Coconut | 30' | | 18" | Fair |
| E | 040 | Ala Moana Blvd | Banyan | 30' | 50' | 48" | Good, Nice Tree |
| E | 041 | Ala Moana Blvd | Coconut | 30' | | 18" | Good, Slight Hourglassing |
| R | 042 | Ala Moana Blvd | Coconut | 20' | | 15" | Good |
| E | 043 | Ala Moana Blvd | Monkeypod | 25' | 45' | 18" | Good |
| E | 044 | Ala Moana Blvd | Date Palm | 40' | | 24" | Bending Trunk |
| E | 045 | Ala Moana Blvd | Coconut | 40' | | 24" | Poor, Hourglassing |
| E | 046 | Ala Moana Blvd | Coconut | 35' | | 14" | Poor, Severe Hourglassing |
| E | 048 | Ala Moana Blvd | Coconut | 40' | | 24" | Fair, Slight Hourglassing |
| E | 049 | Ala Moana Blvd | Coconut | 40' | | 24" | Fair, Slight Hourglassing |
| E | 050 | Ala Moana Blvd | Coconut | 60' | | 24" | Fair, Tall |
| E | 051 | Ala Moana Blvd | Coconut | 25' | | 24" | Fair |
| E | 052 | Ala Moana Blvd | Coconut | 40' | | 24" | Good |
| E | 053 | Ala Moana Blvd | Coconut | 60' | | 24" | Fair, Tall |
| E | 054 | Ala Moana Blvd | Coconut | 60' | | 24" | Fair, Tall |
| E | 055 | Ala Moana Blvd | Coconut | 60' | | 24" | Fair, Tall |
| E | 056 | Ala Moana Blvd | Coconut | 50' | | 24" | Good, Leaning Trunk |
| E | 057 | Ala Moana Blvd | Coconut | 40' | | 24" | Good, Leaning Trunk |
| E | 058 | Ala Moana Blvd | Coconut | 60' | | 24" | Fair, Tall, Leaning |
| E | 059 | Ala Moana Blvd | Coconut | 60' | | 24" | Fair, Tall, Leaning |
| E | 060 | Ala Moana Blvd | Coconut | 25' | | 24" | Fair, Thin Trunk |
| E | 061 | Ala Moana Blvd | Coconut | 50' | | 24" | Fair |
| E | 062 | Ala Moana Blvd | Coconut | 40' | | 24" | Good |
| E | 063 | Kalakaua Avenue | Coconut | 60' | | 18" | Fair, Tall, Leaning |
| E | 064 | Kalakaua Avenue | Coconut | 70' | | 18" | Fair, Tall, Leaning |
| E | 065 | Kalakaua Avenue | Coconut | 65' | | 18" | Fair, Tall |
| E | 066 | Kalakaua Avenue | Coconut | 65' | | 18" | Fair, Tall, Leaning |
| E | 067 | Kalakaua Avenue | Coconut | 40' | | 18" | Good, Leaning |
| E | 068 | Kalakaua Avenue | Coconut | 40' | | 18" | Fair, Hourglassing, Leaning |
| E | 069 | Kalakaua Avenue | Coconut | 30' | | 18" | Fair |
| E | 070 | Kalakaua Avenue | Coconut | 30' | | 18" | Fair |
| E | 071 | Kalakaua Avenue | Coconut | 25' | | 18" | Fair |
| E | 072 | Kalakaua Avenue | Coconut | 40' | | 18" | Fair |
| E | 073 | Kalakaua Avenue | Coconut | 40' | | 18" | Good |
| E | 074 | Kalakaua Avenue | Coconut | 30' | | 18" | Fair |
| E | 075 | Kalakaua Avenue | Coconut | 30' | | 18" | Fair |
| E | 076 | Kalakaua Avenue | Coconut | 30' | | 18" | Fair |
| E | 077 | Kalakaua Avenue | Coconut | 40' | | 16" | Slight Hourglassing |
| E | 078 | Kalakaua Avenue | Coconut | 35' | | 14" | Slight Hourglassing |
| E | 080 | Kalakaua Avenue | Coconut | 30' | | 12" | |
| E | 081 | Kalakaua Avenue | Coconut | 30' | | 18" | Fair, Slight Hourglassing |
| E | 082 | Kalakaua Avenue | Coconut | 30' | | 14" | Fair, Slight Hourglassing |
| E | 083 | Kalakaua Avenue | Coconut | 32' | | 15" | Stressed |
| E | 084 | Kalakaua Avenue | Coconut | 35' | | 16" | Fair, Hourglassing |
| E | 085 | Kalakaua Avenue | Coconut | 30' | | 14" | Fair, Hourglassing |
| E | 086 | Kalakaua Avenue | Coconut | 25' | | 13" | Fair, Hourglassing |
| E | 087 | Kalakaua Avenue | Tree | 10' | 15' | 6" | Small |
| E | 088 | Kalakaua Avenue | Coconut | 40' | | 18" | Fair, Thin Bending Trunk |
| E | 089 | Kalakaua Avenue | Coconut | 40' | | 18" | Fair, Bending Trunk |
| E | 090 | Kalakaua Avenue | Coconut | 40' | | 18" | Fair, Thin Trunk |
| E | 091 | Kalakaua Avenue | Coconut | 35' | | 18" | Fair, Gouge in Trunk |
| E | 092 | Kalakaua Avenue | Coconut | 25' | | 18" | Fair, Bending Trunk |
| E | 093 | Kalakaua Avenue | Coconut | 25' | | 18" | Fair, Bending Trunk |
| E | 095 | Kalakaua Avenue | Coconut | 25' | | 18" | Good |
| E | 095 | Kalakaua Avenue | Coconut | 30' | | 18" | Good |
| E | 096 | Kalakaua Avenue | Coconut | 30' | | 18" | Good |
| E | 097 | Kalakaua Avenue | Coconut | 25' | | 18" | Good |
| E | 098 | Kalakaua Avenue | Coconut | 45' | | 18" | Fair |
| E | 099 | Kalakaua Avenue | Coconut | 45' | | 18" | Fair, Bending Trunk |
| E | 100 | Kalakaua Avenue | Coconut | 45' | | 18" | Fair |
| E | 101 | Kalakaua Avenue | Coconut | 25' | | 18" | Fair |
| E | 102 | Kalakaua Avenue | Coconut | 40' | | 18" | Fair |
| E | 103 | Kalakaua Avenue | Coconut | 20' | | 18" | Fair, Thin Trunk |
| E | 104 | Kalakaua Avenue | Coconut | 20' | | 18" | Fair |
| E | 105 | Kalakaua Avenue | Coconut | 20' | | 18" | Good |
| E | 106 | Kalakaua Avenue | Coconut | 30' | | 18" | Fair, Bending Trunk |
| E | 107 | Kalakaua Avenue | Coconut | 30' | | 18" | Fair |
| E | 108 | Kalakaua Avenue | Coconut | 30' | | 18" | Fair |
| E | 109 | Kalakaua Avenue | Coconut | 30' | | 18" | Fair |
| E | 110 | Kalakaua Avenue | Coconut | 30' | | 18" | Fair |
| E | 111 | Kalakaua Avenue | Coconut | 30' | | 15" | Fair |
| D | 112 | Kalakaua Avenue | Brassaia | | | 24" | Demolish, Do Not Replace |
| E | 113 | Kalakaua Avenue | Banyan | | | | Prune to raise canopy |

## TREE PROTECTION NOTES

GENERAL NOTES:

A. THE TPZ IS ESTABLISHED TO REASONABLY PROTECT THE SPECIFIED TREES AND THEIR CRITICAL ROOT ZONE FROM DAMAGE BY EQUIPMENT, MATERIAL OR CHEMICAL COMPOUNDS RELATED TO CONSTRUCTION ACTIVITY. THIS INCLUDES, BUT IS NOT LIMITED TO:
  1. PROTECTION OF ROOTS FROM MECHANICAL CRUSHING BY HEAVY EQUIPMENT;
  2. PREVENTION OR MINIMIZATION OR SOIL COMPACTION BY HEAVY EQUIPMENT;
  3. PREVENTION OF TOXIC EFFECTS FROM CHEMICAL COMPOUNDS DEPOSITED INTO THE ROOT ZONE; AND
  4. PREVENTION OF MECHAMICAL DAMAGE TO TRUNK AND LIMBS FROM CONTACT WITH TOOLS AND EQUIPMENT AND ACTIVITY ON CONSTRUCTION SITE.

B. THE TPZ SHALL BE DESIGNATED AS AN AREA DEFINED BY THE OUTERMOST EDGE OF EACH TREE'S CANOPY/ DRIPLINE.

C. ACTIVITIES THAT ARE PROHIBITED WITHIN THE TPZ, UNLESS OTHERWISE APPROVED BY THE PROJECT ARBORIST ARE:
  1. DRIVING OR PARKING VEHICLES OR HEAVY EQUIPMENT;
  2. STORAGE OF TOOLS, EQUIPMENT, BUILDING MATERIALS, REFUSE, EXCAVATED SOILS OR ANY OTHER CONSTRUCTION MATERIALS.
  3. STORAGE OR DISCHARGE OF TOXIC MATERIALS OR COMPOUNDS THAT MAY SIGNIFICANTLY CHANGE THE CHEMICAL OR STRUCTURAL CHARACTERISTICS OF A SOIL AND ADVERSELY IMPACT OR KILL PROTECTED TREES (E.G. PAINT, PETROLEUM PRODUCTS, HERBICIDES, CONCRETE, CONTAMINATED WATER);
  4. USE OF PROTECTED TREES AS A WINCH SUPPORT, ANCHORAGE, TEMPORARY POWER POLE, SIGN POSTS OR OTHER SIMILAR FUNCTION;
  5. CUTTING OF TREE ROOTS;
  6. CONSTRUCTION OR DEPOSITION OF ANY STRUCTURES;
  7. GRADE CHANGES;
  8. TRENCHING, EXCAVATION OR TUNNELING; AND
  9. INFILTRATION OF OFF-SITE AND/ OR EROSION SEDIMENTS.

D. THE TPZ SHALL BE CLEARLY DEFINED WITH A FENCE TO PROVIDE A PHYSICAL BARRIER TO PHYSICAL ENCROACHMENT AND CONSTRUCTION ACTIVITY.
  1. FENCING SHALL BE FOUR (4) FOOT HIGH BLACK PLASTIC OR WELDED WIRE MESH FENCE MATERIAL AND;
  2. MOUNTED ON METAL POSTS, DRIVEN INTO THE GROUND TO A DEPTH OF AT LEAST TWO (2) FEET WITH NO MORE FOOT SPACING.
  3. WATERPROOF SIGNS SHALL BE PROMINENTLY LOCATED ON EACH TPZ FENCE AND LABELED "WARNING-TREE PROTECTION ZONE-REMOVAL OF THIS FENCE IS SUBJECT OT PENALTY."

E. THE TPZ SHALL BE MAINTAINED IN FULL FUNCTIONING CONDITION, ACCORDING TO THE APPROVED TREE PROTECTION PLAN (TPP), AT ALL TIMES DURING CONSTRUCTION OPERATIONS.

F. THE TPZ FENCE, AND OTHER TPZ MEASURES AND MATERIALS SHALL ONLY BE REMOVED AFTER THE COMPLETION OF ALL CONSTRUCTION ACTIVITY AND REMOVAL OF ALL CONSTRUCTION EQUIPMENT, STRUCTURES, MATERIALS AND PERSONNEL.

G. ALL TPZ REMOVAL ACTIVITIES SHALL BE CONDUCTED IN A MANNER THAT WILL PREVENT ANY DAMAGE TO THE PROTECTED TREE, REASONABLY MINIMIZE DISTURBANCE TO THE ROOT SYSTEM, AND SHALL NOT PERMIT VEHICLES OR HEAVY EQUIPMENT TO TRAVEL WITHIN THE CRITICAL ROOT ZONE.

## TREE RELOCATION NOTES

1. AT THE BEGINNING OF SITE CLEARING OPERATIONS, RAPIDLY MOVE ALL DESIGNATED MATERIALS AFFECTED BY CONSTRUCTION. ALL PLANTS WILL BE RELOCATED TO THEIR FINAL LOCATION OR TO THE ON-SITE HOLDING AREA.

2. CONDITIONS: IMMEDIATELY ADVISE THE LANDSCAPE ARCHITECT OF ANY POSSIBLE PROBLEMS, DEFECTS OR EXISTING CONDITIONS IN THE TREES WHICH MAY AFFECT THE ABILITY TO SURVIVE RELOCATION OR TRANSPLANTING.

3. WATER SUPPLY: CONFIRM WATER SUPPLY FOR IRRIGATION OF TREES IS AVAILABLE AND IN WORKING ORDER.

4. TRIMMING:
  a. PRIOR TO SITE CLEARING, TRIM ALL PLANTS AND PRE-DIG ROOTBALLS WHENEVER POSSIBLE. REMOVE TRIMMINGS.
  b. SINCE PLANTS WILL BE MOVED ON SITE, TRIM AND SHAPE TO MAINTAIN THE MAXIMUM CANOPY AND SPREAD, REMOVING ONLY SMALLER INNER BRANCHES AS DIRECTED BY THE LANDSCAPE ARCHITECT. REMOVE ALL FOLIAGE FROM TREE.
  c. TRIM PALMS AS DIRECTED TO MINIMIZE SHOCK.
  d. AT THE CONTRACTOR'S OPTION, TREAT PLANTS WITH SYSTEMIC OR FOLIAR INSECTICIDES AND/OR FERTILIZERS IF REQUIRED TO INSURE THE SUCCESS OF THE RELOCATIONS.

5. RELOCATION:
  a. CAREFULLY COORDINATE ALL MOVING OPERATIONS TO MINIMIZE SHOCK AND DAMAGE TO THE PLANTS.
  b. MOVE PLANTS TO FINAL LOCATION OR TO THE ON-SITE HOLDING AREA FOR TEMPORARY STORAGE DURING CONSTRUCTION. SINCE THESE PLANTS WILL BE REPLANTED LATER TAKE ALL PRECAUTIONS TO MINIMIZE FUTURE SHOCK WHEN THE PLANTS ARE REPLANTED. WRAP THE SIDES OF THE ROOTBALLS WITH VISQUEEN OR ACCEPTABLE EQUAL TO ENCOURAGE ROOT GROWTH WITHIN THE BALL AND MINIMIZE DAMAGE DURING REPLANTING. GUY AND FORM BASINS AS DETAILED.

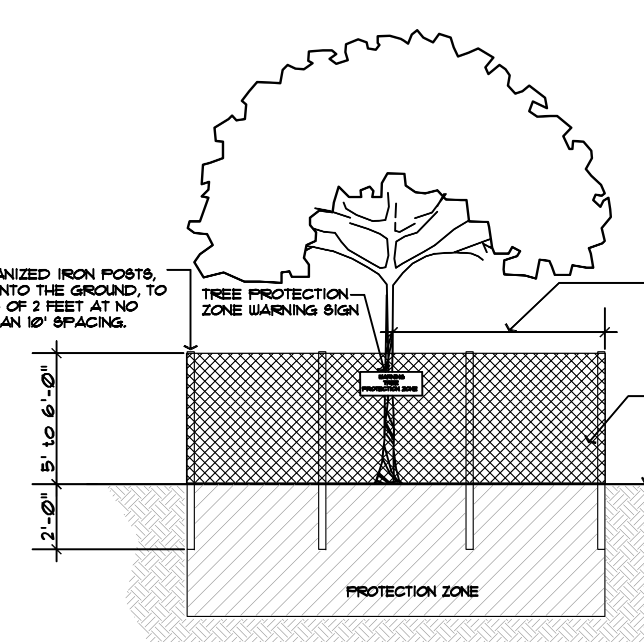
6. STORAGE AND MAINTENANCE:
  a. WATER THOROUGHLY AND REGULARLY: DAILY OR TWO TIMES A DAY DEPENDING ON HEAT AND WATER LOSS.
  b. REGULARLY INSPECT PLANTS TO IDENTIFY DISEASES OR INSECT PESTS. TREAT AS APPROPRIATE.
  c. APPLY FERTILIZER AS REQUIRED TO INSURE THE SUCCESS OF THE RELOCATIONS.

7. EXISTING TREE AND PALM MAINTENANCE:
  a. WATER THOROUGHLY AND REGULARLY: DAILY OR AS NEEDED DEPENDING ON HEAT AND WATER LOSS.
  b. REGULARLY INSPECT PLANTS TO IDENTIFY DISEASES OR INSECT PESTS. TREAT AS APPROPRIATE.
  c. APPLY FERTILIZER AS REQUIRED TO INSURE PLANTS REMAIN HEALTHY.
  d. PRIOR TO FINAL SITE INSPECTION, TRIM ALL PLANTS AND REMOVE TRIMMINGS.

8. RELOCATED OR REPLACED TREES:
ALL RELOCATED OR REPLACEMENT TREES OR PALMS SHALL BE INSTALLED WITHIN THE SEWER EASEMENT.

NOTES:
1. FOR TREES IN NARROW PLANTING STRIPS, THE ENTIRE PLANTING STRIP SHALL BE ENCLOSED.
2. FOR TREE WELLS AND SMALL PLANTER AREAS THAT ARE FULL OF ROOTS, USE PLASTIC TRAFFIC BARRICADES (WATER FILLABLE), MNIMUM 3 EACH, OR TYPE 1 OR TYPE 2 TRAFFIC BARRICADES MINIMUM 4 EACH, OR AS DETERMINED BY COUNTY STANDARDS.
3. IF THE FENCE IS INSIDE THE DRIP LINE, PLYWOOD BOARDS OR STEEL PLATES OVER AN 8" MULCH LAYER WILL BE REQUIRED TO PROTECT THE TREE ROOTS AND GROUNDS FROM DAMAGE, SOIL COMPACTION AND EROSION FROM EQUIPMENT AND VEHICLES.
4. TREE WILL REQUIRE SUPPLEMENTAL WATERING.
5. AVOID DAMAGING TREE ROOTS DURING FENCE POST INSTALLATION.

2" GALVANIZED IRON POSTS, DRIVEN INTO THE GROUND, TO A DEPTH OF 2 FEET AT NO MORE THAN 10' SPACING.

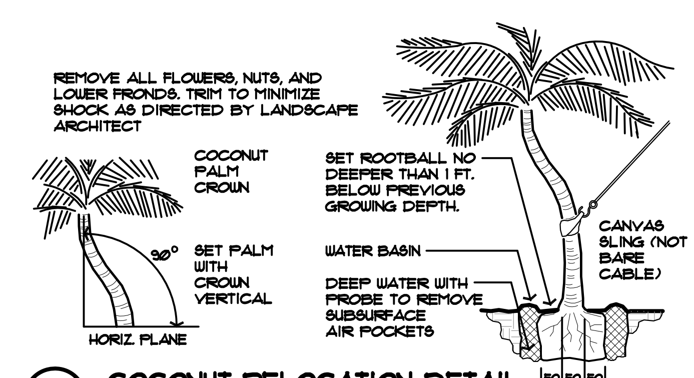



PLACE PROTECTION FENCE AT EDGE OF TREE DRIPLINE OR A MINIMUM OF 10' AWAY FROM OUTSIDE EDGE OF TRUNK OR AS DETERMINED BY THE PROJECT ARBORIST.

PROTECTIVE FENCE

FINISH GRADE

2 TREE PROTECTION DETAIL
NO SCALE




1 COCONUT RELOCATION DETAIL
NO SCALE

McCELVEY ASSOCIATES
~ LANDSCAPE ARCHITECTS ~
E-Mail mail@mccelvey.com
Tel. 1-808-521-2908 Fax. 1-808-528-2854
2752 Woodlawn Dr. Suite 5-214 Honolulu, Hawaii 96822

Consultant

Project
KALIA-FORT DERUSSY WASTEWATER SYSTEM IMPROVEMENTS

Sheet Title
TREE DISPOSITION LEGEND AND DETAILS

Revisions

Drawing Date August 2012
AutoCad File mai-tree-disp.dwg

THIS WORK WAS PREPARED BY ME OR UNDER MY SUPERVISION AND CONSTRUCTION OF THIS PROJECT WILL BE UNDER MY OBSERVATION.

Supervision and Observation of this project is as defined in Section 1.2 of the Hawaii Administrative Rules, Title 16, Chapter 115, Professional Engineers, Architects, Land Surveyors, and Landscape Architects.

SHELLI A. McCELVEY
LICENSED PROFESSIONAL LANDSCAPE ARCHITECT
No. 7119
HAWAII, U.S.A.

License Exp. Date: 04/30/14

Sheet Number
L-003

3 of 3 sheets

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~LANDSCAPE ARCHITECTS~

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Consultant

Project
KALIA-FORT DERUSSY WASTEWATER SYSTEM IMPROVEMENTS

Sheet Title
PLANTING PLAN 1

Revisions

Drawing Date August 2012
AutoCad File mai-plant.dwg

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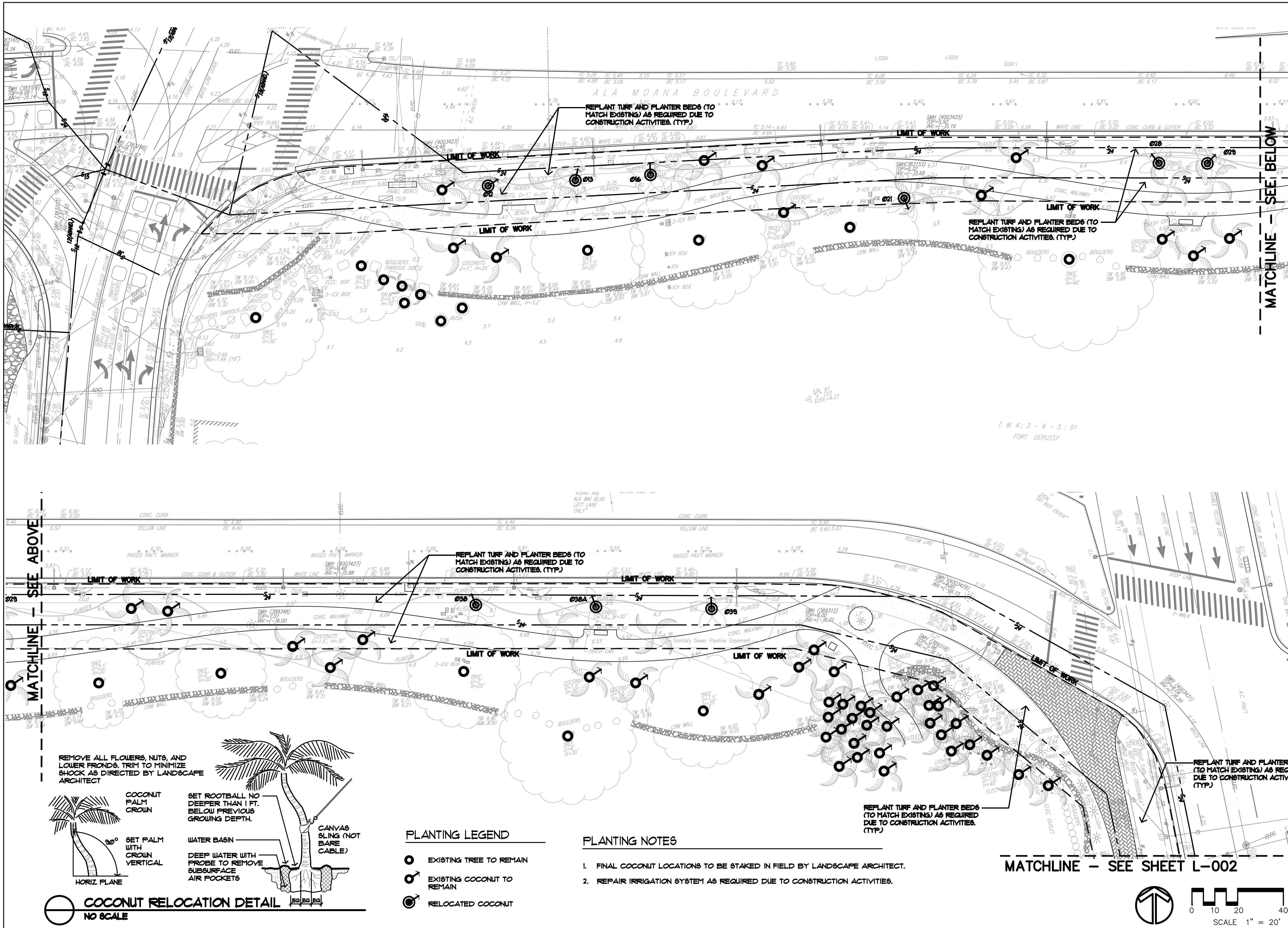
SHELLI A. McCELVEY LICENSED PROFESSIONAL LANDSCAPE ARCHITECT No. 7119 HAWAII, U.S.A.

Sheet Number
L-101



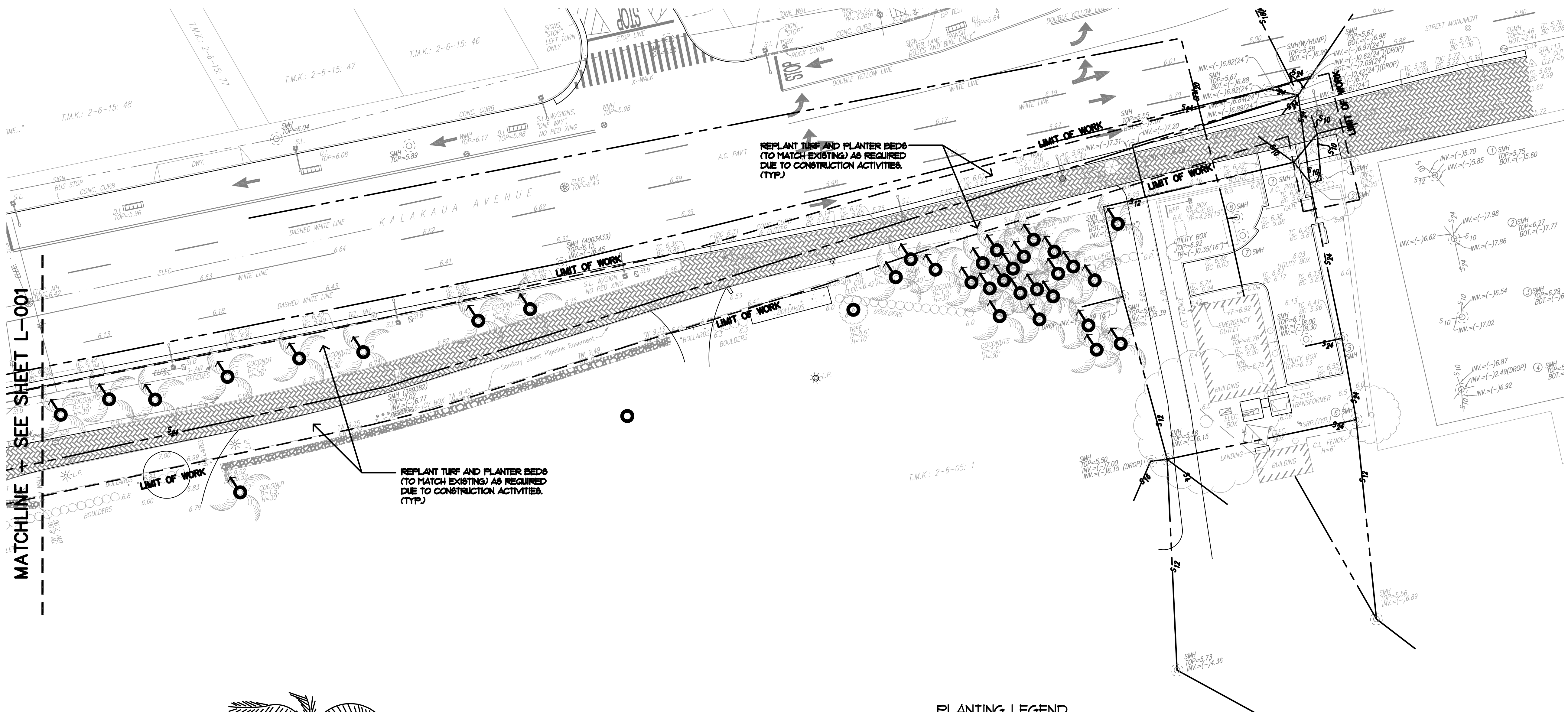


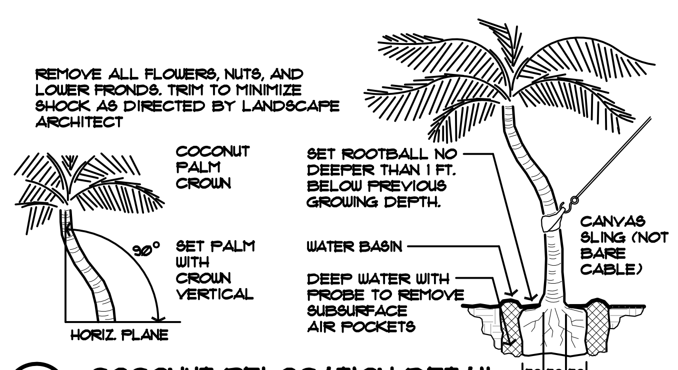

## PLANTING LEGEND

- EXISTING TREE TO REMAIN
- EXISTING COCONUT TO REMAIN
- RELOCATED COCONUT

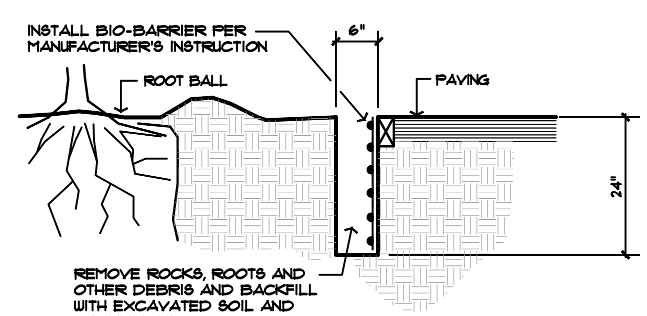
## PLANTING NOTES

1. FINAL COCONUT LOCATIONS TO BE STAKED IN FIELD BY LANDSCAPE ARCHITECT.
2. REPAIR IRRIGATION SYSTEM AS REQUIRED DUE TO CONSTRUCTION ACTIVITIES.




COCONUT RELOCATION DETAIL
NO SCALE




ROOT BARRIER INSTALLATION
NO SCALE

## PLANTING LEGEND

- EXISTING TREE TO REMAIN
- EXISTING COCONUT TO REMAIN
- RELOCATED COCONUT

## PLANTING NOTES

1. FINAL COCONUT LOCATIONS TO BE STAKED IN FIELD BY LANDSCAPE ARCHITECT.
2. REPAIR IRRIGATION SYSTEM AS REQUIRED DUE TO CONSTRUCTION ACTIVITIES.

0 10 20 40
SCALE 1" = 20'
* SCALE 1" = 40' at 11x17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Consultant

Project
KALIA-FORT DERUSSY WASTEWATER SYSTEM IMPROVEMENTS

Sheet Title
PLANTING PLAN 2

Revisions

Drawing Date August 2012
AutoCad File mai-plant.dwg

THIS WORK WAS PREPARED BY ME OR UNDER MY SUPERVISION AND CONSTRUCTION OF THIS PROJECT WILL BE UNDER MY OBSERVATION.

SHELL A. McCELVEY
LICENSED PROFESSIONAL LANDSCAPE ARCHITECT
No. 7119
HAWAII, U.S.A.

Sheet Number
L-102

# APPENDIX G
# ARBORIST ASSESSMENT
# (STEVE NIMZ AND ASSOCIATES, INC.)

Steve Nimz and Associates Inc.
Consulting Arborist Services
PO BOX 10026 Honolulu, Hawaii 96816
Office # (808) 734-5963 Fax # (808) 732-4433
Email: Steve@stevenimz.com

July 27, 2012

Shelli McCelvey
McCelvey Associates, Inc.
442 Ulunui Street # A
Kailua, Hawaii 96734

Re: Kalia/Ft DeRussy WW Improvement Project

Dear Ms. McCelvey:

The following comments are regarding the Kalia/Ft DeRussy WW Improvement Project. After discussion with Shelli McCelvey related to my report dated July 2, 2012 regarding the trenching alignment, it appears additional Coconut Palms will be impacted. Shelli has the most recent detailed drawings to work off.

Near Kalia Road on Ala Moana Boulevard, four (4) additional palms # 2, # 3, # 4 and # 8 will need to be added to the original five (5) palms identified for relocation. Coconut palm # 18 is stressed, but still an acceptable candidate for relocation on-site.

If you have any questions, please contact my office at 808-734-5963.

Respectfully yours,

Steve Nimz,
ASCA Consulting Arborist

ISA Certified Arborist # WE- 0314AM
ISA PNW Certified Tree Risk Assessor # 419

CC: Tracy Furuya- Group 70 International

Steve Nimz and Associates Inc.

Consulting Arborist Services

PO BOX 10026 Honolulu, Hawaii 96816
Office # (808) 734-5963 Fax # (808) 732-4433
Email: Steve@stevenimz.com

July 27, 2012

Shelli McCelvey
McCelvey Associates, Inc.
442 Ulunui Street # A
Kailua, Hawaii 96734

Re: Kalia/Ft DeRussy WW Improvement Project

Dear Ms. McCelvey:

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Near Kalia Road on Ala Moana Boulevard, four (4) additional palms # 2, # 3, # 4 and # 8 will need to be added to the original five (5) palms identified for relocation. Coconut palm # 18 is stressed, but still an acceptable candidate for relocation on-site.

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Respectfully yours,

Steve Nimz,
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ISA Certified Arborist # WE- 0314AM
ISA PNW Certified Tree Risk Assessor # 419

CC: Tracy Furuya- Group 70 International

Steve Nimz and Associates Inc.
Consulting Arborist Services
PO BOX 10026 Honolulu, Hawaii 96816
Office # (808) 734-5963 Fax # (808) 732-4433
Email: Steve@stevenimz.com

July 2, 2012

Tracy A. Furuya
Group 70 International
925 Bethel Street, 5th Floor
Honolulu, Hawaii 96813

Re: Kalia-Fort DeRussy Wastewater System Improvements

Dear Mr. Furuya:

The following tree assessment addresses trees and palms impacted by the proposed thirty (30) inch Kalia-Fort DeRussy Wastewater System Improvement-NEPAEA Project.

Tracy Furuya from Group 70 International requested a review of the alignment in relation to the existing impact to trees and palms. Group 70 International provided a site map that identified the route of the sewer line in red with orange colored highlighter. The construction will consist of an open trench excavation from Kalia Street along the Ala Moana Boulevard around to Kalakaua Avenue (site map). The majority of the four-foot wide trench will be in the sidewalk. The Ala Moana Boulevard sidewalk meanders in a free flow design. The relative straight line trench will be extremely close to select Coconut palms. The final marked alignment of the dig line will determine exactly which palms will be impacted. The minimum distance required for trenching adjacent to palms is twenty-four inches from the edge of the trunk to the edge of the trench on one side of the palm only.

I have numbered the trees and palms within the project work boundaries (site map) that corresponds to the spreadsheet providing tree number, species, size (diameter, height and crown spread, health and structural rating, mitigation (prune, remove, transplant), photographs and comments).

Reviewing the site map and observation during my site inspection; I identified a minimum of five (5) Coconut palms # 11, # 12, # 17, # 18 and # 19 that appear to be within the minimum required excavation boundaries. Coconut palm # 18 was not identified on the original site map.

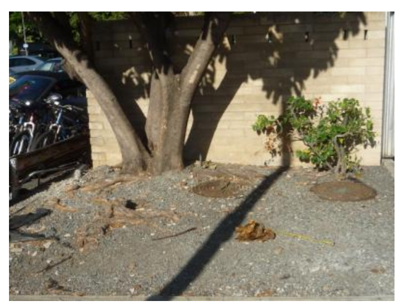
Additional Palm

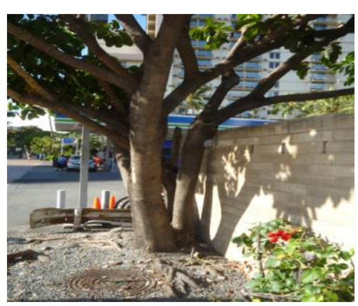
The five (5) Coconut palms are transplantable. I would recommend relocating to a more appropriate permanent location on the Fort DeRussy site. If this cannot be accomplished the other two options include: remove and replace with new Coconut palms or transplant to a holding nursery area and replant when project is completed.

Additional conflicts include the crown of Ficus # 29 growing low over Kalakaua Avenue sidewalk which will interfere with excavation equipment. Mitigation would require crown raising to provide clearance.

At the end of the project where the lines connect to the pumping station. Brassaia tree # 30 is growing against the wall and the root structure is growing around the manhole covers.

It is my opinion the tree should be removed because of potential damage to the wall, conflict with the manholes and excavation.





Large canopy Monkeypod and Ficus trees on Ala Moana Boulevard are next to the wall and outside the excavation area. Select canopies extend over the excavation site. Roots maybe impacted during excavation. The impact will be minimal to the trees with proper root pruning procedures implemented during excavation.

A general Tree Protection Plan is provided with this report. Site specific requirements will be developed after a final site inspection is conducted with design and construction team to determine the exact alignment and marked out.

If you have any questions, please contact my office at 808-734-5963.

Respectfully yours,

Steve Nimz,
ASCA Consulting Arborist

ISA Certified Arborist # WE- 0314AM
ISA PNW Certified Tree Risk Assessor # 419

Attachments: Spreadsheet
Site map
Photographs

Kalia-Fort DeRussy Wastewater System Improvements

Photo # 1

Photo # 2

Photo # 3

Photo # 4

Photo # 5

Photo # 6

Photo # 7


Photo # 8

Photo # 9

Photo # 10

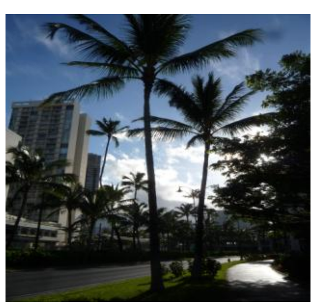


Photo # 11

Photo # 12


Photo # 13


Photo # 14


Photo # 15


Photo # 16


Photo # 17


Photo # 18

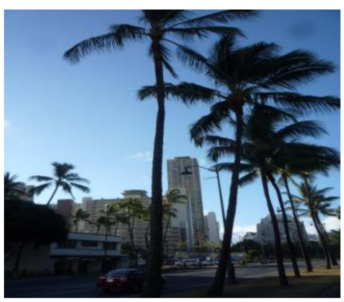


Photo # 19


Photo # 20


Photo # 21


Photo # 22


Photo # 23


Photo # 24


Photo # 25


Photo # 26


Photo # 27


Photo # 28


KALAKAUA AVENUE
KALAKAUA AVENUE
ALA MOANA BOULEVARD
STOP
ADDITIONAL PALM

| Tree # | Species | Diameter (inches) | Height (feet) | Crown Spread | Health Condition | Structural Condition | Prune, Remove, Transplant | Photo | Comments |
|---|---|---|---|---|---|---|---|---|---|
| 1 | Coconut palm | 10 | 20 | | Good | Good | | 1 | Slight hourglassing |
| 2 | Coconut palm | 12 | 22 | | Good | Good | | 1 | |
| 3 | Coconut palm | 14 | 30 | | Good | Good | | 2 | |
| 4 | Coconut palm | 14 | 25 | | Good | Good | | 3 | |
| 5 | Coconut palm | 18 | 35 | | Good | Good | | 3 | Slight hourglassing |
| 6 | Coconut palm | 16 | 30 | | Good | Good | | 4 | |
| 7 | Coconut palm | 16 | 35 | | Good | Good | | 5 | Slight hourglassing |
| 8 | Coconut palm | 18 | 35 | | Good | Good | | 6 | |
| 9 | Coconut palm | 14 | 25 | | Good | Good | | 7 | |
| 10 | Coconut palm | 14 | 25 | | Good | Good | | 8 | |
| 11 | Coconut palm | 14 | 20 | | Good | Good | Transplant? | 9 | |
| 12 | Coconut palm | 16 | 25 | | Good | Good | Transplant? | 10 | |
| 13 | Coconut palm | 15 | 35 | | Good | Good | | 11 | |
| 14 | Coconut palm | 16 | 30 | | Good | Good | | 11 | |
| 15 | Coconut palm | 18 | 25 | | Good | Good | | 12 | |
| 16 | Coconut palm | 14 | 25 | | Good | Good | | 13 | Slight hourglassing |
| 17 | Coconut palm | 14 | 25 | | Good | Good | Transplant | 14 | |
| 18 | Coconut palm | 15 | 30 | | Fair | Good | Transplant | 15 | Stressed, smaller fronds, slight hourglassing |
| 19 | Coconut palm | 15 | 20 | | Good | Good | Transplant? | 16 | |
| 20 | Coconut palm | 14 | 35 | | Fair | Fair-Poor | | 17, 18 | Severe hourglassing, curved upper trunk |
| 21 | Coconut palm | 16 | 40 | | Fair | Fair | | 19 | Slight hourglassing |
| 22 | Coconut palm | 14 | 35 | | Fair | Fair | | 19 | Slight hourglassing |
| 23 | Coconut palm | 12 | 30 | | Fair | Fair | | 20 | Slight hourglassing, curved trunk |
| 24 | Coconut palm | 14 | 30 | | Good | Fair | | 20 | Slight hourglassing |
| 25 | Coconut palm | 15 | 32 | | Fair | Fair | | 21 | Stressed |

| Tree # | Species | Diameter (inches) | Height (feet) | Crown Spread | Health Condition | Structural Condition | Prune or Remove | Photo | Comments |
|---|---|---|---|---|---|---|---|---|---|
| 26 | Coconut palm | 16 | 35 | | Fair | Fair | | 21 | Hourglassing |
| 27 | Coconut palm | 14 | 30 | | Fair | Fair | | 22 | Hourglassing |
| 28 | Coconut palm | 13 | 25 | | Fair | Fair | | 22 | Hourglassing |
| 29 | Ficus | 60 | 35 | 60 | Good | Good | Prune | 23, 24 | Prune and raise off sidewalk |
| 30 | Brassaia | 24 | 15 | 25 | Good | Good | Remove? | 25, 26, 27 | Growing against wall, aggressive roots growing around manhole covers |
| | | | | | | | | | |
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## APPENDIX H

## ARCHAEOLOGICAL LITERATURE REVIEW AND FIELD INSPECTION

## (CULTURAL SURVEYS HAWAII, INC.)

# DRAFT

# Archaeological Literature Review and Field Inspection for the Kālia-Fort DeRussy Wastewater System Improvements, Waikīkī Ahupua‘a, Honolulu (Kona) District, O‘ahu Island

## TMK: [1] 2-6-005:001 por. + easements

**Prepared for**

**Group 70 International, Inc.**


**Prepared by**

**Ena Sroat, B.A.,**

**And**

**Matt McDermott, M.A.,**

**Cultural Surveys Hawai‘i, Inc.**

**Kailua, Hawai‘i**


**(Job Code: WAIKIKI 64)**

**August 2012**


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**1860 Main St.**
**Wailuku, Hawai‘i 96793**
**Ph: (808) 242-9882**
**Fax: (808) 244-1994**

# Management Summary

| | |
|---|---|
| **Reference** | Archaeological Literature Review and Field Inspection for the Kālia-Fort DeRussy Wastewater System Improvements, Waikīkī Ahupuaʻa, Honolulu (Kona) District, Oʻahu Island TMK: [1] 2-6-005:001 por. + easements (Sroat et al. 2012) |
| **Date** | August 2012 |
| **Project Number (s)** | Cultural Surveys Hawaiʻi, Inc. (CSH) Job Code: WAIKIKI 64 |
| **Investigation Permit Number** | CSH conducted the archaeological fieldwork for this investigation under state archaeological permit number 12-04, issued by State of Hawaiʻi Department of Land and Natural Resources / State Historic Preservation Division (DLNR / SHPD) |
| **Project Location** | Kālia Road (between Paoa Place and Ala Moana Boulevard); Ala Moana Boulevard (between Kālia Road and Kalākaua Avenue); Kalākaua Avenue (between Ala Moana Boulevard and Kuhiō Avenue); and the Fort DeRussy Waste Water Pump Station (WWPS). The project area is depicted on the 1998 U.S. Geological Survey 7.5-Minute Series Topographic Map, Honolulu Quadrangle. |
| **Land Jurisdiction** | City & County of Honolulu (City); United States Army (Army) |
| **Agencies** | SHPD/DLNR, City, Army |
| **Project Description** | This Project involves improvements to existing City wastewater collection system along a portion of Kālia Road and a portion of Fort DeRussy. The planned improvements will accommodate sewer flows from the Hale Koa Hotel, the Hilton Hawaiian Village and the service area between the Ala Wai Canal, Kalākaua Avenue and Fort DeRussy. The proposed Kālia Road Sewer Line will replace the existing 12-inch sewer line with a 21-inch sewer line. The Project area will begin at the intersection of Paoa Place and Kālia Road and end at the intersection of Ala Moana Boulevard and Kālia Road. The existing 16-inch diameter sewer line, which traverses across Fort DeRussy in a sewer line easement, will be cut and plugged at the Ala Moana Boulevard and Kālia Road intersection. The existing 24-inch sewer line located on Ala Moana Boulevard and Kalākaua Avenue will be replaced with a 30-inch sewer line. The Project area will begin at the intersection of Kālia Road and Ala Moana Boulevard and end at the Fort DeRussy Waste Water Pumping Station. The work within the Fort DeRussy property will be contained within a City and County of Honolulu sewer line easement. |
| **Project Acreage** | Approximately 1.15 acres. |
| **Area of Potential Effect (APE) and Survey Acreage** | For the purposes of this archaeological literature review and field inspection, the area of potential effect is considered to be the entire approximately 1.15-acre study area. |

| | |
|---|---|
| **Historic Preservation Regulatory Context** | The proposed project is subject to Hawaiʻi State environmental and historic preservation review legislation [Hawaiʻi Revised Statutes (HRS) Chapter 343 and HRS 6E-8/Hawaiʻi Administrative Rules (HAR) Chapter 13-275, respectively]. Due to the involvement of federal lands (U.S. Army Fort DeRussy military reservation) the project is also subject to the federal historic preservation and environmental review process, requiring compliance with Section 106 of the National Historic Preservation Act (NHPA) and the National Environmental Policy Act (NEPA).<br><br>While this investigation does not fulfill the requirements of an archaeological inventory survey investigation (per HAR Chapter 13-276), it serves as a document to facilitate the proposed project's planning and supports historic preservation review compliance by assessing if there are major archaeological concerns within the study area and to develop data on the general nature, density and distribution of archaeological resources. |
| **Fieldwork Effort** | The fieldwork component for this Literature Review and Field Inspection (LRFI) was conducted on January 24, 2012 by CSH project managers Matt McDermott, M.A. (principal investigator) and David Shideler, M.A. This fieldwork consisted of the systematic traverse of the study area to investigate for surface historic properties and the photographic documentation of the surface landscape and above-ground structures. Additionally, as will be reported in the final version of this LRFI report prepared to support the project's final EA, fieldwork for the final LRFI will include the results of archaeological monitoring of several geotechnical borings that are required for project engineering. |
| **Results Summary** | Based on a review of historic documents, the study area, which is located within the *ʻili* (land district) of Kālia within the larger *ahupuaʻa* (district) of Waikīkī, was greatly utilized during the pre-Contact and early post-Contact period as an area of rich wetland resources. The waters of Piʻinaio Stream and the natural coastal wetlands were modified into a complex system of interlocking fishponds and *ʻauwai* (irrigation channels) behind the sandy dunes and swales of the coast.<br><br>During the Māhele land divisions of the mid-1800s Land Commission Awards (LCAs) dotted the drier lands of the area. Within the study area only two LCAs were awarded (LCA #2511 and LCA #2083), both described as house lots.<br><br>During the post-Contact period land use patterns began to shift towards residential and commercial development. The early 1900s saw the most dramatic changes to the study area with the development of Fort DeRussy military reservation and the associated in-filling of the Kālia |

| | |
|---|---|
| | ponds as well as the 1920s Waikīkī land reclamation efforts which filled in the wetlands and streams of Waikīkī.<br><br>Within the past three decades numerous previous archaeological investigations have been conducted within the study area and the immediate vicinity. These studies have provided fairly extensive documentation of the subsurface stratigraphy within the study area and indicate that subsurface cultural and historical deposits continue to exist beneath the numerous fill layers associated with modern development. Archaeological finds documented during these studies include: human burials, pre- and post-Contact cultural layers, buried fishponds, ditches, and other remains of extensive wetland agriculture, historic trash pits, and construction debris.<br><br>In particular, archaeological deposits documented within the study area or immediate vicinity include: remnants of the Loko Kaipuni complex of ponds (SIHP #-4573) along with probable *‘auwai*, historic cultural layers and trash pit features (SIHP #-2780), and numerous human burials, including burial complexes (SIHP #-2780; -4570; -7087).<br><br>In conclusion, it is very likely that any ground disturbance within the study area that impacts areas not previously excavated (i.e. the widening or deepening of extant sewer line trenches) may expose similar cultural and historic deposits. |
| **Recommendations** | The study area has been the focus of numerous previous archaeological studies which have covered almost the entire length of the study corridor or the areas immediately adjacent. Accordingly, previous archaeological documentation has provided a fairly extensive overview of the subsurface stratigraphy within the majority of the study area. For this reason a subsurface archaeological inventory survey is not considered necessary for the project area. However, due to the concentration of pre-Contact and post-Contact cultural and historical deposits within the immediate area, and in particular the potential for human burials, an archaeological monitoring program is warranted as an appropriate mitigation measure for the project’s ground disturbance.<br><br>Background research documents a burial reinterment location (“Burial 11”) within the southernmost portion of the study area, located at the intersection of Kālia Road and Paoa Place. Because the precise location of this reinterment site is not known and may lie within the proposed path of ground disturbance, as part of the project’s archaeological monitoring program careful subsurface probing in the southernmost portion of the project area is warranted. |

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# Section 1 Introduction

## 1.1 Project Background

At the request of Group 70 International, Inc., Cultural Surveys Hawai‘i, Inc. (CSH) completed an archaeological literature review and field inspection for the Kālia-Fort DeRussy Wastewater System Improvements, Waikīkī Ahupua‘a, Honolulu (Kona) District, O‘ahu Island, TMK [1] 2-6-005:001 por. + easements. The study area consists of a linear corridor of proposed sewer line improvements located along Kālia Road (between Paoa Place and Ala Moana Boulevard), Ala Moana Boulevard (between Kālia Road and Kalākaua Avenue), Kalākaua Avenue (between Ala Moana Boulevard and Kuhiō Avenue), and the Fort DeRussy Waste Water Pumping Station. The survey area is depicted on a U.S. Geological Survey (USGS) Topographic Map (Figure 1), a Tax Map Key (TMK) (Figure 2), and on an aerial photograph (Figure 3).

### 1.1.1 Project Description

This Project involves improvements to existing City and County of Honolulu wastewater collection system along a portion of Kālia Road and a portion of Fort DeRussy. The planned improvements will accommodate sewer flows from the Hale Koa Hotel, the Hilton Hawaiian Village and the service area between the Ala Wai Canal, Kalākaua Avenue and Fort DeRussy. The proposed Kālia Road Sewer Line will replace the existing 12-inch sewer line with a 21-inch sewer line. The Project area will begin at the intersection of Paoa Place and Kālia Road and end at the intersection of Ala Moana Boulevard and Kālia Road. The existing 16-inch diameter sewer line, which traverses across Fort DeRussy in a sewer line easement, will be cut and plugged at the Ala Moana Boulevard and Kālia Road intersection. The existing 24-inch sewer line located on Ala Moana Boulevard and Kalākaua Avenue will be replaced with a 30-inch sewer line. The Project area will begin at the intersection of Kālia Road and Ala Moana Boulevard and end at the Fort DeRussy Waste Water Pumping Station. The work within the Fort DeRussy property will be contained within a City and County of Honolulu sewer line easement.

### 1.1.2 Historic Preservation Regulatory Context

The proposed project is subject to Hawai‘i State environmental and historic preservation review legislation [Hawai‘i Revised Statutes (HRS) Chapter 343 and HRS 6E-8/Hawai‘i Administrative Rules (HAR) Chapter 13-275, respectively]. Due to the involvement of federal lands (U.S. Army Fort DeRussy military reservation) the project is also subject to the federal historic preservation and environmental review process, requiring compliance with Section 106 of the National Historic Preservation Act (NHPA) and the National Environmental Policy Act (NEPA).

## 1.2 Scope of Work

This study was not intended to meet the requirements of an archaeological inventory-level survey per the rules and regulations of the State Historic Preservation Division/Department of Land and Natural Resources (SHPD/DLNR). However, the level of work is sufficient to address archaeological site types and locations, and allow for future work recommendations. The literature review and field inspection includes a report detailing research methods and findings.

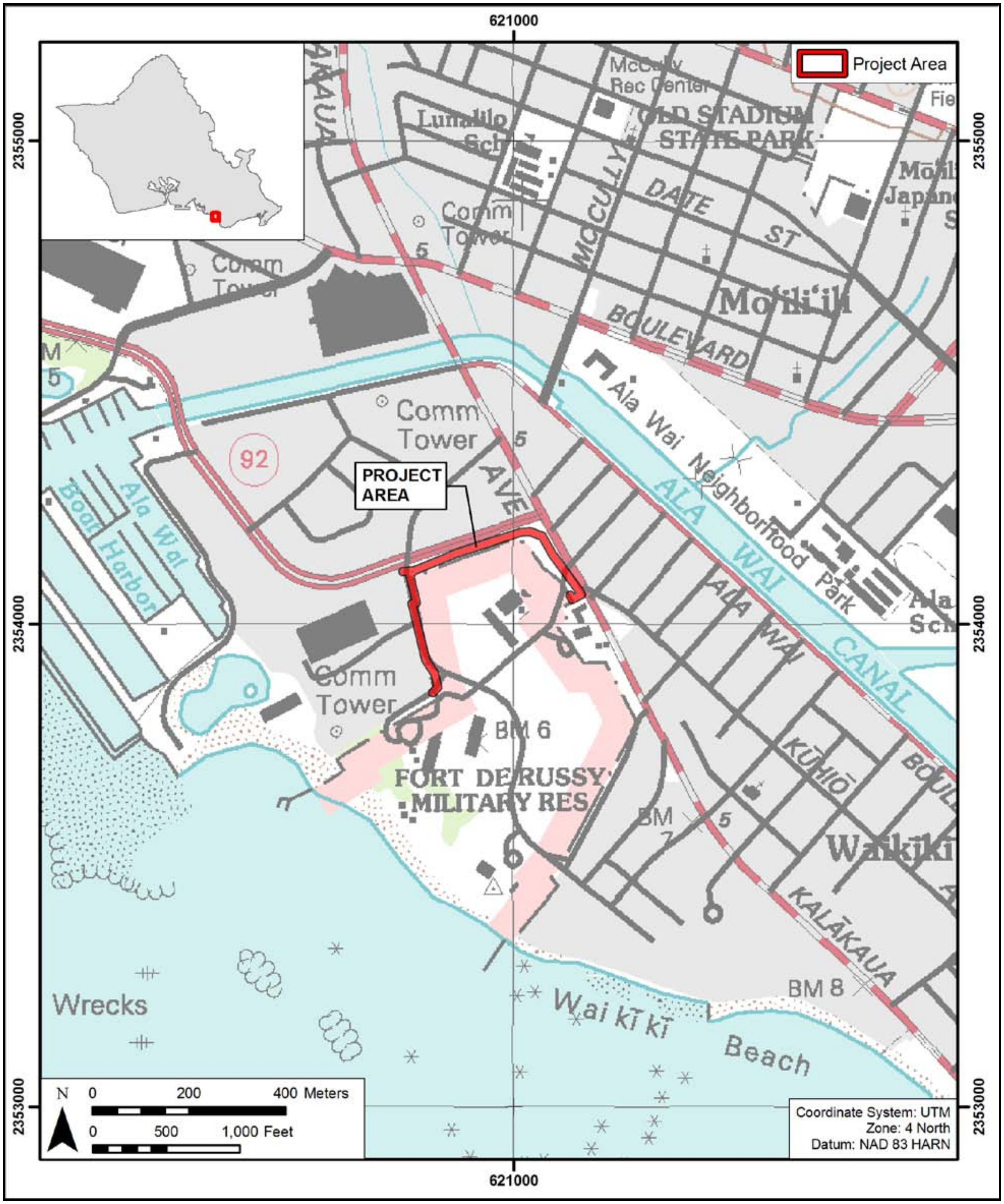


Figure 1. 1998 U.S. Geological Survey 7.5-Minute Series Topographic Map, Honolulu Quadrangle, showing the location of the study area

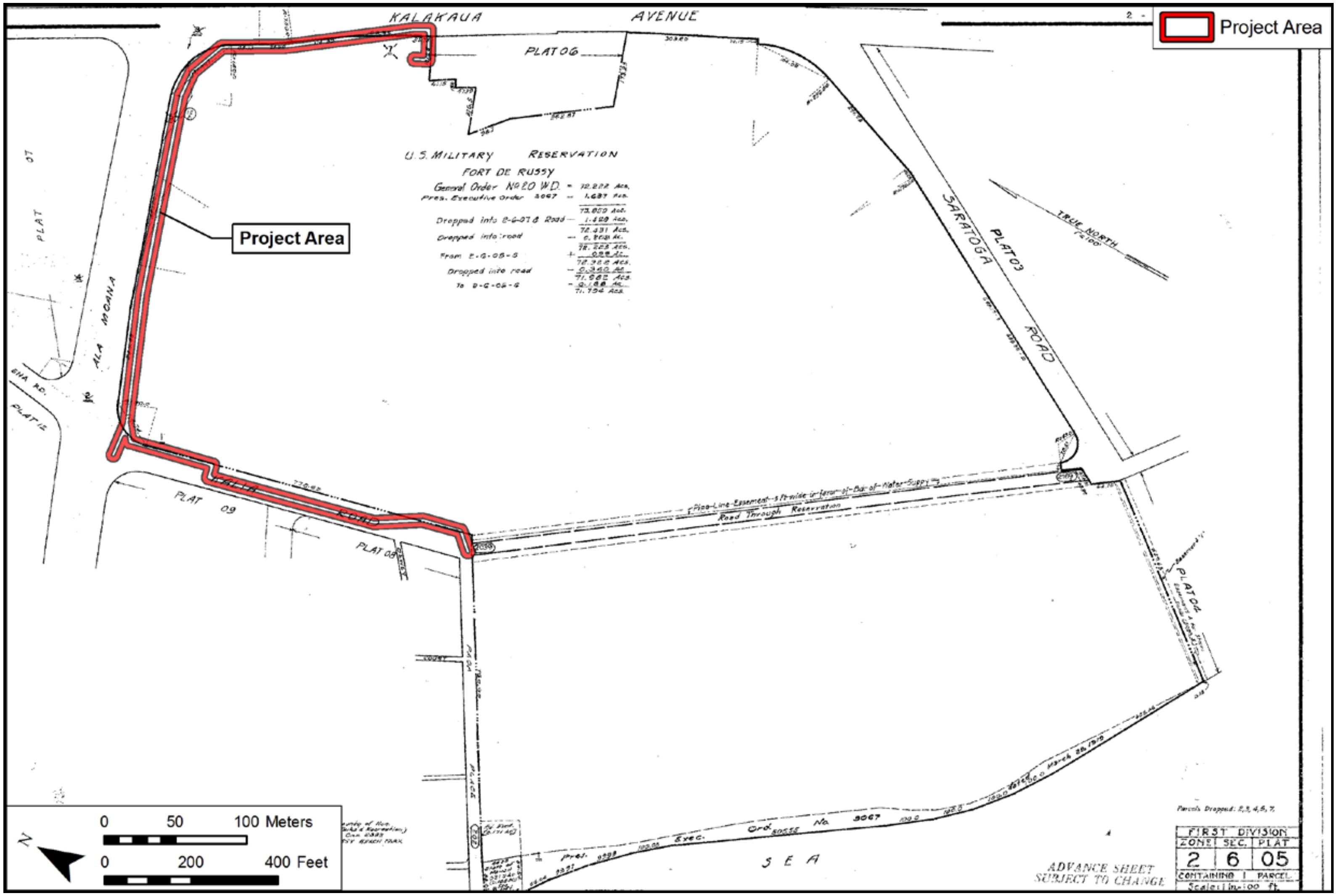


Figure 2. Tax Map Key (TMK) 2-6-005 showing the location of the study area


Figure 3. Aerial photograph (GoogleEarth), showing the location of the study area

The goal was to identify, if possible, any cultural resources documented in historical and archival record.

