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MAY 08 2016

DEPARTMENT OF ENVIRONMENTAL SERVICES
CITY AND COUNTY OF HONOLULU
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DIRECTOR

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DEPUTY DIRECTOR

ROSS S. TANIMOTO, P.E.
DEPUTY DIRECTOR

IN REPLY REFER TO
PRO 18-073

April 26, 2016

RECEIVED
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OFC. OF ENVIRONMENTAL QUALITY CONTROL

Mr. Scott Glenn, Director
Office of Environmental Quality Control
Department of Health
State of Hawai'i
235 South Beretania Street, Room 702
Honolulu, Hawai'i 96813

Dear Mr. Glenn:

The City and County of Honolulu, Department of Environmental Services has determined that an environmental impact statement (EIS) is required for the proposed Honouliuli Wastewater Treatment Plant Secondary Treatment and Support Facilities project; situated at Tax Map Keys 91013007 and 91069003 in Ewa Beach on the island of Oahu.

Enclosed are the documents for you to publish the notice of availability of the Draft EIS for public comment for 45 days in the next edition of the Environmental Notice. The Draft EIS includes copies of the comments received during the 30-day public consultation period for the EIS Preparation Notice, published on July 12, 2010.

Also enclosed is the required OEQC Publication Form, a copy of the Draft EIS, an electronic PDF file of the same and an electronic copy of the publication form in MS Word, which is also being sent via electronic mail to oeqc@doh.hawaii.gov.

If there are any questions, please contact Jack Pobuk, CIP Program Coordinator, at 768-3464, or by email to jpobuk@honolulu.gov.

Sincerely,

Ross S Tanimoto

for Lori M.K. Kahikina, P.E.
Director

Enclosures

AGENCY
PUBLICATION FORM

Project Name:	Honouliuli/Waipahu/Pearl City Wastewater Facilities Plan, Honouliuli Wastewater Treatment Plant Secondary Treatment and Support Facilities
Project Short Name:	Honouliuli WWTP Fac Plan
HRS §343-5 Trigger(s):	§343-5 (9)
Island(s):	Oahu
Judicial District(s):	Ewa
TMK(s):	91013007 and 91069003
Permit(s)/Approval(s):	<u>Federal:</u> • U.S. Army Corps of Engineers Department of the Army Permit (CWA Section 404; Rivers and Harbors Act Section 10) • U.S. Coast Guard USCG Section 9 Permit Applicability Guidance • U.S. Environmental Protection Agency NPDES Form 2A – Discharge of Municipal Wastewater from New and Existing Publicly Owned Treatment Works) • U.S. Fish and Wildlife Service Section 7 Review <u>State of Hawaii:</u> • Department of Business, Economic Development and Tourism, Office of Planning Coastal Zone Management Consistency Determination • Department of Health (DOH) Air Pollution Control Permits (Covered Source Permit and/or Noncovered Source Permit) Construction Plan Review and Approval Noise Variance Permit NPDES NOI Form C – Storm Water Discharges Associated with Construction Activities NPDES NOI Form F – Discharges Associated with Hydrotesting Waters NPDES NOI Form G – Discharges Associated with Construction Activity Dewatering Section 401 Water Quality Certificate • Department of Land and Natural Resources Historic Preservation Division Chapter 6E, HRS Historic Preservation Review • Department of Transportation (DOT) Highways – Permit to Perform Work Within State Highways Harbors – Work within the Energy Corridor <u>City and County of Honolulu:</u> • Board of Water Supply (BWS) Water and Water System Requirements Construction Plan Review and Approval • Department of Environmental Services EIS Approval • Department of Planning and Permitting (DPP) Building Permit Construction Plan Review and Approval Development Plan Public Facilities Map Amendment Dewatering Permit Electrical Permit Grading and Erosion Control Plan Review Grading, Grubbing, and Stockpiling Permit Plumbing Permit Shoreline Setback Variance Sidewalk/Driveway Work Permit Special Management Area Use Permit (Major)

	Street Usage Permit
Proposing/Determining Agency:	City and County of Honolulu, Department of Environmental Services
Contact Name, Email, Telephone, Address	Marisol Olaes, molaes@honolulu.gov, 808.768.3467, 1000 Uluohia Street, Suite 308, Kapolei, HI 96707
Accepting Authority:	Mayor of the City and County of Honolulu
Contact Name, Email, Telephone, Address	Mayor of the City and County of Honolulu Honolulu Hale 530 South King Street, Room 306 Honolulu, Hawaii 96813
Consultant:	AECOM, 1001 Bishop St. Suite 1600, Honolulu, HI 96813
Contact Name, Email, Telephone, Address	Anne Symonds P. E. , Anne.Symonds@aecom.com, 808.529.7280, 1001 Bishop Street Suite 1600, Honolulu, HI 96813

Status (select one)	**Submittal Requirements**
____ DEA-AFNSI	Submit 1) the proposing agency notice of determination/transmittal letter on agency letterhead, 2) this completed OEQC publication form as a Word file, 3) a hard copy of the DEA, and 4) a searchable PDF of the DEA; a 30-day comment period follows from the date of publication in the Notice.
____ FEA-FONSI	Submit 1) the proposing agency notice of determination/transmittal letter on agency letterhead, 2) this completed OEQC publication form as a Word file, 3) a hard copy of the FEA, and 4) a searchable PDF of the FEA; no comment period follows from publication in the Notice.
____ FEA-EISPN	Submit 1) the proposing agency notice of determination/transmittal letter on agency letterhead, 2) this completed OEQC publication form as a Word file, 3) a hard copy of the FEA, and 4) a searchable PDF of the FEA; a 30-day comment period follows from the date of publication in the Notice.
____ Act 172-12 EISPN ("Direct to EIS")	Submit 1) the proposing agency notice of determination letter on agency letterhead and 2) this completed OEQC publication form as a Word file; no EA is required and a 30-day comment period follows from the date of publication in the Notice.
__X__ DEIS	Submit 1) a transmittal letter to the OEQC and to the accepting authority, 2) this completed OEQC publication form as a Word file, 3) a hard copy of the DEIS, 4) a searchable PDF of the DEIS, and 5) a searchable PDF of the distribution list; a 45-day comment period follows from the date of publication in the Notice.
____ FEIS	Submit 1) a transmittal letter to the OEQC and to the accepting authority, 2) this completed OEQC publication form as a Word file, 3) a hard copy of the FEIS, 4) a searchable PDF of the FEIS, and 5) a searchable PDF of the distribution list; no comment period follows from publication in the Notice.
____ FEIS Acceptance Determination	The accepting authority simultaneously transmits to both the OEQC and the proposing agency a letter of its determination of acceptance or nonacceptance (pursuant to Section 11-200-23, HAR) of the FEIS; no comment period ensues upon publication in the Notice.
FEIS Statutory Acceptance	Timely statutory acceptance of the FEIS under Section 343-5(c), HRS, is not applicable to agency actions.
____ Supplemental EIS Determination	The accepting authority simultaneously transmits its notice to both the proposing agency 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 or is not required; no EA is required and no comment period ensues upon publication in the Notice.
____ Withdrawal	Identify the specific document(s) to withdraw and explain in the project summary section.
____ Other	Contact the OEQC if your action is not one of the above items.

Project Summary

The evaluation described in this Draft Environmental Impact Statement (DEIS) is focused on the upgrade of the Honouliuli WWTP required to comply with a First Amended Consent Decree. This DEIS for the Honouliuli WWTP is intended to inform the public and various stakeholders of potential impacts the project may have on the environment and has been prepared in accordance with the Hawaii Revised Statutes Chapter 343.

This project proposes to upgrade and expand the existing Honouliuli WWTP to provide secondary treatment and accommodate projected wastewater flows.

Regardless of which treatment alternative is selected, additional improvements at the Honouliuli WWTP are proposed for the following: Central Laboratory, Ocean Team Facilities, Administration Building, Operations Building, Leeward Region Maintenance, Central Shops, Warehouse, truck wash, central supervisory control and data acquisition operations, septage receiving station, odor control, grounds keeping, janitorial service and security, and Honouliuli Water Recycling Facility. This DEIS also addresses the potential siting of new facilities at the Honouliuli WWTP to help consolidate island-wide wastewater system administrative services.

Improvements to the Honouliuli major sewer conveyance system will be the subject of separate, subsequent environmental review documents.

AECOM Water

Submitted to:
City and County of Honolulu
Department of Environmental Services
1001 Uluohia Street, Suite 308
Kapolei, Hawaii 96707

Prepared by:
AECOM
1001 Bishop Street, Suite 1600
Honolulu, Hawaii 96813

Honouliuli/Waipahu/Pearl City Wastewater Facilities Plan

Environmental Impact Statement

Honouliuli Wastewater Treatment Plant Secondary Treatment and Support Facilities

Environmental Impact Statement–Draft
April 2016

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Glossary of Acronyms and Technical Terms

%	Percent
§	Section
°F	Degree Fahrenheit
ADF	Average Daily Flow
Admin	Administration
ALISH	Agricultural Lands of Importance to the State of Hawaii
AS	Activated Sludge
ATA	Austin Tsutsumi & Associates, Inc.
Bldg	Building
BMP	Best Management Practices
BOD	Biochemical Oxygen Demand
BWS	Board of Water Supply, City and County of Honolulu
CAA	Clean Air Act
CBOD	Carbonaceous Biochemical Oxygen Demand
CCD	Census County Divisions
CCH	City and County of Honolulu
CDP	Census-Designated Place
cfm	Cubic Feet per Minute
CFR	Code of Federal Regulations
CHP	Combined Heat and Power
CO	Carbon Monoxide
CSH	Cultural Surveys Hawai'i, Inc.
CSM	Collection System Maintenance
CWB	Clean Water Branch
CZM	Coastal Zone Management
dB	decibel
dBA	Decibel A-weighted filter (a decibel rating commonly used for measuring sound levels)
DBEDT	Hawaii Department of Business, Economic Development, and Tourism
DDC	Department of Design and Construction
DEIS	Draft Environmental Impact Statement
DEM	Department of Emergency Management
DFM	Department of Facility Maintenance
DHHL	Department of Hawaiian Home Lands
DLNR	Department of Land and Natural Resources, State of Hawaii
DNL	Day-Night Average Sound Level (a system that models the average noise levels over a 24-hour period, typically an average day over the course of a year)
DOH	Department of Health, State of Hawaii
DP	Development Plan
DPP	Department of Planning and Permitting
DPW	Department of Public Works
dtpd	dry tons per day
DWM	Department of Wastewater Management
EA	Environmental Assessment
EIS	Environmental Impact Statement
EJ	Environmental Justice
ENV	Department of Environmental Services
EPA	Environmental Protection Agency, United States
ESA	Endangered Species Act
FACD	First Amended Consent Decree
FEA-EISPN	Final Environmental Assessment-Environmental Impact Statement Preparation Notice
FEIS	Final Environmental Impact Statement

FEMA	Federal Emergency Management Agency
FHA	Federal Housing Administration
Final Sewer I/I Plan	Final Sewer Infiltration and Inflow Plan
FIRM	Flood Insurance Rate Map
FOG	Fats, Oils, and Greases
ft	Feet/Foot
FTE	Full Time Equivalent
FPPA	Farmland Protection Policy Act
GAC	Granular Activated Carbon
GBT	Gravity Belt Thickeners
GHG	Greenhouse Gas
GIS	Geographic Information System
H_2S	Hydrogen Sulfide
HAR	Hawaii Administrative Rules
HDoD	State of Hawaii Department of Defense
HECO	Hawaii Electric Company, Inc.
HEPA	Hawaii Environmental Policy Act
HFD	Honolulu Fire Department
HHCTCP	Honolulu High-Capacity Transit Corridor Project
HoLIS	Honolulu Land Information System
Honouliuli Fac Plan	Honouliuli/Waipahu/Pearl City Wastewater Facilities Plan
Honouliuli WWTP	Honouliuli Wastewater Treatment Plant
HPD	Honolulu Police Department
H-POWER	Honolulu Program of Waste Energy Recovery
HRS	Hawaii Revised Statues
HUD	Federal Department of Housing and Urban Development
HWRF	Honouliuli Water Recycling Facility
I/I	Infiltration/Inflow
I/I Study	Sewer Rehabilitation and Infiltration & Inflow Minimization Study, Volumes 1 to 9
IBC	International Building Code
IPS	Influent Pump Station
IWS	Individual Wastewater System
kWh	Kilowatt Hour
LID	Low Impact Development
LOS	Level of Service
LUC	Land Use Commission
LUO	Land Use Ordinance
MBTA	Migratory Bird Treaty Act
MG	Million Gallons
mg/L	Milligram Per Liter
mgd	Million Gallons per Day
mi.	Mile
MSL	Mean Sea Level
mph	mile per hour
NAAQS	National Ambient Air Quality Standards
NH_3	Ammonia
NOI	Notice of Intent
NO_2	Nitrogen Dioxide
NOx	Nitrogen Oxides
NPDES	National Pollutant Discharge Elimination System
NRCS	Natural Resource Conservation Service
NTU	Nephelometric Turbidity Unit
NWI	National Wetland Inventory
O&M	Operation and Maintenance
O_3	Ozone
OEQC	Office of Environmental Quality Control

ORMP	Hawaiʻi Ocean Resources Management Plan
Pb	Lead
$PM_{2.5}$	Particulate Matter (diameter ≤ 2.5 micrometers)
PM_{10}	Particulate Matter (diameter ≤ 10 micrometers)
ppmV	Parts per Million by Volume
PSRP	Process to Significantly Reduce Pathogens
PUC	Primary Urban Center
PV	Photovoltaic
RAS	Return Activated Sludge
ROI	Region of Influence
RSS	Return Secondary Sludge
SC	Solids Contact
SCADA	Supervisory Control and Data Acquisition
SCAP	Stream Channel Alteration Permit
SCP	Sustainable Communities Plan
SCS	Soil Conservation Service
SFAS	Sewer Flow Analysis System
SHPD	State Historic Preservation Division
SO_2	Sulfur Dioxide
SSO	Sanitary Sewer Overflow
State	State of Hawaii
SWD	Side Water Depth
TF	Trickling Filter
TF/SC	Trickling Filter/Solids Contact
TIAR	Traffic Impact Analysis Report
TS	Total Solids
TSS	Total Suspended Solids
UA	Urbanized Area
UFC	Uniform Fire Code
UHWO	University of Hawaii at West Oahu
U.S.	United States
USCB	United States Census Bureau
USDA	United States Department of Agriculture
USFWS	United States Department of the Interior, Forestry and Wildlife Service
UV	Ultraviolet
v/c	volume to capacity
VOC	Volatile Organic Compound
WAS	Waste Activated Sludge
Wastewater Design Standards	Design Standards of the Department of Wastewater Management, Volume 1 (1993) and Design Standards of the Division of Wastewater Management, Volume 2 (1984)
WSS	Waste Secondary Sludge
WTD	Wastewater Treatment and Disposal
wtpd	wet tons per day
WWTP	Wastewater Treatment Plant

Preface

This Draft Environmental Impact Statement (DEIS) was prepared pursuant to Chapter 343, Hawaii Revised Statutes (HRS), and Title 11, Chapter 200, Administrative Rules, State of Hawaii Department of Health (DOH). The City and County of Honolulu (CCH) Department of Environmental Services (ENV) proposes to upgrade the Honouliuli Wastewater Treatment Plant (WWTP) on the island of Oahu to provide full secondary treatment and expand the facility to accommodate future projected wastewater flow. This includes the potential relocation of non-process facilities (including Administrative support, central supervisory control and data acquisition operations, Laboratory, Ocean Team, Central Shops and the Central Warehouse) that support island-wide wastewater system functions that are currently located at Sand Island WWTP to the Honouliuli WWTP site. The upgrade of the Honouliuli WWTP is required by the First Amended Consent Decree (FACD) described in further detail below.

The CCH ENV is currently preparing the Honouliuli/Waipahu/Pearl City Wastewater Facilities Plan, which updates portions of the West Mamala Bay Facilities Plan (2001) for the Honouliuli sewer basin. The Honouliuli sewer basin encompasses the areas from which current wastewater flows into the Honouliuli WWTP including Halawa, Aiea, Pearl City, Waipio, Waikele, Waipahu, Ewa, Kapolei, and Mililani. The United States (U.S.) Navy facilities at Pearl Harbor and Campbell Industrial Park are excluded because their wastewater does not flow to the CCH system.

The 2010 Consent Decree (Civil No. 94–00765 DAE–KSC) between CCH, DOH, and U.S. Environmental Protection Agency (EPA), now referred to as the FACD, requires CCH to meet certain requirements with respect to its wastewater collection system and WWTPs. In the FACD the CCH agreed to implement measures in its collection system that include the following: repair and replacement of sewers, force mains, and wastewater pump stations; development of condition assessments and spill contingency plans for force mains; development of condition assessments and a systematic cleaning program for gravity mains; and development of a control program for the discharge of grease. In addition, the CCH agreed to complete improvements to the Honouliuli and Sand Island WWTPs. The Honouliuli WWTP must be upgraded to fully meet secondary treatment standards by June 1, 2024. The Sand Island WWTP (which is the subject of a separate DEIS) must be upgraded to meet secondary treatment standards by December 31, 2035, with the possibility of extending the deadline to December 31, 2038. The FACD provides for interim effluent limits that both plants must meet until they achieve full secondary treatment.

The CCH ENV, the proposing agency, has determined that the proposed alternative actions for the Honouliuli WWTP require the preparation of an Environmental Impact Statement. The Final Environmental Assessment-Environmental Impact Statement Preparation Notice (FEA-EISPN) submitted for this project and published in *The Environmental Notice* in July 2010 examined potential impacts associated with proposed upgrades to and/or expansion of the Honouliuli major sewer conveyance system in addition to the Honouliuli WWTP itself. The FEA-EISPN predates the issuance of the FACD described above. Since the FEA-EISPN submittal, the focus of the Honouliuli Fac Plan has shifted to the Honouliuli WWTP improvements necessary to comply with the FACD and meet the June 1, 2024 upgrade deadline. Meanwhile, the timeline for planning and engineering efforts for the conveyance system improvements required to accommodate future wastewater flows associated with projected growth in the sewer basin is independent of the June 1, 2024 upgrade deadline, and the recommendations for the conveyance system are still under consideration.

Therefore, this DEIS only concerns the upgrade and expansion of the Honouliuli WWTP to provide secondary treatment and accommodate projected wastewater flows, as well as addresses the potential location of non-process facilities to accommodate future needs that will arise from upgrading Honouliuli and Sand Island WWTPs to secondary treatment, and other treatment and collection system support facilities improvements. The improvements to the conveyance system and other FACD requirements will be the subject of separate Hawaii Environmental Policy Act (HEPA) environmental review documents to be prepared and submitted when the system improvements are better defined. The CCH ENV communicated this HEPA review approach to the Office of Environmental Quality Control (OEQC) and received OEQC’s concurrence (OEQC 2013).

Several alternatives (herein referred to as options) were considered for secondary treatment upgrades for the Honouliuli WWTP, including:

- Option 1 (includes Sub-options 1A and 1B) – Expand Existing Trickling Filter/Solids Contact (TF/SC) Process to Full Capacity
- Option 2 – Replace Existing TF/SC Process with Activated Sludge (AS) to Full Capacity
- Option 3 (includes Sub-options 3A and 3B) – Add to Existing TF/SC Process with AS to Full Capacity

A "No Action" alternative was also assessed. The proposed upgrades are sized for a projected 2050 design average daily flow (ADF) of 45 mgd. Following an evaluation of each option/sub-option, Option 2 was selected as the preferred alternative, as it meets project needs and criteria and would have the smallest footprint and lowest cost.

This DEIS will be submitted to the OEQC for publication in *The Environmental Notice* and will be available to the public in addition to various Federal, State and CCH agencies. Following the DEIS, a Final Environmental Impact Statement (FEIS) will be prepared to assess the overall environmental impacts of the recommended alternative. This DEIS has been, and the FEIS will be, prepared in compliance with HRS Chapter 343. As part of the environmental process, there is a 45-day review and comment period and informational meetings after the publication of the DEIS. The FEIS will be prepared after the comment period.

During preparation of the FEA-EISPN, various stakeholders and residents were consulted and notified of the proposed upgrades/expansion of the Honouliuli major conveyance system and Honouliuli WWTP from meetings and pre-assessment letters (see Appendix H for a summary of responses to comments and comment letters). Following the submittal of this DEIS, additional meetings will be held to answer questions or comments the public may have on the DEIS. The locations of these meetings will be accessible to the public, including people with disabilities.

Summary Sheet

Project Name	Honouliuli/Waipahu/Pearl City Wastewater Facilities Plan: Honouliuli Wastewater Treatment Plant Secondary Treatment and Facilities
Proposing Agency	City and County of Honolulu (CCH) – Department of Environmental Services (ENV) 1000 Uluohia Street, Suite 308 Kapolei, Hawaii 96707 Lori Kahikina, P.E., Director
Accepting Authority	CCH – ENV 1000 Uluohia Street, Suite 308 Kapolei, Hawaii 96707 Lori Kahikina, P.E., Director
Location	Ewa District, Oahu, Hawaii
Project Area	The project area includes the existing Honouliuli WWTP site and the recently acquired parcel adjacent to the existing WWTP to the north and east (expansion area).
Tax Map Keys	Honouliuli WWTP: 9-1-013:007 and 9-1-069:004 Honouliuli WWTP Expansion Area: 9-1-069:003
Brief Description of the Action	The evaluation described in this Draft Environmental Impact Statement (DEIS) is focused on the upgrade of the Honouliuli WWTP required to comply with a First Amended Consent Decree. This DEIS for the Honouliuli WWTP is intended to inform the public and various stakeholders of potential impacts the project may have on the environment and has been prepared in accordance with the Hawaii Revised Statutes Chapter 343. This project proposes to upgrade and expand the existing Honouliuli WWTP to provide secondary treatment and accommodate projected wastewater flows. The project may also result in a future increase in effluent discharged to Mamala Bay via the Barbers Point Deep Ocean Outfall. Regardless of which treatment alternative is selected, additional improvements at the Honouliuli WWTP are proposed for the following: Central Laboratory, Ocean Team Facilities, Administration Building, Operations Building, Leeward Region Maintenance, Central Shops, Warehouse, truck wash, central supervisory control and data acquisition operations, septage receiving station, odor control, grounds keeping, janitorial service and security, and Honouliuli Water Recycling Facility. This DEIS also addresses the potential siting of new facilities at the Honouliuli WWTP to help consolidate island-wide wastewater system administrative services. Improvements to the Honouliuli major sewer conveyance system will be the subject of separate, subsequent environmental review documents.

Significant Beneficial and Adverse Impacts and Proposed Mitigation Measures	<u>Short-Term Impacts:</u> The proposed project would result in some unavoidable short-term impacts, as described below. These potential impacts are generally minor and would be further minimized through the implementation of BMPs. • Soils – Construction activities would result in unavoidable impacts to soils in the project area due to grading and excavation activities and due to the potential for localized contamination of soils from construction activities (i.e., accidental release of construction equipment fluids). Construction methods to preserve the integrity of existing facilities would be implemented and construction equipment would be maintained in good working condition to reduce the potential for accidental spills. In addition, erosion and sedimentation controls would be implemented to reduce impacts to the natural environment. Soil which is not immediately used for backfilling would be stockpiled and covered or otherwise protected to prevent erosion or sedimentation. In addition, temporary seeding and mulching may be used to minimize soil erosion and provide soil stabilization on slopes. • Groundwater – Construction activities could potentially impact groundwater if encountered during construction. Mitigation measures would be implemented during construction activities to preserve the integrity of existing infrastructure and keep construction equipment in good working condition to prevent accidental spills. Also, dewatering may be necessary for construction below the groundwater table, if necessary, and the construction contractor would be required to include provisions for dewatering. Appropriate BMPs, monitoring of groundwater for contaminants and careful site preparation would be utilized to minimize adverse impacts. Proposed designs would comply with stormwater runoff requirements, pursuant to the Clean Water Act. • Wetlands – It is anticipated that an abandoned irrigation ditch located on the project site would need to be filled to construct the various site components in that location. All work would be performed in accordance with Federal, State, and CCH regulatory requirements including, but not limited to the Section 404 of the Clean Water Act, if applicable. The project team would consult with the Army Corps of Engineers, U.S. Fish and Wildlife, DLNR Commission on Water Resource Management, CCH, and other regulatory agencies, as necessary, to determine whether filling the former irrigation ditch is jurisdictional under current regulations. If the ditch is determined to be jurisdictional by one or more agencies, then the project team would work with the appropriate agencies to determine acceptable mitigation options. • Flora – Vegetation would need to be removed within the expansion property area for construction activities. Native Hawaiian plants are recommended for landscaping within the project area, including species such as: koʻoloaʻula, kou, ʻilieʻe, and ʻaʻaliʻi to minimize unavoidable impacts to vegetation and trees. • Air Quality - Construction-related air quality impacts would result from site preparation and earth moving activities, the movement of construction vehicles on unpaved areas of the site, emissions from construction equipment, and construction of structures. The construction contractor is responsible for complying with DOH regulations which prohibit visible dust emissions at property boundaries. Although short-term air quality impacts are anticipated to be less than significant, the presence of nearby residences and buildings near the project site suggests that open-air areas and naturally ventilated structures could be impacted by dust in spite of compliance with these regulations. BMPs to control dust emissions would be implemented to minimize visible fugitive dust emissions at the property line. The BMPs would include watering of active work areas,

Significant Beneficial and Adverse Impacts and Proposed Mitigation Measures (Continued)	using wind screens, keeping adjacent paved roads clean, and covering open-bodied trucks. Measures to control construction emissions from equipment and vehicles can also be considered if necessary, such as using newer equipment and reducing on-site truck idling time. In addition, increased vehicular emissions due to disruption of traffic by construction equipment and/or commuting construction personnel can be alleviated by moving construction materials and workers to the site during off-peak traffic hours. • Noise – Construction noise would be unavoidable during the project construction period. Short-term increases in noise levels would result from construction activities, vehicles and equipment. The use of muffled equipment, noise barriers, and restrictions on construction hours, as well as adherence to DOH regulations on noise mitigation, would minimize construction and traffic-related noise. For construction work to be performed at night or on weekends and holidays, a Community Noise Variance permit from the DOH would be required if it exceeds regulatory noise levels. • Traffic – An unavoidable slight increase in entering and exiting proposed project traffic is anticipated in some areas during construction activities. Therefore, roadway improvements, including road widening, are recommended at the affected intersections. • Visual and Aesthetic Resources – During construction activities, the presence of cranes and other heavy construction equipment would alter a portion of the viewshed from nearby buildings within the WWTP site. In addition, the proposed improvements would alter the viewshed of the surrounding area by adding new three-dimensional, man-made features. During construction, fencing surrounding the construction site may be provided as needed to provide a visual screen. Any construction impacts regarding visual aesthetics are expected to be short-term and would cease after construction. <u>Long-Term Impacts:</u> The following unavoidable long-term impacts may result from development of the proposed project . • Soils – Following upgrades to the existing WWTP, the potential would still remain for wastewater spills to occur which could result in soil contamination. Soils stability inspections in the vicinity of the foundations of proposed facilities would need to be conducted periodically. • Water Quality – The proposed project will provide wastewater treatment facilities needed to comply with secondary treatment standards. It is also anticipated to have beneficial impacts due to expansion of the WWTP to handle flows from future population increases and development. . • Sludge – There will be an increase in the amount of sludge that is produced, handled, and disposed of due to the upgrade to secondary treatment. • Groundwater – The stormwater detention/infiltration basins proposed at several locations within the project area may have an effect on the local groundwater table. However, these basins would be designed as part of a larger stormwater BMP system and are therefore anticipated to enhance the quality of stormwater recharge to groundwater. In addition, localized effects on groundwater levels may occur due to the potential reduction to local groundwater recharge. • Surface and Coastal Waters – There is a potential for indirect impacts due to additional development allowed by sewered areas, including an increase in wastewater flow to the Honouliuli WWTP and effluent discharged to Mamala Bay.

Significant Beneficial and Adverse Impacts and Proposed Mitigation Measures (Continued)	• Air Quality – The primary air quality concern associated with the proposed project could be potential odor nuisances. The proposed alternatives include odor control for some of the existing facilities and all new facilities. Compliance with all applicable ambient standards, including odor in terms of H_2S concentration levels, would be demonstrated 1) during the final design stage of the project when the air permit is modified for applicable criteria pollutants and 2) after the completion of construction with an ambient monitoring program for odor. There is potential to increase on-site stationary and mobile source emissions due to an increase in the plant operational capacity. However, the possibility of nuisance odor from the Honouliuli WWTP would likely be reduced by the upgrade to the odor control system, which would help minimize nuisance odor downwind of the Honouliuli WWTP. Operation of the plant under future proposed conditions would involve installation of new standby generators to provide expanded emergency power supply, which may cause potential short-term increase in combustion source emissions. However, given their emergency usage purposes, potential air quality impacts would be short in duration and would be unlikely to cause significant air quality impacts. Thus, mitigation measures would unlikely be necessary during the operational period. If a CHP facility is incorporated at the Honouliuli WWTP, it would need to be permitted according to State and Federal air regulations, as operation of the facility has the potential to produce additional emissions over the long term. The potential air emissions from the facility cannot be defined at this time, since the design is currently conceptual, but would be specified in air quality permit applications. • Traffic – An unavoidable slight increase in entering/exiting project traffic is anticipated during peak hours as a result of the proposed project. Road improvements are proposed to minimize long term local impacts to traffic. • Noise – The adverse noise impacts resulting from the proposed activity may include increased vehicular noise due to additional vehicles traveling to and from the facilities, and increased stationary noise resulting from new equipment at the facilities. During the operation of the project, compliance with the DOH property line noise limits for fixed machinery would also be required, and it is expected that the long-term noise impacts associated with the proposed improvements would be minimized by the adherence to the DOH rules regarding noise limits for fixed machinery. Mitigation measures include soundproofing or muffling equipment noise such that noise levels remain below the maximum allowable levels. All CCH wastewater facilities must comply with the noise requirements of the DOH, pursuant to Chapter 46, Title 11, Community Noise Control, HAR. • Energy Consumption – Implementation of the proposed project would increase demand in energy consumption as all alternatives involve operation of new pumps, blowers, and other equipment required to convey and treat wastewater, which would require use of fuel and electricity. There is a potential for energy recovery from digester gas or by utilizing new emerging technology for gasification of sewage sludge. CCH is currently evaluating alternatives to use the digester gas for energy recovery.
Alternatives Considered	Alternatives considered for the WWTP upgrade include the following treatment upgrades: • No Action Alternative • Option 1 – Expand Existing Trickling Filter/Solids Contact (TF/SC) Process to Full Capacity • Option 2 – Replace Existing TF/SC Process with Activated Sludge (AS) to Full Capacity • Option 3 – Add to Existing TF/SC Process with AS to Full Capacity

Unresolved Issues	Project descriptions for every treatment option offer conceptual designs based on available information. It is likely that adjustments will need to be made as the detailed design of the selected option proceeds. As such, the conceptual designs should be regarded as estimates and approximations. The proposed site layout presented in this DEIS is intended to conceptualize the potential for land use at the Honouliuli WWTP site for the ultimate build-out in Year 2050. It is anticipated that further changes to the site layout, support structures, and buildings will occur as part of later detailed design efforts and results of additional environmental review would be included in future documentation. The Honouliuli Wastewater Basin Odor Control Project is ongoing. The project scope addresses odor and corrosion concerns in both the WWTP and tributary collection system. Design of improvements is anticipated to be completed by mid to late 2016. An additional environmental review will be conducted and included in documentation for proposed improvements which are not included in this DEIS. The project assessed in this DEIS only concerns the upgrade and expansion of the Honouliuli WWTP to provide secondary treatment and accommodate projected wastewater flows, as well as addresses the potential relocation of non-process facilities that support island-wide wastewater system functions that are currently located at Sand Island WWTP to the Honouliuli WWTP site. The required environmental review associated with the Honouliuli WWTP upgrades, including estimating the flows that will be conveyed to the WWTP, is included in this DEIS. The improvements to the conveyance system will be the subject of separate environmental review documents to be prepared and submitted when the system improvements are better defined.
Compatibility with Land Use Plans and Policies	State Land Use – The project site is located in the following state land use districts: Urban and Agriculture. The proposed uses are permissible uses in these districts. Zoning – Zoning of the site is Restricted Agriculture District (AG-1) and Intensive Industrial District (I-2). All proposed activities at the site are allowed uses. Compatibility with State and Local Land Use Plans – The project alternatives generally conform with the various relevant land use plans, policies and regulatory controls, including, but not limited to, the Hawaii State Plan, Recreation State Functional Plan, Historic Preservation State Functional Plan, State Coastal Zone Management Program, Ocean Recreation Management Plan, and the CCH's General Plan, Primary Urban Center Development Plan, Central Oahu Sustainable Communities Plan, and Ewa Development Plan. Flood Insurance Rate Map – The Project Area is not located within a flood zone.

Required and Potential Permits and Approvals	Required and potential clearances and permits needed from the various Federal, State and CCH agencies include but are not limited to the following: **Federal:** U.S. Army Corps of Engineers Department of the Army Permit (CWA Section 404; Rivers and Harbors Act Section 10) U.S. Environmental Protection Agency: CWA Section 301(h) Review **State of Hawaii:** Department of Business, Economic Development and Tourism, Office of Planning: Coastal Zone Management Consistency Determination Department of Health (DOH): Air Pollution Control Permits (Covered Source Permit and/or Noncovered Source Permit) Construction Plan Review and Approval Noise Variance Permit Clean Water Branch (CWB) Individual NPDES Form – Coverage for Discharge of Municipal Wastewater from New and Existing Publicly Owned Treatment Works (Modification) CWB NOI Form – Coverage under the NPDES General Permit for Storm Water Discharges Associated with Construction Activities CWB NOI Form – Coverage under the NPDES General Permit for Discharges Associated with Construction Activity Dewatering (if required) Department of Land and Natural Resources – Commission on Water Resource Management Stream Channel Alteration Permit (SCAP) **City and County of Honolulu (CCH):** Board of Water Supply (BWS): Water and Water System Requirements Construction Plan Review and Approval Department of Transportation Street Usage Permit for Construction Department of Environmental Services: EIS Approval Permission to Discharge into CCH storm drain system (required for CWB NPDES stormwater permits) Department of Planning and Permitting (DPP): Building Permit Conditional Use Permit Construction Plan Review and Approval Public Infrastructure Map Revision Dewatering Permit Electrical Permit Flood Certification Grading and Erosion Control Plan Review Grading, Grubbing, and Stockpiling Permit Plumbing Permit Shoreline Setback Variance Sidewalk/Driveway Work Permit Trenching Permit **Other:** Utility Companies Utility Service Requirements Permit Regarding Work on Utility Lines OR&P RR Crossing Traffic Control Plans

1 INTRODUCTION

The City and County of Honolulu (CCH) Department of Environmental Services (ENV) is conducting a planning and engineering study for improvements to the Honouliuli sewer basin wastewater conveyance and treatment facilities required to meet service demands for the year 2035 and beyond. The CCH ENV is undertaking the study to confirm that public investment in essential wastewater infrastructure is directed toward system improvements that provide the greatest benefit to current and future users.

The Honouliuli/Waipahu/Pearl City Wastewater Facilities Plan (Honouliuli Fac Plan) updates the existing West Mamala Bay Facilities Plan (2001). The updating process involves reviewing and evaluating the alternatives and recommendation of the West Mamala Bay Facilities Plan to identify alternatives for the current Honouliuli Fac Plan.

The 2010 Consent Decree (Civil No. 94–00765 DAE–KSC) between CCH, DOH, and U.S. Environmental Protection Agency (EPA), now referred to as the First Amended Consent Decree (FACD), requires CCH to update its wastewater collection system and WWTPs. In the FACD, the CCH agreed to implement measures in its collection system that include the following: repair and replacement of sewers, force mains, and wastewater pump stations; development of condition assessments and spill contingency plans for force mains; development of condition assessments and a systematic cleaning program for gravity mains; and development of a control program for the discharge of grease. In addition, the CCH agreed to complete improvements to the Honouliuli and Sand Island WWTPs. One of the key FACD requirements is that the Honouliuli WWTP be upgraded to a full secondary treatment facility by 2024. Therefore, the Honouliuli Fac Plan evaluates and recommends the necessary improvements to upgrade the Honouliuli WWTP to full secondary treatment to comply with the FACD.

The CCH ENV, the proposing agency, has determined that the proposed alternative actions require the preparation of an Environmental Impact Statement (EIS). The Final Environmental Assessment-Environmental Impact Statement Preparation Notice (FEA-EISPN) submitted for this project and published in *The Environmental Notice* in July 2010 examined potential impacts associated with proposed upgrades to and/or expansion of the Honouliuli major sewer conveyance system in addition to the Honouliuli WWTP itself. The FEA-EISPN predates the issuance of the FACD referenced above. Since the FEA-EISPN submittal, the focus of the Honouliuli Fac Plan has shifted to the Honouliuli WWTP improvements necessary to comply with the FACD and meet the June 1, 2024 upgrade deadline. Meanwhile, the timeline for planning and engineering efforts for the conveyance system improvements required to accommodate future wastewater flows associated with projected growth in the sewer basin is independent of the June 1, 2024 upgrade deadline, and the recommendations for the conveyance system are still under consideration.

Therefore, the project assessed in this Draft Environmental Impact Statement (DEIS) only concerns the upgrade and expansion of the Honouliuli WWTP to provide secondary treatment and accommodate projected wastewater flows, as well as addresses the potential relocation of non-process facilities (including Administrative support, Central Supervisory Control and Data Acquisition [SCADA] operations, Laboratory, Ocean Team, Central Shops and the Central Warehouse) that support island-wide wastewater system functions that are currently located at Sand Island WWTP to the Honouliuli WWTP site. The improvements to the conveyance system and other FACD requirements will be the subject of separate HEPA environmental review documents to be prepared and submitted when the system improvements are better defined. The CCH ENV communicated this HEPA review approach to OEQC and received OEQC's concurrence (OEQC 2013).

1.1 Background

The Honouliuli WWTP was originally built in 1978 as a primary plant and became operational in 1984. As of December 16, 1993, the Honouliuli WWTP operated under NPDES No. HI0020877. The CCH applied to the U.S. Environmental Protection Agency (EPA) to renew the permit before it expired on June 5, 1996. In 2009, the EPA denied reissuing the permit. The Honouliuli WWTP operated under an administrative extension of the permit after it expired in 1996. The NPDES permit was then reissued by the DOH for the Honouliuli WWTP, which became effective March 30, 2014.

The WWTP provides primary treatment to all flow received. In 2013, the average daily flow (ADF) was approximately 26.1 million gallons per day (MGD). Planning for the existing secondary treatment system began in 1990 as a first step toward reclamation of effluent for reuse through irrigation. The existing secondary treatment system was constructed in 1996, in preparation for future water reclamation purposes. Approximately 13 mgd (or about 50 percent [%] of the ADF) receives secondary treatment. The Honouliuli Water Recycling Facility (HWRF) was constructed in 2000 specifically for water reclamation purposes. It is now owned by the Board of Water Supply (BWS) and operated by Veolia. The Facility has a capacity of 12 MGD and produces two grades of recycled water, R1 Water is used for irrigation and Reverse Osmosis (RO) is used for industrial purposes. The facility is currently capable of supplying 10 MGD of R1 water and 2 MGD of RO water.

ADF includes the flow generated by the population in the service area, including residential, commercial, and industrial uses. In addition to these flows, ADF includes water that may enter the system through infiltration, where pipes and mains lie below the water table during normal dry weather. The Honouliuli WWTP serves one of the fastest growing areas in the state; therefore, wastewater flow to the WWTP is projected to increase based on the high potential for population growth, as discussed further in Section 3, and improvements are required to the WWTP to accommodate this additional flow.

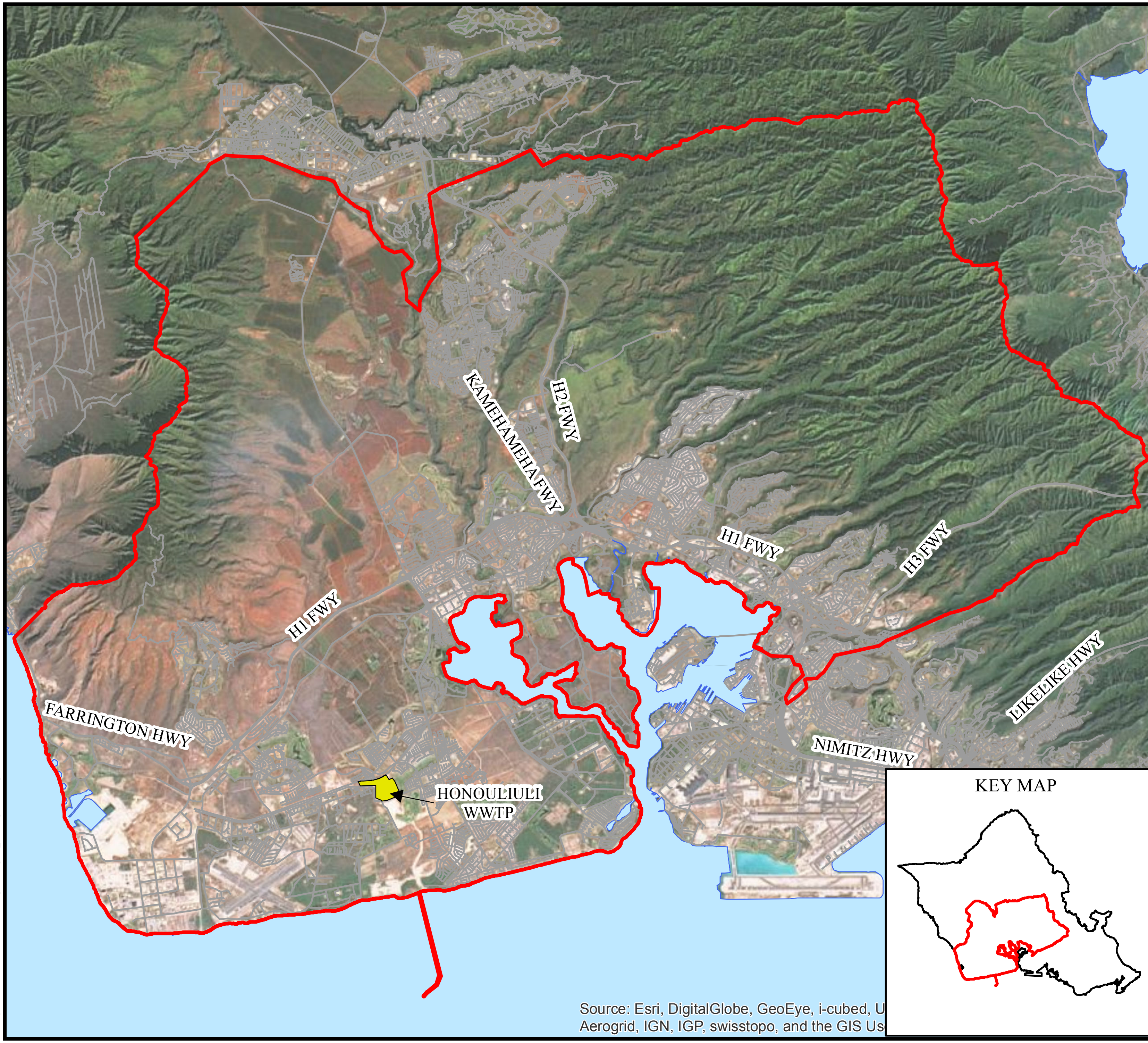
As previously noted, in 2010 the CCH, State, and EPA entered into an agreement currently referred to as the FACD (Civil No. 94-00765 DAE-KSC) that requires the CCH to meet certain established milestones for improving its wastewater collection system and WWTPs. The FACD requires the Honouliuli WWTP to be upgraded to a full secondary treatment facility by 2024. The Honouliuli Fac Plan recommends the necessary improvements to upgrade the Honouliuli WWTP to full secondary treatment to comply with the FACD.

In 2011, CCH acquired 48.4 acres of land abutting the north and east boundaries of the existing Honouliuli WWTP (herein referred to as the expansion property) to provide sufficient space for treatment facilities to comply with the FACD mandates. The Honouliuli WWTP site area, including the expansion property, is currently 100.5 acres.

A detailed description of the existing Honouliuli WWTP is included in Section 1.3 of this DEIS. Alternatives considered for upgrading the Honouliuli WWTP (both hydraulic expansion and expansion to full secondary treatment) and the potential relocation of non-process facilities to the Honouliuli WWTP site are the focus of this DEIS and the subsequent Final Environmental Impact Statement (FEIS) that will be prepared for this project.

1.2 Project Location

The study area includes the existing Honouliuli WWTP located at 91-1000 Geiger Road and expansion property to the north and east, adjacent to the Coral Creek Golf Course. The Honouliuli WWTP project site is identified on Figures 1-1 and 1-2.



City and County of Honolulu

HONOULIULI/ WAIPAHU/ PEARL CITY WASTEWATER FACILITIES PLAN

Legend

Honouliuli Sewershed

Street

0 12,000

Feet

1 inch = 12,000 feet

FIGURE 1-1

REGIONAL MAP

December 2014

AECOM

1001 BISHOP ST, STE 1600
HONOLULU, HAWAII 96813

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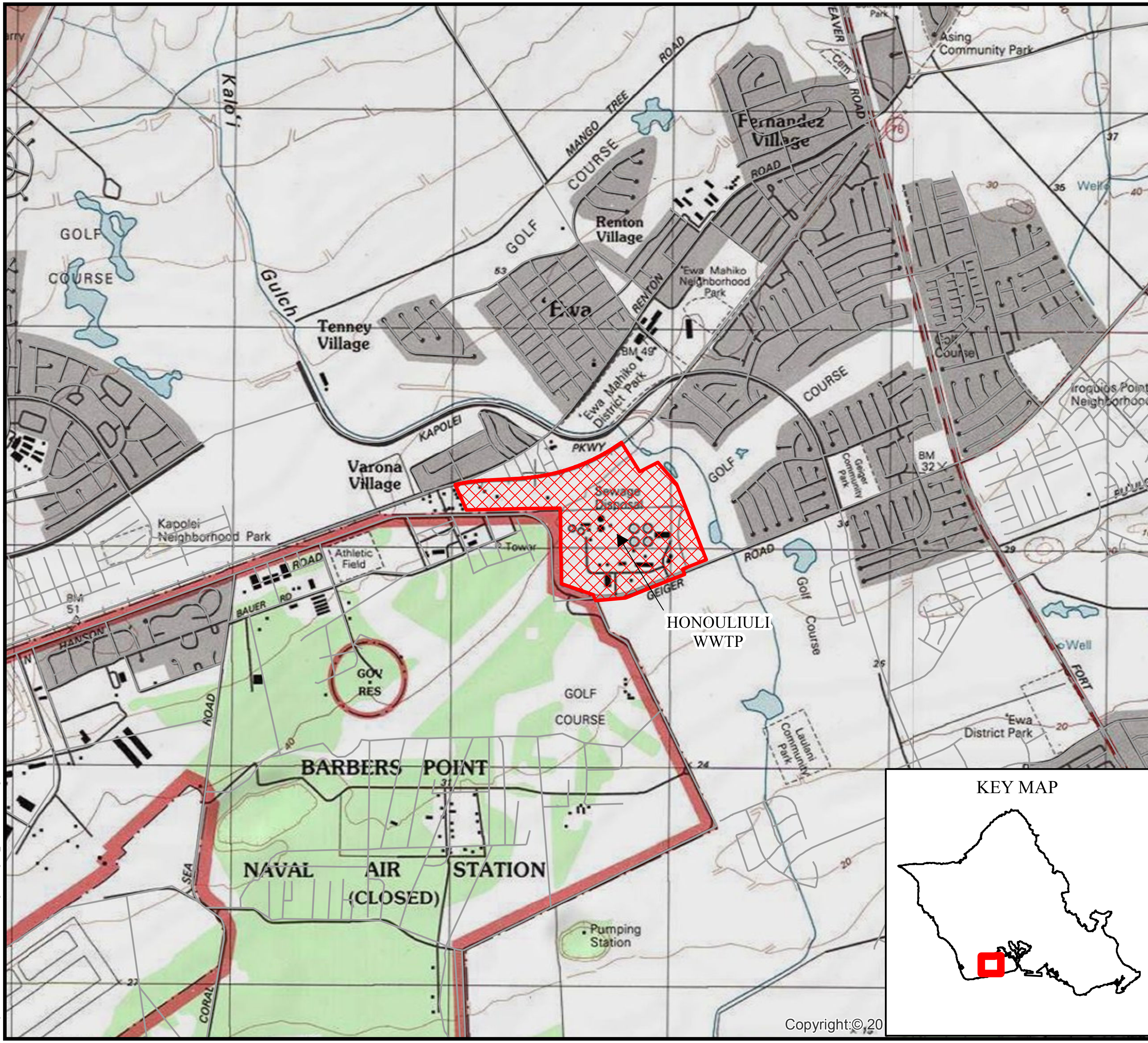


City and County of Honolulu

HONOULIULI/ WAIPAHU/ PEARL CITY WASTEWATER FACILITIES PLAN

Legend

Honouliuli WWTP

Street

0 2,000

Feet

1 inch = 2,000 feet

FIGURE 1-2

PROJECT LOCATION MAP

December 2014

AECOM

1001 BISHOP ST, STE 1600
HONOLULU, HAWAII 96813

G:\Projects\MUNI\60220849HON\Maps\EI\Figure_1-2 Location Map.mxd

1.3 Project Need

This project is being undertaken to address the following needs:

- Protect public health and safety through the development and maintenance of municipal wastewater treatment facilities
- Meet secondary treatment requirements set by EPA under the Clean Water Act
- Accommodate projected wastewater flows from the Honouliuli sewer basin through 2050
- Relocate non-process facilities to accommodate future needs that will arise from upgrading Honouliuli and Sand Island WWTPs to secondary treatment
- Implement certain requirements of federal and state permits and mandates

This project focuses on providing hydraulic and treatment upgrades to the Honouliuli WWTP in order to comply with the FACD. The objective of this project is to comply with regulatory mandates from the State of Hawaii Department of Health (DOH) and EPA, and to provide a basis to meet future wastewater management needs.

1.3.1 Regulatory Mandates

In accordance with the Hawaii Revised Statutes (HRS) Chapter 343, an Environmental Assessment (EA) and/or EIS is required since the project involves the following actions:

- Propose the use of County and State lands and County funds.
- Propose any wastewater facility, except an individual wastewater system or a wastewater facility serving fewer than 50 single-family dwellings or the equivalent.
- Propose any waste-to-energy facility.

The proposing and accepting agency for this project is the CCH ENV. This DEIS will be submitted to the Office of Environmental Quality Control for publication in *The Environmental Notice* and will be available to various Federal, State, and CCH agencies. The intent of this DEIS is to notify interested parties of the project of the potential impacts and mitigation measures and to solicit comments from stakeholders including government agencies, community organizations, private businesses, and the general public.

Following the DEIS, a FEIS will be prepared to assess the overall environmental impacts of the recommended alternative, including any written comments received during the public review of the DEIS. The DEIS has been and the FEIS will be prepared in compliance with the HRS Chapter 343. As part of the environmental process, there will be a 45-day review and comment period and informational meetings after the DEIS is published.

2 EXISTING FACILITIES

The Honouliuli WWTP was originally built in 1978 as a primary plant and became operational in 1984. The rated design capacity is 38 mgd with one unit on standby and 51 mgd with all units in service, according to the Honouliuli WWTP Facility-Wide Operations Manual (Fukunaga and Associates, Inc. and HDR Engineering, Inc. 2011) herein referred to as the O&M Manual. The WWTP provides primary treatment to all flow received. Approximately 13 mgd undergoes further secondary treatment. A portion of the secondary effluent is treated for water reuse at the CCH Board of Water Supply (BWS) HWRF. The solids stream has a rated design capacity of solids generated from 42 mgd of primary treatment and 26 mgd of secondary treatment according to the O&M Manual. The existing Honouliuli WWTP is shown on Figure 2-1.