<u>Scope of Work</u>

1. Historical research to include study of archival sources, historic maps, Land Commission Awards and previous archaeological reports to construct a history of land use and to determine if archaeological sites have been recorded on or near this property.
2. Limited field inspection of the project area to identify any surface archaeological features and to investigate and assess the potential for impact to such sites. This assessment will identify any sensitive areas that may require further investigation or mitigation before the project proceeds. Additionally, as will be reported in the final version of this LRFI report prepared to support the project's final EA, fieldwork for the final LRFI will include the results of archaeological monitoring of several geotechnical borings that are required for project engineering.
3. Preparation of a report to include the results of the historical research and the limited fieldwork with an assessment of archaeological potential based on that research, with recommendations for further archaeological work, if appropriate. It will also provide mitigation recommendations if there are archaeologically sensitive areas that need to be taken into consideration.

## 1.3 Environmental Setting

### 1.3.1 Natural Environment

The study area is located along the southeastern coast of Oʻahu. The Honolulu leeward coastal plain is stratified with late-Pleistocene coral reef substrate overlaid with calcareous marine beach sand, terrigenous sediments, and/or stream-fed alluvial deposits (Armstrong 1973:36). Terrigenous sediments are formed and deposited on land, or are materials derived from land mixed with purely marine material. The modern Honolulu shoreline configuration is primarily the result of three factors: the rising sea level following the end of the Pleistocene (Stearns 1978); the 1.5-2.0 meter high-stand of the sea during the mid to late Holocene; and pre- and post-Contact human landscape modification. Lands within the study area are relatively level with an elevation of 3 ft above mean sea level (AMSL).

The study area receives between 23 and 31 inches (600-800 millimeters) of rainfall per year (Giambelluca et al. 1986). Despite the relatively low rainfall, during pre-Contact and early post-Contact times the natural landscape was rich in water resources in the form of Piʻinaio Stream, which descended from the Koʻolau mountains and formed a ribboned delta as it entered the sea in the *ʻili* (land district) of Kālia in the western portion of Waikīkī, and the surrounding marshy lands behind the dunes and swales of the coastline. Natural vegetation would have consisted of coastal marshland species.

According to U.S. Department of Agriculture (USDA) soil survey data, sediments within the survey area consist primarily of Fill Land (FL) with a portion of Jaucuas Sand (JaC) along the *makai* (seaward) segment of the project area along Kalia Road (Foote et al. 1972) (Figure 4).

The following is a synopsis of each soil series:

> Fill is described as a land type occurring mostly near Pearl Harbor and in Honolulu, adjacent to the ocean. It consists of areas filled with material dredged from the ocean or hauled from nearby areas, garbage, and general material from other sources. (Foote et al. 1972)
>
> Jaucas series consists of excessively drained, calcareous soils that occur as narrow strips on coastal plains, adjacent to the ocean…developed in wind and water deposited sand from coral and seashells…used for pasture, sugarcane, truck crops, alfalfa, recreational areas, wildlife habitat, and urban development. (Foote et al. 1972)

### 1.3.2 Built Environment

The first major modifications to the natural landscape of the study area within Kālia were undertaken following the translocation of the O‘ahu royal seat to Waikīkī in the 1400s. The natural wetlands of Waikīkī were transformed into a large network of fishponds, *‘auwai* (irrigation ditches), bunds, and agricultural fields, such as taro *lo‘i*, banana and sugarcane plantings, and coconut groves. Within the study area an interlocking complex of small fishponds known as the Loko Kaipuni Fishponds were created and remained extant up until the late 1920s. The large Loko Paweo I Fishpond was also in the immediate vicinity.

Subsequent intensive historic development of the project area has resulted in an entirely modified landscape in which the original wetlands have been filled in and surfaced with paved asphalt roads, concrete walkways, and manicured landscaping.

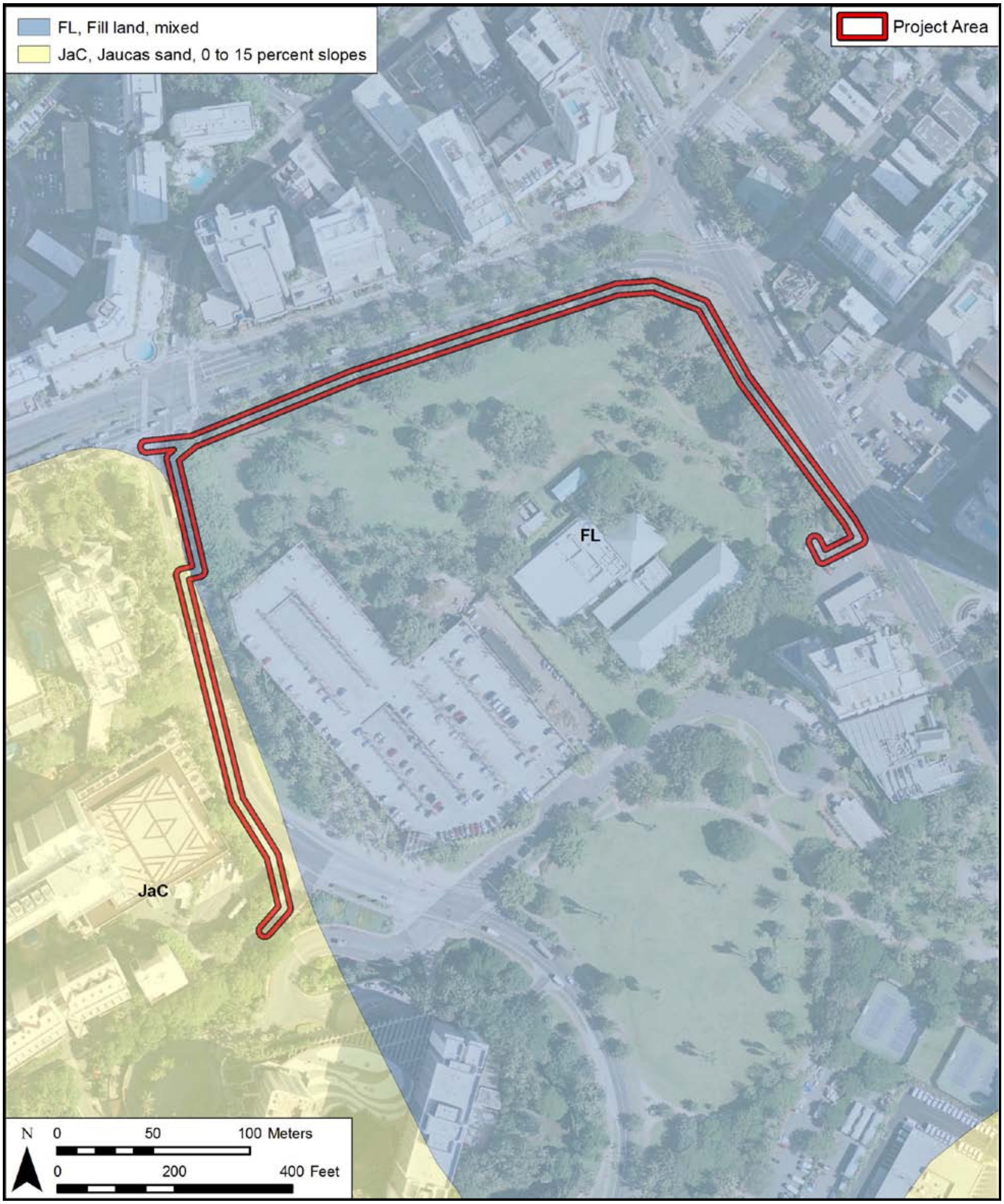


Figure 4. Overlay of Soil Survey of the State of Hawaiʻi (Foote et al. 1972) showing sediment types within the study area (base GoogleEarth aerial photograph)

# Section 2 Methods

## 2.1 Field Methods

The fieldwork component of this literature review and field inspection was carried out under archaeological research permit number 12-04, issued by the Hawaiʻi State Historic Preservation Division/Department of Land and Natural Resources (SHPD/DLNR), per Hawaiʻi Administrative Rules (HAR) Chapter 13-13-282. Fieldwork was conducted on January 24, 2012 by two CSH project managers, Matt McDermott, M.A. (principal investigator) and David Shideler, M.A.

In general, the purpose of the field inspection was to identify any surface archaeological features and to investigate and assess the potential for impact to such sites. Fieldwork consisted of the systematic traverse of the study area and photographic documentation of the landscape and any above-ground structures.

As noted in the Scope of Work, fieldwork for this investigation will include the results of archaeological monitoring of several geotechnical borings that are required for project engineering. These archaeological monitoring results have not yet occurred and will be reported in the final version of this LRFI report prepared to support the project's final EA. Methods for this geotechnical boring archaeological monitoring will include recording stratigraphic observations of the sediments extracted from the approximately 6-inch diameter geotechnical borings. Photos of the geotechnical boring process will be taken and any archaeological results noted.

## 2.2 Document Review

Background research included: a review of previous archaeological studies on file at SHPD; review of documents at Hamilton Library of the University of Hawaiʻi, the Hawaiʻi State Archives, the Mission Houses Museum Library, the Hawaiʻi Public Library, and the Archives of the Bishop Museum; study of historic photographs at the Hawaiʻi State Archives and the Archives of the Bishop Museum; and study of historic maps at the Survey Office of the Department of Land and Natural Resources. Historic maps and photographs from the CSH library were also consulted. In addition, Māhele records were examined from the Waihona ʻAina database (<www.waihona.com>).

This research provided the environmental, cultural, historic, and archaeological background for the study area. The sources studied were used to formulate a predictive model regarding the expected types and locations of historic properties in the study area.

# Section 3 Background Research

## 3.1 Traditional and Historical Background

The study area is located in the *‘ili* (land division) of Kālia within the *ahupua‘a* (larger land division) of Waikīkī, O‘ahu. The area of Kālia abutted the *‘ili* of Kewalo on the west and extended along the coast to the *‘ili* of Helumoa, encompassing the ribboned delta of Pi‘inaio Stream.

### 3.1.1 Waikīkī Pre-Contact to 1800s

By the time of the arrival of Europeans in the Hawaiian Islands during the late eighteenth century, Waikīkī had long been a center of population and political power on O‘ahu. According to Martha Beckwith (1940), by the end of the fourteenth century Waikīkī had become “the ruling seat of the chiefs of Oahu.” The preeminence of Waikīkī continued into the eighteenth century and is betokened by Kamehameha’s decision to reside there upon wresting control of O‘ahu by defeating the island’s chief, Kalanikūpule. The 19th-century Hawaiian historian John Papa ‘Ī‘ī (1959:17), himself a member of the *ali‘i* (chiefly class), described the king’s Waikīkī residence:

> Kamehameha’s houses were at Puaaliilii, *makai* (towards the ocean) of the old road, and extended as far as the west side of the sands of ‘Apuakehau. Within it was Helumoa where Ka‘ahumanu *mā* (and company) went to while away the time. The king built a stone house there, enclosed by a fence . . . (‘Ī‘ī 1959:17).

‘Ī‘ī further noted that the “place had long been a residence of chiefs. It is said that it had been Kekuapoi’s home, through her husband Kahahana, since the time of Kahekili” (‘Ī‘ī 1959:17).

Chiefly residences, however, were only one element of a complex of features that characterized Waikīkī during pre-contact. Beginning in the fifteenth century, a vast system of irrigated taro fields was constructed, extending across the littoral plain from Waikīkī to lower Mānoa and Pālolo valleys. This field system – an impressive feat of engineering the design of which is traditionally attributed to the chief Kalamakua – took advantage of streams descending from Makiki, Mānoa and Pālolo valleys that also provided ample fresh water for the Hawaiians living in the *ahupua‘a* (land division). Water was also available from springs in nearby Mō‘ili‘ili and Punahou. Closer to the Waikīkī shoreline, coconut groves and fishponds dotted the landscape. A sizeable population developed amidst this Hawaiian-engineered abundance. Captain George Vancouver (1798:161-164), arriving at “Whyteete” in 1792, captured something of this profusion in his journals:

> On shores, the villages appeared numerous, large, and in good repair; and the surrounding country pleasingly interspersed with deep, though not extensive valleys; which, with the plains near the sea-side, presented a high degree of cultivation and fertility.
>
> [Our] guides led us to the northward through the village, to an exceedingly well-made causeway, about twelve feet broad, with a ditch on each side.
>
> This opened our view to a spacious plain, which, in the immediate vicinity of the village, had the appearance of the open common fields in England; but, on

> advancing, the major part appeared to be divided into fields of irregular shape and figure, which were separated from each other by low stone walls, and were in a very high state of cultivation. These several portions of land were planted with the eddo or taro root, in different stages of inundation; none being perfectly dry, and some from three to six or seven inches under water. The causeway led us near a mile from the beach, at the end of which was the water we were in quest of. It was a rivulet five or six feet wide, and about two or three feet deep, well banked up, and nearly motionless; some small rills only, finding a passage through the dams that checked the sluggish stream, by which a constant supply was afforded to the taro plantations.
>
> [We] found the plain in a high state of cultivation, mostly under immediate crops of taro; and abounding with a variety of wild fowl, chiefly of the duck kind . . . The sides of the hills, which were at some distance, seemed rocky and barren; the intermediate vallies, which were all inhabited, produced some large trees, and made a pleasing appearance. The plain, however, if we may judge from the labour bestowed on their cultivation, seemed to afford the principal proportion of the different vegetable productions on which the inhabitants depend for their subsistence.

Further details of the exuberant life that must have characterized the Hawaiians use of the lands that included the *ahupuaʻa* of Waikīkī are given by Archibald Menzies (1920:23-24), a naturalist accompanying Vancouver’s expedition:

> The verge of the shore was planted with a large grove of cocoanut palms, affording a delightful shade to the scattered habitations of the natives. Some of those near the beach were raised a few feet from the ground upon a kind of stage, so as to admit the surf to wash underneath them. We pursued a pleasing path back to the plantation, which was nearly level and very extensive, and laid out with great neatness into little fields planted with taro, yams, sweet potatoes and the cloth plant. These, in many cases, were divided by little banks on which grew the sugar cane and a species of Draecena [ti or *kī*] without the aid of much cultivation, and the whole was watered in a most ingenious manner by dividing the general stream into little aqueducts leading in various directions so as to be able to supply the most distant fields at pleasure, and the soil seemed to repay the labour and industry of these people by the luxuriancy of its productions. Here and there we met with ponds of considerable size, and besides being well stocked with fish, they swarmed with water fowl of various kinds such as ducks, coots, water hens, bitterns, plovers and curlews.

However, the traditional Hawaiian focus on Waikīkī as a center of chiefly and agricultural activities on southeastern Oʻahu was soon to change – disrupted by the same Euro-American contact which produced the first documentation (including the records cited above) of that traditional life. The *ahupuaʻa* of Honolulu - with the only sheltered harbor on Oʻahu - became the center for trade with visiting foreign vessels, drawing increasing numbers of Hawaiians away from their traditional environments. Kamehameha himself moved his residence from Waikīkī to the coast near Honolulu harbor, likely in order to maintain his control of the lucrative trade in sandalwood that had developed. By 1828, the missionary Levi Chamberlain (1957:26), describing a journey into Waikīkī, would note:

> Our path led us along the borders of extensive plats of marshy ground, having raised banks on one or more sides, and which were once filled with water, and replenished abundantly with esculent fish; but now overgrown with tall rushes waving in the wind. The land all around for several miles has the appearance of having once been under cultivation. I entered into conversation with the natives respecting this present neglected state. They ascribed it to the decrease of population. (Chamberlain 1957:26)

Tragically, the depopulation of Waikīkī was not simply a result of the attractions of Honolulu (where, by the 1820s, the population was estimated at 6,000 to 7,000) but also of the European diseases that had devastating effects upon the Hawaiian population.

### *3.1.1.1 Kālia*

A Hawaiian saying talks about the pleasant portion of the coast of Kālia in Waikīkī (Pukui 1983:186):

*Ke kai wawalo leo leʻa o Kālia* The pleasing, echoing sea of Kālia.

The ribboned delta of Piʻinaio Stream entered the ocean here, bringing fresh waters from the mountain valleys and creating an area of abundance. The plentiful land and marine resources attracted utilization and settlement of the area **(**Figure 6 and Figure 7). In oral history interviews of residents who lived in Waikīkī before the construction of the Ala Wai Canal, the abundant resources of the area are described (Social Science Research Institute 1985):

> We lived at Kalia, where my dad was a net fisherman. He caught kala, mullet, and weke. He also caught squid [octopus]. There was limu eleele where Piʻinaio Stream entered the ocean. Towards Fort DeRussy there was limu manauea and limu huluhulu waena and a lot of wana. We caught lobsters using nets at night. We used to catch a lot of kala. Where the stream entered the ocean, there was a lot of mud, and there were clams in the mud. We caught opae and oopu in the stream. We fished for papio and white eels. We caught two types of crabs, aama and alamihi. On the reef my dad dived for uhu and kumu, and we did torch fishing at night for mullet, uhu, and kumu. (Fred Paoa, Vol.II)
>
> Limu manauea, limu lipoa, and limu wawaeiole, and big schools of manini were found at Kalia. (John Ernstberg, Vol. I)

Kālia is also a place where ʻ*alamihi* crabs were once plentiful, leading to a play on the word *ʻala-mihi* (path of repentance), indicating someone who is in a repentant mood (Pukui 1983:110):

*Hoʻi i Kālia ka ʻai ʻalamihi.* Gone to Kālia to eat ʻalamihi crabs.

Kālia was also known for a fishing technique used to catch schools of mullet. When a school of mullet appeared, a bag net was set and the men swam out in a row, surrounded the fish, and slapped the water together and kicked their feet, thus driving the frightened fish into the opening of their bag net. The fishermen of Kālia became known as human fishnets (Pukui 1983:150):

*Ka iʻa pīkoi kānaka o Kālia;* The fish caught by the men of Kālia;

Figure 5. 19th century photo of Waikīkī and fishponds, likely taken from Kālia (Hawaiʻi State Archives)

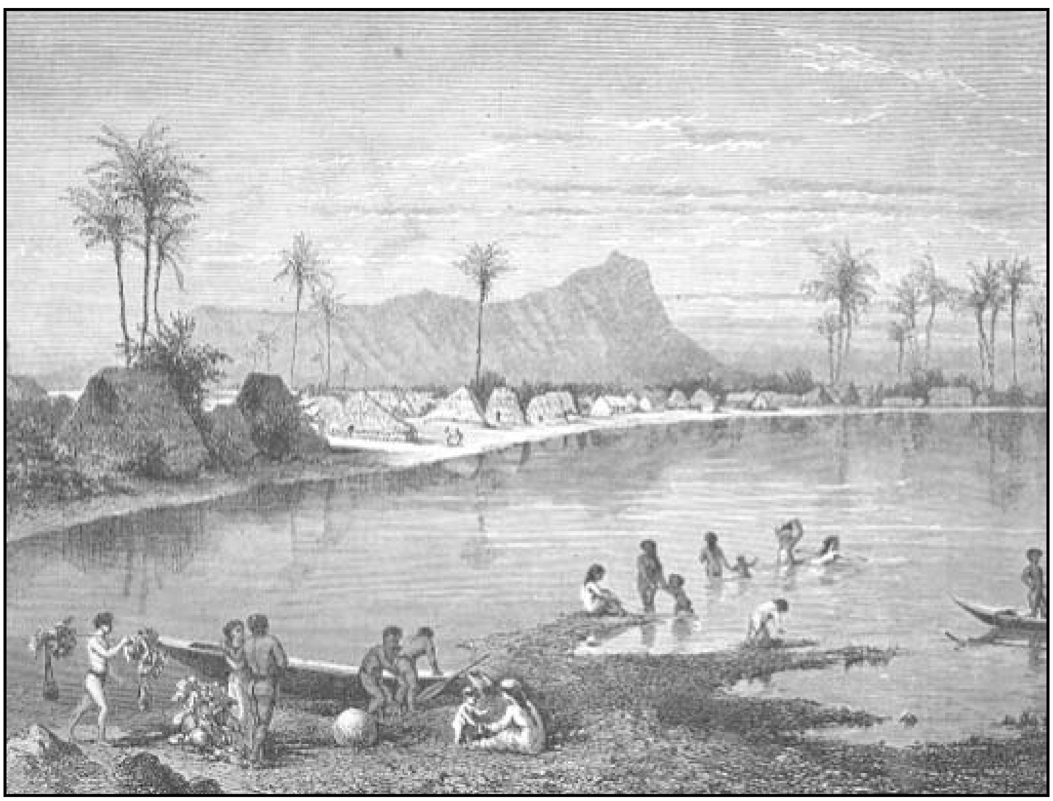

Figure 6. 1853 sketch of Waikīkī with view to Diamond Head, (University of Chicago) (note: close proximity of houses to the shore)

| | |
|---|---|
| *he kānaka ka pīkoi,* | men are the floaters |
| *he kānaka ka pōhaku.* | men are the sinkers |

Kālia is also mentioned in a story about a woman who left her husband and children on Kīpahulu, Maui, to go away with a man of Oʻahu. Her husband missed her and went to see a *kahuna* (priest) who was skilled in *hana aloha* (prayer to evoke love) sorcery. The *kahuna* told the man to find a container with a lid and then speak into it of his love for his wife. The *kahuna* then uttered an incantation into the container, closed it, and threw it into the sea. The wife was fishing one morning at Kālia, Oʻahu, and saw the container. She opened the lid, and was possessed by a great longing to return to her husband. She walked until she found a canoe to take her home (Pukui 1983:158):

| | |
|---|---|
| *Ka makani kāʻili aloha o* | The love-snatching wind |
| *o Kīpahulu.* | of Kīpahulu |

Piʻinaio Stream played a vital role in the geography, and almost certainly the cultural usage, of the *ʻili* of Kālia. The meaning of Piʻinaio is uncertain but it could be an allusion to going inland (*piʻi*), to the location of a *naio* (bastard sandalwood; *Myoporum sandwicense*) tree, as may have commonly grown in the vicinity, to a stream crossing place. The name of the area "Kālia" translated as "waited for" has a sense of "waiting", "loitering", or "hesitating." While the nuance is uncertain one could imagine that the mouth of the Piʻinaio Stream would be a logical place for travelers to pause.

The shallow relatively protected reefs of Waikīkī and the availability of the riparian resources of the Piʻinaio estuary and the back dune ponds that were easily adaptable into fish ponds (the Loko Pāweo and Loko Kaipuni fishpond complexes) would have made the vicinity particularly desirable for Polynesian settlement.

Waikīkī was famous for its fishponds with one listing citing 45 ponds – several of which were at Kālia (Bishop Museum 1989: III 8). John Papa ʻĪʻī (1959:49) relates an account from the early 1800s of a catch at a Kālia fishpond: "so large that a great heap of fish lay spoiling upon the bank of the pond." The waste was disapproved of. This abundance of fishponds may have required significant maintenance and would have provided a potentially huge source of food for distribution at chiefly discretion.

### 3.1.2 Mid- to late-1800s

As the 19th century progressed, Waikīkī was becoming a popular site among foreigners – mostly American – who had settled on Oʻahu. An 1865 article in the *Pacific Commercial Advertiser* mentioned a small community that had developed along the beach. The area continued to be popular with the *ali'i* and several notables had residences there. A visitor to Oʻahu in 1873 described Waikīkī as "a hamlet of plain cottages, whither the people of Honolulu go to revel in bathing clothes, mosquitoes, and solitude, at odd times of the year" (Bliss 1873).

Other developments during the second half of the 19th century, that would form a prelude of changes that would dramatically alter the landscape of Waikīkī during the 20th century, include the improvement of the road connecting Waikīkī to Honolulu (Waikīkī Road, the route of the present Kalākaua Avenue), the building of a tram line between the two areas, and the opening of

Kapi‘olani Park on June 11, 1877. Traditional land-uses in Waikīkī were abandoned or modified. By the end of the 19th century most of the fishponds that had previously proliferated had been neglected and allowed to deteriorate. The remaining taro fields were planted in rice to supply the growing numbers of immigrant laborers imported from China and Japan, and for shipment to the west coast of the United States (Coulter & Chun 1937).

As the sugar industry throughout the Hawaiian kingdom expanded in the second half of the 19th century, the need for increased numbers of field laborers prompted passage of contract labor laws. In 1852, the first Chinese contract laborers arrived in the islands. Upon completion of their contracts, a number of the immigrants remained in the islands, many becoming merchants or rice farmers. As was happening in other locales, in the 1880's, groups of Chinese began leasing and buying (from the Hawaiians of Waikīkī) former taro lands for conversion to rice farming (Coulter & Chun 1937). By 1892, Waikīkī had 542 acres planted in rice, representing almost 12% of the total 4,659 acres planted in rice on O‘ahu (Figure 3).

### *3.1.2.1 The Māhele*

The Organic Acts of 1845 and 1846 initiated the process of the Māhele, the division of Hawaiian lands, which introduced private property into Hawaiian society. In 1848, the crownand the *ali‘i* received their land titles. The *maka‘āinana (*common people) received their *kuleana* awards (individual land parcels) in 1850. It is through records for Land Commission Awards (LCAs) generated during the Māhele that the first specific documentation of life in Hawai‘i, as it had evolved up to the mid-nineteenth century come to light. Although many Hawaiians did not submit or follow through or were not granted the claims for their lands, the distribution of LCAs can provide insight into patterns of residence and agriculture. Many of these patterns of residence and agriculture probably had existed for centuries past. By examining the patterns of *kuleana* (commoner) LCA parcels in the vicinity of the survey area, insight can be gained to the likely intensity and nature of Hawaiian activity in the area.

A review of an 1881 Hawaiian Government survey map by S.E. Bishop indicates two LCAs within the study area (LCA 2511 and LCA 2083:2) (Figure 8). Both LCAs were utilized for house sites (see Appendix A). Additionally, immediately adjacent to the *makai* end of the study area, was located a third LCA (LCA 2033 to Umi), described as a house and small pond. The majority of the study area, however, appears to have been located within or along the perimeters of a concentration of fishponds (the Loko Kaipuni complex) and *‘auwai* (irrigation ditches).

Table 1. Land Commission Awards Located Within the Study Area

| Land Claim # | Claimant | *‘Ili* | Land Use | Landscape Description |
|---|---|---|---|---|
| 2511 | Alapai | Kālia | Coconut grove, house lot | Bounded by a pond and house to the east, a Government road to the north, a government wall to the west and unused land to the south. |
| 2083:2 | Kahiloaho | Kālia | house lot | "an idle land" |

Figure 7. Photo of rice fields in Waikīkī; mauka is Mānoa Valley

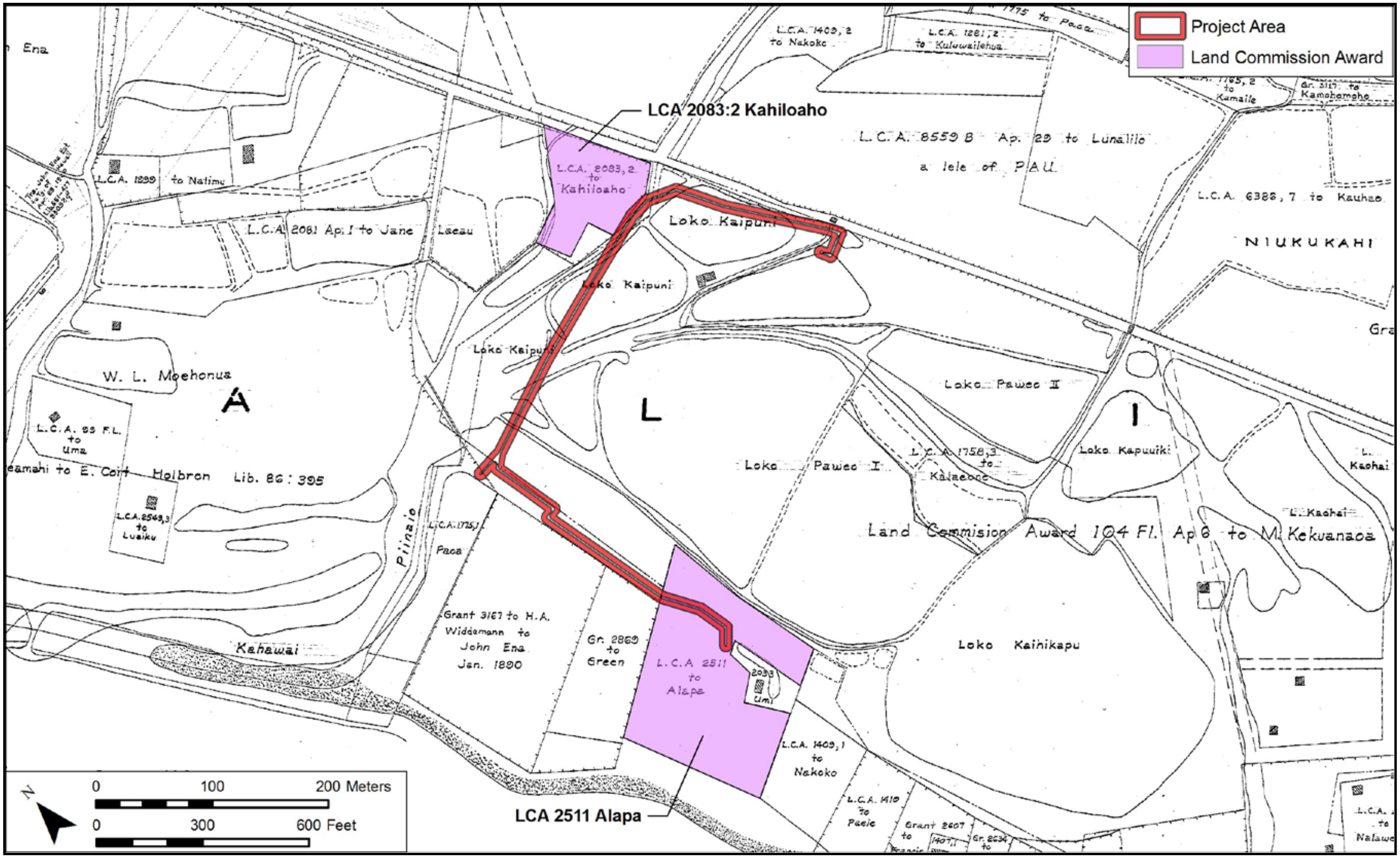


Figure 8. 1881 Hawaiian Government survey map by S.E. Bishop showing the location of Land Commission Awards within the study area

### 3.1.3 1900s

Development of the Kālia area of Waikīkī rapidly gained momentum in the twentieth century. In particular, the development of Fort DeRussy military reservation, the Ala Wai Canal, major vehicular thoroughfares, and ultimately resort development, dramatically changed the landscape of the survey area. As seen in Figure 9 and Figure 10, the fishponds of Kālia remained largely intact up through the late 1800s and early 1900s. However, by 1928 the last of the Kālia fishponds had been filled in, and by 1953, Ala Moana Boulevard had been extended along the previous Piʻinaio Stream and connected to Kalākaua Avenue (see discussion and figures below).

#### *3.1.3.1 Fort DeRussy*

During the first decade of the 20th century, the U.S. War Department acquired more than 70 acres in the Kālia portion of Waikīkī for the establishment of a military reservation called Fort DeRussy, named in honor of Brig. Gen. R.E. DeRussy of the Army Corps of Engineers. The development of Fort DeRussy significantly transformed the landscape.

> On 12 November 1908, a detachment of the 1st Battalion of Engineers from Fort Mason, California, occupied the new post...
>
> Between 1909 and 1911 the engineers were primarily occupied with mapping the island of Oʻahu. At DeRussy other activities also had to be attended to - especially the filling of a portion of the fishponds which covered most of the Fort. This task fell to the Quartermaster Corps, and they accomplished it through the use of an hydraulic dredger which pumped fill from the ocean continuously for nearly a year in order to build up an area on which permanent structures could be built. Thus the Army began the transformation of Waikīkī from wetlands to solid ground. (Hibbard & Franzen 1986:79)

Initial development of Fort DeRussy focused on the filling in of fishponds near the coast (Loko Kaihikapu, Loko Kapuʻuiki, a portion of Loko Paweo I, and possibly Loko Waikuʻapuʻu) (Davis 1989:19). A 1910 U.S. Engineer's map of Waikīkī shows the development of roads and open space in the southern half of Fort DeRussy, although the northern ponds (including those in the study area) were still present (Figure 11). Filling and development proceeded at a rapid pace; a 1919 War Department map shows a network of roads and buildings on Fort DeRussy, with only a portion of the Kaipuni fishponds still remaining in the northern portion of the study area (Figure 12). In 1928, the last of the fishponds (a portion of the Kaipuni complex) at Fort DeRussy were filled with coral spoil from the reef areas at the mouth of the Ala Wai Canal (Nakamura 1979:107) (Figure 13). Between 1943 and 1953 the northern portion of Fort DeRussy had been further developed and Ala Moana Boulevard (previously known as Beach Road) had been extended from Kālia Road to Kalākaua Avenue (Figure 14, Figure 15). A 1978 aerial photograph of the survey area shows the dramatic alteration of the landscape of Kālia over the course of less than a century (Figure 16).


Figure 9. 1887 Hawaiian Government Survey map of Honolulu by W.A. Wall , showing the study area in relation to Piʻinaio Stream, the fishponds of Kālia, and Waikīkī Road (later renamed Kalākaua Avenue)

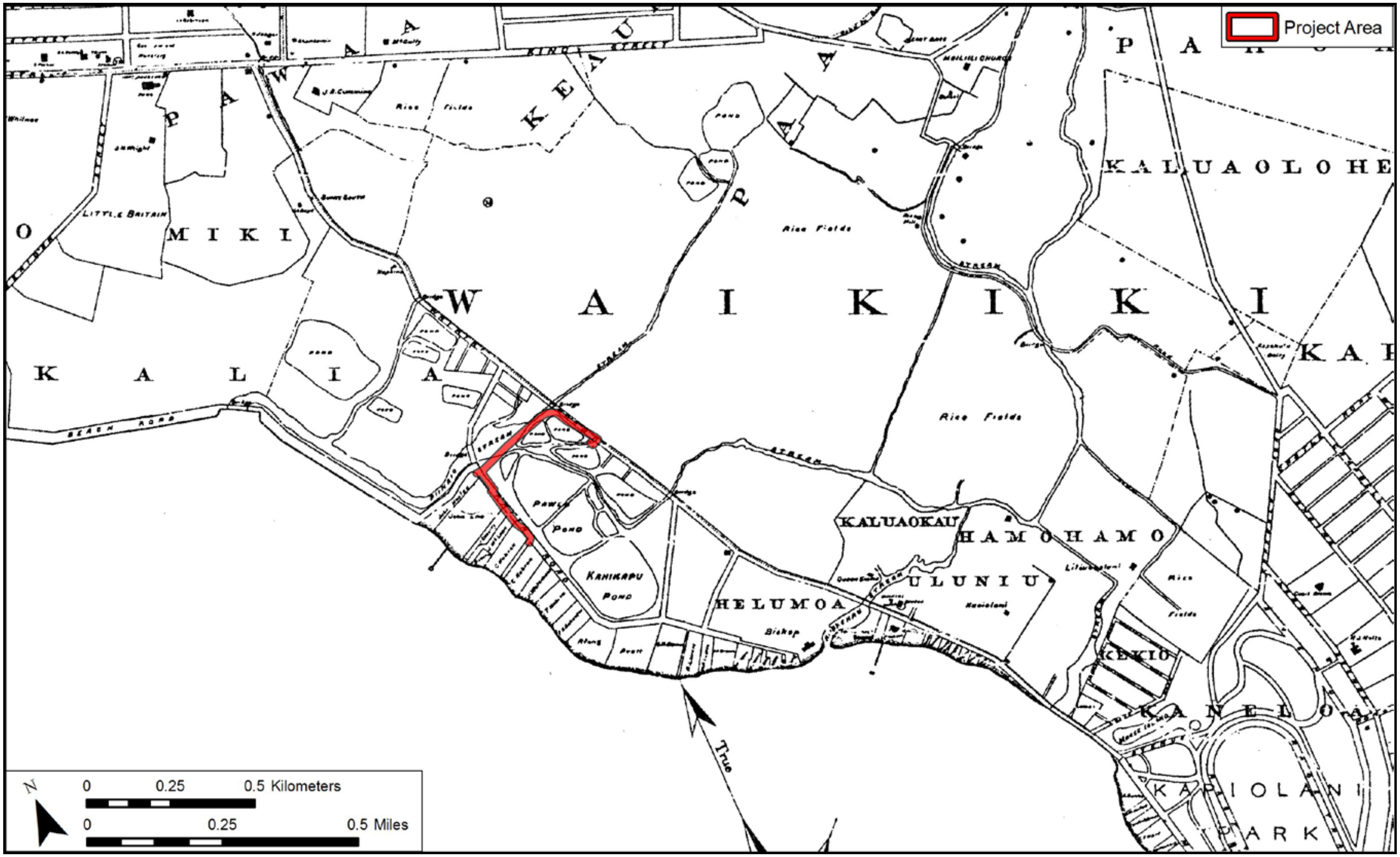


Figure 10. 1897 map by M.D. Monsarrat, showing the study area in relation to Pi‘inaio Stream, the fishponds of Kālia, and the growing road network including, Waikīkī Road (Kalākaua Avenue), Beach Road (Ala Moana Blvd.), and Kālia Road

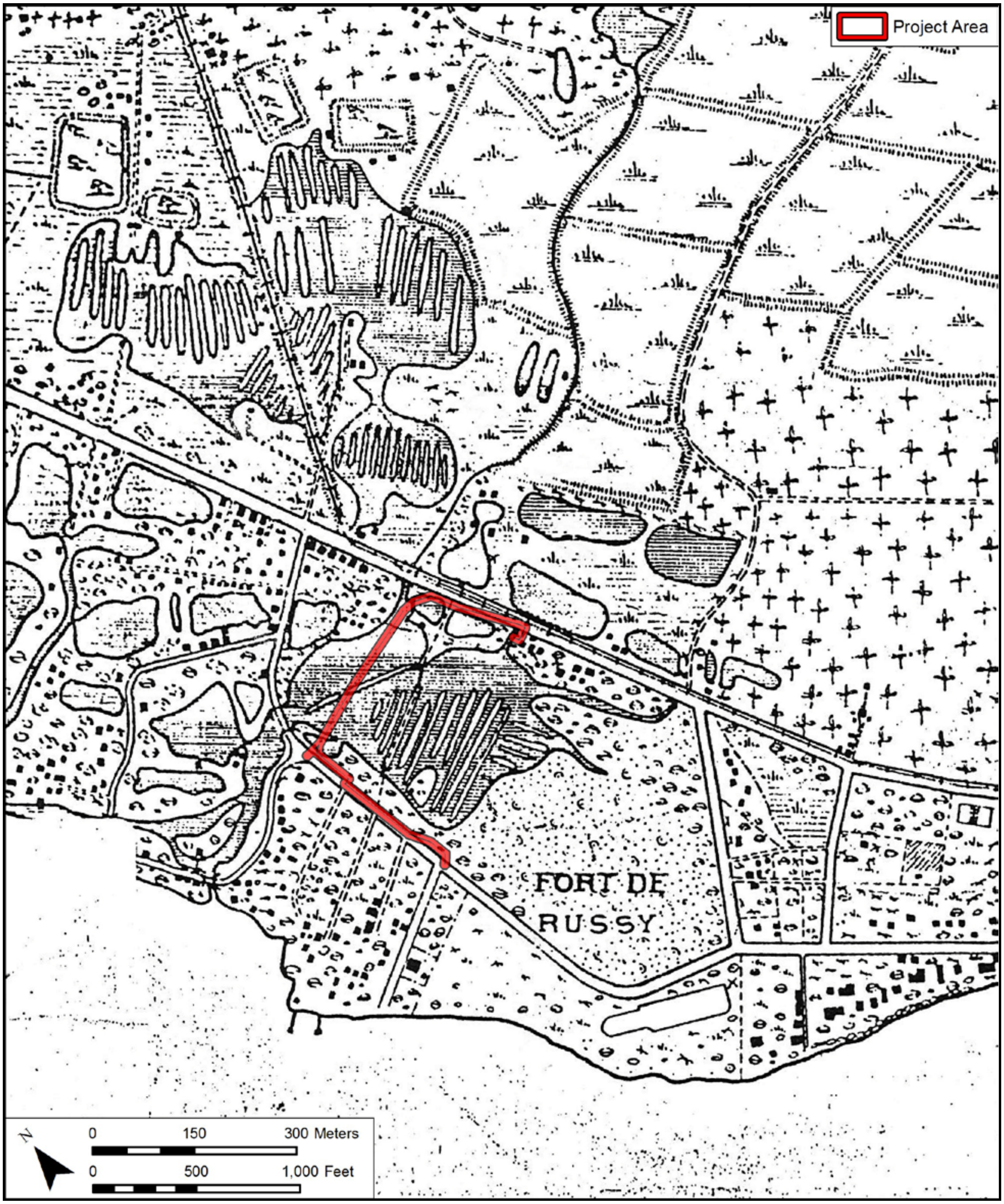


Figure 11. Portion of 1910 U.S. Engineers map of Waikīkī with location of study area. Note the in-filling of the fishponds within the southern portion of Fort DeRussy

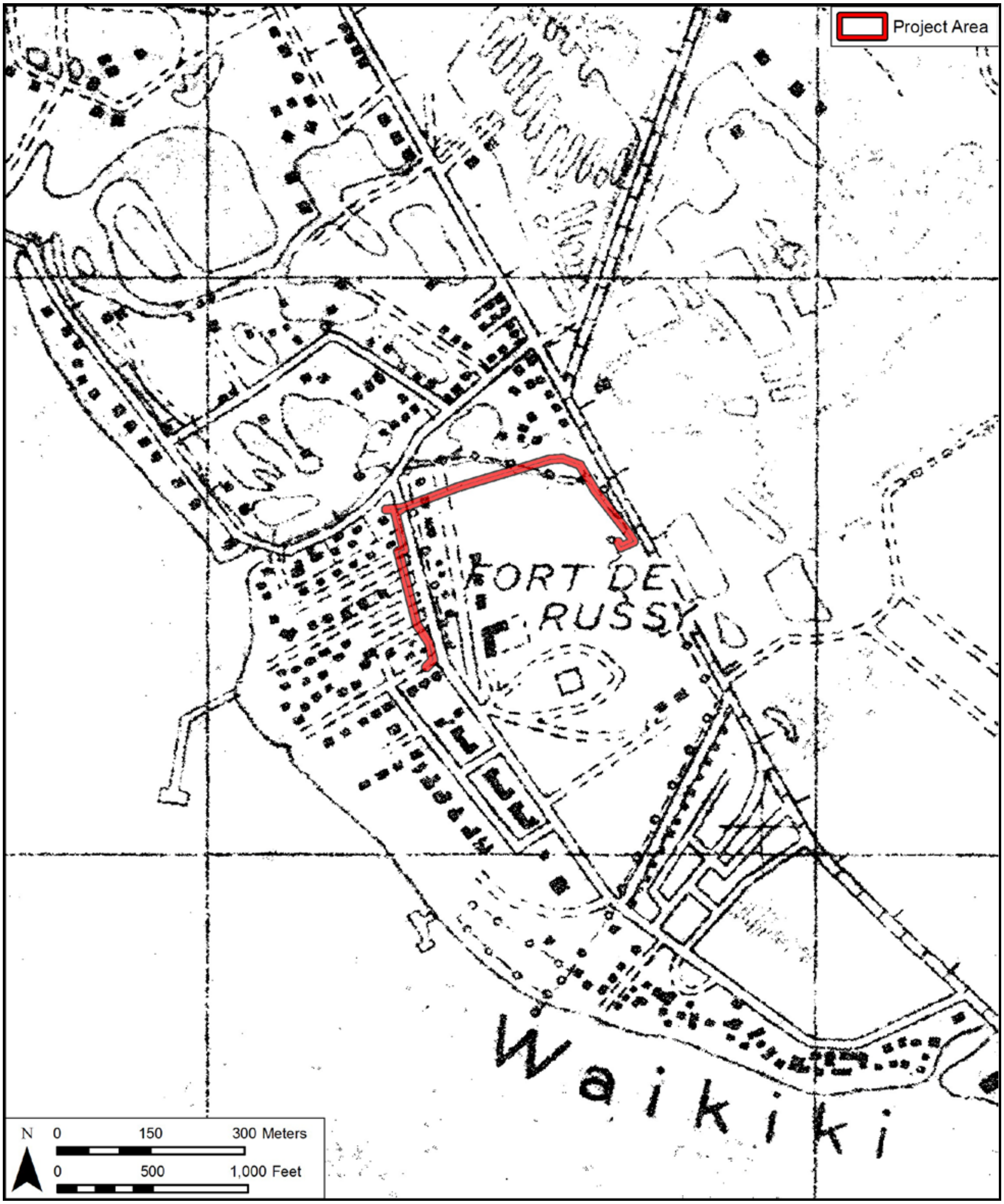


Figure 12. 1919 War Department topographic map, Honolulu Quadrangle, with the location of the study area. Note the remaining fishponds and Piʻinaio Stream within the northeastern corner of the survey area

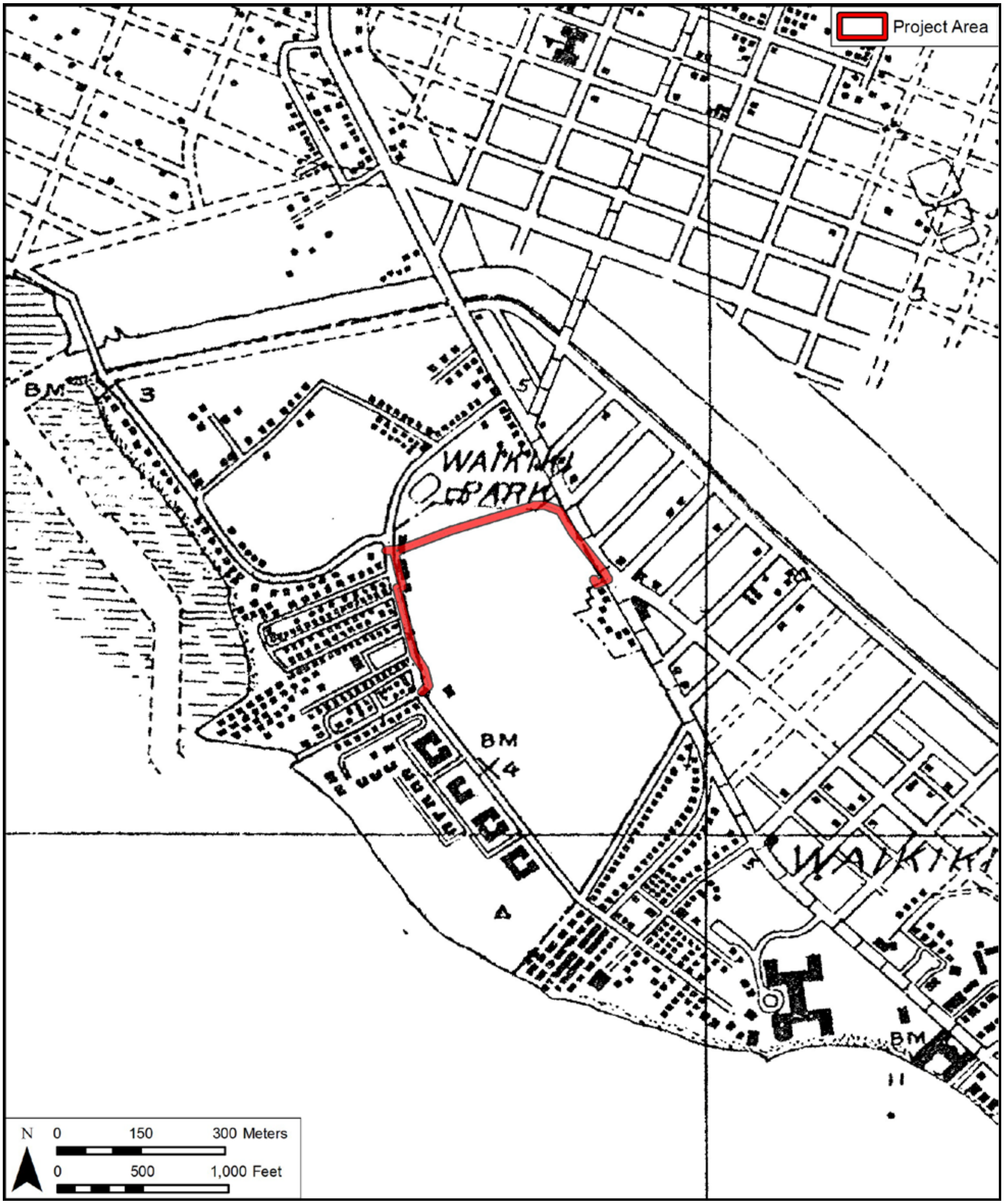


Figure 13. 1927-1928 U.S. Geological Survey Honolulu Quad Map showing the survey area and the complete in-filling of the Kālia wetlands

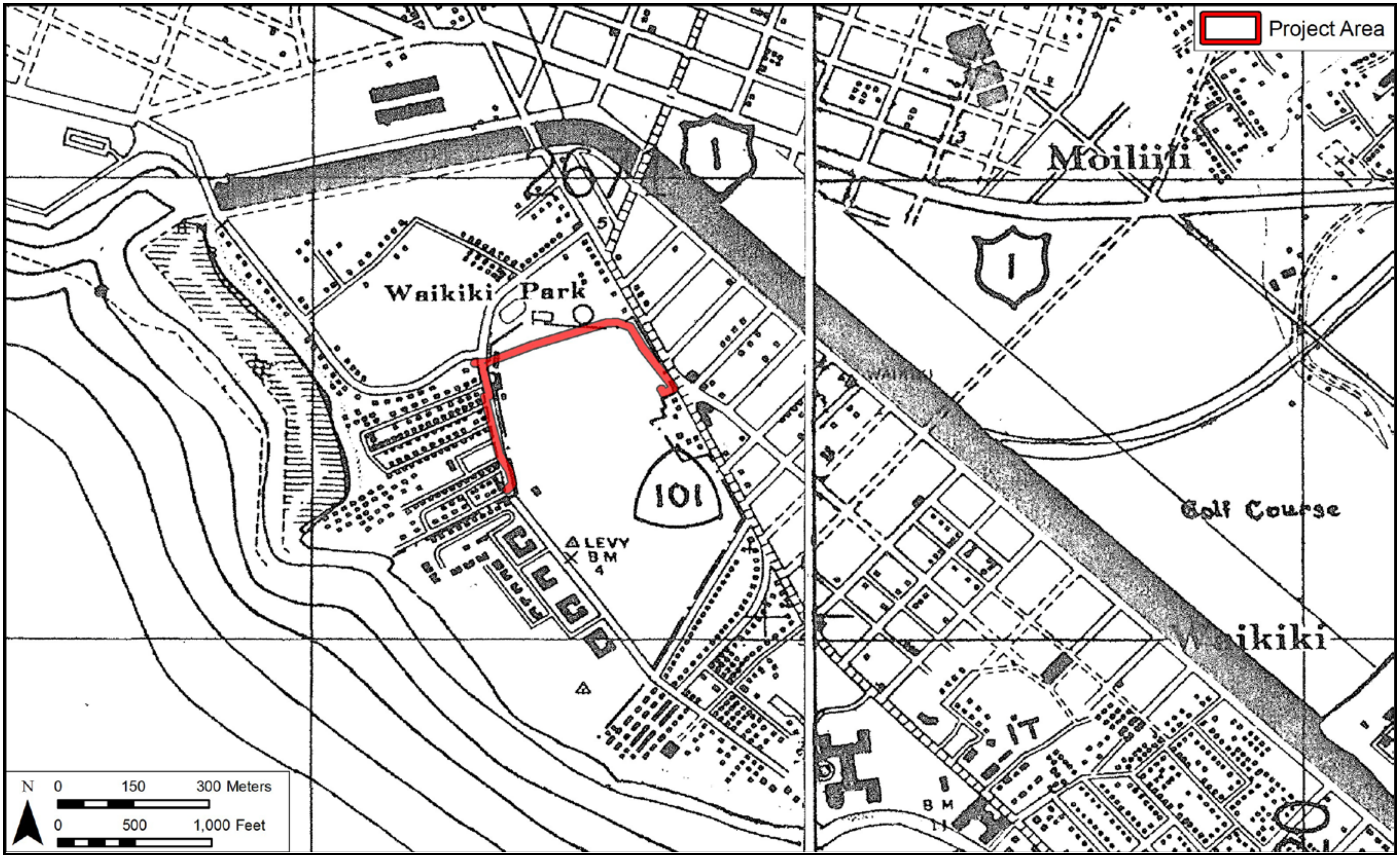


Figure 14. 1943 War Department topographic map, Honolulu Quadrangle, with location of survey area indicated

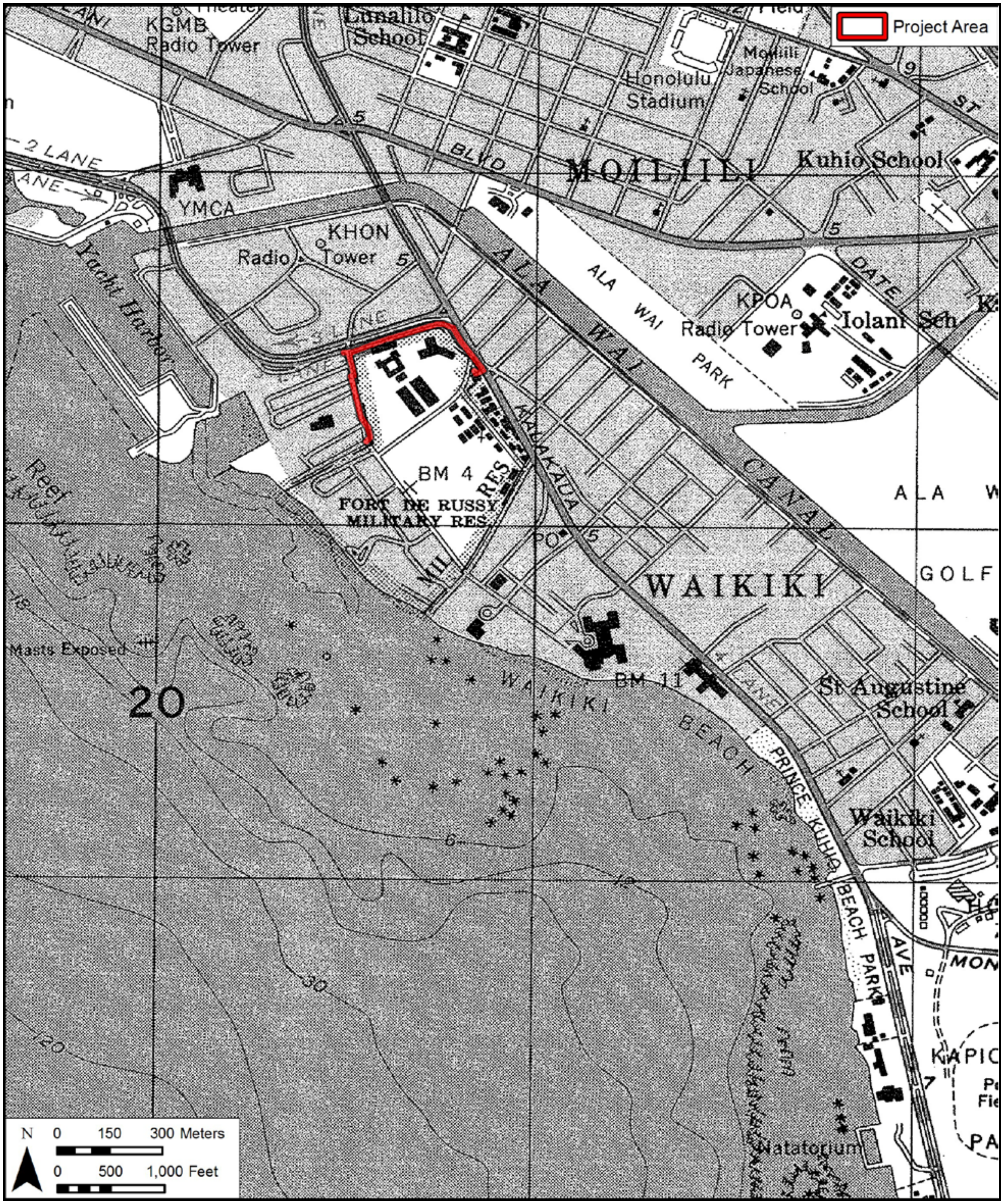


Figure 15. 1953 Army Map Service topographic map, Honolulu Quadrangle, with location of study area indicated

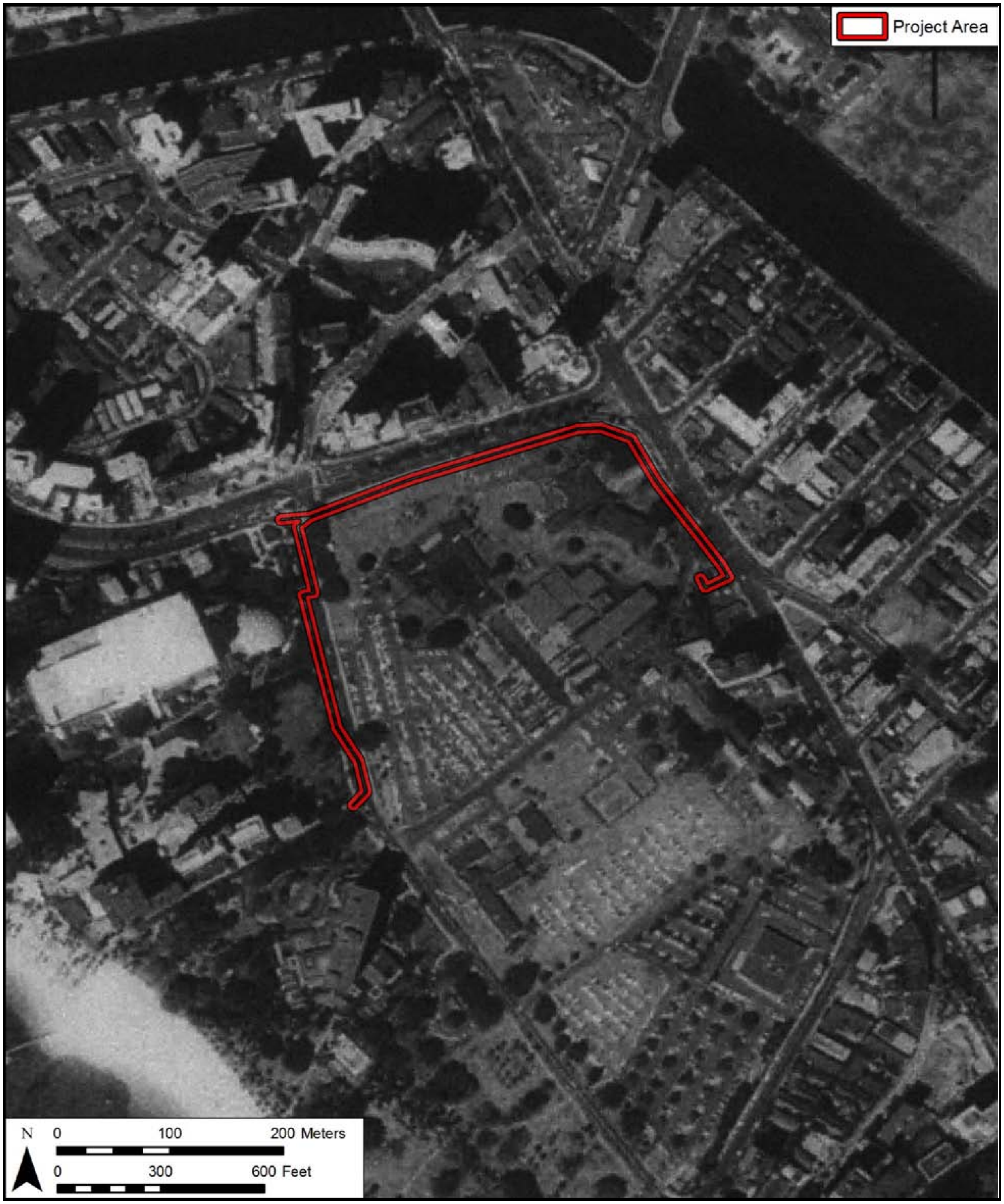


Figure 16. 1978 aerial photograph showing the location of the study area (source: USGS orthophoto quadrangle)

### *3.1.3.2 Ala Wai Drainage Canal*

During the 1920's Waikīkī landscape would be transformed when the construction of the Ala Wai Drainage Canal – begun in 1921 and completed in 1928 – resulted in the draining and filling in of the remaining ponds and irrigated fields of Waikīkī (Figure 17, Figure 18). Dredging for the project was performed by Hawaiian Dredging Company, owned by Walter F. Dillingham, who then sold the dredged sediments to Waikīkī developers. The dredge produced fill for the reclamation of over 600 acres of land in the Waikīkī vicinity, the Waikīkī Land Reclamation project.

The canal was one element of a plan to urbanize Waikīkī and the surrounding districts:

> The [Honolulu city] planning commission began by submitting street layout plans for a Waikīkī reclamation district. In January 1922 a Waikīkī improvement commission resubmitted these plans to the board of supervisors, which, in turn, approved them a year later. From this grew a wider plan that eventually reached the Kapahulu, Mōʻiliʻili, and McCully districts, as well as lower Makiki and Mānoa.
>
> The standard plan for new neighborhoods, with allowances for local terrain, was to be that of a grid, with 80-foot-wide streets crossing 70-foot-wide avenues at right angles so as to leave blocks of house lots about 260 by 620 feet. Allowing for a 10-foot-wide sidewalk and a 10-foot right-of-way [alley] down the center of each block, there would be twenty house lots, each about 60 by 120 feet, in each block. (Johnson 1991:311)

Within the Kālia area in which the study area is located, the dredge from the construction of the Ala Wai Canal was utilized to fill in Piʻinaio Stream, the surrounding wetlands and areas of the coast. A local resident, Fred Paoa, who was interviewed by the University of Hawaiʻi's Social Science Research Institute regarding the area of Kālia in the early twentieth century, described the changes to Kālia:

> Well, after they reclaimed all that land, all the ponds were filled with part of the [dredged] coral…including the strip that they dredged outside the DeRussy and [where] the Hilton Hawaiian Village and ʻIlikai [are now]. They used all to fill the [land on which] Ala Moana Center now [stands]. All that [was] swamp land. And the Hobron Estate which was across from where we lived, all of that was filled in. Even the stream, Piʻināiʻo River, was filled in. (UHCOH 1985, Vol. II: 550-1)

### *3.1.3.3 Development of Waikīkī*

Newly created land tracts following the Ala Wai Canal's construction spurred a rush to development in the 1930's. An article in the Honolulu Star-Bulletin in 1938 extolled the area's progress:

> The expansion of apartment and private residence construction is no secret. Examination of building permits will show that more projects have been completed during the past year, and more are now underway in this area, than in any other section of the territory. (Newton 1939: 10)

Figure 17. Creation of the Ala Wai Canal, showing floating dredge line, circa 1924 (Bishop Museum Archive)

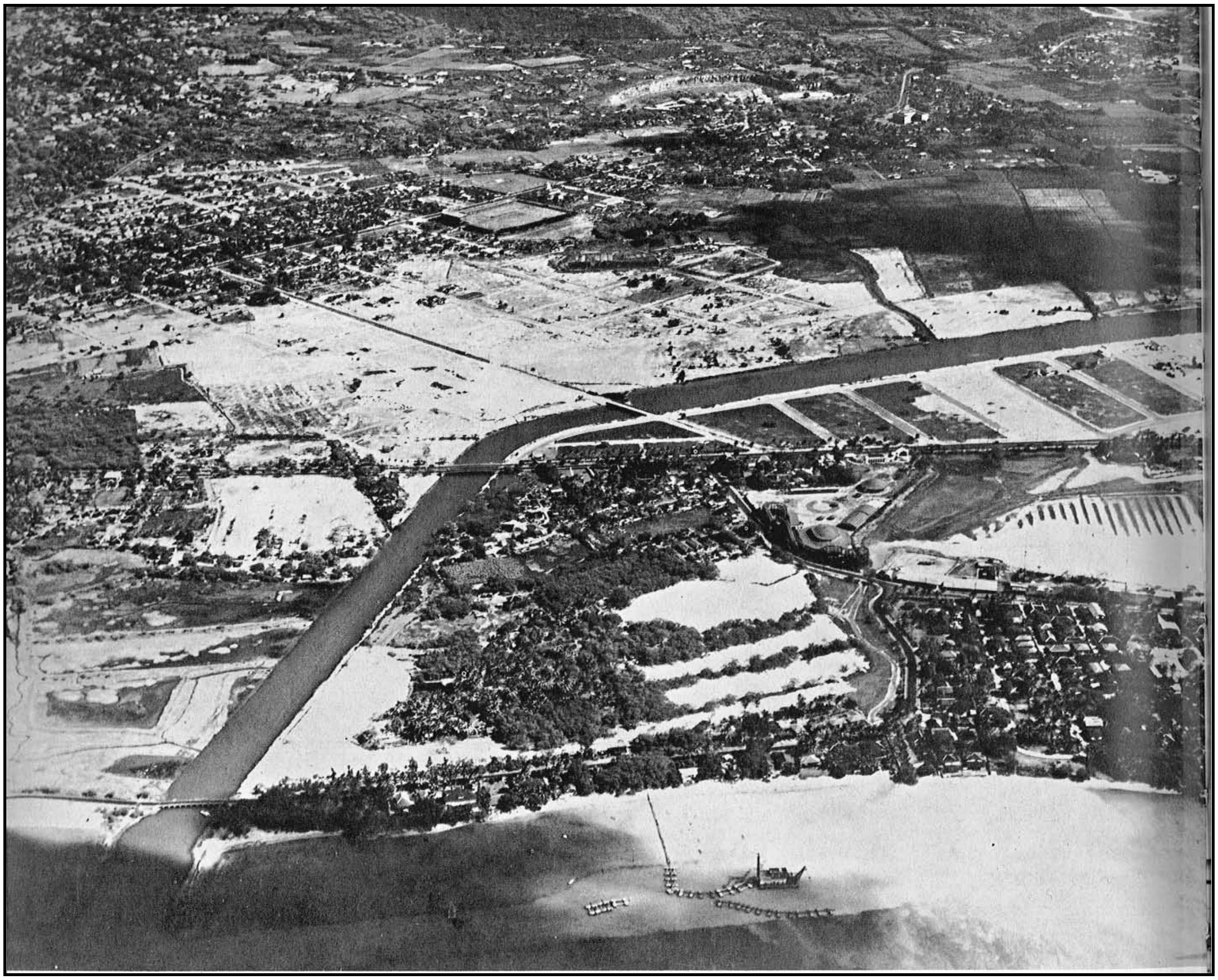

Figure 18. 1927 aerial photo of the completed Ala Wai Canal, showing the reclamation of the Kālia area within Waikīkī with coral fill (dredge and pipe in foreground). The filled-in northwestern portion of Fort DeRussy is visible just *mauka* of the residential cluster and Kālia Road in the central/lower right of the photograph (Bishop Museum Archive)

The entrance of the United States into World War II following the Japanese bombing of Pearl Harbor on December 7, 1941 put on hold plans for the development of Waikīkī as a tourist destination. Until the war's end in 1945, the tourist trade was non-existent "...since the Navy controlled travel to and from Hawaiʻi and did not allow pleasure trips" (Brown 1989: 141). For the duration of the war, Waikīkī was transformed into a recreation area for military personnel.

> It was not the same Waikīkī as before the war, though; barbed wire barricades now lined its sands, and there were other changes too. Fort DeRussy became a huge recreation center, with a dance hall called Maluhia that attracted thousands of men at a time. The Moana Hotel continued to function, but many other establishments and private homes in the area were taken over by the military. (Brown 1989:141)

### 3.1.4 Modern Land Use

#### *3.1.4.1 Post 1950 Modern Land Use*

By the mid-1950s there were more than fifty hotels and apartment buildings from the Kālia area to the Diamond Head end of Kapiʻolani Park. The Waikīkī population, by the mid-1950s, was not limited to transient tourists but included 11,000 permanent residents living in 4,000 single dwellings and apartments in stucco or frame buildings (Figure 6). The intensification of urban dwellings and tourist infrastructure has continued to the present day.

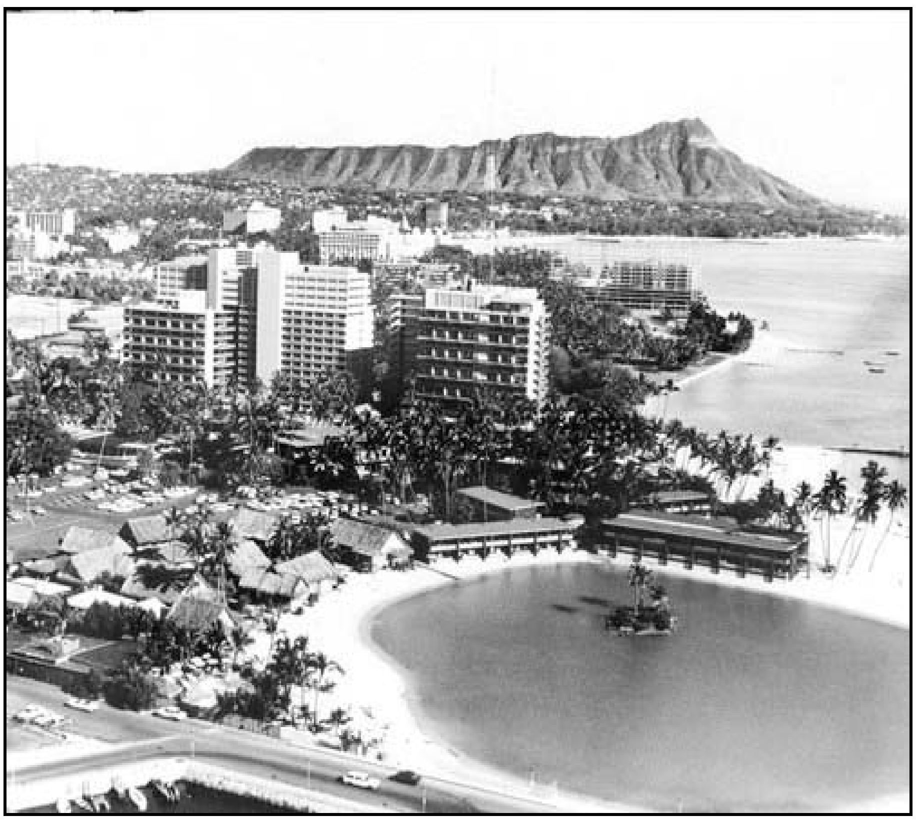

Figure 19. Aerial of the site of Hilton Hawaiian Village in Waikīkī in 1961 (Star Advertiser)

# 3.2 Previous Archaeological Research

### 3.2.1 Previous Archaeology within the Study Area and Immediate Vicinity

Archaeological studies in the immediate vicinity of the current study area are shown in Figure 20 and listed in Table 2, below. Historic properties in relation to the project area are shown in Figure 21. Archaeological monitoring programs, investigations, data recovery, or inventory surveys have previously been conducted along the majority of the study area. Archaeological finds documented during these studies include: human burials, pre- and post-Contact cultural layers, buried fishponds, ditches, and other remains of extensive wetland agriculture, trash pits, and construction debris.

Table 2. Previous Archaeological Studies Within the Study Area and Immediate Vicinity

| Reference | Nature of Study | SIHP #50-80-14 | Findings |
|---|---|---|---|
| Neller 1980 | Inadvertent Discovery Report | -2780 | Inadvertent burial discovery within the southeastern corner of the Hilton Hawaiian Village (area of Tapa Tower). Three disturbed burials postulated as likely of Hawaiian ethnicity and post-1850, SIHP # -2780. |
| Hurlbett et al. 1992 | Archaeological Monitoring | -2780 | 15 subsurface pit features associated with post-contact trash disposal were observed. Features were incorporated into SIHP # -2780 |
| Carlson et al. 1994 | Data Recovery | “Burial Area 6” and “Burial Area 7” (no SIHP #s assigned) | Biosystems Analysis excavated human remains found during realignment of Kālia Road. Burial Area 6 included 27 – 34 individuals in a common pit feature located just SE of the intersection of Paoa Place and Kālia Rd. Burial Area 7 included 4 individuals in association with a cultural layer located in the vicinity of the Army Museum. |
| McMahon 1994 | Inadvertent Discovery Report | | Inadvertent discovery of a single burial of indeterminate ethnicity |

| Reference | Nature of Study | SIHP #50-80-14 | Findings |
|---|---|---|---|
| Denham and Pantaleo 1997a | Archaeological Monitoring | -4570 ; -4574; -4966 | Three historic properties observed: SIHP #-4574, consisting of fishpond sediments (Loko Paweo I), three historic trash pits, and two burials; SIHP #-4570 consisting of a historic trash pit, four fire pits, an ash lens, and an unknown number of human burials; and SIHP #-4966 comprised of pre-contact features and burials representing at least five individuals found in the Koko Head portion of Fort DeRussy |
| Denham and Pantaleo 1997b | Data Recovery | -4570; -4575; -4576; -4579; -4970 | Five previously identified sites investigated |
| Putzi and Cleghorn 2002 | Archaeological Monitoring | -4573, -6399 | Monitoring of force drain line and sewer relief line. Pond sediments, organic sediments, and Jaucas sand documented beneath fill layers along Ala Moana Blvd. and Kalākaua Ave. Two features were identified: a portion of Loko Kaipuni (SIHP #-4573) and a basalt alignment of indeterminate date. Five post-contact pit features were documented within the Hilton Hawaiian Hotel grounds (SIHP # -6399). |
| Rasmussen 2005 | Archaeological Monitoring | N/A | No historic properties observed |
| Mooney et al. 2009 | Archaeological Monitoring | -7086, -7087 | Documented one previously disturbed burial, SIHP # 50-80-14-7087, near the intersection of Kālia Road and Ala Moana Blvd., consisting of a near complete cranium and cranial fragments. The remains were sealed and left *in situ*. Also documented a large historic trash feature complex, SIHP #-7086, along the north side of the Hilton Hawaiian Village |

| Reference | Nature of Study | SIHP #50-80-14 | Findings |
|---|---|---|---|
| Tulchin et al. 2011 | Archaeological Inventory Survey | -2780 | 20 test trenches placed within the area of Rainbow Drive and the bus depot terminal in the southeastern corner of the Hilton Hawaiian Village complex documented a discontinuous A-horizon beneath fill layers. This buried A-horizon (SIHP #-2780) was determined to be the remnants of a stable post-contact historic land surface that has been significantly disturbed by modern development |

#### *3.2.1.1 Neller 1980*

In 1980, three partial sets of human remains were inadvertently discovered during construction activities within the southeastern corner of the Hilton Hawaiian Village [i.e. construction of Tapa Tower]. All three sets of remains had been disturbed by construction activities and were removed from their primary burial context before SHPD archaeologists could document their stratigraphic provenience. The burials were determined to be of Hawaiian ethnicity and post-1850 in age based on a reconstruction of historic period shorelines. The burials were designated SIHP # 50-80-14-2780.

In addition to the three burials, three subsurface features, consisting of pit features pre-dating the construction of the Ala Wai Canal, were also observed. Two of the features had an undetermined function; however Neller (1980) suggested that they may have been filled-in irrigation ditches. A “coffee bean” sinker, used for octopus lures, was collected from the pit fill of one of these possible ditches. The sinker was constructed of pink granite, an imported material which dated the traditional Hawaiian artifact to the post-contact period. The third documented pit feature consisted of a trash pit containing refuse (ceramic & glass artifacts) dated to the late 1890s.

The general stratigraphy observed in this southeastern corner of the Hilton Hawaiian Village consisted of several layers of fill overlying several natural strata: an A-horizon containing charcoal and basalt, a stratum of pale brown Jaucus sand shading into coarser grained gray sand, overlying the coral limestone.

#### *3.2.1.2 Hurlbert et al. 1992*

In 1992, PHRI completed archaeological monitoring of mechanical loop excavations at the Hilton Hawaiian Village. During the course of monitoring, 15 horizontal pit features were observed. Twelve of the pit features consisted of post-contact trash pits, with the remaining three consisting of historic to modern filled-in trenches. All of the artifacts collected from the trash pits were dated to the late 19$^{th}$ and early 20$^{th}$ centuries. The pit features were incorporated into SIHP -2870, previously identified by Neller in 1980.

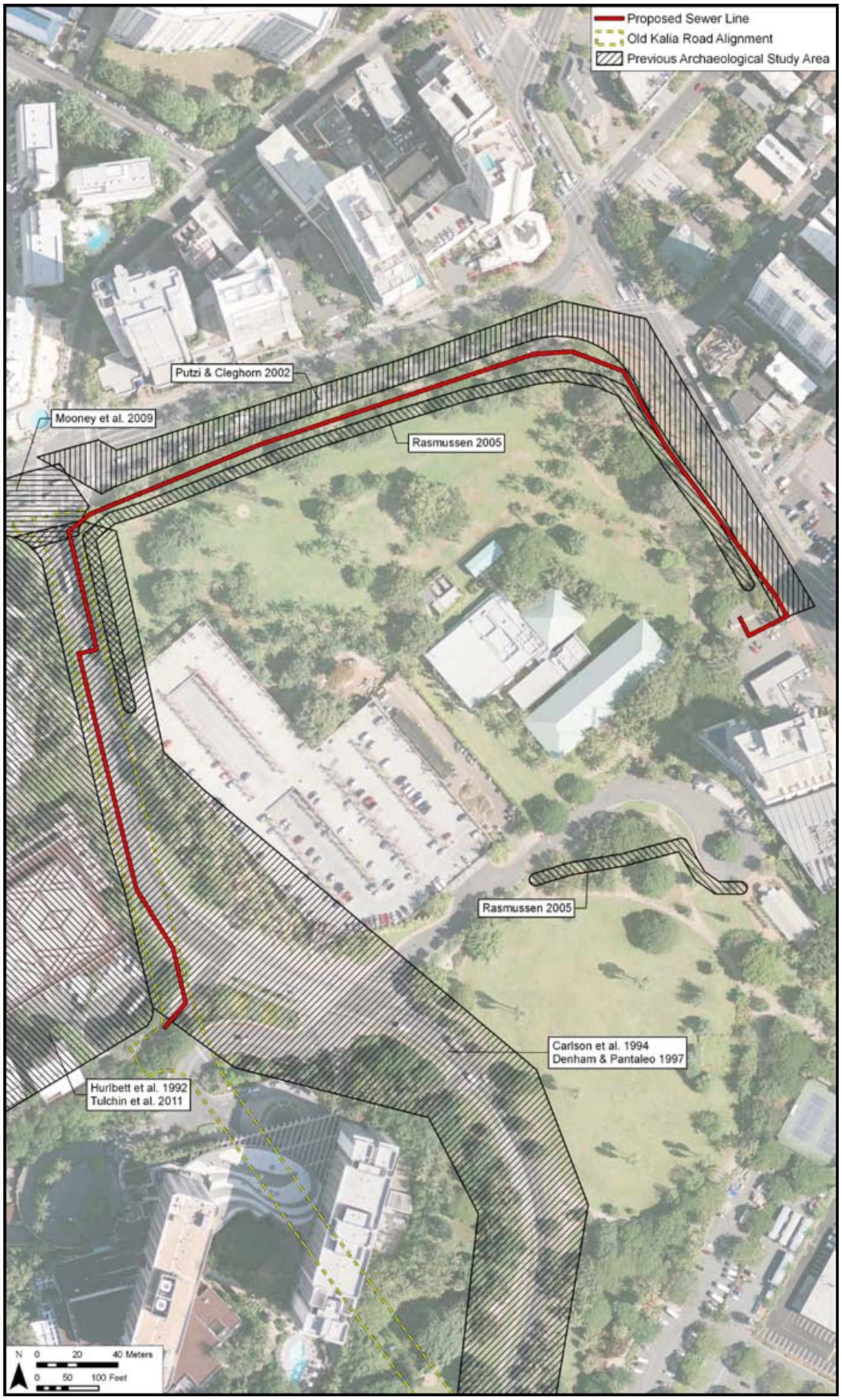


Figure 20. Previous archaeological studies within the study area and immediate vicinity. Note: Inadvertent discoveries of human skeletal remains were also documented during unmonitored construction projects, located in the area of the Tapa Tower (Neller 1980) and the intersection of Kalākaua Avenue and Kuamoʻo Street (McMahon 1994)


Figure 21. Historic properties within the study area and immediate vicinity shaded in yellow, Note: SIHP labels for the different historic properties were omitted to keep burial location information confidential.

A total of 3,819 artifacts were collected within the study area. All artifacts, with the exception of those collected from the pit features, were situated within disturbed sediments. It was determined that all of the artifacts originated from either household refuse or from construction debris originating from successive periods of demolition and construction conducted within the study area. The artifact assemblage consisted primarily of late 19$^{th}$ to early 20$^{th}$ century luxury items associated with health (medicine bottles) and diet (beverage and sauce bottles).

In general, the documented stratigraphy for the Hilton Hawaiian Village property consisted of multiple fill layers (predominantly disturbed sand with smaller portions of Ala Wai dredge material and crushed coral) overlying a culturally sterile sand layer, which was determined to be associated with the historic filling of the coral reef for artificial shoreline/beach expansion. Naturally deposited sediments were observed near the eastern edge of the study area. Limestone bedrock, possibly associated with formerly exposed tidal flats, was observed in the western half of the study area.

#### *3.2.1.3 Carlson et al. 1994*

In 1993, Biosystems Analysis excavated human remains found during realignment of Kālia Road. Burial Area 6 included 27 – 34 individuals in a common pit feature located just southeast of the intersection of Paoa Place and Kālia Rd., approximately 20 to 25 m east of the east corner of the Hilton Hawaiian Village campus. Denham and Pantaleo 1997a provide an SIHP citation of 50-80-14-4570:8 for what Carlson et al. 1994 call “Burial Area 6”. The study concludes this was a hasty, mass interment and “may well represent the remains of Hawaiian warriors who died in one of the battles of the interisland wars of conquest which occurred during the reign of King Kamehameha I.” (Carlson et al. 1994:70). Burial Area 7 included 4 individuals in association with a cultural layer located in the vicinity of the Army Museum just southwest of the intersection of Kālia Road and Saratoga Road. Sediments associated with Loko Paweo I fishpond (SIHP # 50-80-14-4574) were also encountered.

#### *3.2.1.4 McMahon 1994*

On April 28, 1994, an inadvertent discovery of human skeletal remains was uncovered in a backdirt pile during excavation for a waterline at the intersection of Kalākaua Ave and Kuamoʻo Street just *mauka* of the current study area. These remains represented a single individual of indeterminate ethnicity.

#### *3.2.1.5 Denham and Pantaleo 1997a*

In 1993, Biosystems Analysis, Inc. conducted archaeological monitoring along the Kālia Road Realignment Project at Fort DeRussy Military Reservation. These results were written up by Garcia and Associates nearly four years later (Denham and Pantaleo 1997a). Given the passage of time and the different companies involved, it is perhaps no surprise that the data provided is frustratingly incomplete. It appears clear, however, that the descriptions of “Burial” designations in Denham and Pantaleo 1997a correspond directly with the locations provided in Carlson et al. (1994:72). During the monitoring of utility trenches, 10 subsurface features and 9 Burials and Burial Areas were recorded. These were grouped into three sites in the Denham and Pantaleo 1997a report. The sites are discussed below in the order presented.

SIHP # 50-80-14-4574, consisted of fishpond sediments (Loko Paweo I), three historic trash pits, and two burials (authors did not determine the burials' age). The two burials (designated as "4574:5") appear to have been north of the intersection of Kālia Road and Saratoga Road and not in the immediate vicinity of the current study area (Denham and Pantaleo 1997a: 19-20).

SIHP # 50-80-14-4570, consisted of a historic trash pit (-4570:1) dating to the late nineteenth to early twentieth centuries, four fire pits (-4570:2, 4-6), an ash lens (-4570:3), and an unknown number of human burials (in six distinct features) found in the sand dunes on the *makai* side of Loko Paweo I in the vicinity of the current study area (# -4570:7-12). The burials were previously disturbed, incomplete, and some appeared to contain multiple burials. One of these six burial features (SIHP # 50-80-14-4570:8; aka "Burial Area 6") was the focus of the Carlson et al. 1994 study. No information appears to be provided regarding SIHP# -4570:7 "Burials 3 &4", but these are shown as just *mauka* of the Hilton Hawaiian Village campus across Kālia Road. SIHP # -4570:9 "Burial 8", a pre-Contact or early historic interment which was left *in situ*, is described as "just west of the newly constructed entrance driveway to the Hilton Hawaiian Village" (Denham and Pantaleo 1997a:36). SIHP # -4570:10 "Burial 9", is another pre-Contact or early historic interment also left *in situ* seemingly located on the other side of a trench profile "across from Feature 4570:9" (Denham and Pantaleo 1997a:38). SIHP # -4570:11 is another pre-Contact or early historic burial described as within "the west face of the trench", presumably within the same trench as SIHP # -4570:9, 10. SIHP # -4570:12 consisted of a human burial located in "the landscaped area between the new Paoa Place extension and the driveway for the Hilton Hawaiian Hotel" (Denham and Pantaleo 1997a:38). This burial discovery area is located within the current study area and within the pathway of Kālia Road prior to its realignment in 1995. The disturbed remains were collected and reinterred in the base of the excavation.

#### *3.2.1.6 Denham and Pantaleo 1997b*

In 1992, Garcia and Associates conducted archaeological data recovery at Fort DeRussy. Five previously identified sites were investigated. One site (SIHP # 50-80-14-4570) was characterized by such features as a firepit, coral rock concentration, and postholes. An *ʻauwai* and bund system (SIHP # 50-80-14-4970) revealed two channels, three bunds, and a charcoal stain. Another site (SIHP # 50-80-14-4579) revealed a number of features related to permanent historic occupation and possible intermittent prehistoric use, such as five fire pits, two historic middens, and a human burial (the burial encountered in "Area A" well inland of Kālia Road was designated site 4579:4). In addition, three fishponds, Loko Paweo I (SIHP # 50-80-14-4574), Loko Kaʻihikapu (SIHP # 50-80-14-4575), and Loko Paweo II (SIHP # 50-80-14-4576), were identified.

#### *3.2.1.7 Putzi & Cleghorn 2002*

In 2002, Pacific Legacy, Inc. completed archaeological monitoring of sewer connections associated with Hilton Hawaiian Village improvements. Excavations were monitored within the northern portion of the Hilton Hawaiian Village complex for a force drain line and along Ala Moana Boulevard and Kalākaua Avenue for a 24-inch sewer relief line. The changing stratigraphy along the sewer line excavation was extensively documented. Along the Ala Moana Boulevard portion of the sewer line, varying layers of fill deposits overlay extensive, but discontinuous, areas of fishpond sediments. Along the Kalākaua Avenue portion of the sewer line, an area of fishpond sediment (Feature 1) was documented in the central section (in the area of Manhole 6) (SIHP #50-80-14-4573) as well as extensive areas of sand and a section of black organic silty clay containing ash and charcoal. A basalt cobble and boulder alignment of indeterminate age (Feature 2) was documented midway between Manholes 5 and 6. In addition to the sewer line excavation, a sump pit was excavated approximately 10 m south of the sewer line excavation, near Manhole 1 and the intersection of Kālia Road and Ala Moana Boulevard, in what was thought to be the interior of Loko Paweo I. The sump pit exposed a thick layer of fishpond sediment over coral bedrock. Significantly, the sump pit strata documented the complete absence of the varied layers evident within the sewer line excavation. This was believed to indicate the likelihood that the area excavated along Ala Moana Boulevard and Kalākaua Avenue represented the border of the Kaipuni fishpond complex and/or the area between Loko Kaipuni and Auwai Alanaio. The report authors also surmised that as the excavations appeared to be along the stream bank walls of the Loko Kaipuni complex, the area likely would not have been utilized for human burials. The areas of sand deposits and other soils were interpreted as representative of the ends of ‘*auwai* dikes and beds that flowed into Kahawai Alanaio.

#### *3.2.1.8 Rasmussen 2005*

In 2005, the International Archaeological Research Institute, Inc. conducted an archaeological monitoring program for the Asia-Pacific Center for Security Studies Perimeter Barrier Wall project. No significant finds were documented. Stratigraphy observed within the deeper auger excavations for bollard installation consisted mostly of coralline fill overlying either clay (pond sediment) or sand deposits.

#### *3.2.1.9 Mooney et al. 2009*

Between 2005 and 2008, Pacific Legacy, Inc. conducted an archaeological monitoring program for the Hilton Hawaiian Village Grand Waikīkīan Development Project, including the construction of a new Grand Waikīkīan Tower, improvements to the Rainbow Tower loading dock and Lagoon Tower entrance, and excavations for utilities. A previously disturbed human burial, consisting of a near complete cranium and cranial fragments, designated SIHP # 50-80-14-7087, was encountered on the mauka side of the intersection of Ala Moana Boulevard and Kālia Road. The remains were sealed and left in situ. Additionally, a large historic trash feature complex, SIHP # 50-80-14-7086, was found dating from the mid-1800s to mid-1900, yielding nearly 800 artifacts. This complex extended into the *makai* portion of the elbow turn of Ala Moana Boulevard within the current project area. A large number of features contained historic East Asian ceramic fragments, which was speculated to have been associated with the Japanese Tea House of the early 1900s.

An analysis of observed stratigraphy and archival records led to the conclusion that the pre-1880 shoreline lay approximately 10 to 20 meters makai of the present-day Lagoon Drive. This locates the pre-1800 shoreline 60 to 80 meters closer to the present shoreline than was postulated by Neller (1980). Further archaeological monitoring was recommended for all future ground disturbing activities in areas mauka of Lagoon Drive, where the pre-contact shoreline is believed to have been located.

*3.2.1.10 Tulchin et al. 2011*

In 2010, CSH conducted an Archaeological Inventory Survey for the Hilton Hawaiian Village Master Plan Improvements Project. Subsurface test excavations consisted of 20 linear trenches, clustered primarily in the southeastern corner within the bus depot lot and centrally along Rainbow Drive. In general, stratigraphy within the project area consisted of the present resort infrastructure-related ground surface overlying a variable series of relatively thick, often compacted fill layers, a discontinuous, previously disturbed A-horizon, and a previously disturbed or in situ sand and sandy loam to the water table.

Within the southeastern corner of the Hilton Hawaiian Village, just *makai* of the current study area at the intersection of Kālia Road and Paoa Place, thick layers of fill and a high water table sandwiched the presence of natural sediments. In 5 of the 11 trenches excavated within this area, an A-horizon was encountered. Bulk sediment samples collected from the A-horizon documented the presence of fragmentary historic and modern debris. This buried A-horizon (SIHP #50-80-14-2870), found discontinuously within the project area, was determined to be the remnants of a stable post-contact historic land surface that has been significantly disturbed by modern development.

### 3.2.2 Previous Archaeology in the Wider Vicinity of the Project Area

Numerous archaeological studies have been conducted in the wider area surrounding the study area, including further archaeological investigations within the Hilton Hawaiian Village complex, the larger Fort DeRussy area, and along Kalākaua Avenue. Additional previous archaeological studies in these areas are included in Figure 22 and Table 3, below.

Table 3. Previous Archaeological Studies in the Vicinity of the Study Area

| Reference | Nature of Study | SIHP #50-80-14 | Findings |
|---|---|---|---|
| Kimble 1976 | | -9500 (BPBM # Oa-A4-25) | 5 pre-Contact or early historic bundle burials and a sixth possibly twentieth century human burial was encountered during construction of the Hale Koa Hotel on beach at Fort DeRussy |
| Sinoto 1977 | Archaeological Reconnaissance Survey | N/A | No historic properties observed |
| Rosendahl 1989a & 1989b | Archaeological Inventory Survey | N/A | Documented a disturbed cultural layer with historic artifacts |
| Davis 1989 | Archaeological Reconnaissance Survey | -4570, -4573 thru -4577 | Fishponds and other subsurface features observed. Sites # -4573 thru # -4577 are fishponds, # -4570 is a remnant cultural deposit |
| Davis 1991 | Archaeological Monitoring | N/A | A burial observed south of Battery Randolph/Army Museum |
| Streck 1992 | Data Recovery | -9550 | One pre-Contact burial identified (SIHP #5 0-80-14-9550) |

| Reference | Nature of Study | SIHP #50-80-14 | Findings |
|---|---|---|---|
| Simons et al. 1995 | Data Recovery | -4574, -4576, -4579, -4970 | Three previously identified historic properties encountered: Loko Paweo I (SIHP #-4574), Loko Paweo II (SIHP # -4576), and SIHP # 50-80-14-4579, a subsurface cultural layer associated with LCA 1785 and containing one set of fragmented skeletal remains. A newly identified '*auwai* system was also discovered (SIHP # 50-80-14-4970). |
| Ashbury-Smith and Dega 1998 | Archaeological Monitoring | N/A | No historic properties observed |
| Perzinski et al. 1999 | Archaeological Monitoring | -5744 | Two pre-contact or early post-contact Native Hawaiian burials observed (SIHP #-5744 |
| Roberts and Bower 2001 | Archaeological Monitoring | N/A | No historic properties observed |
| Corbin 2001 | Archaeological Inventory Survey | N/A | The stratigraphic sequence consisted of imported fill layers (asphalt, clay loam, crushed coral fill) overlying disturbed sand deposits |
| Elmore and Kennedy 2002 | Archaeological Monitoring | N/A | No historic properties observed |
| Jourdane and Dye 2006 | Archaeological Monitoring | N/A | No historic properties were observed. Documented stratigraphy consisted of fill deposits associated with previous development of the area |
| Tulchin and Hammatt 2007 | Archaeological Inventory Survey | N/A | No historic properties were observed |

#### *3.2.2.1 Kalākaua Avenue area*

**Perzinski et al. 1999**

In 1999, two human burials were inadvertently encountered near the intersection of 'Ena Road and Kalākaua Avenue during excavation for the first phase of the Waikīkī Anti-Crime Lighting Improvements Project. Both appeared to be pre-Contact (possibly early post-Contact) Native Hawaiian burials. These burials (SIHP #50-80-14-5744) were not associated with any cultural remains.

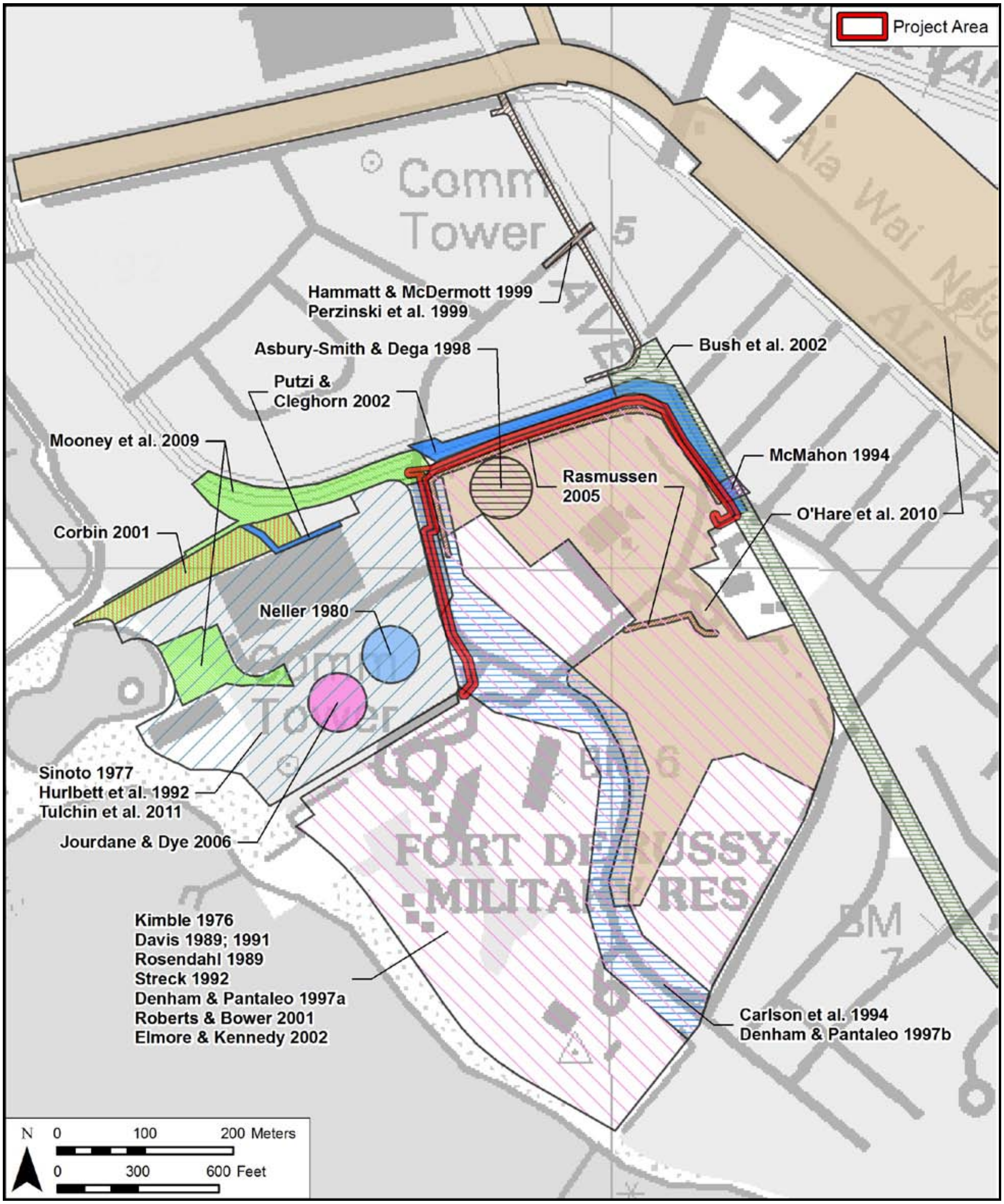


Figure 22. Previous archaeological studies in the wider vicinity of the study area, including the areas of Fort DeRussy, the Hilton Hawaiian Village, and Kalākaua Avenue

**Tulchin and Hammatt 2007**

In 2007, CSH conducted an archaeological inventory survey for the 1944 Kalākaua Avenue Project on the *mauka* side of the intersection of Ala Moana Boulevard and Kalākaua Avenue. A total of 17 backhoe trenches were excavated down to the water table. Documented stratigraphy consisted of varying fill layers, including historic fill associated with the draining and filling of Waikīkī, overlying naturally occurring alluvial sediment. It is believed that the historic fill layers consist of dredge material collected during the construction of the Ala Wai Canal. Two types of dredge material were observed; a thick layer of crushed coral fill overlying a thinner layer of pump dredge, consisting of wet clays containing abundant micro striations, which is indicative of pump dredge deposits. No subsurface historic properties were observed.

*3.2.3 Hale Koa Hotel*

**Bishop Museum (Kimble) 1976**

Denham and Pantaleo (1997a:9, citing Kimble 1976) relate that in 1976: “Five prehistoric or late-historic [sic.?] period bundle burials were recovered from a sand deposit” during construction of Hale Koa Hotel on the beach at Fort DeRussy. A sixth burial was also reported, seemingly from a different context and possibly just pre-dating 1948. The Federal Register “Notice of Inventory Completion for Native American Human Remains and Associated Funerary Objects from the Island of Oahu” (Bishop Museum NAGPRA inventory) of January 28, 1998 makes no mention of these remains as in the museum collection at that time which is consistent with Neller’s (1980: 7) account: “All were reburied near the hotel.” Denham and Pantaleo (1997a:33) provide the detail the re-burial site is north of the Hale Koa Hotel and is marked by a stand of red ti plants.

**Rosendahl 1989a & 1989b**

PHRI carried out an archaeological subsurface inventory survey for a new pool location (Rosendahl 1989a) at the Hale Koa Hotel, Finds were minimal and no human skeletal remains were encountered. A similar study for a Hale Koa Hotel luau facility (Rosendahl 1989b) encountered a disturbed buried cultural layer with associated historic artifacts.

*3.2.4 Hilton Hawaiian Village*

**Sinoto 1977**

In 1977, the Bishop Museum conducted an archaeological reconnaissance survey of the southeast corner of the Hilton Hawaiian Village grounds. No map indicating the specific study area was included with the report, thus making it difficult to pinpoint the exact boundaries of the survey. No historic properties were identified during the surface reconnaissance, however it was noted that the presence of subsurface cultural deposits in the form of human burials and filled-in fishponds were likely. Thus it was recommended that all excavations conducted within the survey area be monitored by an archaeologist.

**Corbin 2001**

In 2001, PHRI completed a subsurface archaeological inventory survey for the northern strip of the Hilton Hawaiian Village complex. The investigation consisted of the excavation of 21 backhoe trenches. In general, the stratigraphic sequence consisted of imported fill layers (asphalt, clay loam, crushed coral fill) overlying disturbed sand deposits. Observed disturbances were associated with prior development of the area (i.e. subsurface utilities and prior building demolition and construction). No historic properties or significant cultural deposits were observed.

**Jourdane and Dye 2006**

In 2006, T.S. Dye & Colleagues, Archaeologists, Inc. completed archaeological monitoring for the construction of the Best Bridal Wedding Chapel at the Hilton Hawaiian Village. No historic properties were observed. Documented stratigraphy consisted of fill deposits associated with previous development of the area.

*3.2.5 Fort DeRussy*

**Kimble 1976**

Five pre-Contact or early historic bundle burials and a sixth possibly twentieth century human burial was encountered during construction of the Hale Koa Hotel on the beach at Fort DeRussy (referenced in Davis 1989 and Denham and Pantaleo 1997a).

**Davis 1989**

In 1989, the International Archaeological Research Institute, Inc. conducted a reconnaissance survey at Fort DeRussy. Eleven test trenches were excavated in widespread locations of inland Fort DeRussy and nine trenches were excavated in the south coastal portion of Fort DeRussy lands. Subsurface testing within the northwestern area of Fort DeRussy (Trenches 1-5, 6-7) in the vicinity of the current study area documented buried fishpond sediments and *ʻauwai* (irrigation ditch) sediments.

**Davis 1991**

In 1991, the International Archaeological Research Institute, Inc. monitored an environmental baseline survey for a Fort DeRussy Military Reservation. While twelve bore holes were monitored in two general areas no archaeological remains were recovered from the coring process. However, based on the excavations conducted in the extreme southern tip of Fort DeRussy lands where intact deposits and features (dating to the 15th century A.D.) were previously noted, it was concluded that nearly continuous, intact prehistoric and early historic cultural deposits underlie the entire area between Battery Randolph and the beach. Davis (1989: 33) reports one burial find, seemingly from his “Burial Pit R” in his “Grid 7” located in LCA 1515:2 which appears to have been located just south (*makai*/Diamond Head) of the Battery Randolph Army Museum. Davis thought this burial dated to circa 1840s/1850s.

**Streck 1992**

In 1992, BioSystems Analysis, Inc. discovered the remains of one post-contact individual (SIHP # 50-80-14-9550) between a probable late pre-Contact burial at the *mauka* end of the Kuroda Parade Ground at Fort DeRussy. Streck (1992:3) notes: “the location of the burial is somewhat unusual for the Waikiki area” in being so far inland (well *mauka* of Kālia Road).

**Simons et al. 1995**

In 1992, BioSystems Analysis, Inc. conducted data recovery excavations at Fort DeRussy in anticipation of new building construction. Three previously identified historic properties were encountered: Loko Paweo I (SIHP # 50-80-14-4574), Loko Paweo II (SIHP # 50-80-14-4576), and SIHP # 50-80-14-4579, a subsurface cultural layer associated with LCA 1785 and containing one set of fragmented skeletal remains. In addition, a newly identified *ʻauwai* system was discovered (SIHP # 50-80-14-4970).

**Ashbury-Smith and Dega 1998**

Scientific Consultant Services conducted monitoring for a shallow water-sprinkler line (30 cmbs), concrete curbing (20 cmbs), and 19 tree holes (120-140 cmbs) within the northern portion of Fort DeRussy just south of Ala Moana Boulevard. Within the tree hole excavations only varying fill layers were encountered.

**Roberts and Bower 2001**

In 2000, Garcia and Associates monitored excavation associated with the installation of a security fence for the Asia-Pacific Center of Fort DeRussy. Seventeen fence postholes (12 inches in diameter and 24 to 36 inches in depth) were excavated. No archaeological resources were identified.

**Elmore and Kennedy 2002**

Archaeological monitoring was required for the installation of a security fence for the Asia-Pacific Center at Fort DeRussy and was carried out in 2002

# Section 4 Results of Fieldwork

A field inspection of the study area was conducted on January 24, 2012 by CSH project managers Matt McDermott, M.A., and David Shideler, M.A. The complete length of the study area was traversed and investigated for any surface historic structures or landscape features. Documentary photographs of the study area were taken and are included below (Figure 23 through Figure 30).

Given the dramatic modifications to the natural landscape within the twentieth century, in the form of the in-filling of Waikīkī's wetlands and streams and the development of Fort DeRussy, Ala Moana Boulevard, Kalākaua Avenue, and Kālia Road, the study area consisted of manicured park land, concrete sidewalks, and asphalt road surfacing. Along Kalākaua Avenue the study area runs from the Fort DeRussy Wastewater Pumping Station through the level grass park area of Fort DeRussy to the corner of Ala Moana Boulevard (Figure 23Figure 24). At the intersection of Kalākaua Avenue and Ala Moana Boulevard a manicured grassy area fronts a rock wall signpost for the “Fort DeRussy Armed Services Recreation Area” (Figure 25). Turning southwest along Ala Moana Boulevard the study area consists of concrete sidewalk and grass lawn bounded by the Fort DeRussy perimeter barrier wall and alignment of large boulders (Figure 26, Figure 27). As the study area turns southeast onto Kālia Road the proposed area of the waste-water replacement line cuts into Kālia Road itself for a majority of the way before entering the *makai* sidewalk near the Hilton Hawaiian Village bus depot exit, cutting across the landscaped corner of Kālia Road and Paoa Place, and ending within the asphalt roadway of Paoa Place (Figure 28, Figure 29, Figure 30). Although documentation within the archaeological monitoring report by Denham and Pantaleo (1997) described the reinterment of an inadvertent discovery (SIHP #-4570:12; i.e. “Burial 11”) within a trench in “the landscaped area between the new Paoa Place extension and the driveway for the Hilton Hawaiian Hotel” (Denham and Pantaleo 1997a:38), no specific indicator of the location of the reinterment was visible (Figure 28, Figure 29).

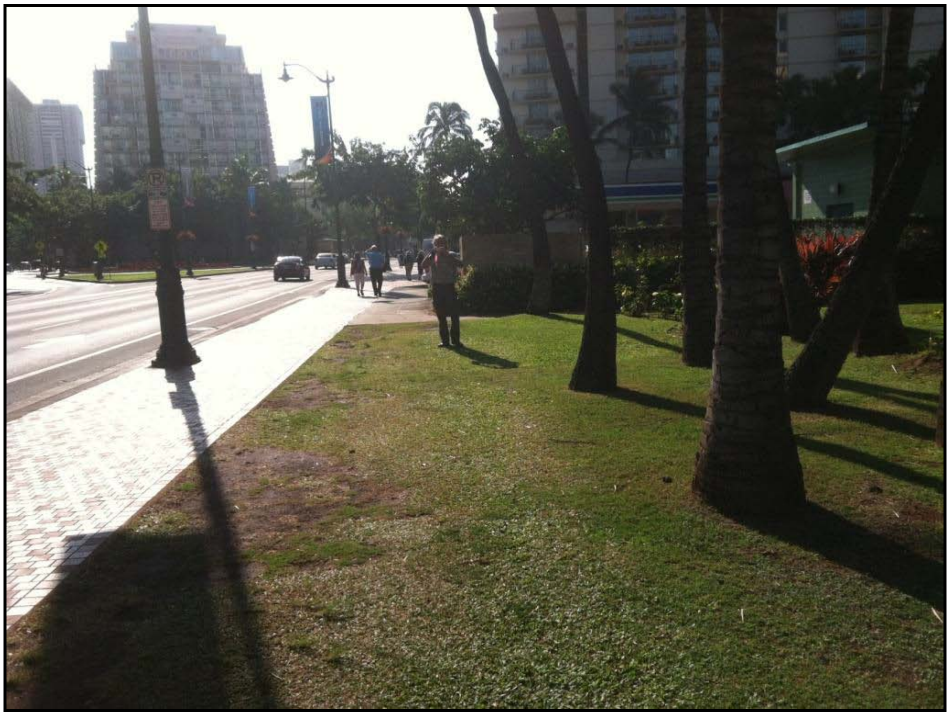

Figure 23. View of the Fort DeRussy Wastewater Pump Station (right) and the study area along Kalākaua Avenue, showing manicured grass and coconut trees

Figure 24. Photograph of Kalākaua Avenue sidewalk along the northern border of Fort DeRussy, showing manicured park with coconut trees


Figure 25. View of the study area at the corner of Kalākaua Avenue and Ala Moana Boulevard

Figure 26. Photograph of the study area adjacent to Ala Moana Boulevard showing the perimeter barrier boulders along Fort DeRussy and manicured sidewalk area

Figure 27. Photograph showing the perimeter barrier wall of Fort DeRussy along the Ala Moana Boulevard sidewalk

Figure 28. Photograph showing the corner of Kālia Road and Paoa Place, in the vicinity of the reinterment location for “Burial 11”


Figure 29. Photograph showing the corner of Kālia Road and Paoa Place, in the vicinity of the reinterment location for "Burial 11"

Figure 30. Photograph of the *makai* end of the project area, located at the head of Paoa Place

# Section 5 Summary and Recommendations

## 5.1 Study Area Summary

During pre-Contact times the *ahupua‘a* of Waikīkī, was an intensely utilized area with abundant natural and cultivated resources that supported a large population. Multiple *heiau* were built throughout the area and traditional accounts refer to the practice of traditional activities, such as surfing and wrestling. Waikīkī also supported a vast network of irrigated taro fields and fishponds, and was an area utilized by the *ali‘i* as a place of residence.

Within the western portion of Waikīkī in the *‘ili* of Kālia, in which the study area is located, the waters of Pi‘inaio Stream entered the coastal region and transformed into a ribboned delta. The abundant waters created an area of natural wetlands behind the coastal beach dunes which were subsequently modified during pre-Contact times into a complex of *loko* (fishponds) and *‘auwai* (irrigation channels) (see Figure 8, Figure 9). Notably, within or immediately adjacent to the current study area, were located the complex of fishponds known as Loko Kaipuni, the large fishpond Loko Paweo I, the large irrigation channel ‘Auwai Alanaio, various lesser *‘auwai*, and berms surrounding the wetlands.

A review of an 1881 Hawaiian Government survey map by S.E. Bishop indicates 2 LCAs within the study area (LCA 2083 to Kahiloaho & LCA 2511 to Alapai) (see Figure 8). Both LCAs were located along the edges of the fishpond complex and were described as house lots.

A series of historic maps from 1881 to 1953 illustrate the dramatic changes that occurred within the study area as post-Contact commercial and military development supplanted the traditional Native Hawaiian way of life (see Figure 8 through Figure 15). Of particular note is the in-filling of the fishponds and waterways of Kālia within the study area during the development of Fort DeRussy beginning in 1908 and the Waikīkī land reclamation efforts of the 1920s. A series of roadways was also developed in tandem with the development of Waikīkī, including: Kalākaua Avenue (the old Waikīkī Road), Ala Moana Boulevard (the old Beach Road which turned up along the path of the old Pi‘inaio Stream), and Kālia Road.

In the past three decades the study area has undergone fairly extensive archaeological investigations in the form of archaeological monitoring programs, data recovery efforts, inventory surveys, and investigations of several inadvertent discoveries of human remains. Archaeological finds documented during these studies include: human burials, pre- and post-Contact cultural layers, buried fishponds, ditches, and other remains of extensive wetland agriculture, historic trash pits, and construction debris. Thus, despite the dramatic modifications to the landscape within the twentieth century, archaeological work has documented the continued existence of subsurface cultural deposits and landscape features beneath the extensive fill layers associated with urban development.

Specifically, and of particular note, previous archaeological research within the study area or immediate vicinity has documented remnants of the Loko Kaipuni complex of ponds (SIHP #-4573) and probable *‘auwai* (Putzi & Cleghorn 2002), historic cultural layers and trash pit features (SIHP #-2780) (Hurlbett et al. 1992; Tulchin et al. 2011), and numerous human burials, including burial complexes (SIHP #-2780; -4570; -7087) (Neller 1980; Carlson et al. 1994; McMahon 1994; Mooney et al. 2009; and Denham & Pantaleo 1997).

In conclusion, archaeological observations have documented the continued subsurface presence of human burials, the pre-1900s modified wetland complex of Kālia, and historic cultural layers and features within the study area. Thus, it is very likely that any ground disturbance within the study area that impacts areas not previously excavated (such the widening or deepening of extant sewer line trenches) may expose similar cultural and historic deposits. Evidence of pre-Contact land use could be in the form of human burials, midden deposits, artifacts (i.e. stone tools), and landscape modifications (i.e. berms, ʻauwai, ponds). Evidence of post-Contact land use could be in the form of human burials, trash pits, and construction debris.

## 5.2 Recommendations

The study area has been the focus of numerous previous archaeological studies which have covered almost the entire length of the study corridor or the areas immediately adjacent. Accordingly, previous archaeological documentation has provided a fairly extensive overview of the subsurface stratigraphy within the majority of the study area. For this reason, a subsurface archaeological inventory survey is not considered necessary for the project area. The abundant existing archaeological information for the project area is sufficient to assess the likelihood of archaeological historic properties in the project area, to assess project effect on these archaeological resources, and make project mitigation recommendations.

Due to the concentration of pre-Contact and post-Contact cultural and historical deposits within the immediate area, and in particular the potential for human burials, an archaeological monitoring program is warranted as an appropriate mitigation measure for ground disturbance conducted within the study area. Archaeological monitoring will facilitate the identification and treatment of any burials that might be discovered during project construction, and will mitigate the project's effect on non-burial archaeological deposits. Under Hawaiʻi State historic preservation legislation, "Archaeological monitoring may be an identification, mitigation, or post-mitigation contingency measure. Monitoring shall entail the archaeological observation of, and possible intervention with, on-going activities which may adversely affect historic properties" (HAR Chapter 13-279-3).