This section describes the major components of the Honouliuli WWTP system including: collection system, liquid treatment system, effluent disposal system, solids handling system, odor control system, and electrical.

2.1 Collection System

The Honouliuli sewer basin is the second largest on Oahu, serving a population of over 300,000. It includes 17 CCH-operated wastewater pump stations excluding the Honouliuli Influent Pump Station (IPS). The Honouliuli WWTP provides primary treatment to all flow, and secondary treatment to a portion of the total flow received. Approximately half of the influent is further treated to secondary treatment.

The Honouliuli gravity collection system is mainly made up of approximately 83% vitrified clay pipes and approximately 9% reinforced concrete pipes. The most common pipe size in the sewer basin is 8-inch diameter pipes which make up approximately 65% of the total length of pipes. A summary of the gravity collection system pipe diameter and material are provided in Table 2-1 and Table 2-2.

2.2 Liquid Treatment System

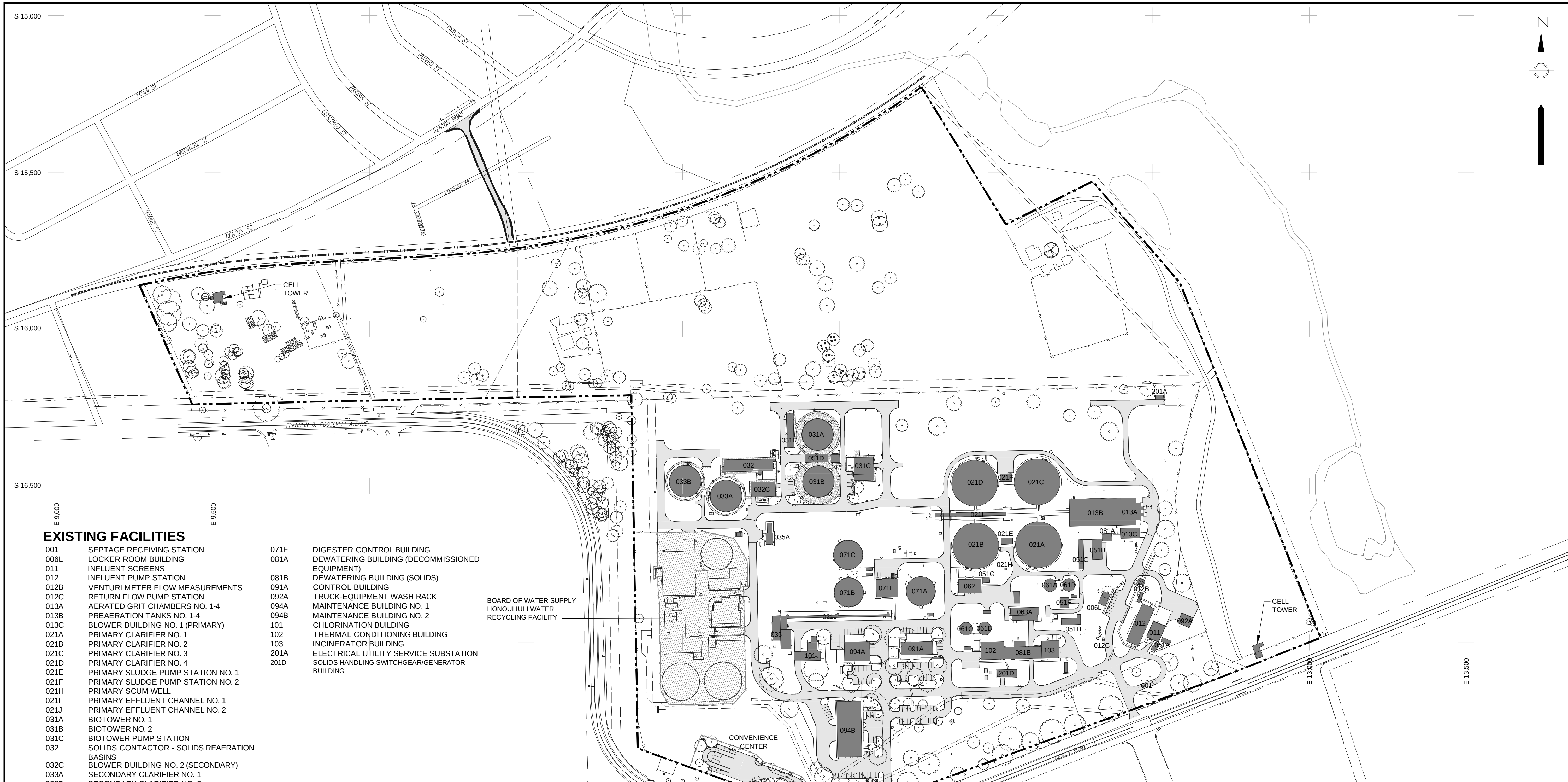
The existing system includes preliminary treatment, primary treatment, and secondary treatment.

2.2.1 Preliminary Treatment

Preliminary treatment is a physical process in which large items such as rags, sticks, grit, grease, and other items are removed from the wastewater. The primary treatment equipment includes the septage receiving station, influent screens, the IPS, influent flow measurements, preaeration tanks, aerated grit chambers, and Blower Building (No. 1).

2.2.1.1 Septage Receiving Station

The septage receiving station is located at the southeastern end of the WWTP (Figure 2-1 shows the existing WWTP site plan). Currently permitted private haulers and CCH ENV haulers discharge septage or liquid sludge at a manhole upstream of the influent screens. There is no odor control facility for the septage receiving station. There is no pump station at the septage receiving station as the septage or liquid sludge flows by gravity via a 12-inch sewer that connects to the 21-inch sewer from Kalaeloa prior to entering the influent junction box.



EXISTING FACILITIES

001	SEPTAGE RECEIVING STATION
006L	LOCKER ROOM BUILDING
011	INFLUENT SCREENS
012	INFLUENT PUMP STATION
012B	VENTURI METER FLOW MEASUREMENTS
012C	RETURN FLOW PUMP STATION
013A	AERATED GRIT CHAMBERS NO. 1-4
013B	PREAERATION TANKS NO. 1-4
013C	BLOWER BUILDING NO. 1 (PRIMARY)
021A	PRIMARY CLARIFIER NO. 1
021B	PRIMARY CLARIFIER NO. 2
021C	PRIMARY CLARIFIER NO. 3
021D	PRIMARY CLARIFIER NO. 4
021E	PRIMARY SLUDGE PUMP STATION NO. 1
021F	PRIMARY SLUDGE PUMP STATION NO. 2
021H	PRIMARY SCUM WELL
021I	PRIMARY EFFLUENT CHANNEL NO. 1
021J	PRIMARY EFFLUENT CHANNEL NO. 2
031A	BIOTOWER NO. 1
031B	BIOTOWER NO. 2
031C	BIOTOWER PUMP STATION
032	SOLIDS CONTACTOR - SOLIDS REAERATION BASINS
032C	BLOWER BUILDING NO. 2 (SECONDARY)
033A	SECONDARY CLARIFIER NO. 1
033B	SECONDARY CLARIFIER NO. 2
035	EFFLUENT SCREENS
035A	PARSHALL FLUME BOX
051A	GRANULAR ACTIVATED CARBON ADSORBERS (PRELIMINARY)
051B	GRANULAR ACTIVATED CARBON ADSORBERS (PRIMARY)
051C	CAUSTIC SCRUBBERS (PRIMARY)
051D	CAUSTIC SCRUBBERS (SECONDARY)
051E	GRANULAR ACTIVATED CARBON ADSORBERS (SECONDARY)
051F	BIOFILTER SYSTEM (PRIMARY SLUDGE)
051G	GRANULAR ACTIVATED CARBON ADSORBERS (SECONDARY SLUDGE)
051H	MULTI-STAGE CHEMICAL SYSTEM (SOLIDS DEWATERING)
061A	PRIMARY SLUDGE GRAVITY THICKENER NO. 1
061B	PRIMARY SLUDGE GRAVITY THICKENER NO. 2
061C	PRIMARY SLUDGE GRAVITY THICKENER NO. 3
061D	PRIMARY SLUDGE GRAVITY THICKENER NO. 4
062	SECONDARY SLUDGE GRAVITY BELT THICKENERS
063A	SLUDGE BLEND TANK
071A	ANAEROBIC DIGESTER NO. 1 - PRIMARY
071B	ANAEROBIC DIGESTER NO. 2 - PRIMARY
071C	ANAEROBIC DIGESTER NO. 3 - SECONDARY
071F	DIGESTER CONTROL BUILDING
081A	DEWATERING BUILDING (DECOMMISSIONED EQUIPMENT)
081B	DEWATERING BUILDING (SOLIDS)
091A	CONTROL BUILDING
092A	TRUCK-EQUIPMENT WASH RACK
094A	MAINTENANCE BUILDING NO. 1
094B	MAINTENANCE BUILDING NO. 2
101	CHLORINATION BUILDING
102	THERMAL CONDITIONING BUILDING
103	INCINERATOR BUILDING
201A	ELECTRICAL UTILITY SERVICE SUBSTATION
201D	SOLIDS HANDLING SWITCHGEAR/GENERATOR BUILDING

REVISION | DATE | BRIEF | BY | APPROVED

DEPARTMENT OF ENVIRONMENTAL SERVICES
CITY AND COUNTY OF HONOLULU

PROJECT:

FIGURE 2-1
HONOULIULI WWTP
EXISTING SITE PLAN

DESIGNED BY: B. STALLINGS
DRAWN BY: M. FRANK
APPROVED:
CHECKED BY: ----
SECTION HEAD
BRANCH HEAD
CHIEF
DATE

THIS WORK WAS PREPARED BY ME OR UNDER MY SUPERVISION.

SIGNATURE

EXPIRATION DATE OF THE LICENSE

JOB NO. W#-##

FILE CABINET | DRAWER | FILE | POCKET | FOLDER | NO.

DRAWING 000 G-005 SHEET 5 OF 169

PATH/FILENAME: S:\PROJECTS_LEGACY\USIG\WASTEWATER\60182588-HONOULIULI FAC PLAN\400 TECH INFO\434 TASK 12\434.15 TASK 12.0 CONCEPTUAL DESIGN\DRAWINGS\CAD FILES\60220849-HONOULIULI WWTP\SHEETS\G\000 G-005.DWG
LAST UPDATE: Wednesday, March 16, 2016 2:29:10 PM PLOT DATE: Wednesday, March 16, 2016 3:13:18 PM

Table 2-1. Summary of Gravity Sewers in the Honouliuli Sewer Basin

Diameter (in)	Number of Reaches	Total Length (ft)	% by Length
6	726	94,709	4
8	10,229	1,692,502	65
10	938	160,498	6
12	876	157,458	6
14	6	1,936	<1
15	620	115,543	4
16	8	14,965	1
18	338	67,387	3
20	7	11,727	<1
21	193	41,462	2
24	279	57,369	2
27	77	14,190	1
30	204	62,272	2
33	18	5,468	<1
36	135	42,645	2
42	88	41,421	2
48	11	12,931	<1
60	1	201	<1
84	26	12,290	<1
Total	14,782	2,606,687	100

Source: DPP 2010.

Table 2-2. Summary of Gravity Sewer Materials in the Honouliuli Sewer Basin

Pipe Material	Number of Reaches	Total Length (ft)	Average Age of Pipes (yr)	% by Length
ACP - Asbestos Cement Pipe	1	2,020	40	<1
CIP - Cast Iron Pipe	44	22,748	44	<1
DIP - Ductile Iron Pipe	54	68,004	29	3
HDPE - High Density Polyethylene	2	538	11	<1
PVC - Polyvinyl Chloride Pipe	631	115,165	15	4
RCP - Reinforced Concrete Pipe	1,000	228,776	33	9
TCP - Terra Cotta Pipe	28	3,402	56	<1
VCP - Vitrified Clay Pipe	12,934	2,150,820	32	83
UNK - Pipe Diameter <8-inch	88	15,210	41	1
Total	14,782	2,606,687	33	100

Source: DPP 2010.

2.2.1.2 Influent Screens

The wastewater from the Honouliuli sewer basin, along with septage from the septage receiving station, flows through the influent screens. Three mechanically cleaned bar screens are located upstream of the IPS wet well.

The screens are located within reinforced concrete channels. Each screen is 5 ft wide with an operating water depth ranging from 3 to 6 ft upstream of the screens. The openings for the bar screens are 0.75-inch to prevent large objects that may cause damage to downstream equipment from entering the WWTP. The screenings are mechanically removed, conveyed via a conveyor belt to a grinder and screenings washer/compactor, then discharged into a hopper. The compacted screenings hopper is then lifted by crane out of a below grade concrete pit that houses the screens, grinder, screenings compactor, and hopper. The compacted screenings are transported to a landfill for disposal.

2.2.1.3 Influent Pump Station

After the influent screens, wastewater is collected in a divided IPS wet well. The existing IPS consists of six extended shaft centrifugal pumps (four 20 mgd electric variable speed pumps and two 36 mgd electric and diesel [dual drive] variable speed pumps). These pumps are located in the basement of the IPS and are vertical non-clog centrifugal pumps with extended shafts connected to motors located at ground level. Each wet well compartment serves three pumps (two 20 mgd and one 36 mgd). The pumps convey the wastewater through two 42-inch diameter force mains. Each force main receives flow from three dedicated pumps: one 36 mgd electric and diesel variable speed pump (dual drive) and two 20 mgd electric variable speed pumps. In the event of a power outage, on-site standby power (located in a trailer adjacent to the IPS building) is able to operate two 20 mgd pumps (one for each force main). In addition, the two 36 mgd dual drive electric/diesel engine units can operate on their diesel engines during power outages. During normal conditions, two or three pumps are in service.

The influent flow is measured in the IPS force mains. There are two venturi flow meters (one on each force main) that measure the flow. The wastewater flows through the IPS force mains to the aerated grit chambers and preaeration tanks.

2.2.1.4 Grit Chambers and Preaeration Tanks

There are four aerated grit chambers and preaeration tanks. Each grit chamber and preaeration tank is 20 ft wide by 210 ft long. The grit chamber portion is 60 ft long and the preaeration tank portion is 150 ft long. The influent flow passes through a rectangular open channel that is 5 ft wide, then through a series of sluice gates into the aerated grit chambers, and then directly into the preaeration tanks. The effluent flow passes out of the preaeration tanks through a series of slide gates connected to a rectangular open channel that is 6 ft wide. The wastewater is then conveyed from the preaeration tanks to the primary clarifiers.

During normal conditions, three trains are in operation, with one train rotated out of service quarterly for maintenance or to be used as a standby train. The aerated grit chambers and preaeration tanks are designed for an average flow of 51 mgd and peak flow of 112 mgd.

2.2.2 Primary Treatment

Primary treatment is a physical process that removes suspended solids and organic material by physical settling. The primary treatment system consists of the primary clarifiers and two primary sludge pump stations.

2.2.2.1 Primary Clarifiers

The four primary clarifiers are each 145 ft in diameter with a minimum sidewater depth of 10 ft. Flow enters the tanks from a splitter box at the end of the rectangular open channels from the aerated grit chamber and preaeration tanks. Flow enters each tank via a 42-inch diameter influent pipe that is connected to the bottom of the splitter box. The pipe drops down below the bottom of the clarifier and is encased in a concrete jacket attached to the bottom of the clarifier floor. Each 42-inch pipe is connected to the clarifier center column. The clarifiers are provided with inboard effluent troughs outfitted with 3-inch v-notch weir plates to convey the effluent to the two primary effluent channels. Each rectangular primary effluent channel services two clarifiers and is 6 ft wide. During normal conditions, three clarifiers are in service and one unit is on standby.

2.2.3 Secondary Treatment

The secondary treatment system at the Honouliuli WWTP was completed in 1996. The Honouliuli WWTP secondary treatment process uses a biological fixed film trickling filter (TF) process to remove biodegradable organic matter and a suspended growth solids contact process for enhanced suspended solids removal. The trickling filter/solids contact (TF/SC) process provides secondary treatment for a constant wastewater flow of 13 mgd (approximately one-half of the current total flow to the Honouliuli WWTP). The secondary treatment system consists of a biotower pump station, biotowers, solids contacts/reaeration basins, secondary clarifiers, Blower Building No. 2, and Parshall flumes.

2.2.3.1 Trickling Filter Pump Station

A constant 13 mgd of primary effluent flows through two 5.5-ft wide screening channels to the TF pump station. In addition to primary effluent, the TF pump station receives recycle flow (TF effluent) from the recycle distribution box. The primary effluent and the TF recycle flows are conveyed by 36-inch diameter pipes into a mixing chamber and then flow into two wet wells, one on either side of the mixing chamber. The pump station, which sits above the mixing chamber and wet wells, has eight vertical turbine pumps. Four pumps (two 6.5 mgd and two 3.25 mgd constant speed vertical turbine pumps) are located over both wet wells. One of the large pumps for each TF is a standby unit (a total of two standby pumps are provided).The station pumps the mixture of primary effluent and TF recycle through two 36-inch pipes to the TFs. Each pipe is equipped with a 36-inch magnetic flow meter to measure the flow.

The biotower pump station conveys a constant flow of 13 mgd to each TF (6.5 mgd of primary effluent and 6.5 mgd of TF recycle flow). By design, the quantity of wastewater receiving secondary treatment is constant and the quantity of recycle flow is constant so adjustments to the gate positions are not required.

2.2.3.2 Trickling Filters

There are two TFs; each unit is 100 ft in diameter with a plastic media depth of 20 ft. The two TFs are designed to treat constant primary effluent flow of 13 mgd (6.5 mgd each). The TF secondary treatment process provides fixed film biological treatment to remove soluble organics in the wastewater thereby reducing soluble BOD_5. The TFs use plastic media to support the growth of bacteria (biofilm) that consume the organic pollutants in the primary effluent. The primary effluent and TF recycle are evenly distributed across the surface of the attached-growth media with a rotating assembly with four distribution arms called a rotary distributor. The hydraulic design of each rotary distributor is based on a constant flow of 13 mgd (6.5 mgd primary effluent and 6.5 mgd TF recycle). The TF pump station provides a constant wetting rate that promotes sloughing of the biofilm that attaches to the plastic media, and prevents organic overloading that would cause odors/septic conditions at the top of the TF towers. During normal conditions, both TFs are in service.

2.2.3.3 Solids Contact and Sludge Reaeration Basins

Settled sludge (return secondary sludge [RSS]) from the two secondary clarifiers is reaerated in four reaeration basins. Each basin is 8 ft wide by 24 ft long with a sidewater depth of 12 ft. The reaerated sludge is discharged into the mixing/distribution chamber where it is mixed with the TF effluent and is distributed equally into the SC basins. The mixture then flows into the solids contactor basins. Each basin is 8 ft wide by 105 ft long with a sidewater depth of 12 ft and volume of 75,000 gallons. The total SC volume is approximately 300,000 gallons. The four SC basins are designed to treat a constant flow of 13 mgd (3.25 mgd in each tank). The SC process is a biological treatment process designed to improve the settleability of the suspended solids through flocculation. Flow from the SC basins is conveyed to two secondary clarifiers. During normal operations, all four solids contact and sludge reaeration basins are in service.

2.2.3.4 Secondary Clarifiers

Effluent from the SC basins is conveyed by gravity to the secondary clarifiers. There are two secondary clarifiers designed to treat a constant flow of 13 mgd (6.5 mgd each). Each secondary clarifier is 100 ft in diameter with a sidewater depth of 16 ft. Flow enters each secondary clarifier via a 36-inch diameter influent pipe that is encased below the floor and connected to the clarifier center column. An inboard effluent trough, outfitted with 3-inch v-notch weir plates, is provided in each clarifier. Flow exits each secondary clarifier via a 36-inch diameter pipe connected to a Parshall flume. During normal conditions, both secondary clarifiers are in operation.

2.3 Effluent Disposal System

The facilities that make up the effluent and outfall system include the effluent channel, effluent screens, effluent flow measurement, ocean outfall, and HWRF. Primary effluent, excess secondary effluent, and reverse osmosis brine are combined in the effluent channel and discharged to the ocean via the outfall. The Barbers Point Deep Ocean Outfall was constructed in 1979 and has a peak flow capacity of 112 mgd. The 84-inch diameter outfall extends approximately 8,760 ft into the ocean and discharges treated effluent approximately 200 ft below the surface through a 1,750-ft long diffuser pipe. The water reclamation processes associated with the HWRF include sand filtration, reverse osmosis, and ultraviolet (UV) disinfection.

2.4 Solids Handling System

The Honouliuli WWTP was recently upgraded under the *Honouliuli Wastewater Treatment Plant New Solids Handling Facility* project (GMP 2004), herein referred to as the *New Solids Handling Facility*. The existing Honouliuli WWTP solids unit processes include gravity thickeners, gravity belt thickeners (GBTs), blend tanks, anaerobic digesters, and centrifuge dewatering. The solids capacity is based on solids removed from 42 mgd of primary treatment and 26 mgd from secondary treatment.

Solids residues from the Honouliuli WWTP are either disposed of at the Waimanalo Gulch Landfill in Kahe Valley, Kapolei or disposed of at the H-Power Facility. Use of the landfill is being phased out. The solids loading to the Honouliuli WWTP is augmented by solids from the Wahiawa and Paalaa Kai WWTPs, which are trucked to the Honouliuli WWTP for further processing and disposal.

2.4.1 Primary Sludge Thickening

There were two gravity thickeners at the Honouliuli WWTP prior to the solids handling upgrades. After the heat treatment system and decant tanks were decommissioned in 2010, the two decant tanks were converted into gravity thickeners, giving the WWTP a total of four gravity thickeners. The sidewall heights of the converted decant tanks were extended to essentially match the existing gravity thickeners. Each gravity thickener is 40 ft in diameter with a side water depth of 10 ft for the original gravity thickeners and 9 ft 4 inches for the converted decant tanks. The thickened primary sludge is conveyed to the sludge blending tanks to be mixed with thickened secondary sludge. During normal operations, only primary sludge is pumped to the gravity thickeners and one gravity thickener is in operation.

2.4.2 Secondary Sludge Thickening

There are two GBTs to thicken secondary sludge from the TF/SC process. The GBTs use porous polyester belts that travel along a series of rollers. The sludge is conditioned with a cationic polymer and is distributed across the surface of the moving belt on the top of the unit. As the belt moves forward, the sludge passes through a series of polyester plows that enhance the drainage of water from the sludge solids. A significant amount of water is drained away from the sludge through the porous belt. The concentrated solids are dropped off the discharge end of the unit into a hopper or chute. During normal conditions, one GBT is in service.

2.4.3 Sludge Blend Tanks

The Honouliuli WWTP currently has four blending tanks. Each blending tank is 20 ft square, with a sidewater depth of 16.5 ft and an effective volume of approximately 49,000 gallons. Thickened sludge from both the gravity thickeners (primary sludge) and the GBTs (secondary sludge) is combined and mixed in the sludge blend tanks. Mixed sludge is then pumped to the anaerobic digesters. Odor is controlled by routing foul air to the Primary Sludge Odor Control System. During normal conditions, three sludge blend tanks are in service.

2.4.4 Anaerobic Digesters

The Honouliuli WWTP currently uses anaerobic digesters to stabilize solids produced by the primary and secondary treatment systems. There are three anaerobic digesters (two primary and one secondary) that receive a mixture of thickened primary and thickened waste secondary sludge (WSS) from the sludge blend tanks. The anaerobic digester process produces digested sludge and digester gas. Digested sludge is pumped to the dewatering centrifuges. A portion of the digester gas is used as fuel in the boiler to provide heat to the digesters. Excess digester gas is flared using the waste gas burner. During normal conditions, one primary and one secondary digester are in service.

2.4.5 Dewatering

The dewatering process at the Honouliuli WWTP is the final stage in the solids treatment process. Digested primary and secondary sludge is pumped from the anaerobic digesters to the three centrifuges located in the dewatering building. The centrifuges further dewater the sludge to 25 to 28% total solids (TS) concentration. Dewatered cake is trucked from the WWTP site to a landfill for disposal and centrate (liquid) is routed back to the WWTP headworks for liquid treatment.

2.5 Odor Control System

The Honouliuli WWTP has six separate odor control systems that collect and treat air emissions from the WWTP. The existing Honouliuli WWTP odor control systems are presently being evaluated under a separate CCH project entitled *Honouliuli Wastewater Basin Odor Control*. The odor control facilities at the WWTP include:

- *Preliminary Odor Control System.* Collects and treats foul air from the influent sewers, influent screens, and IPS wet well. This foul air is conveyed to two activated carbon scrubbers, which are run in parallel. The total capacity of the activated carbon scrubbers is 7,000 cubic feet per minute (cfm).
- *Primary Odor Control System.* Collects and treats foul air from the aerated grit chambers, preaeration tanks, and primary clarifier weirs. This system consists of two-stage treatment that includes two catalytic scrubbers that have been converted into caustic scrubbers, followed by five dual-bed activated carbon scrubbers. The total capacity of the system is 24,000 cfm.
- *Secondary Odor Control System.* Collects and treats foul air from the secondary treatment processes including the biotower pump station and TF/SC process. The Secondary Odor Control System consists of a two-stage treatment system that includes two catalytic scrubbers that have been converted into caustic scrubbers, followed by five dual-bed activated carbon scrubbers. The total capacity of the secondary odor control system is 25,000 cfm.
- *Primary Sludge Odor Control System.* Consists of a four-cell stone media biofilter system that collects and treats foul air from the gravity thickeners and sludge blend tanks. The total capacity of the Primary Sludge Odor Control System is 16,400 cfm.
- *Secondary Sludge Odor Control System.* Consists of an activated carbon system with two units that collect and treat foul air from the GBTs. The capacity of the Secondary Sludge Odor Control System is 3,000 cfm.
- *Solids Dewatering Odor Control System.* Consists of a multistage chemical unit that collects and treats foul air from the centrifuge dewatering building. The Solids Dewatering Odor Control System has a treatment capacity of 22,000 cfm.

2.6 Electrical

While there is limited existing electrical metering at the existing WWTP, the utility bills provide information on the overall electrical demand. Table 2-3 shows the maximum and minimum WWTP electrical demand for data collected from September 2008 to September 2011.

The measured maximum (peak) demand of 1,757 kilowatts (kW) was used as the representative peak demand for the existing WWTP operating with the existing flows.

Table 2-3. Facility Electrical Demand Data

Parameter	Electrical Demand (kW)	Reported Date
Maximum Measured Demand	1,757	Jan 26, 2011
Minimum Measured Demand	1,536	Dec 26, 2009

Legend: kW = kilowatt.
Source: Honouliuli Fac Plan Work Task 12 – Alternative Energy, Electrical Supply, and Distribution Strategy, Item 12.E Technical Memorandum (AECOM 2014a)

2.7 Summary

Table 2-4 summarizes the existing processes at the Honouliuli WWTP.

Table 2-4. Existing Honouliuli WWTP Process Units

Process Unit	No. of Units	Length (ft)	Width (ft)	Diameter (ft)	SWD (ft)	Surface Water Elev. at Avg Flow (ft MSL)	Surface Water Elev. at Peak Flow (ft MSL)	Volume Per Unit (gal)
Influent Screens	3	—	5	—	3 to 6	15.2 (1)	18.5 (1)	—
IPS	6	Extended-shaft centrifugal pumps, four 20-mgd, variable-speed electric, two 36-mgd electric and diesel driven: 92 ft x 11 ft wet well.						
Aerated Grit Chamber	4	60	20	—	13.76	43.2	45.2	123,510
Pre-aeration Tanks	4	150	20	—	14.5	43.2	45.2	325,380
Primary Clarifiers	4	—	—	145	9.96	42.6	42.7	1,230,230 (2)
Biotower Pump Station	8	Vertical turbine, constant-speed pumps (four for each biotower; two 6.5-mgd and two 3.25-mgd capacity pumps) (3)						
Biotowers (3)	2	—	—	100	20	49.3 (4)	49.3 (4)	—
Sludge Re-aeration Tanks (3)	4	24	8	—	12	46.5	46.5	17,230
Solids Contact Tank (3)	4	105	8	—	12	46.5	46.5	75,400
Secondary Clarifiers (3)	2	—	—	100	16	43.1	43.1	939,960 (2)
Effluent Screens	3	—	5.5	—	7.5	30.4 (5)	34.7 (5)	—
Barbers Point Deep Ocean Outfall: **8,760 ft into the ocean to a diffuser section; 1,750 ft in length, approximately 200 ft below surface**								
Gravity Thickener	4	—	—	40	10	52.4	—	94,000
GBTs	2	—	6.5	—	—	—	—	—
Blend Tanks	4	20	20	—	16	62.8	—	47,870
Anaerobic Digesters	3	—	—	90	30	69.5	—	1,427,570
Centrifuges	3	Sludge feed rate = 150 gpm at 2% solids each, maximum solids loading = 1,800 lb/hr						

Legend: Avg. = average; Elev. = elevation; gal = gallon; gpm = gallons per minute, lb/hour = pounds per hour; MSL = mean sea level; SWD = side water depth.
Sources: GMP Hawaii, Inc. (2004); R. M. Towill (1997).
Notes:
(1) Upstream of Mechanical Screens
(2) Volume does not include the cone section of the tank.
(3) Secondary Treatment is a constant 13 mgd
(4) TF Underdrain Trough
(5) Upstream of Effluent Screens

3 BASIS OF DESIGN CRITERIA USED TO DEVELOP SECONDARY TREATMENT AND EXPANSION ALTERNATIVES

The following sections describe the basis of design criteria used to develop alternatives for secondary treatment and expansion of the facility to accommodate future projected wastewater flow. The basis of design criteria was determined based on existing and anticipated standards. In addition, the criteria include consideration for effluent reuse.

3.1 Previous Basin Planning

The *Final Sewer Infiltration and Inflow Plan* (*Final Sewer I/I Plan*) was completed in 1999 in compliance with requirements of a Consent Decree (Civ. No. 94-00765 DAE dated May 15, 1995) between the CCH, DOH, and EPA. The *Final Sewer I/I Plan* established infiltration and inflow rates for each wastewater sewer basin (including the Honouliuli sewer basin).

The flow information gathered as part of the *Final Sewer I/I Plan* was used to populate the Sewer Flow Analysis System (SFAS) Flow Model. The SFAS model has been used to estimate existing and future wastewater flows. The *West Mamala Bay Facilities Plan* (Wilson Okamoto & Associates, Inc. and Brown and Caldwell Consultants 2001) used the SFAS model to project the 2020 peak wet weather flow to the WWTP to be 174 mgd. In addition to the flow at the WWTP, the model showed that a number of the sewers and force mains would have insufficient capacity.

The *West Mamala Bay Facilities Plan* (Wilson Okamoto & Associates, Inc. and Brown and Caldwell Consultants 2001) provided recommendations for upgrades to the Honouliuli WWTP, including odor control, preliminary and primary treatment expansion, effluent pump station, and solids handling modification. The Plan recommended that upgrading to secondary treatment (beyond the 13 mgd in 1999) would not be necessary; however, the Consent Decree requirements superseded this recommendation. The recommendations for odor control and sludge management are being evaluated as part of the Honouliuli Fac Plan.

The CCH has completed the *Final Sewer I/I Plan* with the *Sewer I/I Assessment and Rehabilitation Program Update* project. The first phase of this project installed flow meters and rain gauges throughout the island of Oahu. The flow metering was conducted from 2009 to 2011. The flow data collected was entered into an InfoWorks Model that was used to route flows through the collection and transport system to generate projected flows at the Honouliuli WWTP. The projected 2050 peak wet weather flow from this effort was 126 mgd, which is lower than the projected peak flows derived from the preceding studies. The *Wet Weather I/I Assessment Update Report* (AECOM 2013) summarizes the second phase of the project, which included some additional intensive monitoring conducted from 2011 to 2012 and provided future project recommendations based on monitoring and modeling.

3.1.1 Sludge Management Plan

The Island-wide Sludge Management Plan was completed in 2015. With respect to Honouliuli WWTP, the plan recommended a final sludge processing, hauling, and beneficial use strategy. Key aspects of the plan include accommodating the following:

- Waimanalo Gulch landfill's goal of eventual elimination of sludge receiving
- Future expansion of Honouliuli WWTP from partial secondary to full secondary
- Anticipated growth in the Honouliuli wastewater basin

3.1.2 Odor Control

The Honouliuli Wastewater Basin Odor Control Project is ongoing. The project scope addresses odor and corrosion concerns in both the WWTP and tributary collection system. Planning was completed by October 2015. Areas of concern and potential alternatives have been identified in the Preliminary Engineering Report (AECOM 2014b). Pilot testing for collection system and WWTP controls has been completed and design of improvements is anticipated to be completed by October 2016.

3.2 Population Projections

The Honouliuli WWTP provides service to the developed areas in the region around Pearl Harbor, from Halawa in the east to Ko Olina in the west, and extending to Mililani in the north.

Figure 1-1 identifies the Honouliuli sewer basin boundary. The Honouliuli WWTP services the communities of Halawa, Aiea, Waimalu, Pearl City, Pacific Palisades, Waiawa, Waipahu, Mililani, Waipio, Village Park, Crestview, Waikele, Kunia, Kapolei, West Loch, Ewa Beach, Makakilo, and Ko Olina. The total service area includes approximately 22,000 acres of developed land and 54,000 acres of undeveloped land.

To determine system capacity requirements within the planning period, Honouliuli sewer basin population projections were developed for the year 2035 and year 2050. Conducting the population projections entailed a substantial data collection effort. Key agencies contacted include the Hawaii Department of Business, Economic Development, and Tourism (DBEDT) and CCH Department of Planning and Permitting (DPP), which are responsible for conducting socioeconomic projections for Hawaii and the island of Oahu, respectively. In addition, numerous planning reports and data were reviewed, including the following (listed chronologically):

- *General Plan: Objectives and Policies*, Amended October 2002 (CCH DPP) (according to the DPP website, this plan is in the process of being updated)
- Central Oahu Sustainable Communities Plan, December 2002 (CCH DPP)
- Primary Urban Center Development Plan, June 2004 (CCH DPP)
- Population and Economic Projections for the State of Hawaii to 2035, July 2009 (Hawaii DBEDT)
- CCH Socioeconomic Projections to 2035, September 2009 (CCH DPP)
- Honouliuli High-Capacity Transit Corridor Project Final Environmental Impact Statement/Section 4(f) Evaluation, June 2010 (CCH and US Department of Transportation)
- Annual Report on the Status of Land Use on Oahu: Fiscal Year 2009, August 2010 (CCH DPP)
- Get on Board! Transit Oriented Development Handbook, Spring 2011 (CCH DPP)
- *Oahu Regional Transportation Plan 2035*, April 2011 (Oahu Metropolitan Planning Organization)
- Proposed Revised Ewa Development Plan, May 2011 (CCH DPP)
- 2010 Census Summary File 1 for Hawaii, June 2011 (US Census Bureau)
- *2010 Annual Visitor Research Report*, September 2011 (Hawaii Tourism Authority)

The projections consider long-term, historic trends for the sewer basin, as well as available data and projections released by CCH and large-scale developments and proposed projects in the area. Previously conducted population and employment projections were also referenced to assist with the effort. The source most relied on was the CCH DPP socioeconomic projections to 2035, which are generally used and accepted for county infrastructure planning efforts (AECOM 2011a).

Based on the range of data available at the start of the analysis, the year 2010 was chosen as the current design year. In 2010, a population of over 300,000 was served by the Honouliuli sewer basin. Year 2035 and the corresponding population estimates were used in the evaluation and comparison of alternatives. Population projections to year 2050 were used in reference to the projected build-out of the Honouliuli WWTP. Population projections are provided in Table 3-1. The “population equivalent” values reflect an adjustment of the population projections based on average wastewater use by population category. These values were used to facilitate computation of per capita sanitary flows/loadings. The population projections methodology and detailed results are provided in Appendix A.

Table 3-1. Population Projections

Sewered Area [1]	Projection Update								
	2010 [1]			2035			2050		
	Res	Non-Res	Visitor	Res	Non-Res	Visitor	Res	Non-Res	Visitor
Total	306,417	102,857	1,902	408,234	201,302	11,359	449,424	241,720	14,989
Population Equivalent	325,976 [2]			452,938 [2]			504,239 [2]		

Source: Honouliuli Fac Plan Work Task 4.F.1 – Updated Basis of Design Population, Flows, and Loads Technical Memorandum (AECOM 2012a).
Notes:
(1) Results do not include the following estimated population not served by sewer (based on comparison of aerial photographs and limits of existing collection system): 9,177 Residential; 17,095 Non-Residential.
(2) The following equation was used to arrive at a population value to facilitate computation of per capita sanitary flows/loadings: Population Equivalent = Res Pop. + (11/63) × Non-Res Pop. + (53/63) × Visitor Pop. (63, 11, and 53 are gallons per capita per day wastewater generation values for residential, non-residential, and visitor, respectively).

3.3 Flow Projections

Flows at the Honouliuli WWTP were projected to assist in determining the design capacity for the proposed improvements. Development of flow projections for the intermediate design year of 2035 and design year of 2050 involved development of projections for each of three components of the flow (sanitary flow, dry weather infiltration, and wet weather infiltration/inflow (I/I)). Flow projections were based initially on measurements of actual flows from flow metering conducted in the 2009-2012 period as part of the *Sewer I/I Assessment and Rehabilitation Program Update* project. Projections of future flows were then based on population projections (described above) and anticipated areas of new development within the sewer basin. A calibrated InfoWorks model was used to route flows through the collection and transport system to generate projected flows at the Honouliuli WWTP.

Table 3-2 shows typical year (dry and wet days that make up a “typical” year) flow projections and Table 3-3 shows flow projections for years 2010, 2035, and 2050 that would occur during a 2-year, 6-hour design storm. The flow projections methodology and detailed results are provided in Appendix A.

Table 3-2. Flow Projections from the Honouliuli System Model

Location	Typical Year (MGD)								
	Peak 1 Hour			Maximum 24 Hour			Annual Average		
	2010	2035	2050	2010	2035	2050	2010	2035	2050
WWTP	49.5	69.7	79.5	33.8	50.3	57.0	27.5	39.6	44.4

This table shows total flow (i.e., sanitary flow, dry weather infiltration, and wet-weather infiltration/inflow).
Source: Honouliuli Fac Plan Work Task 4.F.1 – Updated Basis of Design Population, Flows, and Loads Technical Memorandum (AECOM 2012a).

Table 3-3. Storm Flow Projections from the Honouliuli System Model

Location	2 Year, 6 Hour Storm (MGD)					
	Peak 1 Hour			Maximum 24 Hour		
	2010	2035	2050	2010	2035	2050
WWTP	82.2	114.2	126.4	45.0	65.4	73.5

This table shows total flow (i.e., sanitary flow, dry weather infiltration, and wet-weather infiltration/inflow).
Source: Honouliuli Fac Plan Work Task 4.F.1 – Updated Basis of Design Population, Flows, and Loads Technical Memorandum (AECOM 2012a).

The following design storm intervals were then evaluated as part of the *Sewer I/I Assessment and Rehabilitation Program Update* to identify capacity constraints in order to help define and prioritize proposed improvements, which are summarized in Table 3-4.

- 1-year, 6-hour
- 2-year, 6-hour
- 5-year, 6-hour
- 10-year, 6-hour
- 1-year, 24-hour
- 2-year, 24-hour
- 5-year, 24-hour
- 10-year, 24-hour

Table 3-4. Honouliuli Basin Proposed Improvements, Modeling Results

Description	Units	1-Year	2-Year	5-Year	10-Year
Gravity Pipes					
No. of Gravity Pipes	(Count)	N/A	9	42	100
Length of Gravity Pipes	(LF)	N/A	490	7,632	18,634
Force Mains					
No. of Force Mains	(Count)	0	0	0	0
Length of Force Mains	(LF)	0	0	0	0
WWPS					
Waimalu WWPS (23.82 MGD)	MGD	N/A	N/A	N/A	27.01

Source: Sewer I/I Assessment and Rehabilitation Program Update – Final Peak Flow Cost-Effective Analysis Report (AECOM 2012b)

3.4 Anticipated Ocean Discharge Permit Requirements

The Honouliuli WWTP needs to be upgraded to a secondary treatment facility by Year 2024, in accordance with the FACD. Table 3-5 presents the anticipated secondary effluent requirements after the WWTP has been upgraded. These requirements are set by the EPA.

Table 3-5. Anticipated Secondary Effluent Requirements

Parameter (1)	30-day Average Concentration (mg/L)	7-day Average Concentration (mg/L)
BOD_5 (2)	30	45
TSS (2)	30	45

Legend: BOD_5 = biochemical oxygen demand of wastewater during decomposition occurring over a 5-day period; CBOD = carbonaceous biochemical oxygen demand; TSS = total suspended solids.
Source: 40 Code of Federal Regulations (CFR) Section 133.102 Secondary Treatment (2011).
Notes:
(1) Required effluent pH between 6 to 9.
(2) The 30-day average percent removal shall not be less than 85 percent (57 mg/L and 59 mg/L for BOD_5 and TSS, respectively, based on 2011 average daily values). Therefore, the 30 mg/L limit is more stringent for both BOD_5 and TSS.

3.5 Basis of Design Influent and Effluent Quality and Quantity

The proposed Honouliuli WWTP sizing is based on Year 2050 flows and loads, although phasing for construction of structures was also considered. The peak wet weather flows, used in conjunction with representative wastewater concentrations to compute loads, and for design of the facilities, are based on the InfoWorks model identified in the previous section using a 2-year, 6-hour storm. Table 3-6 presents basis of design criteria for Years 2010, 2024 (initial year of new plant operation), 2035, and 2050 influent flows and corresponding loads. Additional detail regarding the load projections is provided in Appendix A.

Table 3-6. Basis of Design Influent Flows and Loads

Year	Avg. Day (mgd)	Max Day (mgd)	Peak Hr (mgd)	BOD_5 (lb/day)	TSS (lb/day)	TKN (lb/day)	NH_3 (lb/day)	TP (lb/day)
2010	27.5 (2)	33.8 (2)	82.2 (2)	78,000	81,000	7,900	5,800	1,000
2010 without Import Sludge (1)	27.5 (2)	33.8 (2)	82.2 (2)	74,000 (347 mg/L)	77,000 (360 mg/L)	7,500 (35 mg/L)	5,400 (25 mg/L)	900 (4.1 mg/L)
2024	36	45	101	91,000 (3)	94,000 (3)	9,300 (3)	6,500 (3)	1,100 (3)
2035	40	50	114	102,000 (3)	106,000 (3)	10,500 (3)	7,300 (3)	1,200 (3)
2050	45	57	126	114,000 (3)	118,000 (3)	11,600 (3)	8,100 (3)	1,400 (3)

Legend: NH_3 = Ammonia; TKN = Total Kjeldahl Nitrogen; TP = total phosphorus.
Source: Honouliuli Fac Plan Work Task 4.F.1 – Updated Basis of Design Population, Flows, and Loads Technical Memorandum (AECOM 2012).
Notes:
(1) Import sludge refers to sludge hauled from Paalaa Kai and Wahiawa WWTPs.
(2) 2010 flows shown are the calibrated flows from the InfoWorks model and are slightly higher than the actual flow.
(3) Based on 2010 without Import Sludge Concentrations.

The primary effluent quality will have an impact on the sizing of the proposed secondary treatment processes required for the upgrade and expansion of the Honouliuli WWTP for Year 2035 and 2050 conditions. With no additional primary clarifiers, it is anticipated that the removal efficiencies will decline as the flows and loads to the primary clarifiers increase. For Year 2050 conditions, used as the basis for sizing secondary treatment options, primary treatment removal efficiencies of 40 percent for BOD5 and 60 percent for total suspended (non-filterable) solids (TSS) were assumed. The basis of design effluent criteria is the anticipated secondary effluent requirements as shown in Table 3-5.

Additional secondary treated effluent will be available following the secondary treatment upgrade, which will provide an opportunity for additional water reuse including groundwater recharge. Currently, effluent reuse limits are presented in the *Reuse Guidelines* and *Hawaii Administrative Rules, Title 11 Department of Health Chapter 62 Wastewater Systems* (DOH 2004).

3.6 Design Standards

Alternative upgrades to the existing wastewater treatment system will be in accordance with the CCH's Design Standards of the Department of Wastewater Management, Volume 1 (DWM 1993), Design Standards of the Division of Wastewater Management, Volume 2 (DPW 1984), collectively referred to as the Wastewater Design Standards, and subsequent updates to these standards. Where supplemental standards are required, the *Recommended Standards for Wastewater Facilities* (commonly referred to as the Ten States Standards) (Health Research, Inc. 2004) and typical standards of practice will be used.

4 ALTERNATIVES CONSIDERED

In compliance with the provisions of Title 11, DOH, Chapter 200, Environmental Impact Statement Rules, Section 11-200-10(6), the alternatives considered are limited to those that would satisfy the objectives of the proposed project, while minimizing the potential for adverse environmental impacts.

Alternatives are considered for secondary treatment upgrades and modifications to the Honouliuli WWTP to meet future flow and water quality requirements. The following three major alternatives (herein referred to as options) for the secondary treatment upgrades are evaluated to achieve the project objectives:

- Option 1 – Expand Existing Trickling Filter/Solids Contact (TF/SC) Process to Full Capacity
- Option 2 – Replace Existing TF/SC Process with Activated Sludge (AS) to Full Capacity
- Option 3 – Add to Existing TF/SC Process with AS to Full Capacity

The “No Action” alternative is also evaluated.

Consideration for phasing was evaluated for the preferred alternative. Phasing is discussed in Section 4.7.

4.1 Common Components to Secondary Treatment Alternatives

The following describes the project activities and upgrades for components that are common to each of the secondary treatment options described in Section 4.2.

4.1.1 Preliminary Treatment System

The influent screens do not have capacity to handle the design peak hour flow of 126 mgd. The units are over 30 years old and nearing the end of their useful life; therefore, replacement of the influent screens is recommended. Space is available within the existing structure to construct two additional flow channels (one on either side of the three existing flow channels). The two new channels and two of the three existing channels would be outfitted with new mechanically cleaned screens. The remaining channel could be left empty (without a screen) to serve as an emergency bypass or could be fit with a new mechanically cleaned screen. Screenings washer-compacters and conveyors would be provided to dewater and discharge the material into a container at grade adjacent to the existing structure. The material would then be hauled off-site for disposal.

Four of the six pumps in the IPS are over 30 years old and nearing the end of their useful life. The remaining two other pumps are approximately 15 years old. These pumps do not provide enough capacity to handle the design peak flow of 126 mgd. Therefore, the influent pumps are proposed to be replaced to handle the design peak flow. The entire IPS structure would be rehabilitated to extend its useful life.

The existing aerated grit chamber/aeration tanks are in need of rehabilitation to address condition and performance issues. The four aerated grit chamber/preaeration tanks would be rehabilitated with concrete, new coatings, covers, diffusers, and a collector mechanism, or refurbished and repurposed to become High Rate Biological Contact (HRBC) tanks. A new flow control channel and divider walls would be constructed between the grit and preaeration zones to facilitate the isolation of individual grit and preaeration zones as well as to allow bypass of the preaeration system. The existing chain and flight grit collector mechanisms would be replaced with new screw collectors. The existing chain and bucket grit conveyors would be replaced with recessed impeller grit pumps to convey the collected grit slurry to a grit washing and dewatering system in the new Grit Building.

The system would both remove grit and strip hydrogen sulfide (H_2S) from the flow prior to entering the clarifiers. The existing preaeration process is known to improve the operating efficiency of the primary clarifiers. The option to preaerate would therefore remain with the option to bypass preaeration added for flexibility of future operation. A fifth grit chamber, preaeration tank or HRBC would be constructed to treat the projected increased flow.

Alternative methods of grit removal will also be considered including use of the vortex removal type systems. Elimination of the preaeration facility would also be considered since with the implementation of secondary treatment, the necessity for optimizing primary clarifier performance would be diminished.

A new Grit Building would be provided to house the grit pumping, washing and dewatering equipment. The below grade level of the building would contain the grit pumps and influent magnetic flow meters. Once the grit slurry is collected it would be pumped to the upper level of the building, washed, and dewatered to remove and separate the heavy particles of grit and solids from organic matter. Grit would then be deposited in a container and the liquid from the grit washing and dewatering process returned to the wastewater stream for treatment. The building would be enclosed and ventilated to the Odor Control System.

4.1.2 Primary Treatment System

The existing primary clarifiers have the capacity to treat future flows through the end of the Year 2050 planning period. However, rehabilitation is required to address the condition and performance issues. The existing primary clarifiers and scum pumping equipment would be rehabilitated (portions replaced) or repurposed to become wet weather storage tanks to address condition and performance issues. Additional HRBC's may become the primary treatment process. The primary clarifier collector mechanisms, scum beaches, and weir troughs would be replaced due to age and deterioration. The tank structure would receive concrete and coating repairs as needed. Portions or the entire primary clarifier surface may be covered for containment of odors.

4.1.3 Wet Weather Management

The WWTP is proposed to be designed to hydraulically pass the peak flow of 126 mgd through all treatment systems during wet weather events with one unit out of service. Wet Weather storage is proposed to reduce peak flows impact on downstream processes; however hydraulic modeling confirmed the capacity assuming that the storage has been filled and the peak continues to flow. The wet weather storage volume necessary was determined by modeling, which was described in Section 3.2. Rectangular wet weather storage tanks are illustrated in the proposed facility plan. The rectangular configuration facilitates clean-up, is simpler to cover if odors occur, and could be converted to primary clarifiers if additional primary clarifier capacity is required in the future. The number and size of tanks would vary depending on the secondary treatment option selected. Therefore, the off-line storage tank volume requirements are described with each of the secondary treatment options in Section 4.2.

Alternative configurations could be considered depending on the final facility configuration. Determination of the final size and configuration would be the result of an iterative process as the project progresses to final design.

4.1.4 Effluent Disposal System

The existing effluent structure, located on the Honouliuli WWTP property, is in poor structural condition; therefore, a new effluent structure is proposed to be constructed and old components demolished. In addition, since the Honouliuli WWTP does not presently disinfect effluent that is discharged to the Barbers Point Ocean Outfall, provisions would be made to incorporate UV disinfection into the secondary treatment option in the event that effluent disinfection is required in the future. The overall UV disinfection structure footprint would include the inlet channel, UV channels, outlet channel, flow control weir and walkway between channels. In addition, with the upgrade of the influent screens, effluent screening would not be necessary. Flow measurement requirements will also need to be addressed in the effluent disposal system as the configuration progresses to final design.

4.1.5 Solids Handling System

The discussion provided below addresses the additional sludge production from the secondary treatment process using the sludge handling approach currently employed at the Honouliuli WWTP (thickening, blending, anaerobic digestion, and centrifuge dewatering). This approach is considered appropriate for budgeting and space planning purposes, while actual sizes and locations may change during the project development. Concurrent to this effort, the Island-wide Sludge Planning and future efforts have recommended sludge processing technologies for implementation at Honouliuli WWTP. The quantity and quality of sludge being processed, and biogas available for beneficial use, depends to an extent on the island-wide sludge planning effort and factors such as on-site processing methods and importation of sludge.

The existing gravity thickeners have sufficient capacity to handle the projected 2050 primary sludge flows and loads; therefore, no upgrades to the gravity thickeners would be required. However, the equipment would be replaced at the end of its design life or replaced with a new process.

The secondary sludge flow, regardless of the secondary treatment alternative selected, is estimated to be 757,000 gpd for the 2050 flows. Based on the estimated flow, three 3.0 meter Gravity Belt Thickener units are proposed and would fit within the existing secondary sludge thickening building; however, other types of equipment can be considered. Polymer feed equipment would be moved outside the existing building into a new, separate structure.