While archaeological monitoring is recommended for the entire project area, the southernmost portion of the study area, which traverses a landscaped corner at the intersection of Kālia Road and Paoa Place, is considered an area of particular sensitivity due to the presence of a documented reinterment location ("Burial 11") (Denham and Pantaleo 1997). Because the precise location of this reinterment site is unmarked and therefore of some concern, careful subsurface probing in the southernmost portion of the project area is recommended as part of the project's archaeological monitoring program.

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# Appendix A Land Commission Awards

## A.1 LCA 2511

Number: 02511

| | |
|---|---|
| Claim Number: | 02511 |
| Claimant: | Alapai |
| Other claimant: | |
| Other name: | |
| Island: | Oahu |
| District: | Kona |
| Ahupuaa: | Waikiki |
| Ili: | Kalia |

| | | | |
|---|---|---|---|
| Apana: | 1 | Awarded: | 1 |
| Loi: | | FR: | |
| Plus: | | NR: | 531v5 |
| Mala Taro: | | FT: | 489v14 |
| Kula: | | NT: | |
| House lot: | | RP: | 3441 |
| Kihapai/Pakanu: | | Number of Royal Patents: | 1 |
| Salt lands: | | Koele/Poalima: | No |
| Wauke: | | Loko: | No |
| Olona: | | Lokoia: | No |
| Noni: | | Fishing Rights: | No |
| Hala: | | Sea/Shore/Dunes: | Yes |
| Sweet Potatoes: | | Auwai/Ditch: | No |
| Irish Potatoes: | | Other Edifice: | No |
| Bananas: | | Spring/Well: | No |
| Breadfruit: | | Pigpen: | No |
| Coconut: | 1 | Road/Path: | Yes |
| Coffee: | | Burial/Graveyard: | No |
| Oranges: | | Wall/Fence: | Yes |
| Bitter Melon/Gourd: | | Stream/Muliwai/River: | No |
| Sugar Cane: | | Pali: | No |
| Tobacco: | | Disease: | No |

| | | | |
|---|---|---|---|
| Koa/Kou Trees: | | Claimant Died: | No |
| Other Plants: | | Other Trees: | |
| Other Mammals: | No | Miscellaneous: | coconut grove,government road |

**No. 2511, Alapai**
**N.R. 531v3**

I, the one whose name is below, hereby state my claim for a coconut grove and a house site. The boundaries of the grove are: on the east is the small pond and the house of Umi, on the north is the Government road, and the government wall, and on the west the government wall also, and an unused place, and on the south is an unused place. That is my claim which is hereby stated.
I am, respectfully,
ALAPAI X, his mark

**F.T. 489v14**
No. 2511, Alapai, claimant

Kanemakua, sworn says, the land of claimant is an Uluniu called Kaneumanuhou in Kalia, Waikiki, Oahu. It is bounded:

Mauka by the public road
Kekaha by the house of Umi
Makai by the sea shore
Honolulul by pa aupuni of Kalia.

Claimant inherited the land from his father, Kahanaumaikai from the time of Kamehameha. He has held it in quiet.

Kamaea, sworn says, the above testimony is true, and is also his own.

[Award 2511, R.P. 3441; Kalia Waikiki Kona; 1 ap.; 4.6 Acs]

# A.3 LCA 2083

Number: 02083

| | |
|---|---|
| Claim Number: | **02083** |
| Claimant: | **Kahiloaho** |
| Other claimant: | |
| Other name: | |
| Island: | **Oahu** |
| District: | **Kona** |
| Ahupuaa: | **Waikiki** |
| Ili: | **Kamookahi, Kanukukahi, Piinaio, Mooiki, Piinao** |

| | | | |
|---|---|---|---|
| Apana: | **3** | Awarded: | **1** |
| Loi: | **3** | FR: | |
| Plus: | | NR: | **350v3** |
| Mala Taro: | | FT: | |
| Kula: | | NT: | **638v3** |
| House lot: | **1** | RP: | **3923** |
| Kihapai/Pakanu: | | Number of Royal Patents: | **1** |
| Salt lands: | | Koele/Poalima: | **No** |
| Wauke: | | Loko: | **No** |
| Olona: | | Lokoia: | **No** |
| Noni: | | Fishing Rights: | **No** |
| Hala: | | Sea/Shore/Dunes: | **No** |
| Sweet Potatoes: | | Auwai/Ditch: | **No** |
| Irish Potatoes: | | Other Edifice: | **No** |
| Bananas: | | Spring/Well: | **No** |
| Breadfruit: | | Pigpen: | **No** |
| Coconut: | | Road/Path: | **No** |
| Coffee: | | Burial/Graveyard: | **No** |
| Oranges: | | Wall/Fence: | **No** |
| Bitter Melon/Gourd: | | Stream/Muliwai/River: | **No** |
| Sugar Cane: | | Pali: | **No** |
| Tobacco: | | Disease: | **No** |

https://www.waihona.com/purchase.asp

Koa/Kou Trees: Claimant Died: No
Other Plants: Other Trees:
Other Mammals: No Miscellaneous:

**No. 2083, Kahiloaho**
**N.R. 350v3**

I, the one those name is below, hereby state my claim for two lo`i. One is at Aipae, and another is at Kaulukukahi /and also/ my house lot and five ponds. This is my claim of which I am telling you, for my keiki, two lo`i at Mookahi.
KAHILOAHO X, his mark
Waikiki, Oahu, 23 December 1847

**N.T. 638v3**
No. 2083, Kahiloaho, July 3, 1850

Ku, sworn, I have seen his land at Waikiki - 3 sections in the ili below:

Section 1 - 1 patch in Mooiki ili.
Section 2 - 2 patches in Mookahi ili.
Section 3 - House lot in Kalia ili.

He received section 1 from Kamakahonu, the konohiki, in 1844. It had been from the king to Kamakahonu; Section 2, from Kaaukualii in 1834; section 3, an idle land on which he worked in 1838, before the death of Kinau and he has lived there comfortably to the present time. No one has objected.

1. The boundaries are:
Mauka, Kahanaumaikai
Waialae, Kamakahonu
Makai, Kaiakoili
Honolulu, Kauhoa.

2.
Mauka, Kanemakua
Waialae, Haumalu
Makai, Kumoanahulu
Honlulu, Keaka.

2. Kaluahinenui's land is around completely.

Haumalu, sworn, Everything which has been mentioned above is true. I have known in the same way.

[Award 2083; R.P. 3923; Kamookahi Waikiki Kona; 2 ap.; .44 Ac.; Kanukukahi Waikiki Kona; 1 ap.; .34 Ac.; Piinaio Waikiki Kona; 1 ap.; 1.73 Acs]

# APPENDIX I
# CULTURAL IMPACT ASSESSMENT
# (CULTURAL SURVEYS HAWAII, INC.)

# Cultural Impact Assessment for the Kālia-Fort DeRussy Wastewater System Improvements Waikīkī, Honolulu (Kona) District, O‘ahu TMK: [1] 2-6-005:001 + easements

**Prepared for**

**Group 70 International, Inc.**


**Prepared by**

**Nicole Ishihara, B.A.**

**and**

**Hallett H. Hammatt, Ph.D.**

**Cultural Surveys Hawai‘i, Inc.**

**Kailua, Hawai‘i**


**(Job Code: WAIKIKI 65)**

**July 2012**


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**Fax: (808) 244-1994**

# Prefatory Remarks on Language and Style

### A Note about Hawaiian and other non-English Words:

Cultural Surveys Hawaiʻi (CSH) recognizes that the Hawaiian language is an official language of the State of Hawaiʻi, it is important to daily life, and using it is essential to conveying a sense of place and identity. In this report, CSH uses italics to identify and highlight all foreign (i.e., non-English and non-Hawaiian) words. Italics are only used for Hawaiian words when citing from a previous document that italicized them. CSH parenthetically translates or defines in the text the non-English words at first mention, and the commonly-used non-English words and their translations are also listed in the *Glossary of Hawaiian Words* (Appendix A) for reference.

### A Note about Plant and Animal Names:

When community participants mention specific plants and animals by Hawaiian, other non-English or common names, CSH provides their possible scientific names (Genus and species) in the *Common and Scientific Names of Plants and Animals Mentioned in Interviews* (Appendix B). CSH derives these possible names from authoritative sources, but since the community participants only name the organisms and do not taxonomically identify them, CSH cannot positively ascertain their scientific identifications. CSH does not attempt in this report to verify the possible scientific names of plants and animals in previously published documents; however, citations of previously published works that include both common and scientific names of plants and animals appear as in the original texts.

# Management Summary

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| **Reference** | Cultural Impact Assessment (CIA) for the Kālia-Fort DeRussy Wastewater System Improvements, Waikīkī Ahupua‘a, Honolulu (Kona) District, Tax Map Key: [1] 2-6-005:001 + easements (Ishihara and Hammatt 2012) |
| **Date** | July 2012 |
| **Project Number (s)** | Cultural Surveys Hawai‘i (CSH) Job Code: WAIKIKI 65 |
| **Agencies** | City and County of Honolulu, Department of Environmental Services; State Historic Preservation Division (DLNR/SHPD); State Office of Environmental Quality Control (OEQC) |
| **Project Location** | Kalia Road (between Paoa Place and Ala Moana Boulevard); Ala Moana Boulevard (between Kālia Road and Kalākaua Avenue); and Kalākaua Avenue (between Ala Moana Boulevard and Kuhiō Avenue) |
| **Land Jurisdiction** | City and County of Honolulu, United States Army (Fort DeRussy) |
| **Project Description** | This Project involves improvements to existing City and County of Honolulu wastewater collection system along a portion of Kālia Road and a portion of Fort DeRussy. The planned improvements will accommodate sewer flows from the Hale Koa Hotel, the Hilton Hawaiian Village and the service area between the Ala Wai Canal, Kalākaua Avenue and Fort DeRussy. The proposed Kālia Road Sewer Line will replace the existing 12-inch sewer line with a 21-inch sewer line. The Project area will begin at the intersection of Paoa Place and Kālia Road and end at the intersection of Ala Moana Boulevard and Kālia Road. The existing 16-inch diameter sewer line, which traverses across Fort DeRussy in a sewer line easement, will be cut and plugged at the Ala Moana Boulevard and Kālia Road intersection. The existing 24-inch sewer line located on Ala Moana Boulevard and Kalākaua Avenue will be replaced with a 30-inch sewer line. The Project area will begin at the intersection of Kālia Road and Ala Moana Boulevard and end at the Fort DeRussy Waste Water Pumping Station. The work within the Fort DeRussy property will be contained within a City and County of Honolulu sewer line easement. |
| **Area of Potential Effect (APE)** | For the purposes of this CIA, the APE is defined as the Project area. While this investigation focused on the Project APE, the study area included the entire modern ahupua‘a (land division usually extending from the uplands to the sea) of Waikīkī Kai. |

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| **Document Purpose** | The Project requires compliance with the State of Hawaiʻi environmental review process (Hawaiʻi Revised Statutes [HRS] Chapter 343), which requires consideration of a proposed project's effect on cultural practices and resources. Group 70 International, Inc. requested CSH conduct this CIA. Through document research and ongoing cultural consultation efforts, this report provides information pertinent to the assessment of the proposed Project's impacts to cultural practices and resources (per the *Office of Environmental Quality Control's Guidelines for Assessing Cultural Impacts*) which may include Traditional Cultural Properties of ongoing cultural significance that may be eligible for inclusion on the State Register of Historic Places, in accordance with Hawaiʻi State Historic Preservation Statute (Chapter 6E) guidelines for significance criteria according to Hawaiʻi Administrative Rules (HAR) §13-275 and §13-284 under Criterion E. The document is intended to support the Project's environmental review and may also serve to support the Project's historic preservation review under HRS Chapter 6E and HAR Chapter 13-275 and 13-284. This CIA investigation may also be used to support the National Historic Preservation Act Section 106 and the National Environmental Policy Act (NEPA) consultation, but does not, in itself, satisfy the cultural consultation requirements of either Section 106 or NEPA. |
| **Consultation Effort** | Hawaiian organizations, agencies and community members were contacted in order to identify individuals with cultural expertise and/or knowledge of the permanent Project footprint and the vicinity. The organizations consulted included the State Historic Preservation Division, the Office of Hawaiian Affairs (OHA), the Oʻahu Island Burial Council (OIBC), Hui Mālama I Nā Kūpuna O Hawaiʻi Nei, the Waikīkī Hawaiian Civic Club, and community members of Waikīkī Ahupuaʻa. |
| **Results of Background Research** | Background research for this Project yielded the following results (presented in approximate chronological order):<br>1. Waikīkī was comprised of a vast system of irrigated taro fields which spanned from Waikīkī Kai to the valleys of Mānoa. The Waikīkī marshland was an excellent place to grow taro, even better than the revered areas of Kāneʻohe and Kahaluʻu on the windward side of Oʻahu.<br>2. The Waikīkī area was full of aquatic resources including hundreds of fishponds that dotted the shoreline of the ahupuaʻa.<br>3. Six heiau (pre-Christian place of worship) are said to have been associated with the Waikīkī area: Papaʻenaʻena Heiau, |

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| | Helumoa Heiau, Kapua Heiau, Kūpalaha Heiau, Kamauakapu Heiau, and Kulanihakoi Heiau (Thrum 1907:44). Thrum also mentions the Wizard Stones of Kapaemāhū at Waikīkī. The Wizard Stones were unearthed in the late 1800s on the premises of the Cleghorn family. According to moʻolelo (oral traditions), four soothsayers from the court of a Tahitian king came to Hawaiʻi and helped to heal many people. Four large stones were gathered from the vicinity of a "bell rock" in Kaimukī and erected in Waikīkī to commemorate them–two at their habitation and two at their bathing place in the sea. The chief of the wizards, Kapaemahu, named his stone after himself, and a virtuous young chiefess was sacrificed and placed beneath the stone. Today they are located at Kūhiō Beach Park (Thrum 1907:139–141).<br>4. During the first decade of the twentieth century, the U.S. War Department acquired more than 70 acres in the Kālia portion of Waikīkī for the establishment of a military reservation called Fort DeRussy, named in honor of Brig. Gen. R.E. DeRussy of the Army Corps of Engineers. Between 1909 and 1911 the engineers were primarily occupied with mapping the island of Oʻahu. At DeRussy other activities also had to be attended to, especially the filling of a portion of the fishponds which covered most of the Fort. The Quartermaster Corps took on the job, accomplishing it through the use of a hydraulic dredger that pumped fill from the ocean continuously for nearly a year in order to build up an area on which permanent structures could be built. Thus the Army began the transformation of Waikīkī from wetlands to solid ground (Hibbard and Franzen 1986:79).<br>5. In 1980, three partial sets of human remains (State Inventory of Historic Properties [SIHP] #50-80-14-2780) and three subsurface features were inadvertently discovered during construction at the southeastern corner of the Hilton Hawaiian Village Tapa Tower (Neller 1980). Subsurface features consisted of pit features pre-dating the construction of the Ala Wai Canal. Two pits had undetermined features; however, Neller suggested they were filled-in irrigation ditches. The third pit was a trash pit consisting of ceramic and glass artifacts dating to the late 1890s. A "coffee bean" sinker used for octopus lures was collected from one the pits. The sinker was made of pink granites, an imported material, dating the traditional artifact to the post-Contact period.<br>6. In 1993, archaeological monitoring was conducted by Biosystems Analysis, Inc. along Kālia Road at Fort DeRussy |

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| | Military Reservation. Results were written by Garcia and Associates almost four years later (Denham and Pantaleo 1997a). SIHP #50-80-14-4574 consisted of fishpond sediments (Loko Paweo I), three historic trash pits, and two burials. SIHP #50-80-14-4570 consisted of a historic trash pit, four fire pits, an ash lens, and an unknown number of human burials (in six distinct features).<br>7. In 1992, archaeological data recovery was conducted at Fort DeRussy (Denham and Pantaleo 1997b). Five previously identified sites were investigated (SIHP #50-80-14-4570). SIHP #50-80-14-4970 consisted of an irrigation ditch and bund system. SIHP #50-80-14-4579 revealed numerous features related to permanent historic occupation and possible intermittent prehistoric use (five fire pits, two historic middens, and a human burial). In addition, three fishponds, Loko Paweo I (-4574), Loko Ka‘ihikapu (-4575), and Loko Paweo II (-4576) were identified.<br>8. In 2009, Pacific Legacy, Inc. conducted an archaeological monitoring for the Hilton Hawaiian Village Grand Waikīkīan Development Project. A previously disturbed human burial (-7087) was found on the mauka side of the intersection of Ala Moana Boulevard and Kālia Road.<br>9. An oral history compilation was conducted by the University of Hawai‘i’s Center for Oral History (UHCOH) in 1985 to capture the voices of several people with extensive knowledge of the history and culture of Waikīkī. These oral histories describe the Kālia area as excellent grounds for aquaculture including fishing and gathering of limu (seaweed). According to Mr. John C. Ernstberg, various limu, including manauea, līpoa, and wāwae‘iole, could be found in Waikīkī. Mr. Earle “Liko” Vida recalls fishing for ‘ōpelu (mackerel), ulua (jack), and pāpio (juvenile jack) in the Kālia area. |
| **Results of Community Consultation** | CSH attempted to contact 123 community members, cultural descendants, and government agency and community organization representatives. Of the 15 people that responded, five kūpuna (elders) and/or kama‘āina (Native-born) participated in formal interviews for more in-depth contributions to the CIA. This community consultation indicates:<br>1. In a written testimony, Mr. Halealoha Ayau of Hui Mālama I Nā Kūpuna O Hawai‘i Nei states that the organization has conducted two reburials in the area. One at the Hilton Hawaiian Village and the other at Fort DeRussy. He suggests that both be identified so they are not disturbed. |

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| | 2. Mr. Greg Kashiwa of Kupuna LLC, recalls surfing and fishing in the Kālia and Fort DeRussy area. A platform once existed off shore where swimmers could congregate. After the tsunami of 1946 the platform disappeared.<br>3. During Mr. Kashiwa's service in the Army, his unit conducted an annual sand replenishment project fronting the Hale Koa hotel. During a routine replenishment, a D9 Cat fell into the ocean causing a coral shelf to collapse. Upon retrieval, a local diver felt fresh water flowing from the rubble. The diver suggested the coral shelf was actually a lava tube connected to the Mō‘ili‘ili fresh water karst and cave system. The Army did not want to draw attention to the problem and did not pursue investigation. Mr. Kashiwa suggests the area "is worth seeing and archaeological traces may remain" within the karst and cave system.<br>4. In a written response, Kamana‘opono Crabbe of OHA states that "existing documentation from separate projects conducted in the area detail the presence of burials and cultural deposits in the vicinity of the instant project area." Mr. Crabbe recommends archaeological monitoring during all project activities.<br>5. Mr. Clarence Medeiros, Jr. describes his great-grandfather, Zen Man Sing (also known as "Zane Man Sing"), a Chinese immigrant who arrived in Hawai‘i in 1888. Mr. Medeiros' great-grandfather, worked in Waikīkī planting rice and taro with relatives. He describes Waikīkī being "all water, swampland" and having "all lo‘i [irrigated terrace] kind of land around 1890s."<br>6. Ms. Sylvia Krewson-Reck lived in Kalihi Valley but spent most of her time in Waikīkī during the late 1930s. Ms. Krewson-Reck became close friends with Joseph Kaopuiki. His nickname was "Scooter Boy." He was a well-known surfer during that time who was known for riding the biggest wave on the North Shore. He was also Ms. Krewson-Reck's tandem surfing partner.<br>7. During Ms. Krewson-Reck's childhood, she recalls going to classmate Lorna Prendergast's home in Kapālama. During this visit, she was introduced to Lorna's grandmother named Ellen. It wasn't until a decade ago that Ms. Krewson-Reck realized that Lorna's grandmother was Ellen Wright Prendergast, Queen Lili‘uokalani's close friend and the woman who wrote "*Kaulana Nā Pua*" or "Famous are the Children," a symbolic |

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| | song of the Hawaiian independence movement.<br>8. Mr. Richard Paglinawan shares the history behind Nā Pōhaku ʻOla Kapaemahu, or the Life-giving Stones or Kapaemahu and Kapuni, commonly referred to as the Wizard Stones. He also traces the royal lineages of aliʻi (chiefs) in Waikīkī.<br>9. Mr. Paglinawan's family regularly visited Waikīkī on Sundays where they visited the zoo, listened to the Royal Hawaiian Band at the Kapiʻolani Park bandstand, swam at San Souci Beach, dove off the diving board at the Natatorium, and listened to music at the International Marketplace in the evenings.<br>10. Mr. Paglinawan and his family gathered limu and caught heʻe (octopus), mullet (ʻamaʻama), pāpio, uhu (parrotfish), and hīnālea (wrasse).<br>11. Mr. Becket led CSH to two cultural sites within the broader landscape of Waikīkī. The first site is located between Waʻahila Ridge and the area known as Kānewai. The site is nestled between a rock face and a steep drop-off. Distinct features such as terracing, a poʻo pōhaku (a stone with an outcropping that looks like a head), and scattered cobbles and boulders make-up the site. The site commands an impressive view of Waikīkī Kai. The second site is located in Kamanele Park in Mānoa Valley. The site is on the makai (towards the ocean) side of the park below the gated grounds of Mid-Pacific Institute. A large natural stone outcropping is noticed at first glance. Behind the large outcropping lies distinct artificial terracing, a possible ahu (altar), and a small rock overhang. A significant feature that Mr. Becket pointed out was an upright stone representing a nanahoa (phallic formation) and two stones below representing a kohe (vagina). Both heiau have distinct features that indicate they are most likely pre-Contact. |

| | |
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| **Impacts and Recommendations** | Based on the information gathered for the cultural and historic background and community consultation detailed in this CIA report, the proposed Project may potentially impact Native Hawaiian burials and cultural beliefs. CSH identifies these potential impacts and makes the following recommendations:<br>1. Mr. Halealoha Ayau and Mr. Kamanaʻopono Crabbe's state that iwi kūpuna (ancestral remains) are located in the Project area, and previous findings in the Project area include three burials and three subsurface features (SIHP #50-80-14-2780; Neller 1980); ten subsurface features and an unknown number of burials (4574 and -4570; Denham and Pantaleo 1997a); an ʻauwai (ditch) and bund system (-4970), a permanent historic occupation site with firepits, midden, and burials (-4579), and three fishponds (-4574 to -4576; Denham and Pantaleo 1997b). In addition, the Project area consists of Jaucas sand deposits, which increases the likelihood of unmarked burials. Further, two additional burials were found in Jaucas sand deposits less than 500 meters south of the Project area, and an additional four burials were found less than 500 meters north of the Project area. From these findings, there is a high possibility that iwi kūpuna may be present within the Project area, and that land-disturbing activities during construction may uncover presently undetected burials or other cultural finds.<br>2. Personnel involved in the construction activities of the Project should be informed of the possibility of inadvertent cultural finds, including human remains. Should any burials or other cultural finds be identified during ground disturbance, the construction contractor should immediately cease all work and the appropriate agencies notified pursuant to applicable law.<br>3. CSH and Group 70 International, Inc., should consult with cultural descendants of Waikīkī and/or lineal descendants connected to the Project area, to develop a reinterment plan and cultural preservation plan in the event that any human remains, cultural sites, or artifacts are uncovered during construction for the Project. |

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# Section 1 Introduction

## 1.1 Project Background

At the request of Group 70 International, Inc., on behalf of the City and County of Honolulu, Department of Environmental Services, Cultural Surveys Hawai‘i Inc. (CSH) is conducting a Cultural Impact Assessment (CIA) for the proposed Kālia-Fort DeRussy Wastewater System Improvements, Waikīkī Ahupua‘a, Honolulu (Kona) District, O‘ahu Island, Tax Map Key: [1] 2-6-005:001 + easements. This CIA investigation may also be used to support the National Historic Preservation Act Section 106 and the National Environmental Policy Act (NEPA) consultation, but does not, in itself, satisfy the cultural consultation requirements of either Section 106 or NEPA.

This Project involves improvements to existing wastewater collection system along a portion of Kālia Road and a portion of Fort DeRussy. The planned improvements will accommodate sewer flows from the Hale Koa Hotel, the Hilton Hawaiian Village and the service area between the Ala Wai Canal, Kalākaua Avenue and Fort DeRussy.

The proposed Kālia Road Sewer Line will replace the existing 12-inch sewer line with a 21-inch line. The Project area will begin at the intersection of Paoa Place and Kālia Road and end at the intersection of Ala Moana Boulevard and Kālia Road. The existing 16-inch diameter sewer line, which traverses across Fort DeRussy in a sewer line easement, will be cut and plugged at the Ala Moana Boulevard and Kālia Road intersection.

The existing 24-inch sewer line located on Ala Moana Boulevard and Kalākaua Avenue will be replaced with a 30-inch sewer line. The Project area will begin at the intersection of Kālia Road and Ala Moana Boulevard and end at the Fort DeRussy Waste Water Pumping Station (Figure 1, Figure 2, Figure 3). The work within the Fort DeRussy property will be contained within a City and County of Honolulu sewer line easement.

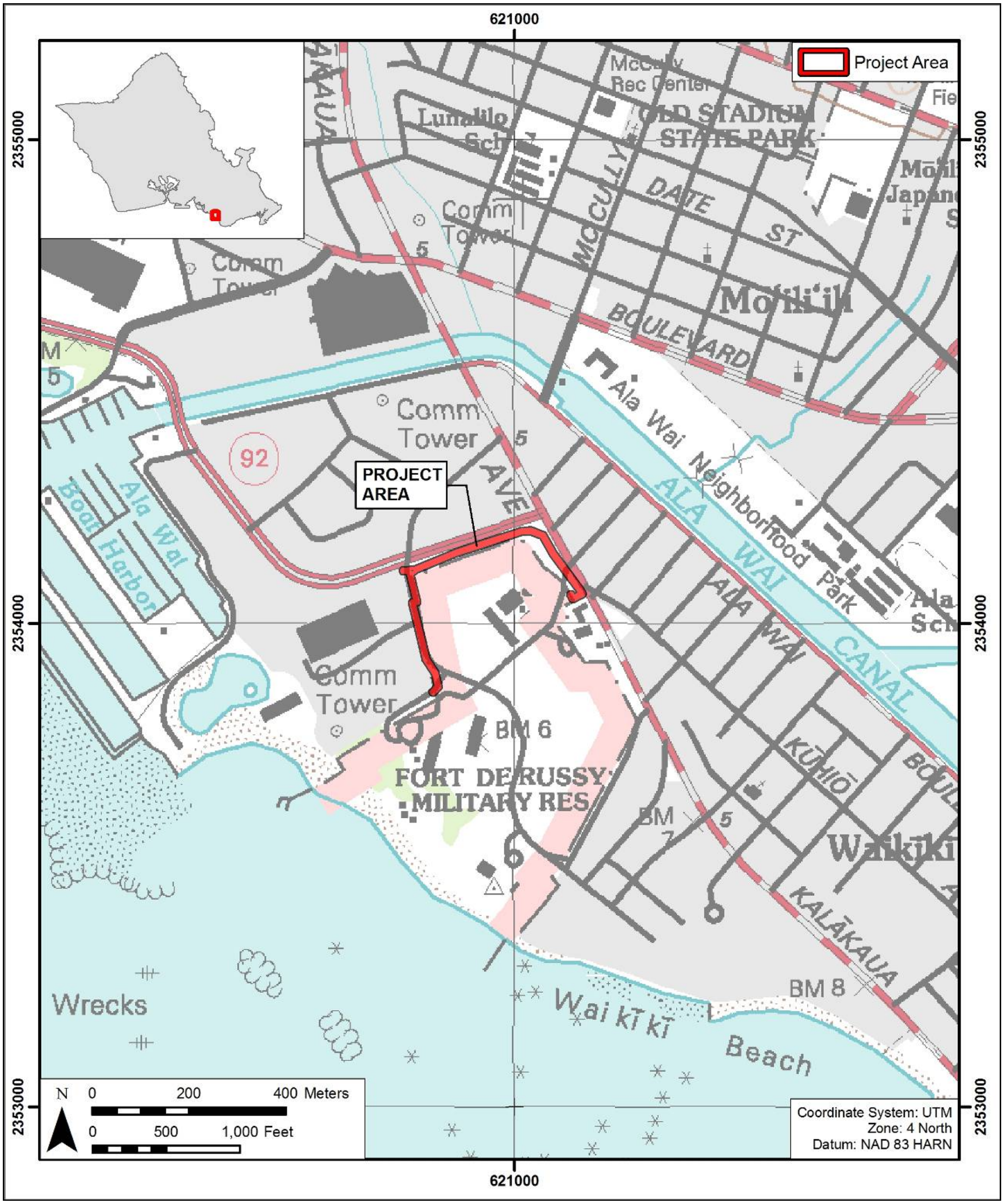
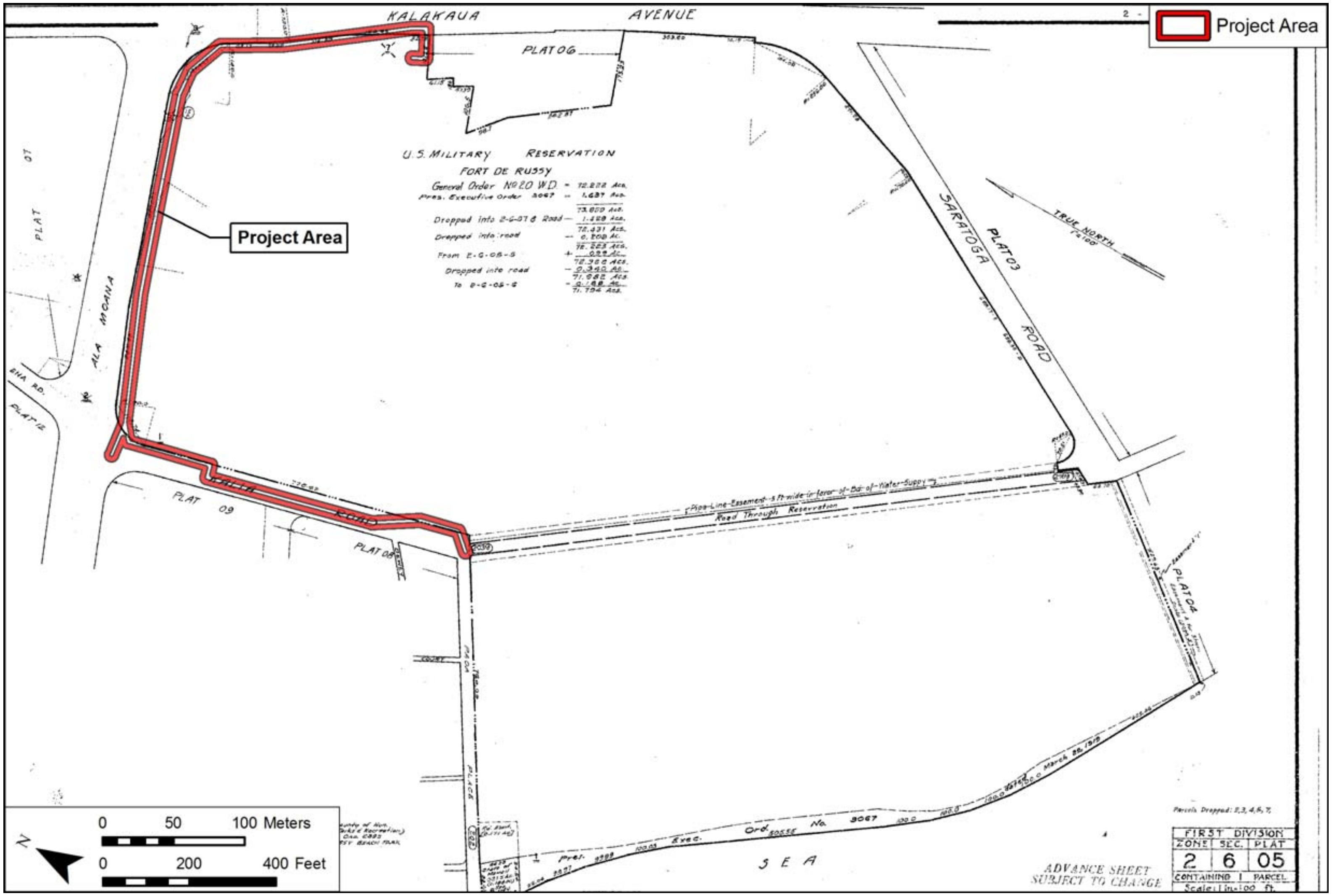



Figure 1. Portion of the 1998 United States Geological Survey (USGS) 7.5-minute series topographic map, Honolulu Quadrangle, showing the Project area


Figure 2. Aerial photograph showing the location of the Project area, including the proposed Fort DeRussy Wastewater Pumping Station (Google Earth 2008)

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## 1.2 Document Purpose

The Project requires compliance with the State of Hawai‘i environmental review process [Hawai‘i Revised Statutes (HRS) Chapter 343], which requires consideration of a proposed Project's effects on cultural practices. CSH is conducting this CIA at the request of Group 70 International, Inc. Through document research and ongoing cultural consultation efforts this draft report provides preliminary information pertinent to the assessment of the proposed Project's impacts to cultural practices and resources (per the *Office of Environmental Quality Control's Guidelines for Assessing Cultural Impacts*), which may include Traditional Cultural Properties (TCP) of ongoing cultural significance that may be eligible for inclusion on the State Register of Historic Places, in accordance with Hawai‘i State Historic Preservation Statute (Chapter 6E) guidelines for significance criteria (HAR §13–275–6) under Criterion E which states to be significant an historic property shall:

> Have an important value to the Native Hawaiian people or to another ethnic group of the state due to associations with cultural practices once carried out, or still carried out, at the property or due to associations with traditional beliefs, events or oral accounts—these associations being important to the group's history and cultural identity.

The document is intended to support the Project's environmental review and may also serve to support the Project's historic preservation review under HRS Chapter 6E–42 and Hawai‘i Administrative Rules Chapter 13–275. This CIA investigation may also be used to support the National Historic Preservation Act Section 106 and the National Environmental Policy Act (NEPA) consultation, but does not, in itself, satisfy the cultural consultation requirements of either Section 106 or NEPA.

## 1.3 Scope of Work

The scope of work for this CIA includes:

1. Examination of cultural and historical resources, including Land Commission documents, historic maps, and previous research reports, with the specific purpose of identifying traditional Hawaiian activities including gathering of plant, animal, and other resources or agricultural pursuits as may be indicated in the historic record.
2. Review of previous archaeological work at and near the subject parcel that may be relevant to reconstructions of traditional land use activities; and to the identification and description of cultural resources, practices, and beliefs associated with the parcel.
3. Consultation and interviews with knowledgeable parties regarding cultural and natural resources and practices at or near the parcel; present and past uses of the parcel; and/or other practices, uses, or traditions associated with the parcel and environs.
4. Preparation of a report that summarizes the results of these research activities and provides recommendations based on findings.

## 1.4 Environmental Setting

### 1.4.1 Natural Environment

The Project area is situated along the southeastern coast of Oʻahu. The Honolulu leeward coastal plain is stratified with late-Pleistocene coral reef substrate overlaid with calcareous marine beach sand, terrigenous sediments, and/or stream-fed alluvial deposits (Armstrong 1973:36). Terrigenous sediments are formed and deposited on land, or are materials derived from land mixed with purely marine material. The Project area receives between 23 and 31 inches (600 and 800 millimeters) of rainfall per year (Giambelluca et al. 1986).

Lands within the Project area are relatively level with an elevation of three ft. above mean sea level (AMSL). According to U.S. Department of Agriculture (USDA) soil survey data, sediments within the Project area consist almost exclusively of Jaucas Sand (JaC), with small pockets of Fill Land (FL) located along the western portion of the Project area (Foote et al. 1972) (Figure 4). As discussed in more detail below, Jaucas sands have been shown to contain many unmarked burials from pre-Contact and early historic times throughout Waikīkī and elsewhere on Oʻahu and other islands. The following is a synopsis of each soil series:

> Jaucas series consists of excessively drained, calcareous soils that occur as narrow strips on coastal plains, adjacent to the ocean…developed in wind and water deposited sand from coral and seashells…used for pasture, sugarcane, truck crops, alfalfa, recreational areas, wildlife habitat, and urban development. (Foote et al. 1972)
>
> Fill is described as a land type occurring mostly near Pearl Harbor and in Honolulu, adjacent to the ocean. It consists of areas filled with material dredged from the ocean or hauled from nearby areas, garbage, and general material from other sources. (Foote et al. 1972)

During pre-Contact and early post-Contact times, natural vegetation would have consisted of coastal marshland species, but the original wetlands have been filled and replaced with an entirely modified landscape and manicured landscaping.

### 1.4.2 Built Environment

The entire Project area has been artificially modified as a result of resort development. High- and low-rise buildings are present throughout the Project area, as well as concrete and asphalt paved roads and walkways. Landscaped trees and hedges are also present throughout the Project area.

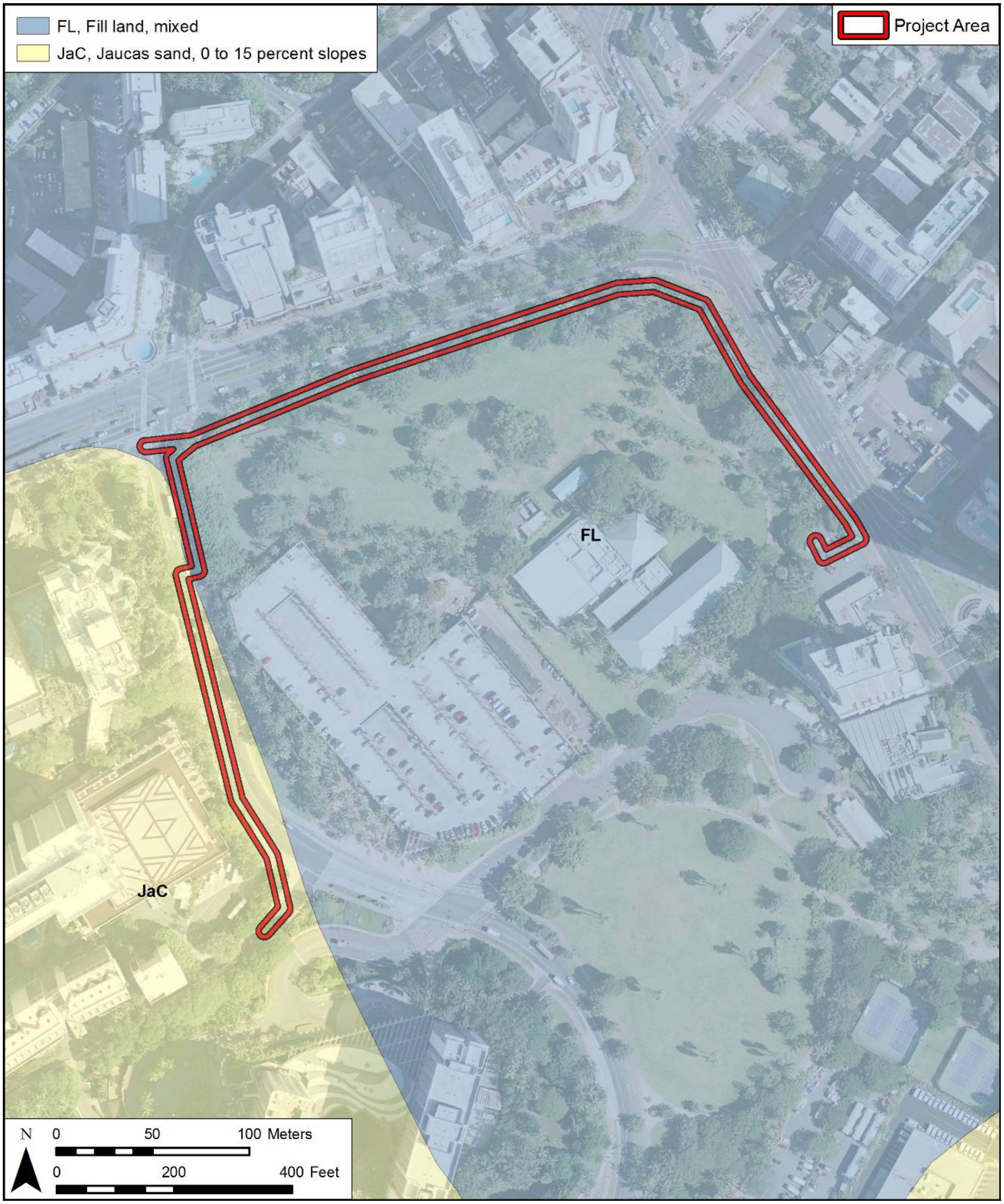


Figure 4. Portion of the 1998 USGS 7.5-minute series topographic map, Honolulu Quadrangle, showing the Project area with soil overlay (Foote el al. 1972)

# Section 2 Methods

## 2.1 Archival Research

Historical documents, maps and existing archaeological information pertaining to Waikīkī Ahupuaʻa, Honolulu (Kona) District and the Project area vicinity—including Honolulu—were researched at the CSH library and other archives including the University of Hawaiʻi at Mānoa's Hamilton Library, the State Historic Preservation Division (SHPD) library, the Hawaiʻi State Archives, the State Land Survey Division, and the archives of the Bishop Museum. Previous archaeological reports for the area were reviewed, as were historic maps and photographs and primary and secondary historical sources. Information on LCAs was accessed through Waihona ʻĀina Corporation's Māhele Data Base (www.waihona.com) and the Office of Hawaiian Affairs' Papakilo Database (www.papakilodatabase.com) as well as a selection of CSH library references.

The definitive source for Hawaiian place names is Pukui et al.'s (1974) *Place Names of Hawaiʻi*, but additional place-name translations and interpretations were also gleaned from historical maps, Land Commission documents available at the Hawaiʻi State Archives or on the internet at www.waihona.com and www.papakilodatabase.com, and from other place-name texts such as Clark (1977). Some place names in this report—discussed in the next section—were also gathered from USGS 7.5-Minute Series topographic maps.

Research for the Traditional Background section centered on Hawaiian activities including: religious and ceremonial knowledge and practices; traditional subsistence land use and settlement patterns; gathering practices and cultivation pursuits; as well as Hawaiian place names and moʻolelo (oral traditions), mele (song), oli (chants), ʻōlelo noʻeau (proverb) and more. The Historic Background section research focused on land transformation, development and population changes beginning in the early post–European Contact era to the present day.

## 2.2 Community Consultation

### 2.2.1 Sampling and Recruitment

A combination of qualitative methods, including purposive, snowball, and expert (or judgment) sampling, were used to identify and invite potential participants to the study. These methods are used for intensive case studies, such as ethnohistoric studies, to recruit people that are hard to identify, or are members of elite groups (Bernard 2006:190). Our purpose is not to establish a representative or random sample. It is to "identify specific groups of people who either possess characteristics or live in circumstances relevant to the social phenomenon being studied. This approach to sampling allows the researcher deliberately to include a wide range of types of informants and also to select key informants with access to important sources of knowledge" (Mays and Pope 1995:110).

We began with purposive sampling informed by referrals from known specialists and relevant agencies. For example, we contacted the SHPD, the Office of Hawaiian Affairs (OHA), Oʻahu Island Burial Council (OIBC), and community and cultural organizations in and around Waikīkī for their brief response/review of the Project and to identify individuals with cultural expertise and/or knowledge of the Project area and vicinity, cultural and lineal descendants, and other appropriate community representatives and members. Based on their in-depth knowledge and experiences, these key respondents then referred CSH to additional potential participants who were added to the pool of invited participants. This is snowball sampling, a chain referral method that entails asking a few key individuals (including agency and organization representatives) to provide their comments and referrals to other locally recognized experts or stakeholders who would be likely candidates for the study (Bernard 2006:192). CSH also employs expert or judgment sampling which involves assembling a group of people with recognized experience and expertise in a specific area (Bernard 2006:189–191). CSH maintains a database that draws on over two decades of established relationships with community consultants: cultural practitioners and specialists, community representatives and cultural and lineal descendants. The names of new potential contacts were also provided by colleagues at CSH and from the researchers' familiarity with people who live in or around the Project area. Please refer to Table 3, Section 6 for a complete list of individuals and organizations who participated in this cultural impact assessment.

CSH focuses on obtaining in-depth information with a high level of validity from a targeted group of relevant stakeholders and local experts. Our qualitative methods do not aim to survey an entire population or subgroup. A depth of understanding about complex issues cannot be gained through comprehensive surveying. Our qualitative methodologies do not include quantitative (statistical) analyses, yet they are recognized as rigorous and thorough. Bernard (2006:25) describes the qualitative methods as "a kind of measurement, an integral part of the complex whole that comprises scientific research." Depending on the size and complexity of the Project, CSH reports include in-depth contributions from about one-third of all participating respondents. Typically this means three to 12 interviews.

### 2.2.2 Informed Consent Protocol

An informed consent process was conducted as follows: (1) before beginning the interview, the CSH researcher explained to the participant how the consent process works, the Project purpose, the intent of the study and how his/her information will be used; (2) the researcher gave him/her a copy of the Authorization and Release Form to read and sign (Appendix C); (3) if the person agreed to participate by way of signing the consent form or by providing oral consent, the researcher started the interview; (4) the interviewee received a copy of the Authorization and Release Form for his/her records, while the original is stored at CSH; (5) after the interview was summarized at CSH (and possibly transcribed in full), the study participant was afforded an opportunity to review the interview notes (or transcription) and summary and to make any corrections, deletions or additions to the substance of their testimony/oral history interview; this was accomplished primarily via phone, post or email follow-up and secondarily by in-person visits; (6) participants received the final approved interview, photographs and the audio-recording and/or transcripts their interview if it was recorded. They were also given information on how to view the draft report on the Office of Environmental Quality Control (OEQC) website and offered a hardcopy of the report once the report is a public document.

### 2.2.3 Interview Techniques

To assist in discussion of natural and cultural resources and cultural practices specific to the Project area, CSH initiated unstructured and semi-structured interviews (as described by Bernard 2006) asking questions from the following broad categories: gathering practices and resources, burials, trails, historic properties and wahi pana (storied place). The interview protocol is tailored to the specific natural and cultural features of the landscape in the Project area identified through archival research and community consultation. These interviews and oral histories supplement and provide depth to consultations from government agencies and community organizations that may provide brief responses, reviews and/or referrals gathered via phone, email and occasionally face-to-face commentary.

#### 2.2.3.1 In-depth Interviews and Oral Histories

Interviews are conducted with individuals or in focus groups comprised of kūpuna (elder) and kama‘āina (Native-born) who have a similar experience or background (e.g., the members of an area club, elders, fishermen, hula dancers). Interviews were conducted initially at a place of the study participant’s choosing (usually at the participant’s home or at a public meeting place) and/or—whenever feasible—during site visits to the Project area. Generally, CSH’s preference is to interview a participant individually or in small groups (two–four); occasionally participants are interviewed in focus groups (six–eight). Following the consent protocol outlined above, interviews may be recorded on tape or a digital audio device and in handwritten notes, and the participant photographed. The interview typically lasts one to four hours, and records the “who, what, when and where” of the interview. In addition to questions outlined above, the interviewee is asked to provided biographical information (e.g., connection to the Project area, genealogy, professional and volunteer affiliations, etc.).

#### 2.2.3.2 Field Interviews

Field interviews are conducted with individuals or in focus groups who have a similar experience or background (e.g., the members of an area club, elders, fishermen, hula dancers) and who are physically able and interested in visiting the Project area. In some cases, field visits are preceded with an off-site interview to gather basic biographical, affiliation and other information about the participant. Initially, CSH researchers usually visit the project area to become familiar with the land and recognized (or potential) cultural places and historic properties in preparation for field interviews. All field activities are performed in a manner so as to minimize impact to the natural and cultural environment in the project area. Where appropriate, Hawaiian protocol may be used before going on to the study area and may include the ho‘okupu (offering) of pule (blessing), and oli. All participants on field visits are asked to respect the integrity of natural and cultural features of the landscape and not remove any cultural artifacts or other resources from the area.

## 2.3 Compensation and Contributions to Community

Many individuals and communities have generously worked with CSH over the years to identify and document the rich natural and cultural resources of these islands for cultural impact, ethno–historical and, more recently, Traditional Cultural Property studies. CSH makes every effort to provide some form of compensation to individuals and communities who contribute to cultural studies. This is done in a variety of ways: individual interview participants are compensated for their time in the form of a small honorarium and/or other makana (gift); community organization representatives (who may not be allowed to receive a gift) are asked if they would like a donation to a Hawaiian charter school or nonprofit of their choice to be made anonymously or in the name of the individual or organization participating in the study; contributors are provided their transcripts, interview summaries, photographs and—when possible—a copy of the cultural impact assessment report; CSH is working to identify a public repository for all cultural studies that will allow easy access to current and past reports; CSH staff do volunteer work for community initiatives that serve to preserve and protect historic and cultural resources (for example in, Lānaʻi, Waimānalo, and Kahoʻolawe). Generally our goal is to provide educational opportunities to students through internships, share our knowledge of historic preservation and cultural resources and the State and Federal laws that guide the historic preservation process, and through involvement in an ongoing working group of public and private stakeholders collaborating to improve and strengthen the Chapter 343 environmental review process.

# Section 3 Traditional Background

## 3.1 Overview

The historic land division of Waikīkī extends on the west from the land called Kou (traditional name for Honolulu) to Lēʻahi (Diamond Head) in a strip along the coast. In modern times, the area identified as Waikīkī generally extends from Kalākaua Avenue on the west, from King Street/Waiʻalae Avenue on the mauka (towards the mountain) side, to Diamond Head on the east side, and to the sea coast on the makai (towards the sea) side. A distinction is sometimes made between Waikīkī Kai, the coastal area on the makai side of the Ala Wai Canal—within which the current Project area is located—and Waikīkī Waena (middle), the mauka lands between King Street/Waiʻalae Avenue and Ala Wai Boulevard.

Large portions of Waikīkī were once part of a wide marshland—including areas along the mauka border of the current Project area and inland from there, which extended as far east as the volcanic craters of Lēʻahi and the Kaimukī dome (where the present day Kaimukī fire station is built). This marshy area was once about three miles long and one mile wide, enclosing approximately 2,000 acres (Kanahele 1995:5–6).

Historic maps shows numerous inland fishponds in the ʻili (subdivision) of Kālia, including Kaihikapu (or Kaʻihikapu), Kaipuni and Paweo (or Pāweo) among others. Prior to the formalization of these fishponds, which would have required extensive social organization and management, it is likely that the area immediately inland of the current Project area was part of a vast natural wetland habitat for shorebirds, fish, and other estuary resources.

Several royal residences (e.g., Kamehameha I and Kamehameha V) and other residential compounds belonging to various aliʻi (chiefly classes) were once located in the area of ʻĀpuakēhau and Helumoa (currently the Royal Hawaiian Hotel), and extending further to the southeast.

## 3.2 Place Names

The name **Waikīkī** translates as "water spurting from many sources," and reveals the character of the intact watershed system of Waikīkī prior to European contact, where water from the valleys of Mānoa and Pālolo gushed forth from underground. Before the construction of the Ala Wai Canal, these streams did not merge until deep within Waikīkī. As they entered the flat plain of Waikīkī, the names of the streams changed: Mānoa Stream became **Kālia Stream** and Pālolo Stream became **Pāhoa Stream**. They joined in the ʻili of **Hamohamo** (rub gently [as the sea on the beach]) and then divided into three new streams that flowed into the sea—**Kuekaunahi, ʻĀpuakēhau**, and **Piʻinaio**. The land between these three streams was called **Waikolu**, meaning "three waters" (Kanahele 1995:7–8).

Waikīkī Kai was once divided into smaller ʻili lands, including (listed generally from west to east) **Kālia** (waited for), **Pau** (finished), **Niukukahi** (coconut standing alone), **Loko Moʻo**, **Keōmuku** (the shortened sand), **Helumoa** (chicken scratch), **Ulukou** (kou tree grove), **Mookahi**, **Kaluaokau**, **Auaukai**, **Hamohamo**, **Uluniu** (coconut grove), **Kapuni** (the surrounding), **Kekio**, **Kāneloa** (tall Kāne), **Kapua** (the flower), and **Kaluahole** (the āhole fish cavern) (Figure 5; ‘Ī‘ī 1959:92–94).

**Kālia ‘Ili**, located in the western section of Waikīkī, is a name used for the central portion of Mānoa Stream and the name of the coastal area where the **Pi‘inaio Stream** emptied into the ocean. The exact meaning of Pi‘inaio is unknown, but pi‘ina means “climb or ascend” (Pukui and Elbert 1986:327). The stream’s mouth was on the western end of the Waikīkī coast, where the Ala Moana Shopping Center is now located, west of Duke Kahanamoku Beach and Lagoon.

**Kaluaokau ‘Ili** is in the central area of Waikīkī. There are several possible meanings of Kaluaokau depending on pronunciation and combination of root words, most of which suggest a place deeply connected to the mana (power) of the Waikīkī ali‘i as indicated by interpretations of human sacrifice. The term may commemorate the sacrifice of Kauhi-a-Kama, as in “the pit of Kau” (Ka-lua-o-Kau), “the pit of Kauhi-a-Kama” (Ka-lua-o-Kauhi-a-Kama), or the “baking of Kauhi-a-Kama” (Kālua-o-Kauhi-a-Kama). The term may also translate as “strike lua of kau [hanging]” (ka-lua-o-kau) in reference to a special technique of public execution and sacrifice by strangling (McKinzie 2005:24–28). It may also translate as “the grave of Ka‘u” (ka-lu‘a-o-ka‘u) (Thrum 1922:641). **‘Āpuakēhau Stream**, literally “basket [of] dew”, flowed through this ‘ili (see 3.6.3, for the mo‘olelo of ‘Ōlohe at ‘Āpuakēhau). The stream was also possibly named for a rain or an abundance of ti, hau (beach hibiscus), and palm plants which lined the banks of the stream (McKinzie and Campbell 2005:17; Pukui et al. 1974).

**Helumoa ‘Ili**, located in the central makai section of Waikīkī, translates as “chicken scratch,” a reference to mo‘olelo about the bodies of sacrificial victims being pecked over for maggots. Two foci of chiefly residence were at places called Helumoa, now the site of the Royal Hawaiian Hotel, and **Ulukou**, now the site of the Moana Hotel (Hibbard and Franzen 1986:2). **‘Āpuakēhau Stream** emptied into the ocean between these two centers. **Kawehewehe**, sometimes synonymous with the mouth of ‘Āpuakēhau Stream and also the name of the reef entrance and channel at what is known today as Grey’s Beach (just east of the contemporary Halekūlani Hotel), translates as “the removal,” which appears to refer to the water’s famous healing powers for removing sickness and forgiving of sins (Pukui et al. 1974:99). A famous surfing spot called **Kalehuawehe** was located at the mouth of ‘Āpuakēhau Stream (Hibbard and Franzen 1986:2).

**Kapua ‘Ili**, located in the eastern section of Waikīkī, was an ancient surfing area, now filled in and part of Kapi‘olani Park (Finney and Housten 1966:28). In 1809, Kamehameha put his nephew, Kanihonui, to death who committed adultery with Ka‘ahumanu, and placed his remains at Papa‘ena‘ena Heiau. As Ka‘ahumanu’s “wrath was aroused,” she began to make plans to take the kingdom from Kamehameha by force when she pronounced a surfing holiday at Kapua, since “the surf was rolling fine then” (‘Ī‘ī 1959:51). Kapua was also a site where “bone-breaking wrestlers” engaged in their sport (Kamakau 1992:72).

While many other place names in Waikīkī have been lost to antiquity, a song composed by Kawelo during the reign of Kākuhihewa (see Section 3.6) provides a glimpse into other place names of Waikīkī and the emotions they once evoked. After Kawelo surfed and participated in wrestling matches at the coconut grove of Helumoa, he sang the following love song for Kou, his sweetheart from Waikīkī, upon his departure to his homeland of Kaua‘i:

| | |
|---|---|
| *Aloha Kou e, Aloha Kou*, | Farewell to thee, farewell Kou, |
| *Ke aloha mai nei Kou iaʻu* | The love of Kou is within me, |
| *Ka hoa hele i ka makani*, | My companion of the windy days |
| *I ka ʻāpaʻapaʻa anu o Ahulu nei*. | And the cold of **Ahulu**. |
| *E ualo mai ana iaʻu nā niu o Pai,* | The coconut trees of **Pai** are calling me back, |
| *E ʻenaʻena mai ana i kuʻu maka,* | They appear as raging fire to my eyes, |
| *Ke aʻā o Kuamānuʻunuʻu,* | Like the volcanic rocks at **Kuamānuʻunuʻu** |
| *ʻIʻiau e kiʻi, e kui, a lei—e* | I am tempted to get them, to string them, and to wear them, |
| *Nāʻākulikuli papa o Huia nei la,* | The ʻākulikuli blossoms there at **Huia** |
| *E ualo mai ana iaʻu—e* | For they are calling me back there |
| | (Hibbard and Franzen 1986:7) |

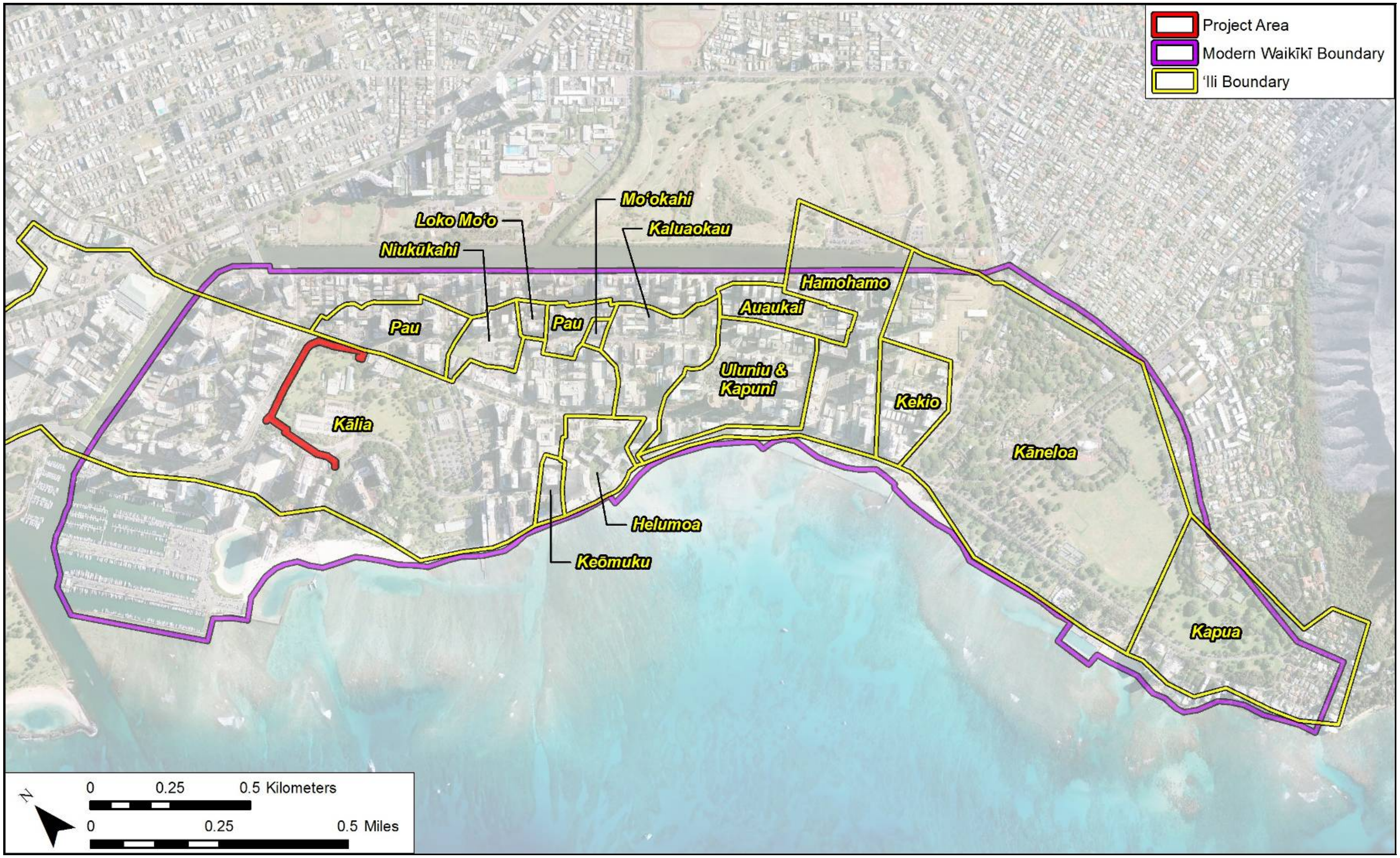


Figure 5. ‘Ili of Waikīkī; the Project area is located in the ‘ili of Kālia (Google Earth 2008)

## 3.3 Aquaculture

Fishponds were one of the most important traditional resources for the Hawaiian community in Waikīkī. Historic maps and images depict the locations of numerous loko iʻa (fishpond) in Waikīkī and historic documents describe "several hundred" and "innumerable" artificial freshwater fishponds extending a mile inland from the shore (Bloxam 1925:35–36, cited in McAllister 1933:76). Two studies by the U.S. Commission of Fish and Fisheries (Bowers 1902:429; Cobb 1902, cited in McAllister 1933:76) listed extant fishponds in Kālia in 1901, including **Kaʻihikapu** (the taboo sacredness), **Kūwili** (stand swirling), **Kaipuni (1 and 2)**, **Paweo (1 and 2)**, **Kapuʻuiki**, **Kapaakea**, **Maalahia**, **Opu**, and **Opukaala**, as well as several fishponds with undocumented names. In addition, historic maps provide the locations of several of these and other fishponds: **Kaohai**, **Oo**, **Halemauuola**, **Moo**, **Kuilei** (lei stringing), and **Kaheana**.

The fame of Kālia's fishponds are attested to in a moʻolelo recounted by John Papa ʻĪʻī (in Wyban 1992) that deals with prohibitions against wasting food:

> Once Kinopu gave a tribute of fish to Kamehameha's son Kinau, at Moehonua's fishpond in Kalia. While Kinau and his wife Kahukuhaakoi (Wahine-pio) were going to Waikiki from Honolulu, the sea came into the pond and fishes of every kind entered the sluice gate. Kinopu ordered the keepers of the pond to lower fish nets and the result was a catch so large that a great heap of fish lay spoiling upon the bank of a pond.
>
> The news of the huge catch reached Kamehameha, who was then with Kalanimoku, war leader and officer of the king's guard. The king said nothing at the time, but sat with bowed head and downcast eyes, apparently disapproving of such reckless waste. (Wyban 1992:87)

Archaeological excavations of several of these loko have uncovered alluvial sediments. Excavated sediments of four loko in Fort DeRussy—Kaʻihikapu (SIHP 50-80-14-4575, Denham and Pantaleo 1997b), Kaipuni (SIHP 50-80-14-4573, Denham and Pantaleo 1997b), Kapuʻuiki (SIHP 50-80-14-4577, Denham and Pantaleo 1997b), and Loko Paweo I (SIHP 50-80-14-4574, Denham and Pantaleo 1997a, 1997b), have radiocarbon dated to approximately A.D. 1400–1700, and indicate inland burning associated with clearance of land for agriculture.

## 3.4 Agriculture and Subsistence

For spiritual and dietary reasons, kalo (taro) was a sacred staple in the Hawaiian diet and way of life. According to Hawaiian mythology, man was born from the taro plant. According to the Kumulipo (origin, genesis), Hāloa, "he of the long breath", is the second son of Wākea (Father Sky) and Papa (Mother Earth). Wākea and Papa's first born, Hāloa-naka was born premature and died shortly after his birth (Kanahele 1995:17). After burying Hāloa-naka, a taro plant sprouted at his grave. Shortly after, a second son (Hāloa) was born. A human child, Hāloa symbolizes taro and man. Taro is a metaphor for life, Kanahele explains:

> In the mythologies of many cultures, plants have been used to symbolize human spiritual growth. Hawaiians made taro a metaphor for life because, like the taro

> plant, it needs to be rooted in good soil and to be constantly nourished with the waters of Kāne. As the stalk grows taller with its leaves reaching toward the light of the sun, symbolized by Wākea, so Hawaiians grow aspiring to be closer to their heavenly spirit. Just as every young shoot can become a full-grown plant, so can they become gods as descendants of Hāloa. As every plant must die, however, they too must die. And from the remains a new plant lives again. In this continuity of life, both plant and man repeat the mystery of the unending cycle. (Kanahele 1995:18)

The Waikīkī marshland was thought of an ideal place for taro cultivation, providing an abundance of water and sunlight (Figure 6). Taro grown under sunnier conditions matures noticeably faster, thus making Waikīkī a key area for cultivation and an even better place for growing taro than the revered ahupua’a of Kāne‘ohe and ‘ili of ‘Āhuimanu in Kahalu‘u (Kanahele 1995:22). ‘Uala (sweet potato) and the prized ipu (gourd) were also abundant in the lower Waikīkī marshlands (Kanahele 1995:35).

The settlers of Waikīkī had to travel mauka to the foothills of Mānoa and the valley of Pālolo to gather grasses, vines, and other fauna (Figure 7). Pili grass could be found in the drier areas of Mānoa as well as Kapahulu and Kaimukī (Kanahele 1995:24). Pili grass was used primarily to thatch homes. Along stream banks grew hau. The tree’s wood proved excellent for outrigger canoe frames and kite supports; the bark was used for ropes, nets, and kapa (cloth); while the flowers were used for medicine (Kanahele 1995:25). Kukui (candlenut) trees could be found mid-way in Mānoa Valley (Kanahele 1995:26). The kernels were used to make ‘inamona (relish) and the oily nut could also be used for stone lamps. The flowers, leaves, branches, and bark were used for medicinal purposes, curing a range of ailments from sore throats to bouts of constipation (Kanahele 1995:26). ‘Ōhia ‘ai (mountain apple) could also be found mid-way in Mānoa Valley (Kanahele 1995:26).

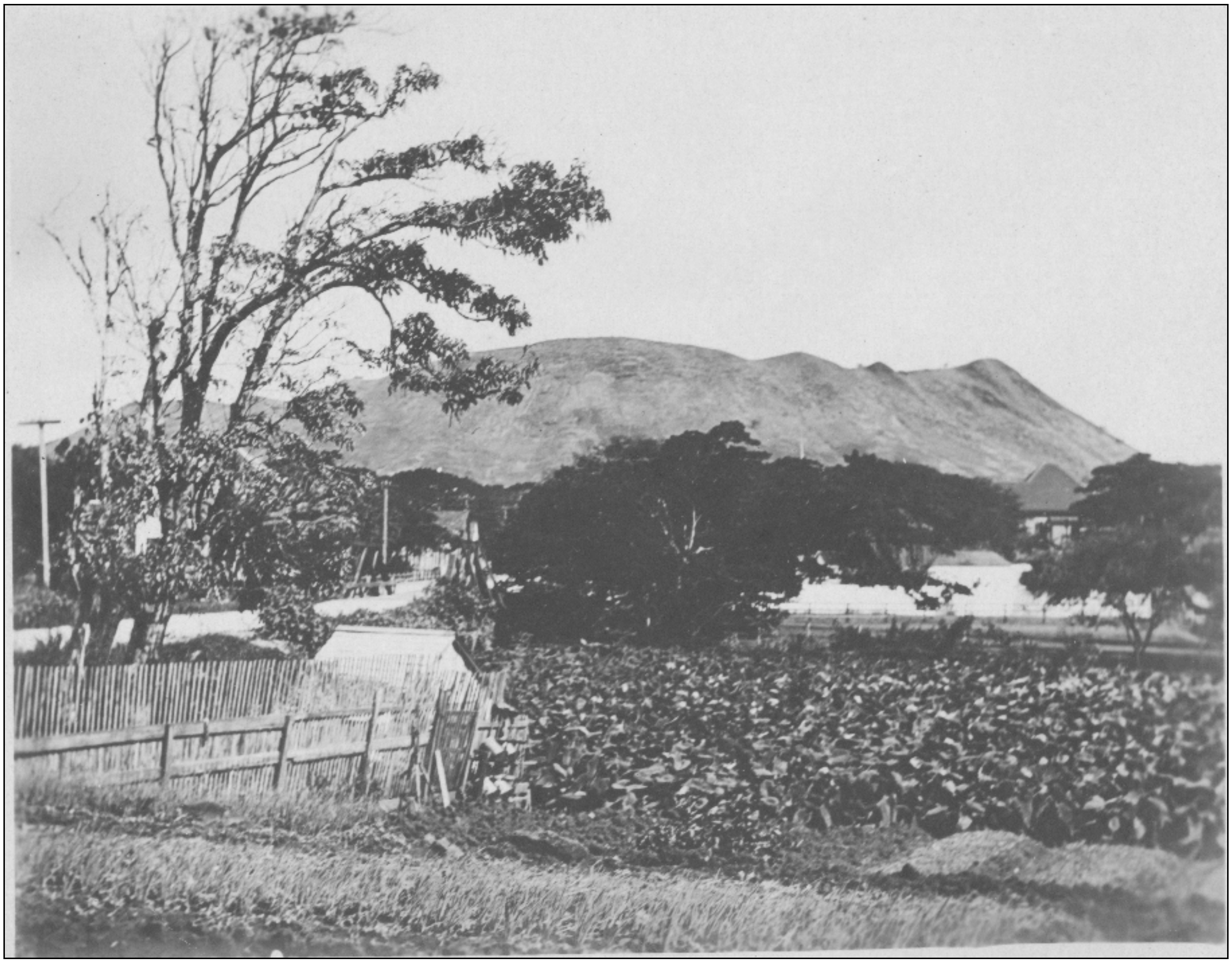

Figure 6. View of Diamond Head across taro fields circa 1900 (University of Hawaiʻi at Mānoa Digital Collection 2012)

Figure 7. Photo of Waikīkī rice fields circa 1890; view looking mauka towards Mānoa (Hawaiʻi State Archives)

## 3.5 Royal Residences

There is a large body of oral-historical information about royal residences and other residential compounds belonging to various ali‘i. According to Martha Beckwith (1940:383), by the end of the fourteenth century, Waikīkī had become “the ruling seat of the chiefs of O‘ahu.” Ma‘ilikukahi, the first mō‘ī (island-wide chief) of O‘ahu, moved the capital of the islands from ‘Ewa and Waialua to Waikīkī in this period. About AD 1350, he constructed a heiau (place of worship) at Helumoa for the Makahiki festival. Two idols, the long god and the short god, were carried on a circuit of the islands, each carried in the opposite direction and meeting again at Kualoa on the windward coast of O‘ahu. The pre-eminence of Waikīkī continued into the eighteenth century and is confirmed by the decision of Kamehameha I, in the midst of unifying control of the islands, to reside there after wresting control of O‘ahu by defeating the island’s chief, Kalanikūpule. The nineteenth-century Hawaiian historian John Papa ‘Ī‘ī (1959:17), himself a member of the ali‘i, described the king’s Waikīkī residence:

> Kamehameha’s houses were at Puaaliilii, makai of the old road, and extended as far as the west side of the sands of Apuakehau. Within it was Helumoa, where Kaahumanu ma [mā–and others] went to while away the time. The king built a stone house there, enclosed by a fence . . . (‘Ī‘ī 1959:17)

‘Ī‘ī further noted that the “. . . place had long been a residence of chiefs. It is said that it had been Kekuapoi’s home, through her husband Kahahana, since the time of Kahekili” (‘Ī‘ī 1959:17). Kamehameha lived here from 1795 to 1809. Puaaliilii has two meanings depending on pronunciation. Pua ali‘ili‘i translates as “flower of the exalted royalty.” With the ‘okina (glottal stop) in a different position, the name pua‘a li‘ili‘i means “little pig.” Since the pig was a sacred animal, both meanings may be correct since both could refer to a royal residence (Acson 1983:19).

Before Kamehameha’s victory at Nu‘uanu, which led to his conquest of O‘ahu, he had promised the mo‘o (water spirit) goddess Kihawahine that he would build her a special dwelling called a hale puaniu, a place at which offerings of bananas, coconuts, and ‘awa (kava) were kept to deify a deceased person and make him or her into a mo‘o or goddess (Pukui and Elbert 1986:347; Kanahele 1995:92):

> Walinu‘u, Walimanoanoa, and Kalamainu‘u were ‘aumakua [deified ancestor] with many bodies. A certain chiefess of the island of Maui named Kihawahine was transfigured into (kaku‘ai ‘ia iloko o) Kalamainu‘u, and she became a goddess with the body of a mo‘o. Kihawahine was a famous mo‘o, perhaps because she had been a chiefess and an ancestor of chiefs, and had been born a real human being. But when she was transfigured she turned into an ‘e‘epa, a mo‘o. She was deified by the chiefs of Maui and Hawaii with kapus [taboo, prohibitions], with the setting up of kapu sticks [pulo‘ulo‘u], and with the kapus of the chiefess Kihawahine . . . when Kamehameha added her to his gods, she was one of his gods that united the kingdom from Hawaii to Kauai. He said: “If you take [‘ai] Oahu, I will build a house for your akua [god] in the calm of Waikiki—a puaniu house [house for defying the dead] for Kalamainu‘u, the akua of Kihawahine.” (Kamakau 1991:85)

There are many references to royal residences for this portion of Waikīkī. ʻĀpuakēhau Stream is one of the two branches of the united Mānoa-Pālolo Stream which once flowed past taro patches and fishponds. The mouth of the stream once emptied out into the ocean at the present location of the east side of the Outrigger Hotel and the west side of the (Sheraton) Moana Hotel. Land on the west side of the stream was known as Kahaloa, "the long place," and on the east, Ulukou, "the kou tree grove." The stream carved a small channel in the seabed where it emptied out in the ocean, creating a special surf, called the "Cornucopia," due to the shape of the breaking waves (Clark 1977:55).

The village of Waikīkī probably centered around the mouth of ʻĀpuakēhau Stream, near the present Royal Hawaiian Hotel. There was a heiau and an athletic field in the village called ʻĀpuakēhau on the land known as Helumoa. The athletic field was called Kahuamokomoko, meaning a "sports field for boxing." It was probably used for other types of games also such as the maika game where stones were rolled to hit a target. Several of the stones used in this game, called ʻulu maika, have been uncovered in this area (Acson 1983:20).

Chiefs who lived at Ulukou included the following individuals: Kahekili, ruler of Maui, who lived his final days here in 1794; Kamehameha I, who lived in a grass shack and later a lava stone house between 1795 and 1809; Kamehameha V, who called his thatch-roofed stone house Kealohilani, meaning "the royal brightness;" and King Kalākaua, who called his home Keʻelanihakoi (Acson 1983:21). Princess Kaʻiulani had a residence on the eastern side of ʻĀpuakēhau. This area was called ʻAuʻaukai by the Hawaiians, which means "to bathe in the sea." Her home was called ʻĀinahau (hau tree land) around the turn of the century when her mother Princess Likelike and her father Governor Archibald Cleghorn lived there.

## 3.6 Moʻolelo

### 3.6.1 The Legend of Kawelo

In the "Legend of Kawelo," two boys are born on the same day—Kawelo-lei-makua, called Kawelo, the great nephew of the king of Kauaʻi, and Kawelo-aikanaka, called ʻAikanaka, the grandson of the king. Kawelo's older brothers and his parents soon moved from Kauaʻi to live at Waikīkī in Oʻahu near the ruling chief of Oʻahu, Kākuhihewa. The older brothers of Kawelo often challenged a famous wrestler living with Kākuhihewa, but they could never beat him.

> *A he mea mau i na kaikuaana o Kawelo ka heenalu, i ka nalu o Kalehuawehe, a pau ka heenalu, hoi aku la a ka muliwai o Apuakehau auau, a pau, hoi aku la a ka hale mokomoko, aole nae he hina o ke kanaka o Kakuhihewa i na kaikuaana o Kawelo.*
>
> The brothers of Kawelo were great surf riders, and they often went to ride the surf at Kalehuawehe [near the present Seaside Hotel in Waikīkī]. After the surf ride they would go to the stream of Apuakehau and wash, and from there they would go to the shed where the wrestling bouts were held and test their skill with Kakuhihewa's strong man; but in all their trials they never once were able to throw him. (Fornander 1918:4)

When the king of Kaua‘i died, ‘Aikanaka became the new king. The grandparents, who longed to see their other children, traveled with Kawelo to O‘ahu, to Ulukou in Waikīkī, near the mouth of the stream ‘Āpuakēhau, where his elder brother and parents had been living. His grandparents later took him just inland of the coast. While Kawelo was working in the fields, he heard some shouting from the beach, and asked his grandparents, “What is that shouting down yonder?” (Fornander 1918:5). The grandparents answered that his older brothers had just finished surfing and must have challenged the king’s strong man. The shouting indicated one of them must have been thrown. Next day, Kawelo went down to the beach, went surfing with his brothers, and then bathed in the freshwater stream of ‘Āpuakēhau. He challenged the strong man to a match, even though his brothers mocked him, saying “Are you strong enough to meet that man? If we whose bones are older cannot throw him, how much less are the chances of yourself, a mere youngster?” (Fornander 1918:6). The strong man, impressed by Kawelo’s courage, said:

> *“Ina wau e kahea penei, ‘Kahewahewa, he ua!’ alaila, kulai kaua.” Hai aku la no hoi o Kawelo i kana olelo hooulu, penei: “Kanepuaa! Ke nahu nei! Alia! Alia i oki ka aina o Kahewahewa, he ua!”*
>
> “If I should call out ‘Kahewahewa, it is raining,’ then we begin.” Kawelo then replied in a mocking way: “Kanepuaa, he is biting, wait awhile, wait awhile. Don’t cut the land of Kahewahewa, it is raining.” (Fornander 1918:6)

Kawelo won the match, shaming his older brothers so much that they returned to Kaua‘i. In another version (Thrum 1923:154), the strong man was from Halemano [central O‘ahu], and was killed by a mighty blow from Kawelo. The man’s body was given to the king of O‘ahu, and was carried as a sacrifice to the gods to a heiau in Lualualei, Wai‘anae.

### 3.6.2 Surfing with Kelea

Surfing was one of the main attractions of Waikīkī to ali‘i and maka‘āinana (commoner). One day a beautiful chiefess with “clear skin and sparkling eyes” who resided on the ‘Ewa plain visited Waikīkī with a few of her ladies-in-waiting (Moser 2008:21). Her name was Keleanuinoho‘ana‘api‘api (“Great Kelea who flutters”). She was offered coconuts from the residents of the area. “This is the most pleasant place we have seen,” remarked the chiefess (Moser 2008:21–22). The kama‘āina (native born) retorted, “This is a place for enjoyment. Over there is a kou grove of Kahaloa where one may view the surfing of the chiefs and of the ali‘i nui Kalamakua.” Delighted by the thought of surfing, Kelea said to her companions, “Let us go on.”

They entered the kou grove of Kahaloa and watched the ali‘i surfing in. Kelea asked the kama‘āina, “Is it possible to obtain a surfboard for the asking?” The kama‘āina were surprised because as someone from the ‘Ewa plain, they thought she was adept at “slicing mo‘okilau ferns and pōpolo [black nightshade] stalk,” not surfing (Kanahele 1995:58). They did not know that their visitor was originally from Maui where she surfed with all the chiefs. Too beautiful to refuse, someone gave her a board.

Before entering the water, she “rubbed off the red dirt of ‘Ewa from her feet so as to look fresh,” and then paddled off into the surf like an expert. As Kelea reached the break, she paddled a little further and waited for a good wave. As she caught the wave, she showed her skill and grace. Those that watched her from onshore cheered in unison.

The chief Kalamakua was working in his field while Kelea was surfing. The shouting from the shoreline startled the chief who asked his men, “What is that shouting reverberating from the seashore?” “It is probably because of a skilled woman surfer,” they answered.

Kalamakua left his field and stood on the shore to watch Kelea. As she rode in on a wave, Kalamakua ran to shore to meet her. When she reached the sand, Kalamakua took her board and asked, “Are you Kelea?” “Yes,” she answered. Kelea stood naked. Kalamakua removed his kīhei (cape) and wrapped it around her as a pa‘u (skirt). Kelea went on to marry Kalamakua.

### 3.6.3 Legend of ‘Ōlohe

‘Āpuakēhau is mentioned in another legend as the home of the cruel chief ‘Ōlohe, a master of the lua wrestling or bone breaking. The defeat of this chief led to the naming of the area now covered by Kapi‘olani Park as Ka-lua-‘Ōlohe, or “the lua fighting of ‘Ōlohe” (Pukui et al. 1974:79):

> Loheloa came from Waipio on a huge log. He came first to Makapuu and then to Keauau Point, now called Leahi. He saw a strange glow like a ball of fire there. He asked for the chief Olohe and was told that the light was his.
>
> He saw some fishermen who told him to go away for he was scaring the fish. He called to Ku and Hina to bring them a school of fish which they did. The natives were grateful. He lifted his huge canoe and rested one end at Haula and the other at Namahana, against the hill. He told the people that he wanted to wrestle with their chief Olohe, a dogman who lived at Apuakehau, Waikiki. A messenger came to tell the chief who accepted the challenge. In the meantime the men were busy catching fish brought to them by Loheloa. A messenger was sent to bring Loheloa to the chief and Loheloa suggested that they wrestle in the open where they can be seen. He would bet his bones and his canoe on himself.
>
> Olohe and Loheloa fought on the field now known as Kapiolani Park. Olohe punched and raised a gale that flattened the ilima bushes. Loheloa slapped his ear hard enough to throw him in the air. The place he fell is called Kalua-Olohe (Olohe’s pit) to this day. Loheloa won and the people shouted with joy over the defeat and death of their cruel chief. (Hainakolo, *Hawaii Holomua*, July 21, 1912, Oahu Place Names, cited in Sterling and Summers 1978:279)

### 3.6.4 Ka‘opulupulu

Thrum (1998:203–214) recounts the legend of the kahuna nui (highest priest), of O‘ahu, Ka‘opulupulu, who lived in Waimea, O‘ahu. He had a son named Kahulupu‘e, who he taught all the traditions and rituals of the priestly caste. At this time, the ali‘i aimoku (ruler) of O‘ahu was Kumuhana, a cruel chief who terrorized his people and would not listen to the counsel of his priest, Kahulupu‘e. Kumuhana was finally driven off the island by the people and the lesser chiefs. When Kahekili, the king of Maui, heard this news, he sent his foster son, Kahahana (brother of Kumuhana), to rule O‘ahu in Kumuhana’s place (ca. 1773). Kahahana chose a grove of coconut and kou trees, called Ulukou, located on the Waikīkī coast as his place of residence, and many ali‘i gathered in that place around him. One day, Kahahana sent a messenger to Ka‘opulupulu to attend him at Ulukou, who traveled from his home in Waimea and was greeted by the retainers of the king when he reached the mouth of the stream ʻĀpuakēhau. At first Kahahana valued the wisdom of the priest, but after several years, Kahahana began to be as cruel to the people as his predecessor, Kumuhana. In protest, the priest Kaʻopulupulu left Waikīkī to return to his home in Waimea, where he tattooed his knees, a sign that Kahahana had turned a deaf ear to his advice. This angered the king, who sent messengers to order Kaʻopulupulu and his son, Kahulupuʻe, to come to Waiʻanae, where Kahahana then resided.

At Waiʻanae, the two men were placed into a special grass hut, one tied to the end post and one tied to the corner post. The next day, Kahahana ordered his men to torture the son, stabbing his eyes and stoning him while his father watched. When Kaʻopulupulu saw this, he commanded his son to flee into the sea, saying these words which contained a prophecy:

| | |
|---|---|
| *E nui ke aho, e kuʻu keiki,* | Take a deep breath, my son, and |
| *a moe i ke kai, no ke kai la* | lay yourself in the sea, for then |
| *hoʻi ka ʻāina.* | the land shall belong to the sea. (Pukui 1983:44) |

Kaʻopulupulu was taken by the soldiers to Puʻuloa (Pearl Harbor), at ʻEwa, and slain before the king. His body was put into a canoe and taken to Waikīkī, where it was placed high in the coconut trees at Kukaeunahi (at the heiau of Helumoa), so that the flesh would decompose and fall to the sand. When the king of Maui, Kahekili, heard this news he grieved for Kaʻopulupulu and turned against his foster son. With his warriors, he set out over the sea for Waikīkī to take back the rulership of Oʻahu under his own authority. This fulfilled the prophecy of Kaʻopulupulu. According to S. M. Kamakau and David Malo, this saying was also in keeping with a prophecy by Kekiopilo presaging the arrival of the islands by Westerners, which would lead to "the foreigners possess[ing] the land" (Thrum 1998:214).

Helumoa means "chicken scratch." In one version, this name refers to the legendary rooster Kaʻau-helu-moa that lived up in Pālolo Valley and came down to this land and scratched for food. According the Legend of Kaʻopulupulu, the name refers to chickens scratching to find the maggots that fell from victims placed in the trees who were human sacrifices at the heiau of ʻĀpuakēhau (Pukui et al. 1974:44):

> The seer, together with the body of the son, was brought to Waikiki, to the coconut grove at the place called Helu-moa. There he was slain and the two bodies hung upon coconut trees. The place was named from the scratching of the chickens about the place where the maggots fell from the bodies of the two men.
>
> Before his death, Kaʻopulupulu uttered this prophecy: -"At the place where my body hangs and its fat flows, chiefs and commoners shall be slain and here shall be the chief-destroying sands of Kakuhihewa." These words were fulfilled soon after, when Kahekili, ruling chief of Maui, conquered the island. But the bitter result did not end there. They were again fulfilled in the time of Kamehameha when, after he had conquered Oahu at the battle of Nuuanu, he went back to Waikiki with his followers and many were stricken with the disease called okuu [possibly cholera] and many died. (Green and Pukui 1936:122–123)

The sand of Helumoa was known as Ke oneʻai aliʻi o Kākuhihewa (The Chief Devouring Sand of Kākuhihewa) because of the curse placed by the kahuna nui Kaʻopulupulu. When Kaʻopulupulu was brought with his son, Kahulupuʻe, to be executed at Waikīkī, he cursed the place where his hinu (body grease) should drip upon the sand. This curse was upon the chiefs and the people (Hibbard and Franzen 1986:5).

This curse continued to have an effect for the descendants of Kamehameha. Kamehameha II died in England. From the warning of this curse by the kahuna (priest), Luau-nui-a-lepokapo, Kauikeaouli, Kamehameha III, transferred the seat of the government from Oʻahu to Lahaina in 1938. He later reconsidered moving back to Oʻahu. His kahuna counseled him:

> "O chief! This land of Oahu of Lua is made bitter by the fat of the man of god and his words lie like a squirming maggot for Kakuhihewa. If you listen to those who ask that the government be taken back to Oahu, it will become a maggot which will consume your race." (Green and Pukui 1936:123)

However, Kauikeaouli ignored the advice, and the prophecy was fulfilled by the smallpox epidemic of 1852-3.

## 3.7 ʻŌlelo Noʻeau of Kālia

The seaweed called limu ʻeleʻele was plentiful near the stream's outlet. A Hawaiian saying talks about this pleasant portion of the coast (Pukui 1983:186):

| | |
|---|---|
| *Ke kai wawalo leo leʻa o Kālia* | The pleasing, echoing sea of Kālia. |

Kālia is also a place where ʻalamihi crabs (common black crab) were once plentiful, leading to a play on the word ʻala-mihi (path of repentance), indicating someone who is in a repentant mood (Pukui 1983:110):

| | |
|---|---|
| *Hoʻi i Kālia ka ʻai ʻalamihi.* | Gone to Kālia to eat ʻalamihi crabs. |

Kālia was also known for a fishing technique used to catch schools of mullet. When a school of mullet appeared, a bag net was set and the men swam out in a row, surrounded the fish, and slapped the water together and kicked their feet, thus driving the frightened fish into the opening of their bag net. The fishermen of Kālia became known as human fishnets (Pukui 1983:150):

| | |
|---|---|
| *Ka iʻa pīkoi kānaka o Kālia;* | *The fish caught by the men of Kālia;* |
| *he kānaka ka pīkoi,* | *men are the floaters,* |
| *he kānaka ka pōhaku.* | *men are the sinkers.* |

Kālia is also mentioned in a story about a woman who left her husband and children on Kīpahulu, Maui to go away with a man of Oʻahu. Her husband missed her and went to see a kahuna who was skilled in hana aloha (sorcery for love making potions with herbs, prayers and even hypnosis). The kahuna told the man to find a container with a lid and then speak into it of his love for his wife. The kahuna then uttered an incantation into the container, closed it, and threw it into the sea. The wife was fishing one morning at Kālia, Oʻahu, and saw the container. She opened the lid, and was possessed by a great longing to return to her husband. She walked until she found a canoe to take her home (Pukui 1983:158):

| | |
|---|---|
| *Ka makani kāʻili aloha o* | *The love-snatching wind* |
| *o Kīpahulu.* | *of Kīpahulu* |

‘Āpuakēhau Stream has sometimes been referred to as the muliwai (river mouth) of Kawehewehe. The place name Kawehewehe, cited by ‘Ī‘ī (1959:93) and in the Māhele records, is also of note. It does not only identify a land area in Waikīkī; according to Hawaiian scholars, it also names:

> [The] Reef entrance and channel off Grey's Beach, just east of the Hale-kū-lani Hotel, Wai-kīkī, Honolulu. The sick were bathed here as treatment. The patient might wear a seaweed (limu-kala) lei and leave it in the water as a request that his sins be forgiven, the lei being a symbol. *Lit.*, the removal. (Pukui et al. 1974:99)

The līpōa seaweed of Waikīkī, especially at Kawehewehe, was so fragrant that one could smell it while standing on the shore. It was often mentioned in mo‘olelo about Waikīkī, including the following saying (Pukui 1983:246):

| | |
|---|---|
| *Na līpoa ‘ala* | The fragrant līpōa |
| *O Kawehewehe.* | of Kawehewehe. |

## 3.8 Heiau and Other Religious Sites

Six heiau are said to have been associated with the Waikīkī area: Papa‘ena‘ena Heiau (also known as Diamond Head), Helumoa Heiau, Kapua Heiau, Kūpalaha Heiau, Kamauakapu Heiau and Kulanihakoi Heiau (Thrum 1907:44). Thrum also mentions the Wizard Stones of Kapaemāhū at Waikīkī described below in this section.

### 3.8.1 Helumoa Heiau

Helumoa Heiau, also known as ‘Āpuakēhau Heiau, was once located near the muliwai of ‘Āpuakēhau Stream in Waikīkī. According to Thrum, portions the Royal Hawaiian Hotel are built on the former site of Helumoa Heiau. Thrum continued that the Royal Hawaiian Hotel was also built on the site of a former athletic field of the ali‘i. When the excavations for the hotel were made, many ‘ulumaika (game stones) were found (Thrum 1907:79). Thrum described Helumoa Heiau as:

> Heiau pookanaka, the place of sacrifice of Kauhi-a-Kama, the defeated moi [mō‘ī] of Maui, in his raid on Oahu about 1610, in the reign of Kaihikapu. (Thrum 1907:44)

Pookanaka or po‘okanaka classification heiau, as mentioned by Thrum above, are ceremoniously used as sacrificial heiau to include human sacrifices (Stokes 1991:24). Fornander continues:

> Kauhiakama, the son of Kamalalawalu was carried prisoner from Maui by the Oahu chiefs and burnt at Apuakehau, in Waikiki, and his skull was used as an ipu honowa (excrement receptacle), hence the vindictiveness of Kahekili to the Oahu chiefs (Fornander 1919:321).

Primarily a war temple, this sacrificial heiau was where Ka‘opulupulu—the last O‘ahu-born Kahuna Nui of O‘ahu—was laid after being slain in Wai‘anae by Kahahana (or Kahāhana). Eventually, Kahahana, himself, was also sacrificed at Helumoa Heiau by Kahekili's invading army from Maui (Thrum 1904:112–113).

### 3.8.2 Papaʻenaʻena Heiau

Papaʻenaʻena Heiau was once located on the Honolulu side of Lēʻahi (Diamond Head). Its walls could be seen from Waikīkī and it was visited and described by many early voyagers to Hawaiʻi (McAllister 1933:71). According to Thrum (1907:44), Papaʻenaʻena Heiau was of poʻokanaka class. Thrum describes the heiau as:

> …130x70 feet in size; a walled and paved structure of opened terrace front, destroyed by Kanaina about 1856, the stones used to enclose Queen Emma's premises and for road work. This heiau is the supposed place of a number of sacrifices by Kam. I. [Kamehameha I] at the opening of last century… (Thrum 1907:44)

Surfing was so important that a heiau was dedicated to the nalu (surf) and heʻe nalu (surf rider). Papaʻenaʻena Heiau was built at the foot of Diamond Head (Kanahele 1995:56). The site overlooked the break what surfers call "First Break" today. "First Break" began at the Kalehuawehe surfing course and extended toward Kawewehi (the deep, dark surf) at Kālia (Feeser 2006:15–16). Today, the Hawaiʻi School for Girls at La Pietra is located on the former site of Papaʻenaʻena Heiau (Becket 1999:x)

### 3.8.3 Kapua Heiau

Kapua Heiau was also mentioned by Thrum as being poʻokanaka class and described as follows:

> Near Kapiolani Park, opposite Camp McKinley. Heiau pookanaka. Fragments of its walls torn down in 1860, show it to have been about 240 feet square; said to be the place of sacrifice of Kaolohaka, a chief from Hawaii, on suspicion of being a spy. (Thrum 1907:44)

### 3.8.4 Kūpalaha Heiau

The classification of Kūpalaha Heiau is unknown according to Thrum, but was closely associated with Papaʻenaʻena Heiau. The location of Kūpalaha Heiau was at Kapiʻolani Park in Waikīkī near the Cunha cottages (Thrum 1907:44). According to the University of Hawaiʻi's Center for Oral History's (UHCOH) *Waikīkī, 1900–1985: Oral Histories*, the Cunha Cottages were located "at the corner of Lemon Road and Kapahulu Avenue" (UHCOH 1985:924).

Kākuhihewa, mōʻī of Oʻahu circa 1540–1634, attempted to sacrifice a man from Honolulu named Kapoʻi at Kūpalaha Heiau for consecrating a heiau called Manuʻa on a day that the mōʻī had made kapu. Kākuhihewa's warriors were then attacked by owls from Molokaʻi, Lanaʻi, Maui, Hawaiʻi, Oʻahu, Kauaʻi and Niʻihau at the order of Kapoʻi's ʻaumakua, which was an owl or pueo. The owls defeated Kākuhihewa's warriors in the moʻolelo known as the "Battle of the Owls." Kākuhihewa acknowledged that Kapoʻi's akua or god was a powerful one and from that time, the owl has been recognized as one of the many deities venerated by the Hawaiian people (Thrum 1905:200–202). The failed attempt to sacrifice Kapoʻi at Kūpalaha Heiau may indicate that this heiau was of poʻokanaka class.

### 3.8.5 The Wizard Stones of Kapaemāhū at Waikīkī

This ancient moʻolelo tells of the Wizard Stones of Kapaemāhū at Waikīkī. According to Thrum (1907) the legend begins in the land of Tahiti:

> From the land of Moaulanuiakea (Tahiti) there came to Hawaii long before the reign of King Kakuihewa [Kākuhihewa], four soothsayers from the Court of the Tahitian King. Their names were: Kapaemahu, Kahaloa, Kapuni and Kinohi. They were received as became their station, and their tall stature, courteous ways and kindly manners made them soon loved by the Hawaiian people. The attractiveness of their fine physique and gentle demeanor was overshadowed by their low, soft speech which endeared them to all with whom they came in contact. They were unsexed by nature, and their habits coincided with their feminine appearance, although manly in stature and general bearing. After a long tour of the islands this quartette of favorites of the gods settled at Ulukou, Waikiki, near the site of the present Moana Hotel.
>
> The wizards or soothsayers proved to be adepts in the science of healing, and many wonderful cures by the laying on of hands are reported to have been effected by them, so that their fame spread all over this island (Oahu), as the ancients say, "from headland to headland." Their wisdom and skill was shown by many acts which gave them prestige among the people.
>
> In course of time, knowing that their days among their Hawaiian friends were drawing to a close, they caused their desire for recognition for past services to be remembered in some tangible form, or manner, so that those who might come after, could see the appreciation of those who had been succored and relieved of pain and suffering by their ministrations during their sojourn among them. As an enduring reminder, the wizards agreed among themselves that the people should be asked to erect four monumental tablets, two to be placed on the ground of the habitation, and two at their usual bathing place in the sea. They gave their decision to the people as a voice from the gods, and instructed that the stones be gathered from the vicinity of the historic "bell rock," at Kaimuki, on the Waialae road.
>
> The night of "Kane" was the time indicated for the commencement of the work of transportation and thousands responded to aid in the labor. Four large selected rocks, weighing several tons each, were taken to the beach lot at Ulukou, Waikiki, two of which were placed in position where their house stood, and the other two were placed in their bathing place in the sea. The Chief of the wizards, Kapaemahu, had his stone so named, and with incantations and ceremonies transferred his withcraft [witchcraft] powers thereto, and sacrifice was offered of a lovely, virtuous young chiefess, and her body placed beneath the stone. Idols indicating the hermaphrodite sex of the wizards were also placed under each stone and tradition tells that the incantations, prayers and fastings lasted one full moon. Tradition further states, as is related in the old-time meles of that period, that, after the ceremonies which included the transfer of all their powers, by each of the wizards to the stones thus placed, that they vanished, and were seen no more, but

> the rocks having lately been discovered they have been exhumed from their bed of sand and placed in position in the locality found, as tangible evidence of a Hawaiian tale. (Thrum 1907:139–141)

In addition to Thrum’s findings, researcher Theodore Kelsey adds that these rituals, prayers, and the celebration took place during the time of “Maweke and Muliealiialii” (Gutmanis 1986:34). James H. Boyd, a cousin of the Cleghorn family, said the rocks were “re-discovered” at the turn of the twentieth century. It was around 1907 when Governor Cleghorn had the rocks exhumed from a bed of sand and positioned in the same locality. His son, Thomas Alexander Cleghorn, recalls playing near and on the stones:

> My father built a two-story dwelling and had the Wizard Stones on our property facing Kalakaua...As a child I played on and around the stones, knowing they held some strange and exciting mana—always respecting the lore connected with them. (Gutmanis 1986:35)

Governor Cleghorn equally respected the Wizard Stones even citing in his will that “it is my wish and I hereby direct that the historical stones now upon the premises last above mentioned shall not be defaced or removed from said premises” (Gutmanis 1986:35). After Cleghorn’s death in 1910, the stones were offered to Bishop Museum whom refused them. Later in 1941, the Cleghorn property was leased for a bowling alley (Figure 8). During the construction of the bowling alley, the stones were broken into several pieces during the excavation (Gutmanis 1986:35). In 1958, the area was taken over by the City and County of Honolulu for a park. When the demolition of the bowling alley began in 1958, the largest stone, Kapaemāhū, was found. Eventually the other three stones were found. Because of their historical significance, the City and County of Honolulu’s Board of Parks and Recreation decided to keep the stones in the area (Figure 9) (Gutmanis 1986:35–36).

Figure 8. Photo of ʻĀinahau Estate circa 1915, the Cleghorn residence; home of Governor Archibald Scott Cleghorn, Princess Miriam Likelike, and their daughter Princess Victoria Kaʻiulani (Hawaiʻi State Archives)

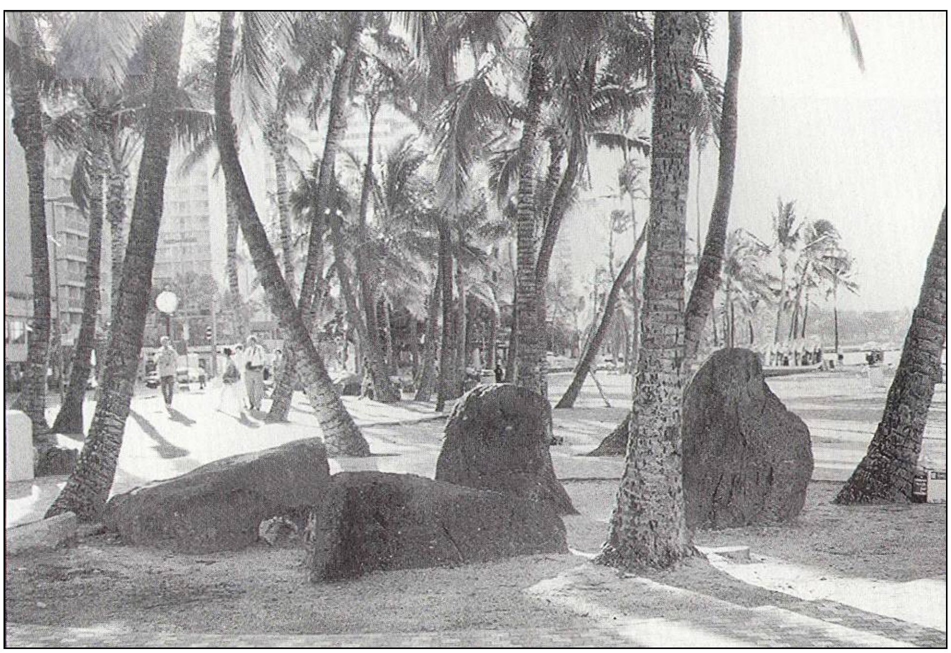

Figure 9. Photo of Waikīkī Wizard Stones, n.d. (Hawaiʻi State Archives)

## 3.9 Human Sacrifices in Waikīkī

Hawaiian authors in the nineteenth and twentieth centuries have emphasized that victims for sacrifice were "criminals," "wrongdoers," or "individuals who had broken tabu, or rendered themselves obnoxious to the chiefs" (Kanahele 1986:116). Another major category of human sacrifice victims was the kauwā. Pukui and Elbert (1986:128) translate kauwā as "Untouchable, outcast, pariah: a caste which lived apart and was drawn on for sacrificial victims."

Waikīkī was famous for the drowning of kauwā with the same formulaic phrase, "Moe mālie i ke kai o ko haku," ('Lie still in the waters of your superior') used for kauwā drowning at Kawailumalumaʻi, Kewalo, and Kualoa. An account of sacrificial drowning of kauwā at Waikīkī appeared in the Hawaiian language newspaper *Ka Loea Kālaiʻāina*:

> *A penei naʻe i kauwā loa [sic. "loaʻa"] ai. Aia a manaʻo ke Aliʻi Nui (Mōʻī) e ʻauʻau kai i Waikīkī. Eia ka nīnau a ke Aliʻi Nui i ke aliʻi ma lalo iho ona, "Pehea āu mau wahi lepo kanu o Puʻu Kuʻua? ʻAʻole paha he mau wahi pōhuli?"*
>
> *Eia ka pane a ke aliʻi ma lalo iho ona, "He Pōhuli nō." ʻO ke kauoha ia akula nō ia e kiʻi.*
>
> *ʻOiai ko kāne me ka wahine e nanea ana me nā keiki, a hiki ʻana ke kiʻi i mau keiki. ʻO ke kū aʻela nō ia o ka makuakāne a lawe ʻana i kāna mau keiki a hiki i Waikīkī.*
>
> *Aia hoʻi a hiki i ka wā a ke Aliʻi e hele ai i ka ʻauʻau kai, a laila, hoouna ʻia mai ke kahu e kiʻi mai i ua keiki a lawe aku ia ma kahi pāpaʻu o ke kai, ma kahi a ke Aliʻi nui e hele kū ʻana, a laila kau nā lima o ka Mōʻī i luna o kahi keiki a me kahi keiki, ma nā ʻāʻī o nā keiki a paʻa ai.*
>
> *ʻO ka hua ʻōlelo ma ka waha o ke Aliʻi nui e ʻōlelo ai, "ʻAʻole pau kuʻu loa! ʻAʻole pau kuʻu loa!" ʻOiai ʻo ia e ʻau ana me ka paʻa nō o nā lima i nā keiki a hiki i ka umauma ke kai o ke aliʻi.*
>
> *Ua lana aʻela nā keiki i luna o ka ʻilikai, aia ke alo i lalo. Eia hoʻi ka ʻōlelo a ka makuakāne ma kula aku nei, "Moe mālie i ke kai o ko Haku," a pēlā aku.*
>
> *ʻO ke kai o Waikīkī ke kai i ʻōlelo ʻia he kai lumalumaʻi kanaka o ka lua, aia i Kualoa.*
>
> Translation:
>
> When the ruling chief wished to go to Waikīkī for sea bathing he asked the chief just below him in rank, "How are my planting places at Puʻu Kuʻua, [a place in the Waiʻanae Range famous as a kauwā residence and place of mixed caste], have they not produced young suckers?" The chief next to him answered, "There are some suckers," and sent someone for them. When the men, women and children least expected it, the messenger came to get some of the children. The father stood up and took his sons to Waikīkī.
>
> Then, when the ruling chief went sea bathing, he sent an attendant to get the boys and take them to a shallow place where the ruling chief would come. Then the

> ruler placed a hand on each of the boys, holding them by the necks. The words he uttered were, “My height has not been reached! My height has not been reached!” He advanced and held onto the boys until the sea was up to his chest. The boys floated on the water face down. The father on shore called out, “Lie still in the sea of your Lord,” and so on.
>
> The Sea of Waikīkī is said to have been used to kill men in and the other place is Kualoa. (*Ka Loea Kālai‘āina* newspaper, July 8, 1899, translation in Sterling and Summers 1978:33)

No specific location at Waikīkī is indicated as the sacrificial site. Numerous accounts of human sacrifice (or near sacrifice) at Waikīkī have a mythopoeic quality for which the historical basis is uncertain.

Papa‘ena‘ena, certainly the most famous, was located at the foot of Diamond Head crater in the environs of the present La Pietra Estates condominium development (Section 3.8.2). Papa‘ena‘ena Heiau is traditionally associated with Kamehameha I who was said to have visited the heiau before setting off to battle for Ni‘ihau and Kaua‘i in 1804. Five years later, according to John Papa ‘Ī‘ī, Kamehameha placed at Papa‘ena‘ena the remains of an adulterer – “all prepared in the customary manner of that time” (‘Ī‘ī 1959:50–51). This would have been one of the last human sacrifices in the kingdom.

In the “Legend of Kapo‘i,” a man from Makiki built a heiau in Mānoa in response to his ‘aumakua (family or personal god), the pueo (owl). Kamakau (1991b:23) gives an account of the near sacrifice of Kapo‘i at Kūpalaha Heiau.

> *Kuku‘i akula a lohe ke ali‘i ‘o Kākuhihewa, e noho ana i Waikīkī, me ka ‘ōlelo ‘ia aku, ua kapu mai nei kekahi kanaka i ka heiau o kona akua, a ua noa. He kānāwai kapu; inā e kūkulu kekahi ali‘i a kanaka paha i ka heiau, a kapu ē ma mua , a noa, ‘a‘ole na‘e i noa ke kapu heiau a ke ali‘i ‘ai moku, a laila, he kipi ‘ia a ho‘okahi ona hope ‘o ka make*. (Kamakau, *Ka Nūpepa Kū‘oko‘a*, July 22, 1865)
>
> <u>Translation:</u>
>
> Word came to the chief Kākuhihewa, who was living in Waikīkī, that a man had dedicated a heiau to his god and had freed the kapu. Kākuhihewa had issued a decree that no chief or man (kanaka) was to build a heiau and dedicate it and free it before the heiau of the ali‘i ai moku, the paramount chief himself, had been dedicated and freed. This would be an act of rebellion and death would be the penalty. Therefore, Kapo‘i, the wrongdoer, was fetched and led to the heiau of Kūpalaha in Waikīkī. (Kamakau 1991:23)

## 3.10 Accounts of Battles at Waikīkī

The following section is a summary of ancient battles associated with Waikīkī according to Kamakau.

### 3.10.1 Kahekili's Invasion of Oʻahu circa 1783

In 1867, Kamakau wrote the following account of the invasion of the island of Oʻahu by the Maui ruling chief, Kahekili:

> *I ka pae ʻana o Kahekili a me nā ʻau waʻa kaua o nā liʻi o Maui, ma Waikīkī, e noho ana nō ka Mōʻī Kahahana ma Kawānanakoa, ma Nuʻuanu, ma uka o Honolulu. I ka lohe ʻana o Kahahana, ua hiki mai ʻo Kahekili me nā ʻau waʻa i lako i nā mea kaua. Ua piha hoʻi mai Kaʻalāwai a hiki i Kawehewehe ka paʻa i nā waʻa kaua o Kahekili mai Maui, Molokaʻi a me Lānaʻi mai, no laila, makaʻu honua ʻē wale ihola nō ʻo Kahahana, a hoʻākoakoa aʻela i kona poʻe aliʻi a me nā koa . . . ʻewalu ko lākou nui i hele i ke kaua. Ua komo loa kēia poʻe ʻewalu i loko o ʻĀpuakēhau, i laila kahi i kaua ai me ke koa launa ʻole, a ua hoʻopuni ʻia mai lākou a puni e nā koa o Maui, a laila, wāhi aʻela kēia poʻe ʻewalu i loko o ka puoko o ke kaua , a nahā aʻela ka poʻe i hoʻopuni ai iā lākou nei. I ko lākou luli ʻana aʻe naʻe e hoʻi mai, ua piha loa ʻo mua i nā koa, ʻaʻohe wahi kaʻawale o Kawehewehe, e hiolo ana nā pololū e like me nā paka ua, akā, ʻaʻohe naʻe he wahi mea a pōʻino ʻo kēia poʻe ʻahi kananā, akā, ʻo kēlā poʻe koa o Maui ua pau i ka make. I ka hiki ʻana i kuāuna o Punaluʻu, e iho mai ai i Luahinewai, e hiki mai ai i nā niu a Kuakuaaka . . . ʻEkolu hoʻouka kaua ʻana o nā ʻaoʻao ʻelua, a ua make like nō.*
>
> *I ka malama o Ianuari 1, o ka A. D. 1783, ua ʻākoakoa nā aliʻi a me nā pūkaua, nā pūʻali a me nā koa o Kahekili, a māhele ʻia ihola ʻelua poʻe kaua. Mahele 1. ʻO Kahekili ka pūkaua. Mahele 2. ʻO Hūʻeu ka pūkaua. ʻO kā Hūʻeu poʻe kaua, ma uka o Kānelāau a me Kapapak⌒lea, ma uka o Pūowaina. ʻO ka m~hele mua, ma luna o Hekili a hiki i Kahēhuna a me ʻAuwaiolimu. ʻO Kaheiki ke kahua kaua.*
>
> *Ma kēia hoʻouka kaua ʻana, ua lilo ka wai o ke kahawai o Kaheiki i koko, no ke āhau lālā kukui o ka heana i ka wai, no ka mea ua kūmano ʻia ke kahawai i ke kino o nā kānaka i make i ke kaua. ʻO ke kaua ma luna iho o ka haiau ʻo Kaheiki ke kaua i heʻe ai, no ka mea, ua piʻi aʻela kekahi kaua ma ke kualapa pili o Pauoa, a iho ma Kapena, a uluāoʻa aʻela ka hoʻouka ʻana o ke kaua . . . Lilo ihola ke aupuni o Oʻahu a me Molokaʻi.* (Kamakau, *Ka Nūpepa Kūʻokoʻa,* March, 30, 1867)
>
> <u>Translation:</u>
>
> Kahahana, [ruling chief of Oʻahu] who was then living at Kawānanakoa in Nuʻuanu, back of Honolulu, was filled with consternation when he heard that Kahekili had come with a fleet of war canoes that reached from Kaʻalāwai to Kawehewehe, and he rallied his warriors about him [but] eight of the warriors . . . went to ʻĀpuakēhau and fought against the whole host, and when they found themselves surrounded by the Maui warriors they broke through the front lines, only to find their way of retreat bristling with more warriors and no way to turn in all of Kawehewehe. Spears fell upon them like rain, but it was they who slew the warriors of Maui. At the border of Punaluʻu, on the way down to Luahinewai and

> the coconut grove of Kuakuaaka [there was fighting] . . . Three times both sides attacked, and three times both were defeated.
>
> In January 1783, a decisive battle was fought with Kaheiki as the battlefield. Kahekili's forces were divided into two companies, one under Hūʻeu's leadership stationed at Kānelāʻau and Kapapakōlea back of Pūowaina and the other under his own command stationed from above Hekili to Kahēhuna and ʻAuwaiolimu.
>
> In this battle the waters of the stream of Kaheiki ran red with blood from the heaps of broken corpses . . . on the ridge facing Pauoa and from thence down to Kapena another attack was made against the defense stationed back of the heiau of Kaheiki . . . thus Oʻahu and Molokai were taken. (Kamakau 1992:135–137)

A reconstruction of Kamakau's account of Kahekili's attack definitely suggests battle casualties in Waikīkī.

### 3.10.2 Account of the Invasion of Kamehameha, circa 1795

In 1867, Samuel M. Kamakau wrote the following account of the invasion of the island of Oʻahu by the ruling chief, Kamehameha:

> *Holo akula hoʻi ka ʻau waʻa kaua o Kamehameha a pae i Waikīkī, a ua pani ʻia mai Waiʻalae a Waikīkī e nā ʻau waʻa kaua o Kamehameha.*
>
> *ʻO Kalanikūpule hoʻi a me kona mau aliʻi, e noho ana lākou ma Nuʻuanu, Kanoneakapueo, Kahapaʻakai, Luakaha, Kawānakoa, Kaukahōkū, Kapaeli, Kaumuohena a me Pūʻiwa n~ kahua kaua.* (Kamakau, *Ka Nūpepa Kūʻokoʻa*, June 8, 1867)
>
> Translation:
>
> Kamehameha's fleet landed at Waikīkī where it covered the beaches from Waiʻalae to Waikīkī. Kalanikūpule and his chiefs were stationed at strategic points in Nuʻuanu at Kanoneakapueo, Kahapaʻakai, Luakaha, Kawananakoa, Kaukahoku, Kapaʻeli, Kaumuʻohena a me Puʻiwa, where the fighting began. (Kamakau 1992:172)

This account emphasizes that the main fighting started in the uplands, but fighting at Waikīkī is certainly not to be ruled out.

### 3.10.3 Burials

Our present evaluation of the Waikīkī burials is much more mundane than battle deaths or human sacrifices - namely that the vast majority of the deceased were the common people of Waikīkī. Withington, probably referring to the ʻōkuʻu (disease at time of Kamehameha, perhaps cholera or dysentery) plague (circa 1804), says: "A few years of peace settled over the Islands. Kamehameha and other warring chiefs took this opportunity to re-establish their forces, which had been greatly reduced through war and disease. A terrible epidemic of measles had attacked the people of the islands. It is claimed that more than three hundred bodies were carried out to sea from Waikīkī in one day," (Withington 1953:16). Possibly many of the Waikīkī burials relate to such early depopulation by introduced diseases.

Rank seems to have had profound influences on places available for disposal. A king's body, or those of his attendants, could be placed within the district of the king's authority. Many geographical features were available. Fewer were available to lesser chiefs and their attendants, who were presumably limited to their own districts. The number of geographical features available for disposal seems to have decreased as rank decreased. Disposal for members of an extended family living in an ʻili was restricted to those geographical features located within the land unit, whether broken lava flats, lava tubes, earth plains, or sand dunes (Bowen 1961:21).

According to Bowen (1961:21), most Hawaiians in the pre-Contact period belonged to the makaʻāinana or commoner class and their bones were usually buried in no other area than their particular ʻili; this particular practice is reflected in a Hawaiian term for one's natal locality — kulāiwi meaning "plain of one's bones" (Cleghorn 1987:41).

Burials are commonly reported from clean, consolidated sand deposits, clearly a common place of interment practiced by Hawaiians (Cleghorn 1987:42). One of the earliest references to burials was made by Urey Lisiansky (1814:122), who visited Hawaiʻi in June, 1804. He notes: "The poor are buried anywhere along the beach . . ."

Commenting on the nature of burial areas and body positions used in burial, Ellis says:

> The common people committed their dead to the earth in a most singular manner. The body was flexed, bound with cord, wrapped in a coarse mat, and buried one or two days after death. Graves were . . . either simply pits dug in the earth, or large enclosures . . . Occasionally they buried their dead in sequestered places at a short distance from their habitations, but frequently in their gardens and sometimes in their houses. Their graves were not deep and the bodies were usually placed in them in a sitting posture. (Ellis 1827:361–363)

Regarding the Castle burials, in Waikīkī, Bowen goes on to report: "Concerning the circumstances of burial, Emerson says: 'From the absence of fractures and marks of violence in the bones I have examined, such as might have been caused in battle, I am inclined to think that the site where they were found was at one time a Hawaiian cemetery" (Bowen 1961:149)

Areas immediately inland and adjacent to the Project area have yielded a large number of burials from both pre-Contact and early historic times. Many archaeological studies have documented burials in both Jaucas sand deposits and in more terrigenous sediments throughout Waikīkī.