During the project development there may be an option to keep the existing blend tanks or build four new sludge blend tanks, which are proposed to be located south of the existing primary clarifiers and west of the existing gravity thickeners.

Depending on the selected sludge conditioning option, up to two additional primary anaerobic digesters or thermal hydrolysis processes would also be constructed as well as a cake handling and storage facility to meet the Year 2050 flows and loads. The two digesters would be 90 ft in diameter to match the existing units. The digesters would be located within the site west of the existing digesters. A new Digester Control Building would be constructed to support anaerobic digesters operations. Estimated sludge quantities are listed in Table 4-1. The volume of sludge is larger than existing due to the projected growth in population as well as the additional amount of solids removed in secondary treatment. Undigested dewatered and dried quantities would likely not be produced at the WWTP and are therefore not included in this table. Dewatering performance is anticipated to be 25% TS.

Table 4-1. Year 2050 Estimated Sludge Quantities – Annual Average

Parameter	Undigested Sludge	Digested Sludge
Flow (gallons/day)	273,000	273,000
Sludge Solids Content (% TS)	5% (digester feed)	2.7% (digester output)
Sludge Load (dtpd)	55	31
Dewatered Cake Load (wtpd @ 25% TS)	N/A	124
Dewatered Cake Load Load (wtpd @ 30% TS)	N/A	103
Dried Biosolids Load (1) (wtpd @ 92% TS)	N/A	34

Legend: dtpd = dry tons per day; N/A = not applicable; wtpd = wet tons per day.
Source: Based on information presented in *Technical Memorandum 12.O Honouliuli, WWTP Concept Design Report.*
Note: (1) Biosolids drying is a potential future final sludge processing alternative for implementation. If drying is not implemented, dewatered cake would be the final sludge output from the WWTP.

The digested sludge is anticipated to have the following qualities:

- TS = 2.7%
- Volatile Solids/TS = 64%
- Digester Volatile Solids Reduction = 55%

Immediately after digestion, the digested biosolids would still be in a liquid, free-flowing form. The anaerobic digestion process is considered a Process to Significantly Reduce Pathogens (PSRP) by the EPA 40 Code of Federal Regulations (CFR) Part 503 regulation. The anaerobically digested biosolids are considered “Class B” by the EPA. Application of Class B Biosolids involves site use restrictions to minimize the potential for human or animal exposure. Following digestion, it would then be pumped to the centrifuges for dewatering.

The dewatered cake would be similar in composition to how it is today, which is a moist, semi-solid, soil-like material. It would require specialized pumps or conveyors for transporting, and it is not typically stored in tanks unless the tank contains a specialized “live bottom” consisting of screw feeders or hydraulic rams.

Thermally dried biosolids would be granular or in a pellet-like form, and would contain little moisture. Thermal drying is considered a “Process to Further Reduce Pathogens” by the EPA 40 CFR Part 503 regulation. The dried biosolids would be considered “Class A” if bacterial counts met Class A standards at the time of distribution.

4.1.6 Odor Control System

The Honouliuli Wastewater Basin Odor Control Project evaluated and recommended improvements to the odor control systems at the Honouliuli WWTP. The existing Preliminary Odor Control System is overloaded; therefore, it is recommended that the existing granulated activated carbon (GAC) adsorbers be replaced with biological odor control systems.

Replacing the existing Primary Odor Control System with new biological odor control systems, in addition, to the new treatment facilities. The odor control improvements can be centralized or decentralized.

The estimated odor control air flows are provided in Table 4-2.

Table 4-2. Estimated Odor Control Air Flows

Odor Source	Existing Capacity (cfm)	After Honouliuli Basin Odor Control Project (cfm)	After Honouliuli Fac Plan Phase 1 Improvements (cfm)	After Honouliuli Fac Plan Phase 2 Improvements (cfm)	After Honouliuli Fac Plan Phase 3 Improvements (cfm)
IPS and Sewers	7,000 [(1)]	14,304	14,304	14,304	14,304
Grit/Preaeration and Primary Clarifiers	24,000 [(2)]	24,000 [(2)]	26,684 [(3)]	28,154 [(4)]	28,154
Grit Building	—	—	5,994	5,994	5,994
Primary Influent/Effluent Channels	—	—	2,016	2,016	2,016
Septage Receiving	—	—	1,500	1,500	1,500
TF Pump Station, TFs, and Sludge Reaeration and Solids Contact Tanks [(5)]	25,000	25,000	25,000	25,000	25,000
Wet Weather Tanks	—	—	—	6,165	32,880
Aeration Tank Influent Channels	—	—	4,665	4,665	6,995
Overflow Structure	—	—	680	680	680
Aeration Tank Anoxic Zones	—	—	19,710	19,710	29,565
Aeration Tank Aerobic Zones	—	—	—	—	59,130
Gravity Thickeners and Sludge Blend Tanks [(6)]	16,400	16,400	16,400	16,400	16,400
Sludge Blend Tanks (new)	—	—	1,200	1,200	1,200
Gravity Belt Thickeners [(7)]	3,000	3,000	3,000	3,000	3,000
Centrifuge Building [(8)]	22,000	22,000	22,000	22,000	22,000
Sludge/FOG Receiving Building	—	—	15,000	15,000	15,000
Total Airflow	97,400	104,704	158,153	165,788	263,818
Incremental Airflow	—	7,304	53,449	7,635	98,030

Legend: — = Data not available.

Notes:

(1) Existing Preliminary Odor Control capacity is 7,000 cfm and existing flow is 14,304 cfm. This system would be replaced with new odor control system.

(2) Existing Primary Odor Control capacity is 24,000 cfm and existing air flow is 13,804 cfm. This system would remain in service until the Honouliuli Fac Plan Phase 1 Improvements. Phases are described in Section 4.7 Project Phasing and Schedule.

(3) Following Honouliuli Fac Plan Phase 1 Improvements to the grit/preaeration system and installation of flat covers for the primary clarifiers. Phases are described in Section 4.7 Project Phasing and Schedule.

(4) Following Honouliuli Fac Plan Phase 2 Improvements –addition of 5th grit/preaeration train and installation of flat covers for the primary clarifiers. Phases are described in Section 4.7 Project Phasing and Schedule.

(5) Secondary Odor Control System would remain.

(6) Primary Sludge Odor Control System would remain.

(7) Secondary Sludge Odor Control System would remain.

(8) Dewatering Odor Control System would remain.

In addition to the new biological odor control systems, grit covers, primary clarifier covers, and primary effluent channel covers are recommended for odor containment. Odor control processes, sizes, and configurations would be refined as the project progresses to final design

4.1.7 Electrical

Table 4-3 presents the estimated electrical loads at the WWTP in Year 2050. HECO substation upgrades may be required to handle the new secondary power requirements.

Table 4-3. Estimated Electrical Load

Item	Rating	Unit	Rating	Unit
Existing	4,050	hp	3,020	kW
Process Loads Removed	3,630	hp	2,710	kW
Secondary Treatment Process Loads Added[1]	1,700 to 4,000	hp	1,270 to 2,980	kW
Common Treatment Process Loads Added	4,300	hp	3,210	kW
Sum of Building Loads Added	-	-	1,200	kW
Net Additional Loads Added [2]	-	-	5,990 to 7,700	kW

Notes:
[1] Range of electrical load for the secondary treatment options
[2] "Net Additional Loads Added" is the difference in process loads, which is the net additional process loads, added to the building loads.

4.1.8 Perimeter Access, Security and Fence

The existing perimeter chain link fence would be removed and replaced with a new combination of walls, ornamental fence, and chain link fence. The selection of fence type would be determined based on location on the property. Fences or walls along roadways and the perimeter would be improved to provide an aesthetically pleasing view to replace the industrial look that currently exists, including linear landscape elements along the fences/walls. The landscaping elements could be irrigated with reclaimed water or they could be drought-tolerant plants, grasses, and native species. Additional considerations are as follows:

- Security cameras would be located at entrances, fuel stations, selected perimeter locations and other locations where safety or security is a concern.
- The height and setback of the walls would be considered to minimize impacts to the surrounding neighborhoods.
- At least 10 ft of clear space would be provided on both sides of fences for vehicle access, which would support air quality monitoring as well as fence maintenance.
- The main gate is currently kept open during the day and is locked with access via automated card reader after hours. A pressure plate opens the gate for vehicles leaving the plant. The gate may be closed 24/7 in the future and a method of observation and control would need to be incorporated.

4.1.9 Stormwater Quantity and Quality Control

Honouliuli WWTP drainage design will incorporate best management practices (BMPs) and Low Impact Development (LID) principles to minimize the volume and improve the quality of stormwater runoff from the facility and to comply with NPDES permit requirements and CCH drainage standards. New CCH drainage standards requiring LID strategies went into effect in June 2013 (DPP 2012). Unless infeasible, the design storm runoff volume of 1 inch must be retained onsite using Post-Construction Treatment Control BMPs. In addition, designs must incorporate Source Control BMPs to prevent and control pollutants at their source and Site Design Strategies to minimize runoff volume and reduce the hydrologic impact of the development. Stormwater BMPs for Honouliuli WWTP will be selected during final design based on the location and potential for stormwater pollutants within the facility.

Stormwater from areas of the facility that do not generate large levels of pollutants will be retained onsite and allowed to infiltrate through shallow stormwater basins. The facility plan site layout drawings show more than the needed area of stormwater infiltration basins to infiltrate the required design storm runoff volume. Surface flow conveyance features, such as vegetated swales and vegetated buffer zones, will also be incorporated to address constructability issues and provide additional treatment. Discharge from the swales and basins will be provided into existing storm drainage facilities for overflows produced by storms in excess of the design storm. Consideration will be given to implementation of other BMPs from the new drainage standards that can serve as demonstration-type installations for future developments.

Areas of the facility with the potential to generate a high level of pollutants in stormwater runoff will drain to the WWTP for treatment. This includes areas with high potential for spills or which are subject to frequent wash-down, such as headworks and septage receiving facilities. Site drainage design will utilize grading, contouring, and curbs to prevent mixing of drainage from clean areas, and will consider roofs or other coverings to minimize the volume of polluted runoff that would need to be routed to the treatment plant. During final design of the WWTP, the use of containment or gates will be considered in strategic locations to contain any possible spills within the process area of the WWTP and prevent spills from leaving the site or entering the administrative areas. It is recommended that these operational and non-LID structural BMPs be incorporated into the design process with input from WWTP staff.

4.1.10 Alternative Energy

As part of CCH's Sustainability and Climate Protection Strategy, current technologies and practices to make the WWTP more energy efficient and sustainable were examined. Digester gas is available at the facility. As a result, a combined heat and power (CHP) installation makes the most sense as the first investment in alternative energy, as it uses a resource available specifically at this facility. If a CHP facility is incorporated at Honouliuli WWTP to make beneficial use of digester biogas, it would need to be permitted according to local, state and federal air regulations. If the CHP cannot meet the yearly electrical energy demand, it would then make sense to augment the CHP system with energy from another alternative source. The following technologies were considered feasible to support some of the energy demands at the Honouliuli WWTP based on this evaluation:

- Solar Photovoltaic (PV)
  - Converts energy from the sun to electricity.
- Solar Thermal – Hot Water
  - Extracts thermal energy from the sun to heat potable water for domestic uses.
- Biosolids – Digestion/CHP Near Term
  - Utilizes anaerobic digester gas to generate electricity and heat for use at the generating location or off-site.
- Biosolids – Fluid Bed Incineration
  - Produces an inert ash from a combustion reaction that occurs in the presence of excess oxygen. The digestion/CHP option is preferred due to high capital, O&M costs.
- Biosolids – Gasification
  - Converts coal and other biomass to a fuel gas (syngas). The digestion/CHP option is preferred due to high capital, O&M costs and a potential need for supplemental fossil fuel consumption.

The following technologies would not be feasible:

- Wind Power
  - Not recommended due to lack of wind at the Honouliuli WWTP site.
- Solar Thermal – Process Hot Water
  - Not necessary if the CHP unit is installed, which would supply primary process heat needs at the Honouliuli WWTP.

- Solar Thermal – Sludge Drying (land area and sludge quantity dependent)
  - Utilizes energy from the sun to dry biosolids without the use of supplemental fossil fuels. Includes a drying bed inside a greenhouse that maximizes solar energy while protecting biosolids from precipitation. Requires a large area of land and is applicable to smaller treatment facilities with lower cost land availability.
- Solar Thermal – Electricity Generation
  - Not recommended as this system is still in the development stage, works best at large scales, and requires significant maintenance.
- Biosolids – Digestion/Gas Cleaning/Biomethane Production
  - Biomethane can be added to existing natural gas pipelines or used in fleet vehicles that are configured to operate on natural gas. High costs of electricity, petroleum and synthetic natural gas locally have competing financial considerations for CHP or cleaning for biomethane use.

Thermal systems may be the most feasible option, depending on the location and thermal output of the CHP system. Although a net zero energy demand may be feasible, emergency power and reliability considerations would require back-up power generators and maintaining electrical utility service connection.

4.2 Secondary Treatment Alternatives

The following sections describe the alternatives considered for secondary treatment upgrades for the Honouliuli WWTP. The proposed upgrades are sized for the 2050 design ADF of 45 mgd. With the exception of the “No Action” alternative, all of the secondary treatment upgrade alternatives would meet the basis of design criteria. Table 4-4 compares the secondary treatment options.

In the following comparison of alternatives, it was recognized that the effluent quality of the Activated Sludge (AS) systems would normally exceed that of the TF/SC systems due to the nitrification and denitrification options available with the AS processes. In order to have an even comparison of alternatives the effluent quality should be approximately equal. Therefore, in the TF/SC options below additional add-on facilities for nitrification and denitrification were included in the analysis.

Differences between the secondary treatment alternatives include:

- Option 1 has a large footprint and a high capital cost. This option requires add on facilities for nitrification and denitrification.
- Option 2 has the smallest footprint and the lowest capital cost. This treatment process would be able to produce effluent to meet the design criteria. In addition, phasing could allow for the use of existing TF/SC.
- Option 3 is similar to Option 2 with the exception that tank sizes are slightly different. This option requires add on facilities for nitrification and denitrification for the TF/SC effluent portion.

As stated above, all options would meet the basis of design criteria.

Table 4-4. Comparison of Secondary Treatment Options

Facilities	Sub-option 1A	Sub-option 1B	Option 2	Sub-option 3A	Sub-option 3B
Required Major Treatment Units					
Reuse existing TF/SC process (two TFs, four SC basins and two secondary clarifiers)	x	x	Decommission existing process	x	x
Add new TFs	Add 4 TFs	Add 6 nitrifying TFs	—	—	Add 2
Add new SC basins	Add 4	Add 6	—	—	Add 4
Add new AS aeration basins	—	—	Add 6	Add 6	Add 6
Add new secondary clarifiers	Add 4	Add 6	Add 6	—	Add 2
Add new nitrification filters	Add 10	—	—	Add 4	Add 6
Add new denitrification filters	Add 16	Add 16	—	Add 6	Add 8
Ancillary Facilities					
One new TF IPS	x	x	—	—	x
One new SC blower building	x	x	—	—	x
New RAS and WSS or WAS pumping systems	RAS and WSS	RAS and WSS	RAS and WAS	RAS and WAS	RAS, WSS, and WAS
Add new nitrification/denitrification pump building	x	Denitrification building only	—	x	x
Additional pumping to the nitrification and denitrification filters	x	To denitrification filters only	—	—	—
Bypassing of the nitrification and denitrification filters for flows beyond 67 mgd	x	Denitrification filters only	—	—	—
New electrical power and control equipment	—	—	x	—	—
Add AS pump and blower building	—	—	—	x	x
Treatment level achieved	Secondary	Secondary	Secondary	Secondary	Secondary

Legend: — = Not included in Option; x = Included in Option; RAS = return activated sludge; WAS = waste activated sludge.

4.2.1 No Action Alternative

The “No Action” alternative would not address any of the project objectives as it involves no upgrades to the existing treatment systems, hydraulics of the disposal system or improvements to the Honouliuli WWTP. The “No Action” Alternative would fail to fulfill requirements of the FACD. Failure to comply with this Consent Decree requirement by December 2024 could result in the imposition of monetary fines for each day thereafter that the WWTP does not provide secondary treatment to all flow that enters the site and is discharged via the outfall to the ocean.

4.2.2 Option 1 – Expand Existing TF/SC Process to Full Capacity

Option 1 for the secondary treatment alternatives would involve maintaining the existing 13 mgd of TF/SC capacity and adding 32 mgd of additional TF/SC capacity to attain full secondary treatment of Year 2050 design average flow of 45 mgd. Nitrification and denitrification would be assumed to be needed and are included for purposes of an even comparison of alternatvives. . There are two options to provide nitrification and denitrification:

- Sub-option 1A: Maintains the existing 13 mgd of TF/SC capacity; constructs 32 mgd of additional TF/SC, and provides nitrification and denitrification filters. Figure 4-1 shows a preliminary site layout for Sub-option 1A.

- Sub-option 1B: Modifies the existing TF/SC process and provides nitrifying TFs, and denitrification filters. Figure 4-2 shows a preliminary site layout for Sub-option 1B.

4.2.3 Option 2 – Replace Existing TF/SC Process with AS to Full Capacity

Option 2 would involve construction of a 45 mgd AS process and the subsequent decommissioning of the existing 13 mgd TF/SC process. All secondary treatment at the Honouliuli WWTP would be provided by the AS process. This option does not require the addition of nitrification and denitrification filters. Figure 4-3 shows a preliminary site layout for Option 2.

AS effluent would be supplied to HWRF and TF/SC effluent would be disposed of through the ocean outfall (during Phase 1, as described in Section 4.7 Project Phasing and Schedule). AS effluent would be higher quality than TF/SC effluent, which is expected to be of benefit to the HWRF and its customers. The HWRF brine water along with excess reverse osmosis water would continue to be discharged through the outfall. A new 84-inch pipeline would be installed to convey the AS secondary treatment effluent to a point of connection with the existing 84-inch ocean outfall.

4.2.4 Option 3 – Add to Existing TF/SC Process with AS to Full Capacity

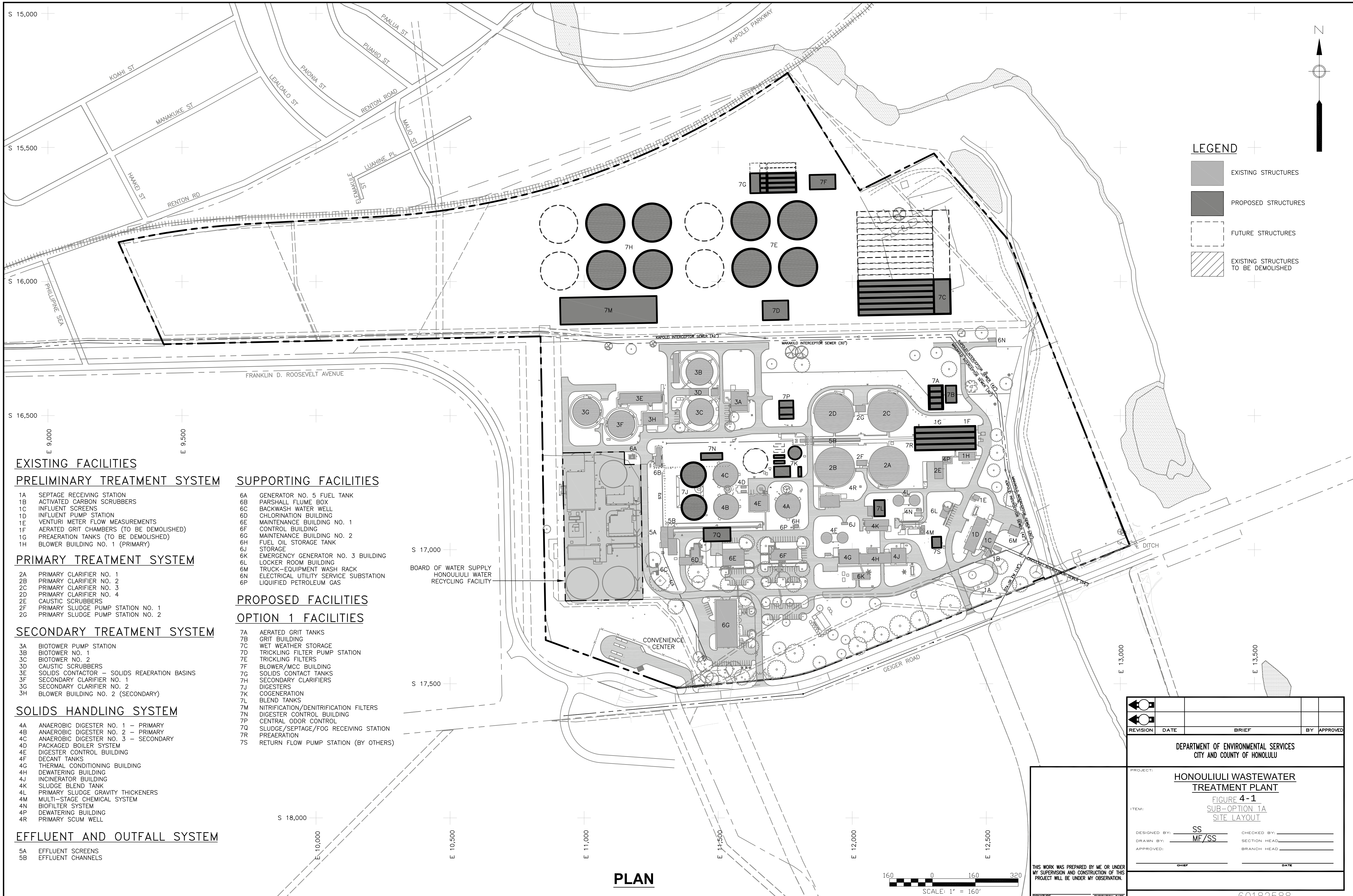
Option 3 would maintain the existing 13 mgd TF/SC process in operation and add additional TF/SC and/or AS capacity. There are two sub-options for Option 3:

- Sub-option 3A: The existing TF/SC process has a capacity of 13 mgd and would remain in service following appropriate rehabilitation to continue operation through Year 2050. A new 32 mgd AS process would be constructed to provide the required total secondary treatment capacity of 45 mgd through the Year 2050. For this option, the TF/SC would treat a constant flow of 13 mgd and the AS process would be sized to handle peak flows.

  Sub-option 3A would require nitrification and denitrification for the existing TF/SC process. Figure 4-4 shows a preliminary site layout for Sub-option 3A.

- Sub-option 3B: The existing 13 mgd capacity TF/SC process was designed and constructed in a manner to facilitate the doubling of treatment capacity through construction of identically sized treatment units in a symmetrical “butterfly” manner to the existing. This would result in a total of 26 mgd TF/SC treatment process capacity.

  For this Sub-option, the existing 13 mgd TF/SC process would remain in service following appropriate rehabilitation to continue operation through Year 2050. An additional 13 mgd of TF/SC capacity would be constructed as outlined above. A new 19 mgd capacity AS process would be constructed to provide the required total secondary treatment capacity of 45 mgd through the Year 2050. For this option, the TF/SC would treat a constant flow of 26 mgd and the AS process would be sized to handle peak flows. Nitrification and denitrification filters would be required for the TF/SC effluent. Figure 4-5 shows a preliminary site layout for Sub-option 3B.



EXISTING FACILITIES

PRELIMINARY TREATMENT SYSTEM

- 1A SEPTAGE RECEIVING STATION
- 1B ACTIVATED CARBON SCRUBBERS
- 1C INFLUENT SCREENS
- 1D INFLUENT PUMP STATION
- 1E VENTURI METER FLOW MEASUREMENTS
- 1F AERATED GRIT CHAMBERS (TO BE DEMOLISHED)
- 1G PREAERATION TANKS (TO BE DEMOLISHED)
- 1H BLOWER BUILDING NO. 1 (PRIMARY)

PRIMARY TREATMENT SYSTEM

- 2A PRIMARY CLARIFIER NO. 1
- 2B PRIMARY CLARIFIER NO. 2
- 2C PRIMARY CLARIFIER NO. 3
- 2D PRIMARY CLARIFIER NO. 4
- 2E CAUSTIC SCRUBBERS
- 2F PRIMARY SLUDGE PUMP STATION NO. 1
- 2G PRIMARY SLUDGE PUMP STATION NO. 2

SECONDARY TREATMENT SYSTEM

- 3A BIOTOWER PUMP STATION
- 3B BIOTOWER NO. 1
- 3C BIOTOWER NO. 2
- 3D CAUSTIC SCRUBBERS
- 3E SOLIDS CONTACTOR – SOLIDS REAERATION BASINS
- 3F SECONDARY CLARIFIER NO. 1
- 3G SECONDARY CLARIFIER NO. 2
- 3H BLOWER BUILDING NO. 2 (SECONDARY)

SOLIDS HANDLING SYSTEM

- 4A ANAEROBIC DIGESTER NO. 1 – PRIMARY
- 4B ANAEROBIC DIGESTER NO. 2 – PRIMARY
- 4C ANAEROBIC DIGESTER NO. 3 – SECONDARY
- 4D PACKAGED BOILER SYSTEM
- 4E DIGESTER CONTROL BUILDING
- 4F DECANT TANKS
- 4G THERMAL CONDITIONING BUILDING
- 4H DEWATERING BUILDING
- 4J INCINERATOR BUILDING
- 4K SLUDGE BLEND TANK
- 4L PRIMARY SLUDGE GRAVITY THICKENERS
- 4M MULTI-STAGE CHEMICAL SYSTEM
- 4N BIOFILTER SYSTEM
- 4P DEWATERING BUILDING
- 4R PRIMARY SCUM WELL

EFFLUENT AND OUTFALL SYSTEM

- 5A EFFLUENT SCREENS
- 5B EFFLUENT CHANNELS

SUPPORTING FACILITIES

- 6A GENERATOR NO. 5 FUEL TANK
- 6B PARSHALL FLUME BOX
- 6C BACKWASH WATER WELL
- 6D CHLORINATION BUILDING
- 6E MAINTENANCE BUILDING NO. 1
- 6F CONTROL BUILDING
- 6G MAINTENANCE BUILDING NO. 2
- 6H FUEL OIL STORAGE TANK
- 6J STORAGE
- 6K EMERGENCY GENERATOR NO. 3 BUILDING
- 6L LOCKER ROOM BUILDING
- 6M TRUCK-EQUIPMENT WASH RACK
- 6N ELECTRICAL UTILITY SERVICE SUBSTATION
- 6P LIQUIFIED PETROLEUM GAS

PROPOSED FACILITIES

OPTION 1 FACILITIES

- 7A AERATED GRIT TANKS
- 7B GRIT BUILDING
- 7C WET WEATHER STORAGE
- 7D TRICKLING FILTER PUMP STATION
- 7E TRICKLING FILTERS
- 7F BLOWER/MCC BUILDING
- 7G SOLIDS CONTACT TANKS
- 7H SECONDARY CLARIFIERS
- 7J DIGESTERS
- 7K COGENERATION
- 7L BLEND TANKS
- 7M NITRIFICATION/DENITRIFICATION FILTERS
- 7N DIGESTER CONTROL BUILDING
- 7P CENTRAL ODOR CONTROL
- 7Q SLUDGE/SEPTAGE/FOG RECEIVING STATION
- 7R PREAERATION
- 7S RETURN FLOW PUMP STATION (BY OTHERS)

REVISION	DATE	BRIEF	BY	APPROVED

DEPARTMENT OF ENVIRONMENTAL SERVICES
CITY AND COUNTY OF HONOLULU

PROJECT: HONOULIULI WASTEWATER TREATMENT PLANT

FIGURE 4-1

ITEM: SUB-OPTION 1A SITE LAYOUT

DESIGNED BY: SS
DRAWN BY: MF/SS
APPROVED:
CHECKED BY:
SECTION HEAD:
BRANCH HEAD:
CHIEF
DATE

THIS WORK WAS PREPARED BY ME OR UNDER MY SUPERVISION AND CONSTRUCTION OF THIS PROJECT WILL BE UNDER MY OBSERVATION.

SIGNATURE
EXPIRATION DATE OF THE LICENSE

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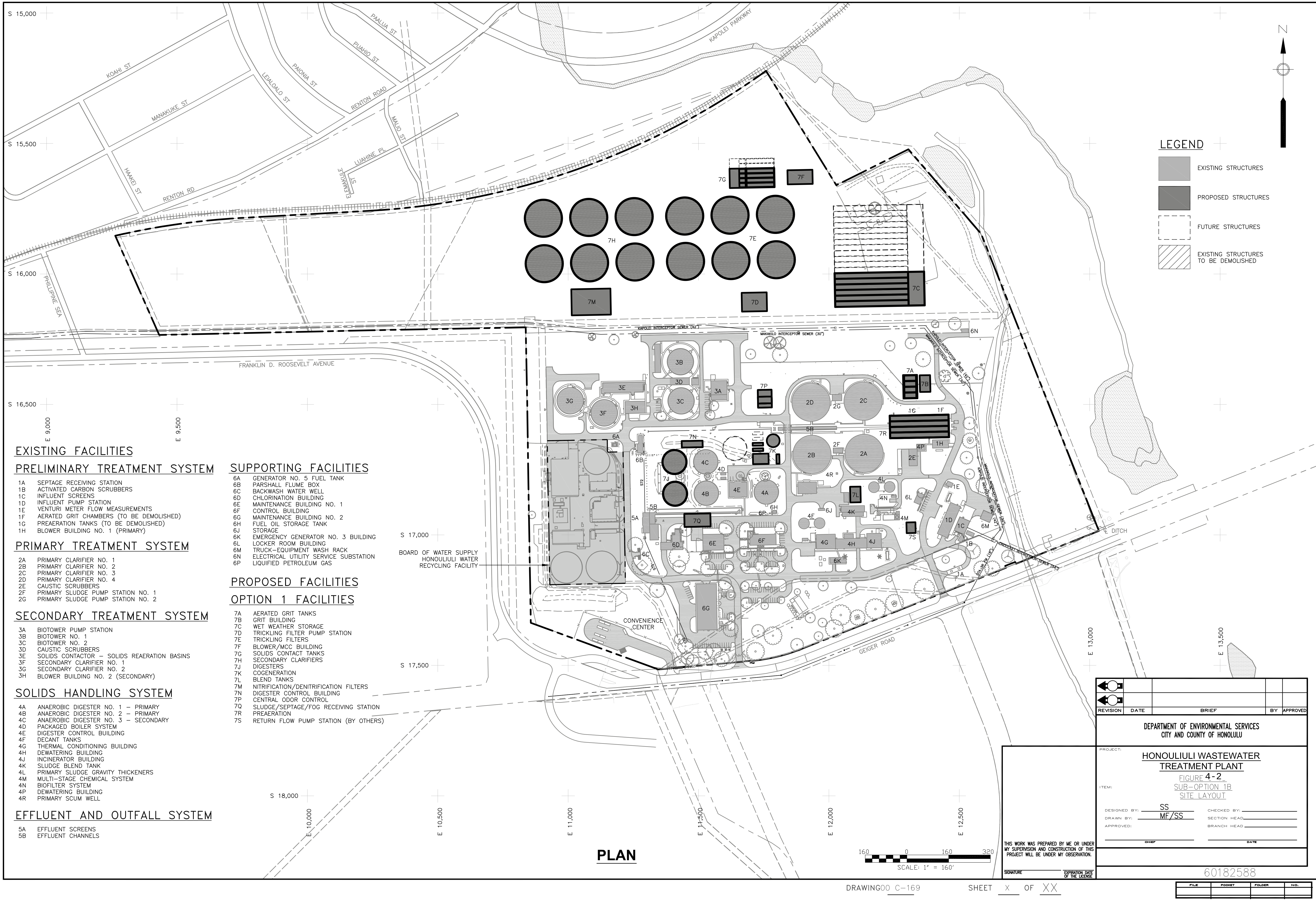
FILE	POCKET	FOLDER	NO.



LEGEND
EXISTING STRUCTURES
PROPOSED STRUCTURES
FUTURE STRUCTURES
EXISTING STRUCTURES TO BE DEMOLISHED
EXISTING FACILITIES
PRELIMINARY TREATMENT SYSTEM
1A SEPTAGE RECEIVING STATION
1B ACTIVATED CARBON SCRUBBERS
1C INFLUENT SCREENS
1D INFLUENT PUMP STATION
1E VENTURI METER FLOW MEASUREMENTS
1F AERATED GRIT CHAMBERS (TO BE DEMOLISHED)
1G PREAERATION TANKS (TO BE DEMOLISHED)
1H BLOWER BUILDING NO. 1 (PRIMARY)
PRIMARY TREATMENT SYSTEM
2A PRIMARY CLARIFIER NO. 1
2B PRIMARY CLARIFIER NO. 2
2C PRIMARY CLARIFIER NO. 3
2D PRIMARY CLARIFIER NO. 4
2E CAUSTIC SCRUBBERS
2F PRIMARY SLUDGE PUMP STATION NO. 1
2G PRIMARY SLUDGE PUMP STATION NO. 2
SECONDARY TREATMENT SYSTEM
3A BIOTOWER PUMP STATION
3B BIOTOWER NO. 1
3C BIOTOWER NO. 2
3D CAUSTIC SCRUBBERS
3E SOLIDS CONTACTOR – SOLIDS REAERATION BASINS
3F SECONDARY CLARIFIER NO. 1
3G SECONDARY CLARIFIER NO. 2
3H BLOWER BUILDING NO. 2 (SECONDARY)
SOLIDS HANDLING SYSTEM
4A ANAEROBIC DIGESTER NO. 1 – PRIMARY
4B ANAEROBIC DIGESTER NO. 2 – PRIMARY
4C ANAEROBIC DIGESTER NO. 3 – SECONDARY
4D PACKAGED BOILER SYSTEM
4E DIGESTER CONTROL BUILDING
4F DECANT TANKS
4G THERMAL CONDITIONING BUILDING
4H DEWATERING BUILDING
4J INCINERATOR BUILDING
4K SLUDGE BLEND TANK
4L PRIMARY SLUDGE GRAVITY THICKENERS
4M MULTI-STAGE CHEMICAL SYSTEM
4N BIOFILTER SYSTEM
4P DEWATERING BUILDING
4R PRIMARY SCUM WELL
EFFLUENT AND OUTFALL SYSTEM
5A EFFLUENT SCREENS
5B EFFLUENT CHANNELS
SUPPORTING FACILITIES
6A GENERATOR NO. 5 FUEL TANK
6B PARSHALL FLUME BOX
6C BACKWASH WATER WELL
6D CHLORINATION BUILDING
6E MAINTENANCE BUILDING NO. 1
6F CONTROL BUILDING
6G MAINTENANCE BUILDING NO. 2
6H FUEL OIL STORAGE TANK
6J STORAGE
6K EMERGENCY GENERATOR NO. 3 BUILDING
6L LOCKER ROOM BUILDING
6M TRUCK-EQUIPMENT WASH RACK
6N ELECTRICAL UTILITY SERVICE SUBSTATION
6P LIQUIFIED PETROLEUM GAS
PROPOSED FACILITIES
OPTION 1 FACILITIES
7A AERATED GRIT TANKS
7B GRIT BUILDING
7C WET WEATHER STORAGE
7D TRICKLING FILTER PUMP STATION
7E TRICKLING FILTERS
7F BLOWER/MCC BUILDING
7G SOLIDS CONTACT TANKS
7H SECONDARY CLARIFIERS
7J DIGESTERS
7K COGENERATION
7L BLEND TANKS
7M NITRIFICATION/DENITRIFICATION FILTERS
7N DIGESTER CONTROL BUILDING
7P CENTRAL ODOR CONTROL
7Q SLUDGE/SEPTAGE/FOG RECEIVING STATION
7R PREAERATION
7S RETURN FLOW PUMP STATION (BY OTHERS)
BOARD OF WATER SUPPLY HONOULIULI WATER RECYCLING FACILITY
CONVENIENCE CENTER
KAPOLEI INTERCEPTOR SEWER (42")
MAKAKILO INTERCEPTOR SEWER (30")
FRANKLIN D. ROOSEVELT AVENUE
GEIGER ROAD
RENTON RD
RENTON ROAD
KAPOLEI PARKWAY
KOAHI ST
MANAKUKE ST
LEIALOALO ST
PAIONIA ST
PUAHIO ST
PAALUA ST
MAIO ST
LUAHINE PL
HAAKEI ST
PHILIPPINE SEA
DITCH
S 15,000
S 15,500
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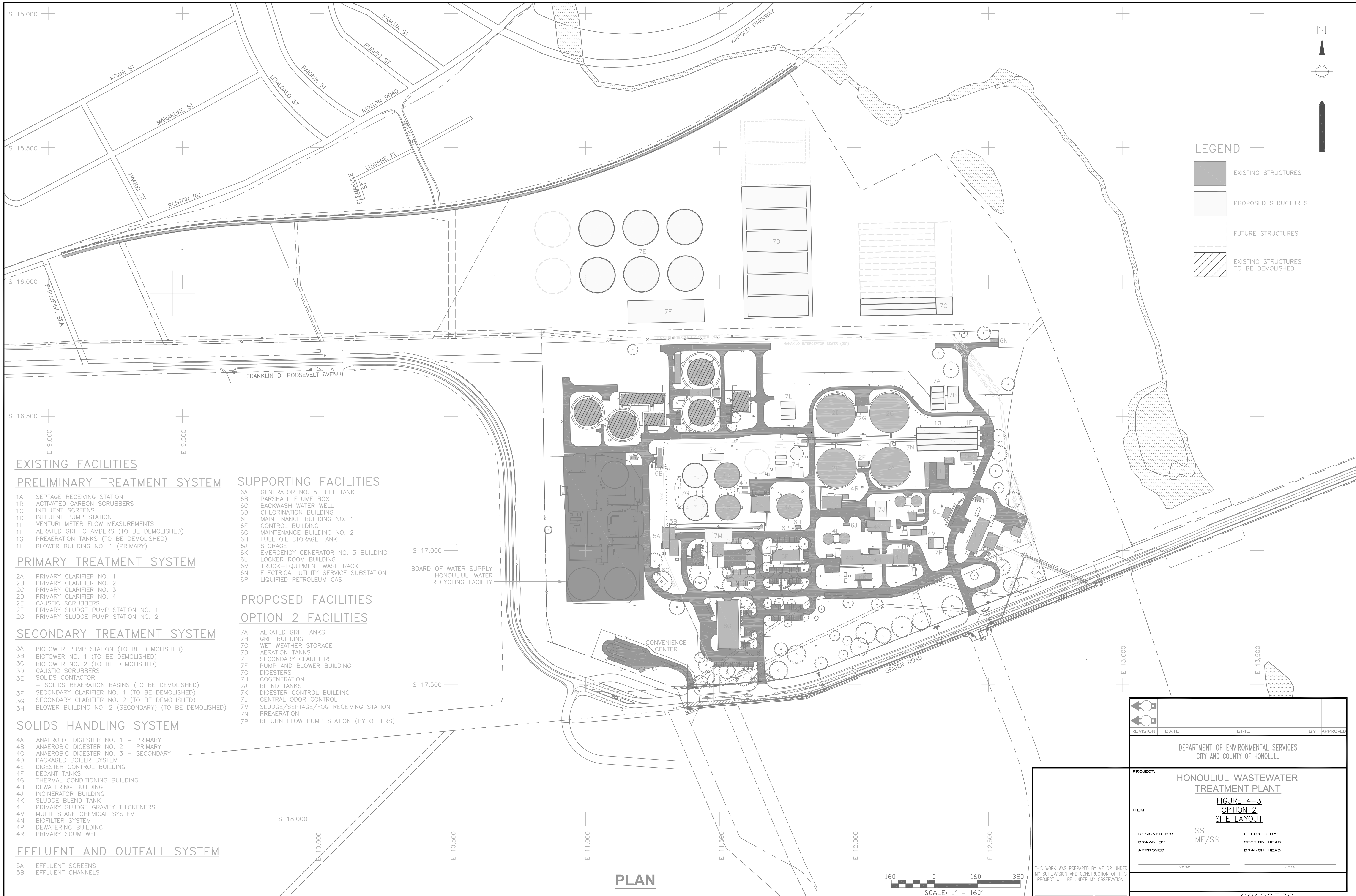
E 10,000
E 10,500
E 11,000
E 11,500
E 12,000
E 12,500
E 13,000
E 13,500
N
PLAN
160 0 160 320
SCALE: 1" = 160'
REVISION DATE BRIEF BY APPROVED
DEPARTMENT OF ENVIRONMENTAL SERVICES
CITY AND COUNTY OF HONOLULU
PROJECT:
HONOULIULI WASTEWATER TREATMENT PLANT
FIGURE 4-2
ITEM:
SUB-OPTION 1B
SITE LAYOUT
DESIGNED BY: SS
DRAWN BY: MF/SS
APPROVED:
CHECKED BY:
SECTION HEAD
BRANCH HEAD
CHIEF
DATE
THIS WORK WAS PREPARED BY ME OR UNDER MY SUPERVISION AND CONSTRUCTION OF THIS PROJECT WILL BE UNDER MY OBSERVATION.
SIGNATURE
EXPIRATION DATE OF THE LICENSE
60182588
DRAWING 00 C-169
SHEET X OF XX
FILE POCKET FOLDER NO.



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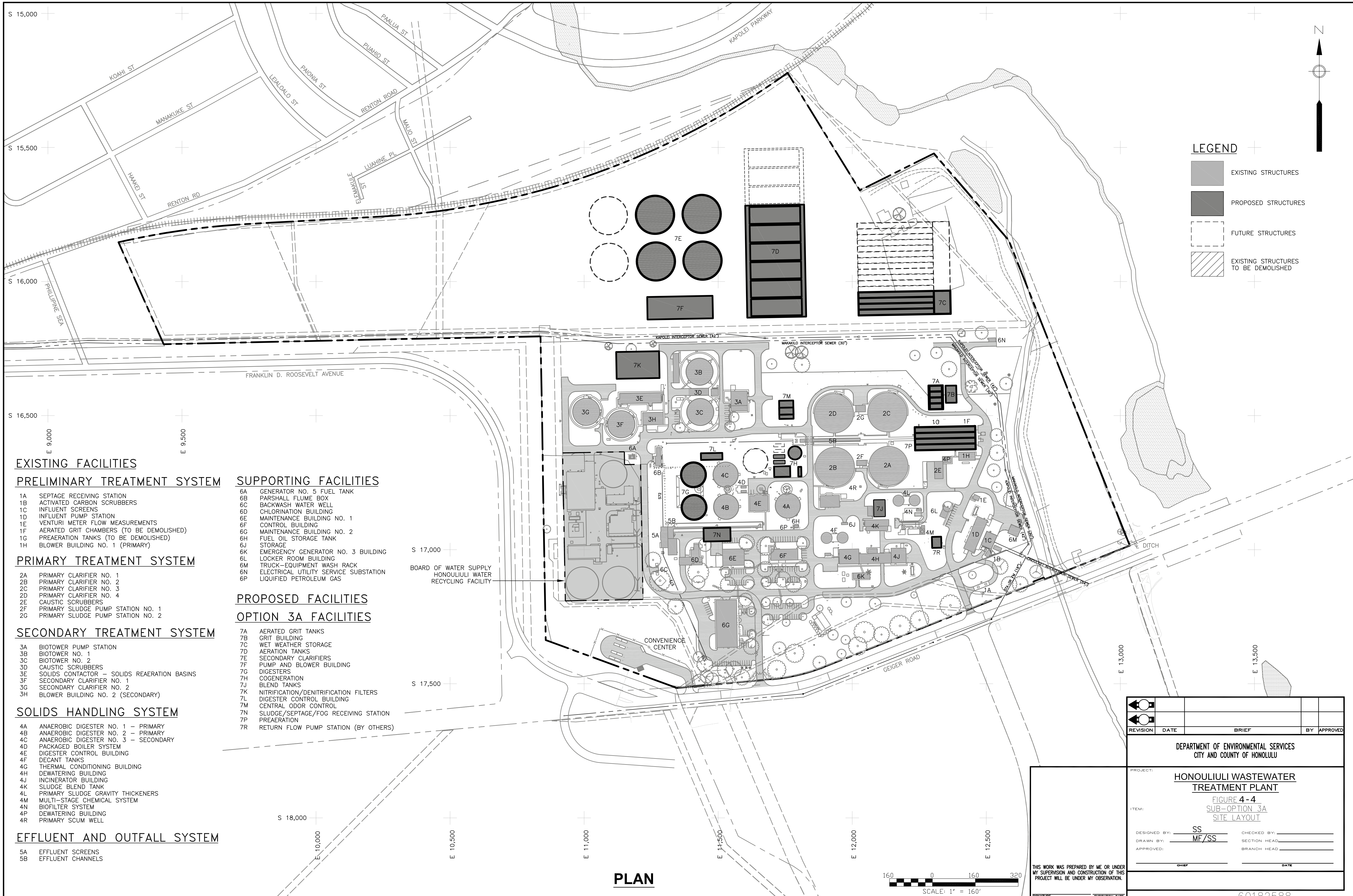

EXISTING FACILITIES

PRELIMINARY TREATMENT SYSTEM

- 1A SEPTAGE RECEIVING STATION
- 1B ACTIVATED CARBON SCRUBBERS
- 1C INFLUENT SCREENS
- 1D INFLUENT PUMP STATION
- 1E VENTURI METER FLOW MEASUREMENTS
- 1F AERATED GRIT CHAMBERS (TO BE DEMOLISHED)
- 1G PREAERATION TANKS (TO BE DEMOLISHED)
- 1H BLOWER BUILDING NO. 1 (PRIMARY)

PRIMARY TREATMENT SYSTEM

- 2A PRIMARY CLARIFIER NO. 1
- 2B PRIMARY CLARIFIER NO. 2
- 2C PRIMARY CLARIFIER NO. 3
- 2D PRIMARY CLARIFIER NO. 4
- 2E CAUSTIC SCRUBBERS
- 2F PRIMARY SLUDGE PUMP STATION NO. 1
- 2G PRIMARY SLUDGE PUMP STATION NO. 2

SECONDARY TREATMENT SYSTEM

- 3A BIOTOWER PUMP STATION
- 3B BIOTOWER NO. 1
- 3C BIOTOWER NO. 2
- 3D CAUSTIC SCRUBBERS
- 3E SOLIDS CONTACTOR – SOLIDS REAERATION BASINS
- 3F SECONDARY CLARIFIER NO. 1
- 3G SECONDARY CLARIFIER NO. 2
- 3H BLOWER BUILDING NO. 2 (SECONDARY)

SOLIDS HANDLING SYSTEM

- 4A ANAEROBIC DIGESTER NO. 1 – PRIMARY
- 4B ANAEROBIC DIGESTER NO. 2 – PRIMARY
- 4C ANAEROBIC DIGESTER NO. 3 – SECONDARY
- 4D PACKAGED BOILER SYSTEM
- 4E DIGESTER CONTROL BUILDING
- 4F DECANT TANKS
- 4G THERMAL CONDITIONING BUILDING
- 4H DEWATERING BUILDING
- 4J INCINERATOR BUILDING
- 4K SLUDGE BLEND TANK
- 4L PRIMARY SLUDGE GRAVITY THICKENERS
- 4M MULTI-STAGE CHEMICAL SYSTEM
- 4N BIOFILTER SYSTEM
- 4P DEWATERING BUILDING
- 4R PRIMARY SCUM WELL

EFFLUENT AND OUTFALL SYSTEM

- 5A EFFLUENT SCREENS
- 5B EFFLUENT CHANNELS

SUPPORTING FACILITIES

- 6A GENERATOR NO. 5 FUEL TANK
- 6B PARSHALL FLUME BOX
- 6C BACKWASH WATER WELL
- 6D CHLORINATION BUILDING
- 6E MAINTENANCE BUILDING NO. 1
- 6F CONTROL BUILDING
- 6G MAINTENANCE BUILDING NO. 2
- 6H FUEL OIL STORAGE TANK
- 6J STORAGE
- 6K EMERGENCY GENERATOR NO. 3 BUILDING
- 6L LOCKER ROOM BUILDING
- 6M TRUCK-EQUIPMENT WASH RACK
- 6N ELECTRICAL UTILITY SERVICE SUBSTATION
- 6P LIQUIFIED PETROLEUM GAS

PROPOSED FACILITIES

OPTION 3A FACILITIES

- 7A AERATED GRIT TANKS
- 7B GRIT BUILDING
- 7C WET WEATHER STORAGE
- 7D AERATION TANKS
- 7E SECONDARY CLARIFIERS
- 7F PUMP AND BLOWER BUILDING
- 7G DIGESTERS
- 7H COGENERATION
- 7J BLEND TANKS
- 7K NITRIFICATION/DENITRIFICATION FILTERS
- 7L DIGESTER CONTROL BUILDING
- 7M CENTRAL ODOR CONTROL
- 7N SLUDGE/SEPTAGE/FOG RECEIVING STATION
- 7P PREAERATION
- 7R RETURN FLOW PUMP STATION (BY OTHERS)

PLAN

REVISION	DATE	BRIEF	BY	APPROVED

DEPARTMENT OF ENVIRONMENTAL SERVICES
CITY AND COUNTY OF HONOLULU

PROJECT: HONOULIULI WASTEWATER TREATMENT PLANT

ITEM: FIGURE 4-4
SUB-OPTION 3A
SITE LAYOUT

DESIGNED BY: SS
DRAWN BY: MF/SS
APPROVED:
CHECKED BY:
SECTION HEAD
BRANCH HEAD
CHIEF
DATE

THIS WORK WAS PREPARED BY ME OR UNDER MY SUPERVISION AND CONSTRUCTION OF THIS PROJECT WILL BE UNDER MY OBSERVATION.