In 1993, archaeological monitoring was conducted by Biosystems Analysis, Inc. along Kālia Road at Fort DeRussy Military Reservation. Results were written by Garcia and Associates almost four years later (Denham and Pantaleo 1997a). SIHP #50-80-10-4570 consisted of a historic trash pit, four fire pits, an ash lens, and an unknown number of human burials (in six distinct features). SIHP #50-80-14-4574 consisted of fishpond sediments from Loko Paweo I, three historic trash pits, and two burials (authors did not determine burials' age).

In 1992, Garcia and Associates conducted archaeological data recovery at Fort DeRussy. Five previously investigated. SIHP #50-80-14-4570 was characterized by features such as a firepit, coral rock concentration, and postholes. An irrigation ditch and bund system (-4970) revealed a number of features related to permanent historic occupation and possible intermittent prehistoric use including five firepits, two historic middens, and a human burial. In addition, three fishponds, Loko Paweo I (-4574), Loko Kaʻihikapu (-4575), and Loko Paweo II (-4576) were identified (Denham and Pantaleo 1997b).

In 2009, Pacific Legacy, Inc. conducted an archaeological monitoring for the Hilton Hawaiian Village Grand Waikīkīan Development Project (Mooney et al. 2009). A previously disturbed human burial (-7087) was found on the mauka side of the intersection of Ala Moana Boulevard and Kālia Road. The remains were sealed and left *in situ*.

Table 1 is a listing of SIHPs found within and in the vicinity of the Project area. Figure 10 displays previous archaeology done in the immediate and in the vicinity of the Project area.

Table 1. List of SIHPs found within and in the vicinity of Project area

| SIHP Number | Author | Year | Findings | Notes |
|---|---|---|---|---|
| -2780 | Neller | 1980 | Human burials and 19th century artifacts | Construction of Tapa Tower at Hilton Hawaiian Village near Fort DeRussy |
| -4570 | Denham and Pantaleo | 1997a<br>1997b | Historic trash pit, four fire pits, ash lens, and human burials | Unknown number of human burials |
| -4573 | Putzi and Cleghorn | 2002 | Fishpond | Loko Kaipuni (filled, now Fort DeRussy) |
| -4574 | Denham and Pantaleo | 1997a | Fishpond | Loko Paweo I (filled, now Fort DeRussy) |
| -4575 | Denham and Pantaleo | 1997b | Fishpond | Loko Kaʻihikapu (filled, now Fort DeRussy) |
| -4576 | Denham and Pantaleo | 1997b | Fishpond | Loko Paweo II (filled, now Fort DeRussy |
| -4579 | Denham and Pantaleo | 1997b | Fire pits, midden, and a human burial | Features related to permanent historic occupation and possible intermittent prehistoric use (five fire pits, two historic middens, and a human burial |

| SIHP Number | Author | Year | Findings | Notes |
|---|---|---|---|---|
| -4890 | McMahon, Nancy | 1994 | Human remains | Mauka of Kalākaua Avenue near Kuamo‘o Street, burial found in back pile of fill; right femur, radius, tibia, fibula, rib and bone fragments |
| -4966 | Denham and Pantaleo | 1997a | Pre-contact features and burials | At least five individuals were found in the Koko Head portion of Fort DeRussy |
| -4970 | Denham and Pantaleo | 1997b | Previously identified historic property | Irrigation ditch and bund system |
| -5744 (1 & 2) | Perzinski et al. | 1999 | Two pre-Contact or early post-Contact Native Hawaiian burials | N/A |
| -6873 | Bell and McDermott | 2006 | Isolated traditional Hawaiian burial | Undetermined age |
| -7087 | Mooney et al. | 2009 | Previously disturbed human burial | Near complete cranium and cranial fragments; near intersection of Kālia Road and Ala Moana Boulevard; remains were sealed and left *in situ* |
| -9500 | Kimble | 1976 | Five pre-Contact Human burials | From construction of Hale Koa Hotel on beach fronting Fort DeRussy |
| -9550 | Streck | 1992 | One pre-Contact burial | N/A |

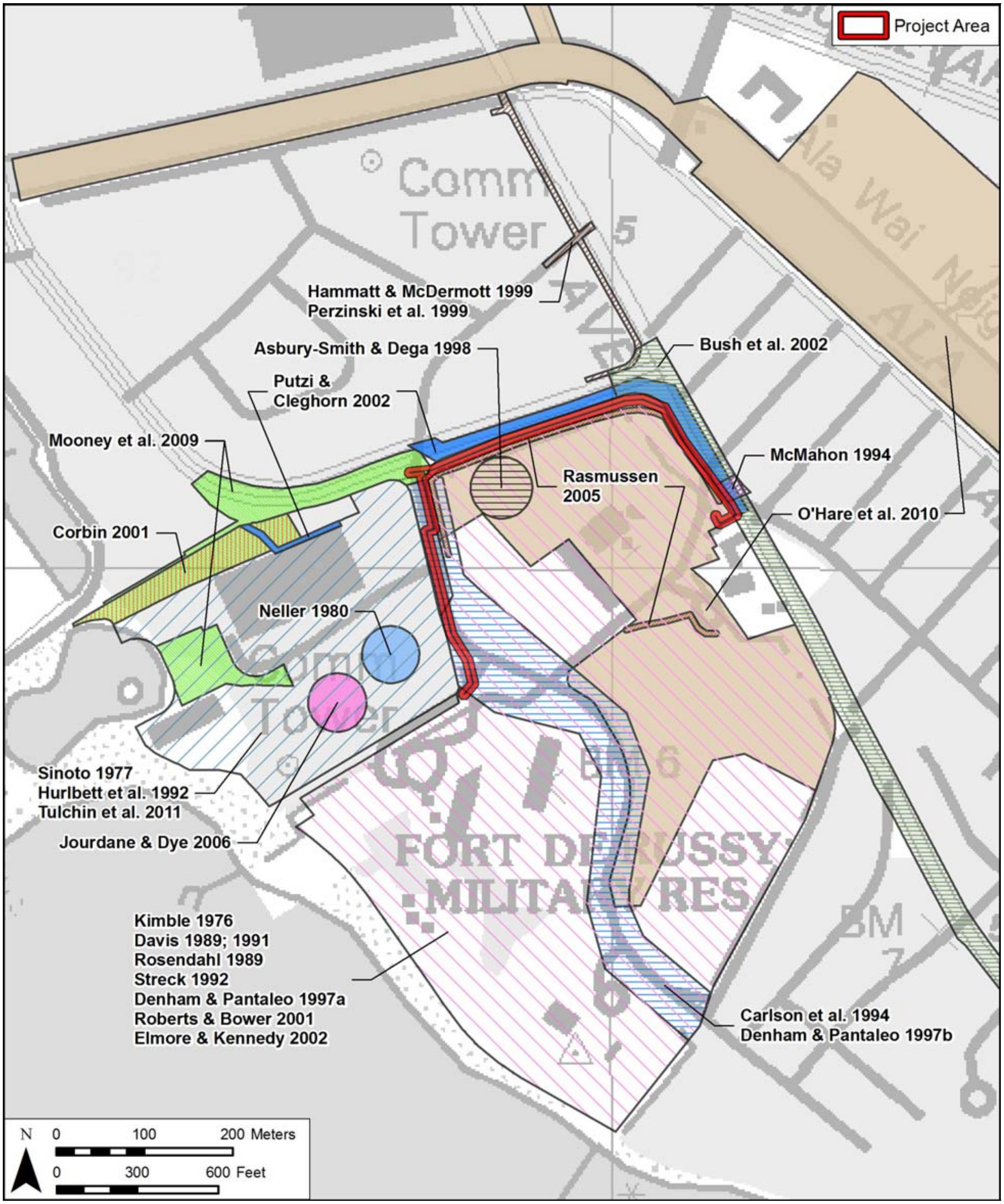


Figure 10. Previous archaeology within Project area and in the vicinity of (base map, a portion of the 1998 USGS 7.5 minute topographic Honolulu quadrangle)

## 3.11 Trails

In *Fragments of Hawaiian History*, ‘Ī‘ī described the “Honolulu trails of about 1810” (‘Ī‘ī 1959:89), including the trail from Honolulu to Waikīkī (Figure 11):

> The trail from Kawaiahao which led to lower Waikiki went along Kaananiau, into the coconut grove at Pawaa, the coconut grove of Kuakuaka, then down to Piinaio; along the upper side of Kahanaumaikai’s coconut grove, along the border of Kaihikapu pond, into Kawehewehe; then through the center of Helumoa of Puaaliilii, down to the mouth of the Apuakehau stream; along the sandy beach of Ulukou to Kapuni, where the surfs roll in; thence to the stream of Kuekaunahi; to Waiaula . . . (‘Ī‘ī 1959:92)

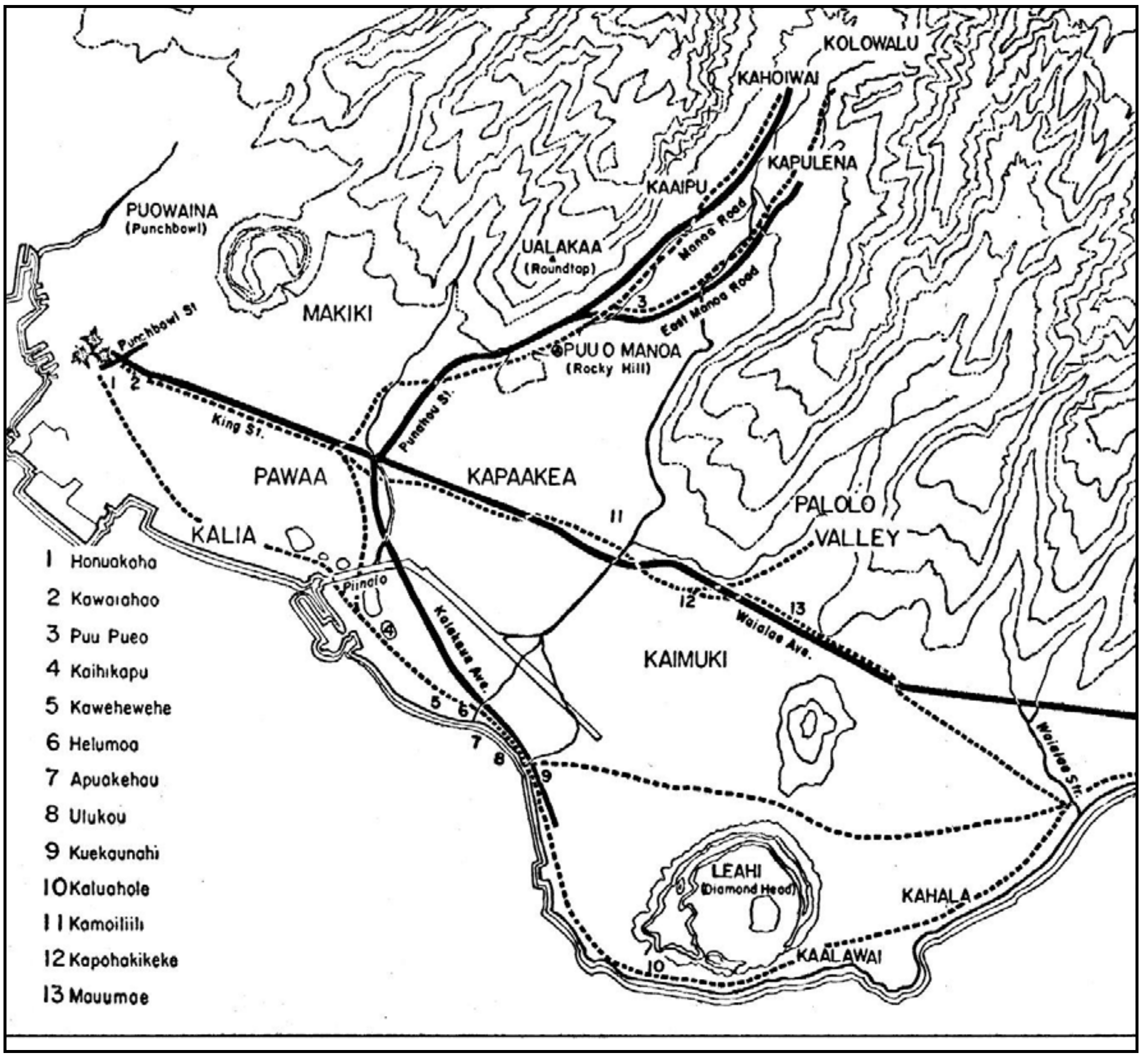


Figure 11. Trails on the southwest coast of O‘ahu ca. 1810 (Sketch by Gerald Ober; reprinted in ‘Ī‘ī 1959:93; not to scale), showing locations of some place names in Waikīkī

# Section 4 Historical Background

## 4.1 Late Pre-Contact/Early Historic Period

Waikīkī, by the time of the arrival of Europeans in the Hawaiian Islands during the late eighteenth century, had long been a center of population and political power on O‘ahu. According to Martha Beckwith (1940), by the end of the fourteenth century, Waikīkī had become “the ruling seat of the chiefs of O‘ahu.” Waikīkī also became a popular area for chiefly residences from the reign of Ma‘ilikukahi, the first mō‘ī (island-wide chief) of O‘ahu (see Section 3.5 for an expanded account).

Chiefly residences, however, were only one element of a complex of features which were able to sustain a large population that characterized Waikīkī up to pre-Contact times. Waikīkī was a sacred place rich in aquaculture and sea harvesting as well as a favored area for habitation and surfing. Beginning in the fifteenth century, a vast system of irrigated taro fields was constructed, extending across the littoral plain from Waikīkī to lower Mānoa and Pālolo valleys. This field system—an impressive feat of engineering of which is traditionally attributed to the chief Kalamakua–took advantage of streams descending from Makiki, Mānoa, and Pālolo valleys which also provided ample fresh water for the Hawaiians living in the ahupua‘a. Water was also available from springs in nearby Mō‘ili‘ili and Punahou. Closer to the Waikīkī shoreline, coconut groves and fishponds dotted the landscape. A sizeable population developed amidst this Hawaiian-engineered abundance. Captain George Vancouver, arriving at “Whyteete” in 1792, captured something of this profusion in his journals:

> On shores, the villages appeared numerous, large, and in good repair; and the surrounding country pleasingly interspersed with deep, though not extensive valleys; which, with the plains near the sea-side, presented a high degree of cultivation and fertility.
>
> [Our] guides led us to the northward through the village, to an exceedingly well-made causeway, about twelve feet broad, with a ditch on each side.
>
> This opened our view to a spacious plain, which, in the immediate vicinity of the village, had the appearance of the open common fields in England; but, on advancing, the major part appeared to be divided into fields of irregular shape and figure, which were separated from each other by low stone walls, and were in a very high state of cultivation. These several portions of land were planted with the eddo or *taro* root, in different stages of inundation; none being perfectly dry, and some from three to six or seven inches under water. The causeway led us near a mile from the beach, at the end of which was the water we were in quest of. It was a rivulet five or six feet wide, and about two or three feet deep, well banked up, and nearly motionless; some small rills only, finding a passage through the dams that checked the sluggish stream, by which a constant supply was afforded to the *taro* plantations.
>
> [We] found the plain in a high state of cultivation, mostly under immediate crops of *taro*; and abounding with a variety of wild fowl, chiefly of the duck kind...The

> sides of the hills, which were at some distance, seemed rocky and barren; the intermediate vallies, which were all inhabited, produced some large trees, and made a pleasing appearance. The plain, however, if we may judge from the labour bestowed on their cultivation, seemed to afford the principal proportion of the different vegetable productions on which the inhabitants depend for their subsistence. (Vancouver 1798:161–164)

Further details of the exuberant life that must have characterized the Hawaiians use of the lands that included the ahupua‘a of Waikīkī are given by Archibald Menzies, a naturalist accompanying Vancouver's expedition:

> The verge of the shore was planted with a large grove of coconut palms, affording a delightful shade to the scattered habitations of the natives. Some of those near the beach were raised a few feet from the ground upon a kind of stage, so as to admit the surf to wash underneath them. We pursued a pleasing path back to the plantation, which was nearly level and very extensive, and laid out with great neatness into little fields planted with taro, yams, sweet potatoes and the cloth plant. These, in many cases, were divided by little banks on which grew the sugar cane and a species of *Draecena* without the aid of much cultivation, and the whole was watered in a most ingenious manner by dividing the general stream into little aqueducts leading in various directions so as to be able to supply the most distant fields at pleasure, and the soil seemed to repay the labour and industry of these people by the luxuriancy of its productions. Here and there we met with ponds of considerable size, and besides being well stocked with fish, they swarmed with water fowl of various kinds such as ducks, coots, water hens, bitterns, plovers and curlews. (Menzies 1920:23–24)

However, the traditional Hawaiian focus on Waikīkī as a center of chiefly and agricultural activities on southeastern O‘ahu was soon to change, disrupted by the same Euro-American Contact which produced the first documentation (including the records cited above) of that traditional life. The ahupua‘a of Honolulu, with the only sheltered harbor on O‘ahu, became the center for trade with visiting foreign vessels, drawing increasing numbers of Hawaiians away from their traditional environments. The shift in pre-eminence is illustrated by the fact that Kamehameha moved his residence from Waikīkī to Honolulu. Indeed, by 1828, Levi Chamberlain describing a journey into Waikīkī would note:

> Our path led us along the borders of extensive plats of marshy ground, having raised banks on one or more sides, and which were once filled with water, and replenished abundantly with esculent fish; but now overgrown with tall rushes waving in the wind. The land all around for several miles has the appearance of having once been under cultivation. I entered into conversation with the natives respecting this present neglected state. They ascribed it to the decrease of population. (Chamberlain 1957:26)

Tragically, the depopulation of Waikīkī was not simply a result of the attractions of Honolulu (where, by the 1820s, the population was estimated at 6,000 to 7,000) but also of the European diseases that had devastating effects upon the Hawaiian populace.

## 4.2 Mid- to late-1800s

As the nineteenth century progressed, Waikīkī was becoming a popular site among foreigners—mostly American—who had settled on O‘ahu. An 1865 article in the *Pacific Commercial Advertiser* mentioned a small community that had developed along the beach. The area continued to be popular with the ali‘i and several notables had residences there.

Other developments during the second half of the nineteenth century, a prelude of changes that would dramatically alter the landscape of Waikīkī during the twentieth century, include the improvement of the road connecting Waikīkī to Honolulu (the route of the present Kalākaua Ave.), the building of a tram line between the two areas, and the opening of Kapi‘olani Park on June 11, 1877. Traditional land-uses in Waikīkī were abandoned or modified. By the end of the nineteenth century most of the fishponds that had previously proliferated had been neglected and allowed to deteriorate. The remaining taro fields were planted in rice to supply the growing numbers of immigrant laborers imported from China and Japan, and for shipment to the west coast of the United States (Coulter and Chun 1937).

As the sugar industry throughout the Hawaiian kingdom expanded in the second half of the nineteenth century, the need for increased numbers of field laborers prompted passage of contract labor laws. In 1852, the first Chinese contract laborers arrived in the islands. Upon completion of their contracts, a number of the immigrants remained in the islands, many becoming merchants or rice farmers. As was happening in other locales in the 1880s, groups of Chinese began leasing and buying (from the Hawaiians of Waikīkī) former taro lands for conversion to rice farming (Coulter and Chun 1937). By 1892, Waikīkī had 542 acres planted in rice, representing almost 12% of the total 4,659 acres planted in rice on O‘ahu.

### 4.2.1 The Māhele

To try to maintain sovereignty of the land, the Mō‘ī, Kauikeaouli (Kamehameha III) in 1846–1848 supervised the Māhele—the division of Hawaiian lands—that transformed the land system in Hawai‘i from collective to private ownership. Modeled after Western concepts, certain lands to be reserved for himself and the royal house were known as Crown Lands, lands claimed by ali‘i and their konohiki were called Konohiki Lands, and lands set aside to generate revenue for the government were known as Government Lands. In 1850, these three categories of land were subject to the rights of the maka‘āinana and other tenants (naturalized foreigners, non-Hawaiians born in the islands, or long-term resident foreigners), who could make claims for their habitation and agricultural plots, known as kuleana (Native land rights) parcels (Chinen 1958:8–15).

Under the Kuleana Act of 1850, the maka‘āinana were required to file their claims with the Board of Commissioners to Quiet Land Titles (Land Commission) within a specified time period in order to apply for fee-simple title to their lands. The claim could only be filed after the claimant arranged and paid for a survey, and two witnesses testified that they knew the claimant and the boundaries of the land, knew that the claimant had lived on the land since 1939, and knew that no one had challenged the claim. Then, the maka‘āinana could present their claims to the Land Commission to receive their Land Commission Award (LCA) (Kame‘eleihiwa 1992).

Not everyone who was eligible to apply for kuleana lands did so and not all of those claims were awarded. Some claimants failed to follow through and come before the Land Commission, some did not produce two witnesses, and some did not get their land surveyed. In addition, some makaʻāinana may have been reluctant to claim ʻāina that had been traditionally controlled by their aliʻi, some may have not been familiar with the concept of private land ownership, and some may have not known about the Māhele, the process of making claims (which required a survey) or the strict deadline for making claims. Further, the Land Commission was comprised largely of foreign missionaries, so the small number of claimants and awards may reflect only those makaʻāinana who were in good standing with the church. Significantly, the surveying of the land was not standardized (Kameʻeleihiwa 1992:296–297).

A total of 14,195 claims were filed and 8,421 awards were approved to about 29 percent of the 29,220 adult Native Hawaiian males living at the time of the Māhele, averaging three acres each (Kameʻeleihiwa 1992:295). Out of the potential 2,500,000 acres of Crown and Government lands, 28,658 acres of land were awarded to the makaʻāinana, less than one percent of the total acreage of Hawaiʻi (Kameʻeleihiwa 1993:295). The small number of kuleana awards and their small size prevented the makaʻāinana from maintaining their independent subsistence, often forcing them to abandon their newly acquired property (Chinen 1958:32).

Although many Hawaiians did not submit or follow through on claims for their lands, the distribution and written testimonies of LCAs can provide insight into patterns of residence and agriculture. Many of these patterns probably had existed for centuries. By examining the patterns of kuleana LCA parcels in the vicinity of the Project area, insight can be gained to the likely intensity and nature of Hawaiian activity in the area at the time.

Table 2 displays Land Commission Awards granted in the Kālia area. The table includes land commission number, awardee, ahupuaʻa, ʻili, and notes on land use. Research efforts yielded the area was rich in taro farming and aquaculture. Many awardees were granted portions of fishponds to raise fish or part of a stream to help irrigate their land. Figure 12 is Registered Map 1398 (Bishop 1881) overlaid with the Project area. This particular map displays LCAs that are within the Project area and illustrates the extensive cultural landscape of fishponds and water ways that once existed in Waikīkī.

Table 2. Land Commission Awards in the Kālia area; LCA number, claimant, ahupua‘a, ‘ili, and notes on land use

| LCA | Claimant | Ahupua‘a | ‘Ili | Notes |
|---|---|---|---|---|
| **LCAs in the Project area** | | | | |
| 2083 | Kahiloaho | Waikīkī | Kālia, Kamo‘okahi, Moaiki | Moaiki ‘āpana (portion): One lo‘i (irrigated terrace) kalo<br>Kamo‘okahi ‘āpana: Two lo‘i kalo<br>Kālia ‘āpana: house lot |
| 2511 | Alapai | Waikīkī | Kālia | No information available |
| **LCAs in the vicinity of the Project area** | | | | |
| 5FL | Kapilimanu | Waikīkī | Kālia, Pahupahupua‘a | Kālia ‘āpana: two house lots; two sections of streams; one fishpond<br>Pahupahupua‘a ‘āpana: four lo‘i kalo; one ‘auwai (ditch) |
| 6FL | Wa‘a | Waikīkī | Waiala, Kālia, Haole | Kula ‘āina (plain); one lo‘i kalo; section of a stream |
| 7FL | Namalie | Waikīkī | Waiala, Haole, Kālia | Kula ‘āina; two lo‘i kalo; ‘auwai; one fishpond |
| 8FL | Kuaiwahie | Waikīkī | Kālia | One house lot; kula ‘āina; section of a stream; one fishpond; two lo‘i kalo |
| 31FL | Waihinano | Waikīkī | Kālia, Pawa‘a | Pawa‘a ‘āpana: 22 lo‘i and kula ‘āina<br>Kālia ‘āpana: house lot |
| 32FL | Kunewa, E.K. | Waikīkī | Kālia, Haole | Haole ‘āpana: two lo‘i<br>Kālia ‘āpana: Section of a stream; house lot; two fishponds |

| LCA | Claimant | Ahupua‘a | ‘Ili | Notes |
|---|---|---|---|---|
| 35FL | Mahuka | Waikīkī | Kālia, Kanukuaula, Kaolokohonu, Kaikahi | No information available |
| 99FL | Uma | Waikīkī | Kālia | House lot and fishpond |
| 100FL | Kekaula | Waikīkī | Kālia | Two fish ponds; five kiopua (pool for raising fish); one lo‘i; house lot; piece of land |
| 101FL | Kaluaoku | Waikīkī | Kālia | Two fishponds; three kiopua; one lo‘i |
| 104FL | Kekuanaoa, M. | Waikīkī | Kālia, Kaukahoku, Kuhimana, Alewa, Kuanwai, Kuwili, Pi‘inaio, Kapuni, Kamanolepo | No information available |
| 1268 | Nakai | Waikīkī | Kālia, Kiki, Waiaka, Kanainui | One house lot with fence; five lo‘i kalo |
| 1275 | Mo‘okini | Waikīkī | Kālia, Kapa‘akea, Kiki | Stone fence with house lot; nine lo‘i kalo; claimant had lands since the time of Kamehameha I |
| 1409 | Nakoko | Waikīkī | Kālia, Aikahi | Kālia ‘āpana: One house lot partly fenced; claimant had lands since the time of Ka‘ahumanu |
| 1410 | Paele | Waikīkī | Kālia, Kuilei | Kālia ‘āpana: One house lot, not fenced; three lo‘i kalo; Keolaloa gave these lands to claimant in the time of Ka‘ahumanu |
| 1436 | Kaleipapopao | Waikīkī | Kālia, Kahakai, Nukunukuaula, Kanukuaula | One lo‘i kalo; house lot; and a stream |
| 1437 | Kaohulenui | Waikīkī | Kālia, Pahupahupua‘a, Hamohamo | House lot in Hamohamo; kula ‘āina in Pahupahupua‘a; and kalo patches in Kālia |
| 1510 | Kaluahinenui | Waikīkī | Kālia, Kanukuaula | House lot in Makalie; one kalo patch in Kanukuaula; one patch in Kaikapai; one patch in Waealae Kiki; Ka‘ahumanu gave these lands to the claimant |

| LCA | Claimant | Ahupua‘a | ‘Ili | Notes |
|---|---|---|---|---|
| 1512 | Nalaweha | Waikīkī | Kālia, Kanukuaula | House lot |
| 1514 | Nalaweha | Waikīkī | Kālia, Kanukuaula, Pahupahupua‘a | One house lot partly fenced |
| 1515 | Kaihuolua | Waikīkī | Kālia, Kahakai | Three lo‘i kalo; one house lot enclosed; claimant had lands since the time of Ka‘ahumanu |
| 1736 | Kuaiwa | Waikīkī | Kālia | Two lo‘i kalo; claimant had the land from Kanahi in the time of Kinau (circa 1840) |
| 1737 | Kapaole | Waikīkī | Kālia, Piliamo‘o, Kiokapu | Consists of several lots; two fenced house lots; two lo‘i kalo |
| 1758 | Kalaione | Waikīkī | Kālia, Kamoku | One lo‘i kalo; claimant received land from Kulewailehua in 1836; claimant is the son in law of Kulewailehua |
| 1765 | Kaihikaele and Kamaile | Waikīkī | Kālia | No information available |
| 1775 | Pawa | Waikīkī | Kālia | One house lot; claimant received land from Ka‘ahumanu |
| 1816 | Ka‘aha | Waikīkī | Kālia, Kapa‘akea, Hopoe, Pau | Claimant died in 1848; daughter (Kahele) lives on the land with her husband Ka‘ana‘ana; kalo and kula in one piece; seven lo‘i kalo; claimant received lots from Kanaina in the time of Ka‘ahumanu |
| 1999 | Nalimu | Waikīkī | Kālia | Fenced house lot; claimed land through his wife, Kamakani, who obtained it from her ancestors who lived in this place from the time of Kamehameha I |
| 2077 | Kanakaole | Waikīkī | Kālia, Kamo‘okahi, Kaluahole | One lo‘i kalo; claimant had the land from the time of Kamehameha I |
| 2079 | Kauhola | Waikīkī | Kālia, Makiki, Mokahi, Hohe, Kawaia‘ala, Kaluahole | No information available |
| 2081 | Kaoneanea | Waikīkī | Kālia, Kamo‘okahi | Two lo‘i kalo; fish pond |

| LCA | Claimant | Ahupua‘a | ‘Ili | Notes |
|---|---|---|---|---|
| 2082 | Kuene (John Needles) | Waikīkī | Kālia, Kamo‘okahi | Four lo‘i kalo; house lot |
| 2549 | Luaiku | Waikīkī | Maulukikepa, Kālia | No information available |
| 6450 | Kaunuohua | Waikīkī | Mokauea, Pu‘ulena, Kālia, Kiokapu | Land was given to claimant from Kamehameha III in 1848 |
| 6616 | Nu‘uanu | Waikīkī | Kālia, Kaluahole, Kanewai | No information available |
| 7597 | Kamaukoli, Anederea | Waikīkī | Auaukai, Kālia, Nanapua | Kālia ‘āpana: Three lo‘i kalo; kula mahi‘ai (farming plains) |
| 8023 | Aua | Waikīkī | Auauakai, Kālia, Keomuku | No information available |
| 9532 | Kapapa | Waikīkī | Kālia | No information available |
| 9533 | Kaluaoku | Waikīkī | Kālia | No information available |
| 9538 | Waialala | Waikīkī | Kālia | No information available |
| 9983 | Lilikalani | Waikīkī | Kālia, Kauamoa | No information available |

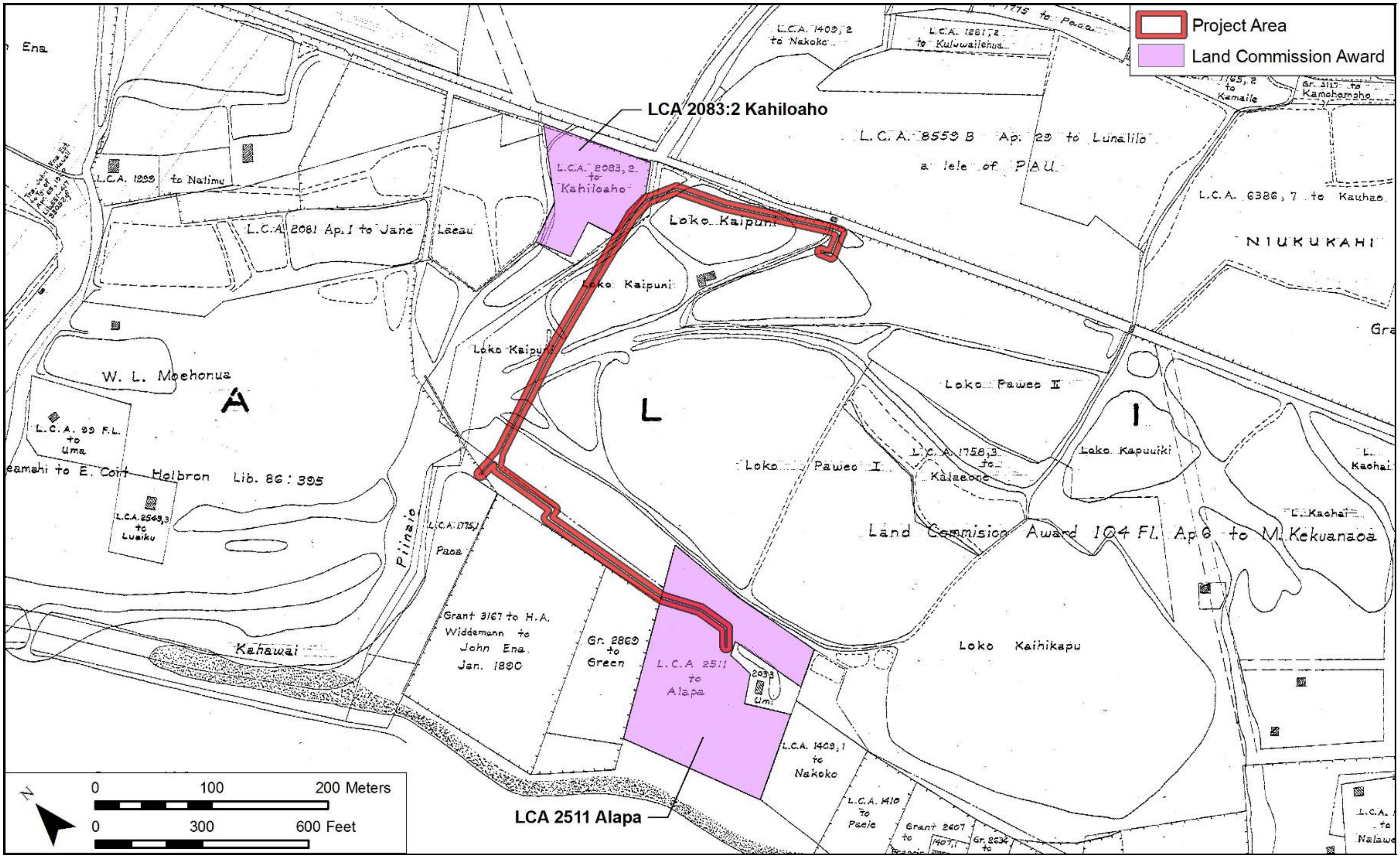


Figure 12. LCAs and fishponds in the vicinity of Project area; LCAs within the Project area are highlighted (Registered Map 1398, Bishop 1881)

## 4.3 1900s

During the first decade of the twentieth century, the U.S. War Department acquired more than 70-acres in the Kālia portion of Waikīkī for the establishment of a military reservation called Fort DeRussy, named in honor of Brig. Gen. R.E. DeRussy of the Army Corps of Engineers.

> On 12 November 1908, a detachment of the 1st Battalion of Engineers from Fort Mason, California, occupied the new post...
>
> Between 1909 and 1911 the engineers were primarily occupied with mapping the island of O‘ahu. At DeRussy other activities also had to be attended to - especially the filling of a portion of the fishponds which covered most of the Fort. This task fell to the Quartermaster Corps, and they accomplished it through the use of an hydraulic dredger which pumped fill from the ocean continuously for nearly a year in order to build up an area on which permanent structures could be built. Thus the Army began the transformation of Waikīkī from wetlands to solid ground. (Hibbard and Franzen 1986:79)

During the 1920s Waikīkī landscape would be transformed when the construction of the Ala Wai Drainage Canal—begun in 1921 and completed in 1928—resulted in the draining and filling in of the remaining fishponds and irrigated fields of Waikīkī. The canal was one element of a plan to urbanize Waikīkī and the surrounding districts:

> The [Honolulu city] planning commission began by submitting street layout plans for a Waikīkī reclamation district. In January 1922 a Waikīkī improvement commission resubmitted these plans to the board of supervisors, which, in turn, approved them a year later. From this grew a wider plan that eventually reached the Kapahulu, Mō‘ili‘ili, and McCully districts, as well as lower Makiki and Mānoa.
>
> The standard plan for new neighborhoods, with allowances for local terrain, was to be that of a grid, with 80-foot-wide streets crossing 70-foot-wide avenues at right angles so as to leave blocks of house lots about 260 by 620 feet. Allowing for a 10-foot-wide sidewalk and a 10-foot right-of-way [alley] down the center of each block, there would be twenty house lots, each about 60 by 120 feet, in each block. (Johnson 1991:311)

Newly created land tracts following the Ala Wai Canal’s construction spurred a rush to development in the 1930s. An article in the *Honolulu Star-Bulletin* in 1938 extolled the area’s progress:

> The expansion of apartment and private residence construction is no secret. Examination of building permits will show that more projects have been completed during the past year, and more are now underway in this area, than in any other section of the territory.
>
> These developments are being made by island residents who have recognized the fact that Waikīkī presents the unparalleled possibility for safe investment with excellent return. (Newton 1939:10)

### 4.3.1 World War II

The entrance of the United States into World War II following the Japanese bombing of Pearl Harbor on December 7, 1941 put on hold plans for the development of Waikīkī as a tourist destination. Until the war’s end in 1945, the tourist trade was non-existent “...since the Navy controlled travel to and from Hawai‘i and did not allow pleasure trips” (Brown 1989:141). For the duration of the war, Waikīkī was transformed into a recreation area for military personnel.

> It was not the same Waikīkī as before the war, though; barbed wire barricades now lined its sands, and there were other changes too. Fort DeRussy became a huge recreation center, with a dance hall called Maluhia that attracted thousands of men at a time. The Moana Hotel continued to function, but many other establishments and private homes in the area were taken over by the military. (Brown 1989:141)

### 4.3.2 Tourism in Waikīkī

By the mid-1950s there were more than 50 hotels and apartment buildings from the Kālia area to the Diamond Head end of Kapi‘olani Park. The Waikīkī population, by the mid-1950s, was not limited to transient tourists but included 11,000 permanent residents living in 4,000 single dwellings and apartments in stucco or frame buildings.

Between 1954 and 1955, Henry J, Kaiser and Fritz Burns purchased the Niumalu Hotel and its surrounding lots, which were located adjacent to the current Project area (Hibbard and Franzen 1986:144). The duo commissioned architects Welton Beckett and Ed Bauer, and landscape architect Richard Tongg to design the hotel. When the hotel was completed, it was called the Kaiser Hawaiian Village. It was a complex of 24 thatched roofed guest cottages and boasted three below sea level salt water swimming pools that contained continuously flowing and filtered ocean water (Hibbard and Franzen 1986:145). In 1961, hotelier Conrad N. Hilton purchased Kaiser’s interest in the hotel. The name Hilton was added to the hotel. Today, the 22-acre complex consists of six towers with guest accommodations, 20 restaurants, 90 shops, an artificial lagoon, four pools, a branch of the Bishop Museum, and a concierge with guest activities (Feeser and Chan 2006:39).

Development of hotel properties in Waikīkī during the 1950s raised concern over public rights of way for access to the Waikīkī beach which, like all of Hawai‘i’s beaches, is public from the ocean to the high water mark. The population in 2000 included 13,124 residents in the Waikīkī-Kālia area, 17,216 in the McCully/Kapahulu neighborhoods, 13,877 in the combined Punahou/Mō‘ili‘ili area, 13,712 in the Kapahulu/Diamond Head areas, and 16,529 persons in the Kaimukī area (Schmitt 1977:18–19).

## 4.4 Historic Maps

A series of historic maps from 1887 to 1953 illustrate the dramatic changes that occurred within the Project area as Western commercial interests supplanted the traditional Native Hawaiian way of life. Of note is the artificial extension of the coastline and successive waves of resort development.

An 1887 Hawaiian Government Survey map of Honolulu indicates that the Project area is adjacent to Waikīkī Road and was partially built over a grouping of fishponds (Figure 13).

An 1897 map of Honolulu by M.D. Monsarrat indicates the various ‘ili of Waikīkī (Figure 14). The ‘ili mentioned on this map are from west to east; Kālia, Helumoa, Kaluaokau, Uluniu, Hamohamo, Kekio and Kāneloa. The northeast portion of the Project area is adjacent to Waikīkī Road. The northwestern portion of the Project area covers Pi‘inaio Stream and a few unnamed fishponds. The southwestern portion of the Project area covers Kālia Road and fronts a couple of properties. The entire Project area surrounds Paweo Fishpond. Kanikapu Fishpond neighbors Paweo Fishpond on the Diamond Head side.

A 1910 U.S. Engineers map of Waikīkī indicates that the Project area now surrounds Fort DeRussy (Figure 15).

A 1919 War Department topographic map shows extensive development, in the form of roads and dwellings, both within and in the immediate vicinity of the Project area (Figure 16). Additionally, a large pier is shown extending from the northwestern portion of the Project area into the ocean. Of note is the absence of any remnant of aquaculture or agriculture in the immediate area. Also all that remains of Pi‘inaio Stream is a small wetland area.

A 1927-28 USGS topographic map indicates extensive development within and in the vicinity of the Project area (Figure 17). Almost the entire Project area has been filled in with dwellings. All ponds and marsh lands have been filled-in and drained, likely associated with the construction of the Ala Wai Canal which is now indicated to the north and east of the Project area. The pier that once stood southwest of the Project area on the beach is now gone. The Royal Hawaiian Hotel grounds are depicted on this map and the ‘Āpuakēhau Stream has been filled in, which will later be called Princess Ka‘iulani Avenue.

A 1933 War Department topographic map shows a little more development within the vicinity of the Project area (Figure 18).

A 1943 War Department topographic map shows little change within the Project area from the late 1920s (Figure 19). However, it appears that the coastline has been slightly expanded within the northwestern portion of the Project area. The Ala Wai Golf Course is depicted on this map.

A 1953 Army Map Service topographic map shows development along the coastline of the Project area (Figure 20). A pier is shown jutting out from the northwest. Just north of the pier, the coastline appears to have been modified for the creation of a small boat harbor, likely used to drop off passengers to the resort. Construction of the boat harbor probably entailed extensive dredging and the fortification of the coastline with some sort of retaining walls. Also of note is the development of a yacht harbor northwest of the Project area. Southeast of the Project area is the Natatorium.

A 1978 USGS topographic map indicates several roads that traverse over the Ala Wai Canal (Figure 21). The Waikīkī area is heavily urbanized. The pier and boat harbor to the northwest of the Project area is heavily populated with boats. Just south of the boat harbor is the Hilton Hawaiian Village and man-made lagoon.


Figure 13. Portion of 1887 Hawaiian Government Survey map of Honolulu by W.A. Wall, showing the location of the Project area (Library of Congress, Geography and Map Division, Washington, D.C.)

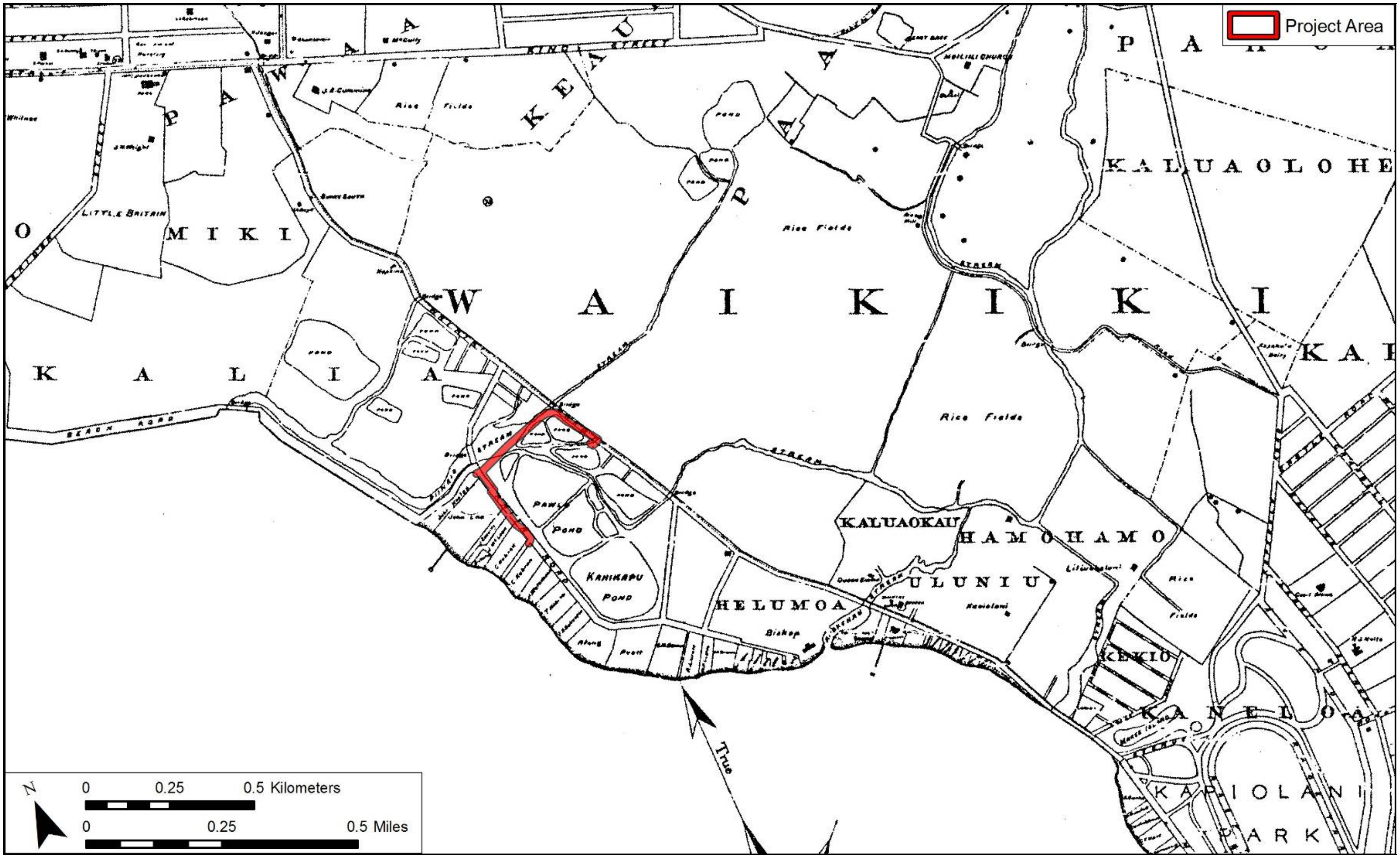


Figure 14. Portion of 1897 M.D. Monsarrat map of Honolulu with location of Project area indicate (Reg. Map No. 1910, Hawai‘i Land Survey Division)

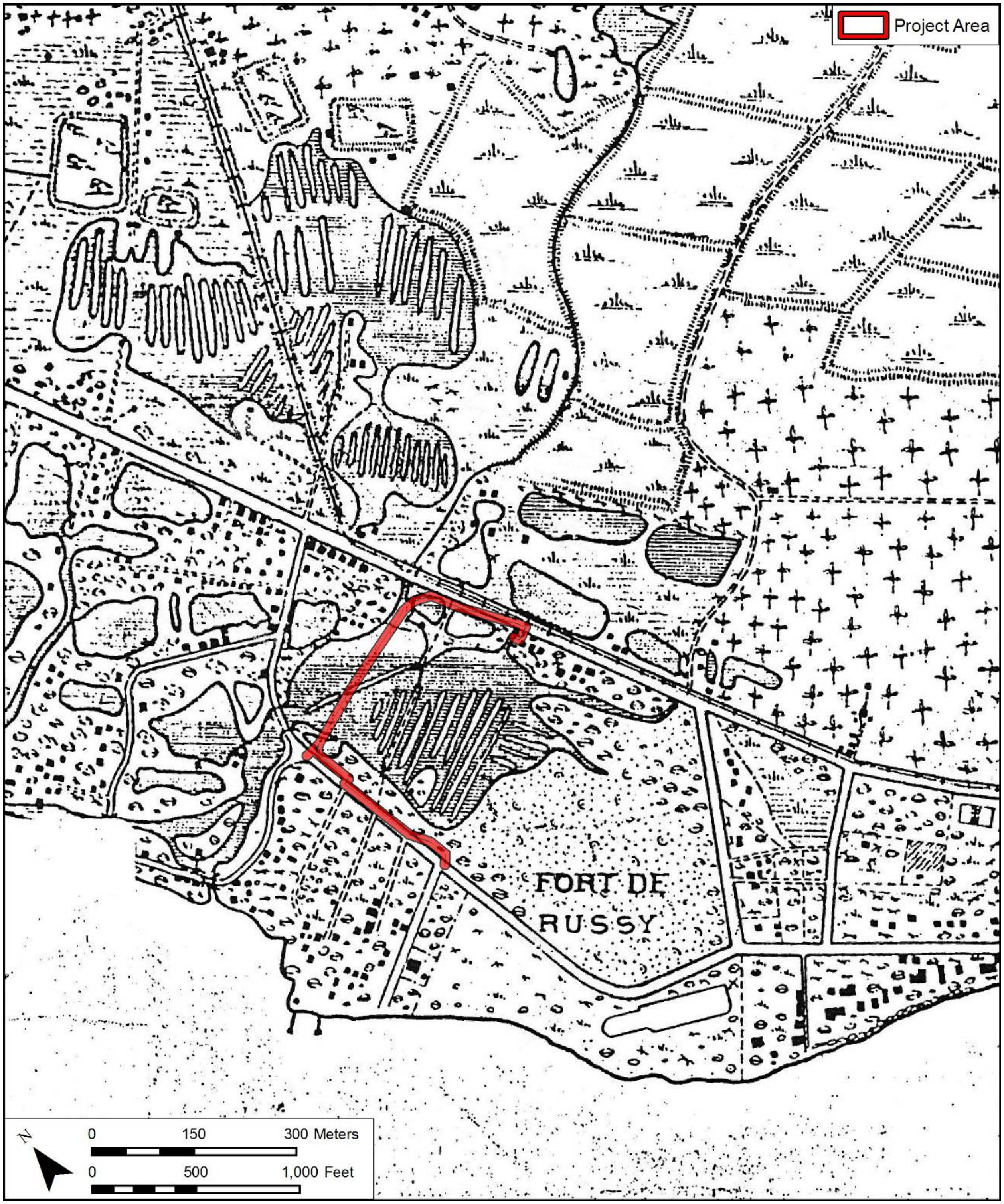


Figure 15. Portion of 1910 U.S. Army Engineer District, Honolulu map of Waikīkī, with location of Project area indicate (U.S. Army Engineer District Honolulu)

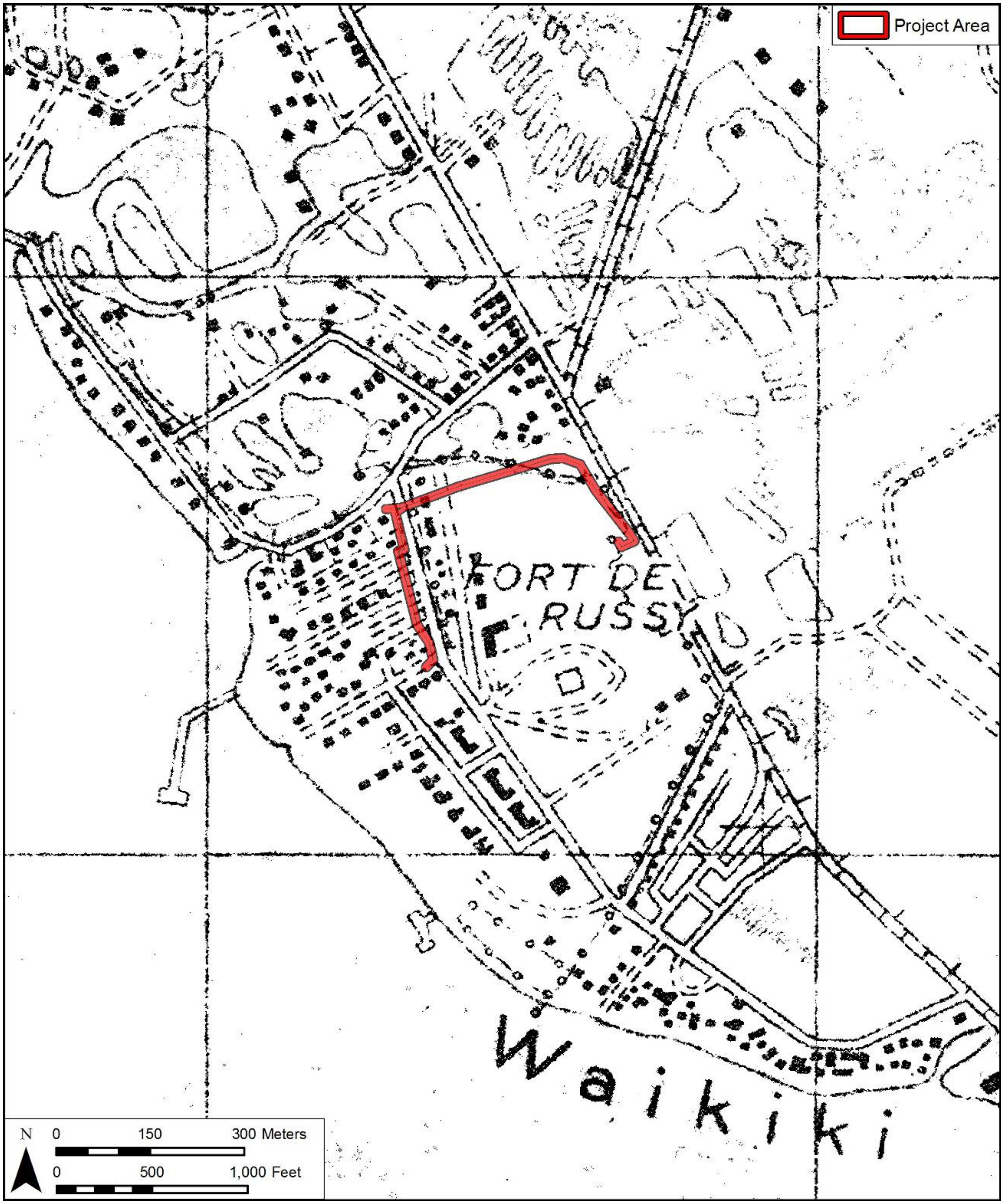


Figure 16. 1919 U.S. War Department topographic map, Honolulu Quadrangle, with location of Project area indicated (USGS Information Services)

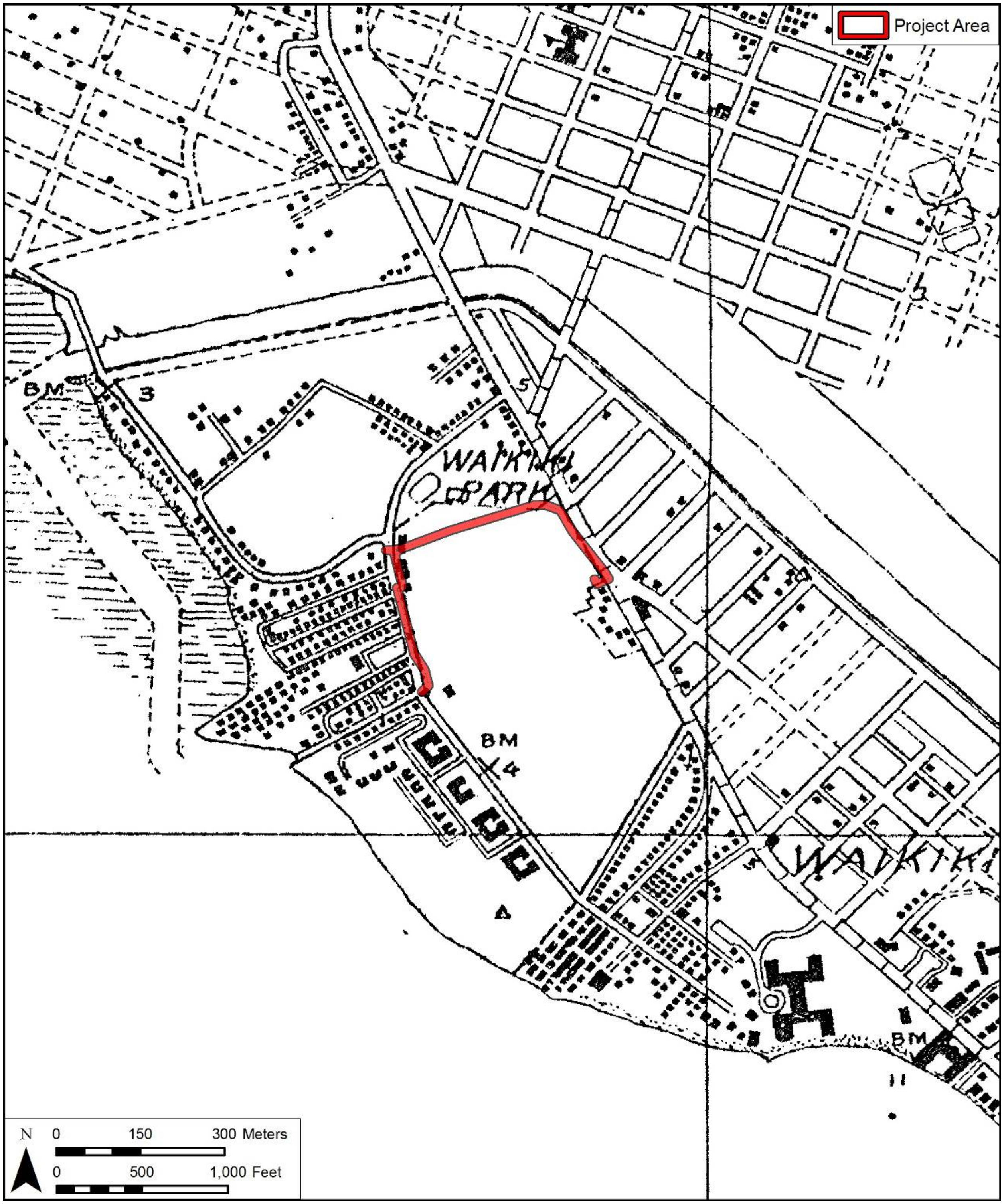


Figure 17. 1927-28 USGS topographic map, Honolulu Quadrangle, with location of Project area indicated (USGS Information Services)


Figure 18. 1933 USGS topographic map, Honolulu Quadrangle, with location of Project area indicated (USGS Information Services)