SIGNATURE
EXPIRATION DATE OF THE LICENSE

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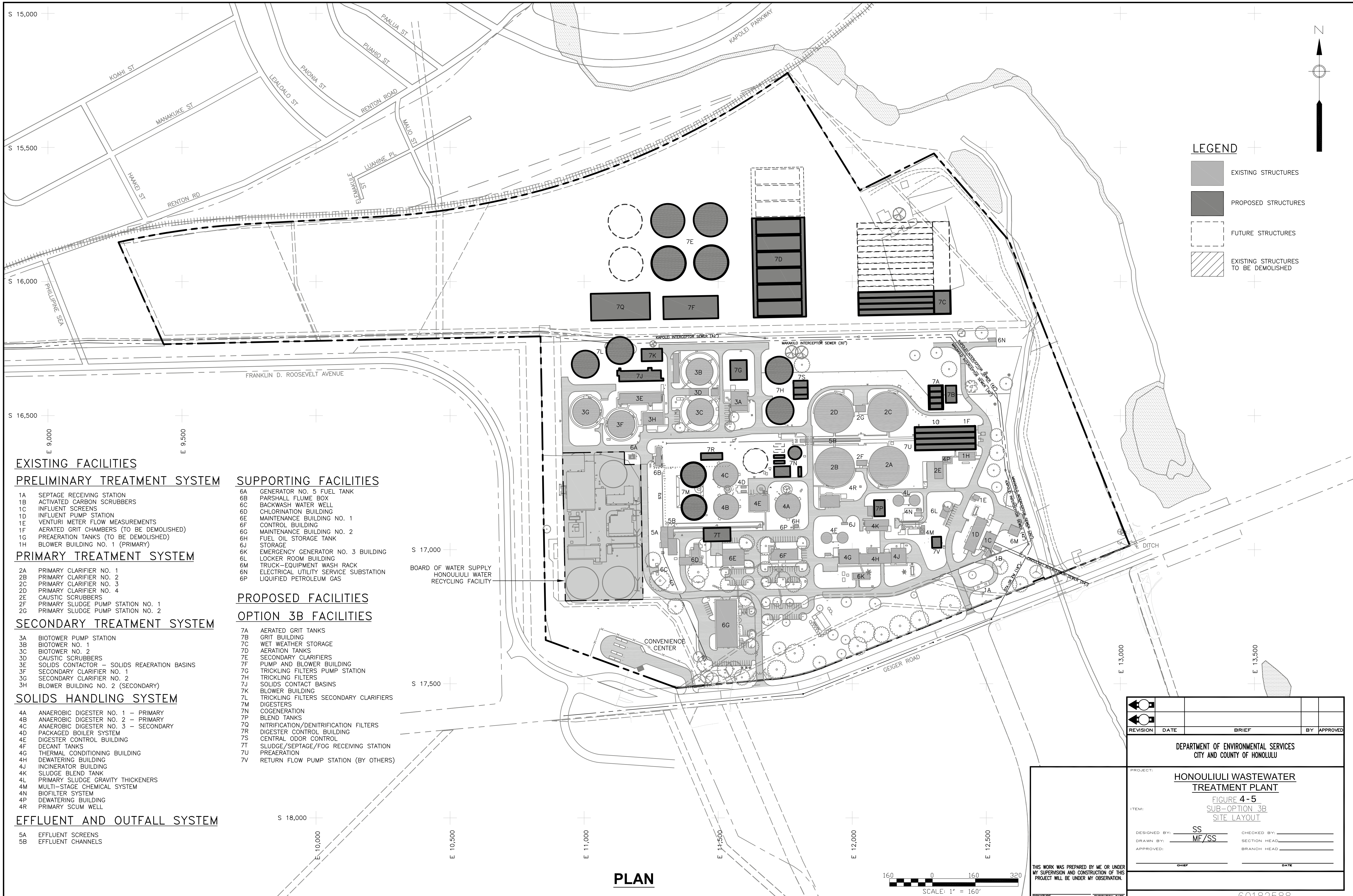

EXISTING FACILITIES

PRELIMINARY TREATMENT SYSTEM

1A SEPTAGE RECEIVING STATION
1B ACTIVATED CARBON SCRUBBERS
1C INFLUENT SCREENS
1D INFLUENT PUMP STATION
1E VENTURI METER FLOW MEASUREMENTS
1F AERATED GRIT CHAMBERS (TO BE DEMOLISHED)
1G PREAERATION TANKS (TO BE DEMOLISHED)
1H BLOWER BUILDING NO. 1 (PRIMARY)

PRIMARY TREATMENT SYSTEM

2A PRIMARY CLARIFIER NO. 1
2B PRIMARY CLARIFIER NO. 2
2C PRIMARY CLARIFIER NO. 3
2D PRIMARY CLARIFIER NO. 4
2E CAUSTIC SCRUBBERS
2F PRIMARY SLUDGE PUMP STATION NO. 1
2G PRIMARY SLUDGE PUMP STATION NO. 2

SECONDARY TREATMENT SYSTEM

3A BIOTOWER PUMP STATION
3B BIOTOWER NO. 1
3C BIOTOWER NO. 2
3D CAUSTIC SCRUBBERS
3E SOLIDS CONTACTOR – SOLIDS REAERATION BASINS
3F SECONDARY CLARIFIER NO. 1
3G SECONDARY CLARIFIER NO. 2
3H BLOWER BUILDING NO. 2 (SECONDARY)

SOLIDS HANDLING SYSTEM

4A ANAEROBIC DIGESTER NO. 1 – PRIMARY
4B ANAEROBIC DIGESTER NO. 2 – PRIMARY
4C ANAEROBIC DIGESTER NO. 3 – SECONDARY
4D PACKAGED BOILER SYSTEM
4E DIGESTER CONTROL BUILDING
4F DECANT TANKS
4G THERMAL CONDITIONING BUILDING
4H DEWATERING BUILDING
4J INCINERATOR BUILDING
4K SLUDGE BLEND TANK
4L PRIMARY SLUDGE GRAVITY THICKENERS
4M MULTI-STAGE CHEMICAL SYSTEM
4N BIOFILTER SYSTEM
4P DEWATERING BUILDING
4R PRIMARY SCUM WELL

EFFLUENT AND OUTFALL SYSTEM

5A EFFLUENT SCREENS
5B EFFLUENT CHANNELS

SUPPORTING FACILITIES

6A GENERATOR NO. 5 FUEL TANK
6B PARSHALL FLUME BOX
6C BACKWASH WATER WELL
6D CHLORINATION BUILDING
6E MAINTENANCE BUILDING NO. 1
6F CONTROL BUILDING
6G MAINTENANCE BUILDING NO. 2
6H FUEL OIL STORAGE TANK
6J STORAGE
6K EMERGENCY GENERATOR NO. 3 BUILDING
6L LOCKER ROOM BUILDING
6M TRUCK-EQUIPMENT WASH RACK
6N ELECTRICAL UTILITY SERVICE SUBSTATION
6P LIQUIFIED PETROLEUM GAS

PROPOSED FACILITIES

OPTION 3B FACILITIES

7A AERATED GRIT TANKS
7B GRIT BUILDING
7C WET WEATHER STORAGE
7D AERATION TANKS
7E SECONDARY CLARIFIERS
7F PUMP AND BLOWER BUILDING
7G TRICKLING FILTERS PUMP STATION
7H TRICKLING FILTERS
7J SOLIDS CONTACT BASINS
7K BLOWER BUILDING
7L TRICKLING FILTERS SECONDARY CLARIFIERS
7M DIGESTERS
7N COGENERATION
7P BLEND TANKS
7Q NITRIFICATION/DENITRIFICATION FILTERS
7R DIGESTER CONTROL BUILDING
7S CENTRAL ODOR CONTROL
7T SLUDGE/SEPTAGE/FOG RECEIVING STATION
7U PREAERATION
7V RETURN FLOW PUMP STATION (BY OTHERS)

REVISION	DATE	BRIEF	BY	APPROVED

DEPARTMENT OF ENVIRONMENTAL SERVICES
CITY AND COUNTY OF HONOLULU

PROJECT: HONOULIULI WASTEWATER TREATMENT PLANT

FIGURE 4-5
ITEM: SUB-OPTION 3B SITE LAYOUT

DESIGNED BY: SS
DRAWN BY: MF/SS
APPROVED:
CHECKED BY:
SECTION HEAD:
BRANCH HEAD:
CHIEF
DATE

THIS WORK WAS PREPARED BY ME OR UNDER MY SUPERVISION AND CONSTRUCTION OF THIS PROJECT WILL BE UNDER MY OBSERVATION.

SIGNATURE
EXPIRATION DATE OF THE LICENSE

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FILE	POCKET	FOLDER	NO.

4.3 Costs Estimate Comparison

The preliminary capital costs for each option are presented in Table 4-5.

Table 4-5. Cost Comparison of Alternatives

Item	Sub-option 1A	Sub-option 1B	Option 2	Sub-option 3A	Sub-option 3B
Secondary Treatment	$184,800,000 (1)	$177,500,000 (1)	$146,000,000 (2)	$158,900,000 (1)	$186,900,000 (1)
Process (common)	$129,100,000	$129,100,000	$129,100,000	$129,100,000	$129,100,000
Non-Process (Common)	$47,500,000	$47,500,000	$47,500,000	$47,500,000	$47,500,000
Total	$361,400,000	$354,100,000	$322,600,000	$335,500,000	$363,500,000

Notes:
(1) Secondary Treatment Cost from TM 12.C and updated using ENR factor (June 2012 [9,200] to September 2013 [9,552])
(2) Secondary Treatment Cost from Draft TM 12.N

4.4 Recommended Alternative

Phased implementation of Option 2 is recommended for the upgrade of the Honouliuli WWTP to full secondary treatment. Option 2 is the lowest capital and O&M cost option, additionally it would:

- Use the existing TF/SC process to the end of its useful life, maximizing the reuse of current assets
- Produce a higher quality secondary effluent than is currently produced at the WWTP with associated benefits for effluent reuse.
- Reduce future land use requirements with the smallest footprint of evaluated options

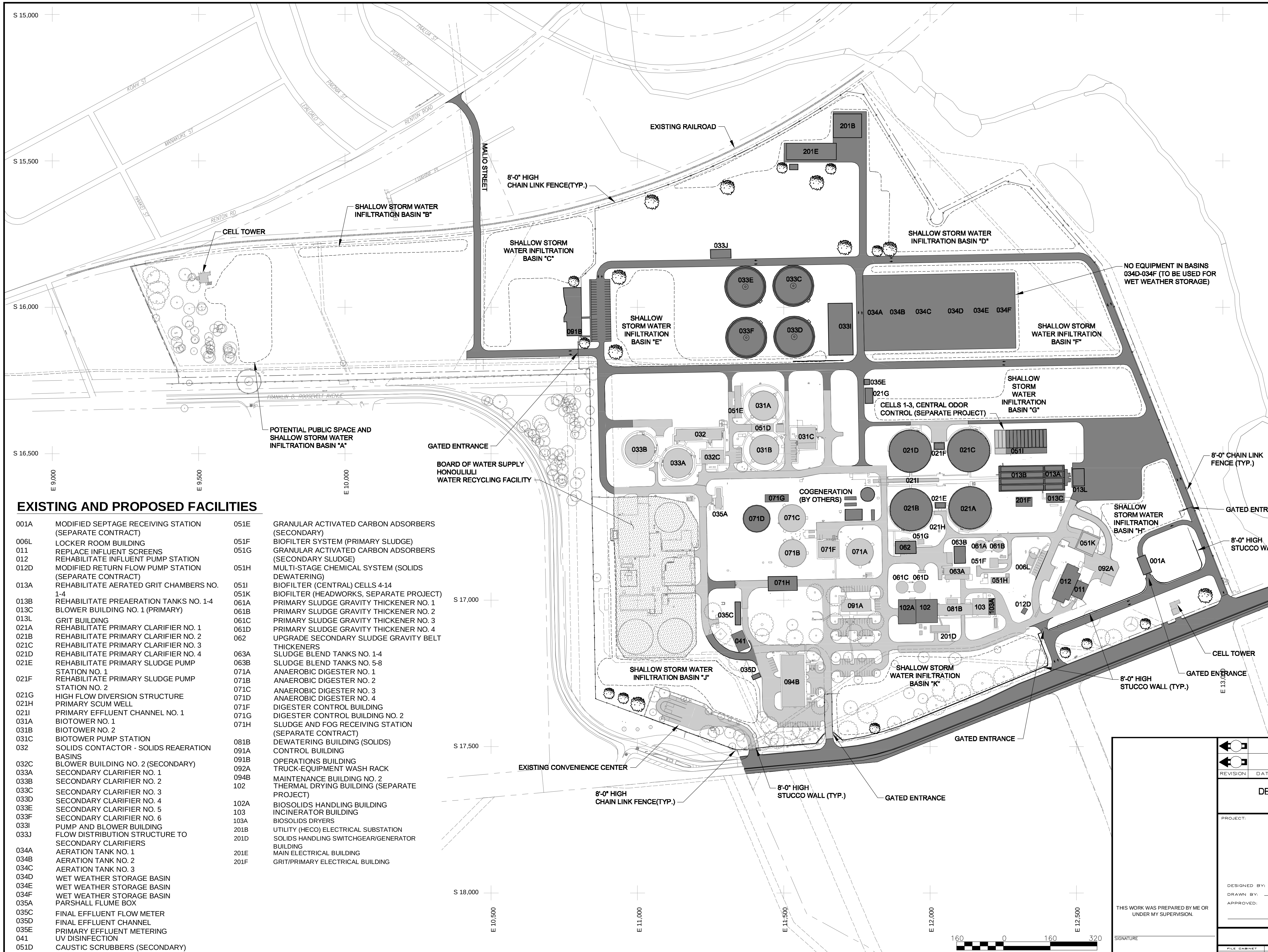
Once the secondary treatment option was selected, the location of the treatment facilities and site layout components were refined.

4.5 Recommended Site Layout

Potential facilities, including process related facilities for the Honouliuli WWTP (operations building, maintenance, warehouse, truck parking, collection system maintenance (CSM) dewatering, septage receiving station, and sludge receiving station) and non-process related facilities (administration building, laboratory building, ocean team boathouse, and central shops) have been proposed to be located at the Honouliuli WWTP site to accommodate the proposed secondary treatment upgrades and maximize use of available developable land. A summary of the anticipated staffing, building footprint, and parking needs for each proposed facility is provided in Table 4-6.

Multiple site layout concept alternatives were developed to conceptualize the potential for land use at the Honouliuli WWTP site for the ultimate build-out in Year 2050. Figure 4-6 presents the recommended general site layout for Option 2. There is the potential for a perimeter walking/biking path around the entire site, as shown on Figure 4-6, that would provide the public with a source of recreational activity. The path would be located outside the fenced areas. A separate entrance and parking area would be provided for users of the walking/biking path.

The total estimated construction cost, inclusive of the costs of upgrading the Honouliuli WWTP and the costs of constructing facilities at the Honouliuli WWTP required to relocate non-process related functions to the plant, is $760 million. It is understood that some of these functional needs may be met at alternative off site locations in lieu of the Honouliuli WWTP site. In addition, several buildings may be restored or demolished; sites of demolished buildings would be made available for future operational needs. It is anticipated that further changes to the site layout, support structures, and buildings will occur as part of later detailed design efforts. However, for the purposes of evaluating potential environmental and social impacts of total site development, the site layout represents the location of all potential support facilities at the Honouliuli WWTP site.



EXISTING AND PROPOSED FACILITIES

001A	MODIFIED SEPTAGE RECEIVING STATION (SEPARATE CONTRACT)
006L	LOCKER ROOM BUILDING
011	REPLACE INFLUENT SCREENS
012	REHABILITATE INFLUENT PUMP STATION
012D	MODIFIED RETURN FLOW PUMP STATION (SEPARATE CONTRACT)
013A	REHABILITATE AERATED GRIT CHAMBERS NO. 1-4
013B	REHABILITATE PREAERATION TANKS NO. 1-4
013C	BLOWER BUILDING NO. 1 (PRIMARY)
013L	GRIT BUILDING
021A	REHABILITATE PRIMARY CLARIFIER NO. 1
021B	REHABILITATE PRIMARY CLARIFIER NO. 2
021C	REHABILITATE PRIMARY CLARIFIER NO. 3
021D	REHABILITATE PRIMARY CLARIFIER NO. 4
021E	REHABILITATE PRIMARY SLUDGE PUMP STATION NO. 1
021F	REHABILITATE PRIMARY SLUDGE PUMP STATION NO. 2
021G	HIGH FLOW DIVERSION STRUCTURE
021H	PRIMARY SCUM WELL
021I	PRIMARY EFFLUENT CHANNEL NO. 1
031A	BIOTOWER NO. 1
031B	BIOTOWER NO. 2
031C	BIOTOWER PUMP STATION
032	SOLIDS CONTACTOR - SOLIDS REAERATION BASINS
032C	BLOWER BUILDING NO. 2 (SECONDARY)
033A	SECONDARY CLARIFIER NO. 1
033B	SECONDARY CLARIFIER NO. 2
033C	SECONDARY CLARIFIER NO. 3
033D	SECONDARY CLARIFIER NO. 4
033E	SECONDARY CLARIFIER NO. 5
033F	SECONDARY CLARIFIER NO. 6
033I	PUMP AND BLOWER BUILDING
033J	FLOW DISTRIBUTION STRUCTURE TO SECONDARY CLARIFIERS
034A	AERATION TANK NO. 1
034B	AERATION TANK NO. 2
034C	AERATION TANK NO. 3
034D	WET WEATHER STORAGE BASIN
034E	WET WEATHER STORAGE BASIN
034F	WET WEATHER STORAGE BASIN
035A	PARSHALL FLUME BOX
035C	FINAL EFFLUENT FLOW METER
035D	FINAL EFFLUENT CHANNEL
035E	PRIMARY EFFLUENT METERING
041	UV DISINFECTION
051D	CAUSTIC SCRUBBERS (SECONDARY)
051E	GRANULAR ACTIVATED CARBON ADSORBERS (SECONDARY)
051F	BIOFILTER SYSTEM (PRIMARY SLUDGE)
051G	GRANULAR ACTIVATED CARBON ADSORBERS (SECONDARY SLUDGE)
051H	MULTI-STAGE CHEMICAL SYSTEM (SOLIDS DEWATERING)
051I	BIOFILTER (CENTRAL) CELLS 4-14
051K	BIOFILTER (HEADWORKS, SEPARATE PROJECT)
061A	PRIMARY SLUDGE GRAVITY THICKENER NO. 1
061B	PRIMARY SLUDGE GRAVITY THICKENER NO. 2
061C	PRIMARY SLUDGE GRAVITY THICKENER NO. 3
061D	PRIMARY SLUDGE GRAVITY THICKENER NO. 4
062	UPGRADE SECONDARY SLUDGE GRAVITY BELT THICKENERS
063A	SLUDGE BLEND TANKS NO. 1-4
063B	SLUDGE BLEND TANKS NO. 5-8
071A	ANAEROBIC DIGESTER NO. 1
071B	ANAEROBIC DIGESTER NO. 2
071C	ANAEROBIC DIGESTER NO. 3
071D	ANAEROBIC DIGESTER NO. 4
071F	DIGESTER CONTROL BUILDING
071G	DIGESTER CONTROL BUILDING NO. 2
071H	SLUDGE AND FOG RECEIVING STATION (SEPARATE CONTRACT)
081B	DEWATERING BUILDING (SOLIDS)
091A	CONTROL BUILDING
091B	OPERATIONS BUILDING
092A	TRUCK-EQUIPMENT WASH RACK
094B	MAINTENANCE BUILDING NO. 2
102	THERMAL DRYING BUILDING (SEPARATE PROJECT)
102A	BIOSOLIDS HANDLING BUILDING
103	INCINERATOR BUILDING
103A	BIOSOLIDS DRYERS
201B	UTILITY (HECO) ELECTRICAL SUBSTATION
201D	SOLIDS HANDLING SWITCHGEAR/GENERATOR BUILDING
201E	MAIN ELECTRICAL BUILDING
201F	GRIT/PRIMARY ELECTRICAL BUILDING

LEGEND

EXISTING

PHASE 1

THE MINIMUM REQUIRED INFILTRATION AREA IS APPROXIMATELY 8.0 ACRES

INFILTRATION BASIN	AREA (ACRES)
A	1.28
B	0.42
C	2.01
D	3.56
E	1.50
F	2.56
G	2.41
H	0.88
J	1.50
K	2.58

TOTAL INFILTRATION AREA = 18.7 ACRES

THE PROJECT EXCEEDS MINIMUM INFILTRATION AREA REQUIREMENTS

DESIGN CONSIDERATIONS:

1. THE AREA OF SHALLOW STORM WATER INFILTRATION BASINS PROVIDED IS GREATER THAN WHAT IS REQUIRED. DURING DESIGN, FINAL LOCATIONS AND SIZES OF THESE BASINS WILL BE RE-EVALUATED.
2. THE SHALLOW STORM WATER INFILTRATION BASINS MAY SERVE A DUAL PURPOSE AND ARE POTENTIAL LOCATIONS FOR PHOTOVOLTAICS, (SEE SHEET 000 E-003).

REVISION	DATE	BRIEF	BY	APPROVED

DEPARTMENT OF ENVIRONMENTAL SERVICES
CITY AND COUNTY OF HONOLULU

PROJECT: HONOULIULI WWTP

FIGURE 4-6
PHASE 1 SITE PLAN

DESIGNED BY: T. HAMIC
DRAWN BY: M. FRANK
APPROVED:
CHECKED BY: ----
SECTION HEAD
BRANCH HEAD
CHIEF
DATE

THIS WORK WAS PREPARED BY ME OR UNDER MY SUPERVISION.

SIGNATURE

EXPIRATION DATE OF THE LICENSE

JOB NO. W#-##

FILE CABINET | DRAWER | FILE | POCKET | FOLDER | NO.

PATH/FILENAME: S:\PROJECTS_LEGACY\USIQ\WASTEWATER\60182588-HONOULIULI FAC PLAN\400 TECH INFO\434 TASK 12\434.15 TASK 12.0 CONCEPTUAL DESIGN\DRAWINGS\CAD FILES\60220849-HONOULIULI WWTP\SHEETS\G\000 G-020.DWG
PLOT DATE: Wednesday, March 16, 2016 3:13:51 PM
LAST UPDATE: Wednesday, March 16, 2016 3:04:28 PM

Table 4-6. Functional Areas, Estimated Staffing, and Estimated Footprint

Functional Area	Existing/Proposed Facility	Estimated Staffing/Need	Estimated Footprint (Sq. Ft.)	Estimated Additional Parking Stalls [(1)]
Administration [(2)] (CSM, DDC, ENV, Refuse, and WTD)	Proposed	200 additional people	45,000 (100 ft × 450 ft)	240
BWS-HWRF [(3)]	Existing/Potential Expansion	1 RO storage tank	1-5 acres	Located within BWS site
Central Shops [(2)]	Proposed	125% of existing	23,000 (132 ft × 175 ft)	28
Convenience Center [(2)]	Existing	Same as existing	40,000 (100 ft × 400 ft)	Located within Convenience Center site
CSM Sewer Cleaning Debris [(3)]	Proposed	Same as existing	5,000 (50 ft × 100 ft)	2
DFM Storm Drain Debris [(3)]	Proposed	Same as existing	5,000 (50 ft × 100 ft)	30
Laboratory (Central) [(2)]	Proposed	42 additional people	Combined with Ocean Team	55
Maintenance [(3)]	Proposed	28 additional people [(1)]	45,000 (150 ft × 300 ft)	60
Multi-Purpose Rooms [(2)]	Within proposed Operations Bldg.	50 additional people	3,000 (40 ft × 75 ft)	Included with Admin Parking
Ocean Team [(2)]	Proposed	11 additional people	28,500 (100 ft × 285 ft)	10
Operations [(3)]	Proposed	31 additional people [(1)]	Within treatment processes	44
SCADA/Instrumentation (Central) [(3)]	Within proposed Admin Bldg.	8 additional people	2,250 (45 ft × 50 ft)	19
Secondary Treatment [(3)]	Proposed	Full secondary treatment	20 acres	None
Septage/FOG Receiving Station [(3)]	Existing	Same as existing	1,200 (20 ft × 60 ft)	None
Warehouse/Storage [(3)]	Proposed	200% of existing	25,600 (160 ft ×160 ft)	22
Solar Farm [(2)]	Proposed	10% of existing yearly kWh average (6,328,800 kWh)	1.6 acres (100 ft × 500 ft and 100 ft × 200 ft)	None
Truck Wash [(3)]	Proposed	Truck washing station to accommodate 2-3 trucks	4,000 (40 ft × 100 ft)	None
Estimated Total	—	370 additional staff	—	270 additional parking stalls

Legend: Admin = Administration; Bldg. = Building; DDC = Department of Design and Construction; DFM = Department of Facility Maintenance; FOG = fats, oils, and greases; kWh = kilowatt hour; WTD = Wastewater Treatment and Disposal.
(1) The parking indicated is for additional parking areas. With limited exception, existing parking throughout the site will not be replaced or removed.
(2) Non-process facility
(3) Process facility

4.5.1 Demolition of Existing Facilities

Areas, structures, and buildings identified for abandonment and demolition include:

- Chlorination Building
- Maintenance Building No. 1
- Control Building

- Effluent Channels, Screens and Structure
- Septage Receiving Station

The TF/SC secondary treatment system is anticipated to be demolished at the end of useful life prior to 2035, unless the facilities can be reused with upgrades and rehabilitation. If the land this system occupies becomes available, it could be considered for such uses as HWRF expansion, sludge handling, tertiary treatment, or support facilities. The timing of these future needs may be a factor in determining the end of life for the TF/SC treatment works. Any additional expansion would be subject to additional environmental review.

The Thermal Conditioning, Dewatering, and Incineration Buildings may be demolished to facilitate a larger sludge processing operation dependent on the outcome of the *Island-wide Sludge Management Plan*. However, if dewatering only is required in the future it is anticipated that at a minimum the Dewatering Building would remain with some interior modification.

The Aerated Grit Chamber and Preaeration Tanks structure will either be demolished or rehabilitated with modification. The determination of retaining the preaeration process and associated structure will be made following startup of the future treatment works.

4.5.2 Treatment Works

A pump and blower building is proposed within the proposed secondary treatment works. Placement of the grit removal system would depend on location of major access roads. It would be preferred to keep the grit removal system adjacent to the IPS for purposes of hydraulics and piping efficiencies. If the Geiger Road Sludge and Septage Receiving Entrance is converted into the new Main Entrance with access through the existing treatment works area, this would result in a separation of the IPS and grit removal system to opposite sides of the new drive.

4.5.3 Support Facilities

Leeward Maintenance, Central Shops, and the Warehouse would be located in one new contiguous structure north of the new secondary treatment works. The arrangement of the structure places the Leeward Maintenance and Central Shops areas such that they are connected with respective access on opposite sides of the building. This arrangement would facilitate the integration, separation, or reconfiguration of these respective functions to meet future needs. The warehouse would be situated in such a manner as to function independently while having ability to easily interface with Leeward Maintenance and Central Shops through interconnection within the same overall building structure. Due to the shipping and receiving functions of the warehouse, access would be provided from both sides of the facility.

4.5.4 Co-Located Facilities

Administration and Laboratory Buildings would be located on the northwest portion of the site in two separate buildings. These buildings would face each other across a courtyard area and would be arranged in an east to west manner to limit sun exposure on exterior walls and to face Roosevelt Avenue, which would be the primary entrance point. Reception, SCADA, and multifunction meeting/training areas would be located in the Administrative building. In addition to the outside parking shown, parking would be provided under the Administration and Laboratory Buildings.

The Ocean Team would be located in a new building adjacent to the laboratory, which would facilitate sample delivery and coordination purposes. The building and surrounding parking area would be provided with a separate fenced enclosure and security.

A new Operations Building would be provided west of the new secondary treatment works and the Leeward Maintenance, Central Shops, and Warehouse. This building location would facilitate operation of the new treatment works and administrative interactions with the Administration, Laboratory, and Leeward Maintenance, Central Shops, and Warehouse. However, this location would be on the far side of the site from the IPS, headworks, and main entrance points on Geiger Road.

The HWRF expansion area would be located directly north of its current location. Initially, the area north of the existing TF/SC treatment works would be available, with additional area becoming available at the end of the TF/SC useful life (between 2030 and 2035). Timing of land availability and space requirements would need to be coordinated to determine if this phasing would be suitable to meet HWRF needs.

The new Truck Washes and CSM Sewer Debris Drying Area would be located east and outside of the treatment works area. This area would need to be accessed using the same entrance as the Leeward Maintenance, Central Shops, and Warehouse.

4.5.5 Access Points and Vehicle Management

The Operations, Leeward Maintenance, Central Shops, and Warehouse functions could all access the site through what is currently the Geiger Road sludge and septage receiving entrance. This entrance would be expanded and improved to provide a four-way intersection with the “Ewa by Gentry” property across Geiger Road. It is anticipated that, at a minimum, Geiger Road would need to be provided with turn lanes, as well as acceleration and deceleration lanes, into and out of the property to accommodate large trucks (as discussed in Section 5.10 Traffic). The intent would be to route large truck traffic and shift worker vehicles around the perimeter of the site and not through the treatment works area.

The Leeward Maintenance, Central Shops, Warehouse, Truck Wash, CSM Sewer Debris Drying, and Refuse Convenience Center functions could also access the site through what is currently the Geiger Road additional property entrance. This entrance would be expanded and improved to provide turn lanes, as well as acceleration and deceleration lanes, into and out of the property to accommodate large trucks. Although this entrance would not be across Geiger Road from the “Ewa by Gentry” property in a way that would facilitate a four-way intersection, it would provide access to the maintenance, warehouse, and CSM activities without having to traverse through the treatment works area.

HWRF, Central Hauled Waste Receiving, Sludge and Fats, Oils, and Greases Receiving Station, and the Future Central Sludge Handling facilities could all access the site through the existing Geiger Road main entrance. With the understanding that these functions all operate independent of each other, with separate operating times and security requirements, the current single point of entry gate may need to be modified to provide separate gated entrances to each function. Other configurations may include modification of the treatment works fence to exclude these areas, with each of these areas having respectively fenced and secured areas.

The Administration, Ocean Team, and Laboratory Buildings could be accessed from Roosevelt Avenue through a new entrance. This entrance would also be the main receiving entrance for visitors to the treatment, operations, maintenance, or warehouse facilities. The Ocean Team would require daily access for boats and trailers. It is anticipated that Roosevelt Avenue would need to be provided with turn lanes, as well as acceleration and deceleration lanes into and out of the property, to accommodate the first shift (8am to 5pm) nature of the large number of office type workers.

Malio Street would be improved and the entrance to the property extended from the north to the south to the point of intersection with the gravity sewers, which run the length of the property from west to east. This could provide access to the Administration Building, Ocean Team Building, Laboratory Building, Operations Building, Leeward Maintenance, Central Shops, and Warehouse. This entrance would also provide access to Kapolei Parkway via Renton Road. Highway access via Kapolei Parkway may be more desirable for some activities, which may dictate future use and need for this entrance. It is anticipated that Malio Street and Renton Road, up to the Kapolei Highway intersection, would need to be improved to accommodate truck traffic to and from the site.

A new plant access road would be developed along the easement of the gravity sewers, which run the length of the property from west to east providing a “T” intersection with the Malio Street extension (Figure 4-6). This road would connect the Administration, Ocean Team, and Laboratory Building area to the treatment works, Operations Building, Leeward Maintenance, Central Shops, and Warehouse. Security at this access point could be monitored and controlled at the Operations Building. The development of multiple access points and interconnecting internal roads is important for providing alternative entrances in times of emergencies.

4.6 Project Funding

Funding for the project would be through the Sewer Revenue Bonds issued by the CCH; additionally CCH has an option to apply for a low interest loan from the state revolving fund (SRF) loan for some or all of the funds needed. This will be determined as the project is developed.

4.7 Project Phasing and Schedule

The FACD states that "CCH shall Complete Construction of facilities necessary to comply with secondary treatment standards of the [Clean Water] Act, as defined by 40 CFR Part 133, for wastewater discharges from the Honouliuli WWTP by the compliance milestone of June 1, 2024, and shall meet the following interim compliance milestones:

- By January 1, 2017, CCH shall execute a design contract and issue a notice to proceed with the design of all secondary treatment process facilities needed to comply with secondary treatment standards for wastewater discharges from the Honouliuli WWTP.
- By January 1, 2019, CCH shall execute a construction contract (or contracts) and issue a notice (or notices) to proceed with construction of all secondary treatment process facilities necessary to comply with secondary treatment standards for wastewater discharges from the Honouliuli WWTP.

The proposed implementation of full secondary treatment is a two-phase build out (of Option 2) to eventually provide full secondary treatment using an AS process. Initially, the existing TF/SC process, with a capacity of 13 mgd or more depending on the interim process utilized and the number of new facilities constructed, would remain in service following appropriate rehabilitation to allow it to continue operation through to the end of its useful life (+/-2035). An AS process would be constructed to provide supplemental secondary treatment, with the intent to provide full AS treatment at the end of the TF/SC useful life. The TF/SC would treat a constant flow of 13 mgd and the AS process would be sized to handle peak flows, including wet weather flows. The proposed components for both of the phases for build-out of secondary treatment could be as follows:

- Phase 1 (completed 2023) – upgrade the secondary treatment design average capacity to 40 mgd and design peak capacity to 114 mgd.
  - Preliminary and primary treatment including four new influent mechanically cleaned screens, one new emergency bypass channel, six new influent pumps, and rehabilitation and modification of the existing grit removal system.
  - Existing TF/SC process (two TFs, four SC basins, and two secondary clarifiers) continue to remain in service.
  - Secondary treatment including six new AS aeration basins with anoxic selectors (three with aeration and mixing equipment and three without) and four new secondary clarifiers.
  - Wet weather storage provided by the three aeration basins without equipment installed.
  - Sludge processing to meet increase in sludge production due to additional flow and full secondary treatment.
  - Ancillary facilities consisting of a Pump and Blower Building to house aeration blowers, Return Active Sludge (RAS) pumps, waste activated sludge (WAS) pumps, and controls, and Main Electrical Building for electrical supply and backup power equipment.
- Phase 2 (completed 2035) – increase the design average capacity to 45 mgd and the design peak capacity to 126 mgd.
  - Existing TF/SC process (two TFs, four SC basins and two secondary clarifiers) decommissioned or re-purposed.
  - Secondary treatment modifications, including installing aeration and mixing equipment in three unfinished AS basins (previously used for offline wet weather storage), and two new secondary clarifiers (total of six).
  - Wet weather storage provided by wet weather storage basins.

- Sludge processing to meet increase in sludge production due to additional flow.
- Additional aeration blowers, RAS pumps, WAS pumps, and controls in the Pump and Blower Building and electrical supply and backup power equipment in the Main Electrical Building.

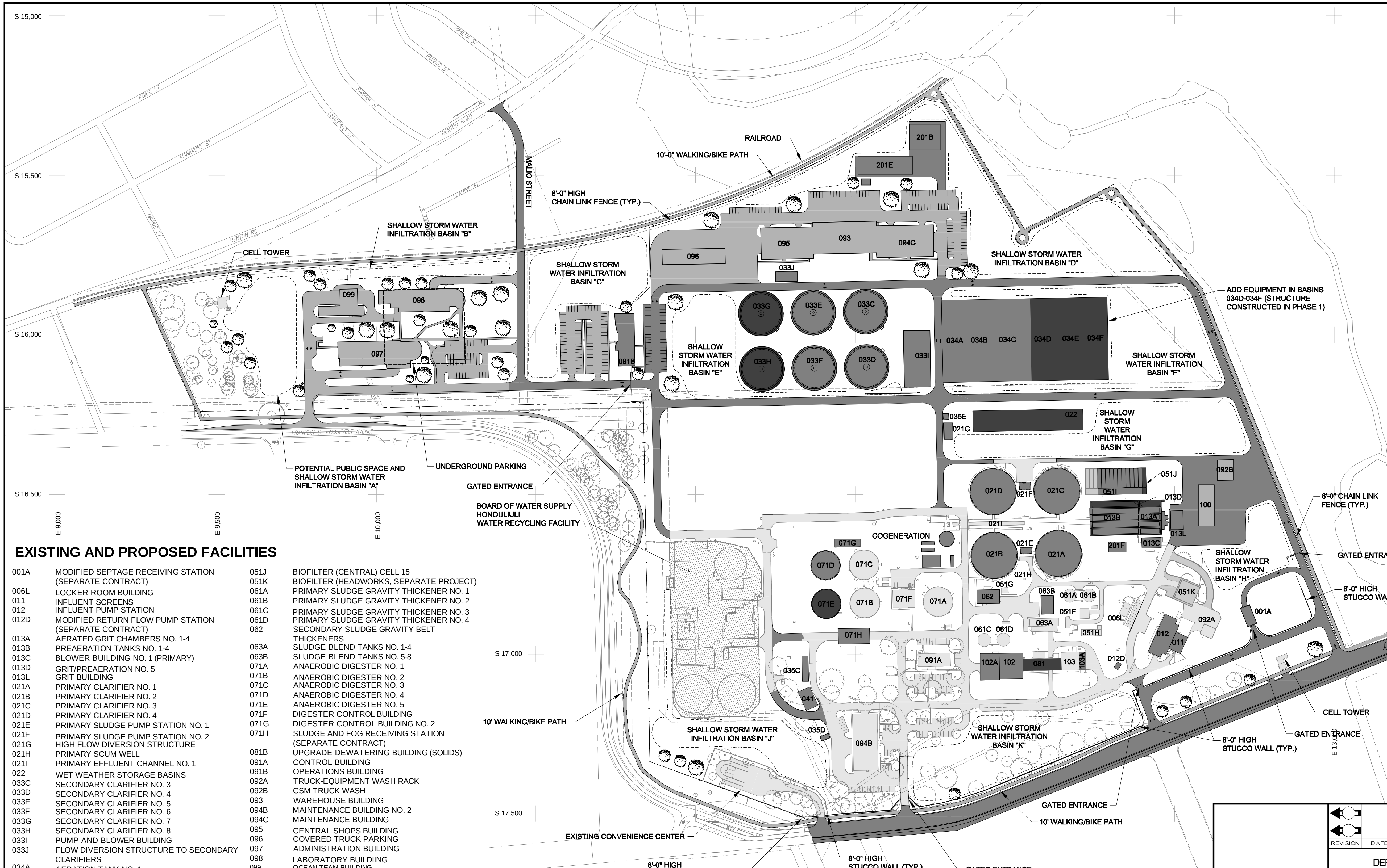
– Phase 3 (any work beyond 2050) – increase the design average capacity beyond 45 mgd and the design peak capacity beyond 126 mgd. Needs will be reassessed prior to Phase 3.

- Expansion of the odor control system may be required to address the odor control needs of the additional proposed facilities.

Figure 4-6, Figure 4-7, and Figure 4-8 present the recommended concept layouts for Phase 1, Phase 2, and Phase 3, respectively. These layouts are intended to provide implementation flexibility and dedicated function areas with independent access and operation. These recommendations may or may not be carried into detailed design and implementation.

In the interim, upgrades and maintenance would continue as issues arise.

Figure 4-9 shows the recommended timeline for the proposed Honouliuli WWTP upgrades. This DEIS only addresses Phase 1 and Phase 2, as Phase 3 concerns needs beyond the current planning period to 2050. Therefore, Phase 3 is not shown on this figure. Note that the planning/design portion of Phase 1 has begun, as described in this DEIS.



LEGEND

- EXISTING
- PHASE 1
- NON-PROCESS FACILITIES
- PHASE 2

N

THE MINIMUM REQUIRED INFILTRATION AREA IS APPROXIMATELY 8.0 ACRES

INFILTRATION BASIN	AREA (ACRES)
A	1.28
B	0.42
C	2.01
D	3.56
E	1.50
F	2.56
G	2.41
H	0.88
J	1.50
K	2.58

TOTAL INFILTRATION AREA = 18.7 ACRES

THE PROJECT EXCEEDS MINIMUM INFILTRATION AREA REQUIREMENTS

DESIGN CONSIDERATIONS:

1. THE AREA OF SHALLOW STORM WATER INFILTRATION BASINS PROVIDED IS GREATER THAN WHAT IS REQUIRED. DURING DESIGN, FINAL LOCATIONS AND SIZES OF THESE BASINS WILL BE RE-EVALUATED.
2. THE SHALLOW STORM WATER INFILTRATION BASINS MAY SERVE A DUAL PURPOSE AND ARE POTENTIAL LOCATIONS FOR PHOTOVOLTAICS, (SEE SHEET 000 E-003).

EXISTING AND PROPOSED FACILITIES

001A	MODIFIED SEPTAGE RECEIVING STATION (SEPARATE CONTRACT)
006L	LOCKER ROOM BUILDING
011	INFLUENT SCREENS
012	INFLUENT PUMP STATION
012D	MODIFIED RETURN FLOW PUMP STATION (SEPARATE CONTRACT)
013A	AERATED GRIT CHAMBERS NO. 1-4
013B	PREAERATION TANKS NO. 1-4
013C	BLOWER BUILDING NO. 1 (PRIMARY)
013D	GRIT/PREAERATION NO. 5
013L	GRIT BUILDING
021A	PRIMARY CLARIFIER NO. 1
021B	PRIMARY CLARIFIER NO. 2
021C	PRIMARY CLARIFIER NO. 3
021D	PRIMARY CLARIFIER NO. 4
021E	PRIMARY SLUDGE PUMP STATION NO. 1
021F	PRIMARY SLUDGE PUMP STATION NO. 2
021G	HIGH FLOW DIVERSION STRUCTURE
021H	PRIMARY SCUM WELL
021I	PRIMARY EFFLUENT CHANNEL NO. 1
022	WET WEATHER STORAGE BASINS
033C	SECONDARY CLARIFIER NO. 3
033D	SECONDARY CLARIFIER NO. 4
033E	SECONDARY CLARIFIER NO. 5
033F	SECONDARY CLARIFIER NO. 6
033G	SECONDARY CLARIFIER NO. 7
033H	SECONDARY CLARIFIER NO. 8
033I	PUMP AND BLOWER BUILDING
033J	FLOW DIVERSION STRUCTURE TO SECONDARY CLARIFIERS
034A	AERATION TANK NO. 1
034B	AERATION TANK NO. 2
034C	AERATION TANK NO. 3
034D	AERATION TANK NO. 4
034E	AERATION TANK NO. 5
034F	AERATION TANK NO. 6
035A	PARSHALL FLUME BOX
035C	FINAL EFFLUENT METER
035D	FINAL EFFLUENT CHANNEL
035E	PRIMARY EFFLUENT METERING
041	UV DISINFECTION
051D	CAUSTIC SCRUBBERS (SECONDARY)
051F	BIOFILTER SYSTEM (PRIMARY SLUDGE)
051G	GRANULAR ACTIVATED CARBON ADSORBERS (SECONDARY SLUDGE)
051H	MULTI-STAGE CHEMICAL SYSTEM (SOLIDS DEWATERING)
051I	BIOFILTER (CENTRAL) CELLS 4-14
051J	BIOFILTER (CENTRAL) CELL 15
051K	BIOFILTER (HEADWORKS, SEPARATE PROJECT)
061A	PRIMARY SLUDGE GRAVITY THICKENER NO. 1
061B	PRIMARY SLUDGE GRAVITY THICKENER NO. 2
061C	PRIMARY SLUDGE GRAVITY THICKENER NO. 3
061D	PRIMARY SLUDGE GRAVITY THICKENER NO. 4
062	SECONDARY SLUDGE GRAVITY BELT THICKENERS
063A	SLUDGE BLEND TANKS NO. 1-4
063B	SLUDGE BLEND TANKS NO. 5-8
071A	ANAEROBIC DIGESTER NO. 1
071B	ANAEROBIC DIGESTER NO. 2
071C	ANAEROBIC DIGESTER NO. 3
071D	ANAEROBIC DIGESTER NO. 4
071E	ANAEROBIC DIGESTER NO. 5
071F	DIGESTER CONTROL BUILDING
071G	DIGESTER CONTROL BUILDING NO. 2
071H	SLUDGE AND FOG RECEIVING STATION (SEPARATE CONTRACT)
081B	UPGRADE DEWATERING BUILDING (SOLIDS)
091A	CONTROL BUILDING
091B	OPERATIONS BUILDING
092A	TRUCK-EQUIPMENT WASH RACK
092B	CSM TRUCK WASH
093	WAREHOUSE BUILDING
094B	MAINTENANCE BUILDING NO. 2
094C	MAINTENANCE BUILDING
095	CENTRAL SHOPS BUILDING
096	COVERED TRUCK PARKING
097	ADMINISTRATION BUILDING
098	LABORATORY BUILDIING
099	OCEAN TEAM BUILDING
100	COLLECTION SYSTEM MAINTENANCE DEWATERING
102	THERMAL DRYING BUILDING (SEPARATE PROJECT)
102A	BIOSOLIDS HANDLING BUILDING
103	INCINERATOR BUILDING
103A	BIOSOLIDS DRYERS
201B	UTILITY (HECO) ELECTRICAL SUBSTATION
201E	MAIN ELECTRICAL BUILDING
201F	GRIT/PRIMARY ELECTRICAL BUILDING

160 0 160 320

SCALE: 1" = 160'

REVISION | DATE | BRIEF | BY | APPROVED

DEPARTMENT OF ENVIRONMENTAL SERVICES
CITY AND COUNTY OF HONOLULU

PROJECT:

HONOULIULI WWTP

FIGURE 4-7
PHASE 2 SITE PLAN

DESIGNED BY:
DRAWN BY:
APPROVED:
CHIEF
CHECKED BY:
SECTION HEAD:
BRANCH HEAD:
DATE

THIS WORK WAS PREPARED BY ME OR UNDER MY SUPERVISION.

SIGNATURE

EXPIRATION DATE OF THE LICENSE

JOB NO. W#-##

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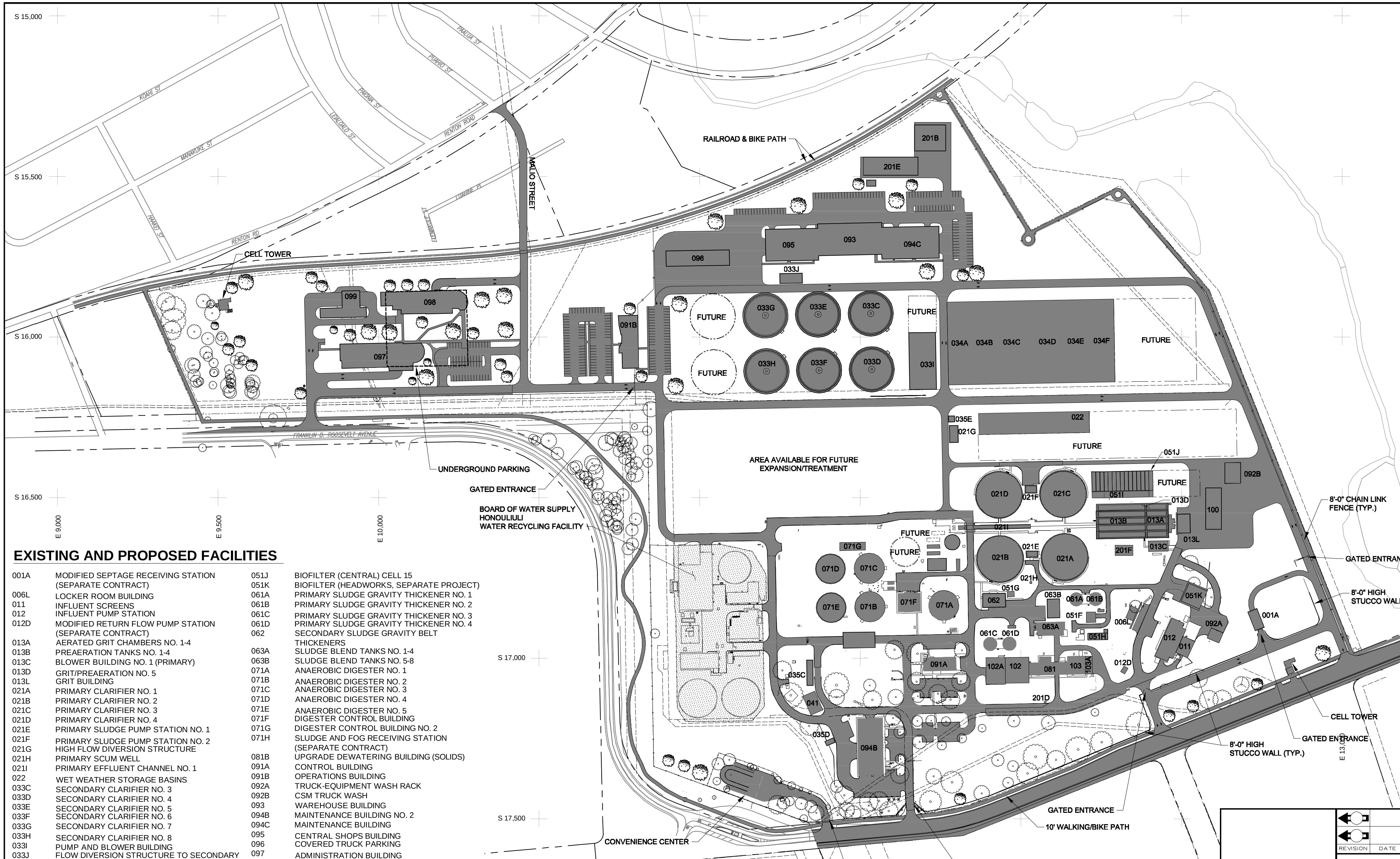

LEGEND

EXISTING

FUTURE

THE MINIMUM REQUIRED INFILTRATION AREA IS APPROXIMATELY 8.0 ACRES

INFILTRATION BASIN	AREA (ACRES)
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033D	SECONDARY CLARIFIER NO. 4
033E	SECONDARY CLARIFIER NO. 5
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035D	FINAL EFFLUENT CHANNEL
035E	PRIMARY EFFLUENT METERING
041	UV DISINFECTION
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081B	UPGRADE DEWATERING BUILDING (SOLIDS)
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100	COLLECTION SYSTEM MAINTENANCE DEWATERING
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103A	BIOSOLIDS DRYERS
201B	UTILITY (HECO) ELECTRICAL SUBSTATION
201E	MAIN ELECTRICAL BUILDING
201F	GRIT/PRIMARY ELECTRICAL BUILDING

REVISION	DATE	BRIEF	BY	APPROVED

DEPARTMENT OF ENVIRONMENTAL SERVICES
CITY AND COUNTY OF HONOLULU

PROJECT:
HONOULIULI WWTP

FIGURE 4-8
PHASE 3 SITE PLAN

DESIGNED BY: ----
DRAWN BY: ----
APPROVED:
CHIEF
CHECKED BY: ----
SECTION HEAD
BRANCH HEAD
DATE

THIS WORK WAS PREPARED BY ME OR UNDER MY SUPERVISION.

SIGNATURE

EXPIRATION DATE OF THE LICENSE

JOB NO. W#-##

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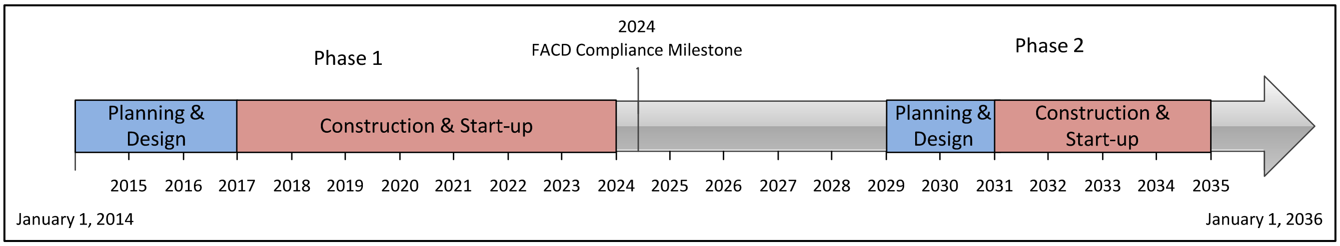
LAST UPDATE: Wednesday, March 16, 2016 3:07:40 PM PLOT DATE: Wednesday, March 16, 2016 3:15:01 PM

Figure 4-9. Recommended Timeline



5 EXISTING ENVIRONMENT, IMPACTS AND MITIGATION MEASURES

This section discusses preliminary findings and information on the existing environment, potential impacts and mitigation measures for the proposed project. The existing environmental conditions in the project area are presented where data is available; however, where sufficient detail to characterize the area is not available, general information and characteristics on the larger sewer basin or the island are provided. Geographic information system (GIS) information used in this document is from the following sources: 1) HoLIS provided by the CCH DPP, 2) Hawaii State GIS Program provided by the DBEDT, and 3) data from the United States Census Bureau (USCB) and the Oahu Metropolitan Planning Organization (OMPO) (incorporated into GIS for socioeconomic analysis). The study area (the geographic area that would be most affected by the proposed expansion and upgrading of the Honouliuli WWTP and relocating of non-process related functions and facilities from the Sand Island WWTP and other locations to the Honouliuli WWTP) for each environmental parameter is typically within the immediate vicinity of the Honouliuli WWTP unless otherwise discussed (i.e., socioeconomics). A future baseline or future without the project was considered for some technical analyses (i.e., traffic, air, and noise), when applicable.

Whenever practicable, potential impacts are divided into Construction Impacts and Operational Impacts. Construction Impacts are, in general, short term impacts due to construction activities. Operational Impacts are, in general, long term impacts from normal operation of the facilities. Mitigation measures that would reduce the impact of construction or operation of the alternatives on the natural environment are presented. No off site work is proposed as part of the proposed project; therefore, the potential direct impacts associated with the project reflect proposed activities solely within the Honouliuli WWTP site.

This project would be designed to the extent possible to: 1) avoid, 2) minimize and 3) mitigate impacts of the proposed project on existing resources in the project area.

5.1 Climate

5.1.1 Existing Setting

The climate in Hawaii is considered subtropical with annual temperatures in the project area ranging from 60°F to 85°F and mean monthly temperatures ranging from 73°F in January and February to 81°F in August. The mean annual rainfall in the project area ranges from 50 to 76 cm (20 to 30 inches). The project area is located within the leeward physiographic zone of Oahu; therefore, the area experiences relatively low rainfall. The islands are exposed to trade and Kona winds. Trade winds are from the northeast and prevail approximately 70 percent of the time. Kona winds are from the south. Average wind in the area ranges from 15 to 25 mph with gusts over 35 mph.

5.1.2 Impacts and Mitigation Measures

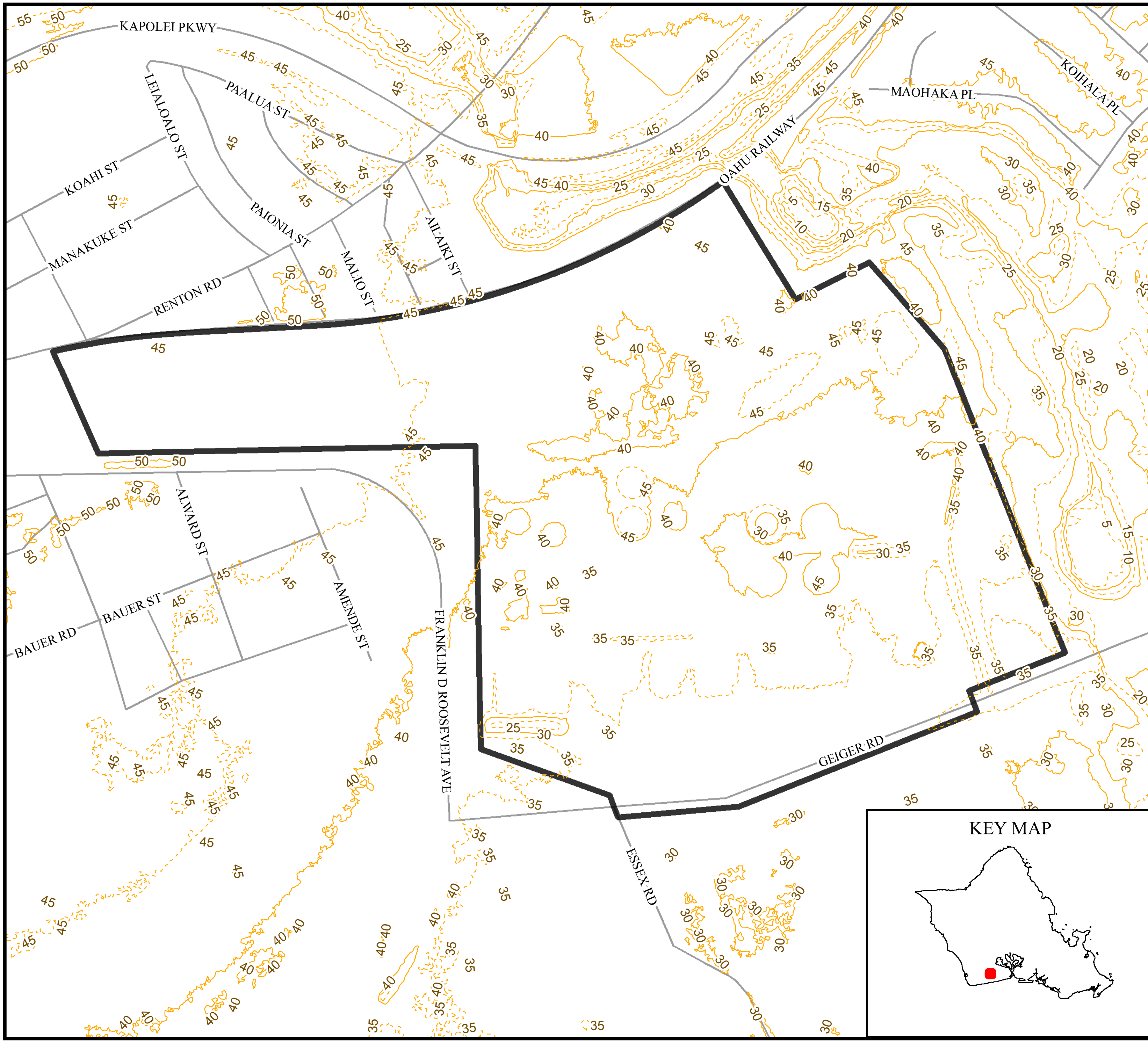
No significant impacts on climate in the project area are anticipated as a result of construction or operation regardless of the alternative selected. Parameters such as temperature, wind, or rainfall levels are not anticipated to be affected. Therefore, no mitigation measures are proposed.

5.2 Physiography

5.2.1 Geology and Topography

5.2.1.1 Existing Setting

The eastern portion of the island of Oahu, where the WWTP site is located, was created by the (inactive) Waianae volcano. The WWTP is located within the coastal plain area called the Ewa Plains, south of the Schofield plateau. Topography within the Ewa plains in the vicinity of the WWTP is gently sloping and relatively flat. Elevation at the WWTP property ranges from 25 ft mean sea level (MSL) in the southern portion of the site to 45 ft MSL in the northern portion of the site (Figure 5-1).



City and County of Honolulu

HONOULIULI/ WAIPAHU/ PEARL CITY WASTEWATER FACILITIES PLAN

Legend

- Honouliuli WWTP
- Elevation Contours
  - 10-ft contours
  - 5-ft contours
- Street

0 — 500 Feet

1 inch = 500 feet

FIGURE 5-1

TOPOGRAPHY

December 2014

AECOM
1001 BISHOP ST, STE 1600
HONOLULU, HAWAII 96813

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5.2.1.2 Construction Impacts and Mitigation Measures

Regardless of the alternative selected, construction of the project is not anticipated to impact the geology of the project area. The WWTP site, in which the proposed upgrades and secondary treatment improvement alternatives and the potential siting of new facilities would be located (as well as proposed roadway improvements and construction of new WWTP site entrances), is highly developable (relatively flat to moderately sloping) land, so relatively minimal alterations to the topography of the site would be required. Excavation and trenching may be necessary for construction of facilities and installation of utilities.

5.2.1.3 Operational Impacts and Mitigation Measures

It is anticipated that the normal operation of the proposed facilities would not affect the topography or geology of the project site. Excavation and trenching may be necessary for emergency work on the proposed facilities.

5.2.2 Soils

5.2.2.1 Existing Setting

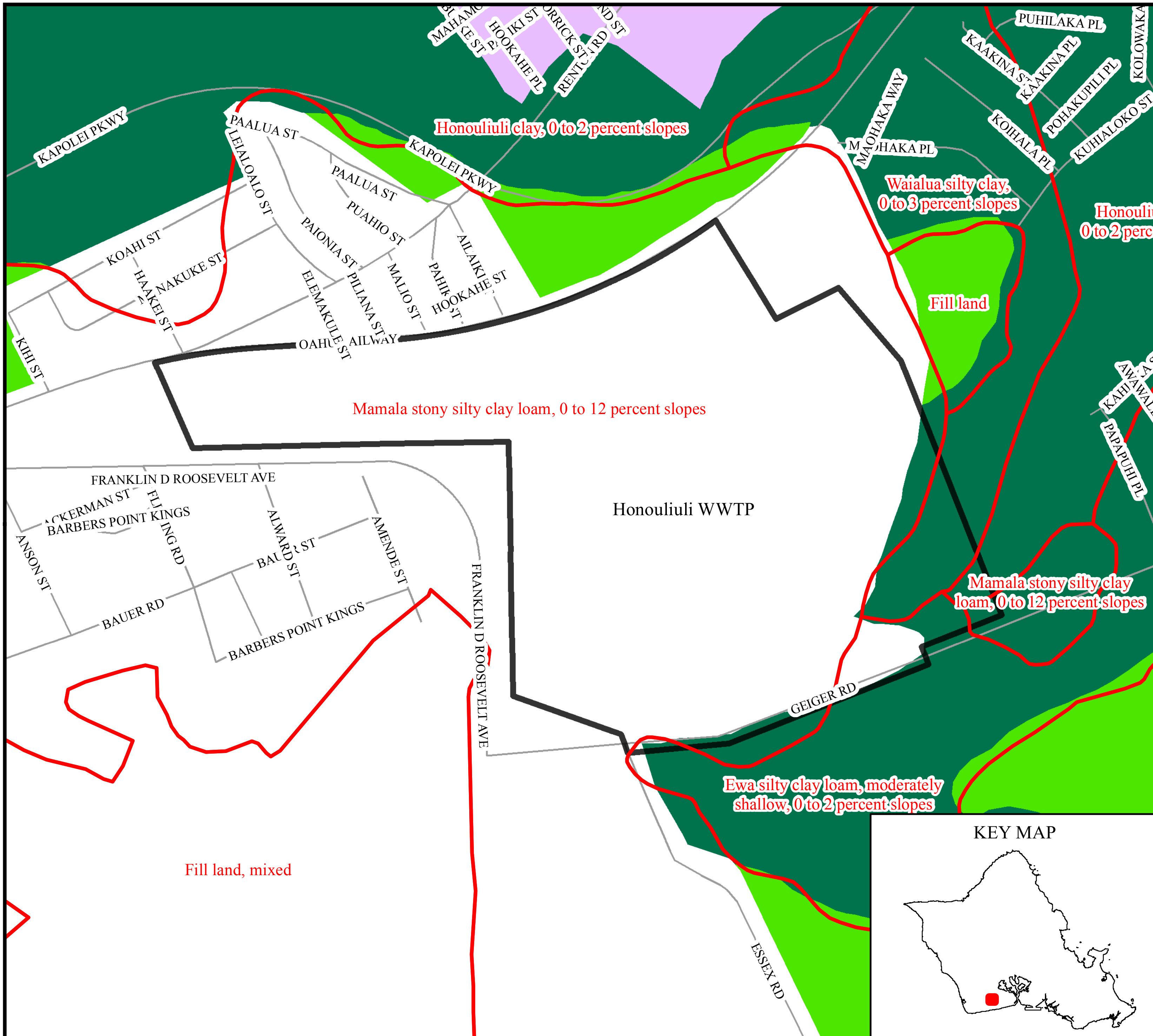
Three soil suitability studies have been prepared for lands in Hawaii. The principal focus of these studies is to describe the physical attributes and relative productivity of different land types for agricultural production within the State of Hawaii. The three studies are the U.S. Department of Agriculture (USDA) Natural Resources Conservation Service (formerly U.S. Soil Conservation Service) Soil Survey, the University of Hawaii Land Study Bureau Detailed Land Classification, and the State of Hawaii Department of Agriculture’s Agricultural Lands of Importance to the State of Hawaii (ALISH).

According to the USDA Soil Conservation Service (SCS) Soil Survey of Islands of Kauai, Oahu, Maui, Molokai, and Lanai, State of Hawaii (USDA SCS 1972), there are seven soil associations on Oahu, one of which is located at the WWTP site. The soil association in the project area is Lualualei-Fill land-Ewa association defined as: deep, nearly level to moderately sloping, well-drained soils that have a fine textured or moderately fine textured subsoil or underlying material and areas of fill land located on coastal plains.

Soils on the site are classified primarily as Mamala stony silty clay loam, 0 to 12% slopes; with a small portion of Ewa silty clay loam, moderately shallow, 0 to 2% slopes; and Waialua silty clay on 0 to 3% slopes in the southeastern corner of the Honouliuli WWTP property (Figure 5-2).

Other soil information was gathered from the Hawaii Statewide GIS Program website including information on erosion potential of the land, agricultural productivity and ALISH. The erosion potential of the land in the project area is considered potentially highly erodible.

Agricultural productivity within the limits of the WWTP site is considered unclassified, with the exception of an area of prime agricultural land in the southeastern corner of the site, as shown on Figure 5-2. Prime agricultural land/prime farmland is defined by the USDA Natural Resource Conservation Service (NRCS) as land best suited for the production of food, feed, forage and fiber crops. Although the area has historically been utilized for agricultural purposes, the WWTP site has since been developed and urbanized; therefore, it would be considered unsuitable for crop production, either because the land value of the property is too high for unsubsidized agricultural use or because crop production would be incompatible with surrounding land uses. There are no regulations specific to this designation; however, federally assisted/managed/funded projects may be subject to the Farmland Protection Policy Act (FPPA) (USDA NRCS 1981). According to Part 523, Subpart B, 523.10B(ii) of the FPPA Manual, lands identified as “urbanized area” (UA) on USCB maps are not subject to provisions of the FPPA (USDA NRCS 2013). The Honouliuli WWTP is located within an area designated as UA as shown on the 2010 Census – Urbanized Area Reference Map for Urban Honolulu (USCB 2012); therefore, it is not anticipated that the project would be subject to the FPPA.



City and County of Honolulu

HONOULIULI/ WAIPAHU/ PEARL CITY WASTEWATER FACILITIES PLAN

Legend

- Honouliuli WWTP
- Street
- Soils

Agricultural Land Type

- Unclassified
- Other lands
- Prime lands

0 — 600 Feet

1 inch = 600 feet

FIGURE 5-2

SOILS AND AGRICULTURAL LAND OF IMPORTANCE TO THE STATE OF HAWAII (ALISH)

December 2014

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5.2.2.2 Construction Impacts and Mitigation Measures

For all alternatives considered, construction activities would result in impacts to the soils in the project area, including soil loss. Excavation is likely to be necessary for the construction of new structures within the WWTP site, including the potential for construction of an underground parking garage (the option to build underground parking is currently conceptual). Roadway improvements and construction of new entrances may also impact local soils.

In addition, regardless of the alternative selected, localized contamination of soils could result from construction activities, as there is the potential for accidental release of construction equipment fluids (e.g., oil and grease) or damage to existing utility lines.

Mitigation measures would be implemented during construction activities to minimize the potential for impacts. Since construction of the project would require grading of 7,500 square feet or more of land, a drainage and erosion control plan would be prepared by an engineer and submitted for approval by the CCH Department of Planning and Permitting, in accordance with the CCH Permits, Bonds and Inspection for Grading, Soil Erosion and Sediment Control Regulations (14 Regulations of Honolulu 14.2(c)). Construction methods to preserve the integrity of existing facilities would be implemented and construction equipment would be maintained in good working condition to reduce the potential for accidental spills. In addition, although construction activities would involve grading and excavation, mitigation measures such as erosion and sedimentation controls (i.e., silt fence, filter bags) would be implemented to reduce impacts to the natural environment. Soil which is not immediately used for backfilling would be stockpiled and covered or otherwise protected (e.g., surrounded by silt fence) to prevent erosion or sedimentation. In addition, temporary seeding and mulching may be used to minimize soil erosion and provide soil stabilization on slopes.

5.2.2.3 Operational Impacts and Mitigation Measures

The primary objective of all the alternatives is to upgrade and improve the existing WWTP; thereby, providing capacity for future flows and secondary treatment. However, even with an improved system, there is the potential for wastewater spills to occur which would result in contamination of the soils. Soils stability inspections near the proposed facilities would need to be conducted periodically to make sure there are no issues with the foundation of the facilities.

The larger stormwater BMP system, including stormwater detention/infiltration basins at several locations within the project area and vegetated drainage swales, would enhance drainage and erosion control during operation. With the implementation of the BMP system, this project is not anticipated to result in operational impacts to soils.

5.3 Hydrology

5.3.1 Groundwater

5.3.1.1 Existing Setting

The Honouliuli WWTP site is located within the Waipahu-Waiawa system within the Pearl Harbor State of Hawaii Department of Land and Natural Resources (DLNR) aquifer sector. The sustainable yield for the Waipahu-Waiawa system is approximately 16 MGD, and it is the primary source of drinking water for the study area. The closest well to the WWTP site is approximately 3.1 miles to the north. The WWTP site is also located within the Southern Oahu Basal Aquifer, which is designated as a Sole Source Aquifer by the EPA. EPA review is required for federally funded projects within a Sole Source Aquifer to determine if there is potential for contamination. EPA review is not required for state, local, or privately funded projects (EPA 2014).

Groundwater moves downward until it encounters impermeable geological features and contributes to the freshwater (Ghyben-Herzberg) lens or emerges as springs. In Hawaii, the thickness of the lens generally decreases seaward, but it can be “dammed” near the coastline by sediments or limestone caprock. The majority of the water supply on Oahu is from the freshwater within these aquifer systems. There are no public groundwater wells within a one-mile radius of the WWTP site (SWCA 2015).

Groundwater recharge is a potentially feasible effluent use in addition to irrigation and industrial use that has been identified for Honouliuli effluent. According to *Water Reuse: Issues, Technologies, and Applications* (Metcalf & Eddy 2007), "groundwater recharge has been used to: (1) reduce, stop, or even reverse declines of groundwater levels; (2) protect underground freshwater in coastal aquifers against saltwater and brackish water intrusion; and (3) store surface water, including flood or other surplus water and reclaimed water, for future reuse." In groundwater recharge, the effluent moves from the surface water to the groundwater via the vadose layer. The soils, sand, and roots in the vadose layer act as a filter before the effluent reaches the groundwater.

5.3.1.2 Construction Impacts and Mitigation Measures

It is anticipated that limits would be applied to the Honouliuli WWTP effluent if the reclaimed water from the HWRF were considered for aquifer recharge, or reuse irrigation per current *Guidelines for the Treatment and Use of Recycled Water* (DOH 2002), hereafter referred to as the *Reuse Guidelines.* The proposed limits are shown in Table 5-1. Discharge locations for groundwater recharge have not been identified yet.

Table 5-1. Irrigation or Groundwater Recharge Criteria

Parameter	Limit
BOD_5, mg/L	30
TSS, mg/L	30
Total Nitrogen, mg/L	10
Total Phosphorus, mg/L	1
Turbidity, NTU	2
Fecal Coliform, per 100 mL	2.2 [1]

Legend: mL = milliliter.
Source: DOH 2002
[1] For disinfected R-1 Water.

Regardless of the alternative selected, construction activities could potentially impact groundwater if encountered during construction (e.g., potential for accidental release of construction equipment fluids (e.g., oil and grease)). Mitigation measures would be implemented during construction activities to preserve the integrity of existing infrastructure (sewer piping, etc.) and keep construction equipment in good working condition to prevent accidental spills. Also, dewatering may be necessary for construction that occurs below the groundwater table, including construction of a potential underground parking facility. Any construction activity occurring in or near groundwater would be conducted in accordance with applicable regulations. In addition, appropriate BMPs (e.g., silt fences, proper storage and movement of spoil), monitoring of groundwater and careful site preparation would be utilized to minimize adverse impacts.

A copy of the DEIS will be submitted to EPA Region 9 due to the location of the Honouliuli WWTP within the Southern Oahu Basal Aquifer.

5.3.1.3 Operational Impacts and Mitigation Measures

The stormwater detention/infiltration basins proposed at several locations within the project area may have an effect on the local groundwater table by raising the local groundwater table near the basins during and for some time after rain events (groundwater mounding). Since these basins would be designed as part of a larger stormwater BMP system including vegetated drainage swales, this system is anticipated to enhance the quality of stormwater recharge to groundwater.

Regardless of the alternative selected, this project is being implemented to reduce the potential of sanitary sewer overflows (SSOs) by increasing capacity of the existing treatment system for current and future needs. The proposed increase in capacity could also enable and/or encourage currently unsewered areas to connect to a centralized system, as was conservatively assumed for flow projections for design purposes. Unsewered areas in the sewer basin are on individual wastewater systems (IWSs). IWSs, if not maintained properly, may contaminate groundwater.

The conversion of existing on-site wastewater treatment population to sewered population may also result in a reduction to local groundwater recharge, as its wastewater no longer would be discharged to the groundwater, but would be conveyed to the WWTP and discharged at the ocean outfall. Depending on the sub-basin area, this could have localized effects on groundwater levels.

As with any wastewater system, there is the potential for leakage and breakage in sewerlines that would result in impacts to groundwater; therefore, mitigation measures for the operational impacts include proper operation and maintenance of the proposed facilities.

5.3.2 Surface Water

A natural resources survey, including a discussion of streams in the vicinity of the proposed project, was conducted by SWCA in November 2014 (SWCA 2015). It is attached to this DEIS in its entirety as Appendix B and summarized below as it pertains to the project site and immediate vicinity.

5.3.2.1 Existing Setting

A National Wetland Inventory (NWI)-mapped wetland (former drainage ditch) is located in the eastern portion of the property, generally oriented north-south, as shown on Figure 5-3. This wetland is part of the abandoned irrigation system from when the area was used for agricultural purposes and no longer functions as an active irrigation ditch. Some standing water may be observed during rain events; however, surface water does not appear to persist throughout the year.

In addition, the Kaloi Gulch Stream lies to the north of the site and several small ponds associated with Coral Creek Golf Course are located to the east of the project site, as shown on Figure 5-3. Wetlands. Several of these small ponds are connected by small stream segments.

5.3.2.2 Construction Impacts and Mitigation Measures

Erosion and sedimentation measures would be employed where necessary during construction activities; therefore, nearby off site surface waters are not anticipated to be impacted as a result of stormwater during construction activities.

The existing abandoned irrigation ditch described above would be permanently impacted (filled) during site construction. Since this ditch is no longer used for irrigation purposes, no impacts to the ability to irrigate within the vicinity of the proposed project are anticipated. The project team will consult with the Army Corps of Engineers, U.S. Fish and Wildlife, CCH, and other regulatory agencies, as necessary, to determine whether filling the former irrigation ditch is jurisdictional under current regulations. If the ditch is determined to be jurisdictional by one or more agencies, then the project team would work with the appropriate agencies to determine acceptable mitigation options. A Channel Alteration Permit (SCAP) may be required from the DLNR Commission on Water Resource Management for any temporary or permanent activity within the former irrigation ditch, and a wetland survey may be required.

New CCH drainage standards requiring low impact development strategies went into effect in June 2013 (DPP 2012). The design storm runoff from 1 inch of rainfall must be retained on-site to the maximum extent practicable, using Post-Construction Treatment Control BMPs. The design of stormwater retention and quality basins must take into consideration the soil type, proximity to the groundwater table, and stormwater discharge permit limits.

Stormwater management retention/infiltration basins and related facilities are proposed throughout the WWTP site, as shown on Figure 4-6, the Site Layout for Phase 1. The stormwater basins at the Honouliuli WWTP site would be shallow dry basins except during and after storm events, until infiltration and/or evaporation of basin contents is complete. Surface flow conveyance would be used to the greatest extent possible by incorporating vegetative drainage swales to address constructability issues as well as to enhance stormwater quality.

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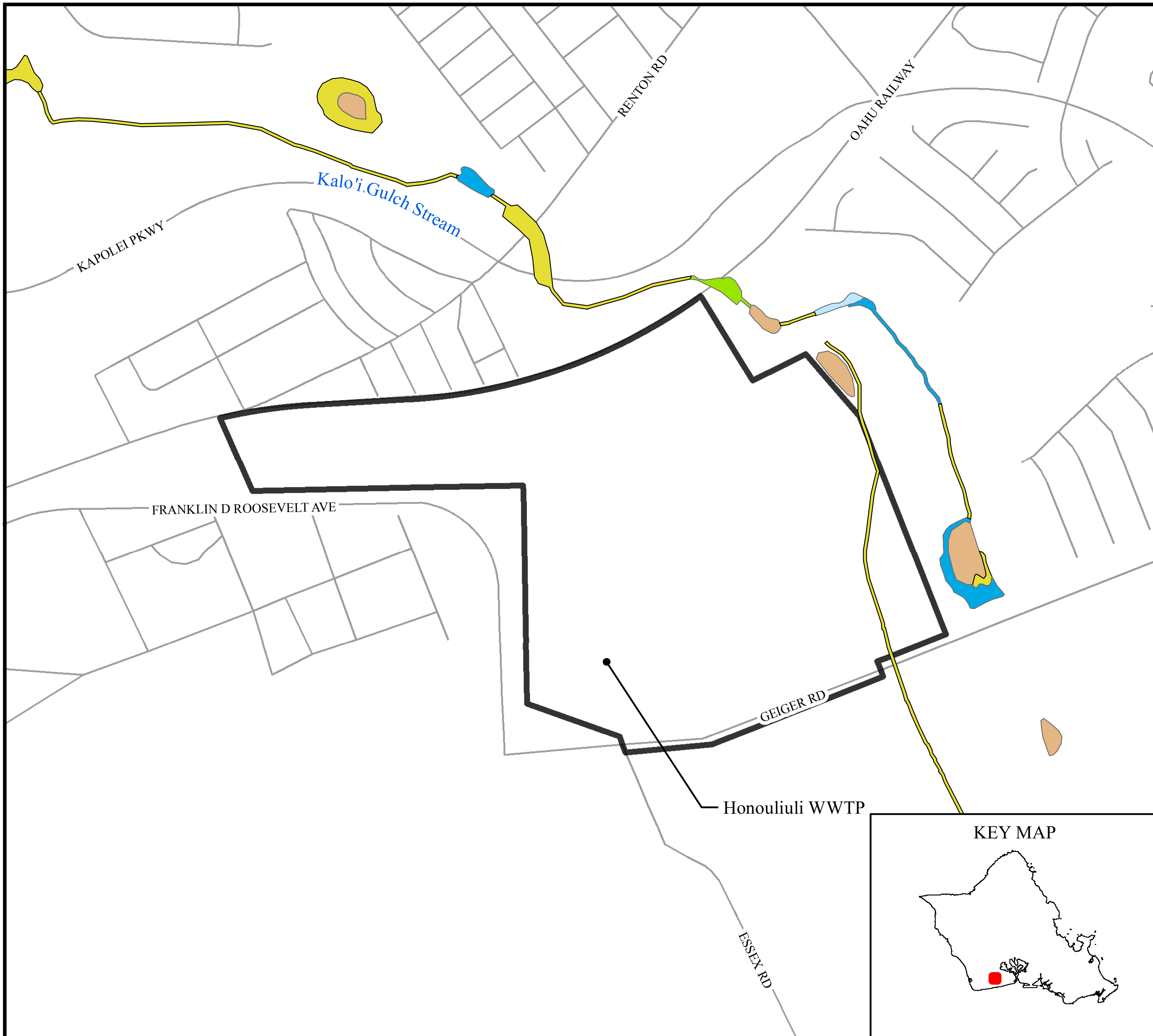

Legend

- Honouliuli WWTP
- Wetland Type
- Freshwater Emergent Wetland
- Freshwater Forested/Shrub Wetland
- Freshwater Pond
- Freshwater Unconsolidated Shore/ Temporarily Flooded
- Riverine
- Street

0 700
Feet
1 inch = 700 feet

FIGURE 5-3

WETLANDS

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Consideration would be given to implementation of various best management practice structures from the new drainage standards that can serve as demonstration-type installations for future developments. In addition, the road frontage area along Geiger Road with large trees and a landscaped area would be used as a vegetative buffer and for stormwater management. This area would provide overland flow of stormwater across a vegetated area that would perform as both a vegetated swale and an infiltration area.

5.3.2.4 Operational Impacts and Mitigation Measures

The project may result in an increase in future effluent discharged to Mamala Bay via the Barbers Point Deep Ocean Outfall. However, with the implementation of BMPs on site, this project is not anticipated to result in operational impacts to nearby surface waters.

5.3.3 Coastal Waters

A natural resources survey was conducted by SWCA in November 2014 (SWCA 2015). It is attached to this DEIS in its entirety as Appendix B and information relevant to coastal waters is summarized below.

5.3.3.1 Existing Setting

The nearest coastal water to the project site is West Mamala Bay (and Pacific Ocean), located approximately 1.8 miles south of the project site. Pearl Harbor (West Loch) is located approximately 2.2 miles northeast of the project site.

The effluent from the Honouliuli WWTP is discharged to Mamala Bay via the Barbers Point Deep Ocean Outfall. As described in Section 2.3, the 84-inch diameter outfall extends approximately 8,760 ft into the ocean and discharges treated effluent approximately 200 ft below the surface through a 1,750-ft long diffuser pipe. The marine environment in the vicinity of the Barbers Point outfall comprises a barren area of low-relief, calcium carbonate sand bottom, although the outfall pipe and armor rock provide areas of increased habitat complexity (Smith and Dollar 1987). Smith and Dollar (1987) observed very few macro-benthic invertebrates or fish in the outfall environment.

5.3.3.2 Construction Impacts and Mitigation Measures

Since the nearest coastal water is located approximately 1.8 miles from the project site, it is unlikely that construction activities at the Honouliuli WWTP would directly impact coastal waters as a result of stormwater runoff and sedimentation. However, potential impacts would be mitigated by adherence to Federal, State, and City water quality regulations governing grading, excavation, stockpiling, and sedimentation and erosion by stormwater during construction. No construction activities are proposed in the vicinity of the outfall.

5.3.3.3 Operational Impacts and Mitigation Measures

Operation of the proposed project is for purposes of compliance with the consent decree which requires treatment facilities necessary to comply with secondary treatment standards, as discussed further in Section 5.7, Water Quality. In addition, this project would minimize the potential of additional SSOs from the existing conveyance and treatment system. The increase in the capacity would allow the connection of currently unsewered areas on IWSs into the CCH's wastewater system and would be consistent with Primary Urban Center (PUC) and Ewa Development Plans and the Central Oahu Sustainable Communities Plan; therefore reducing the chances of contamination to coastal waters.

There is a potential for indirect impacts due to additional development allowed by sewered areas, including an increase in wastewater flow to the Honouliuli WWTP and effluent discharged to Mamala Bay.

5.4 Natural Hazards

5.4.1 Hurricanes

5.4.1.1 Existing Setting

Tropical storm systems that have sustained winds exceeding 73 miles per hour, form in warm tropical waters near the equator, and strike in the Atlantic and Eastern Pacific Oceans are known as hurricanes. Similar tropical storm systems that strike in the Western Pacific Ocean, Indian Ocean and Southern Pacific Oceans are called typhoons and cyclones, respectively. Due to the geographic location of Hawaii within the Eastern Pacific Ocean, tropical storms that strike Hawaii are referred to as hurricanes. In Hawaii, hurricane season runs from June 1st to November 30th. The last major hurricane (Category 4) was Iniki, which passed over Kauai on September 11, 1992. Although most of the damage was on Kauai, Oahu also experienced some damage from wind and storm surge, which did not impact the Honouliuli WWTP. When a hurricane hits the island, the wastewater management facilities are just as likely to be damaged as any other structure in the area.

5.4.1.2 Impacts and Mitigation Measures

Regardless of the alternative selected, neither construction nor operation related activities are expected to impact hurricanes or the frequency of hurricanes in the project area. However, during construction, there is the potential that a hurricane could occur. A public emergency siren operated by the State of Hawaii Department of Defense (HDoD), which would be used in the event of a hurricane, is located at Ewa Makai Middle School approximately 0.6 miles southeast of the site. This alarm may not be audible at the WWTP site, as these sirens are typically audible within 0.5 miles. However, information would also be available via television, internet, and radio.

In the event that a hurricane is predicted, construction equipment would be secured and all applicable Federal, State, and CCH requirements would be implemented to reduce potential damage. Emergency procedures outlined in the Honouliuli WWTP Health and Safety Plan would be followed. If evacuation is required, the nearest Public Emergency/ Hurricane Evacuation Shelter is located at Ewa Elementary (see Figure 5-13), approximately 0.7 miles north of the WWTP site. The closest open shelter can also be found by texting “shelter 96706”, which is the zip code of the Honouliuli WWTP, to “43362” (4FEMA) (FEMA 2014).

As a long-term measure, the wastewater management facilities would be designed and constructed to meet all applicable International Building Code (IBC) and Federal, State, and CCH requirements to help protect against potential structural impacts resulting from a hurricane. Back-up power supply would be available at the facilities to help prevent SSOs during emergencies and power outages.

5.4.2 Tsunamis

5.4.2.1 Existing Setting

Tsunamis are a series of waves that are created by sea floor movements caused by earthquakes, landslides, or volcanic eruptions. The Hawaiian Islands are always at risk for tsunamis, as the islands are susceptible to tsunamis generated from earthquake and volcanic activity from the area bordering the Pacific Ocean (also known as the “Rim of Fire”). The last major tsunami was the 1960 Hilo tsunami. Although this particular tsunami did not affect Oahu, tsunamis can be a hazard on Oahu.

The CCH Department of Emergency Management (DEM) completed revised Oahu tsunami evacuation zone maps in 2010. According to the tsunami evacuation zone maps, the WWTP site is not located within a tsunami evacuation zone. The Honouliuli WWTP is located approximately 1.5 miles north of the shoreline (areas within 1 mile of the coastline are at greater risk, according to the Federal Emergency Management Agency [FEMA]).

5.4.2.2 Impacts and Mitigation Measures

Regardless of the alternative selected, neither construction nor operation related activities are expected to impact tsunamis or the frequency of tsunamis in the project area.

As mentioned in Section 5.4.1, Hurricanes, the HDoD public emergency siren located at Ewa Makai Middle School would be used in the event of a tsunami. As previously mentioned, this alarm may not be audible at the WWTP site. Information would also be available via television, internet, and radio.

In the event that a tsunami alert is given, construction equipment would be secured and all applicable Federal, State, and CCH requirements would be implemented to reduce potential damage. Emergency procedures outlined in the Honouliuli WWTP Health and Safety Plan should be followed. FEMA recommends moving to higher ground, at least two miles from the coastline (FEMA 2014). If evacuation is required, the closest Public Emergency/ Hurricane Evacuation Shelter located greater than 2 miles from the shoreline is located at Ewa Elementary (see Figure 5-13), approximately 0.7 miles north of the WWTP site. The closest open shelter can also be found by texting “shelter 96706” to “43362” (4FEMA) (FEMA 2014).

As a long-term measure, the wastewater management facilities would be designed and constructed to meet all applicable IBC and Federal, State, and CCH requirements to help protect against potential structural impacts resulting from a tsunami. Back-up power supply would be available at the facilities to help prevent SSOs during emergencies and power outages.

5.4.3 Earthquakes

5.4.3.1 Existing Setting

Oahu does not have any active volcanoes; therefore, the island is not subject to significant earthquakes from volcanic activity. However, earthquakes are not uncommon in Hawaii. Most earthquakes in the Hawaiian Islands are caused by volcanic activity on the island of Hawaii, the Big Island. Earthquakes that reach Oahu are generally not strong and cause little or no damage. One of the larger and more recent earthquakes occurred offshore of Puakō, Hawaii. The earthquake measured 6.7 on the Richter scale and caused minor damages on the island of Oahu. When an earthquake hits the island, the wastewater management facilities are just as likely to be damaged as any other structure in the area.

The IBC classifies likelihood of seismic activity into zones ranging from 0 to 4. Seismic Zone 0 represents no chance of severe ground shaking and Seismic Zone 4 represents a 10% chance of severe shaking in a 50-year interval. The IBC classifies Oahu as Seismic Zone 2A.

5.4.3.2 Impacts and Mitigation Measures

Regardless of the alternative selected, neither construction nor operation related activities are expected to impact earthquakes or the frequency of earthquakes in the project area. However, there is the potential for an earthquake to occur during construction or operation. Therefore, all applicable Federal, State, and CCH requirements would be implemented to minimize impacts that may result during the construction of the proposed project. In addition, as a long-term measure, the proposed wastewater management facilities would be designed and constructed to meet Seismic Zone 2A requirements and all applicable IBC and Federal, State, and CCH requirements. Back-up power supply would be available at the facilities to help prevent SSOs during emergencies and power outages.

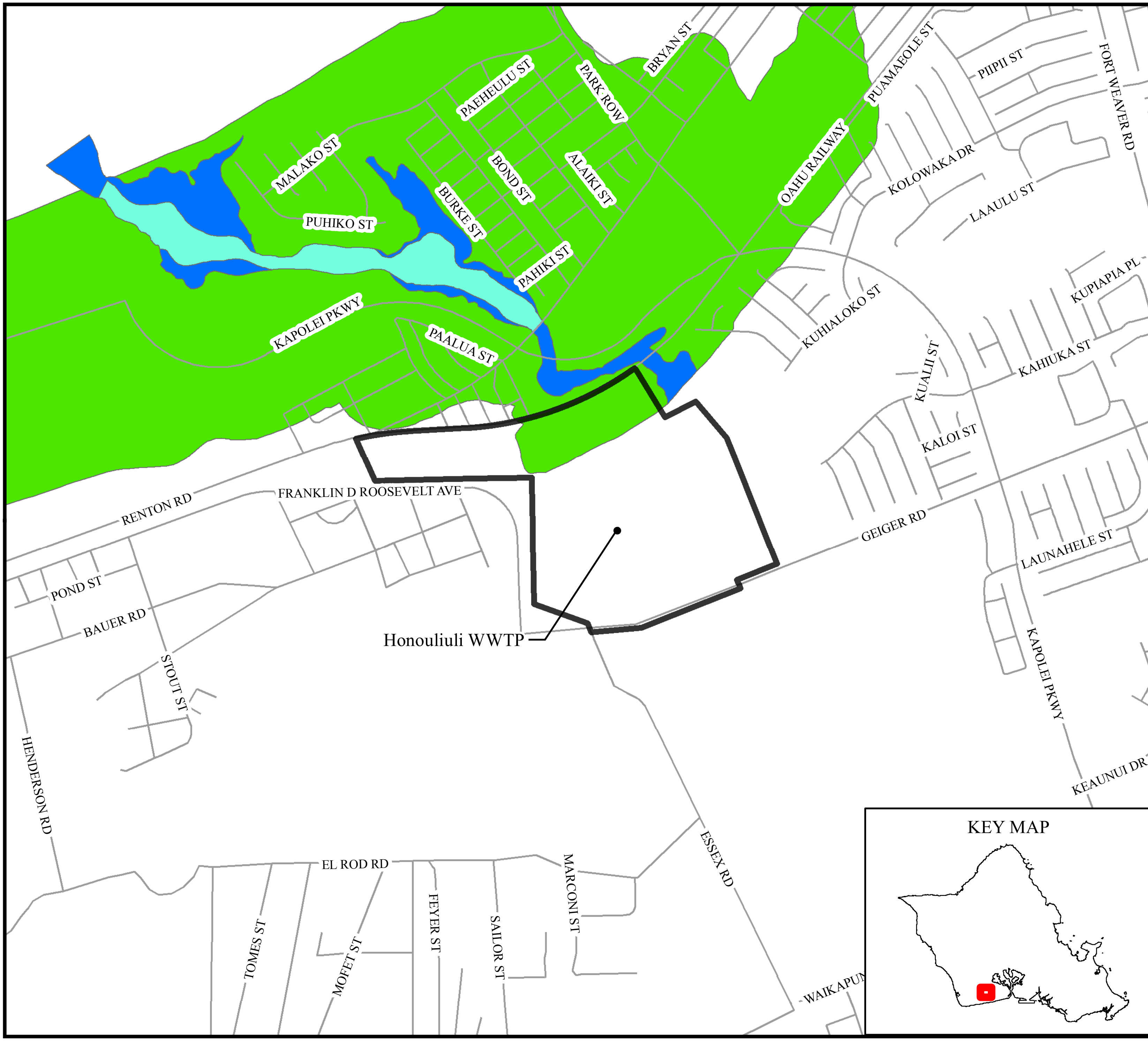
5.4.4 Flood Hazard

5.4.4.1 Existing Setting

The Honouliuli WWTP is located to the north of the southwestern coastline on the island of Oahu. The CCH DPP has digitized FEMA’s flood insurance rate maps from 2006 to 2007 into a GIS flood zone layer. According to the digitized flood zone layer, the WWTP is not located within a flood prone area (Figure 5-4).

5.4.4.2 Construction Impacts and Mitigation Measures

The existing Honouliuli WWTP is not located within a flood zone; therefore, regardless of the alternative implemented, no flood hazard impacts are anticipated.



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HONOULIULI/ WAIPAHU/ PEARL CITY WASTEWATER FACILITIES PLAN

FIGURE 5-4

PROJECT AREA FIRM

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5.4.4.3 Operational Impacts and Mitigation Measures

No permanent changes in grade within the flood zone are proposed. Therefore, no operational impacts are anticipated.

5.5 Natural Environment

A natural resources survey was conducted by SWCA on November 16, 2014 (SWCA 2015). The survey included the area within the fenceline of the original WWTP site as well as the area to the immediate north, northwest and east of the bounds of the existing Honouliuli WWTP (hereafter referred to as the expansion property). The *Biological Resource Assessment* summarizing the results of this survey is attached to this DEIS in its entirety as Appendix B and is summarized below (SWCA 2015).

5.5.1 Flora

5.5.1.1 Existing Setting

In general, the vegetation observed within the surveyed area is typical of the vegetation typically found within disturbed urban areas. Within the fenceline of the original WWTP site, the areas around the treatment works are generally paved or covered with gravel to facilitate maintenance. Areas typically not requiring access for treatment works are manicured grass. Several large well-established cultivated trees are located sporadically throughout the property and along Geiger Road to the south of the site. The majority of vegetation on the expansion property is grass, brush, and small trees, as further described below. Open areas with extensive patches of bare ground, gravel, and asphalt exist within this area; the expansion area has been disturbed by past and current land uses (SWCA 2015).

During the natural resources survey, a total of 79 plant taxa were observed within the survey area, including four species native to the Hawaiian Islands: ‘a‘ali‘i (*Dodonaea viscosa*), hinahina (*Vitex rotundifolia*), ma ‘o hau hele (*Hibiscus brackenridgei*), and ‘uhaloa (*Waltheria indica*), which are all common throughout the Hawaiian Islands. Of the four indigenous plant species, only one, the ma ‘o hau hele (the Hawaiian state flower), is a Federally-listed species. However, this species was observed within a garden adjacent to a facility building; therefore, it is likely cultivated and not naturally occurring. No other State- or Federally-listed threatened, endangered, or candidate plant species were observed in this area during the survey. Although the Honouliuli WWTP is located within the historical range of the endangered ko‘oloa‘ula (*Abutilon menziesii*), the species was not observed during the natural resources survey and is not known to have recently been documented in the project area. According to the Threatened and Endangered Plants layer from the Hawaii Statewide GIS Program, there are no known threatened or endangered plants in the project area.

The vegetation in expansion property portion of the survey area is primarily characterized as a highly disturbed kiawe (*Prosopis pallida*) forest that covers approximately 47.8 acres with sparse Guinea grass (*Urochloa maxima*) cover in the understory due to the presence of leaf litter, dry conditions, and grazing (

Figure 5-5). Metal scraps, debris, and graveled and asphalt areas were observed within portions of the surveyed area. The kiawe trees range from 4.5–8 meters (15–26 ft) tall and comprise approximately 70% of the tree cover throughout the survey area. Large koa haole (*Leucaena leucocephala*) and Manila tamarind (*Pithecellobium dulce*) trees sparsely scattered throughout the kiawe forest comprise most of the remaining tree cover. Two herbaceous species, lion’s ear (*Leonotis nepetifolia*) and golden crown-beard (*Verbesina encelioides*), are widely distributed throughout the understory. Other non-native herbaceous and shrub species scattered sparsely throughout the area or in isolated patches include khaki weed (*Alternanthera pungens*), spiny amaranth (*Amaranthus spinosus*), wild bean (*Macroptilium lathyroides*), hairy abutilon (*Abutilon grandifolium*), bracted fanpetals (*Sida ciliaris*), and Cuban jute (*Sida rhombifolia*). The non-native, parasitic western field dodder (*Cuscuta campestris*) was also found within larger trees during the survey.

Figure 5-5. Kiawe Forest within the Expansion Property with Sparse Guinea Grass Cover in the Understory (SWCA 2015).

5.5.1.2 Construction Impacts and Mitigation Measures

The total anticipated area of grading, grubbing, and clearing for construction activities is approximately 75 acres. Regardless of the alternative implemented, it would be necessary to clear vegetation for the construction of new facilities within the expansion property. Tree clearing for improvements within the existing WWTP site would not be required. Given that the area has been highly altered by human activity and generally lacks environmentally sensitive naturally occurring species, the proposed work is not expected to result in any significant adverse impact on the flora within the WWTP site. Native Hawaiian plants are recommended for landscaping within the project area, including species such as: koʻoloaʻula, kou (*Cordia subcordata*), ʻilieʻe (*Plumbago zeylanica*), and ʻaʻaliʻi.

5.5.1.3 Operational Impacts and Mitigation Measures

Although construction of new structures would result in permanent impacts to the plants present at the WWTP site, the proposed facilities would be located within previously disturbed areas. Areas with new facilities would be landscaped after construction; native plant species are recommended for landscaping whenever possible. Therefore, no significant operational impacts to flora in the area are anticipated, regardless of the alternative implemented.

5.5.2 Fauna

5.5.2.1 Existing Setting

The fauna within the surveyed vicinity of the WWTP site is dominated by non-native birds and mammals. Nine introduced and one indigenous bird species were recorded during the natural resources survey in the surveyed vicinity of the WWTP site. The common myna (*Acridotheres tristis*) was the most frequently observed, as well as the zebra dove (*Geopelia striata*) and spotted dove (*Streptopelia chinensis*). All of these species are common to the main Hawaiian Islands, particularly in urban or disturbed areas (HAS 2005; as referenced in SWCA 2015).

Only one native species, the migratory Pacific golden plover (*Pluvialis fulva*), was observed in this area. This species is abundant throughout Hawaii.

The WWTP site is located directly adjacent to the Coral Creek Golf Course, which contains water features that are attractive to waterbirds. As a result, it is possible that endangered Hawaiian stilts (*Himantopus knudseni*) could be present in close proximity to the proposed project area. Hawaiian stilts, as well as Hawaiian coots (*Fulica alai*), are highly mobile and may occupy newly, sometimes unintentionally, created habitat for foraging and even nesting such as areas that hold standing water after heavy rainfall. There are currently no nesting water birds within the proposed project area.

Four migratory bird species protected under the amended Migratory Bird Treaty Act (MBTA) of 1918 were observed during the survey, including the cattle egret (*Bubulcus ibis*), Hawaiian duck–mallard hybrids, Pacific golden plover, and house finch (*Haemorhous mexicanus*).

Other fauna observed during the survey included mammals: feral cats (*Felis catus*) and small Asian mongooses (*Herpestes javanicus*); and invertebrates: the globe skimmer (*Pantala flavescens*) and two butterflies, including the Gulf fritillary (*Agraulis vanillae*) and the western pygmy blue butterfly (*Brephidium exilis*). The globe skimmer is native to Hawaii. No reptiles or amphibians were observed during the survey.

No State- or Federally-listed threatened, endangered, or candidate bird, mammal, or insect species were observed during the survey of the Honouliuli WWTP site. The endangered pueo (*Asio flammeus sandwichensis*) was not observed during the survey; however, this bird species occurs in habitat found at the WWTP site, including wet and dry forests, grasslands, shrublands, and urban areas. The endangered Hawaiian hoary bat (*Lasiurus cinereus semotus*) is the only native land mammal in Hawaii, and there are no native reptiles or amphibians in Hawaii. Surveys were not conducted for the endangered Hawaiian hoary bat, but this species is not likely to utilize the highly fragmented and urban area in the vicinity of the WWTP site.

No aquatic fauna was observed or is known to occur at the proposed project site. Aquatic fauna that may occur in the vicinity of the Barbers Point ocean outfall in Mamala Bay include large numbers of fish such as bluestripe snapper (*Lutjanus kasmira*), *blotcheye soldierfish* (*Myripristis berndti*), and bigeye scad (*Selar crumenophthalmus*) and mammals including spinner dolphins (*Stenella longirostris*). Federally endangered species that may occur in Mamala Bay in limited numbers include humpback whales (*Megaptera novaeangliae*), Hawaiian monk seals (*Monachus schauinslandi*), and green sea turtles (*Chelonia mydas*). The monk seal is not common in the main Hawaiian Islands. Marine mammals are protected under the Marine Mammal Protection Act.

5.5.2.2 Construction Impacts and Mitigation Measures

Regardless of the alternative selected, the proposed project activities are not expected to impact non-native and native species.

Considering the presence of endangered waterbirds in the vicinity of the WWTP site, endangered/listed species may be attracted to construction sites or facilities if (temporary) habitat is created. Construction activities could create temporary depressions at the work sites that, if they accumulate standing water, might attract waterbirds, particularly the endangered Hawaiian stilt. Should this happen, activities in the area would be disrupted and may be stopped temporarily in compliance with the Endangered Species Act (ESA). Other BMPs, including conducting nest searches during nesting periods (February to August for the Hawaiian stilt) prior to the start of construction may be employed, as recommended in SWCA 2015.

Construction lights are known to blind and disorient migratory birds. Therefore, during construction, mitigation measures including shielding lights and facing the lights downward would be used to minimize impacts to migratory birds. All work would be in accordance with Federal, State and CCH regulatory requirements including, but not limited to the MBTA and the ESA.

Due to the presence of suitable habitat for the endangered pueo in the vicinity of the WWTP, mitigation measures would be implemented to reduce disturbance to the species, including suspending work with heavy machinery or vehicular traffic within 300 feet of any area where indications of nesting are observed until young birds have the opportunity to fledge (SWCA 2015).

Although the potential for encountering Hawaiian hoary bats is small, measures to avoid impacts include: avoiding the use of barbed wire on the top of any fences erected for the proposed project to help prevent entanglement and avoiding trimming trees taller than 15 ft between June 1 and September 15 during the period when juvenile bats may be roosting.

No construction activities are proposed in the vicinity of the outfall; therefore, impacts to marine fauna in the vicinity of the outfall are not anticipated.

5.5.2.3 Operational Impacts and Mitigation Measures

Few long-term impacts to fauna are anticipated from operation and maintenance, regardless of the alternative implemented. Fauna observed within the area would likely find suitable habitat in nearby areas. The operation of an upgraded (secondary treatment) Honouliuli WWTP is expected to improve the quality of the wastewater discharged; thus reducing the chance of altering the marine environment. The upgrade is likely to reduce nutrient and chemical pollution from the wastewater.

5.5.3 Wetlands

5.5.3.1 Existing Setting

The U.S. Army Corps of Engineers, EPA, and DOH define wetlands as areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs and similar areas.

The Kaloʻi Gulch Stream is located to the north and east of the project site. Manmade ponds located within the golf course to the north and east of the project area are connected to this stream. The USFWS's NWI classifies these ponds as “PUBHx“ (Palustrine Unconsolidated Bottom, permanently flooded, and excavated). One manmade pond located within the golf course is located adjacent to the WWTP property. In addition, an abandoned irrigation ditch flows from this pond south through the existing WWTP facility and is classified as “PSS3Ax” (Palustrine Scrub-Shrub, Broad-Leaved Evergreen, temporarily flooded, and excavated wetland). Figure 5-3 illustrates wetlands identified by the U.S. Fish and Wildlife Service's (USFWS) NWI within the vicinity of the project area.

5.5.3.2 Construction Impacts and Mitigation Measures

During design, facilities would be located to: 1) avoid to the maximum extent practicable, 2) minimize and 3) mitigate impacts to the wetland resources in the project area. However, it is anticipated that the former irrigation ditch located on the project site would need to be filled to construct the various site components in that location. The project team will consult with the Army Corps of Engineers, USFWS, CCH, and other regulatory agencies, as necessary, to determine whether filling the abandoned irrigation ditch is jurisdictional under current regulations. If the ditch is determined to be jurisdictional by one or more agencies, then the project team would work with the appropriate agencies to determine acceptable mitigation options. A SCAP may be required from the DLNR Commission on Water Resource Management for any temporary or permanent activity within the former irrigation ditch, and a wetland survey would likely be required. All work would be performed in accordance with Federal, State, and CCH regulatory requirements including, but not limited to the Section 404 of the Clean Water Act, if applicable.