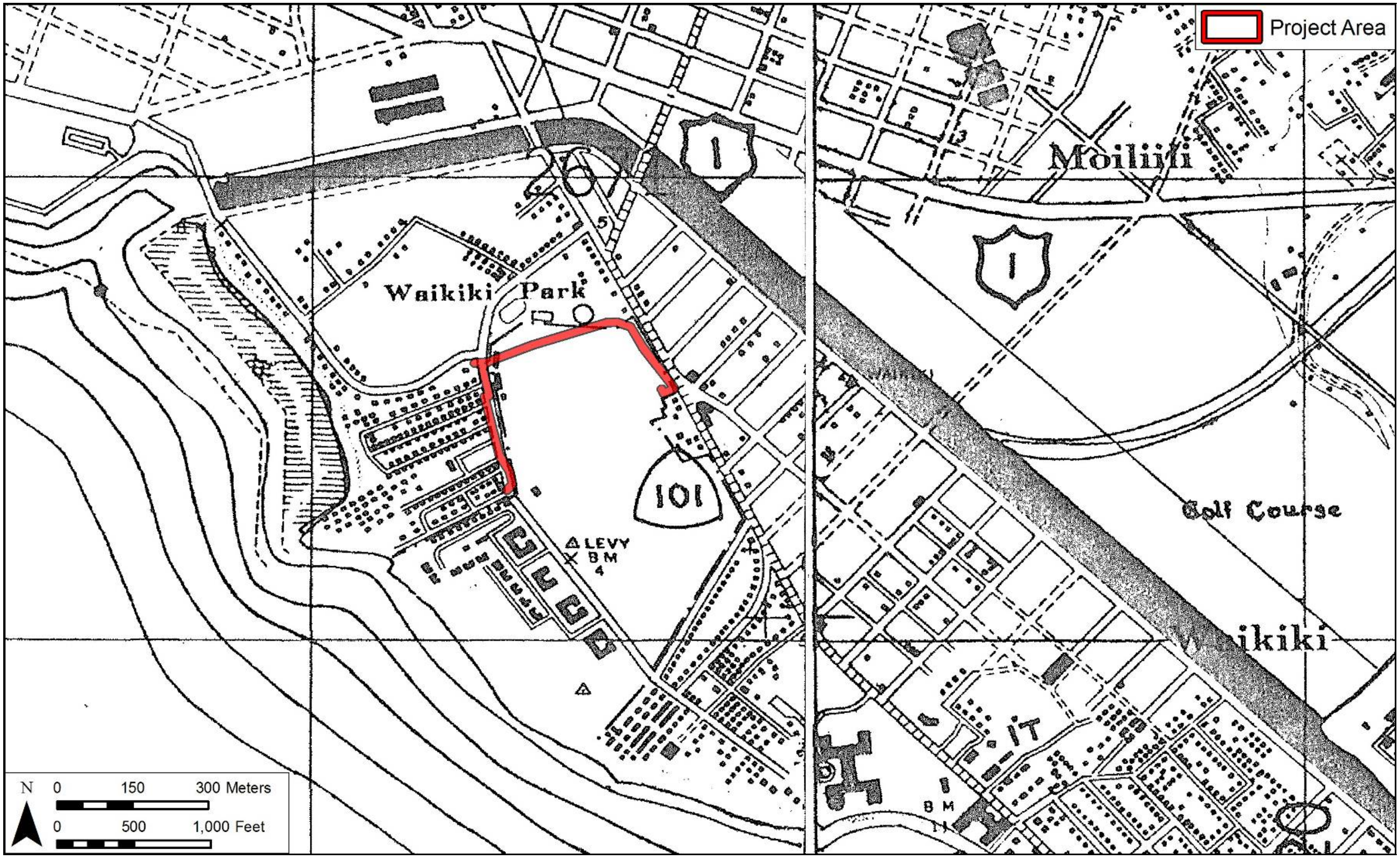


Figure 19. 1943 U.S. War Department topographic map, Honolulu Quadrangle, with location of Project area indicated (USGS Information Services)

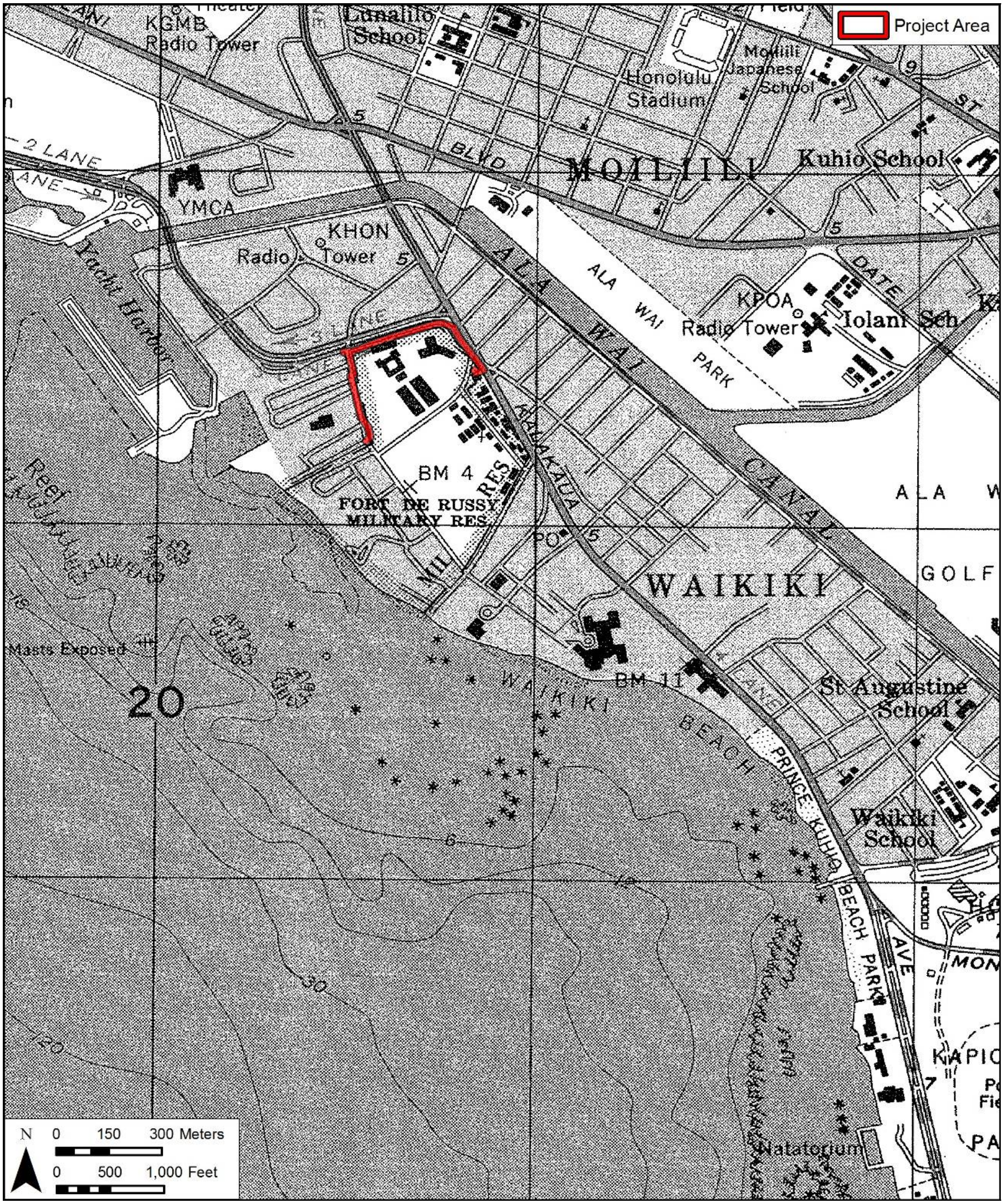


Figure 20. 1953 Army Map Service topographic map, Honolulu Quadrangle, with location of Project area indicated (USGS Information Services)

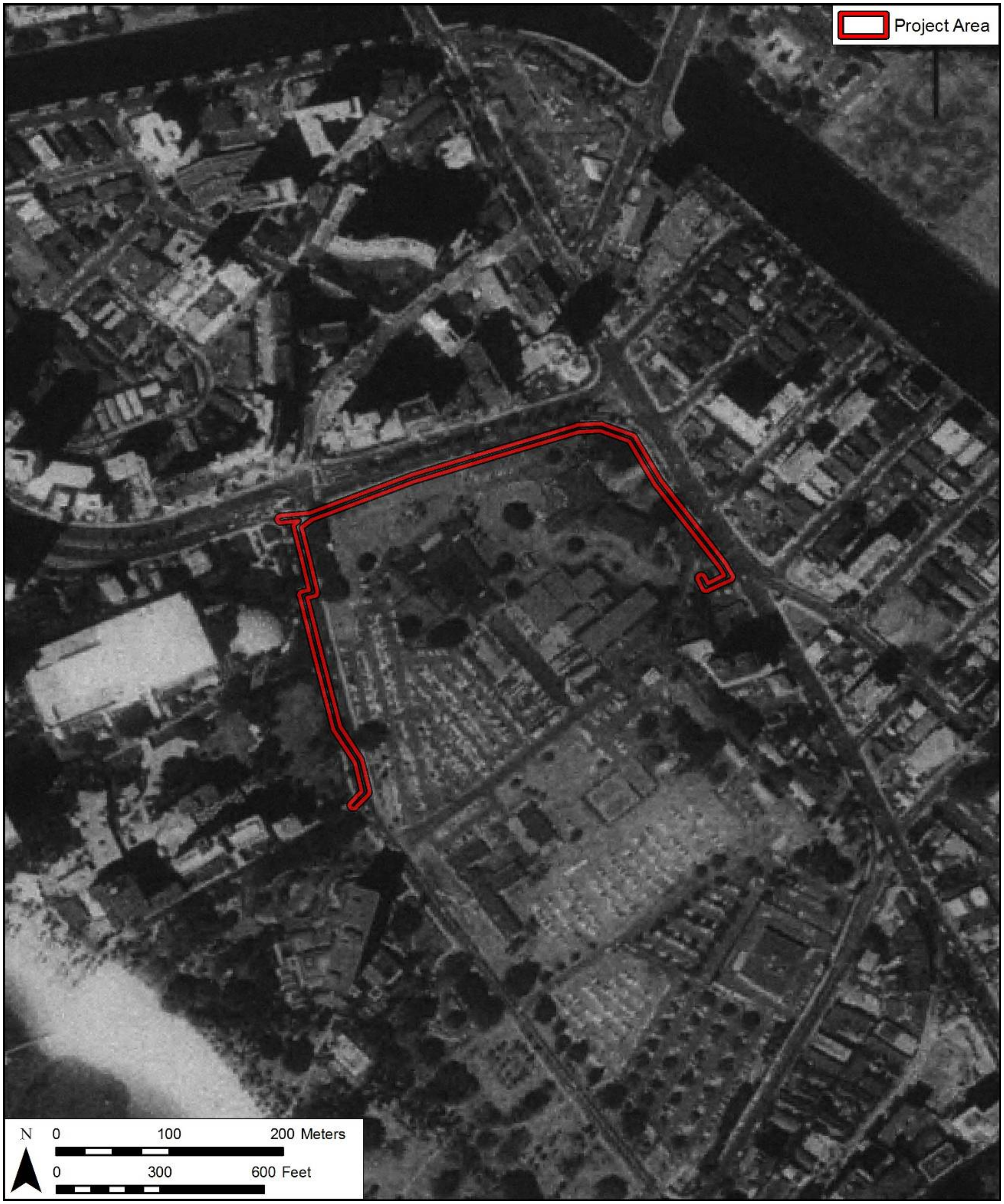


Figure 21. 1978 USGS Orthoimagery topographic map, Honolulu Quadrangle, with location of Project area indicated (USGS Information Services)

# Section 5 Previous Oral History Research

The following section draws from previous oral history research conducted by the University of Hawai‘i’s Center for Oral History (UHCOH) in 1985 to highlight the voices of several people who have or have had deep knowledge of the culture and history of the ahupua‘a of Waikīkī. The UHCOH’s *Waikīkī, 1900–1985: Oral Histories Project* was originally conceived as a one year project, but extended to three to more adequately cover the topics under the study. This oral histories project consisted of four researchers/interviewers and three transcribers over a period of three years. Summaries and excerpts from this vast collection of oral histories are presented below in this section. Please note that diacritical marks for Hawaiian words are presented as they appeared in the actual UHCOH’s *Waikīkī, 1900–1985: Oral Histories Project.*

## 5.1 John C. Ernstberg

The UHCOH’s *Waikīkī, 1900–1985: Oral Histories Project* interviewed Mr. John C. Ernstberg on March 15, 1985 at his home in Waikīkī. Mr. Ernstberg was born in 1910 in Kahului, Maui and is a former Waikīkī beach boy, musician and a retired Honolulu City and County lifeguard. In his interview with UHCOH, Mr. Ernstberg described the various ocean resources in Waikīkī during his youth:

> The limu [seaweed] was there. You want limu. You need limu now. All the Hawaiian[s] do. I do. My wife needs limu because she’s got goiter, in that for the throat and things like that. Before all the limu, all the līpoa and everything i can get here manauea, līpoa, wāwae‘iole and eh, everything you like. All kinds of limu. You like līpoa?
>
> You like manini (reef surgeonfish)? I love manini, one, two manini. I go out there, see, I go on the reef over there when the tide coming up. You go out there with your net, walk outside on the reef, flat reef, you wait over there. Soon as the tide starts coming up, you see the manini. All big schools come up. They go on top of the reef. When the wave break, you can see them—all that green. You stay up there. You wait, wait, wait, wait till they all come on the flat one time. Throw. You look, you see the all green and spiral. You go in there and pick ‘em up little by little now. Go pick up, put ‘em all in your bag. You look—full, ‘nough. Going home. (UHCOH 1985:125)

## 5.2 Lemon “Rusty” Holt

The UHCOH’s *Waikīkī, 1900–1985: Oral Histories Project* interviewed Mr. Lemon “Rusty” Holt on March 15, 1985 at his home in Wilhemina Rise in Honolulu. Mr. Holt was born and raised in Waikīkī in 1904. Mr. Holt graduated from Kamehameha Schools in 1928 and later from the University of Hawai‘i. Later he became a postmaster, personnel department head, and store and apartment manager. In his interview with UHCOH, Mr. Holt described his experiences with the dangers of gathering wana (sea urchin) in Waikīkī during his youth:

> The best wana grounds is at where Queen’s Surf is. There’s a little channel, and right next to the channel is a reef. Wana growing underneath running water or

(white) waves breaking is supposed to be fat. Good wana. Worthwhile getting and eating. You pick them in the month of October. They're fatter then.

Well, one day we went out, and (who was) steering, I forget. I was in the middle. We had gotten what wana we wanted—three or four gunny sack bags, filled up. They were in the front of me, at the bow was my sister Dawn Kinney, who just recently passed away. So in coming in, we caught a wave, a good sized wave. We shouldn't have. We shouldn't have, but we did. I can't remember now who was steering. Anyway, we caught the wave and as we came in, it ran into white water. The spray, came into the boat. My sister, who was sitting at the bow, when the spray came in, leaned back. When she leaned back, she leaned back onto the wana (bags), into the spears. Those spears are deadly because they break off. You can't get them out unless you use tweezers right away. I don't know how many hours it took for somebody to pick out all they could find.

Years later, quite a few years later, I can't remember how many years later, my sister complained of her big toe hurting. So somebody got a razor and started to scrape around where she said it was hurting because they could feel it was hard. Then somebody got a pair of tweezers, and they opened it up a little bit, and they pulled out the tip of one of those wana spears.

After all those years, one of them came out in her big toe. It was white in color, being in the stream, the bloodstream, all that time. But they could see, they could tell that it was still in the shape of the wana point. (UHCOH 1985:808–809)

## 5.3 Earle "Liko" Vida

UHCOH also interviewed Earl "Liko" Vida for the *Waikīkī, 1900–1985: Oral Histories Project.* Earle "Liko" Vida was interviewed on March 21, 1985 at his home in Wai‘alae. Mr. Vida was born on October 23, 1901 at 1713 Ala Moana Road (formerly Kaiser Hospital, currently the location of the Hawai‘i Prince Hotel). He was raised in the Kālia area of Waikīkī. His father, Henry Cornwall Vida, was a superintendent for Hawaiian Dredging Company, and supervised the construction of the Ala Wai Canal during the 1920s. His mother was Lena Hart Vida from Waimea, Kaua‘i.

Mr. Vida recalls the Jarrett family living makai of him; the Paoa family near Fort DeRussy; and between those two areas lived the Clarks, Nauweles, Campbells, Vidas, Harbottles, and Simersons. He states that they "were all practically one family."

Mr. Vida describes fishing with Kaimi, an old local fisherman who lived in the Kālia area, and the types of fish they would catch:

‘Ōpelu, and go out and get ulua, pāpio. He'll get the pāpios right in the waves. As the waves break, you can see them. He goes in his little canoe, and he has a drag line all the time with floaters. And when the float comes in on the wave, bang, then he pulls it in. So, he was a crackerjack. I used to do the same thing and watched him. I'd go into the channels with my little outboard motor. Of course, he never had an outboard motor. He always paddled his canoe. (UHCOH 1985:582)

On gathering sustenance in the Kālia area:

> All of us that lived on the beach, our food (came) right from the ocean. Of course, we raised pigs and stuff like that. I had a little piggery there that I raised (pigs), and Mother would kālua [to bake in an underground oven] a pig. And we had our chickens. It was just like a regular farm. (UHCOH 1985:586)

# Section 6 Community Consultation

Throughout the course of this assessment, an effort was made to contact and consult with Hawaiian organizations, agencies, and community members including cultural descendants of Waikīkī, in order to identify potentially knowledgeable individuals with cultural expertise and/or knowledge of the ahupua‘a of Waikīkī. CSH initiated the outreach effort in February 2012 through letters, email, telephone calls, and in-person contact. CSH completed the community consultation in April 2012. In the majority of cases, CSH presented community members with a letter, an aerial photograph, and map of the Project area. In most cases, two to three attempts were made to contact individuals, organizations, and agencies. Community outreach letters were sent to a total of 123 individuals or groups, 15 responded, and five of these kama‘āina and/or kūpuna met with CSH for more in-depth interviews. The results of the community consultation process are presented in Table 3. The interview summaries are presented in Section 7

Table 3. Results of Community Consultation

| Name | Affiliation | Comments |
|---|---|---|
| Agard, Louis “Buzzy” | Resident | CSH sent email February 13, 2012<br><br>CSH sent 2nd email March 13, 2012 |
| Ahlo, Charles | Cultural Descendent | CSH sent letter February 14, 2012<br><br>CSH sent 2nd letter March 7, 2012 |
| Ailā, William | Hui Mālama I Nā Kūpuna O Hawai‘i Nei | CSH sent email February 13, 2012 |
| Aiu, Pua | Administrator, SHPD | CSH sent email on June 6, 2012<br><br>CSH sent a 2nd letter with revised Project area on June 22, 2012 |
| Among, Les A. | Waikīkī Neighborhood Board | CSH sent email February 13, 2012<br><br>CSH sent 2nd email March 13, 2012 |
| Apaka, Jeff | Waikīkī Neighborhood Board | CSH sent email February 13, 2012<br><br>CSH sent 2nd email March 13, 2012 |
| Arcalas, Cara | Cultural Descendent | CSH sent letter February 14, 2012<br><br>Letter was returned February 27, 2012 |

| Name | Affiliation | Comments |
|---|---|---|
| Ayau, Halealoha | Hui Mālama I Nā Kūpuna O Hawai‘i Nei | CSH sent email February 13, 2012<br><br>Mr. Ayau responded to CSH via email on February 14, 2012:<br><br>Hui Mālama I Na Kupuna O Hawai'i Nei has conducted two reburials in this area, one at the Hilton Hawaiian Village (near Kalia Road) and the other at Fort DeRussy. Both should be marked on maps by the respective landowners. Both need to be identified as to location so that they are not disturbed. Please advise, mahalo. |
| Bates, Cline | Cultural Descendent | CSH sent letter February 14, 2012<br><br>CSH sent 2nd letter March 7, 2012 |
| Bates, Ke‘ala | Cultural Descendent | CSH sent letter February 14, 2012<br><br>CSH sent 2nd letter March 7, 2012 |
| Battle, Cherie Kahealani | Cultural Descendent | CSH sent letter February 14, 2012<br><br>Letter was returned February 27, 2012 |

| Name | Affiliation | Comments |
|---|---|---|
| Becket, Jan | Photographer, author | CSH sent email February 13, 2012<br><br>Mr. Becket replied on February 16, 2012:<br><br>Got the letter and would be happy to contribute whatever, probably images. I know of two cultural sites directly above Waikiki, one of which is the heiau up at Wa'ahila. Let's plan a huaka'i [trip]. I have my two-week spring break coming up at the end of March, but it could also be on a weekend before then. Not too sure of my schedule at this point, though.<br><br>CSH accompanied Mr. Becket on a site visit to Waʻahila Ridge and Kamanele Park on April 28, 2012<br><br>Mr. Becket approved interview summary on April 16, 2012 |
| Bissen, Tony | Cultural Historian at the Moana Surfrider Hotel | CSH sent letter February 14, 2012<br><br>CSH sent 2nd letter March 7, 2012 |
| Blaisdell, Dr. Kekuni | Professor Emeritus, kupuna | CSH sent email February 13, 2012<br><br>Email was returned Februrary 13, 2012, mailbox too full |
| Boyd, Manu | Kumu hula, composer, chanter, cultural specialist, Cultural Director at Royal Hawaiian Shopping Center | CSH sent letter February 14, 2012<br><br>CSH sent 2nd letter March 7, 2012 |
| Brown, Desoto | Bishop Museum Archivist, specializes in 20th Century Waikīkī and tourism in Waikīkī | CSH sent email March 6, 2012 |

| Name | Affiliation | Comments |
|---|---|---|
| Cameron, Reginald "Sam" | Cultural Descendent | CSH sent letter February 14, 2012<br><br>CSH sent 2nd letter March 7, 2012 |
| Cayan, Phyllis "Coochie" | History & Cultural Branch Chief, SHPD | CSH sent email February 13, 2012<br><br>CSH sent 2nd email April 9, 2012<br><br>CSH sent 3rd email May 9, 2012<br><br>CSH sent a 4th email on June 6, 2012 |
| Crabbe, Kamanaʻopono | Chief Executive Officer, OHA | CSH sent an email to Momilani Lazo, assistant to Mr. Crabbe, on June 6, 2012<br><br>Ms. Lazo requested that CSH send all Project details by mail on June 6, 2012<br><br>CSH sent a hard copy on June 7, 2012<br><br>CSH sent a letter with revised Project area on June 22, 2012<br><br>OHA responded to CSH on June 26, 2012 (see Section 6.2) |
| Cruz, Dr. Lynette | Anthropology Professor | CSH called and left a message on April 5, 2012<br><br>CSH received an email response April 6, 2012; see written response |
| Del Toro, Bejamin | Cultural Descendent | CSH sent letter February 14, 2012 |
| Del Toro, Daniel | Cultural Descendent | CSH sent letter February 14, 2012 |
| Del Toro, Rachel | Cultural Descendent | CSH sent letter February 14, 2012 |
| Del Toro, Samuel | Cultural Descendent | CSH sent letter February 14, 2012 |

| Name | Affiliation | Comments |
|---|---|---|
| Diamond, Van Horn | Cultural Descendent, former OIBC Chair | CSH sent email February 13, 2012<br><br>CSH conducted interview by phone March 23, 2012; Mr. Diamond gave permission to re-use portions of previously conducted interview<br><br>CSH sent a letter with revised Project area on June 22, 2012 |
| Downing, George | Legendary waterman | CSH sent email February 13, 2012<br><br>CSH sent 2nd email March 13, 2012 |
| Falemei, Hina Wong | OIBC Chair | CSH sent letter February 14, 2012<br><br>CSH sent 2nd letter March 7, 2012 |
| Finley, Bob | Waikīkī Neighborhood Board | CSH sent email February 13, 2012<br><br>Mr. Finley responded to CSH via email on February 13, 2012:<br><br>I lack any historical or cultural information to oppose this project. It seems to be a logical one that simply replaces something that has been in existence for decades in Waikiki and common sense (the Kaiolu Street Disaster) dictates that aging pipes must be replaced or upgraded to meet sewage requirements.<br><br>Hopefully this project will be done during the upcoming Hilton Master Plan Project and the Ft. DeRussy improvements.<br><br>I will pass this on to my board members for further comment. |
| Gomes, Phoebe | Cultural Descendent | CSH sent letter February 14, 2012<br><br>CSH sent 2nd letter March 7, 2012 |

| Name | Affiliation | Comments |
|---|---|---|
| Gomes Jr., Robert | Cultural Descendent | CSH sent letter February 14, 2012<br>CSH sent 2nd letter March 7, 2012 |
| Gomes, Robin | Cultural Descendent | CSH sent letter February 14, 2012<br>CSH sent 2nd letter March 7, 2012 |
| Gon, Sam | Senior Scientist and Cultural Advisor, The Nature Conservancy of Hawai‘i | CSH sent email April 12, 2012 |
| Gora, Amelia K. | Cultural Descendent | CSH sent email February 13, 2012<br>Email was returned Februrary 16, 2012<br>CSH sent a 2nd letter with revised Project area on July 10, 2012 |
| Grace, Nadine | Cultural Descendent | CSH sent letter February 14, 2012<br>CSH sent 2nd letter March 7, 2012 |
| Ha‘ole, William Papa‘iku | Mo‘olelo, ukulele teacher, and docent at ‘Iolani Palace | CSH sent email February 13, 2012<br>CSH sent 2nd email March 13, 2012 |
| Harris, Cy K. | Cultural Descendent | CSH sent email February 13, 2012<br>CSH sent 2nd email March 13, 2012 |
| Hatchie, Andrew | Cultural Descendent | CSH sent letter February 14, 2012<br>CSH sent 2nd letter March 7, 2012 |
| Hukiku, Clarence Moses | Cultural Descendent | CSH sent letter February 15, 2012<br>CSH sent 2nd letter March 7, 2012 |
| Ka‘awakauo, Emma | Cultural Descendent | CSH sent letter February 14, 2012<br>CSH sent 2nd letter March 7, 2012 |

| Name | Affiliation | Comments |
|---|---|---|
| Kahanamoku, Samuel A.<br><br>(contact person is Greg Kashiwa) | Kama‘āina of Kālia, employed by Kupuna LLC | CSH sent email Feburary 13, 2012<br><br>Mr. Kashiwa replied on behalf of Mr. Kahanamoku on February 14, 2012; see written response. |
| Kaleikini, Ali‘ikaua | Cultural Descendent | CSH mailed letter February 14, 2012<br><br>Ms. Paulette Kaleikini replied on behalf of the Kaleikini ‘Ohana on February 22, 2012 via email; see written response. |
| Kaleikini, Haloa | Cultural Descendent | Ms. Paulette Kaleikini replied on behalf of the Kaleikini ‘Ohana on February 22, 2012 via email; see written response. |
| Kaleikini, Kala | Cultural Descendent | CSH mailed letter February 14, 2012<br><br>Ms. Paulette Kaleikini replied on behalf of the Kaleikini ‘Ohana on February 22 |
| Kaleikini, Mahiaimoku | Cultural Descendent | Ms. Paulette Kaleikini replied on behalf of the Kaleikini ‘Ohana on February 22 |
| Kaleikini, Moehonua | Cultural Descendent | Ms. Paulette Kaleikini replied on behalf of the Kaleikini ‘Ohana on February 22 |
| Kaleikini, No‘eau | Cultural Descendent | CSH mailed letter February 14, 2012<br><br>Ms. Paulette Kaleikini replied on behalf of the Kaleikini ‘Ohana on February 22 |

| Name | Affiliation | Comments |
|---|---|---|
| Kaleikini, Paulette | Cultural Descendent | CSH sent email February 13, 2012<br><br>Email was returned on February 13, 2012<br><br>CSH sent a letter on Feburary 14, 2012<br><br>Ms. Paulette Kaleikini replied on behalf of the Kaleikini ‘Ohana on February 22, 2012 via email<br><br>CSH sent a letter with revised Project area on June 22, 2012 |
| Kaleikini, Tuahine | Cultural Descendent | Ms. Paulette Kaleikini replied on behalf of the Kaleikini ‘Ohana on February 22 |
| Kam, Thelma | Director of Cultural Services at Starwood Hotels, Waikīkī | CSH sent letter February 14, 2012<br><br>CSH sent 2nd letter March 7, 2012 |
| Kāne, Shad | OIBC; Cultural Consultant for the Association of Hawaiian Civic Club’s Historic Preservation Committee | CSH sent email April 12, 2012 |
| Keana‘āina, Betty | Cultural Descendent | CSH sent letter February 14, 2012<br><br>CSH sent 2nd letter March 7, 2012 |
| Keana‘āina, Kīhei | Cultural Descendent | CSH sent letter February 14, 2012<br><br>CSH sent 2nd letter March 7, 2012 |
| Keana‘āina, Luther | Cultural Descendent | CSH sent letter February 14, 2012<br><br>CSH sent 2nd letter March 7, 2012 |
| Keana‘āina, Michelle | Cultural Descendent | CSH sent letter February 14, 2012<br><br>CSH sent 2nd letter March 7, 2012 |

| Name | Affiliation | Comments |
|---|---|---|
| Keana‘āina, Noelani | Cultural Descendent | CSH sent letter February 14, 2012<br>CSH sent 2nd letter March 7, 2012 |
| Keana‘āina, Regina | Cultural Descendent | CSH sent letter February 14, 2012<br>CSH sent 2nd letter March 7, 2012 |
| Keana‘āina, Vicky | Cultural Descendent | CSH sent letter February 14, 2012<br>CSH sent 2nd letter March 7, 2012 |
| Keana‘āina, Wilsam | Cultural Descendent | CSH sent letter February 14, 2012<br>CSH sent 2nd letter March 7, 2012 |
| Kekaula, Ashford | Cultural Descendent | CSH sent email February 13, 2012 |
| Kekaula, Mary K. | Cultural Descendent | CSH sent letter February 14, 2012 |
| Keli‘inoi, Kalahikiola | Cultural Descendent | CSH sent letter February 14, 2012<br>Ms. Paulette Kaleikini replied on behalf of the Kaleikini ‘Ohana on February 22; see written response. |
| Keli‘inoi, Moani | Cultural Descendent | CSH sent letter Feburary 14, 2012 |
| Keli‘ipa‘akaua, Chase | Cultural Descendent | CSH sent letter February 14, 2012<br>CSH sent 2nd letter March 7, 2012 |
| Keli‘ipa‘akaua, Justin | Cultural Descendent | CSH sent letter February 14, 2012<br>CSH sent 2nd letter March 7, 2012 |
| Keohokālole, Adrian K. | Cultural Descendent | CSH sent letter February 15, 2012<br>CSH sent 2nd letter March 7, 2012 |
| Keohokālole, Dennis | Cultural Descendent | CSH sent letter February 14, 2012<br>CSH sent 2nd letter March 7, 2012 |

| Name | Affiliation | Comments |
|---|---|---|
| Keohokālole, Emalia E. | Cultural Descendent | CSH sent letter February 14, 2012<br><br>CSH sent 2nd letter March 7, 2012 |
| Keohokālole, James Hoapili | Cultural Descendent | CSH sent letter February 14, 2012<br><br>CSH sent 2nd letter March 7, 2012<br><br>Letter was returned to on March 13, 2012 |
| Keohokālole, Joseph Moses Keaweheulu | Cultural Descendent | CSH sent letter February 14, 2012<br><br>CSH sent 2nd letter March 7, 2012<br><br>Letter was returned on March 13, 2012 |
| Keohokālole, Lori Lani | Cultural Descendent | CSH sent letter February 14, 2012<br><br>Letter was returned on February 27, 2012 |
| Kini, Debbie | Cultural Descendent | CSH sent letter February 15, 2012<br><br>CSH sent 2nd letter March 7, 2012 |
| Kini, Nalani | Cultural Descendent | CSH sent letter February 15, 2012<br><br>CSH sent 2nd letter March 7, 2012 |
| Koko, Kanaloa | Cultural Descendent | CSH sent letter February 15, 2012<br><br>CSH sent 2nd letter March 7, 2012 |
| Krewson-Reck, Sylvia | Grew up in Waikīkī | CSH conducted phone interview March 23, 2012; Ms. Krewson-Reck gave permission to re-use portions of previously conducted interview<br><br>CSH sent a letter with revised Project area on June 22, 2012 |

| Name | Affiliation | Comments |
|---|---|---|
| Kruse, T. Kehaulani | OIBC Kona Representative | CSH sent letter February 15, 2012<br><br>CSH sent 2nd letter March 7, 2012 |
| Kuloloio, Manuel | Cultural Descendent | CSH sent letter February 15, 2012<br><br>CSH sent 2nd letter March 7, 2012<br><br>Letter was returned to March 13, 2012 |
| Lew, Haumea | Cultural Descendent | CSH sent letter February 15, 2012<br><br>CSH sent 2nd letter March 7, 2012 |
| Lindsey, Keola | OHA | CSH sent email February 13, 2012<br><br>Mr. Lindsey replied to CSH via email on Feburary 13, 2012:<br><br>I will take a look at the CIA consultation request attached to your email. Will a hardcopy follow via US Mail (just so I can be on the look out for it). I ran into Hal Hammatt last week Wednesday outside of the DLNR building when the OIBC meeting was cancelled. I am sure CSH had several items on the agenda. I also saw someone from the USAG-HI who mentioned they were there for this specific project because a portion of it is on federal lands (I think?).<br><br>CSH sent 2nd email April 9, 2012 |
| Lopes, Kamaha‘o | Cultural Descendent | CSH mailed letter February 15, 2012<br><br>Letter was returned to CSH on February 27, 2012 |
| Lopes, Leina‘ala | Cultural Descendent | CSH sent letter February 15, 2012<br><br>CSH sent 2nd letter March 7, 2012 |

| Name | Affiliation | Comments |
|---|---|---|
| Lopes, Puahone Kini | Cultural Descendent | CSH sent letter February 15, 2012<br><br>Letter was returned to CSH on February 27, 2012 |
| Luka, Alika | Cultural Descendent | CSH mailed letter February 15, 2012<br><br>CSH sent 2nd letter March 7, 2012 |
| Mamac, Violet L. Medeiros | Cultural Descendent | CSH sent letter March 7, 2012 |
| McDonalad, Ruby Keanaʻāina | Cultural Descendent | CSH sent letter February 15, 2012<br><br>CSH sent 2nd letter March 7, 2012 |

| Name | Affiliation | Comments |
|---|---|---|
| Medeiros Jr., Clarence | Cultural Descendent | CSH sent letter February 15, 2012<br><br>CSH sent 2nd letter March 7, 2012<br><br>CSH contacted Mr. Medeiros via email on March 13, 2012 and March 15, 2012<br><br>Mr. Medeiros responded to CSH on March 17, 2012:<br><br>You may use my previous statement and I do have new mana'o. My great-great grandfather immigrated from China and lived in the Waikiki area when rice was being cultivated there. His family were merchants and owned stores in Waikiki. Call me if you want/need more info.<br><br>CSH emailed Mr. Medeiros on March 18, 2012 to discuss new mana‘o<br><br>CSH emailed Mr. Medeiros with revisions to interview summary on March 21, 2012<br><br>Mr. Medeiros approved interview summary on March 27, 2012<br><br>CSH sent a letter with revised Project area on June 22, 2012 |
| Medeiros, David | Cultural Descendent | CSH sent letter February 15, 2012<br><br>Letter was returned to CSH on February 28, 2012 |
| Medeiros, Jacob L. | Cultural Descendent | CSH sent letter February 15, 2012<br><br>CSH sent 2nd letter March 7, 2012 |
| Medeiros, Jamison K. | Cultural Descendent | CSH sent letter February 15, 2012<br><br>CSH sent 2nd letter March 7, 2012 |

| Name | Affiliation | Comments |
|---|---|---|
| Medeiros, Jayla A. | Cultural Descendent | CSH sent letter February 15, 2012<br>CSH sent 2nd letter March 7, 2012 |
| Medeiros, Jim | Cultural Descendent | CSH sent 2nd letter March 7, 2012 |
| Medeiros, Roland | Cultural Descendent | CSH sent letter February 15, 2012<br>CSH sent 2nd letter March 7, 2012 |
| Miller, ʻIhilani Silva | Former entertainer at the Moana Surfrider | CSH sent letter February 15, 2012<br>CSH sent 2nd letter March 7, 2012 |
| Naguwa, Joan | Waikiki Community Center Executive Director | CSH sent e-mail February 13, 2012<br>CSH sent 2nd letter March 7, 2012 |
| Nobrega, Malia Pelekikena | Waikīkī Hawaiian Civic Club | CSH sent e-mail February 13, 2012<br>CSH sent 2nd letter March 7, 2012 |
| Norman, Carolyn | Cultural Descendent | CSH sent e-mail February 13, 2012<br>CSH sent 2nd letter March 7, 2012 |
| Norman, Eileen | Cultural Descendent | CSH sent letter February 15, 2012<br>CSH sent 2nd letter March 7, 2012 |
| Norman, Kaleo | Cultural Descendent | CSH sent letter February 15, 2012<br>CSH sent 2nd letter March 7, 2012 |
| Norman, Keliʻinui | Cultural Descendent | CSH sent letter February 15, 2012<br>CSH sent 2nd letter March 7, 2012 |
| Norman, Theodore | Cultural Descendent | CSH sent letter February 15, 2012<br>CSH sent 2nd letter March 7, 2012 |
| Olds, Nalani | Cultural Descendent | CSH sent letter February 15, 2012<br>CSH sent 2nd letter March 7, 2012 |

| Name | Affiliation | Comments |
|---|---|---|
| Paglinawan, Richard | Queen Lili‘uokalani Children's Center | CSH sent letter February 15, 2012<br><br>CSH sent 2nd letter March 7, 2012<br><br>CSH called and left a message March 15, 2012<br><br>CSH conducted a phone interview on March 16, 2012; Mr. Paglinawan gave permission to re-use portions of previously conducted interviews<br><br>CSH sent a letter with revised Project area on June 22, 2012 |
| Paoa, Clarke | Kama‘āina of Kālia | CSH sent letter February 15, 2012<br><br>CSH sent 2nd letter March 7, 2012 |
| Papa, Jr., Richard Likeke | Cultural Descendent | CSH sent letter February 15, 2012<br><br>CSH sent 2nd letter March 7, 2012 |
| Pascua, Bruce H. | Cultural Descendent | CSH sent letter February 15, 2012<br><br>CSH sent 2nd letter March 7, 2012 |
| Peters, David | Queen Lili‘uokalani Estate trustee | CSH sent letter February 15, 2012<br><br>CSH sent 2nd letter March 7, 2012 |
| Rash, Regina | Cultural Descendent | CSH sent letter February 15, 2012<br><br>CSH sent 2nd letter March 7, 2012 |
| Rochlen, Lillian Keanuenue Kaeo | Artist | CSH sent letter February 15, 2012<br><br>CSH sent 2nd letter March 7, 2012 |
| Roy, Corbett | Cultural Descendent | CSH sent letter February 15, 2012<br><br>CSH sent 2nd letter March 7, 2012 |

| Name | Affiliation | Comments |
|---|---|---|
| Shirai, Jacqueline | Cultural Descendent | CSH sent letter February 15, 2012<br><br>CSH sent 2nd letter March 7, 2012 |
| Shirai, Jr., Thomas T. | Cultural Descendent | CSH sent letter February 15, 2012<br><br>CSH sent 2nd letter March 7, 2012 |
| Silva, Lisa Gomes | Cultural Descendent | CSH sent letter February 15, 2012 |
| Soares, Moani | Cultural Descendent | Ms. Paulette Kaleikini replied on behalf of the Kaleikini 'Ohana on February 22; see written response. |
| Souza, William D. | Royal Order of Kamehameha, Kūhiō Chapter | CSH sent letter February 15, 2012<br><br>CSH sent 2nd letter March 7, 2012 |
| Spinney, Charles | Cultural Descendent | CSH sent letter February 15, 2012<br><br>CSH sent 2nd letter March 7, 2012 |
| Suzuki, Ashley | Cultural Descendent | CSH sent letter February 15, 2012<br><br>Letter was returned to CSH on February 27, 2012 |
| Suzuki, Kimberly | Cultural Descendent | CSH sent letter February 15, 2012<br><br>Letter was returned to CSH on February 27, 2012 |
| Takaki, Miles | Cultural Descendent | CSH sent letter February 15, 2012<br><br>CSH sent 2nd letter March 7, 2012 |
| Takaki, Moses | Cultural Descendent | CSH sent letter February 15, 2012<br><br>CSH sent 2nd letter March 7, 2012 |
| Takaki, Tracy | Cultural Descendent | CSH sent letter February 15, 2012<br><br>CSH sent 2nd letter March 7, 2012 |

| Name | Affiliation | Comments |
|---|---|---|
| Theone, Nicole Gulia | Cultural Descendent | CSH sent letter February 15, 2012<br><br>Letter was returned to CSH on February 27, 2012 |
| Wagner, Pat (Low) | Cultural Descendent | CSH sent letter February 15, 2012<br><br>CSH sent 2nd letter March 7, 2012 |
| Waikīkī Community Center Kūpuna | Community center | CSH sent e-mail February 13, 2012 |
| Williams, Evern | Pālolo/Kaimukī Community Media Center at Jarrett Middle School | CSH sent e-mail February 13, 2012<br><br>CSH sent 2nd letter March 7, 2012 |
| Yokooji, Dayleen | Cultural Descendent | CSH sent letter February 15, 2012<br><br>CSH sent 2nd letter March 7, 2012 |

## 6.1 State Historic Preservation Division

CSH contacted Phyllis "Coochie" Cayan, former History and Culture Branch Chief of SHPD, on the following dates: February 1; April 9; May 9; and June 6, 2012. CSH also contacted Pua Aiu, Administrator of SHPD, on June 6 and 22, 2012. CSH did not receive a response from SHPD.

## 6.2 Office of Hawaiian Affairs

CSH contacted Keola Lindsey of the Office of Hawaiian Affairs, on February 13 and April 9, 2012. CSH also contacted Momilani Lazo, assistant to Kamanaʻopono Crabbe (CEO of OHA), on June 6, 2012. Ms. Lazo requested all information regarding the Project be sent via mail. CSH sent a letter and aerials of the Project area to Ms. Lazo on June 7, 2012 and subsequently on June 22, 2012. CSH received a response from Mr. Crabbe on June 26, 2012 (Figure 22).

Documentation from separate projects conducted in the area detected "the presence of burials and cultural deposits in the vicinity of the instant project area." OHA recommends that archaeological monitoring is warranted involving all project activities. During excavation, if any "iwi kūpuna [ancestral remains], cultural items, or sub-surface cultural deposits are encountered during any ground disturbing activities associated with this project, OHA will expect all work in the immediate vicinity of the discovery to immediately cease and the appropriate agencies, organizations or individuals notified and afforded the opportunity to participate in consultation to determine appropriate treatment pursuant to the requirements of applicable Federal of State law." OHA recognizes the intent of the project is necessary regarding improvements and upgrades to the current waste water system to ensure adequate protection for natural and cultural resources. OHA has no referrals for consultation.

## 6.3 Greg Kashiwa

CSH contacted Samuel A. "Bunny" Kahanamoku of Kupuna LLC, on February 13, 2012. Greg Kashiwa of Kupuna LLC, replied with the following statement:

> My memories of the Ft DeRussy area come from my childhood memories surfing and fishing in the area. The first thing I remember, there used to be a large raft/platform anchored off shore where swimmers could go to. After the tsunami of 1946, it was gone. Further there was a large concrete shore battery emplacement on shore. The Hale Koa hotel site contained the officers club and related facilities. I further recall during my army service that my unit the 411th Engineers did an annual sand replenishment project for the beach frontage there. We would haul sand from Nanakuli and spread it along the shoreline. This usually took several weekends. On one such event we lost a D9 Cat that fell into the ocean when a coral shelf collapsed. During retrieval one of our local divers mentioned that he thought the collapsed area was actually a lava tube coming from the Moiliili area, and he could feel fresh water flowing from the rubble. This was never pursued because the army didn't want to draw attention to the problem. In those days there were no regulations like now. While unconfirmed, I assume that tube system is still connected to the tubes beneath

> Moiliili that exist today. Have you seen it?? It is worth seeing and archaeological traces may remain down there. The tubes are connected to the Willows and flows under the Ala Moana center. It is worthy of study, and tell Hal I know a guy who can get you in there.

Mr. Kashiwa referred CSH to Samuel "Bunny" Kahanamoku. Mr. Kahanamoku's family is from the Kālia area and was connected to the beach boy society in Waikīkī. Due to time constraints, CSH was unable to contact Mr. Kahanamoku.

## 6.4 Paulette Kaleikini and the Kaleikini ʻOhana

CSH contacted Paulette Kaleikini, a cultural descendent of Waikīkī, via email on February 13, 2012. The email was returned to CSH the same day. CSH sent a letter to Ms. Kaleikini on February 14, 2012. Ms. Kaleikini responded via email to CSH on February 22, 2012 with the following statement:

> Aloha no e Nicole,
>
> This is in response to your inquiry at the request of Group 70 International for the county's proposed Hilton Hawaiian Village/Fort DeRussy Wastewater System Improvements Project.
>
> The project will take place on land situated in an area and ahupuaa that has been impacted and its cultural, historic and archaeological sites destroyed by overdevelopment. There are countless books and printed information containing the information you seek of this area and these should suffice. Any additional traditional gathering or cultural practices which have not yet been documented, should remain with its kahu or keeper.
>
> Our immediate concern is that there be an archaeological inventory survey conducted at this project site and completed before any work begins. We request to be informed should there be an AIS and to be kept abreast of further development of this project.
>
> Let me know if you have any questions.
>
> This email is in response for the following concerned individuals:
>
> Paulette Ka'anohi Kaleikini
>
> Moani Soares
>
> Tuahine Kaleikini
>
> Kala Kaleikini
>
> Kalahikiola Keliinoi
>
> Kilinahe Keliinoi
>
> Aliikaua Kaleikini
>
> No'eau Kaleikini

Haloa Kaleikini

Mahiaimoku Kaleikini

Moehonua Kaleikini

## 6.5 Dr. Lynette Cruz

CSH contact Dr. Lynette Cruz, an anthropology professor at Hawai‘i Pacific University, via phone on April 5, 2012. Dr. Cruz emailed CSH with the following response regarding “The Changing of the Season”, an event that takes place in Waikīkī Ahupua‘a to watch the sun set over Pu‘u o Kapolei (Honouliuli Ahupua‘a). Although Pu‘u o Kapolei is outside of Waikīkī Ahupua‘a, the event commemorates and perpetuates an event practiced pre-Contact. Dr. Cruz’s response follows:

> If you talked with Brian about the event that happens in Waikiki, right next to the Waikiki Aquarium, then it’s the one now being called ‘the changing of the seasons,’ during which time the sun changes direction (from our point of view on the ground) going west and heads back toward the east. Essentially, when viewed from Waikiki, the sun sets further and further west until it falls into the crater called Puu o Kapolei (or pu‘u pa la‘ila‘i, depending on who’s telling the story). That crater no longer exists, as it was bulldozed long ago for development. However, from Waikiki, you can see, more or less, where the crater would have been and the sun falls into it. There is a ceremony that was practiced in ancient times to mark that change. On or about May 1, the event happens and thereafter, the sun moves toward the east. In Waikiki, it is marked by ceremony that usually begins around 5:30, so people can watch the change happen. Sam Gon and others from kumu John Lake’s halau do the ceremony. It’s free. I hope to make it this year. You folks should go, too! And bring your dinner, a mat or chair to sit on and your camera.

Dr. Cruz responded again on April 12, 2012:

> And just fyi, Shad Kane and other practitioners from Kapolei area have been holding a ceremony there for the last few years that coincides with the Waikiki one at the same day/time. you might want to add that to the report. He probably has more to share with you. I have tons of photos from the past ‘changing of the seasons’ events, as I believe we’re the ones who started the original commemorations back in the mid 1990s. A friend who used to work there, Mark Heckman, sent out an announcement of the history of that area and I took that to kumu John Lake to ask him if he knew about it. He said yes, he had done research on that many years ago, but no one had ever asked him or his hālau to perform until I brought that info to his house. That was the first year we did it, in front of the Waikiki Natatorium because some other group was using the aquarium for a party that same evening. We heard all their noise and music, but the aquarium staff was more interested in what we were doing. About 100 people showed up at our event just from word-of-mouth and email notices. One of the staff persons came outside and invited us to do the ceremonies inside the

aquarium the following year, which we did. That continued for several years until the aquarium got a new director who didn’t think cultural stuff was important, so they booted us out, basically, and we’ve been next to the Aquarium (town side) ever since. Sam Gon, who took over after kumu Lake passed, can probably give you the whole rundown, including the chants that they use.

PHONE (808) 594-1888 FAX (808) 594-1865

**STATE OF HAWAI'I**
**OFFICE OF HAWAIIAN AFFAIRS**
711 KAPI'OLANI BOULEVARD, SUITE 500
HONOLULU, HAWAI'I 96813

HRD12_6311

June 26, 2012

Nicole Ishihara, Cultural Researcher
Cultural Surveys Hawaiʻi, Inc.
P.O. Box 1114
Kailua, Hawaiʻi 96734

Re: Pre-Cultural Impact Assessment consultation
Fort DeRussy Wastewater System Improvements Project
Waikīkī, Island of Oʻahu

Dear Nicole Ishihara:

The Office of Hawaiian Affairs (OHA) is in receipt of your June 6, 2012 letter with enclosures seeking comments ahead of a cultural impact assessment (CIA) that will be prepared to support a wastewater system improvements project (project) that is proposed by the Hilton Hawaiian Village Beach Resort and Spa in Waikīkī on the Island of Oʻahu. Project activities will replace approximately 2, 600 linear feet of existing gravity sewer line extending along Kālia Road, Ala Moana Boulevard and Kalākaua Avenue. Equipment upgrades at the Fort DeRussy Wastewater Pump Station will also be completed. The project will contribute to meeting a 2010 Environmental Protection Agency Consent Decree to upgrade the Fort DeRussy Wastewater System (system) to accommodate 2030 projected peak flows.

A portion of the project extends over lands that are currently under the control of the Department of the Army-United States Army Garrison, Hawaiʻi (USAG-HI). This Federal nexus serves as the "trigger" for applicable Federal laws including, but not necessarily limited to the National Environmental Policy Act (NEPA) and the National Historic Preservation Act (NHPA).

Existing documentation from separate projects conducted in the area detail the presence of burials and cultural deposits in the vicinity of the instant project area. Thus, it appears that archaeological monitoring of all project activities is warranted.

Nicole Ishihara, Cultural Researcher
Cultural Surveys Hawai‘i, Inc.
June 26, 2012
Page 2

In the event iwi kūpuna, cultural items, or sub-surface cultural deposits are encountered during any ground disturbing activities associated with this project, OHA will expect all work in the immediate vicinity of the discovery to immediately cease and the appropriate agencies, organizations or individuals notified and afforded the opportunity to participate in consultation to determine appropriate treatment pursuant to the requirements of applicable Federal or State law.

Overall, OHA recognizes that the intent of this project is the complete necessary improvements and upgrades to the system to ensure adequate protections for both natural and cultural resources (which in traditional Hawaiian thinking are one and the same). We look forward to seeing the project completed. OHA has no referrals to individuals and organizations for consultation to offer at this time. Thank you for initiating consultation at this early stage and we look forward to reviewing the CIA and providing additional comments at that time. Should you have any questions, please contact Keola Lindsey at 594-0244 or keolal@oha.org.

‘O wau iho nō me ka ‘oia‘i‘o,

Kamana'opono M. Crabbe, Ph.D.
Ka Pouhana, Chief Executive Officer

KM:kl

Figure 22. Response from Kamana‘opono Crabbe, CEO of OHA

# Section 7 Interviews

## 7.1 Acknowledgements

The authors and researchers of this report extend our deep appreciation to everyone who took time to speak and share their mana‘o (thought) with CSH whether in interviews or brief consultations, including contacts who opted not to contribute to the current cultural impact assessment, but nevertheless spent time explaining their position on the proposed projects. We request that if these interviews are used in future documents, the words of contributors are reproduced accurately and not in any way altered, and that if large excerpts from interviews are used, report preparers obtain the express written consent of the interviewee/s.

## 7.2 Clarence Medeiros, Jr.

CSH talked with Mr. Clarence Medeiros, Jr. on March 12, 2012, to follow-up on a previously conducted interview in Kailua-Kona, Hawai‘i on May 27, 2010 (Cruz and Hammatt 2011) and by phone on December 29, 2004 for a cultural evaluation of the International Market Place (Mitchell et al. 2005). In this interview and in the past statements regarding projects in Waikīkī, which Mr. Medeiros approved to be re-used, he details his ‘ohana (family) links to Waikīkī as well as provide comments specific to this Project. He has four documented genealogical connections with Waikīkī.

Mr. Medeiros was born in 1952 in South Kona to Clarence Medeiros Sr. and Pansy Hua Kalalahua. He served in the United States Army from 1969 to 1972, including a tour of duty in Vietnam. Mr. Medeiros is married to his wife, Nellie, and they tend to a coffee, taro, and macadamia nut farm on Hawai‘i Island. They have two children: Jacob, 36, and Kareen, 38.

Mr. Medeiros’ interest in his genealogy was sparked when he first saw a picture of his grandmother, Violet Leihulu Mokuohai Parker. Grandma Violet was tall, fair and had green eyes. But inside, she was pure Hawaiian. Mr. Medeiros grew up learning about his grandmother through stories from his parents, kūpuna, and from his grand-uncle, the famed canoe carver Charles Mokuohai Parker, the brother of Grandma Violet. Grand-uncle Charles made canoes for canoe clubs throughout the islands. By the time Mr. Medeiros was in his 20s, he had spent many hours documenting his family connections. Using sources such as oral history, Mormon genealogical records and scholarly works, he outlined four connections to the Waikīkī area.

Mr. Medeiros states that the Project area involves Waikīkī Kai, and is part of Honolulu district. While showing CSH a map of 1874 Waikīkī, he notes that “Mānoa, Makiki, and Pauoa ahupua‘a all take care of the Waikīkī area. Most of the land we are talking about went through Kamehameha IV. Kamehameha IV owned several big portions.”

Stating that he has Hawaiian, Portuguese, English, Scottish, Spanish and Chinese in his background, Mr. Medeiros explains that his first connection to Waikīkī is through his great-great-great grandfather, Samuel Puhalahua. He documented that LCA 1268 was awarded to Nakai and it involved 1.60 acres and 23/100 acres in Waikīkī waena, not at the beach area of Waikīkī. The land consisted of a lo‘i. Nakai conveyed the land to William Smith who later conveyed it to Naomi Nakuapa Puhalahua, the wife of Kuwalu Puhalahua. Kuwalu, the father of Samuel Puhalahua, was Mr. Medeiros' great-great-great-great grandfather.

Samuel Puhalahua married Kanika and they had a son named John Mokuohai Puhalahua, the great-great-grandfather of Mr. Medeiros. Mr. Puhalahua married a half-English, half-Hawaiian woman named Kaehamalaole Elemakule Clark. They had one child, Abigail Mokuohai, who is the great-grandmother of Mr. Medeiros. Abigail married William Parker Jr. and they had two children, one of them was Violet Leihulu Mokuohai Parker, who was the grandmother of Mr. Medeiros and whose picture first inspired his genealogical interest when he was a young boy.

As for the second connection to the Waikīkī area, Mr. Medeiros describes his great-grandfather, Zen Man Sing, (also known as "Zane Man Sing"), who is connected to Mr. Medeiros' maternal side. His great-grandfather was Chinese and arrived in Hawaiʻi in 1888. Shortly after his arrival, Mr. Medeiros' great-grandfather worked in Waikīkī with relatives planting rice and taro and working in the Sun/Soong stores which were owned by his mother's family. Mr. Medeiros states the following:

> It was all water, swampland. Waikīkī was all loʻi kind of land around 1890s. Life was kind of hard then. But they [great-grandfather and family] are Chinese; they are business-minded. They are looking to get better. After five years of planting rice, great-grandpa came to Kona, hearing stories that coffee would make money. He went to Hoʻokena where he met my great-grandmother, Kaaumoana Niau. They got married and ended up in Kalahiki. Then he moved back to Oʻahu. All his kids were raised in Kalahiki as well as Oʻahu. Now they are all over Honolulu.

From this union, Mr. Medeiros' grandma, Annie, was born in Waiea, South Kona. Her full name was Annie Man Sing Zen, and she did not follow her parents and siblings when they later moved to Honolulu. Instead, she stayed behind and lived with different family members in Kiʻilae, Honaunau, Kēōkea and Kalahiki. Grandma Annie married her first husband, Charles Hua, the grandfather of Mr. Medeiros. After his death, Annie married Charles Weeks.

In 1975, Mr. Medeiros went to a family reunion and spent time with his grandma Annie and other relatives:

> My grandma was still alive at that time. In her 90s, and also one of her brothers. We got to talk about their life in Kalahiki and Oʻahu…They remembered going to school in Kalahiki and Hoʻokena; [they] walked to school, fished, worked in the farm and picked coffee. When they moved to Oʻahu, they worked in a hotel. The older ones liked the old-time life, fishing, hunting which they could do in Kalihiki, but not in Oʻahu.

Regarding the third connection to Waikīkī, Mr. Medeiros explains that his grand-aunt Miriam Peleuli Crowingburg Amalu owned several parcels of choice land in Waikīkī. She and Mr. Medeiros share the same bloodline through a relative named Kameeiamoku. Miriam was a close friend and relative of Queen Liliʻuokalani and often visited the palace to see the queen. She later had her properties auctioned off and conveyed to others. It was from Miriam's grandson that some properties were conveyed to Mr. Medeiros. These properties included 1¼ of an acre in Hoʻokena Beach and 300-plus acres in Waiea on Hawaiʻi Island.

His fourth connection to the ahupua‘a of Waikīkī is from the Portuguese side of his family. When Mr. Medeiros was around seven years old, he attended school in O‘ahu. He first lived with his great-grandmother Mary Costa Pimental. Great-grandma Mary was married three times: her first marriage was to Marion Medeiros, whose son was Frank Medeiros. Frank Medeiros had married Grandma Violet, who was a direct descendant of Samuel Puhalahua who owned land in the middle part of Waikīkī (see above).

Mr. Medeiros' great-grandma Mary's maiden name was "Pacheco" and she came from a Portuguese-Italian background. During the year he visited and lived with them in their home on Birch St., Mr. Medeiros would watch his great-grandpa by marriage, Frank Pimental, play bocci (ancient game stemming from the Roman Empire which resembled bowling) along with other elderly men. He and great-grandma Mary would bake bread every Thursday. All the great-aunts would converge to help with the baking of bread and malassadas (sweet doughnuts originating from a Portuguese colony), and they would hug and squeeze their eight-year-old great-nephew until he was blue.

While his father worked for the survey of the Wilson Tunnel, Mr. Medeiros went to Lanakila School in Kalihi. His father also worked part-time for former Mayor Frank Fasi as a truck driver. Mr. Medeiros remembered old landmarks of Honolulu during his time there, like the old Honolulu Stadium and Ft. DeRussy where his great-grandpa played bocci. In Kalihi, there was a wigwam store that is no longer there. The remaining eight months of that year, Mr. Medeiros lived with his father's half-sister who was also named Violet. Her neighbors were relatives of Mr. Medeiros' mother. Kalihi had a river, and there he used to catch tilapia with relatives and friends.

When asked if he had any specific concerns or recommendations for the proposed Hilton Hawaiian Village/Fort DeRussy Wastewater System Improvements Project, Mr. Medeiros expressed that he does not have any objections to the Project and he gave approval to use a previous statement related to his connections to Waikīkī.

## 7.3 Sylvia Krewson-Reck

CSH interviewed Mrs. Sylvia Krewson-Reck by phone on October 18, 2011 and previously at her home in Kahalu‘u on the windward side of O‘ahu on March 23, 2010 (Cruz and Hammatt 2010). Aunt Sylvia, as she is affectionately known, was born in 1929. When she was seven years old she and her family moved to O‘ahu to a small home in Kalihi Valley. She spent childhood time in the Waikīkī area beginning at the age of eight. Two years later, she and her siblings were put into the custody of the St. Mary's Orphanage on King Street in Mō‘ili‘ili, where they spent the next five years:

> …we were placed in the St. Mary's Orphanage; we attended Lunalilo School in Honolulu. We still had visits from our parents every now and then but we continued to stay at St Mary's. I was lucky enough to be named "Princess O‘ahu" on May 1, 1941 for Lunalilo School…I don't know how that happened but there I was, "Princess O‘ahu" with the flowers and all on May Day. I was taught a poem to give the aging Hawaiians at the Lunalilo Home for the Elders.

> I remember riding the trolley from the orphanage into Waikīkī. As we rode on McCully Street heading towards Waikīkī, on the left hand side or the Diamond Head side of McCully Street, were all these fishponds and loʻi [
>
> Figure 23 and Figure 24]. Didn't have all the buildings like now. It was taro and fishponds but I guess they all got filled in.

In 1932, George P. Mossman opened Lālani Hawaiian Village in Waikīkī to demonstrate traditional hula in tribute to the monarchy. The presence of Kuluwaimaka, the former chanter for Kalākaua, lent the village much credibility (Figure 25). After spending five years at St. Mary's, Aunt Sylvia attended the Lālani Hawaiian Village in Waikīkī, at the corner of Kalākaua Avenue and Kapahulu Boulevard:

> I became a student at Lālani Hawaiian Village. That's where I started learning about the Hawaiian culture and specific dance for the royalty. It was right near the beach in Waikīkī. I believe the person that ran the village was George Mossman. He even created a place in the village that I believe was a heiau. There was a Hawaiian cultural feel to the place. I danced hula there. Our hālau [hula group] was called "Hoʻo Naʻauao Hawaiʻi o Mokīmana." It means "Spread Knowledge of Hawaiʻi" (through the dance). My kumu hula [hula teacher] was Pualani, Leilani, and Piʻilani Mossman, they were wonderful people.

Often her parents took her to play at Waikīkī beach, where she enjoyed the beaches and surfed:

> When my father used to take us kids with him, he would bring us to the beach at Waikīkī. He would hang out at this bar called the Waikīkī Tavern. It was right on the beach, so he'd be at the beer garden and us kids would be on the beach. So we basically grew up on Waikīkī beach. All the old timers were there. Folks like George Downing was there. My surfing partner was Joseph Kaopuiki [Figure 26]. His nick name was "Scooter Boy." He was known at that time as the surfer who rode the biggest wave on the North Shore. Everyone knew him. He was Cherokee Hawaiian. He was a really close friend of mine, he was a little older than me but we were really close. He would take me tandem surfing all the time. We were best friends but he never made a move on me, I'll never forget that [smiling as she said that]. I think he respected me too much. He was such a good man…quiet…and very respectful.
>
> Anyway, while we were at the beach my dad was at the Tavern. Richard Kauhi was a musician upstairs at the Tavern. He played the piano and sang. He was so good. When I hear his songs now, it brings back those memories, he died very young.

Aunt Sylvia elaborated about the Hawaiian music scene in Waikīkī when she was growing up:

> At night in Waikīkī, there were all these Hawaiian music entertainers. It was before Don Ho's time. Under the big Banyan tree at Kūhiō Beach, the Kalima Brothers used to play for the crowds and they'd pass a bucket around for

> donations. They were really great musicians. At night, you could hear the music and people would follow the music and that’s where the party was.
>
> Gabby Pahinui was also playing. His gig was at this hotel called Niumalu Hotel. He played with Pua Alameida, I remember they were good. It was before Gabby was big time. They played at this dinner and dance place. I used to go there on dates.

After the illegal overthrow of the Hawaiian Kingdom in 1893, members of the Royal Hawaiian Band visited Ellen Wright Prendergast, a close friend of Queen Lili‘uokalani, and expressed their unhappiness with the takeover of the Hawaiian Kingdom. At her father’s home in Kapālama, Ms. Prendergast put the band member’s feelings into the song “*Kaulana Nā Pua*,” or “Famous are the Children.” Today, this song continues to be symbolic of the Hawaiian independence movement. Aunt Sylvia shared a story of Ms. Prendergast during her teen years:

> I had a classmate and her name was Lorna Prendergast. One day after school we went to her home in Kapālama. While there, he grandmother, an older woman, came through the kitchen. Lorna introduced her grandmother to us. She was very nice to us and they had a piano in which we played and sang songs. This was in 1947.
>
> One day about ten years ago, I recalled that day in 1947 and it was then that I realized that Lorna’s grandmother was Ellen Wright Prendergast, the woman who wrote *Kaulana Nā Pua*. On that day at Lorna’s house, we never heard of that song so we just played on the piano and had fun.

Aunt Sylvia also recalls that in *Hawaii’s Story* (1898), Lili‘uokalani wrote that she delighted in seeing people of opposite political views enjoy themselves at Hamohamo, her seaside estate (now Kuhiō Beach). To Aunt Sylvia, these people were most magnanimous.

Aunty Sylvia does not have any concerns or recommendations regarding the Project or the Project area.


Figure 23. Photograph of trolley on Waikīkī Road circa 1940 described by Mrs. Krewson-Reck in her interview (photograph courtesy Hawai‘i State Archives)

Figure 24. View of Diamond Head from McCully Street showing fields of lo‘i kalo circa 1940 described by Mrs. Krewson-Reck in her interview (photograph courtesy of Kamehameha Schools’ Baker Collection 1826–1940)

Figure 25. Kuluwaimaka, the court chanter for Kalākaua, at the Lālani Village (Hibbard and Franzen1986:130)

Figure 26. Photograph of Aunt Sylvia Krewson-Reck with Joseph “Scooter Boy” Kaopuiki circa 1945 (photograph courtesy of Aunt Sylvia Krewson-Reck)

## 7.4 Van Horn Diamond

CSH interviewed Van Horn Diamond by phone on October 18, 2011 and previously on June 21, 2010 in Honolulu (Cruz and Hammatt 2011). Mr. Diamond was born and raised in Waikīkī. Mr. Diamond served six years on the OIBC and is the former OIBC chairperson. His family's residence was on Kānekapōlei Street, named after one of the wives of Kamehameha I. Mr. Diamond adds that most of the place names in Waikīkī, including the street names, were associated with Kamehameha I or the ali‘i class in general.

Mr. Diamond describes his mother's occupation during his youth:

> My mom was a schoolteacher and played music. My grandmother had a hula troupe and her sister had a hula troupe. My grandmother's hula troupe was the Honolulu Girls. They called it glee clubs at the time. Her sister's one was the Royal Hawaiian Girls Glee Club. The Royal Hawaiian Girls Glee Club was the ones that maintained and performed at the Kodak Hula show all these years.

Mr. Diamond describes his childhood home on Kānekapōlei Street:

> It was pretty much urbanized by then. When I was growing up there was a fence line. On the other side of the fence were date trees. And the other side of the fig trees there were bachelors' quarters, Filipino workers for the hotels. And the community shower and there were these banyan trees. That was Supervisor's Road. And where the parking lot is, it connects to Kānekapōlei, that part of the parking lot, there was a platform. It could've been… Now, in retrospect, it could've been a platform for iwi [bone], for whatever. What I saw there was, they had like, rotted out, badminton net kind of situation. And they had backboard for basketball. That's all there was. But thinking about it now, it could've been a platform. And the banyan tree was right there.
>
> Where we lived, I go the ball game, I walk home. Cheaper than riding the bus. Take too long the bus. Gotta get on the bus in front of the stadium, go all the way to Pāwa‘a, where Cinerama was, get off there, get on another bus and we'd get on the bus that came from Mānoa, then it'd take you down around by Fisherman's Wharf and come all the way and then up along the Ala Wai. Or take the bus that went right down through Waikīkī and ended up by the Moana Hotel, Moana Surfrider, then walk home. Too long! So we just got off, walk down.

During his childhood, Mr. Diamond listened to the musicians who played at the International Market Place, including Don Ho. He has fond memories of the group, "Hawaii Calls," which broadcast its radio show from the banyan tree inside the Moana Hotel. Musicians in Waikīkī during the 1940s and 1950s were unionized already. Mr. Diamond shares some insight into what it was like for his mother being a musician in the union:

> There was a union, but they didn't pay that much attention to it. Some were unionized, some were not. My mom got kicked out of the union because she wouldn't stop playing for her mother. She knew who the union president was and one day she was playing at the Royal Hawaiian Hotel on arrival day, or boat day and the union president showed up. He was wondering what she was doing. She

> said, “Oh, I got kicked out of the union.” So he got her back in. She got back in after she saw him.

Mr. Diamond has no concerns or recommendations regarding the current Project or Project area.

## 7.5 Richard Paglinawan

CSH interviewed Richard Paglinawan in Waimānalo on September 20, 2011. Mr. Paglinawan, who was born in 1936 and raised in Waiāhole Ahupua‘a, is a special assistant at the Queen Emma Foundation and was formerly the administrator of OHA. He had previously prepared the following documents for the Queen Emma Land Company, which he shared with CSH: *Some Notes on the Nā Pohaku ‘Ola Kapaemahu a Kapuni Restoration Project* (1997) and *Waikiki Then and Waikiki Now* (2008).

Mr. Paglinawan describes the history of Nā Pōhaku ‘Ola Kapaemahu a Kapuni, or the Life-giving Stones of Kapaemahu and Kapuni, commonly referred to as the Wizard Stones. According to Mr. Paglinawan’s summary of various mo‘olelo, four healers gifted in medicinal practices once came from Kahiki (the ancestral homeland of the Hawaiians), most likely the sacred land of Raiatea. While some sources claim that they were homosexuals, Tūtū (grandma) Mary Kawena Pukui asserts that they were gender neutral. The wizards included Kapaemahu, who, due to his impartial gender, could examine and heal both men and women, Kahoe, a diagnostician who could determine illness just by visual assessment, Kahaloa, who was able to breathe life into ill patients, and Kapuni, who could envelope his patients with his mana (power) to overcome their illness.

When the four healers returned to Kahiki, they had stones placed to commemorate their existence. They were most likely quarried from a site in Kaimuki near the present-day intersection of Wai‘alae Avenue and 5th Avenue, and then transported to Waikīkī. The coastal and inland region of Waikīkī was dominated by lo‘i, which would have made the movement of these pōhaku difficult, but, according to Dr. George S. Kanahele, the stones may have been moved on a 12-foot wide causeway that extended between Mānoa and Waikīkī, which was observed by George Vancouver in 1792.

Two of the commemorative stones were placed at the healers’ residences, and two were placed in their bathing place in the sea. The Honorable A.S. Cleghorn unearthed an eight-ton stone at his residence close to the Moana Hotel in 1905. Another stone weighing ten tons was uncovered by Mr. Lutted, and two more were excavated in a straight line with the others. Underneath the ten-ton stone Mr. Cleghorn uncovered a female jaw bone and some crude images, which he later cemented onto the stone. In 1941, the Waikiki Bowling Alley was constructed with the stones serving as part of the foundation, but were then uncovered in 1958 when the building was razed. In 1963 the stones were located together on the beach, and in 1980 they were relocated to their present site near the police substation. The location of Mr. Cleghorn’s cement casings indicated that the stones had been positioned incorrectly; however, a decision was reached to leave them as they had been placed.

Mr. Paglinawan also traces royal lineages in Waikīkī. The ali‘i Mā‘ilikūkahi, born at the sacred site of Kūkaniloko in the fifteenth century, was installed as the mō‘ī at the heiau of

Kapukapuākea, after which he moved to the lands of Helumoa in Waikīkī. This marked a shift in royal residence to Waikīkī. In the eighteenth century, Kahekili, the ruling chief of O‘ahu, stipulated that his nephew and mō‘ī of O‘ahu, Kahāhana, should give him the lands of Kualoa. Kahāhana's priest, Ka‘ōpulupulu, was strongly opposed to forsaking the sovereignty of O‘ahu, but when Kahāhana did not listen to his advice, Ka‘ōpulupulu prophesized their deaths and the future invasion of ruling chiefs from Hawai‘i Island (Kamehameha) and foreigners, resulting in the loss of O‘ahu (and Hawaiian) sovereignty:

> According to Tūtū's [Mary Kawena Pukui] version, which is interesting, Ka‘ōpulupulu, when making that prophecy, was in Nānākuli. What he did was to tattoo his knee. And in tattooing his knee, because he had given advice to Kahāhana [who] did not heed his advice, he tattooed his knee so that when people would look and say "Ka‘ōpulupulu, how come your knee is tattooed?", he said "My chief was deaf, kuli, to my advice." And the prophecy that he gave that he would be killed, Ka‘ōpulupulu would be killed, and that Kahāhana himself would also be killed and offered as a human sacrifice on the same heiau. To seal that fate, he had told his son, Kahulupue, to go out on Pōka‘ī Bay and drown himself. Now it's very rare to see [a] Hawaiian drown himself because they're good fishermen. So he must have swam way the hell out. But did, in fact, drown himself. And according to Ka‘ōpulupulu the prophecy was sealed at that time.

Ka‘ōpulupulu, who was slain by Kahāhana at ‘Āpuakēhau Heiau, was strung up on a tree, such that chickens were eating maggots that fell from the rotting bodies, hence the name Helumoa, or "chicken scratch." After the death of Ka‘ōpulupulu, Kahekili invaded O‘ahu in 1780 to overthrow Kahāhana (who was later sacrificed on the same heiau as Ka‘ōpulupulu), clogging the streams of ‘Ewa with bodies of the slain chiefly lines, and settling in Helumoa.

Then, Kamehameha invaded O‘ahu in 1795 from Hawai‘i Island, landing 10,000 canoes with 30,000 troops in Waikīkī, to defeat Kalanikupule, the son of Kahekili. Kamehameha's warriors were housed and fed on the only upraised land in Waikīkī—the land of Helumoa (near the International Market Place). Epidemics in the 1800s may have resulted in many Hawai‘i Island ali‘i buried in the area.

Mr. Paglinawan's family regularly came to Waikīkī on Sundays, where they visited the zoo, listened to the Royal Hawaiian Band at the bandstand, swam at San Souci Beach, dove off a diving board at the Natatorium, and listened to the music at the International Market Place in the evenings. In the tidal pools by the Natatorium, he and his family also gathered limu and caught he‘e (octopus), mullet (‘ama‘ama), pāpio, uhu (parrotfish), and hīnālea (wrasse), and consumed the fish that same day.

Mr. Paglinawan does not have any concerns for the proposed Project at the Hilton Hawaiian Village/Fort DeRussy.

## 7.6 Jan Becket

Jan Becket is a teacher with Kamehameha Schools who is well-recognized for his black-and-white photographic documentation of sacred sites. He has conducted extensive archival research on sites of cultural significance, learned from kūpuna, and photographed many undocumented sites on O‘ahu, which resulted in a co-written book, *Pana O‘ahu* (Becket and Singer 1999). He is a member of the Committee for the Preservation of Cultural Sites and Properties under the O‘ahu Council of Hawaiian Civic Clubs, and reports back to the chair of the committee (Shad Kāne) on issues concerning cultural sites in the Kona district of O‘ahu.

On March 28, 2012, Mr. Becket led CSH on a site visit to two cultural sites within the broad cultural landscape of Waikīkī (Figure 27, Figure 28, Figure 29). One cultural site is located in the center of Wa‘ahila Valley on the lower slope of Wa‘ahila Ridge. This site, nestled between a rock face, a steep drop-off and three low, basalt walls, would command an impressive view of Waikīkī were it not for the unchecked vegetation. The site is now composed two small terraces built upon natural rock, a po‘o pōhaku (a stone with an outcropping that looks like a head), and an area of loose cobbles and boulders. An enclosing wall runs along the makai side of the site. Based on a previous visit, Mr. Becket points out how mountain bikers ten years ago had used the stones from the mauka wall of the enclosure to make a pavement that allowed them to actually ride across the site and jump off the po‘o pōhaku. While Mr. Becket helped bring awareness of this site destruction to the State that eventually led to the closing of the biker’s access trail, there is currently a homeless person living within this site.

Paul Rosendahl assessed this cultural site (no excavations) as part of an archaeological inventory survey in a nearby area in 1996 (Figure 30). Designated as Site 5463, Rosendahl (1996:22) described it as “an area used for agriculture, with some potential for containing habitation features,” that was likely associated with pre-Contact activity.

Mr. Becket and other members of the Committee for the Preservation of Cultural Sites and Properties, under the O‘ahu Council of Hawaiian Civic Clubs, collectively felt that Site 5463 may be a possible heiau. In a letter to the DLNR in 2001, the preservation committee explains their reasoning:

> …It is the only ancient structure in that area, with no features usually associated with agriculture (‘*auwai, lo‘i*) either in the surrounding forest or within the structure itself. Although the structure sits on marginal upland soil, it lies above the Mānoa/Mō‘ili‘ili plain, one of the richest growing areas on O‘ahu. This unusual placement raises the question of which crops might have been raised so far from habitations and from other, far more productive cultivation areas. No house platforms are evident within the enclosure.
>
> On the other hand, no information about the rectangular enclosure contradicts the interpretation of its function as ceremonial. It looks out over Waikiki, directly over the ancient seat of political power for the entire island since the time of Ma‘ilikukahi: Helumoa (or ‘Apuakehau), now the location of the Royal Hawaiian Hotel. Often, *heiau* were deliberately placed so that they would command such sweeping views. Furthermore, at the center of the enclosure lies an unusual and prominent stone [the po‘o pōhaku]. Our cultural resource experts tell us that some *heiau* were constructed around such prominent stones, which were the focus of the structures, their reason for existing. Although no one can be absolutely sure at this point, the enclosure does appear to be constructed around such a stone, although the archaeological survey makes no mention of it.

The preservation committee elaborates how the area surrounding Site 5463 is culturally significant in several ways. The ridge of Waʻahila is a wao nahele (upland forest zone) close to the city that is available for gathering and other cultural activities. The ridge is also associated with one of the early gods—Kauhi, whose form can be seen along the ridgeline from Mānoa. This wahi pana of Kauhi makes the ridge, to some degree, a wai akua (abode of the gods), according to the preservation committee.

The other cultural site is located in Kamanele Park in Mānoa Valley (Figure 31, Figure 32). Situated on the makai side of the park just below the grounds of the Mid-Pacific Institute is, at first glance, a large natural stone outcropping. An archaeologist had previously pointed out to Mr. Becket that the grains of most of these large stones, remnants of a basalt lava flow that cooled in an unusual way, run in the same direction, indicating that this is a natural formation. Behind this massive feature and along its sides, however, are several areas of distinct artificial terracing, as well as a small rock overhang. After clearing some vegetation, Mr. Becket indicated an alignment of stones that is possibly an ahu. He noted how an upright stone rises above two stones that form a kohe, with a small terrace below it (Figure 33); a similar Papa/Wākea feature exists at a recorded heiau in Hālawa Valley, in the complex under the H-3 Freeway and at a site at Maunawili, Oʻahu, according to Mr. Becket.

Mr. Becket also recalls that an early twentieth century article titled “Where Fact and Fancy Meet,” published in *The Mid-Pacific Student* (1907, Vol. VI, No. 7) described three heiau in Mānoa Valley—Ka-ua-laa (the sacred rain), Ka-uwalo-malie (the place of the silent crying), and Ka-ui-o-Mānoa (the beauty of Mānoa). The description of the latter heiau as being located on “the rounded knoll” on the Mid-Pacific property may refer to the Kamanele Park cultural site, according to Mr. Becket.

Mr. Becket also shared (with the permission of the chair of the Committee) a report from the Committee for the Preservation of Cultural Sites and Properties to the O’ahu Council of Hawaiian Civic Clubs in 2011 regarding the cultural significance of this site. The Committee noted that an old City and County map labeled the site as a heiau, and explained their rationale for why this cultural site was pre-Contact: The features include stone-faced terraces, small platforms and enclosures. In 2011, the Committee report to the Oʻahu Council of Hawaiian Civic Clubs reiterated their statement that this culturally significant site was likely a pre-Contact structure. The report elaborated that although questions had been previously raised about the name of the structure, the primary issue surrounding this unrecorded site is its origin and function. The Committee’s cultural experts observed that pre-Contact use of existing natural rock formations was not unusual and can be seen in several major heiau on Oʻahu, and that both ends of this outcrop appear to have been modified, in addition to the features described above.

Mr. Becket does not have any concerns or recommendations about the Hilton Hawaiian Village/Fort DeRussy waste water treatment Project.


Figure 27. Po‘o Pōhaku in foreground at Wa‘ahila Ridge overlooking Waikīkī Ahupua‘a (Jan Becket 2012)


Figure 28. Po‘o Pōhaku at unnamed site; in the back of the pōhaku lies a fenced area with rebar and liter; a homeless camp dominates the site (Jan Becket 2012)


Figure 29. The unnamed site circa 1998 (Jan Becket 1998)

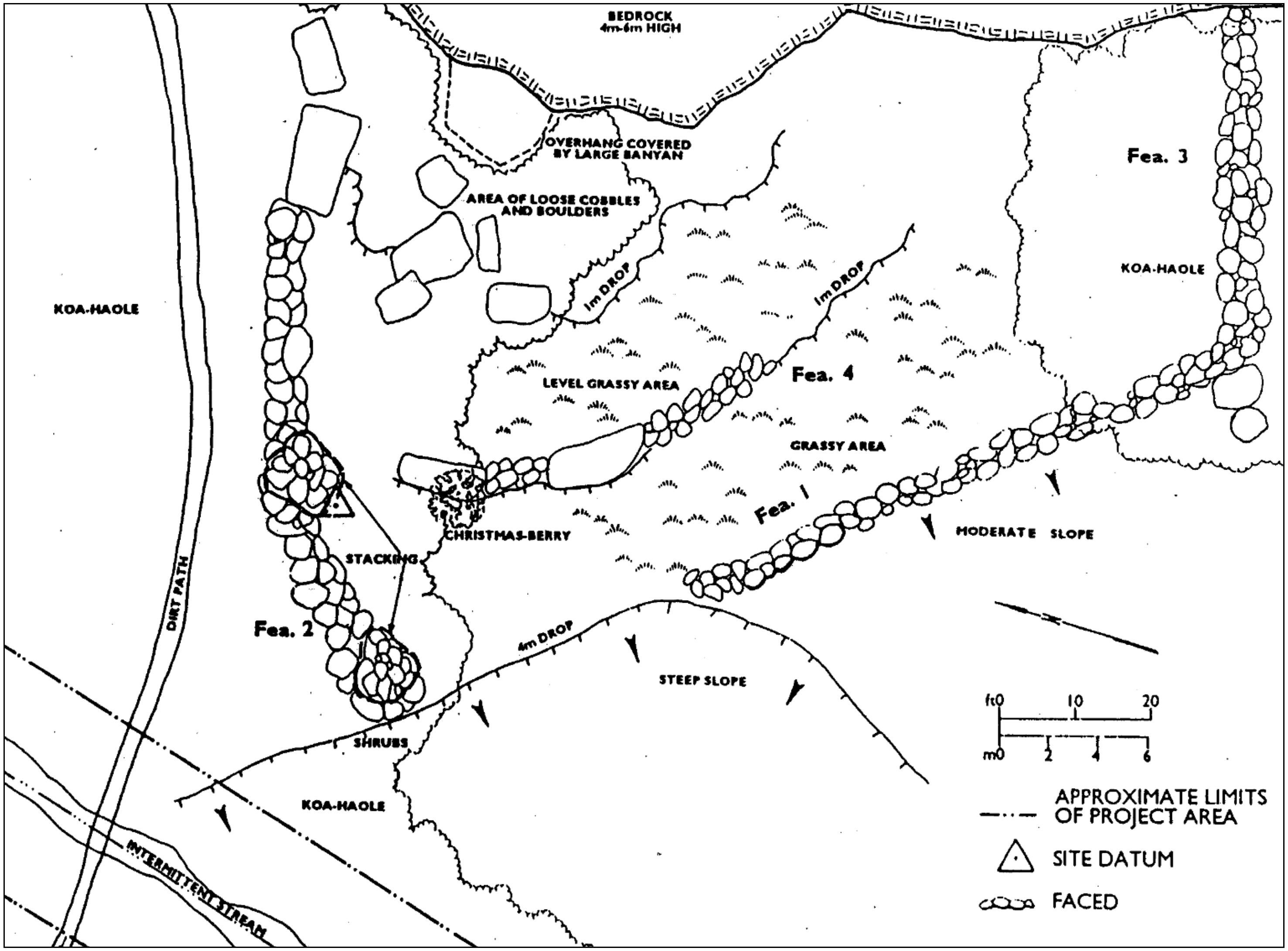


Figure 30. Sketch of Site 5463 prior to destruction by mountain bikers and squatters (Rosendahl 1996)


Figure 31. Immediate backside of the large natural outcropping at Kamanele Park in Mānoa (Jan Becket 2012)


Figure 32. Makai of the large natural outcropping lays a hill with artificial terracing, overgrown with vines and dotted with trees (Jan Becket 2012)


Figure 33. Mr. Becket pointed out this significant feature of what represents male and female reproductive organs; the upright stone in the middle represents a nanahoa (phallic symbol); the two flat stones on both sides of the upright and the outcropping below represent a kohe (vagina); also known as a Papa/Wākea feature (Jan Becket 2012)

# Section 8 Cultural Landscape of the Project Area

Discussions of specific aspects of traditional Hawaiian culture as they may relate to the permanent Project footprint are presented below. This section integrates information from Sections 3-7 in order to examine cultural resources and practices identified within or in proximity to the permanent Project footprint in the broader context of the encompassing landscape of Waikīkī Ahupua‘a.

The lands of Waikīkī were once well-watered with fishponds and streams that were of great importance to the Hawaiian community. The fishponds, lo‘i kalo, and other cultivations were vital in comprising the cultural landscape of Waikīkī. These former lands, once rich in Hawaiian culture, have largely been filled in due to recent urban developments. The Ala Wai Canal project in the early 1920s produced enough dredged material to fill in every waterway, pond or stream in Waikīkī. By 1926, the well-watered lands of Waikīkī no longer existed.

## 8.1 Wahi Pana and Mo‘olelo

There is a large body of oral-historical information about royal residences and other compounds belonging to various ali‘i in the Waikīkī area. Waikīkī had become “the ruling seat of the chiefs of O‘ahu.” In January of 1783, Kahekili traveled from Maui with his warriors to O‘ahu and invaded the island. Nearly ten years later, Kamehameha and his forces invaded the island of O‘ahu. Landing from Wai‘alae to Waikīkī, Kamehameha’s army began their battle against Kalanikūpule, the son of Kahekili, in Waikīkī and ended over the Nu‘uanu Pali. Mr. Richard Paglinawan has added that many of Kamehameha’s warriors were housed and fed on the only upraised land in Waikīkī—the land of Helumoa (near the International Market Place). It is believed that due to epidemics in the 1800s, many ali‘i from Hawai‘i Island were buried in the area.

Āpuakēhau Stream is also associated with the “Legend of Kawelo.” This mo‘olelo is about two boys born on the same day, Kawelo-lei-makua, called Kawelo, the great nephew of the king of Kaua‘i, and Kawelo-aikanaka, called ‘Aikanaka, the grandson of the king. Kawelo’s older brothers and his parents soon moved from Kaua‘i to live at Waikīkī near the ruling chief of O‘ahu, Kākuhihewa. The older brothers of Kawelo often challenged a famous wrestler living with Kākuhihewa, but they could never beat him. When Kawelo’s older brothers returned from surfing at Kalehuawehe in Waikīkī, they would wash off at Āpuakēhau Stream, from there they would go to the shed where the wrestling bouts were held and test their skill with Kākuhihewa’s strong man. In all their trials, Kawelo’s brothers were unable to throw him.

While Kawelo was working in the fields, he heard some shouting from the beach, and asked his grandparents, “What is that shouting down yonder?” (Fornander 1918:5). The grandparents answered that his older brothers had just finished surfing and must have challenged the king’s strong man. The shouting indicated one of them must have been thrown. Next day, Kawelo went down to the beach, went surfing with his brothers, and then bathed in the freshwater stream of ‘Āpuakēhau. He challenged the strong man to a match, even though his brothers mocked him, saying “Are you strong enough to meet that man? If we whose bones are older cannot throw him, how much less are the chances of yourself, a mere youngster?” (Fornander 1918:6). Kawelo won the match, shaming his older brothers so much that they returned to Kaua‘i.

Mr. Paglinawan describes the history of Nā Pōhaku ‘Ola Kapaemahu a Kapuni, or the Life-giving Stones of Kapaemahu and Kapuni, commonly referred to as the Wizard Stones. According to Mr. Paglinawan’s summary of various mo‘olelo, four healers gifted in medicinal practices once came from Kahiki (the ancestral homeland of the Hawaiians), most likely the sacred land of Raiatea. While some sources claim that they were homosexuals, Tūtū Mary Kawena Pukui asserts that they were gender neutral. The wizards included Kapaemahu, who, due to his impartial gender, could examine and heal both men and women, Kahoe, a diagnostician who could determine illness just by visual assessment, Kahaloa, who was able to breathe life into ill patients, and Kapuni, who could envelope his patients with his mana to overcome their illness.

When the four healers returned to Kahiki, they had stones placed to commemorate their existence. They were most likely quarried from a site in Kaimuki near the present-day intersection of Wai‘alae Avenue and 5th Avenue, and then transported to Waikīkī. Moving these pōhaku was deemed difficult due to the makeup of the landscape. But according to Dr. George S. Kanahele, the stones may have been moved on a 12-foot wide causeway that extended between Mānoa and Waikīkī, which was observed by George Vancouver in 1792. Two of the commemorative stones were placed at the healers’ residences, and two were placed in their bathing place in the sea. The Honorable A.S. Cleghorn unearthed an eight-ton stone at his residence close to the Moana Hotel in 1905. Another stone weighing ten tons was uncovered by Mr. Lutted, and two more were excavated in a straight line with the others. Underneath the ten-ton stone Mr. Cleghorn uncovered a female jaw bone and some crude images, which he later cemented onto the stone. In 1941, the Waikiki Bowling Alley was constructed with the stones serving as part of the foundation, but were then uncovered in 1958 when the building was razed. In 1963 the stones were located together on the beach, and in 1980 they were relocated to their present site near the police substation. The location of Mr. Cleghorn’s cement casings indicated that the stones had been positioned incorrectly; however, a decision was reached to leave them as they had been placed.

Mr. Paglinawan also traces royal lineages in Waikīkī. The ali‘i Mā‘ilikūkahi, born at the sacred site of Kūkaniloko in the fifteenth century, was installed as the mō‘ī at the heiau of Kapukapuākea, after which he moved to the lands of Helumoa in Waikīkī. This marked a shift in royal residence to Waikīkī. In the eighteenth century, Kahekili, the ruling chief of O‘ahu, stipulated that his nephew and mō‘ī of O‘ahu, Kahāhana, should give him the lands of Kualoa. Kahāhana’s priest, Ka‘ōpulupulu, was strongly opposed to forsaking the sovereignty of O‘ahu, but when Kahāhana did not listen to his advice, Ka‘ōpulupulu prophesized their deaths and the future invasion of ruling chiefs from Hawai‘i Island (Kamehameha) and foreigners, resulting in the loss of O‘ahu (and Hawaiian) sovereignty:

Ka‘ōpulupulu, who was slain by Kahāhana at ‘Āpuakēhau Heiau, was strung up on a tree, such that chickens were eating maggots that fell from the rotting bodies, hence the name Helumoa, or “chicken scratch.” After the death of Ka‘ōpulupulu, Kahekili invaded O‘ahu in 1780 to overthrow Kahāhana (who was later sacrificed on the same heiau as Ka‘ōpulupulu), clogging the streams of ‘Ewa with bodies of the slain chiefly lines, and settling in Helumoa.

## 8.2 Plant Gathering and Cultivation

Waikīkī was thought of an ideal place for taro cultivation providing an abundance of water and sunlight. Taro grown under sunnier conditions matures noticeably faster, thus making Waikīkī a key area for cultivation and in respect, an even better place for growing taro than the revered ahupua'a of Kāneʻohe and ʻili of ʻĀhuimanu in Kahaluʻu (Kanahele 1995:22). ʻUala and the prized ipu were also abundant in the lower Waikīkī marshlands (Kanahele 1995:35).

The settlers of Waikīkī had to travel mauka to the foothills of Mānoa and the valley of Pālolo to gather grasses, vines, and other fauna. Along stream banks grew hau. Kukui trees could be found mid-way in Mānoa Valley (Kanahele 1995:26). ʻŌhia ʻai could also be found mid-way in Mānoa Valley (Kanahele 1995:26).

Mr. Clarence Medeiros, Jr. describes his great-grandfather, Zen Man Sing, (also known as "Zane Man Sing") who arrived from China in 1888. He describes that shortly after his arrival, Mr. Medeiros' great-grandfather worked in Waikīkī with relatives planting rice and taro and working in the Sun/Soong stores which were owned by his mother's family. He recalls a story that Waikīkī was "all loʻi kind of land around 1890s" and that his great-grandfather planted rice.

Ms. Sylvia Krewson-Reck recalls the riding a trolley into Waikīkī and describes the Diamond Head side of McCully Street full of fishponds and loʻi. Buildings didn't exists like today in the area. Now the fishponds and loʻi are filled in.

## 8.3 Marine and Freshwater Gathering

Fishponds were one of the most important traditional resources for the Hawaiian community of Waikīkī. Historic maps and documents depict several loko iʻa in Waikīkī. Historical documentation describe "several hundred" and "innumerable" artificial freshwater fishponds extending a mile inland from the shore (Bloxam 1925:35–36, cited in McAllister 1933:76). According to a study conducted by the U.S. Commission of Fish and Fisheries, several fishponds were listed in the Kālia area in 1901 including: Kaʻihikapu, Kūwili, Kaipuni 1 and 2, Kapuʻuiki, Kapaʻakea, Maʻalahia, Opu, and Opukaʻala, and others that with undocumented names. In addition, historic maps provide the locations of these fishponds and others including Kaohai, Oʻo, Halemauʻuola, Moʻo, Kuilei, and Kaheana (Bishop 1881).

In an UHCOH interview, Mr. John C. Ernstberg recalls gathering various ocean resources during his youth in Waikīkī. He describes limu being readily available for food and medicinal purposes. Varieties such as manauea, līpoa, and wāwaeʻiole were available on the shores of Waikīkī. Fish such as manini were available on the reef and could be caught when the tide was rising.

Mr. Lemon "Rusty" Holt also participated in UHCOH project. He was interviewed for the project and recalls the best wana grounds in Waikīkī is Queen's Surf. He describes a channel near Queen's Surf. To the right of the channel is a reef where the wana grow on the underside where the surf breaks. He continues:

> Wana growing underneath running water or (white) waves breaking is supposed to be fat. Good wana. Worthwhile getting and eating. You pick them in the month of October. They're fatter then. (UHCOH 1985:808–809)

Mr. Earle "Liko" Vida was interviewed for the UHCOH project on March 21, 1985. Mr. Vida grew up in the Kālia area of Waikīkī. He describes fishing with Kaimi, an old local fisherman who lived in the Kālia area, and the various fish they would catch:

> ‘Ōpelu, and go out and get ulua, pāpio. He'll get the pāpios right in the waves. As the waves break, you can see them. He goes in his little canoe, and he has a drag line all the time with floaters. And when the float comes in on the wave, bang, then he pulls it in. So, he was a crackerjack. I used to do the same thing and watched him. I'd go into the channels with my little outboard motor. Of course, he never had an outboard motor. He always paddled his canoe. (UHCOH 1985: 582)

Mr. Vida continues that all families that lived on the beach, most of their food came from the ocean. In addition to ocean resources for sustenance, they also raised their own pigs and chickens "just like a regular farm."

## 8.4 Surfing and Ocean Recreation

Mr. Greg Kashiwa of Kupuna LLC, fondly recalls surfing and fishing in the Fort DeRussy area. During his youth, there was a large platform anchored off-shore where swimmers would congregate. However, after a tsunami in 1946, the platform vanished.

Ms. Kreson-Reck retells a story of her surfing partner during the Waikīkī beach boy era:

> My surfing partner was Joseph Kaopuiki. His nick name was "Scooter Boy." He was known at that time as the surfer who rode the biggest wave on the North Shore. Everyone knew him. He was Cherokee Hawaiian. He was a really close friend of mine, he was a little older than me but we were really close. He would take me tandem surfing all the time. We were best friends but he never made a move on me, I'll never forget that [smiling as she said that]. I think he respected me too much. He was such a good man…quiet…and very respectful.

## 8.5 Burials

Numerous sources indicate sacrificial drownings, sacrificial offerings, executions, and deaths during battles in the coastal Waikīkī area. Royalty and commoners may have also buried their dead in the Jaucus sand deposits. Excavations have yielded numerous burial concentrations and individual concentrations. In the vicinity of the Project area two burials and one isolated femur have been discovered to date within the current Project area.

In 1980, during construction of the Tapa Tower at Hilton Hawaiian Village in the southeastern corner of the subject parcel (specifically, at the corner of Kalia and Paoa Place), these burials—determined by the SHPD to be Native Hawaiian individuals from post-Contact (historic-era) times—were removed and relocated to a reburial site on the resort grounds (Neller 1980:6). The general location of the reinterment site is in the southeastern corner of the parcel. A more specific understanding of the location of the reinterment site is known by the owner of the Hilton Hawaiian Village, former staff of the SHPD, former members of the O‘ahu Island Burial Council (OIBC) and descendents, as memorialized in a 1991 reburial agreement between the State Historic Preservation Officer and the landowner.

## 8.6 Cultural and Historic Features

Six heiau are said to have been associated with the Waikīkī area: Papa‘ena‘ena Heiau (Lē‘ahi), Helumoa Heiau, Kapua Heiau, Kūpalaha Heiau, Kamauakapu Heiau and Kulanihakoi Heiau (Thrum 1907:44). Thrum also mentions the Wizard Stones of Kapaemāhū at Waikīkī.

Mr. Kashiwa retells a story about the Mō‘ili‘ili karst and cave system and the connection to the Waikīkī area. During his service in the Army, his unit conducted an annual sand replenishment project in front of the Hale Koa Hotel. This required hauling sand from Nanakuli and spreading it along the shoreline. During a routine replenishment, a D9 Cat fell into the ocean causing a coral shelf to collapse. During retrieval of the D9, a diver “could feel fresh water flowing from the rubble.” The diver believed that the collapsed coral shelf was actually a lava tube that was connected to the Mō‘ili‘ili fresh water karst and cave system. Mr. Kashiwa adds that “it is worth seeing and archaeological traces may remain” suggesting the lava tube possibly connects Waikīkī Kai to the Mō‘ili‘ili area. Mr. Jan Becket led CSH on a site visit to two cultural sites within the broad cultural landscape of Waikīkī. One cultural site is located between Wa‘ahila Ridge and Kānewai, near the University of Hawai‘i at Mānoa, Hawaiian Studies building. The site is nestled between a rock face and a steep drop-off. The site is made up of two small terraces built upon natural rock, a po‘o pōhaku which stands at the front of the heiau, and loose cobbles and stones scattered on the outskirts of the heiau. The site commands an impressive view of Waikīkī, however, the area is tremendously overgrown and neglected.

The second site is located at Kamanele Park in Mānoa Valley. The site is situated on the makai side of the park just below the gated grounds of Mid-Pacific Institute. At first glance is a large natural stone outcropping. Behind the massive formation lies distinct artificial terracing and a small rock overhang. A possible ahu and an upright stone feature, also known as a Papa/Wakea feature, exist at the site. Both sites have distinct features which indicate they are most likely pre-Contact heiau.

# Section 9 Summary and Recommendations

CSH undertook this CIA at the request of Group 70 International, Inc., on behalf of the City and County of Honolulu, Department of Environmental Services. The cultural survey broadly included the entire ahupuaʻa of Waikīkī.

## 9.1 Results of Background Research

Background research for this Project yielded the following results (presented in approximate chronological order):

1. Waikīkī was comprised of a vast system of irrigated taro fields which spanned from Waikīkī Kai to the valleys of Mānoa. The Waikīkī marshland was an excellent place to grow taro, even better than the revered areas of Kāneʻohe and Kahaluʻu on the windward side of Oʻahu.

2. The Waikīkī area was full of aquatic resources including hundreds of fishponds which dotted the shoreline of the ahupuaʻa.

3. Six heiau are said to have been associated with the Waikīkī area: Papaʻenaʻena Heiau, Helumoa Heiau, Kapua Heiau, Kūpalaha Heiau, Kamauakapu Heiau and Kulanihakoi Heiau (Thrum 1907:44). Thrum also mentions the Wizard Stones of Kapaemāhū at Waikīkī. The Wizard Stones were unearthed in the late 1800s on the premises of the Cleghorn family. According to moʻolelo, four soothsayers from the court of a Tahiti king came to Hawaiʻi and helped to heal many people. Four large stones were gathered from the vicinity of a "bell rock" in Kaimukī and erected in Waikīkī to commemorate them, two at their habitation and two at their bathing place in the sea. The chief of the wizards, Kapaemahu, named his stone after himself, and a virtuous young chiefess was sacrificed and placed beneath the stone. Today they are located at Kūhiō Beach Park (Thrum 1907:139–141).

4. During the first decade of the twentieth century, the U.S. War Department acquired more than 70 acres in the Kālia portion of Waikīkī for the establishment of a military reservation called Fort DeRussy, named in honor of Brig. Gen. R.E. DeRussy of the Army Corps of Engineers. Between 1909 and 1911 the engineers were primarily occupied with mapping the island of Oʻahu. At DeRussy other activities also had to be attended to - especially the filling of a portion of the fishponds which covered most of the Fort. The Quartermaster Corps took on the job, accomplishing it through the use of a hydraulic dredger which pumped fill from the ocean continuously for nearly a year in order to build up an area on which permanent structures could be built. Thus the Army began the transformation of Waikīkī from wetlands to solid ground. (Hibbard and Franzen 1986:79). In 1980, three partial sets of human remains (State Inventory of Historic Properties [SIHP] #50-80-14-2780) and three subsurface features were inadvertently discovered during construction at the southeastern corner of the Hilton Hawaiian Village Tapa Tower (Neller 1980). Subsurface features consisted of pit

features pre-dating the construction of the Ala Wai Canal. Two pits had undetermined features; however, Neller suggested they were filled-in irrigation ditches. The third pit was a trash pit consisting of ceramic and glass artifacts dating to the late 1890s. A “coffee bean” sinker used for octopus lures was collected from one the pits. The sinker was made of pink granites, an imported material, dating the traditional artifact to the post-Contact period.

5. In 1993, archaeological monitoring was conducted by Biosystems Analysis, Inc. along Kālia Road at Fort DeRussy Military Reservation. Results were written by Garcia and Associates almost four years later (Denham and Pantaleo 1997a). SIHP #50-80-14-4574 consisted of fishpond sediments (Loko Paweo I), three historic trash pits, and two burials. SIHP #50-80-14-4570 consisted of a historic trash pit, four fire pits, an ash lens, and an unknown number of human burials (in six distinct features).

6. In 1992, archaeological data recovery was conducted at Fort DeRussy (Denham and Pantaleo 1997b). Five previously identified sites were investigated (SIHP #50-80-14-4570). SIHP #50-80-14-4970 consisted of an irrigation ditch and bund system. SIHP #50-80-14-4579 revealed numerous features related to permanent historic occupation and possible intermittent prehistoric use (five fire pits, two historic middens, and a human burial). In addition, three fishponds, Loko Paweo I (-4574), Loko Ka‘ihikapu (-4575), and Loko Paweo II (-4576) were identified.

7. In 2009, Pacific Legacy, Inc. conducted an archaeological monitoring for the Hilton Hawaiian Village Grand Waikīkīan Development Project. A previously disturbed human burial (-7087) was found on the mauka side of the intersection of Ala Moana Boulevard and Kālia Road.

8. An oral history compilation was conducted by the University of Hawai‘i’s Center for Oral History (UHCOH) in 1985 to capture the voices of several people with extensive knowledge of the history and culture of Waikīkī. These oral histories describe the Kālia area as excellent grounds for aquaculture including fishing and gathering of limu (seaweed). According to Mr. John C. Ernstberg, various limu including manauea, līpoa, and wāwae‘iole could be found in Waikīkī. Mr. Earle “Liko” Vida recalls fishing for ‘ōpelu, ulua, and pāpio in the Kālia area.

## 9.2 Results of Community Consultation

CSH attempted to contact 123 community members and government agency and community organization representatives for this CIA report; of those, 15 responded and five participated in formal interviews for more in-depth contributions to the CIA. This community consultation indicates:

1. In a written testimony, Mr. Halealoha Ayau of Hui Mālama I Nā Kūpuna O Hawai‘i Nei states that the organization has conducted two reburials in the area. One at the Hilton Hawaiian Village and the other at Fort DeRussy. He suggests that both be identified so they are not disturbed.

2. Mr. Greg Kashiwa of Kupuna LLC, recalls surfing and fishing in the Kālia and Fort DeRussy area. A platform once existed off shore where swimmers could congregate. After the tsunami of 1946 the platform disappeared.
3. During Mr. Kashiwa’s service in the Army, his unit conducted an annual sand replenishment project fronting the Hale Koa hotel. During a routine replenishment, a D9 Cat fell into the ocean causing a coral shelf to collapse. Upon retrieval, a local diver felt fresh water flowing from the rubble. The diver suggested the coral shelf was actually a lava tube connected to the Mō‘ili‘ili fresh water karst and cave system. The Army did not want to draw attention to the problem and did not pursue investigation. Mr. Kashiwa suggests the area “is worth seeing and archaeological traces may remain” within the karst and cave system.
4. In a written response, Kamana‘opono Crabbe of OHA states that “existing documentation from separate projects conducted in the area detail the presence of burials and cultural deposits in the vicinity of the instant project area.” Mr. Crabbe recommends archaeological monitoring during all project activities.
5. Mr. Clarence Medeiros, Jr. describes his great-grandfather, Zen Man Sing (also known as “Zane Man Sing”), a Chinese immigrant who arrived in Hawai‘i in 1888. Mr. Medeiros’ great-grandfather, worked in Waikīkī planting rice and taro with relatives. He describes Waikīkī being “all water, swampland” and having “all lo‘i [irrigated terrace] kind of land around 1890s.”
6. Ms. Sylvia Kreson-Reck lived in Kalihi Valley but spent most of her time in Waikīkī during the late 1930s. Ms. Krewson-Reck became close friends with Joseph Kaopuiki. His nickname was “Scooter Boy.” He was a well-known surfer during that time that was known for riding the biggest wave on the North Shore. He was also Ms. Krewson-Reck’s tandem surfing partner.
7. During Ms. Krewson-Reck’s childhood, she recalls going to classmate Lorna Prendergast’s home in Kapālama. During this visit, she was introduced to Lorna’s grandmother named Ellen. It wasn’t until a decade ago that Ms. Krewson-Reck realized that Lorna’s grandmother was Ellen Wright Prendergast, Queen Lili‘uokalani’s close friend and the woman who wrote “*Kaulana Nā Pua*” or “Famous are the Children,” a symbolic song of the Hawaiian independence movement.
8. Mr. Richard Paglinawan shared the history behind Nā Pōhaku ‘Ola Kapaemahu, or the Life-giving Stones or Kapaemahu and Kapuni, commonly referred to as the Wizard Stones. He also traces the royal lineages of ali‘i in Waikīkī.
9. Mr. Paglinawan’s family regularly visited Waikīkī on Sundays where they visited the zoo, listened to the Royal Hawaiian Band at the Kapi‘olani Park bandstand, swam at San Souci Beach, dove off the diving board at the Natatorium, and listened to music at the International Marketplace in the evenings.

10. Mr. Paglinawan and his family would gather limu and caught heʻe, mullet, pāpio, uhu, and hīnālea.

11. Mr. Becket led CSH to two cultural sites. The first between Waʻahila Ridge and the area known as Kānewai. The site is nestled between a rock face and a steep drop-off. Distinct features such as terracing, a poʻo pōhaku, and scattered cobbles and boulders make-up the site. The site commands an impressive view of Waikīkī. The second site is located in Kamanele Park in Mānoa Valley. The site is on the makai side of the park below the gated grounds of Mid-Pacific Institute. A large natural stone outcropping is noticed at first glance. Behind the large outcropping lies distinct artificial terracing, a possible ahu, and a small rock overhang. A significant feature that Mr. Becket pointed out was an upright stone representing a nanahoa and two stones below representing a kohe. Both heiau have distinct features which indicate they are most likely pre-Contact.

## 9.3 Cultural Impacts and Recommendations

Based on the information gathered for the cultural and historic background and community consultation detailed in this CIA report, the proposed Project may potentially impact Native Hawaiian burials and cultural beliefs. CSH identifies these potential impacts and makes the following recommendations:

1. Mr. Halealoha Ayau and Mr. Kamanaʻopono Crabbe's state that iwi kūpuna (ancestral remains) are located in the Project area, and previous findings in the Project area include three burials and three subsurface features (SIHP #50-80-14-2780; Neller 1980); ten subsurface features and an unknown number of burials (4574 and -4570; Denham and Pantaleo 1997a); an ʻauwai (ditch) and bund system (-4970), a permanent historic occupation site with firepits, midden, and burials (-4579), and three fishponds (-4574 to -4576; Denham and Pantaleo 1997b). In addition, the Project area consists of Jaucas sand deposits, which increases the likelihood of unmarked burials. Further, two additional burials were found in Jaucas sand deposits less than 500 meters south of the Project area, and an additional four burials were found less than 500 meters north of the Project area. From these findings, there is a high possibility that iwi kūpuna may be present within the Project area, and that land-disturbing activities during construction may uncover presently undetected burials or other cultural finds.

2. Personnel involved in the construction activities of the Project should be informed of the possibility of inadvertent cultural finds, including human remains. Should any burials or other cultural finds be identified during ground disturbance, the construction contractor should immediately cease all work and the appropriate agencies notified pursuant to applicable law.

3. CSH and Group 70 International Inc., should consult with the cultural and/or lineal descendants to develop a reinterment plan and cultural preservation plan in the event that any human remains, cultural sites, or artifacts be uncovered during construction for the Project.

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# Appendix A Glossary of Hawaiian Words

To highlight the various and complex meanings of Hawaiian words, the complete translations from Pukui and Elbert (1986) are used unless otherwise noted. In some cases, alternate translations may resonate stronger with Hawaiians today; these are placed prior to the Pukui and Elbert (1986) translations and marked with “(common).”

Diacritical markings used in the Hawaiian words are the ‘okina and the kahakō. The ‘okina, or glottal stop, is only found between two vowels or at the beginning of a word that starts with a vowel. A break in speech is created between the sounds of the two vowels. The pronunciation of the ‘okina is similar to saying “oh-oh.” The ‘okina is written as a backwards apostrophe. The kahakō is only found above a vowel. It stresses or elongates a vowel sound from one beat to two beats. The kahakō is written as a line above a vowel.

| Hawaiian Word | English Translation |
|---|---|
| Ahupua‘a | Land division usually extending from the uplands to the sea |
| ‘Alamihi | Common black crab |
| Ali‘i, ali‘i aimoku | Chief, chiefess, ruler, monarch |
| ‘Āpana | Portion |
| ‘Auwai | Ditch |
| Hālau | Long house for canoes or hula instruction |
| Hana aloha | Love magic, to practice love magic |
| He‘e nalu | To ride a surfboard; surfing; surf rider |
| Heiau | Pre-Christian place of worship, shrine; some heiau were elaborately constructed like a stone platforms or a simple earth terrace |
| Hinu | Body grease |
| Huaka‘i | Trip, voyage |
| ‘Ili | Land section, a subdivision of an ahupua‘a |
| ‘Inamona | Relish made of the cooked kernel of the candlenut (kukui), mashed with salt |

| Hawaiian Word | English Translation |
|---|---|
| Ipu | Bottle gourd |
| Iwi | Bones |
| Iwi kūpuna | Ancestral remains |
| Kahu | Guardian, keeper |
| Kahuna | Priest, sorcerer |
| Kahuna nui | High priest |
| Kalo | Taro |
| Kālua | To bake in an underground oven |
| Kama‘āina | Native-born; literally translating to “land child” |
| Kapa | Tapa, as made from wauke or māmaki bark; clothes or bedclothes of any kind |
| Kapu | Taboo, prohibited |
| Kauwā | Outcast, pariah, slave, untouchable, menial; a caste which lived apart and was drawn on for human sacrifices |
| Kīhei | Shawl, cape |
| Kinolau | Body forms |
| Kiopua | Pond used to raise fish |
| Kohe | Vagina |
| Konohiki | Headman of an ahupua‘a under the chief |
| Kula | Plain, field |
| Kula ‘āina | Upland |
| Kuleana | Right, privilege, concern, responsibility |
| Kumu hula | Hula teacher |

| Hawaiian Word | English Translation |
|---|---|
| Kumulipo | Origin, genesis |
| Kupuna (Kūpuna, plural) | Grandparent, elder |
| Limu | Seaweed |
| Lo‘i | Irrigated terrace, especially for taro but also for rice |
| Loko i‘a | Fish pond |
| Māhele | Portion, division; land division of 1848 known as The Great Māhele |
| Makai | Towards the ocean |
| Maka‘āinana | Commoner |
| Mana | Power |
| Mana‘o | Thought, idea, belief |
| Manini | Reef surgeonfish |
| Mauka | Toward the mountain |
| Mele | Song, anthem |
| Mō‘ī | King, sovereign, monarch |
| Moku | District |
| Mo‘o | Narrow strip of land, smaller than an ‘ili |
| Mo‘olelo | Story, tale, myth |
| Nalu | Wave, surf |
| Nanahoa | Phallic rock |
| Nuku | Moutain pass or gap |
| ‘Ohana | Family |
| ‘Ōhi‘a ‘ai | Mountain apple |

| Hawaiian Word | English Translation |
|---|---|
| ʻOkina | Glottal stop |
| ʻŌkuʻu | Squatting; disease at time of Kamehameha I, perhaps cholera or dysentery; people were squatting (ʻōkuʻu) to defecate |
| ʻŌlelo noʻeau | Proverb, wise saying |
| Oli | Chant that was not danced to, especially with prolonged phrases chanted in one breath, often with a trill (iʻi) at the end of each phrase |
| ʻŌpelu | Mackerel scad |
| Pāpio | Fish, Juvenille jack |
| Paʻu | Skirt |
| Pōhaku | Rock, stone |
| Poʻokanaka | Classification of a heiau; sacrificial heiau |
| Poʻo pōhaku | Head stone with outcropping, usually found at a heiau |
| Pōpolo | The black nightshade; often used for medicinal purposes in Hawaiian culture |
| Tūtū | Grandma |
| ʻUala | Sweet potato |
| Ulua | Fish, Jack |
| ʻUlu maika | Stone used in maika game; bowling, bowling ball |
| Waena | Middle |
| Wahi pana | Legendary place |
| Wana | Sea urchin |
| Wao nahele | Upland forest zone |

# Appendix B Common and Scientific Names for Plants and Animals Mentioned in Interviews

| Common Names | | Possible Scientific Names | | Source |
|---|---|---|---|---|
| Hawaiian | Other | Genus | Species | |
| ‘Ama‘ama | Striped mullet | *Mugil* | *cephalus* | Hoover 1993 |
| He‘e | Octopus | multiple families and species | | Pukui and Elbert 1986 |
| Hinalea | Wrasse | multiple families and species | | Hoover 1993 |
| Limu | Seaweed, algae | *Asparagopsis* | *taxiformis* | Hoover 1993 |
| Pāpio | Juvenille bigeye jack | *Caranx* | *sexfasciatus* | Hoover 1993 |
| Uhu | Parrotfish | multiple families and species | | Hoover 1993 |

# Appendix C Authorization and Release Form

**Cultural Surveys Hawai‘i, Inc.**
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## AUTHORIZATION AND RELEASE FORM

Cultural Surveys Hawai‘i (CSH) appreciates the generosity of the *kūpuna* and *kama‘āina* who are sharing their knowledge of cultural and historic properties, and experiences of past and present cultural practices for the proposed Hilton Hawaiian Village/Fort DeRussy Wastewater System Improvements Project, Waikīkī Ahupua‘a, Honolulu (Kona) District, O‘ahu Island, Tax Map Key: [1] 2-6-005:001. We understand our responsibility in respecting the wishes and concerns of the interviewees participating in our study. Here are the procedures we promise to follow:

1. The interview will not be tape-recorded without your knowledge and explicit permission.
2. If recorded, you will have the opportunity to review the written transcript of our interview with you. At that time you may make any additions, deletions or corrections you wish.
3. If recorded, you will be given a copy of the interview notes for your records.
4. You will be given a copy of this release form for your records.
5. You will be given any photographs taken of you during the interview.

For your protection, we need your written confirmation that:

1. You consent to the use of the complete transcript and/or interview quotes for reports on cultural sites and practices, historic documentation, and/or academic purposes.
2. You agree that the interview shall be made available to the public.
3. If a photograph is taken during the interview, you consent to the photograph being included in any report/s or publication/s generated by this cultural study.

I, ______________________________________, agree to the procedures outlined above and, by my
(Please print your name here)
signature, give my consent and release for this interview to be used as specified.

______________________________________
(Signature)

______________________________________
(Date)