5.5.3.3 Operational Impacts and Mitigation Measures

This project is not anticipated to result in operational impacts to nearby wetlands. Wetlands may be indirectly affected by the lowering of groundwater due to increased water demand from the projected increase in population and potential subsequent reduction of groundwater recharge. However, there is potential that treated effluent would be used for groundwater recharge, thereby minimizing impacts to groundwater. Discharge locations for groundwater recharge have not been identified yet.

5.6 Archaeological and Historical Resources

At the request of AECOM, Cultural Surveys Hawai'i, Inc. (CSH) prepared an archaeological assessment for the proposed project (Yucha et al. 2015). The assessment is attached to this DEIS in its entirety as Appendix C and summarized below. The scope of work for the archaeological assessment comprised:

1. Historical research including study of archival sources, historic maps, Land Commission Awards (land titles), and previous archaeological reports to construct a history of land use and determine if archaeological sites have been recorded on or near the project area.
2. A pedestrian inspection of the southwestern portion of the project area, including the heavily built-out WWTP, to identify any surface archaeological features and to investigate and assess the potential for impact to such sites. This inspection was undertaken to identify sensitive areas that may require further investigation or mitigation before the project proceeds.
3. Preparation of the assessment report including the results of the historical research and the fieldwork with an assessment of archaeological potential based on that research, and with recommendations for further archaeological work, if appropriate. Mitigation recommendations, if there are archaeologically sensitive areas that need to be taken into consideration, also would be provided.

5.6.1 Existing Setting

The project area is within an inland, dry coral plain that in pre-Contact times had a thin to absent soil layer. Due to its distance from the coast and Pearl Harbor, and from an adequate source of fresh water, this inland area was little used during the period prior to Western contact. Within or in the vicinity of the project area, there are no Land Commission Awards, indicating that during the division and redistribution of land in 1848 there were no verified claims to lands in the area. From the late 1800s through the late 1900s, a century of commercial sugar cane cultivation was enabled by the drilling of groundwater wells and the diversion of surface water from distant stream systems, as well as by the hydraulic transport of soils from mountain slopes to the plain. The intensive land disturbance associated with the establishment and operation of the cane plantations probably removed most of any evidence of pre-Contact use that may have existed.

Previous archaeological studies have not reported archaeological resources within or in the vicinity of the project area, and the archaeological sensitivity of the area is generally regarded as low. O'Hare et al. (2011) noted that the project area has been extensively disturbed by prior infrastructure construction and is of relatively low archaeological concern. In another study, O'Hare et al. (2007) focused on the area in the vicinity of the expansion property, along the north and east sides of the Honouliuli WWTP, but identified no historic properties. This study found evidence of extreme ground disturbance and did not find Hawaiian traditional features on the surface. O'Hare et al. (2007) concluded that it is highly unlikely that there are any subsurface Hawaiian features intact. The existing WWTP is not known to have been the subject of previous formal archaeological investigation; however, the property has undergone extensive land disturbance associated with the construction of the infrastructure at the plant. Table 5-2 lists previously recorded historic sites within a 0.5-mile radius of the project area.

Table 5-2. Historic Sites 0.5 Miles of the Project Area

State Inventory of Historic Properties Number	Site Type	Description	Significance
50-80-12-5127	Military	World War II ‘Ewa runway site	Recommended eligible for National Register of Historical Places
50-80-12-9708	Sugar plantation infrastructure	Waialua Agricultural Company Engine No. 6	On National Register of Historic Places
50-80-12-9714	Sugar plantation infrastructure	Oahu Railway and Land Company right of way	On National Register of Historic Places
50-80-12-9761	Sugar plantation infrastructure	Railway rolling stock	On Hawaii Register of Historic Places
50-80-12-9786	Sugar plantation infrastructure	‘Ewa Village Historic District	On National Register of Historic Places

Source: Yucha et al. 2015.

On October 24, 2014, CSH conducted a pedestrian inspection of the southwestern portion of the project area which has been entirely developed with infrastructure related to the Honouliuli WWTP, and a reconnaissance of the remainder of the project area which comprised relatively undeveloped contiguous areas to the north and east of the plant. No historic properties were identified within either the WWTP portion or the undeveloped portion of the project area.

CSH recommends no further cultural resource management work for the proposed project.

5.6.1.1 Construction Impacts and Mitigation Measures

Although shallow subsurface work may be conducted within the project area, the proposed project would not involve construction activities in the vicinity of previously identified historical or archaeological sites listed or eligible for listing on the Hawaii Register of Historic Places or the National Register of Historic Places. In addition, surface conditions observed during field inspections on and in the vicinity of the project area suggest a low probability of encountering archaeological, cultural, or historic resources during construction activities. The project area has a low level of archaeological concern; therefore, construction in this area is not anticipated to adversely impact cultural or archaeological resources. CSH’s effect recommendation for the proposed project is “no historic properties affected” (Yucha et al. 2015).

Potential impacts to any archaeological, cultural, or historic resources that may be encountered during construction of the proposed improvements would be mitigated by complying with HRS Chapter 6E, Historic Preservation. The proposed approach is to identify areas of concern and provide data for the determination of appropriate mitigation prior to implementation of specific projects. The DLNR State Historic Preservation Division (SHPD) would be consulted regarding the proper handling of such resources within the project area prior to implementation of the project. Should any significant archaeological, cultural, or historic sites be found during construction activities, all work in the vicinity would cease and the DLNR SHPD would be promptly notified.

5.6.1.2 Operations Impacts and Mitigation Measures

Operation of the wastewater system once the project has been completed is not anticipated to impact archaeological or historic resources.

5.7 Water Quality

5.7.1 Existing Setting

The Honouliuli WWTP discharges via the Barbers Point outfall to Mamala Bay, which is classified in the Hawaii DOH Water Quality Standards (HAR Section [§]11-54-2) as a Class A “dry” (defined as the average fresh water inflow from the land is less than one percent of the embayment volume per day) “open coastal water” (defined as marine waters bounded by the 183 meters or 600 ft depth contour and the shoreline). Permitted effluent discharges in Mamala Bay include point sources such as the Sand Island, Honouliuli, and Fort Kamehameha WWTPs and NPDES permitted industrial and agricultural sources and non-point sources such as stormwater. Long term studies of benthic organisms in the vicinity of the Barbers Point ocean outfall compared to control sites indicate that effects of the existing effluent are negligible (SWCA 2015).

The Honouliuli WWTP is governed by NPDES Permit No. HI0020877 (effective March 30,2014). The 2010 Consent Decree has interim limits until full secondary treatment is completed. Table 5-3 shows the Honouliuli WWTP 2010 Consent Decree effluent limits.

Table 5-3. Honouliuli WWTP Effluent Limits

Discharge Limitations					Monitoring Requirements	
Discharge Parameter	**Average Monthly**	**Average Weekly**	**Maximum Daily**	**Units**	**Minimum Frequency**	**Sample Type**
Flow[1]	report	report	report	mgd	continuous	recorder or totalizer
BOD_5 [1]	53,679	166 55,424	report	mg/L lbs/day	daily	24-hour composite
	As a monthly average, not less than 30% removal efficiency from influent stream					
TSS [1]	50 16,721	53 17,580	report	mg/L lbs/day	daily	24-hour composite
	As a monthly average, not less than 60% removal efficiency from influent stream					
pH [2]	Not less than 6.0 standard units nor greater than 9.0 standard units				five times/week	grab

Legend: — = not applicable; lbs/day = pounds per day.
Source: 2010 Consent Decree (Civil No. 94-00765 DAE-KSC); 2014 Reissued NPDES Permit No. HI0020877
Notes:
(1) 2010 Consent Decree interim limits.
(2) The terms and conditions of the reissued NPDES Permit HI0020877 remain in full force for parameters other than flow, BOD_5, and TSS.

The 2012 and 2013 effluent data (Table 5-4) provided by CCH indicates that the Honouliuli WWTP consistently complies with the 2010 Consent Decree interim limits. However, additional treatment will be necessary to meet the treatment limits that would be associated with future full secondary treatment requirements.

Table 5-4. 2012 and 2013 Honouliuli WWTP Effluent Outfall Discharge Data

Discharge Parameter	Average Monthly (1)	Average Weekly (2)	Daily Average (3)	Maximum Daily	Minimum Daily	Monthly Removal Efficiency (4)
2012						
Flow, mgd	23.0	27.9	20.5	32.1	16.3	—
BOD_5, mg/L	133	143	121	176	79	68.0%
TSS, mg/L	38	42	35	50	22	89.9%
2013						
Flow, mgd	23.6	25.2	21.5	29.5	17.2	—
BOD5, mg/L	122.3	135	116	180	77.5	67.4%
TSS, mg/L	39.3	50	36	68	22	88.7%

Legend: — = not applicable
Source: 2012 CCH Honouliuli WWTP data, as presented in *Technical Memorandum 12.O, Honouliuli WWTP Concept Design Report*
Notes:
(1) Highest of the 12 actual monthly averages.
(2) Highest of the 52 actual weekly averages (Sunday to Saturday).
(3) Average of 365 days.
(4) Lowest of the 12 actual monthly averages.

Upgrades to the Honouliuli WWTP would be designed to comply with the 2010 Consent Decree and would result in the reduction in biological oxygen demand (BOD) and total suspended solids (TSS), as shown in Table 5-5. Although effluent flow to Mamala Bay is anticipated to increase due to the projected population growth within the sewershed, effluent concentrations and overall loads would decrease as a result of the proposed upgrade to secondary treatment.

Table 5-5. Reduction in BOD and TSS anticipated from proposed upgrades to the Honouliuli WWTP

Parameter	Existing	Proposed	% Change
Flow (average daily) (gpd) (1)	25,800,000	45,000,000	57.3
Flow (liters/day)1	97,660,000	170,343,540	57.3
BOD (mg/L)	120	15	-87.5
BOD (mg/day)	12,083,035,104	2,555,153,100	-78.9
BOD (lb/day)	26,639	5,633	-78.9
TSS (mg/L)	36	15	-58.3
TSS (mg/day)	3,624,910,531	2,555,153,100	-29.5
TSS (lb/day)	7,992	5,633	-29.5

Note: (1) Based on 2012effluent data presented in *TM 12.O, Honouliuli WWTP Concept Design Report*

As previously mentioned in Section 5.3.2 Surface Water and Section 5.5.3 Wetlands, a mapped wetland (former drainage ditch) is located in the eastern portion of the WWTP site; however, this wetland no longer functions as an active irrigation ditch.

5.7.1.1 Construction Impacts and Mitigation Measures

In the short-term, potential construction impacts to the mapped wetland located within the project area would be mitigated by adherence to State and CCH water quality regulations governing grading, excavation, and stockpiling.

The proposed stormwater basins at the Honouliuli WWTP site would be shallow dry basins except during and after storm events, until infiltration and/or evaporation of basin contents is complete. Vegetative drainage swales would be used when feasible to help enhance stormwater quality.

5.7.1.2 Operations Impacts and Mitigation Measures

With the proposed treatment processes, permit compliance will be accomplished in the following ways.

- Influent and effluent flow meters compliant with DOH standard conditions would measure the flow. Influent flow would be measured by a magnetic flow meter downstream of the influent pumps. Effluent flow would be measured by a flow meter in the outfall. The flow meters would be tied into the SCADA system and data logged in the Real Time Historian for use in NPDES reporting.
- There would be composite samplers on the influent and effluent flow streams to collect samples for daily composite reporting requirements. The influent sampler would continue to be located upstream of the influent screens. The effluent sampler would be located downstream of where the brine from the recycled water facility joins with secondary clarifier effluent. Both composite samplers would be flow paced based on the respective (influent or effluent) flow signal.
- Standard sample locations would be provided to plant operations for collection of grab samples.

Overall, the proposed project will provide wastewater treatment facilities necessary to comply with secondary treatment standards and have beneficial long-term water quality impacts on groundwater (due to the potential to replace IWSs, which may contaminate groundwater, with a centralized sewer system) and surface and coastal waters, as it would better manage peak wastewater flows. The proposed alternatives also provide for storage of peak wet-weather inflow and infiltration to prevent or minimize wastewater spills.

5.8 Air Quality

Air quality is defined by ambient air concentrations of specific pollutants of concern with respect to the health and welfare of the general public. Air quality can be affected by air pollutants produced by mobile sources, such as vehicular traffic, non-road equipment used for construction activities, etc.; and by fixed or immobile facilities, referred to as “stationary sources”. Stationary sources can include combustion and industrial stacks and exhaust vents. Potential air quality impacts in the vicinity of the Honouliuli WWTP would occur from both construction and operational activities associated with implementation of the proposed improvements. The analysis of these potential air quality impacts was conducted and is detailed in an air quality analysis technical memorandum prepared by AECOM in November 2014 (AECOM 2014c). It is attached to this DEIS in its entirety as Appendix D and is summarized below.

5.8.1 Existing Setting

Regional and local climate, together with the amount and type of human activity, generally dictate the air quality of a given location. The climate of the project area is very much affected by its leeward and coastal situation. Winds are predominantly trade winds from the east/northeast, except for occasional periods when Kona storms may generate strong winds from the south or when trade winds are weak and land breeze/sea breeze circulations may develop. Wind speeds typically vary between approximately 5 and 15 miles per hour, providing relatively good ventilation much of the time. Temperatures in leeward areas of Oahu are generally very moderate, with average daily temperatures ranging from approximately 70°F to 84°F. The extreme minimum temperature recorded at Honolulu Airport is 54°F, while the extreme maximum temperature is 95°F. This area of Oahu is one of the drier locations in the state, with rainfall often highly variable from one year to the next. Monthly rainfall has been measured to range from as little as a trace to as much as 10 inches. Average annual rainfall is approximately 20 to 30 inches, with summer months typically the driest.

To protect public health and welfare, the EPA, under the requirements of the 1970 Clean Air Act (CAA) as amended in 1977 and 1990, has established National Ambient Air Quality Standards (NAAQS) for six air pollutants known as criteria pollutants (40 CFR 50): carbon monoxide (CO), nitrogen dioxide (NO_2), ozone (O_3), particulate matter (PM_{10} [particulate matter with a diameter ≤ 10 micrometers], and $PM_{2.5}$ [particulate matter with a diameter ≤ 2.5 micrometers]), lead (Pb), and sulfur dioxide (SO_2). Note that O_3 is not emitted directly into the atmosphere; instead it is created by the combination of nitrogen oxides (NO_x) and volatile organic compounds (VOC), which are referred to as O_3 precursors.

The state of Hawaii has essentially adopted the NAAQS, although the Hawaii standards for CO are more stringent than the national standards. In addition to criteria pollutants, Hawaii also has an ambient standard for H_2S.

Existing ambient air quality conditions can be illustrated based on the attainment or nonattainment status of the NAAQS and Hawaii standards. Based on air quality data collected and published by the EPA and DOH, the State of Hawaii complies with all applicable ambient standards, including the NAAQS and State Ambient Air Quality Standards. The air in Hawaii is clean and low in pollutants, and the area where the project is located is designated as attainment for all air quality standards.

In addition to the NAAQS, the CAA also sets permit rules and emission standards for stationary pollution sources of certain sizes. The DOH has adopted the EPA-established stationary source regulations and acts as the administrator to enforce stationary source air pollution control regulations in Hawaii (DOH, Title 11, Chapter 60.1, Air Pollution Control). DOH grants an air permit to applicable facilities for not only federal enforceable major sources but also non-major sources in the state. The Honouliuli WWTP is a minor source for criteria pollutants and is operating under a non-covered source permit (No. 0215-020N) issued by the DOH.

Since H_2S is the primary compound in wastewater collection and treatment systems that causes odor, the DOH-established ambient standard 0.025 parts per million by volume (ppmV) in any 1-hour period at the property line of a facility can be used as a measure of potential odor effects. The Honouliuli WWTP has six separate odor control systems that collect and treat foul air from the WWTP. Odor Control System Permit No. 0215-02-N limits the H_2S concentrations at each individual odor control system outlet. Ongoing monitoring is conducted at 13 fenceline monitoring locations along the original property line and at the outlet stacks of each odor control system in compliance with permit requirements.

Although there are currently no greenhouse gas (GHG) emission limits for CCH WWTPs, in 2007 the Hawaii State Legislature passed Act 234, “Global Warming Solutions Act” which Governor Linda Lingle signed into law. Act 234 required the DBEDT and DOH to update their Inventory of Greenhouse Gas Emissions Estimates for 1990 by December 31, 2008 and to reduce the amount of GHG emissions in Hawaii to levels at or below 1990 levels by 2020. As a result of Act 234, ICF International completed the Hawaii Greenhouse Gas Inventory: 1990 and 2007 in December 2008 for DBEDT.

5.8.1.1 Construction Impacts and Mitigation Measures

Regardless of the alternative selected, short-term impacts to air quality would result from the proposed project either directly or indirectly as a consequence of project construction.

The major potential short-term air quality impact of the project would occur from emission of fugitive dust during construction activities. During construction phases, emissions from engine exhausts would also occur both from on-site construction equipment and from vehicles used by construction workers and from trucks traveling to and from the project construction site.

However, given the phasing of construction activities over several years, hot spot air quality concerns associated with concentrated equipment operations would be limited. Moreover, the construction equipment required for the proposed project is typical of equipment used for routine infrastructure development projects in urban areas. Short-term emissions, including GHG emissions, from the small number of construction equipment would be inconsequential compared to regional emissions or the US inventory for GHG emissions, factoring in the substantially greater number of unrelated on-road vehicles and associated emissions that constitute the majority of baseline mobile emissions in the project area. Therefore, construction equipment impacts are anticipated to be less than significant.

During the worst-case construction year, 2021, it is anticipated that a total of 185 construction workers would arrive at the site during the AM peak hour and 185 construction workers would exit the site during the PM peak hour, in addition to 8 total trips (4 entering and 4 exiting) generated by cement trucks during each of the AM and PM peak hours of traffic. According to the traffic impact analysis described in Section 5.10, the level of service with or without the project at affected intersections would remain at similar levels. Therefore, the air quality impacts from on-road mobile source operations associated with construction activities would be temporary and comparable to the 2021 baseline condition, resulting in no significant impacts.

It is anticipated that a short-term increase in GHG emissions would occur associated with construction activities. However, such an increase would be temporary and would be further evaluated during the final design stage when proposed project component is well defined and emissions can be reasonably forecasted.

Although mitigation measures are not warranted during the construction period, BMPs to control construction emissions would be implemented to minimize visible fugitive dust emissions at the property line. The BMPs would include watering of active work areas, using wind screens, keeping adjacent paved roads clean, and covering open-bodied trucks. Additional measures can also be considered if necessary, such as using newer equipment, reducing truck on-site idling time, and moving construction materials and workers to and from the project sites during off-peak traffic hours.

5.8.1.2 Operational Impacts and Mitigation Measures

After construction activities are completed, the long-term operational air quality impacts with the implementation of the proposed project would include an upgrade to the standby power capacity, possible introduction of a new energy saving combined heat and power (CHP) system, and an increase in mobile source operation due to the plant expansion and an increase in wastewater treatment capacity.

Under future operational conditions, three smaller existing generators would continue to provide emergency power to the current load, and new diesel powered generators would provide standby power to the new loads. Given their emergency usage purposes, potential air quality impacts would be short in duration and would be unlikely to cause significant air quality impacts.

A CHP facility may be incorporated at the Honouliuli WWTP to make beneficial use of digester biogas. If such a facility is incorporated at the Honouliuli WWTP, it would need to be permitted according to State and Federal air regulations. Since this facility would be a new stationary source, the emissions at the Honouliuli WWTP would increase resulting in adverse air quality impacts on the local level. However, because the feasibility of constructing such a facility is still under evaluation and has no design specifics, the potential air emissions from the facility cannot be reasonably estimated. If the CHP facility option is elected in the future, the CHP facility would need to be considered for future air quality permitting in conjunction with the biosolids disposal process during the design stage. During the air permitting process, it is anticipated that a separate air quality impact modeling analysis would be conducted to address potential air quality impacts associated with the CHP facility.

With an anticipated 55 peak hour vehicles entering the project site under the future operational condition, the traffic movements with and without the project at affected intersections in 2030 would remain operating at similar levels of service. Therefore, the air quality impacts from on-road mobile source operations associated with operational activities would be comparable to the 2030 baseline condition, causing less than significant off-site mobile source air quality impacts.

The proposed project recommends replacing the existing Primary Odor Control System with new biological odor control systems. Similarly, odor control would be provided to the new treatment facilities. In addition, grit covers, primary clarifier covers, and primary effluent channel covers are recommended for odor containment. These project activities and upgrades to components are common to each of the secondary treatment options. Therefore, compounded with the improvements to the existing Primary Odor Control System and the proposed secondary treatment alternative, the odor impacts under the proposed plant improvement plan are not anticipated to be significant. The ambient odor monitoring program to be implemented after the completion of the project would demonstrate compliance with the DOH ambient odor standard in terms of H_2S concentration levels.

Similar to the criteria pollutants, it is anticipated that an increase in GHG would occur associated with the project. However, such an increase would be further evaluated during the final design stage when the proposed project component is well defined and emissions can be reasonably forecasted. Given its global effects, such a typical infrastructure development project in an urban area would unlikely cause any meaningful global warming effects.

The potential long-term air quality impacts to the project area are not anticipated to be significant, although there is the potential to increase on-site stationary and mobile source emissions due to an increase in the plant operational capacity. These project-induced emissions are mostly short in duration, with the exception of the operation of a potential CHP facility. Thus, mitigation measures in excess of odor control measures would unlikely be necessary during the operational period. Compliance with all applicable ambient standards, including odor in terms of H_2S concentration levels, would be further demonstrated 1) during the final design stage of the project when the air permit is modified for applicable criteria pollutants and 2) after the completion of construction with an ambient monitoring program for odor.

5.9 Noise

An acoustical study, which included an analysis of noise near the WWTP site, was prepared by Ebisu & Associates in January 2015 (Ebisu & Associates 2015). It is attached to this DEIS in its entirety as Appendix E and is summarized below.

5.9.1.1 Existing Setting

Daytime and nighttime noise measurements were obtained in October 2014 at or near the boundary lines of the Honouliuli WWTP site to provide a basis for describing the existing background noise levels at noise sensitive receptors in the project environs and to determine if the facility is in compliance with DOH noise limits. The project is located within the AG-1 (Restricted Agriculture) and I-2 (Intensive Industrial) zoning districts, within which the current DOH noise limit is 70 dBA for both daytime and nighttime periods. DOH stipulates that noise levels shall not exceed the maximum permissible sound levels for more than 10% of the time within any 20 minute period, at any time except by permit or variance. Figure 1 of Appendix E identifies the measurement locations, and Table 1 of Appendix E presents the results of the noise measurements. The major noise sources at the existing Honouliuli WWTP are identified on Figure 2 of Appendix E and include: Dewatering Building Centrifuge, Influent Pump Station, Blower Building #1 (Primary), BioTower Pump Station Booster Fan, and Caustic Scrubber Odor Control Blower. These five major noise sources are anticipated to remain at their present general locations through the evaluation period (i.e. through 2030). During the daytime, motor vehicle traffic and aircraft noise become the dominant noise sources along the Honouliuli WWTP property lines, and the noise measurements were influenced by these off-site noise sources more than the WWTP noise sources. Based on the recorded measurements, the Honouliuli WWTP site is in full compliance with the 70 dBA DOH noise limit for both the daytime and nighttime periods.

Also, traffic noise level measurements were performed in the vicinity of the Honouliuli WWTP site in December 2014. Table 3 and Figure 3 of Appendix E present the results and locations, respectively, of these measurements. Table 4 of Appendix E presents the calculated hourly average, or Leq(h), traffic noise levels at 50, 75, and 100 feet setback distances from the roadways' centerlines during the PM peak traffic hour, which reflects the highest hourly volume of traffic on the project area roads. The Hawaii State Department of Transportation considers traffic noise levels less than 66 Leq(h) to be acceptable for noise sensitive land uses. This criterion level was exceeded at 50 feet from the centerlines of Geiger Road and Roosevelt Avenue.

The U.S. Department of Housing and Urban Development (HUD) uses the Day-Night Average Sound Level (or DNL) descriptor in evaluating acceptable noise levels at noise sensitive locations. The DNL descriptor incorporates a 24-hour average of daytime and nighttime noise levels, with the nighttime noise levels increased by 10 decibels (or dB) prior to computing the 24-hour average. A noise level of 65 DNL is considered to be acceptable for noise sensitive uses by HUD. Traffic noise levels in DNL may be estimated by adding 1 unit to the peak hour Leq(h), so a traffic noise level of 66 Leq(h) during the PM peak hour would result in a 67 DNL value, or 2 DNL units above the HUD noise standard.

Table 5 in Appendix E presents the existing setback distances to the 65, 70, and 75 DNL traffic noise contour lines for unobstructed line-of-sight conditions along the roadways in the immediate environs of the WWTP site. As indicated in Table 5, setback distances in the order of 68 to 70 feet from the centerlines of Geiger Road and Roosevelt Avenue are required to not exceed the HUD 65 DNL noise standard.

5.9.1.2 Construction Impacts and Mitigation Measures

The potential construction noise levels associated with the proposed project were evaluated for the potential impacts and relationship to the current Federal Housing Administration (FHA)/HUD noise standard.

Audible construction noise would be unavoidable during the project construction period. The construction work required for the project would be performed in phases and would move from one location to another throughout the construction period; thus, the length of exposure to construction-related noise at any receptor location would be less than the construction period for the entire project. Also, most of the work would be performed during the normally permitted hours of 7:00 am to 6:00 pm on weekdays, and between 9:00 am to 6:00 pm on Saturdays. Figure 5 in Appendix E depicts the range of noise levels of various types of construction equipment that may be used at the project site when measured at 50 feet from the equipment. The decrease in construction equipment noise with increasing distance from the noisier equipment is shown in Figure 6 of Appendix E.

The predicted increases in traffic noise levels attributable to project-related traffic during the peak construction year (2021) were also evaluated, and it was concluded that these increases would not exceed 1 dB along Renton Road between Kapolei Parkway and the proposed WWTP site entrance road, hereafter referred to as “Honouliuli Driveway 5 (DW5)”. Along all other roadways in the immediate environs of the WWTP site, increases in traffic noise levels associated with the project construction traffic were expected to be less than 0.5 dB. Therefore, noise impacts associated with construction-related traffic are not expected at noise sensitive receptors within the immediate environs of the WWTP site.

Noise sensitive residences that are predicted to experience the highest noise levels during construction activities are located northwest of the WWTP site along Phillipine Sea and Renton Road. Predicted construction noise levels at these residences during the site preparation phase of the work in northwest portion of the WWTP site range from 62 to 71 dBA (plus or minus 5 dBA). The highest predicted noise levels during construction are expected to occur at the Coral Creek Golf Course during proposed infrastructure improvements along the eastern boundary of the WWTP site. The closest residences located to the east of the WWTP site are beyond the Coral Creek Golf Course and are anticipated to experience construction noise levels of 65 dBA (plus or minus 5 dBA). Impacts associated with construction noise are not expected to be in the “public health and welfare” category due to the temporary nature of the work conducted within normally permitted hours. Instead, these impacts would be limited to the temporary degradation of the quality of the acoustic environment in the immediate vicinity of the WWTP site.

As is typically the situation with construction projects, it would not be practical or feasible to reduce or eliminate all construction noise to inaudible levels because of the relatively long period of actual construction activities and the relatively low levels of background noise in the surrounding areas. However, special construction noise mitigation measures would be implemented during construction activities. These measures would include: sound attenuation treatment of fixed machinery which operate continuously, so as to limit their combined maximum noise levels to 65 dBA at the closest receptors (i.e. the adjacent golf course and nearest residences) during the daytime and to 45 or 50 dBA at the property lines toward the closest residences during the nighttime; and requiring the use of broadband back-up alarms for vehicles which operate on the construction sites in place of the more commonly used high frequency, beeper back-up alarms. The use of properly muffled construction equipment would also be required on the job site.

Construction activities would be carried out in accordance with HRS Chapter 342F, Noise Pollution, Hawaii Administrative Rules (HAR) Title 11, Chapter 46, Community Noise Control and all Federal, State, and CCH laws and regulations. According to HAR Title 11, Chapter 46, construction activity is permitted Monday through Friday from 7:00 am to 6:00 pm and Saturday from 9:00 am to 6:00 pm. Construction activities associated with the proposed project would comply with these time restrictions to the extent practicable. A Community Noise Variance would be required to exceed the maximum permissible sound levels or for work outside of normal hours.

5.9.1.3 Operational Impacts and Mitigation Measures

Estimates of future WWTP noise levels were conducted by modeling the source noise levels of the WWTP equipment and facilities expected to be in operation following completion of the proposed Phase 2 improvements in 2030. Figure 4 in Appendix E depicts the locations of the future noise sources that were included in the noise modeling, and Table 8 in Appendix E presents the estimated noise levels of these sources at a 50-foot distance. Sound attenuation measures such as enclosures, the addition of silencers or mufflers or acoustical louvers, the use of sound absorptive interior finishes, or the use of sound rated doors were not included in the noise modeling assumptions. The proposed emergency generators in the Main Electrical Building (Building #201E) were not included in the noise modeling because of their intermittent operation during testing or emergencies and since they would likely be sound attenuated so as to not exceed the DOH noise limit of 70 dBA at the WWTP site property boundary during their operation.

Table 9 in Appendix E presents the results of the calculations of predicted plant noise levels at the WWTP site's perimeter at locations A through J without sound attenuation treatments applied to the various noise sources. The results in Table 9 were controlled by the dominant noise sources located in Building #0331 (the blower building) and Building #201F (the grit building). The utilization of sound attenuation treatments to all proposed noise sources (with the exception of the emergency generators) would not likely be required to comply with the 70 dBA DOH noise limit along the WWTP site property boundary. However, acoustical treatments of louder noise sources would be incorporated into the project design to reduce their contributions to the total WWTP site noise levels.

Future road traffic noise levels associated with operation of the proposed project in 2030 were also assessed. By 2030, traffic noise level increase attributable to project traffic is expected to be less than 1.0 dB at all roadways in the project environs, except along the section of Renton Road between Kapolei Parkway and the proposed DW5 entrance. The estimated increases in future traffic noise levels along this section of Renton Road are 0.9 dB due to non-project traffic and 2.0 dB due to project traffic. Since existing traffic volumes along this section of roadway are relatively low (approximately 343 vehicles per hour), and since this area is currently undeveloped within 50 feet of the roadway's centerline, these increases in future traffic noise levels are not expected to result in exceedances of traffic noise level criteria along this roadway section.

Along Renton Road west of the proposed DW5 entrance where existing residences are located, future traffic noise level increases associated with the project are not expected to occur. Also, along Roosevelt Avenue in the vicinity of Phillipine Sea, future traffic noise level increases associated with project traffic are anticipated to be less than 0.2 dB by the year 2030. Along Geiger Road and Roosevelt Avenue where existing traffic noise levels exceed the 66 Leq(h) and 65 DNL noise impact thresholds, future increases in traffic noise levels due to project traffic are lower than the increases associated with non-project traffic, and are predicted to be less than 0.8 Leq(h) or DNL. These increases are not considered to be significant.

5.10 Traffic

A traffic impact analysis report (TIAR), which includes an analysis of traffic near the Honouliuli WWTP site, was prepared by Austin Tsutsumi & Associates, Inc. (ATA) in November 2014 (ATA 2014). It is attached to this DEIS in its entirety as Appendix F and summarized below.

5.10.1 Existing Setting

Primary access to the Honouliuli WWTP is through an entrance on Geiger Road, hereafter referred to as "Honouliuli Driveway 1 (DW1)", west of the Coral Creek Golf Course and south of the Honouliuli WWTP Control Building. The Septage Receiving Station is accessed through a separate entrance from Geiger Road east of the main entrance, hereafter referred to as "Honouliuli Driveway 2 (DW2)". The expansion property can currently be accessed from the north from Malio Street via Renton Road and from Geiger Road east of the Septage Receiving Station entrance. The Ewa Convenience Center is accessed from Geiger Road west of the main WWTP entrance at DW1.

The majority of parking is located near the main entrance from Geiger Road and distributed around the Control Building, Maintenance Building Number (No.) 1, Chlorination Building, and Maintenance Building No. 2. Minor additional parking is located at the Locker Room Building and Biotower Pump Station. Golf carts are parked where convenient around the site. HWRF has parking within its facility.

ATA conducted manual turning movement counts and field observations for critical intersections during the peak hour and at a time when schools were known to be in-session. Existing traffic volumes, lane configuration and movement level of service (LOS) are illustrated in Figure 5-6. Manual turning movement traffic counts and field observations were conducted at the following study intersections in the vicinity of the WWTP site (intersection numbering below corresponds with numbering in Figure 5-6):

1. Kualakai Parkway/Kapolei Parkway – northwest of the Honouliuli WWTP property
2. Renton Road/Kapolei Parkway – immediately north of the Honouliuli WWTP property
3. Renton Road/Phillipine Sea – west of the Honouliuli WWTP property
4. Roosevelt Avenue/Phillipine Sea – southwest of the Honouliuli WWTP property
5. Roosevelt Avenue/Geiger Road/Essex Road – immediately southwest of the Honouliuli WWTP property
6. Geiger Road/Ewa Refuse Convenience Center Driveway (ECRC) – in the southwest corner of the Honouliuli WWTP
7. Geiger Road/DW1 – located at the southern boundary of the Honouliuli WWTP property
8. Geiger Road/DW2 – located in the southeast corner of the Honouliuli WWTP property
9. Geiger Road/Kapolei Parkway – southeast of the Honouliuli WWTP property
10. Fort Weaver Road/Geiger Road/Iroquois Road – east of the Honouliuli WWTP property
11. Renton Road/Fort Weaver Road – northeast of the Honouliuli WWTP property

Analysis for the study intersections was performed by ATA using methodologies prescribed by the Highway Capacity Manual (TRB 2010). The analysis included control delay results, based on intersection lane geometry, signal timing inputs and hourly traffic volume for signalized and unsignalized intersections. Traffic software calculations, as confirmed or refined by field observations, constituted the technical analysis. Using the peak hour manual count volumes, the traffic software was run and a Level of Service (LOS) was assigned to each intersection. LOS is used to analyze roadways and intersections by categorizing traffic flow and assigning qualitative levels of traffic, with values ranging from free-flow conditions at LOS A to congested conditions at LOS F.

The weekday morning (AM) and afternoon (PM) peak hour turning movement data utilized in this report was collected on Wednesday, September 3, 2014. Based on this traffic count data, the weekday AM peak hour of traffic was determined to be from 7:00 AM to 8:00 AM and the PM peak hour of traffic was determined to be from 4:00 PM to 5:00 PM.

At all signalized study intersections, with the exception of Fort Weaver Road intersections, most vehicles typically cleared each intersection within one signal cycle without any heavy queuing or congestion. All study intersections operate at LOS D or better with adequate capacity except for the following intersections (none of which are located immediately adjacent to the Honouliuli WWTP property):

- Renton Road/Kapolei Parkway (intersection #2 on Figure 5-6 located to the north of the Honouliuli WWTP):

  All movements of this intersection currently operate at LOS D or better during the AM and PM peak hours of traffic with the exception of the northbound left-turn movement, which operates at LOS E during the AM peak hour of traffic. Although the northbound left-turn movement operates at LOS E during the AM peak hour of traffic, adequate capacity is provided.

- Geiger Road/Kapolei Parkway (intersection #9 on Figure 5-6 located to the southeast of the Honouliuli WWTP):

  The eastbound left-turn movement operates at LOS E(E) during the AM(PM) peak hours, but is generally low volume movements of only 8(45) vehicles, respectively. All remaining movements of this intersection operate at LOS D or better during the AM and PM peak hour of traffic.

- Fort Weaver Road/Geiger Road/Iroquois Road & Renton Road/ Fort Weaver Road (intersections #10 and #11 on Figure 5-6 located to the east of the Honouliuli WWTP):

  The majority of movements at these intersections currently operate at LOS E/F conditions during the AM and PM peak hours of traffic mainly due to long delays as a result of requisite long cycle lengths (approximately 4 minutes long). These two intersections also provide split-phase signal operation on the side streets and long pedestrian crossing times across Fort Weaver Road, which contribute to the long delays. During the AM peak hour, the northbound traffic is generally heavier, while during the PM peak hour, traffic is heavier in the southbound direction.

5.10.1.1 Base Year 2021

The year 2021 was selected as the base year to reflect the anticipated peak year of construction activity, which was assumed to occur during Phase 1 construction of the Honouliuli WWTP. It is anticipated that by year 2021, traffic will have increased significantly over existing conditions due to the continuing development of the Ewa-Kapolei region. The following intersections are anticipated to operate at LOS E/F in 2021:

– Kualakai Parkway/Kapolei Parkway intersection (intersection #1 on Figure 5-6, located to the northwest of the Honouliuli WWTP):

  Upon build-out of the Ka Makana Alii Shopping Center, one of the proposed accesses to the shopping center is anticipated to be provided as a new south leg extension from the existing Kualakai Parkway/Kapolei Parkway intersection, ultimately providing a 4-legged intersection. With the improvements at the intersection, the low volume northbound left-turn movement is projected to operate at LOS F during the AM peak hour with only 5 vehicles anticipated to make the left-turn onto Kapolei Parkway. During the PM peak hour, all left-turn movements will operate at LOS E conditions.

– Renton Road/Kapolei Parkway (intersection #2 on Figure 5-6):

  This intersection is forecast to operate similar to existing conditions during the AM and PM peak hours of traffic. However, the southbound left-turn movement will worsen to LOS E during the AM peak hour of traffic and the northbound left-turn movement will worsen to LOS E during the PM peak hour of traffic.

– Geiger Road/Kapolei Parkway (intersection #9 on Figure 5-6):

  The intersection is anticipated to operate overall at LOS D during the AM and PM peak hours of traffic. Due to increased traffic, all left-turn movements are anticipated to operate at LOS E during both peak hours, with the low volume eastbound left-turn movement of 10 vehicles, operating at LOS F.

– Fort Weaver Road/Geiger Road/Iroquois Road & Renton Road/Fort Weaver Road (intersections #10 and #11 on Figure 5-6 located to the east of the Honouliuli WWTP):

  Similar to Existing conditions, the intersections along Fort Weaver Road through the Ewa region will continue to experience LOS F at some movements. However, this is generally ascribed to requisite long traffic signal cycle lengths, split phase operation, and generally long crosswalk lengths across Fort Weaver Road.

All unsignalized study intersections will continue operating at LOS D or better during the AM and PM peak hours of traffic. Table 2 (in Appendix F) shows the Existing and Base Year 2021 LOS at the study intersections.

5.10.1.2 Base Year 2030

The year 2030 was selected as the base year to reflect the anticipated build-out of the Honouliuli WWTP. By year 2030, traffic will continue to increase due to the continuing development of the Ewa-Kapolei region. Based on a LOS comparison between Base Year 2021 and Base Year 2030, the majority of individual movements that are projected to operate at LOS E/F for Base Year 2021 conditions will continue operating at similar levels of service for Base Year 2030 conditions during the AM and PM peak hours of traffic except for the following:

– Kualakai Parkway/Kapolei Parkway (intersection #1 on Figure 5-6):

  The low volume northbound left-turn movement will operate at LOS F during the PM peak hour.

– Renton Road/Kapolei Parkway (intersection #2 on Figure 5-6):

  During the AM peak hour, the northbound approach will worsen to LOS E conditions, with the mainline through movement along Kapolei Parkway nearing its capacity. In addition, the westbound and southbound left-turn movements will operate at LOS E during the PM peak hour of traffic. In order to mitigate the deficiencies of the intersection, dual southbound left-turn lanes were recommended to accommodate the relatively high 275(320) southbound left-turn vehicles during the AM(PM) peak hours.

With the dual southbound left-turn lanes, all movements at the intersection are forecast to operate similar to Base Year 2021 conditions.

- Roosevelt Avenue/Phillipine Sea (intersection #4 on Figure 5-6 located to the southwest of the Honouliuli WWTP):

  The southbound shared left/through/right-turn lane is anticipated to worsen from LOS D to LOS E. With a low 15(20) vehicles making the southbound left-turn movement, the heavier southbound right-turn movement should not be heavily impacted. Based on existing observations, the southbound queues did extend beyond four vehicles, with the majority of queues typically consisting of only one vehicle.

- Geiger Road/Kapolei Parkway (intersection #9 on Figure 5-6):

  During the AM peak hour, the westbound and southbound left-turn movements will worsen to LOS F. In addition, northbound left-turn movement will worsen to LOS F at overcapacity conditions. During the PM peak hour, the westbound left-turn movement will worsen to LOS F, and the southbound through movement along Kapolei Parkway will operate near capacity. In order to mitigate the deficiencies of the intersection, dual northbound left-turn lanes were recommended to accommodate the high 470(215) northbound left-turn vehicles during the AM(PM) peak hours. Also, the eastbound approach along Geiger Road was restriped from one left-turn, one through and one shared through/right to one left-turn, one through and one right-turn. With the dual northbound left-turn lanes and eastbound restriping, all movements are forecast to operate similar to Base Year 2021 conditions.

- Fort Weaver Road/Geiger Road/Iroquois Road & Renton Road/Fort Weaver Road (intersections #10 and #11 on Figure 5-6):

  The intersections along Fort Weaver Road through the Ewa region will experience LOS F and over-capacity conditions at some movements. However, this is generally ascribed to requisite long traffic signal cycle lengths, split phase operation and generally long crosswalk lengths across Fort Weaver Road.

Table 3 in (in Appendix F) shows the Base Year 2021 and Base Year 2030 LOS at the study intersections.

5.10.2 Construction Impacts and Mitigation Measures

Future year 2021 trip generation is the anticipated peak year of construction activity, which was assumed to occur during Phase 1 construction of the Honouliuli WWTP. It was estimated that the project would generate 185 construction workers to/from the site, with the assumption of 1 vehicle trip per construction worker. Therefore, 185 construction workers would arrive to the site during the AM peak hour and 185 construction workers would exit the site during the PM peak hour. This was assumed to be a relatively conservative estimate, since workers may commute outside the studied peak hours of traffic and carpooling would likely occur.

In addition to the 185 construction workers, 8 total trips (4 entering and 4 exiting) were assumed to be generated by cement trucks during each of the AM and PM peak hours of traffic. This was also a conservative estimate, since it is likely that these trucks would probably avoid peak hours of traffic.

Figure 5-7 illustrates the Project Generated Traffic Volumes for Year 2021. Refer to Appendix F for illustrations of the forecast traffic volumes, lane configuration, and LOS for Future Year 2021 conditions. Additionally, Table 5 (in Appendix F) summarizes the delay, volume to capacity (v/c), and LOS at the study intersections for Base Year 2021 and Future Year 2021 conditions.

Based on a LOS comparison between Future Year 2021 and Base Year 2021, the majority of individual movements that are projected to operate at LOS E/F for Base Year 2021 conditions will continue operating at similar levels of service for Future Year 2021 conditions during the AM and PM peak hours of traffic except for the following:

- Fort Weaver Road/Geiger Road/Iroquois Road & Renton Road/Fort Weaver Road (intersections #10 and #11 on Figure 5-7):

The intersections along Fort Weaver Road through the Ewa region will experience LOS F and over-capacity conditions at some movements. However, this is generally ascribed to requisite long traffic signal cycle lengths, split phase operation and generally long crosswalk lengths across Fort Weaver Road.

- Geiger Road/DW2 (intersection #8 located in the southeast corner of the Honouliuli WWTP property on Figure 5-7):

The southbound shared left/through/right-turn lane is anticipated to operate at LOS E during the PM peak hour. The southbound left-turn movement currently operates with 20 vehicles and queues were not observed to extend beyond a couple vehicles long. An additional 30 left-turn vehicles generated by construction worker trips should have minimal impacts to the queues along the southbound approach.

Future Year 2021 Project trips were assigned to all existing driveways in addition to three new proposed accesses, as shown on Figure 5-7. Trip distribution is based on existing traffic flow patterns throughout the study area. All movements at the three new project driveway intersections will operate adequately at LOS D or better during the AM and PM peak hours of traffic. The first access is proposed to be located approximately 600 feet east of the existing Geiger Road/DW2 intersection (intersection #8 on Figure 5-6) and will hereafter be referred to as “Honouliuli Driveway 3 (DW3)” (intersection #12 on Figure 5-7). The second access is proposed to be located approximately 600 feet east of the existing Roosevelt Avenue/Phillipine Sea intersection (intersection #4 on Figure 5-6) and will hereafter be referred to as “Honouliuli Driveway 4 (DW4)” (intersection #13 on Figure 5-7). The third access is proposed to be located along Renton Road adjacent to the Malio Street intersection. The new access is proposed near Malio Street. For purposes of this study, this new access along Renton Road will hereafter be referred to as DW5 (intersection #14 on Figure 5-7).

Although entering traffic volumes at the proposed project driveways are anticipated to operate with adequate LOS, eastbound left-turn lanes are recommended along Geiger Road and Roosevelt Avenue at the intersections with Honouliuli Driveways, including DW1, DW2, DW3 and DW4, and a westbound left-turn lane is recommended at the Renton Road/DW5 intersection (intersection #14 on Figure 5-7). In addition, the left-turn lanes entering these driveways should provide for a minimum storage of at least 50 feet, while the Renton Road/DW5 intersection should provide a minimum of at least 125 feet of storage.

Due to increased regional growth along the major thoroughfares and slight increase in exiting proposed project traffic, the Geiger Road/DW2 intersection will operate at LOS E conditions along its southbound approach but should not experience heavy queuing due to its low volume.

In summary, the following roadway improvements are recommended:

<u>Geiger Road at its intersection with Honouliuli Driveways: DW1, DW2 and DW3 (intersections 7, 8, and 12 on Figure 5-7)</u>

1. Eastbound Approach
   a. Widen to provide a left-turn storage lane.
   b. Provide for a minimum storage of at least 50 feet.

<u>Roosevelt Avenue/DW4 Intersection (intersection 13 on Figure 5-7)</u>

1. Eastbound Approach
   a. Widen to provide a left-turn storage lane.
   b. Provide for a minimum storage of at least 50 feet.

<u>Renton Road/DW5 Intersection (intersection 14 on Figure 5-7)</u>

1. Westbound Approach
   a. Widen to provide a left-turn storage lane.
   b. Provide for a minimum storage of at least 125 feet.

5.10.3 Operational Impacts and Mitigation Measures

The trip generation for the Future Year 2030 scenario was based on the full build-out of the project. The current staffing level at the Honouliuli WWTP is at 39 full time equivalent (FTE) positions, while the build-out of the project will increase the staffing to an estimated 320 FTE positions. This results in an eight-fold increase to the number of employees at the Honouliuli WWTP. In order to determine the growth in traffic generated by this increase to 320 FTE, all existing traffic turning movements were increased linearly by a factor of 8.

Future Year 2030 Project trips were assigned to all existing driveways, in addition to the three proposed new access points. Trip distribution is based on existing traffic flow patterns throughout the study area. Figure 5-8 illustrates the Project Generated Traffic volumes for Year 2030. See Appendix F for illustration of the forecast traffic volumes, lane configuration, and LOS for Future Year 2030 conditions. Table 7 (in Appendix F) summarizes the delay, v/c, and LOS at the study intersections for Base Year 2030 and Future Year 2030 conditions.

Based on a LOS comparison between Future Year 2030 and Base Year 2030/Future Year 2021, the majority of individual movements projected to operate at LOS E/F for Base Year 2030/Future Year 2021 conditions will continue operating at similar levels of service for Future Year 2030 conditions during the AM and PM peak hours of traffic, except for the following:

- Geiger Road/DW1 (intersection #7 on Figure 5-8):

  This intersection is forecast to operate similar to Base Year 2030 conditions with the exception of the southbound shared left/through/right movement which is projected to operate at LOS E during the PM peak hours of traffic. The southbound left-turn movement currently operates with only 10 vehicles and queues were not observed to extend beyond one vehicle long. An additional 35 left-turn vehicles anticipated to be generated by the proposed project should have minimal impacts to the queues along the southbound approach.

- Geiger Road/DW2 (intersection #8 on Figure 5-8):

  The southbound shared left/through/right movement is projected to operate at LOS E(F) during the AM(PM) peak hours of traffic, respectively. The southbound approach will continue to operate at a low 20 vehicle right-turn movement and 70 vehicle left-turn movement during the more critical PM peak hour. With an anticipated average of only 1 southbound left-turn vehicle arriving every minute, the increase in southbound traffic should have minimal impacts on southbound queues.

- Geiger Road/DW3 (intersection #12 on Figure 5-8):

  This new proposed access is forecast to operate at LOS D or better during the AM and PM peak hours of traffic with the exception of the southbound shared left/right-turn movement which is projected to operate at LOS F during the PM peak hour of traffic. The southbound left-turn movement will operate at a low 50 vehicles during the PM peak hour. With an anticipated average of less than 1 southbound left-turn vehicle arriving every minute, the movement should not experience heavy southbound queues.

- Fort Weaver Road/Geiger Road/Iroquois Road & Renton Road/Fort Weaver Road (intersections #10 and #11 on Figure 5-8):

  As previously discussed, intersections along Fort Weaver Road through the Ewa region will continue to experience LOS F and over-capacity conditions at some movements. However, this is generally ascribed to requisite long traffic signal cycle lengths, split phase operation, and generally long crosswalk lengths across Fort Weaver Road.

In conclusion, based on an anticipated increase in regional growth along the major thoroughfares (without the project), slight increase anticipated in entering/exiting project traffic during peak hours as a result of the proposed project, and proposed improvements to accommodate the slight increase, impacts to traffic in the region due to operation of the proposed project are not anticipated.

Figure 5-6. Existing Lane Configuration, Volume, and LOS

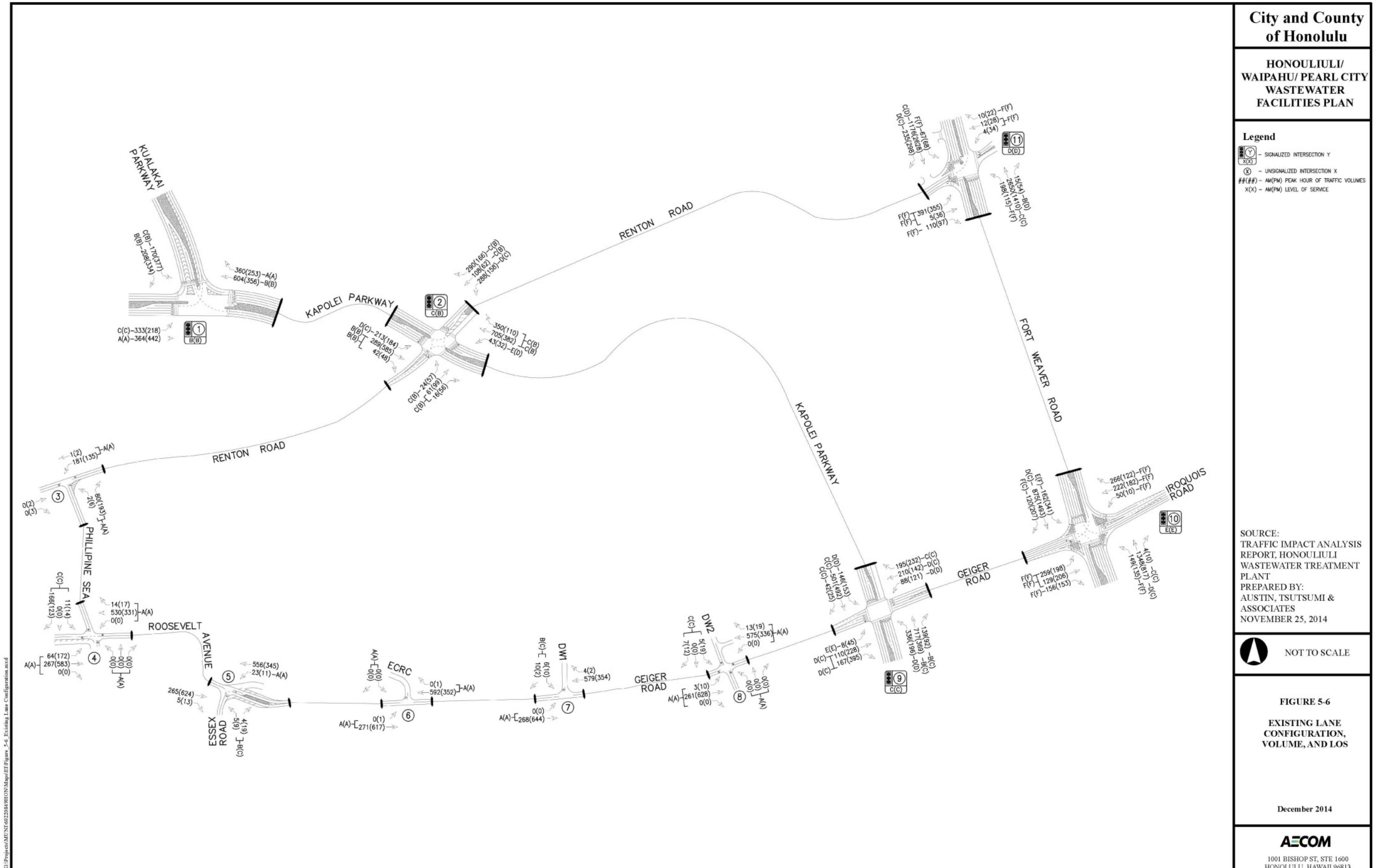


Figure 5-7. Year 2021 Project Only Volumes

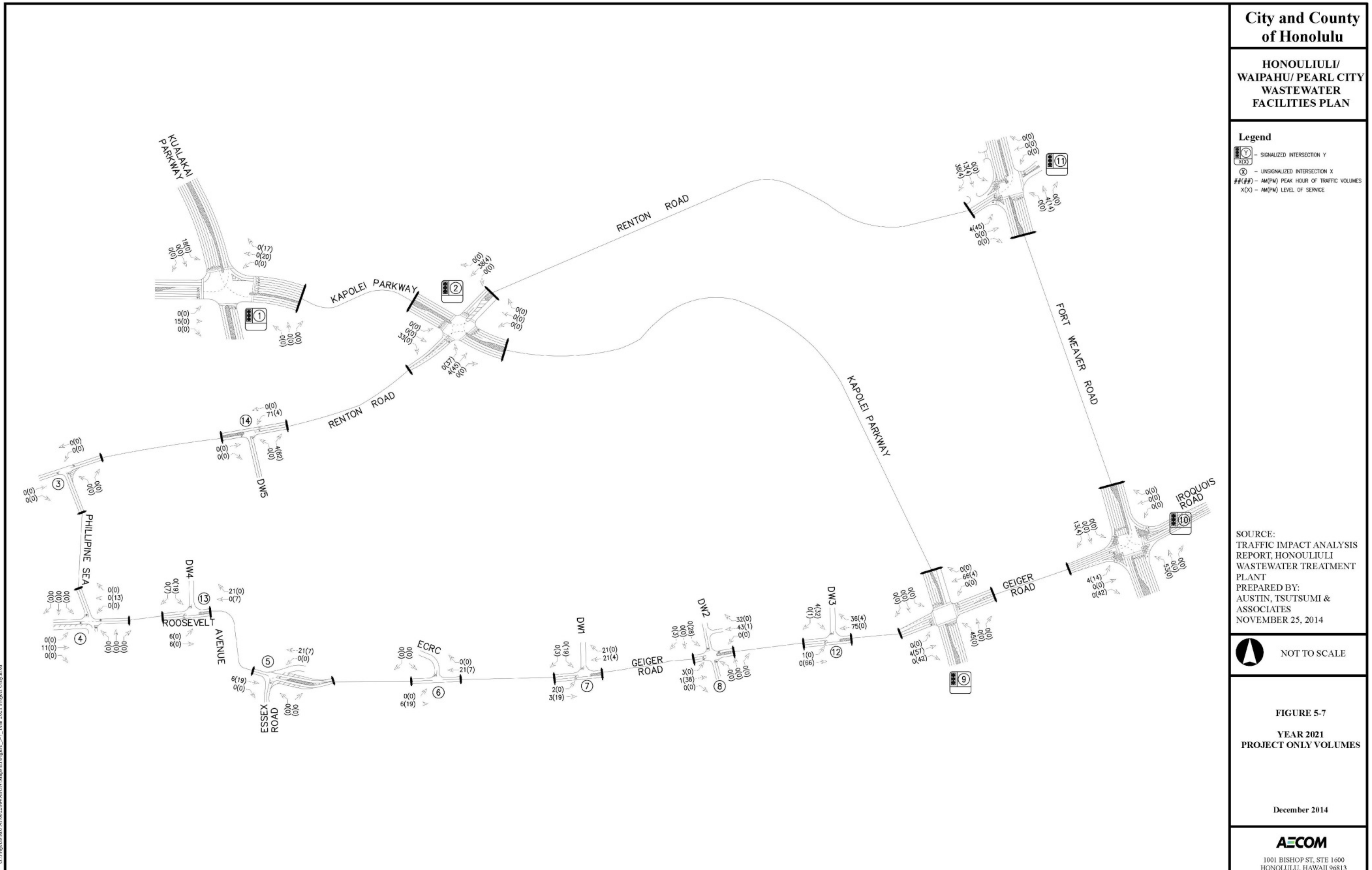
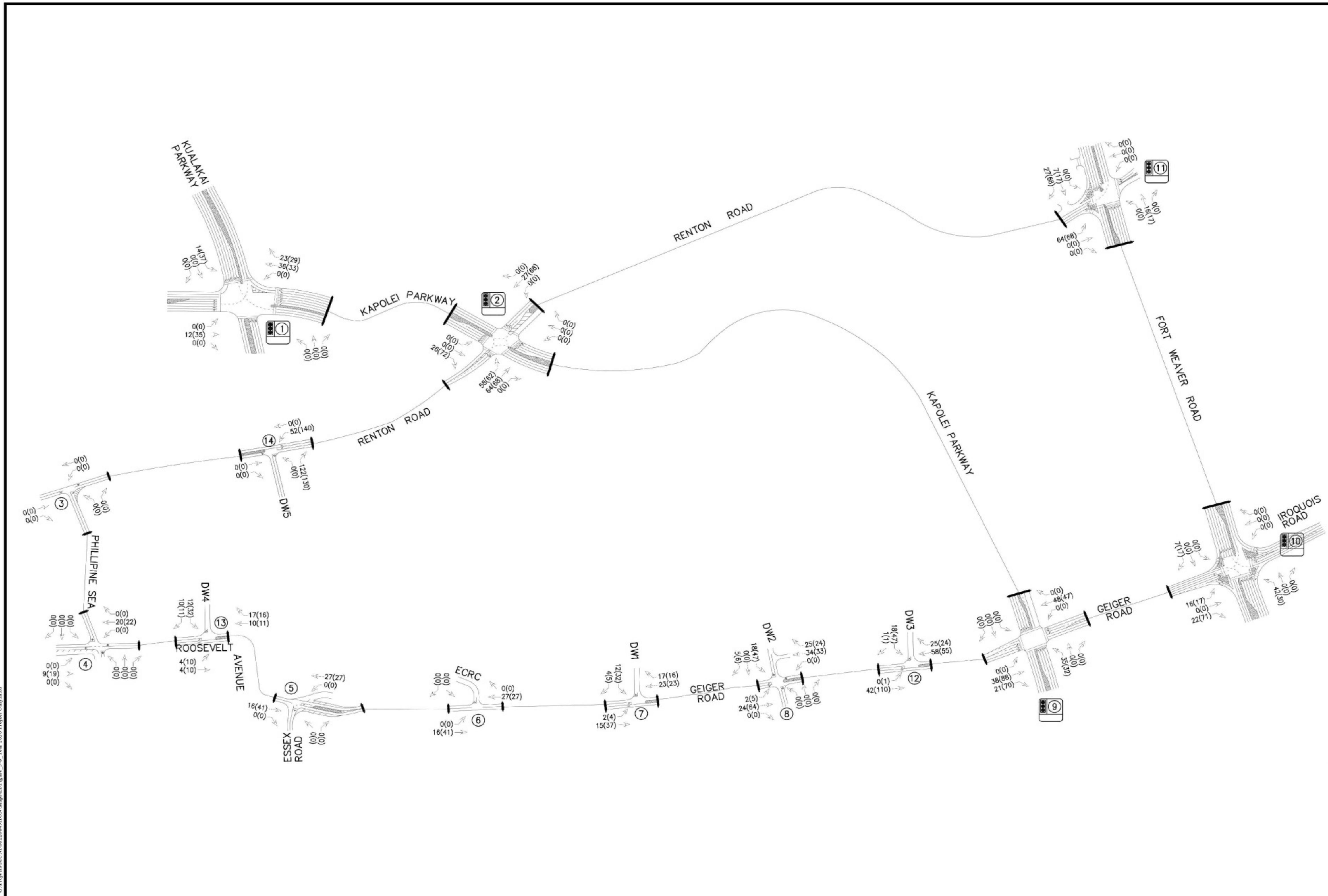


Figure 5-8. Year 2030 Project Only Volumes



City and County of Honolulu

HONOULIULI/ WAIPAHU/ PEARL CITY WASTEWATER FACILITIES PLAN

Legend

- SIGNALIZED INTERSECTION Y
- UNSIGNALIZED INTERSECTION X
##(##) - AM(PM) PEAK HOUR OF TRAFFIC VOLUMES
X(X) - AM(PM) LEVEL OF SERVICE

SOURCE:
TRAFFIC IMPACT ANALYSIS REPORT, HONOULIULI WASTEWATER TREATMENT PLANT
PREPARED BY:
AUSTIN, TSUTSUMI & ASSOCIATES
NOVEMBER 25, 2014

NOT TO SCALE

FIGURE 5-8

YEAR 2030
PROJECT ONLY VOLUMES

December 2014

AECOM
1001 BISHOP ST, STE 1600
HONOLULU, HAWAII 96813

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5.11 Visual and Aesthetic Resources

5.11.1 Existing Setting

The visual character of the project site is primarily an industrial setting due to the existing treatment facilities. The WWTP site is visible from nearby golf courses, including Coral Creek Golf Course to the east of the site and Barbers Point Golf Course located to the south of the project site, and residential neighborhoods located along the western and northwestern expansion property boundary. Views of the WWTP from the golf courses are partially screened by the existing tree canopy located between the WWTP site and the golf courses on each golf course property. The WWTP project site is also visible from a rail trail/bike path within the old OR&L railway, located immediately north of the expansion property. Trees within the expansion property currently provide a visual screen between the existing WWTP and the Coral Creek Golf Course, residential areas, and the rail trail. Other nearby properties within viewing distance of the project site include industrial land uses.

5.11.2 Construction Impacts and Mitigation Measures

Construction of the proposed improvements, regardless of the alternative, would result in temporary impacts to the viewshed from Coral Creek Golf Course, residential areas, and the rail trail/bikepath due to the clearing of trees within the expansion property and subsequent construction activities following tree clearing. Visual impacts during construction as viewed from Barbers Point Golf Course are anticipated to be minimal as a result of an existing tree canopy between the site and the golf course.

During construction, fencing surrounding the construction site may be provided as needed to provide a visual screen from construction equipment. Any construction impacts regarding visual aesthetics are expected to be short-term and would cease after construction.

The existing perimeter chain link fence would be removed and replaced with a new combination of walls, ornamental fence, and chain link fence. The selection of fence type would be determined based on location on the property. Fencelines/walls along roadways/property boundaries would be improved to provide an aesthetically pleasing view to replace the industrial look that currently exists, with linear landscape elements along the fences/walls.

5.11.3 Operational Impacts and Mitigation Measures

The proposed project, regardless of the alternative, would include new structures that would be consistent with the industrial character of the existing facility. The facilities would be designed to blend in the new structures with the existing structures and would be designed in accordance with CCH rules and regulations. The viewshed from Coral Creek Golf Course, residential areas, and the rail trail/bikepath would be impacted by the change in character from forest to industrial uses. However, as previously noted, the expansion property is an area that has been disturbed by past and current land uses.

The area around the facilities would be fenced and landscaped. The landscaping elements would be irrigated with reclaimed water or drought-tolerant plants, and grasses and native species would be planted whenever feasible. The height and setback of the walls would be considered to minimize impacts to the surrounding neighborhoods. At least 10 ft of clear space would be provided on both sides of fencelines for vehicle access, which would support fenceline maintenance. A perimeter walking/biking path around the entire site would provide the public with a source of recreational activity. The path would be located outside the fenced areas. A separate entrance and parking area would be provided for users of the walking/biking path.

Regardless of the alternative implemented, anticipated indirect impacts to visual aesthetics are associated with upgrades and improvements to the treatment system to allow future developments (residential, commercial and industrial) in the sewer basin to connect to the existing wastewater system, as envisioned in the PUC and Ewa Development Plans. These future developments are expected to result in a more urbanized look in the sewer basin.

5.12 Socioeconomics

The socioeconomic region of influence (ROI) is the geographic area that would be most affected by the proposed expansion and upgrading of the Honouliuli WWTP, and relocating of non-process related functions and facilities from the Sand Island WWTP and other locations to the Honouliuli WWTP. The ROI is selected as the basis on which social and economic impacts of the proposed project are analyzed, as it encompasses the expected residency distribution of Honouliuli WWTP and Sand Island WWTP employees, their commuting patterns, and the location of businesses providing goods and services to the WWTPs, its personnel, and their families. The ROI for the socioeconomic environment comprises the following census county divisions (CCDs), which are subdivisions of Honolulu County recognized by the USCB:

- Ewa CCD, in which the Honouliuli WWTP is located, as the primary component of the ROI (defined as primary since the project is located in this area)
- Honolulu CCD, in which the Sand Island WWTP is located, as a secondary component of the ROI (defined as secondary as it the actual project site is located outside of this area)

There is a potential for a greater magnitude of socioeconomic effects within the primary component of the ROI, as the project would result in very large construction and operation expenditures at the Honouliuli WWTP, but no or minimal expenditures at the Sand Island WWTP. However, there is greater certainty of socioeconomic effects within the primary component, as the project entails the expansion and upgrading of the Honouliuli WWTP, but addresses the relocation of non-process facilities from the Sand Island WWTP as a potential action.

The ROI, depicted in Figure 5-9, encompasses a land area of approximately 254 square miles (USCB 2014a), representing about 42.3 percent of the county land area (USCB 2014b). Data for Honolulu County are provided as needed in lieu of data available for the CCDs and for context and comparison, and data for the State of Hawaii are provided as relevant for context and general comparison.

5.12.1 Demographics and Economics

Population and Housing

The USCB conducts a census of the United States every 10 years, in years ending in zero, to count the population and housing units for the entire United States. The most recent decennial census was conducted in 2010. Table 5-6 presents population statistics for the ROI. Population data were derived based on the 2000 Census and the 2010 Census.

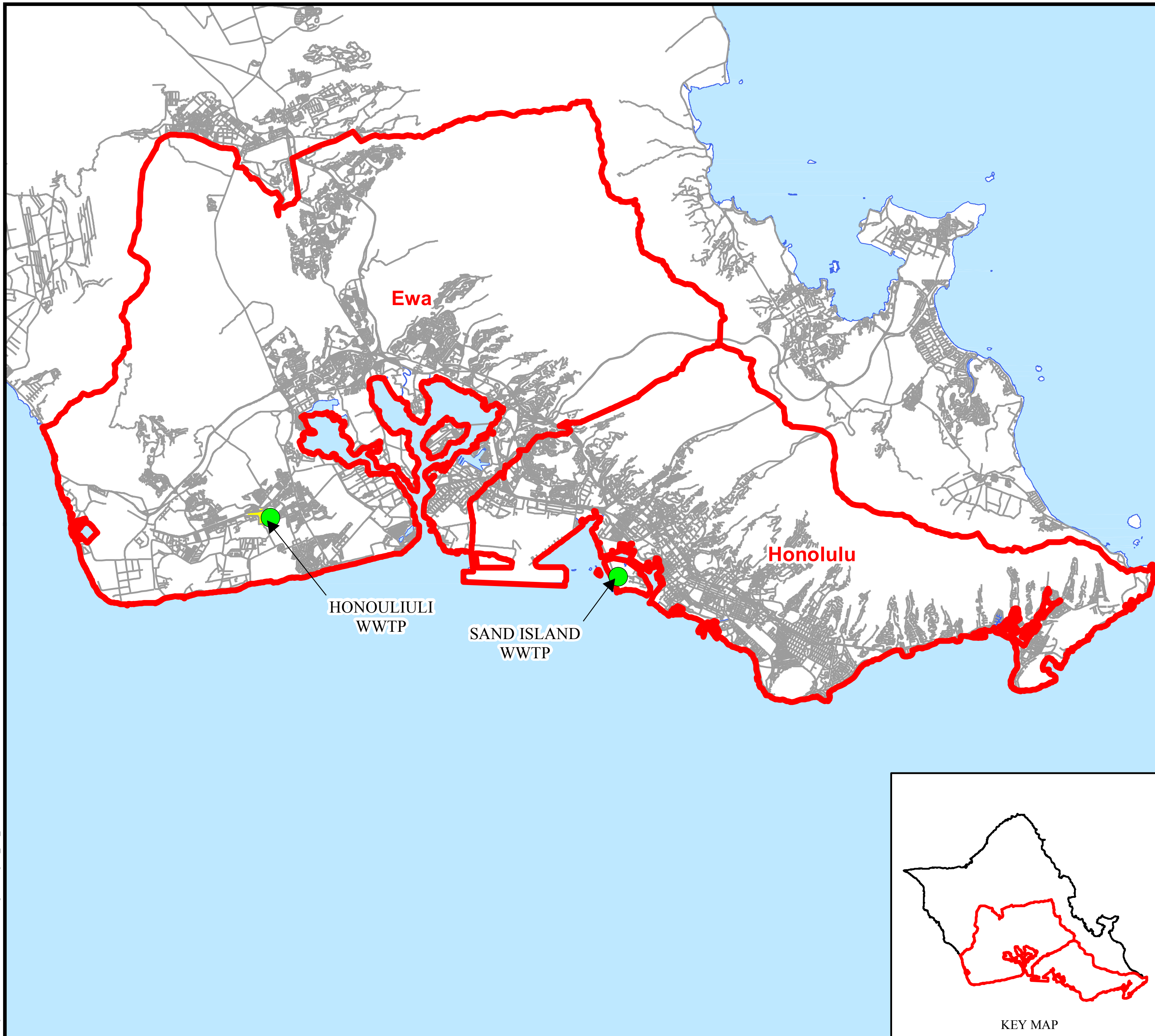
Table 5-6. Population, 2000 and 2010, and Population Density, 2010

Geographic Area	Land area (sq. miles)	Population			2010 Density (persons per square mile)
		2000	2010	Percent Change 2000-2010[1]	
Ewa CCD	165	272,328	323,118	19%	1,958[1]
Honolulu CCD	89	372,279	390,738	5%	4,390[1]
ROI	**254**	**644,607[1]**	**713,856[1]**	**11%**	**2,810[1]**
Honolulu County	601	876,156	953,207	9%	1,586
Hawaii	6,422	1,211,537	1,360,301	12%	212

Sources: USCB 2014b; USCB 2014c, DP-1, Profile of General Demographic Characteristics, 2000 Census and 2010 Census.
[1]Values were calculated based on USCB estimates.

The Honouliuli WWTP and Sand Island WWTP are located in a densely-populated and robust region. ROI population density is about 2,810 persons per square mile; substantially higher than the approximately 1,590 persons per square mile population density of Honolulu County and the 210 persons per square mile density of the State of Hawaii (USCB 2014b). Ewa CCD encompasses a land area of approximately 165 square miles and a water area of about 77 square miles, and Honolulu CCD encompasses a land area of approximately 89 square miles and a water area of about 1,127 square miles (USCB 2014a).

The population within the ROI increased 11 percent from 2000 to 2010; similar to the 12 percent increase in population of the State of Hawaii during that time period. Ewa CCD was the fastest growing area among the geographic areas of comparison, growing approximately 19 percent between 2000 and 2010.



City and County of Honolulu

HONOULIULI/ WAIPAHU/ PEARL CITY WASTEWATER FACILITIES PLAN

Legend

- WWTPs
- Census County Divisions
- Street

0 20,000
Feet
1 inch = 20,000 feet

FIGURE 5-9

SOCIOECONOMIC REGION OF INFLUENCE

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Table 5-7 provides population projections for Honolulu County and the State of Hawaii prepared by the DBEDT (DBEDT 2012). Based on DBEDT population projections, the population of Honolulu County will be about 1,003,700 in 2020 and 1,052,100 in 2030, an approximately 5 percent increase per decade. For the State of Hawaii, DBEDT estimates an approximately 8 percent increase between 2010 and 2020, as well as between 2020 and 2030. This rate of increase for the state is higher than the anticipated increase in Honolulu County.

Table 5-7. Population Projections, 2010-2035

Geographic Area	2010	2015	2020	2025	2030	2035
Honolulu County	953,207	976,192	1,003,706	1,029,414	1,052,134	1,071,225
Hawaii	1,360,301	1,418,252	1,481,236	1,543,244	1,602,338	1,657,500

Sources: USCB 2014c, DP-1, Profile of General Demographic Characteristics, 2010 Census; DBEDT 2012.

Based on USCB American Community Survey five-year estimates for 2008-2012, the number of housing units in the ROI totaled about 263,660, as shown in Table 5-8. Approximately 5.7 percent of the housing units in the Ewa CCD were vacant and 10.5 percent of the units in the Honolulu CCD were vacant. The comparable vacancy rate for Hawaii was substantially higher, at 13.9 percent. However, according to the DBEDT, residential housing units currently are in short supply in the state (DBEDT 2014). Although not explicitly stated by the DBEDT (2014), this characterization may be due in part to the large proportion of housing units in Hawaii that are vacant for seasonal, recreational, or occasional use. In 2010, approximately 46.9 percent of the State's total vacant housing units were vacant for seasonal, recreational, or occasional use, and about 16.2 percent of the vacant units in the Ewa CCD and 39.9 percent of the vacant units in the Honolulu CCD were vacant for this reason (USCB 2014c, DP-1, Profile of General Demographic Characteristics, 2010 Census). In recent years, housing demand in Hawaii has increased due to population growth, the conversion of homes to visitor use due a limited supply of hotel rooms (especially on Oahu), and the shifting of military forces to Hawaii (DBEDT 2014).

Table 5-8. Housing Units, 2008-2012

Geographic Area	Total Housing Units	Occupied Housing Units	Vacant Housing Units	Percent Vacant[1]
Ewa CCD	100,797	95,056	5,741	5.7
Honolulu CCD	162,862	145,723	17,139	10.5
ROI	263,659	240,779	22,880	8.7
Honolulu County	337,389	308,490	28,899	8.6
Hawaii	519,811	447,453	72,358	13.9

Source: USCB 2014c, DP04, Selected Housing Characteristics, 2008-2012 American Community Survey.
[1]Values were calculated based on USCB estimates.

Employment and Income

Total employment in Honolulu County was approximately 562,820 jobs in 2010, as shown in Table 5-9. The industries that employed the most people in the county were government (19.7 percent), retail trade (10.0 percent), and health services (9.8 percent). Based on DBEDT projections, between 2010 and 2035, employment in Honolulu County is expected to grow most rapidly in education, health, and business services, with estimated cumulative expansions over 25 years of 41.2, 40.0, and 38.4 percent, respectively.

Table 5-9. Honolulu County Civilian Jobs by Sector, 2010-2035

Geographic Area	2010	2015	2020	2025	2030	2035
Agriculture	3,460	3,450	3,420	3,370	3,310	3,250
Mining and construction	28,160	30,130	31,930	32,720	33,420	34,200
Food processing	4,410	4,470	4,530	4,570	4,610	4,640
Other manufacturing	8,330	8,400	8,440	8,450	8,450	8,430
Transportation	20,200	20,950	21,580	22,060	22,530	22,970
Information	9,380	9,490	9,960	10,320	10,730	11,090
Utilities	2,180	2,260	2,350	2,420	2,490	2,550
Wholesale trade	16,850	17,240	17,600	17,900	18,180	18,420
Retail trade	56,070	57,220	58,200	59,000	59,680	60,200
Finance and insurance	24,960	25,950	26,900	27,750	28,460	29,030
Real estate and rentals	24,330	24,630	24,820	24,910	24,940	24,890
Professional services	34,090	36,510	38,870	41,090	43,210	45,230
Business services	45,440	49,090	52,720	56,240	59,610	62,870
Educational services	15,230	16,530	17,810	19,060	20,300	21,500
Health services	54,990	59,600	64,140	68,570	72,890	76,970
Arts and entertainment	11,940	12,460	12,910	13,290	13,650	13,990
Hotels	15,110	15,450	15,710	15,890	16,080	16,270
Eating and drinking	41,540	43,540	45,330	46,920	48,480	49,990
Other services	35,360	36,800	38,090	39,210	40,210	41,040
Government	110,800	113,570	116,450	119,340	122,220	124,870
Total Civilian Jobs	**562,820**	**587,750**	**611,770**	**633,060**	**653,450**	**672,390**

Sources: DBEDT 2012.

Unemployment rates in Honolulu County decreased at an increasing pace over the last five years, as shown in, Table 5-10, decreasing by more than a quarter from 2009 to 2013. The unemployment rates for the State of Hawaii also decreased over the five-year period, although the rates for the state consistently were higher than the rates for Honolulu County.

Table 5-10. Annual Average Labor Force, 2009-2013

Geographic Area	2009	2010	2011	2012	2013
Honolulu County					
Labor Force	443,556	453,991	458,737	455,937	456,804
Employed	417,987	428,111	433,409	432,869	437,230
Unemployed	25,569	25,880	25,328	23,068	19,574
Unemployment Rate (%)	5.8	5.7	5.5	5.1	4.3
Hawaii					
Unemployment Rate (%)	6.8	6.7	6.5	5.7	4.8

Source: United States Bureau of Labor Statistics, 2014.

Table 5-11 summarizes total personal income data for Honolulu County for the last four years. The United States Bureau of Economic Analysis calculates total personal income as the sum of labor income plus dividends, interest, and rent, plus transfer payments, minus contributions for government insurance, and minus the adjustment for residence. Total personal income in the county increased by approximately 11.8 percent from 2009 to 2012.

Table 5-11. Honolulu County Total Personal Income, 2009-2012

Geographic Area	2009	2010	2011	2012
Total Personal Income ($)	42,363,319	43,243,596	45,662,776	47,382,065
Earnings by Place of Work	30,799,392	31,642,263	33,210,211	34,451,141
Dividends, Interest, and Rent	9,435,291	9,153,105	9,576,812	10,157,594
Transfer Payments	5,600,753	6,115,629	6,375,677	6,402,104
Contributions for Government Insurance	3,456,972	3,648,965	3,475,965	3,605,003
Adjustments for Residence	15,145	18,436	23,959	23,771

Source: United States Bureau of Economic Analysis, 2014.

Construction Impacts and Mitigation Measures

The proposed project would construct (at the Honouliuli WWTP) process facilities and non-process facilities relocated from the Sand Island WWTP, and would cost an estimated $760 million to complete. This total construction cost is inclusive of the costs of upgrading the Honouliuli WWTP and the costs of constructing facilities at the Honouliuli WWTP required to relocate non-process related functions to the plant. As detailed in Appendix G, Economic and Fiscal Impacts, the construction expenditures would result in one-time increases in economic output, employment, and earnings, and one-time increases in fiscal revenues of the state. The economic impacts of project construction would include the impact of expenditures on construction materials, and on earnings of construction workers and professional service providers during the construction period, as well as the impacts of those changes on the overall economy of the CCH.

On a one-time basis, project construction would have an estimated total economic impact of $1.6 billion in output, supporting a total of approximately 13,430 jobs, earnings of $520 million, and fiscal revenues of $70 million (Table 5-12). The estimated construction period is 9 years (AECOM 2014d). Although construction expenditures and therefore the resulting effects actually would vary from year to year, the estimated total economic impact translates to an average annual economic impact of about $180 million, which would support approximately 1,490 jobs, earnings of $60 million, and fiscal revenues of $7.6 million per year. Providing each job or employee represents one household and assuming the current average household size of 2.98 people in Honolulu County

(USCB 2014b), jobs resulting directly or indirectly from project construction would support approximately 4,450 residents on average during project construction.

Table 5-12. One-Time Economic and Fiscal Impacts of Construction

	Output	**Earnings**	Employment	State Tax
	Million $	Million $	Jobs	Million $
Direct/Indirect Impact	1,126	380	9,462	43
Induced Impact	493	137	3,965	25
Total Impact	1,619	517	13,427	68

The current ROI construction labor force might not be sufficient to fill the jobs, although the construction industry in Hawaii is projected to grow, both on the short term (DBEDT 2014) and on the long term (Table 5-9), with the mining and construction sector expected to expand approximately 13.4 percent between 2010 and 2020 (DBEDT 2012). Employment growth is beneficial to an economy, and expansion of the industry base results in economic benefits on the region. Socioeconomic concerns would materialize if expansion occurs in a short time frame or if other aspects of the economy also undergo a rapid expansion during the same time period. Possible labor shortages could occur, resulting in a rise in labor costs and ultimately a rise in overall construction costs. However, the market would respond to a shortage with new workers entering the construction industry from other industries or new workers coming from outside the region to fill available jobs. If new workers were to enter the region in response to a construction labor shortage, the households that relocate to the ROI would need a supply of housing, to which the local economies likely would respond by increasing the supply.

Operational Impacts and Mitigation Measures

With operation of the proposed project, the number of personnel at the Honouliuli WWTP is projected to increase from the existing 39 employees to a projected ultimate 320 employees. However, in addition to upgrading the Honouliuli WWTP, the project also would entail the relocating of non-process related functions and facilities from the Sand Island WWTP and other locations to the Honouliuli WWTP. Approximately 120 jobs and personnel currently at the Sand Island WWTP would be relocated to the Honouliuli WWTP. Additional jobs and personnel potentially would be relocated to the Honouliuli WWTP from other locations. The likely effect of these jobs would be a shift of expenditures from areas near the Sand Island WWTP and other locations to areas closer to the Honouliuli WWTP, and from the employees' original places of residence to their new places of residence, were some employees to choose to move to be closer to their relocated jobs. Of the projected 320 future employees at Honouliuli, fewer than 161 would be newly employed in new jobs that would result from the project. These new jobs and the operation of new or expanded functions and facilities at the Honouliuli WWTP would be new to the City and County, and would have a continuing economic impact from the WWTP's ongoing operating expenditures.

Annual expenditures from operations of the proposed project would result in ongoing increases in economic output, employment, and earnings, and ongoing increases in fiscal revenues. Projected operations costs were used to estimate economic and fiscal impacts during the operation of the upgraded Honouliuli WWTP, exclusive of the non-process related functions and facilities relocated from the Sand Island WWTP and other locations to the Honouliuli WWTP (Appendix G). Whereas the economic and fiscal impacts of construction evaluated above cover both upgrading the Honouliuli WWTP and constructing non-process related facilities at the plant, the ongoing impacts of operating the non-process related facilities are not evaluated here, as those operating costs are undetermined at the time of writing.

The annual operating expenditures for the proposed project are estimated to be approximately $19.8 million (AECOM 2014e). On an ongoing basis, plant operation related to the upgrading of the Honouliuli WWTP would result in an estimated annual impact of $28.5 million in output, supporting about 90 jobs, earnings of $3.8 million, and fiscal revenues of $990,000 (Table 5-13). Providing each job represents one household and assuming the current average household size of 2.98 people in Honolulu County (USCB 2014b), jobs resulting directly or indirectly from these operations would support approximately 270 residents on average.

Table 5-13. Ongoing Economic and Fiscal Impacts of Operations

	Output	**Earnings**	Employment	State Tax
	Million $	Million $	Jobs	$
Direct/Indirect Impact	24.9	2.8	59	792,000
Induced Impact	3.6	1.0	30	198,000
Total Annual Impact	28.5	3.8	89	990,000

Both construction and operation effects from the proposed project would be beneficial, providing regional economic benefits from construction spending and labor, as well as long-term positive effects on employment and income in the region. As noted above, approximately 120 jobs and personnel would be relocated from the Sand Island WWTP, likely resulting in a shifting of expenditures to areas closer to the Honouliuli WWTP. Nonetheless, implementation of the project would have overall, beneficial impacts on employment and income.

5.12.2 Environmental Justice and Protection of Children

Environmental Justice

In the United States, environmental justice (EJ) minority populations are comprised of any races that are not white. However, the racial composition of Hawaii is different than that of the United States as a whole, with whites comprising the majority of the population (approximately 74 percent) in the United States, but no group comprising a majority in Hawaii. In Hawaii, the largest racial group is Asian, accounting for approximately 40 percent of the population (Kahihikolo 2008). Because the populations on Hawaii and Oahu are so racially diverse, EJ minority populations in the vicinity of the Honouliuli WWTP were identified using an approach based on the methodology developed by the OMPO (OMPO 2004), as recommended in the *Hawaii Environmental Justice Initiative Report* (Kahihikolo 2008). The objective of the OMPO methodology is to determine where EJ is a concern by taking into account the unique Asian population and the racially diverse areas on Oahu (OMPO 2004).

To identify areas where EJ could be a concern in the immediate vicinity of the Honouliuli WWTP — hereafter referred to as the affected area — racial population data for 2010 Census block groups were analyzed. Minority populations in block groups located adjacent to and including the Honouliuli WWTP (located in Block Group 1 of Census Tract 84.11) were compared to minority populations in all block groups throughout Honolulu County. Each minority group was evaluated separately to identify those areas in the county where each minority population is concentrated in a disproportionate way. Consistent with the OMPO methodology, disproportionality was defined as exceeding one standard deviation above the mean relative concentration of a minority group, with the relative concentration for each block group normalized for the areal size of the block group. If this threshold was exceeded for any of the race categories evaluated, an EJ population was determined to be present.

Based on this analysis, six of the eight block groups in the affected area are minority populations (Figure 5-10, Table 5-14). EJ minority populations within the six block groups with minority populations are associated with disproportionately large Hispanic and Latino populations relative to the average for block groups in Honolulu County, which may be attributed to the military-related population in those block groups (OMPO 2004).

Table 5-14. Adjusted Percentage Minority, 2010

Geographic Area	White	Black	American Indian and Alaskan Native	Asian	Native Hawaiian and Other Pacific Islander	Other	Hispanic
Calculated Honolulu County Threshold (percent)	42.7	5.6	1.0	70.7	25.8	1.4	12.2
Block Group 1, Census Tract 84.11	17.4	2.8	0.2	53.0	12.2	0.4	**14.1**
Block Group 1, Census Tract 84.10	19.7	3.4	0.2	57.2	9.6	0.3	9.7
Block Group 2, Census Tract 84.11	19.4	4.0	0.6	50.3	12.1	0.6	**13.2**
Block Group 1, Census Tract 84.12	20.0	4.4	0.9	47.5	14.1	0.5	**12.8**
Block Group 2, Census Tract 84.12	19.2	3.5	0.3	47.1	15.1	0.1	**14.7**
Block Group 1, Census Tract 85.02	35.1	**8.2**	**1.2**	14.2	25.8	0.3	**15.1**
Block Group 2, Census Tract 86.17	8.8	1.4	0.2	61.5	14.9	1.2	11.9
Block Group 2, Census Tract 115	14.0	1.8	0.5	29.6	**39.9**	0.0	**14.1**

Sources: USCB 2014c, QT-P4, Race, Combinations of Two Races, and Not Hispanic or Latino, 2010 Census; OMPO 2004.

Notes:

The Honouliuli WWTP is located in Block Group 1, Census Tract 84.11.

Bold values indicate population percentages of minority populations.

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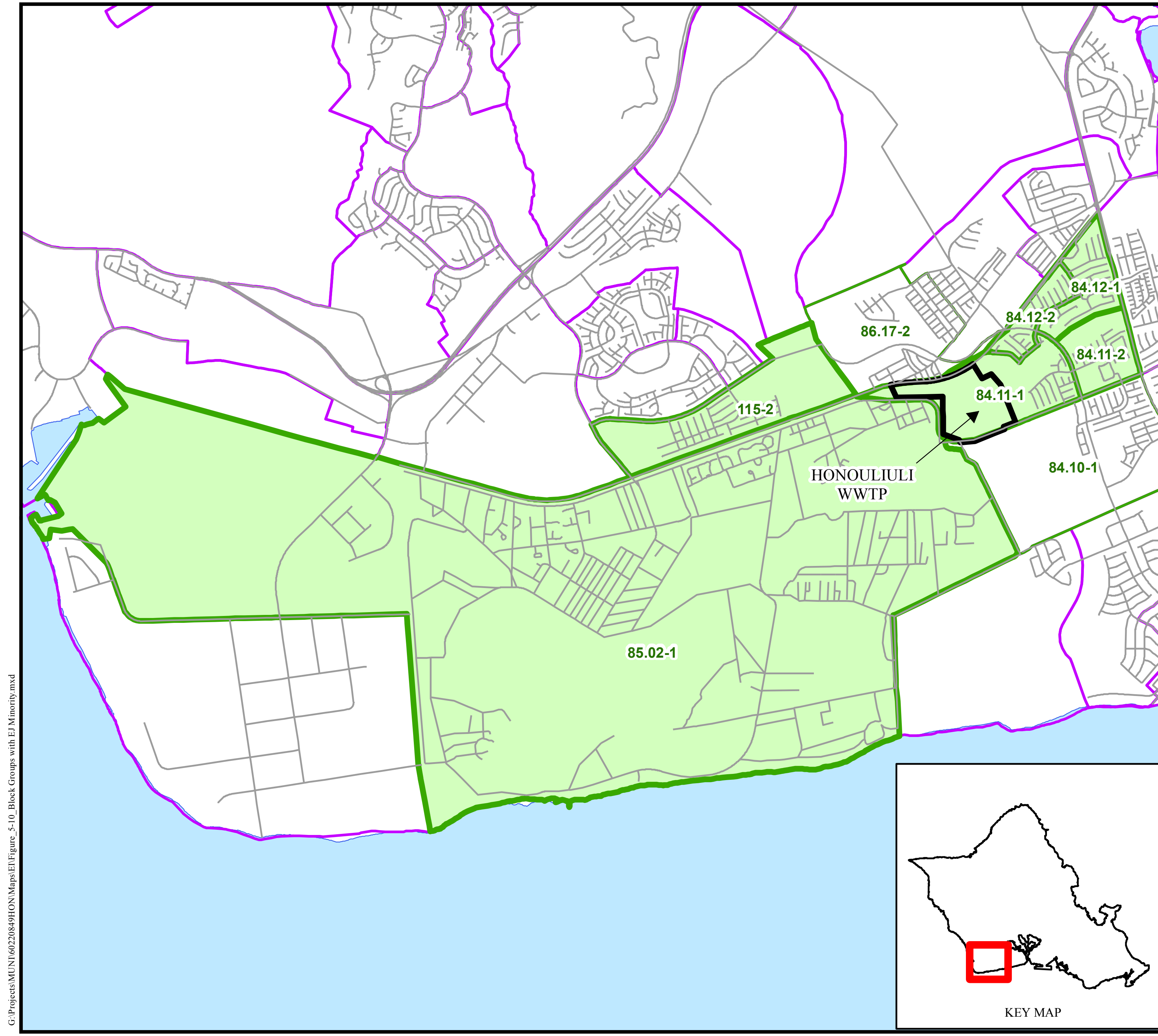

Legend

- Honouliuli WWTP
- Minority Block Group
- Other Adjacent Block Group
- Other Block Group
- Street

0 4,000
Feet
1 inch = 4,000 feet

FIGURE 5-10

BLOCK GROUPS WITH ENVIRONMENTAL JUSTICE MINORITY POPULATIONS

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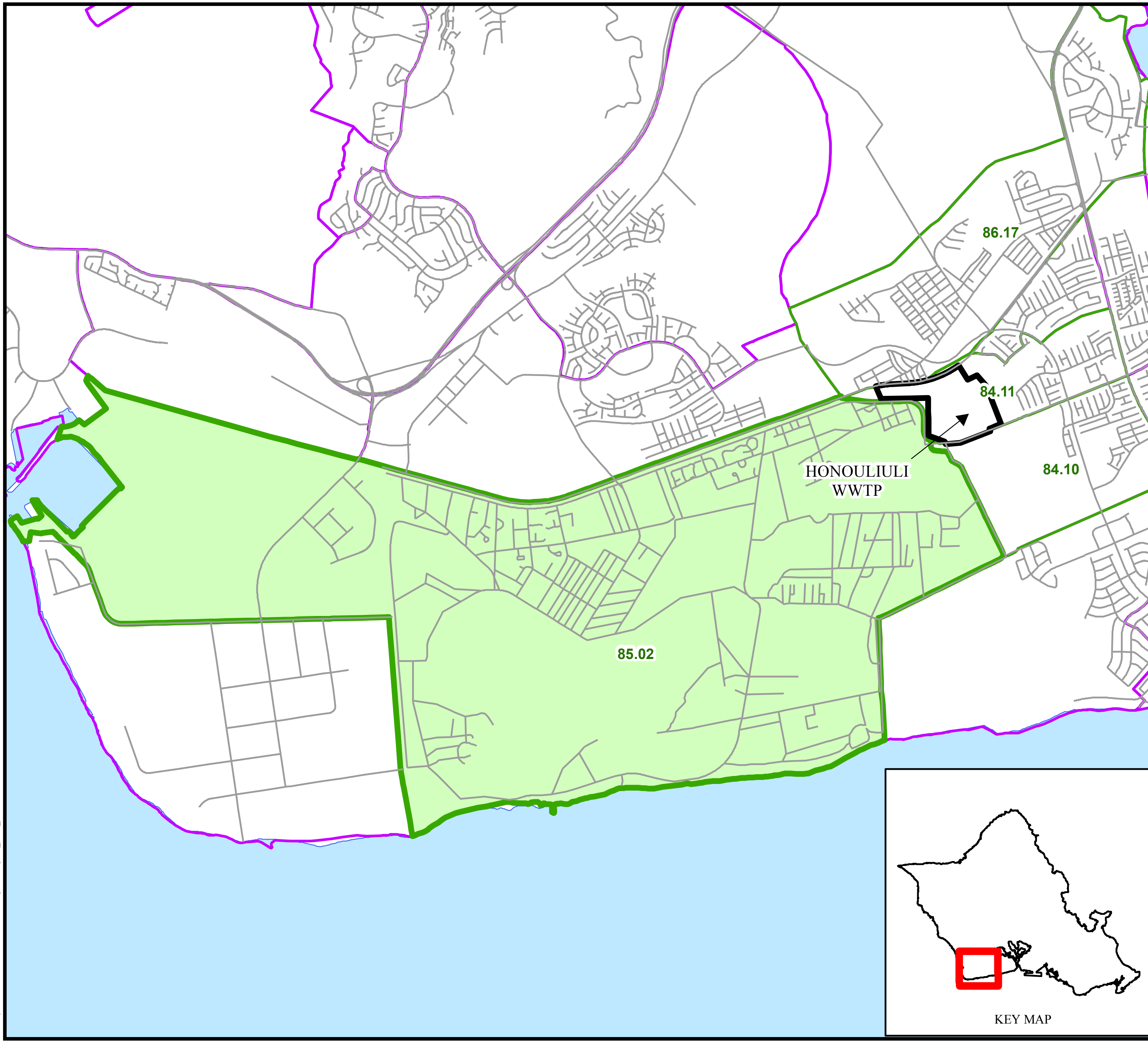
The USCB determines poverty status by using a set of dollar-value thresholds that vary by family size and composition (USCB 2014c, Glossary). If a family's total income is less than the dollar value of the appropriate threshold, then that family and every individual in it are considered to be in poverty. Similarly, if an unrelated individual's total income is less than the appropriate threshold, then that individual is considered to be in poverty. The poverty thresholds do not vary geographically. They are updated annually to allow for changes in the cost of living (inflation factor) using the Consumer Price Index.

As recent, applicable data at the block group level were not available, census tract-level data were used to identify low-income populations. Table 5-15 presents the 2008-2012 American Community Survey five-year estimates for families and individuals in the affected area whose annual income was below the poverty level. The percentage of low-income families in Census Tract 85.02 is by far the highest in the affected area. With the exception of this census tract, the tracts in the affected area have percentages of low-income families lower than in Honolulu County overall, as well as lower than in Honolulu CCD. Therefore, environmental justice will be assessed for low-income populations in Census Tract 85.02 (Figure 5-11).

Table 5-15. Percentage Low Income, 2008-2012

Geographic Area		Low-Income Population (percent)
Area of Comparison	Honolulu County	9.6
Socioeconomic ROI	Honolulu CCD	10.9
	Ewa CCD	6.5
Affected Area	Census Tract 84.11	4.0
	Census Tract 84.05	2.4
	Census Tract 84.06	3.4
	Census Tract 84.10	1.4
	Census Tract 84.12	3.3
	Census Tract 85.02	**21.3**
	Census Tract 86.17	7.6
	Census Tract 115	3.7

Source: USCB 2014c, DP03, Selected Economic Characteristics, 2008-2012 American Community Survey.
Notes:
The Honouliuli WWTP is located in Census Tract 84.11.
Bold values indicate population percentages of low-income populations.



City and County of Honolulu

HONOULIULI/ WAIPAHU/ PEARL CITY WASTEWATER FACILITIES PLAN

FIGURE 5-11

CENSUS TRACTS WITH ENVIRONMENTAL JUSTICE LOW-INCOME POPULATIONS

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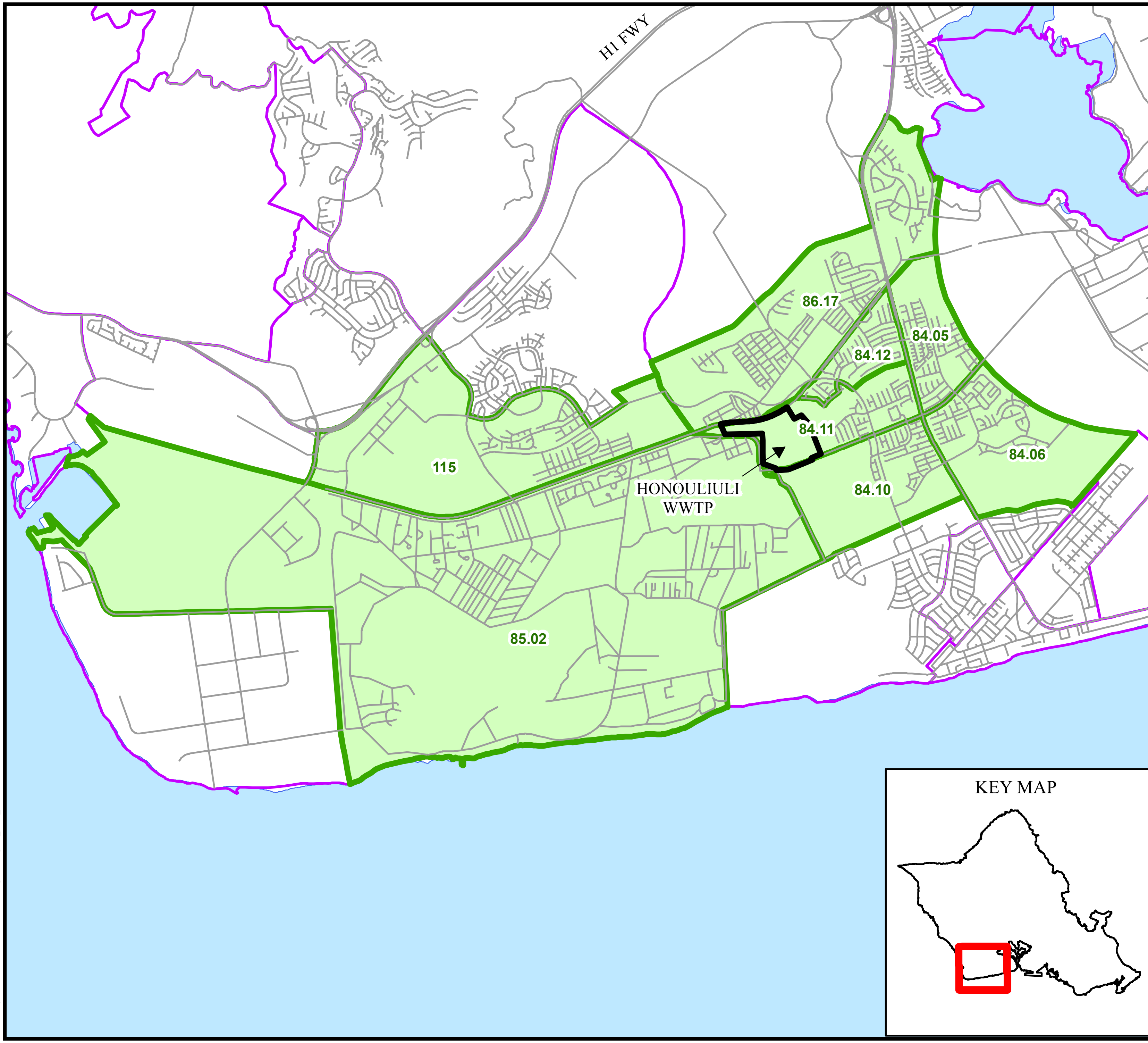
Protection of Children

For the purposes of this analysis, census tracts located adjacent to and including the Honouliuli WWTP were considered the areas potentially most affected by the proposed upgrading of the Honouliuli WWTP. The number and percentage of children under 18 within census tracts, the CCDs within the ROI, and Honolulu County were determined based on 2010 Census data (Table 5-16). The percentage of children under 18 in each of the census tracts in the vicinity of the Honouliuli WWTP was higher than the percentages of children under 18 in all other areas considered for comparison. Therefore, a concentration of children is present in all census tracts in the affected area, including the census tract in which the Honouliuli WWTP is located, Census Tract 84.11 (Figure 5-12).

Table 5-16. Number and Percentage Children, 2010

Geographic Area		Children Under 18	
		Number	Percent
Area of Comparison	Honolulu County	210,500	22.1
Socioeconomic ROI	Honolulu CCD	69,807	17.9
	Ewa CCD	80,225	24.8
Affected Area	Census Tract 84.11	**1,000**	**29**
	Census Tract 84.05	**1,476**	**31.6**
	Census Tract 84.06	**2,078**	**34.7**
	Census Tract 84.10	**668**	**28.5**
	Census Tract 84.12	**1,739**	**26.6**
	Census Tract 85.02	**595**	**27.9**
	Census Tract 86.17	**2,512**	**26.8**
	Census Tract 115	**1,885**	**34.3**

Source: USCB 2014c, P12 Sex by Age, 2010 Census.
Notes:
The Honouliuli WWTP is located in Census Tract 84.11.
Bold values indicate population numbers and percentages of concentrations of children.



City and County of Honolulu

HONOULIULI/ WAIPAHU/ PEARL CITY WASTEWATER FACILITIES PLAN

Legend

- Honouliuli WWTP
- Tract with Concentration of Children
- Other Tract
- Street

0 4,000
Feet
1 inch = 5,000 feet

FIGURE 5-12

CENSUS TRACTS WITH CONCENTRATIONS OF CHILDREN

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Impacts and Mitigation Measures

Although EJ populations and concentrations of children are present in the affected area, based on the analyses presented in this EIS, the proposed project would have less than significant adverse human health or environmental impacts. Negative impacts on the population in the project vicinity are not anticipated, and the project would provide improved wastewater treatment for the surrounding population. The proposed project would allow the wastewater system to safely and efficiently accommodate projected flows up to the year 2035 and provide an adequate wastewater system to support the needs of the population and economy in the service area. With respect specifically to children, as described in Section 5.14.2 Public Schools, the nearest public school to the project site is located approximately 0.6 miles from the Honouliuli WWTP and there are no known childcare facilities within a one-mile radius of the project.

The effects of implementing the project would not be appreciably more severe or greater in magnitude in minority or low-income communities, or in communities with high concentrations of children. Therefore, no disproportionately high and adverse human health or environmental effects on minority populations and low-income populations would occur. Likewise, implementation of the project would not pose disproportionate environmental health or safety risks to children. The proposed project would not negatively impact EJ populations, and would not negatively impact children. There could possibly be direct and indirect benefits to these population groups as a result of additional job opportunities.

5.13 Infrastructure and Utilities

The following section provides a brief overview of the existing water, wastewater, solid waste disposal, electrical, and communications systems, and public services and the direct impacts that the proposed wastewater system improvements would have on each.

Increased capacity in the wastewater treatment system serves the projected increase in development and urban expansion along the Honolulu High-Capacity Transit Corridor Project (HHCTCP) within the sewershed, as planned by the CCH. Information regarding this projected expansion, which may result in increased demands on the CCH’s overall public infrastructure services, was addressed in HHCTCP Final Environmental Impact Statement published on June 25, 2010 in the Federal Register.

5.13.1 Water

5.13.1.1 Existing Setting

The emergency fire and potable water supply for the island of Oahu is provided by the CCH BWS, which is a semi-autonomous agency that constructs, operates, and maintains the pumping stations and associated distribution network. The BWS relies solely on groundwater for potable water supply. The Honouliuli WWTP site is located within the Waipahu-Waiawa system, which is the primary source of drinking water for the study area. The closest well to the WWTP site is approximately 3.1 miles to the north. For industrial and irrigation purposes, the BWS utilizes the HWRF, operated by Veolia Water North America and located on the western side of the Honouliuli WWTP, which recycles wastewater for non-potable uses. Access to the HWRF is through the main access gate of the Honouliuli WWTP along Geiger Road. The HWRF provides tertiary treatment to approximately 13 mgd of secondary effluent from the WWTP.

5.13.1.2 Construction Impacts and Mitigation Measures

The BWS has requested consideration of a dedicated entrance and that 3 to 5 acres of land be set aside and reserved for HWRF upgrades, improvements, and/or expansion. The final determination of land area, location, and timing of expansion would need to be defined with BWS during detailed design.

Water system improvements near the Honouliuli WWTP may be required to improve the reliability of the existing potable water system and for the potential expansion of the Honouliuli WWTP. Coordination with the BWS would be necessary during design to avoid or minimize the potential for conflicts regarding the reclamation and reuse of wastewater. Requests for additional potable water or recycled water by consumers must be submitted to BWS for review. Construction drawings would be submitted to BWS review as part of the building permit application process and the estimate of water required during construction and availability of the water would be confirmed during the review and approval of the building permit application.

5.13.1.3 Operational Impacts and Mitigation Measures

The treatment alternatives include the upgrade/construction of wastewater facilities, and may require additional potable and/or emergency water service during operation. BWS recommends the use of drought tolerant/low water use facilities and xeriscaping principles for all landscaping and installation of an efficient irrigation system, such as drip irrigation, incorporating moisture sensors to avoid the operation of the system in the rain and if the ground has adequate moisture. These recommendations would be implemented for the proposed project, regardless of the alternative selected.

5.13.2 Wastewater

5.13.2.1 Existing Setting

The existing wastewater infrastructure in the project area is described in Section 3. Improvement of the existing wastewater treatment system is the focus of the ongoing evaluation and the subject of this DEIS. Wastewater is collected primarily by gravity to 16 pump stations distributed throughout the Honouliuli Sewershed. Wastewater is then pumped through force mains to the interceptor sewers leading to the Honouliuli WWTP, where it is treated and discharged through the Barbers Point Deep Ocean Outfall, located approximately 1.7 miles offshore at a depth of 200 feet.

5.13.2.2 Construction Impacts and Mitigation Measures

Construction is proposed to occur at the existing WWTP site. The plant would continue to operate during construction activities, which are anticipated to continue for several years. Effluent discharged will remain in compliance with the 2010 Consent Decree. It is possible that processes may be temporarily interrupted on occasion to connect new structures and facilities to the existing system, and temporary pumping and piping may be required. Staging areas at the Honouliuli WWTP would be designed to avoid impacting any existing sewer pipes in the vicinity of the project site.

5.13.2.3 Operational Impacts and Mitigation Measures

As mandated by the EPA, the long-term goal of this project is to upgrade the WWTP to secondary treatment. The project may also improve some water quality parameters as it would provide additional treatment capacity to meet future population growth and development and better manage peak wastewater flows, as described in Section 5.7 Water Quality.

5.13.3 Solid Waste Disposal

5.13.3.1 Existing Setting

The Ewa Convenience Center, located at 91-1000 Geiger Road at the southwest corner of the Honouliuli WWTP, accepts residential municipal solid waste only. Multiple roll-off dumpsters are used onsite for the separate collection of different types of materials: combustibles are processed at the Honolulu Program of Waste Energy Recovery (H-POWER), a waste-to-energy facility located at the Campbell Industrial Park in Kapolei; non-combustibles are taken to the Waimanalo Gulch Landfill in Kahe Valley; yard waste is hauled to mulching and composting sites; and large appliances, tires and auto batteries are taken to recycling facilities. There are plans to close the Waimanalo Gulch Landfill and/or limit the amount of solids disposed of. The solids loading to the WWTP comes from the Honouliuli WWTP system in addition to the solids from the Wahiawa and Paalaa Kai WWTPs, which are trucked to the Honouliuli WWTP for further processing and disposal. Construction debris is transported to the PVT Land Company located in Nanakuli by private haulers.

5.13.3.2 Construction Impacts and Mitigation Measures

The construction of the proposed project may have some impact on the solid waste disposal operations within the project area. Approximately 673,250 cubic yards would be excavated for new structures, most of which (approximately 573,000 cubic yards) would be used as backfill onsite. Excess excavated material would be approximately 100,000 cubic yards (equivalent to the estimated volume of the buried foundation of each new structure). Coordination with local landfills and recycling centers for the disposal of construction debris and/or hazardous materials may be required and the ultimate disposal location will depend on space availability at local landfills. Disposal would be in accordance with appropriate regulations and standards.

5.13.3.3 Operational Impacts and Mitigation Measures

The proposed project is expected to have minimal impact on the solid waste disposal operations within the project area. Solid waste generated at the WWTP would continue to be disposed of in accordance with local requirements.

The upgrade of the existing WWTP to full secondary treatment would increase the solids production. The CCH has evaluated options for biosolids processing and disposal in an effort to reduce solids disposal to the landfill. The CCH ENV developed an *Island-wide Sludge Management Plan (2015)*, which recommended sludge processing technologies for implementation at Honouliuli WWTP. Potential options include building two new conventional mesophilic anaerobic digesters to accommodate the proposed secondary treatment upgrade and population growth, as recommended in TM 11.D.4. The quantity and quality of sludge being processed, and biogas available for beneficial use, will depend to an extent on the outcome of the island-wide sludge planning effort and factors such as on-site processing methods and importation of sludge.

Waste minimization options include composting or further solids handling to reduce the volume of solids such as drying. Drying is the recommended process to provide for sludge reuse by land application as a sludge disposal method. In addition, other solid residuals from the wastewater treatment process, including screenings and grit would be washed and compacted. These measures are consistent with current best practices for handling residuals and are consistent with waste minimization goals.

Another sustainable opportunity is the conversion of solids to energy. There are both off-site and on-site opportunities for the conversion of solids to energy. One off-site alternative is to haul the solids from Honouliuli WWTP to H-POWER. H-POWER is currently accepting sludge and is a viable outlet in the near future. On-site waste-to-energy alternatives include incineration and closed-coupled processes.

5.13.4 Electrical and Communication Services

5.13.4.1 Existing Setting

Hawaii Electric Company (HECO) supplies electricity to the majority of Oahu. Two of HECO's major facilities, the Kahe and Waiau Power Plants, are located within approximately 5 miles of the WWTP site. Overall facility electrical demand currently ranges from 1,536 to 1,757 kW (AECOM 2014a). Telephone and internet services within the project area are provided by Hawaiian Telcom and Oceanic Time Warner Cable. Oceanic Time Warner Cable also provides cable services within the project area. These services are transmitted through underground and aerial lines located in the project area.

There are two cell phone towers located on the WWTP property, one in the southeast corner and the other in the northwest corner.

5.13.4.2 Construction Impacts and Mitigation Measures

Construction of the project would require electricity mostly generated by the burning of fossil fuels and imported fuels for powering equipment and vehicles during construction.

The existing overhead power lines are recommended to be replaced with underground utilities, and the backbone of the electrical distribution would be expanded to areas with new facilities. Regardless of the alternative selected, coordination with HECO, Hawaiian Telcom, and Oceanic Time Warner Cable, would be conducted to minimize and/or avoid potential conflicts with any underground and overhead utility lines in the project area. Proposed improvements, including staging areas, would be designed to avoid impacting any existing electrical and communication lines.

No impacts to the two cell phone towers and their current vehicular access ways are anticipated.

5.13.4.3 Operational Impacts and Mitigation Measures

An increase in energy consumption would be necessary at the existing Honouliuli WWTP for the proposed project. The increase in energy usage to upgrade the WWTP from primary treatment to secondary treatment and additional solid treatment could be substantial in the WWTP’s overall energy consumption. Secondary treatment under aerobic conditions is typically done at the expense of increasing energy consumption while also increasing the solids from microbial synthesis that adds to disposal burden. Electrical demand is anticipated to be 6,943 kW following upgrades to the Honouliuli WWTP, which is higher than the current estimated peak electrical demand (1,757 kW) (AECOM 2014a). Comparing alternatives, it is anticipated that Sub-options 1B and 1A would consume the smallest amount of electricity and Option 2 and Sub-option 3A would consume the most electricity (AECOM 2014e). Energy savings measures may be employed, regardless of the alternative selected, to offset this anticipated increase, such as new light fixtures and skylights, new more efficient blowers and pumps, and new solar panels (AECOM 2014a).

There is a potential for energy recovery from digester gas or by utilizing new emerging technology for gasification of sewage sludge. However, at this time, it is not known if the net energy consumption could be feasibly reduced to favorable levels through the implementation of new technologies that are emerging on the market. CCH is currently evaluating alternatives to use the digester gas for energy recovery.

If a CHP facility is incorporated at the Honouliuli WWTP, it would need to be permitted according to local, State and Federal air regulations, including air permitting in conjunction with the biosolids disposal.

5.13.5 Gas

5.13.5.1 Existing Setting

The Gas Company, LLC maintains underground utility gas mains which serve commercial and residential customers throughout the project area. There are no known major gas lines within the proposed project site.

5.13.5.2 Impacts and Mitigation Measures

Regardless of the alternative selected, coordination with the Gas Company, LLC would be necessary to minimize and/or avoid potential conflicts with the existing gas utilities. Although there are no known major gas lines in the vicinity of proposed construction activities, gas handling systems would be necessary, including piping for the anaerobic digesters. None of the proposed processes are anticipated to require natural gas as a fuel source. The proposed standby generators would use diesel fuel. The thermal dryer would use digester gas as a fuel source. Any leftover digester gas would be:

1. Used to generate electricity (cogeneration)
2. Cleaned and sold as a commercial fuel, or
3. Burned with the existing waste gas flare that is presently used at the site.

Based on the initial coordination, impacts would not be anticipated during construction or operation of the proposed project, regardless of the alternative selected.

5.14 Public Services and Facilities

5.14.1 Police and Fire Protection Services

5.14.1.1 Existing Setting

The Honolulu Police Department (HPD) and Honolulu Fire Department (HFD) provide emergency services to the island of Oahu. The HPD has divided the island into eight patrol districts with five district stations. The Kapolei district station is located within the project area (District 8).

5.14.1.2 Construction Impacts and Mitigation Measures

Coordination with the HPD during construction would be necessary to mitigate traffic congestion and ensure public safety, in those instances when traffic control cannot be provided by the contractor(s) employees alone. When necessary, off-duty police officers would be scheduled and hired.

Coordination with the HFD for the safe design of new or upgraded structures would also be necessary; plans would be submitted to the HFD for review and approval during the design phase. Based on their recommendations and the 1997 Uniform Fire Code (UFC), a fire apparatus access road for every facility, building or portion of building within their jurisdiction would be provided when the structure is more than 150 ft from a fire apparatus access road (UFC Section 902.2.1). In accordance with the UFC Section 903.2, on-site fire hydrants and mains capable of supplying the required fire flow would also be provided when any portion of a facility or building is in excess of 150 ft from a water supply. The water supply would also be provided as approved by the county in terms of supplying the required fire flow for fire protection.

5.14.1.3 Operational Impacts and Mitigation Measures

The operation of the proposed wastewater system improvements is expected to have minimal impact on the HPD and HFD.

5.14.2 Public Schools

5.14.2.1 Existing Setting

There are several public schools located in the vicinity of the project area (within approximately 1 mile [mi.]) including:

- Ewa Makai Middle School (approx. 0.6 mi.)
- Ewa Elementary School (approx. 0.7 mi.)
- Kapolei Middle School (approx. 0.8 mi.)
- Keoneula Elementary School (approx. 1.0 mi.)
- Holomua Elementary School (approx. 1.0 mi.)

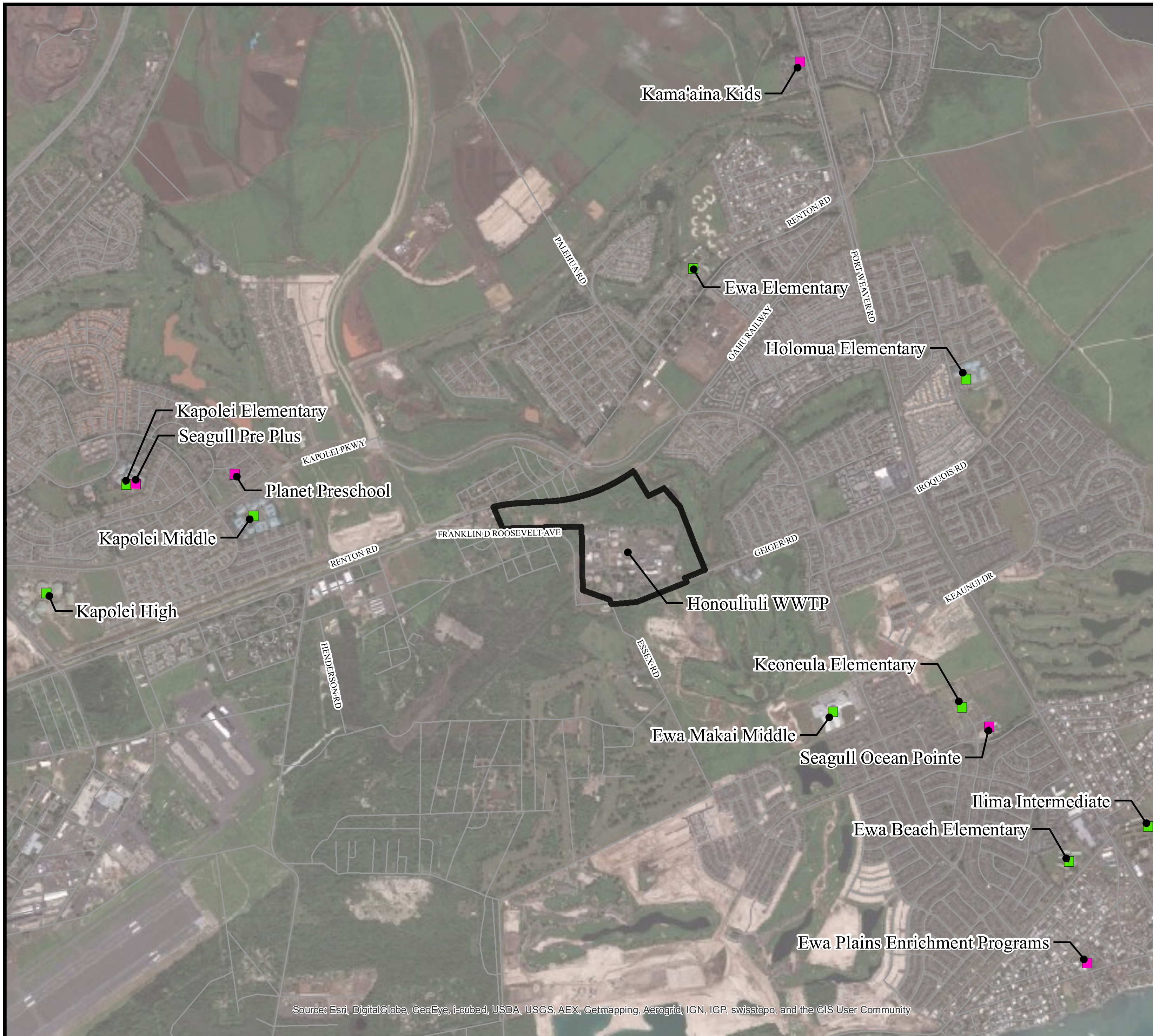
There are no childcare facilities within a 1 mi. radius of the project site. The nearest childcare facilities include:

- Seagull schools (two locations, approx. 1.3 mi. and 1.7 mi.)
- Planet Preschool (approx. 1.4 mi.)
- Kamaʻaina Kids (approx. 1.9 mi.)
- Ewa Plains Enrichment Programs approx. 2 mi.)

Figure 5-13 shows the public schools and childcare facilities in the project area.

City and County of Honolulu

HONOULIULI/ WAIPAHU/ PEARL CITY WASTEWATER FACILITIES PLAN



Legend
- Honouliuli WWTP
- Public School
- Childcare Facility
- Street

0 1,600 Feet
1 inch = 2,400 feet

FIGURE 5-13

PUBLIC SCHOOLS AND CHILDCARE FACILITIES

December 2014

AECOM
1001 BISHOP ST, STE 1600
HONOLULU, HAWAII 96813

G:\Projects\MUNI\60220849HON\Maps\EI\Figure_5-13 Public Schools and Childcare Facilities.mxd

5.14.2.2 Construction Impacts and Mitigation Measures

Public schools and childcare facilities in the vicinity of the project area are not anticipated to be impacted by construction activities (including any increases in noise or traffic) at the Honouliuli WWTP site, due to the distance between the project site and public schools/childcare facilities in the area. The nearest public school to the project site is the Ewa Makai Middle School located approximately 0.6 mi. to the southeast, and there are no childcare facilities within a 1 mi. radius of the project. As previously mentioned, there may be a slight increase in traffic during construction activities at the Fort Weaver Road/Geiger Road/Iroquois Road & Renton Road/Fort Weaver Road intersections (intersections #10 and #11 on Figure 5-7), which are located in the vicinity of Ewa and Holomua Elementary Schools (Figure 5-13).

5.14.2.3 Operational Impacts and Mitigation Measures

Operational effects to schools or childcare facilities are not anticipated as a result of any of the project alternatives, with the exception of the potential for a slight increase in traffic at the Fort Weaver Road/Geiger Road/Iroquois Road & Renton Road/Fort Weaver Road intersections (intersections #10 and #11 on Figure 5-7), located in the vicinity of Ewa and Holomua Elementary Schools.

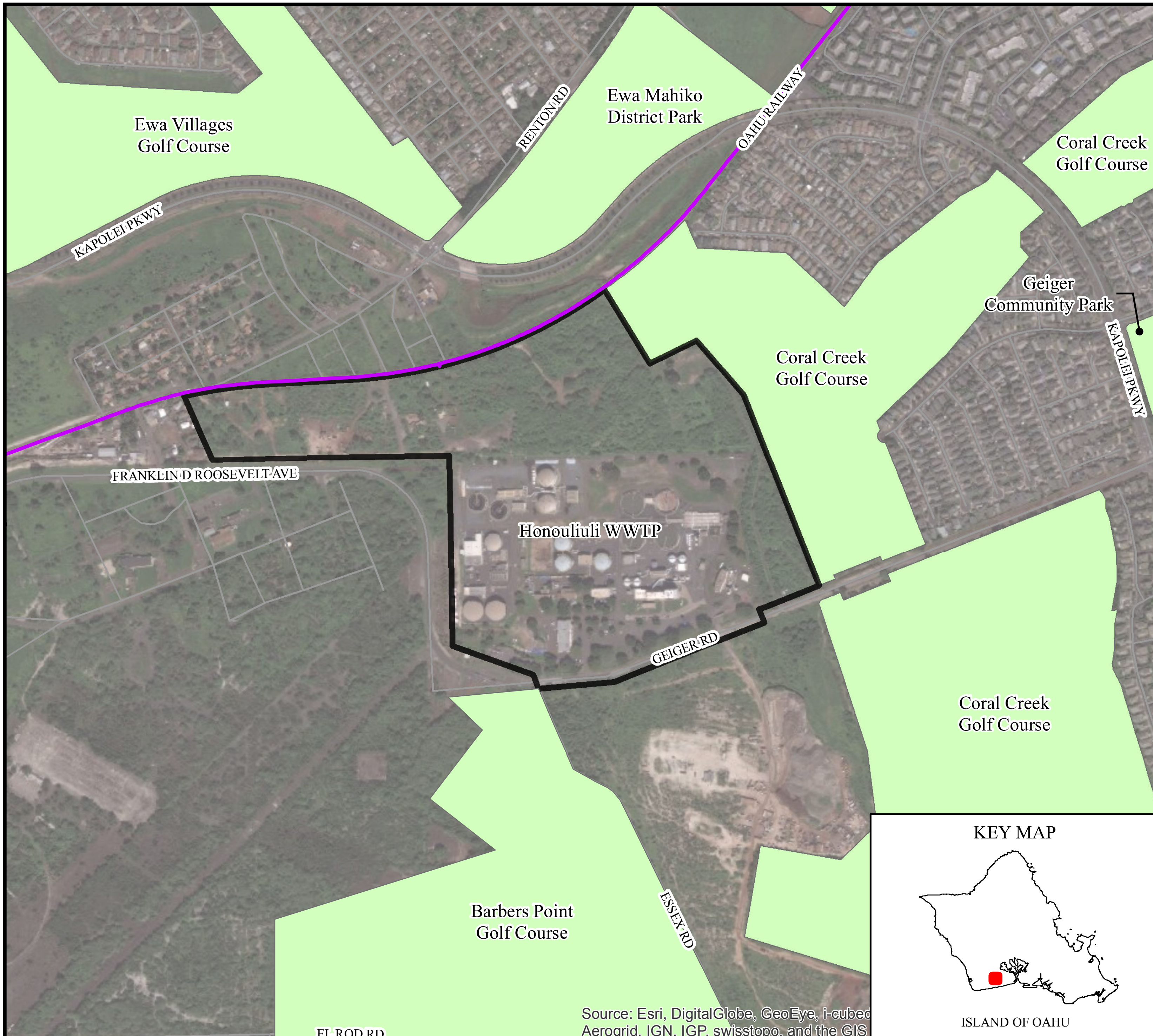
5.14.3 Parks and Recreational Areas

5.14.3.1 Existing Setting

Several recreational areas including golf courses, parks, and a bike trail are located near the project area (within 1 mi.) including:

- Coral Creek Golf Course
- Barbers Point Golf Course
- Ewa Villages Golf Course
- Geiger Community Park
- Ewa Mahiko District Park
- Rail trail/bike path within the old OR&L railway

Figure 5-14. Parks and Recreational Areas shows the parks and recreational areas in the project area. Of the recreational areas listed above, Coral Creek Golf Course and rail trail/bike path are located closest to project activities; the golf course lies directly adjacent to the eastern boundary of the project parcel and the bike path is located to the north.



City and County of Honolulu

HONOULIULI/ WAIPAHU/ PEARL CITY WASTEWATER FACILITIES PLAN

Legend

- Honouliuli WWTP
- Parks and Recreational Areas
- Street
- Rail Trail

0 800 Feet
1 inch = 800 feet

FIGURE 5-14

PARKS AND RECREATIONAL AREAS

December 2014

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G:\Projects\MUNI\60220849HON\Maps\EI\Figure_5-14 Park and Rec Areas.mxd

5.14.3.2 Construction Impacts and Mitigation Measures

The WWTP alternatives are not anticipated to directly impact park or golf course facilities as a result of construction activities. However, some secondary minor impacts as a result of construction, such as noise, slight increase in traffic, or temporary aesthetic impacts (as discussed in this document) may occur near the closest recreation areas (Coral Creek Golf Course and possibly the bike path). However, these secondary impacts are anticipated to be minor in nature.

In general, if the alternative implemented potentially impacts any park or recreational use, owners of these recreational areas, as well as the CCH Department of Parks and Recreation, would be consulted for acceptability before proceeding further and to coordinate work to avoid any impairment to public use of these facilities.

5.14.3.3 Operational Impacts and Mitigation Measures

Regardless of the alternative implemented, no operational effects to parks and recreational facilities are anticipated, other than periodic inspection and/or maintenance of proposed wastewater management facilities located near park/golf course property. Mitigation measures include the proper design and construction of wastewater facilities.

6 INDIRECT AND CUMULATIVE IMPACTS

6.1 Indirect Impacts

Indirect (also referred to as secondary) effects are effects that are caused by an action but occur later in time or are farther removed in distance, but are still reasonably foreseeable. Such effects may include impacts on environmental resources or public facilities that occur as a result of a project's influence on the pattern of land use or growth rate.

This proposed project focuses on providing hydraulic and treatment upgrades to the Honouliuli WWTP in order to comply with the FACD and to comply with regulatory mandates from the DOH and EPA. Although effluent flow to Mamala Bay is anticipated to increase due to the projected population growth within the sewershed, effluent concentrations and overall loads would decrease as a result of the proposed upgrade to secondary treatment.

The project also provides a basis to meet future wastewater management needs for the projected growth and development in the Honouliuli sewer basin. As noted in Section 3.2, Honouliuli sewer basin population projections were developed for the year 2035 and year 2050 to determine system capacity requirements within the planning period. The projections consider long-term, historic trends for the sewer basin, as well as available data and projections released by CCH and large-scale developments and proposed projects in the area. Previously conducted population and employment projections were also referenced to assist with the effort. The source most relied on was the CCH DPP socioeconomic projections to 2035, which are generally used and accepted for county infrastructure planning efforts (AECOM 2011a).

The results of the population projections indicate overall robust growth within the Honouliuli sewer basin. Most of this growth is projected to occur within the Honouliuli IPS tributary area, where the growing City of Kapolei is located as well as several proposed master planned communities, resorts, and other developments. The population projections methodology and detailed results are provided in Appendix A.

The proposed project is not a population generator in and of itself; rather it is intended to meet the needs of the projected population in the Honouliuli sewer basin. The strong projected growth within the Honouliuli sewer basin is supported by recent growth trends as well as CCH DPP planning documents and growth policies. Additional detail regarding the relationship of State and County land use plans, policies, and controls relating to the proposed project is provided in Section 7.

As stated in Section 5.13.1, construction expenditures associated with the proposed project would result in one-time increases in economic output, employment, and earnings, and one-time increases in fiscal revenues of the state. The economic impacts of project construction would include the impact of expenditures on construction materials, and on earnings of construction workers and professional service providers during the construction period, as well as the impacts of those changes on the overall economy of the CCH. In addition, annual expenditures from operations of the proposed project would result in ongoing increases in economic output, employment, and earnings, and ongoing increases in fiscal revenues.

On a one-time basis, project construction would have an estimated total economic impact of $1.6 billion in output, supporting a total of approximately 13,430 jobs and earnings of $520 million (Section 5.13.1). On an ongoing basis, plant operation related to the upgrading of the Honouliuli WWTP would result in an estimated annual impact of $28.5 million in output, supporting about 90 jobs and earnings of $3.8 million. These economic impacts comprise the volume of economic activity initially produced by constructing and operating the project (direct effects), as well as indirect effects produced by purchases of inputs from local industries and induced effects produced by household spending that results from changes in earnings. Both construction and operation effects from the proposed project would be beneficial, providing regional economic benefits from construction spending and labor, as well as long-term positive effects on employment and income in the region. Implementation of the project would have beneficial impacts on employment and income.

6.2 Cumulative Impacts

Cumulative impacts are typically defined as the impacts on the environment which result from the incremental impact of a project when added to other past, present, and reasonably foreseeable future actions. The potential environmental effect resulting from the incremental impacts of the proposed upgrade to the Honouliuli WWTP, when added to other recent, ongoing, or proposed construction projects occurring at or in the vicinity of the Honouliuli WWTP, is considered in the cumulative effects analysis in this section.

Known major development projects within the general vicinity of the Honouliuli WWTP are listed in Table 6-1. The approximate locations of the developments are identified in Figure 6-1.

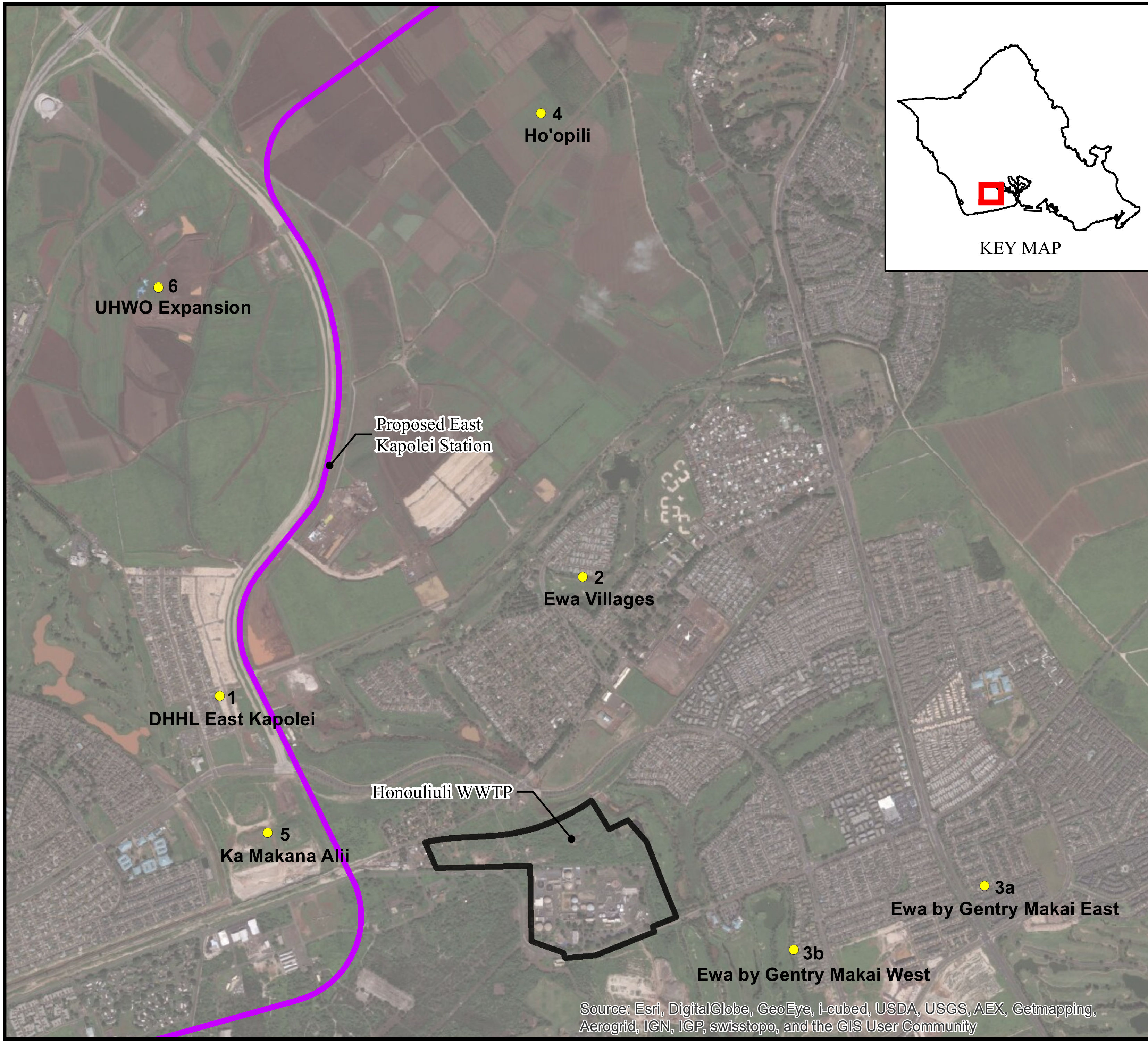
Table 6-1. Status of Known Major Development Projects within the vicinity of the Honouliuli WWTP

Development Name [1]	Original Land Area (Acres) from Development Plans		Status	Remaining Land Area (Acres) to be Developed	
	Res	Non-Res		Res	Non-Res
1. DHHL East Kapolei (also referred to as East Kapolei II)	341	67	Proposed	341	67
2. Ewa Villages	54	—	Proposed	54	-
3a/3b. Ewa by Gentry Makai (East and West)	172	—	Under construction; nearing build-out; approx. 80% complete	34	—
4. Ho'opili	1,600 (Mixed Use)		Proposed	1,600 (Mixed Use)	
5. Ka Makana Alii	—	67	Proposed	—	67
6. UHWO Expansion	—	Approx. 224	Proposed	—	Approx. 224

Legend: DHHL = Department of Hawaiian Home Lands, State of Hawaii; UHWO = University of Hawaii at West Oahu
Sources: Ewa Development Plan, July 2013 (DPP 2013a). Online project status research conducted by AECOM, November and December 2014.
Note: (1) Approximate locations of developments identified on Figure 6-1.

A 20-mile elevated rail line is in the process of construction as part of the Honouliuli Rail Transit Project. A portion of this rail line is located to the north and west of the Honouliuli WWTP (Figure 6-1) and has the potential to encourage higher density, transit oriented development near proposed stations (DPP 2011). The closest proposed station to the project, East Kapolei Station (scheduled to open in 2017), is located more than 1 mi. northwest of the Honouliuli WWTP, as shown on Figure 6-1.

At the Honouliuli WWTP site, there is the potential for a CHP facility to be incorporated on the property. Since this facility would be a new stationary source, the emissions at the Honouliuli WWTP would increase, resulting in adverse air quality impacts on the local level. If the CHP facility option is elected in the future, the CHP facility would need to be considered for future local, State, and Federal air quality permitting in conjunction with the biosolids disposal process during the design stage.



City and County of Honolulu

HONOULIULI/ WAIPAHU/ PEARL CITY WASTEWATER FACILITIES PLAN

FIGURE 6-1

KNOWN MAJOR DEVELOPMENT PROJECTS WITHIN THE VICINITY OF THE HONOULIULI WWTP

December 2014

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1001 BISHOP ST, STE 1600
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7 RELATIONSHIP OF ACTION TO STATE AND COUNTY LAND USE POLICIES AND CONTROLS

Development within the State of Hawaii is guided through a combination of land use plans, policies and controls set at the State level and tiered down to the CCH level. This section addresses the various guidance documents, rules and regulations and how the project relates to each relevant State or County plan. The plans were reviewed to assess consistency of the proposed project alternatives with development, plans, zoning, and special management area goals and requirements. The project area includes potential development activity within the Ewa planning area as well as other portions of the Honouliuli sewer basin.

7.1 State of Hawaii

The State of Hawaii maintains a statewide planning system that includes State and County Land Use Plans, Policies and Controls to provide standards and guidelines for development. Updating the West Mamala Bay Facilities Plan and evaluating the need for expansion and upgrade to the Honouliuli WWTP is necessary to address the Consent Decree and to safely accommodate future growth and development. This DEIS references the appropriate Plans, Policies and Controls to assist in evaluating the proposed project.

7.1.1 Hawaii State Plan

The Hawaii State Plan sets forth overall goals, objectives, policies and priorities for the State to guide future long-range development. The purpose of the Hawaii State planning process, as defined in HRS, Chapter 226, is to:

- Guide the future long-range development of the State.
- Identify the goals, objectives, policies, and priorities for the State.
- Provide a basis for determining priorities and allocating limited resources.
- Improve coordination of federal, state, and county plans, policies, programs, projects, and regulatory activities.
- Establish a system for plan formulation and program coordination to integrate major State, and county activities.

Of note for wastewater facility planning are the objectives and policies relating to liquid waste facility systems quoted below:

§226-14 Objective and policies for facility systems; in general.

> (a) Planning for the State's facility systems in general shall be directed towards achievement of the objective of water, transportation, waste disposal, and energy and telecommunication systems that support statewide social, economic, and physical objectives.
>
> (b) To achieve the general facility systems objective, it shall be the policy of this state to:
>
>> (1) Accommodate the needs of Hawaii's people through coordination of facility systems and capital improvement priorities in consonance with state and county plans.
>>
>> (2) Encourage flexibility in the design and development of facility systems to promote prudent use of resources and accommodate changing public demands and priorities.
>>
>> (3) Ensure that required facility systems can be supported within resource capacities and at reasonable cost to the user.
>>
>> (4) Pursue alternative methods of financing programs and projects and cost-saving techniques in the planning, construction, and maintenance of facility systems.

§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 sewerage facilities that complement planned growth.
> >
> > (3) Promote research to develop more efficient and economical treatment and disposal of solid and liquid wastes.

7.1.1.1 Discussion

The proposed project is consistent with the above objectives and policies of HRS, Chapter 226, Hawaii State Planning Act. The project would enable the CCH to maintain basic sanitation standards relating to wastewater collection and treatment in one of Oahu’s largest wastewater service areas. The project would result in adequate sewerage facilities to support both current and future economic activities.

7.1.2 State Functional Plans

State Functional Plans are the framework for implementation of the Hawaii State Plan by establishing policies and guidelines for specific activities. State Functional Plans are developed by the agency responsible for the functional area, including agriculture, conservation lands, education, energy, higher education, health, historic preservation, housing, recreation, tourism, and transportation. The proposed alternatives are consistent with the following State Functional Plans:

7.1.2.1 Recreation State Functional Plan

> *Issue Area IV. Resource Conservation and Management*
> *Objective IV-B: Prevent Degradation of the Marine Environment*
> *Policy IV-B(1): Enhance water quality to provide high-quality ocean recreation opportunities.*
> *Implementing Action IV-B(1)a: Regularly monitor water quality at key ocean recreation sites.*

The proposed project would have beneficial water quality impacts on coastal waters in the vicinity of the existing ocean outfall, regardless of the alternative selected, as the quality of effluent would be significantly improved following secondary treatment. As part of NPDES permit requirements for the Honouliuli WWTP, monitoring is regularly conducted at shoreline, nearshore and offshore stations to assess aesthetic conditions for recreational uses and to determine compliance with applicable water quality standards.

7.1.2.2 Historic Preservation State Functional Plan

> *Issue Area I. Preservation of Historic Sites*
> *Objective B: Protection of Historic Properties*
> *Policy B.2. Establish and make available a variety of mechanisms to better protect historic properties.*
> *Implementing Action B.2.c: Respond to the discovery of prehistoric/historic burials in a timely and sensitive manner, which takes into consideration cultural concerns.*

An archaeological literature review and field investigation were conducted for the proposed project. No significant short- or long-term impacts to historic or archaeological resources are anticipated as a result of the construction and operation of the proposed project. Should any significant historic or archaeological resources be found during construction activities, all work would cease within the immediate area and SHPD would be notified immediately.

7.1.3 State Land Use Classification

The Land Use Commission (LUC) administers the state wide zoning law as outlined in Chapter 205 of the HRS and Title 15, Chapter 15 of the HAR. The purpose of the LUC is to designate all lands in the state into one of four land use districts: Urban, Rural, Agricultural, and Conservation to preserve, protect and encourage development and preservation of lands for those uses to which they are best suited in the interest of public health and welfare of the people. A brief description of each land use is provided in the following list:

- Urban District – areas with “city-like” concentrations of people, structures and services and vacant areas for future development. Jurisdiction lies with the respective county through ordinances and rules.
- Rural District – primarily small farms intermixed with low density residential lots of ½ acre or more. Jurisdiction of these areas lies with the LUC and respective counties and permitted uses generally include those relating to agricultural use and low-density residential lots; however, variances may be obtained.
- Agricultural District – includes lands for cultivation of crops, aquaculture, raising livestock, wind energy facility, timber cultivation, agriculture support activities and land with significant potential for agriculture uses. Uses permitted within the district are based on the Land Study Bureau’s productivity categories. Lands in the highest productivity categories (A or B) are governed by statute and uses in the lower categories (C, D, E or U) are established by the commission stated in HRS 205-4.5.
- Conservation District – lands comprised of existing forest and water reserve zones and area necessary to protect watersheds and water resources, scenic and historic areas, parks, wilderness, open space, recreational areas, habitats of endemic plants, fish and wildlife, and all submerged lands seaward of the shoreline. These areas are governed by the State DLNR.

7.1.3.1 Discussion

The project area is located within Urban and Agricultural Districts (Figure 7-1). Permissible uses within each district are defined in HAR Title 15, Chapter 15-24. The proposed project activities and uses are permissible within the both the Urban and Agricultural Districts.

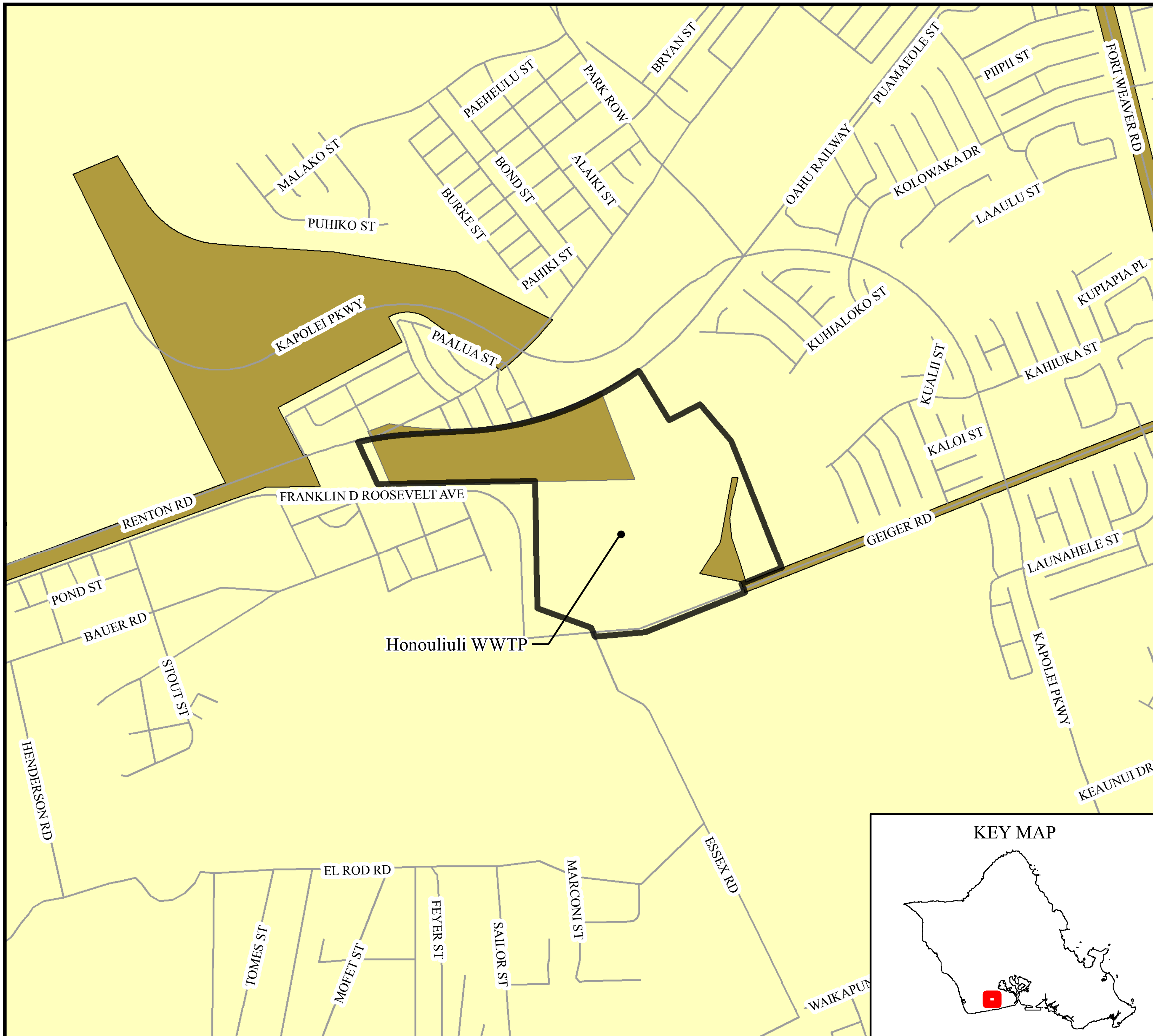
7.1.4 Coastal Zone Management Program

The purpose of the Hawaii Coastal Zone Management (CZM) Program is to “provide for the effective management, beneficial use, protection, and development of the coastal zone”. Hawaii’s CZM was established through Chapter 205A, HRS, and is administered by the Hawaii Office of Planning. Chapter 205A requires compliance with CZM objectives and policies outlined in Chapter 205A-2(b), the following of which are applicable to the proposed project.

> *(1) Recreational Resources:*
> *Objective: Provide coastal recreational opportunities accessible to the public.*
> *Policy (B): Provide adequate, accessible, and diverse recreational opportunities in the coastal zone management area by:*
>
> > *(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.*

The purpose of the proposed project is to improve the quality of effluent discharged to Mamala Bay. Therefore, the proposed project would have beneficial water quality impacts on coastal waters in the project area, including Mamala Bay, which is used for a variety of water recreation activities.

> *(4) Coastal Ecosystems:*
> *Objective: Protect valuable coastal ecosystems, including reefs, from disruption and minimize adverse impacts on all coastal ecosystems.*



City and County of Honolulu

HONOULIULI/ WAIPAHU/ PEARL CITY WASTEWATER FACILITIES PLAN

Legend

Honouliuli WWTP

Street

State Landuse District

Agriculture

Urban

0 1,200

Feet

1 inch = 1,200 feet

FIGURE 7-1

LAND USE DISTRICTS

December 2014

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1001 BISHOP ST, STE 1600
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> *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.*

The purpose of the proposed project is to improve the quality of effluent discharged to Mamala Bay. Although flows are anticipated to increase, the upgrade to secondary treatment would reduce the concentration of water quality parameters in plant discharge.

7.1.5 Ocean Recreation Management Plan

The Hawaiʻi Ocean Resources Management Plan (ORMP) is a statewide plan mandated by HRS, Chapter 205A. The Hawaiʻi CZM Program in the State Office of Planning, DBEDT, is charged with reviewing and periodically updating the ORMP, as well as coordinating its overall implementation. Developed in collaboration with government agencies and with input from non-governmental organizations, private sector, community groups, and other stakeholders, the ORMP calls for substantive changes in the State's approach to natural and cultural resources management. It recommends an integrated approach to managing natural and cultural resources, building on traditional Hawaiian management principles, that considers the impacts of landbased activities on ocean resources and fosters collaboration and stewardship. These changes will take time to fully realize. As a result, this ORMP establishes 5-year management priorities to achieve a longer-term goal of improving the condition of ocean resources in the State. The ORMP outlines actions that will be carried out primarily by State agencies, as the plan can only direct State agencies to action. Implementation of short- and long-term goals, however, will require the active involvement, support, and assistance of Federal and county government agencies and communities across the State.

The ORMP lays out a phased approach, comprised of four phases, with experiences and lessons learned from each phase informing the next and with expected outcomes of each 5-year phase defined through the year 2030. The 2006 ORMP was for the first phase, the Demonstration phase. The 2013 ORMP, an update of the 2006 ORMP, covers the second phase, Adaptation. The third phase, Institutionalization, is anticipated to begin in 2021, with the final phase, Mainstreaming, in 2030.

Management priorities are designed to strengthen ongoing efforts to manage ocean resources and demonstrate new integrated management approaches. These management priorities are organized under three perspectives to provide a focused framework for action: Perspective 1, Connecting Land and Sea; Perspective 2, Preserving Our Ocean Heritage; and Perspective 3, Promoting Collaboration and Stewardship. Perspective 1 addresses land-based activities that impact ocean resources. Under Perspective 1, one of the management goals is to "Improve coastal and stream water quality" by "…outreach to wastewater treatment plant operators to increase wastewater recycling" (CZM 2013). This will be measured by an "increase in percentage of wastewater recycled annually and by the number of outreach activities conducted for wastewater recycling" (CZM 2013).

7.1.5.1 Discussion

The proposed project is consistent with the ORMP and would help meet the goals of Perspective 1, as the improvements to the existing Honouliuli WWTP would have beneficial water quality impacts on surface, ground, and coastal waters in the project area and due to the potential for reuse of treated effluent from the WWTP.

7.2 City and County of Honolulu

The CCH DPP manages anticipated future population and land use growth through policies, planning principles, guidelines and regulations set forth in the Oahu General Plan, Development and Sustainable Community Plans, and implementing ordinances and regulations. The DPP maintains and updates the Oahu General Plan, regional Development/Sustainable Community Plans, Development Plan Land Use Annual Reports, and Special Area and Neighborhood Master Plans to guide the policy, investment and decision making process. This DEIS was prepared in conformance with the guidelines set forth in these documents for analysis on the advantages and disadvantages of the proposed project and its alternatives for the CCH.

7.2.1 General Plan

The Oahu General Plan was adopted in 1977 with subsequent amendments leading to the revised 2002 edition (according to the DPP website, as viewed in December 2014, this plan is in the process of being updated). The work associated with the proposed project is consistent with the objectives within the General Plan. These objectives include planning for anticipated future population growth and the increased demands for future sewerage and solid waste disposal services. Policies contained in the General Plan are implemented by the CCH government through ordinances and resolutions as well as rules and regulations. Development Plans for each community provide for the land use and public facilities planning and the sequence in which the development would occur in accordance with the objectives and policies outlined in the General Plan.

The General Plan, a requirement of the CCH Charter, is a written commitment by the CCH to a future for the Island of Oahu. The current plan, approved in 2002, is a statement of the long-range social, economic, environmental, and design objectives and a statement of broad policies which facilitate the attainment of the objectives of the plan. Wastewater facilities are considered utilities. Therefore, the most relevant section of the General Plan is Section V, entitled “Transportation and Utilities.”

Section V, Transportation and Utilities

Objective B: To meet the needs of the people of Oahu for an adequate supply of water and for environmentally sound systems of waste disposal.

Policy 3 - Encourage the development of new technology which will reduce the cost of providing water and the cost of waste disposal.

Policy 5 - Provide safe, efficient, and environmentally sensitive waste-collection and waste disposal services.

Objective C: To maintain a high level of service for all utilities.

Policy 1 - Maintain existing utility systems in order to avoid major breakdowns.

Policy 2 - Provide improvements to utilities in existing neighborhoods to reduce substandard conditions.

Policy 3 - Plan for the timely and orderly expansion of utility systems.

Objective D: To maintain transportation and utility systems which will help Oahu continue to be a desirable place to live and visit.

Policy 1- Give primary emphasis in the capital-improvement program to the maintenance and improvement of existing roads and utilities.

Policy 2 - Use the transportation and utility systems as a means of guiding growth and the pattern of land use on Oahu.

Policy 4 - Evaluate the social, economic, and environmental impact of additions to the transportation and utility systems before they are constructed.

Policy 5 - Require the installation of underground utility lines wherever feasible.

7.2.1.1 Discussion

The project is consistent with Section V, Objective B, concerning environmentally-sound utility systems. The planning process is concerned with improving the safety, efficiency and environmental sensitivity of wastewater collection and treatment services. Implementation of the wastewater facility improvements would enhance efficiency of the systems and the secondary treatment to provide safe waste collection and disposal.

Objective C is aimed at maintaining a high level of service for all utilities under the jurisdiction of the CCH, including wastewater collection and treatment. Planned improvements would benefit the urban communities within the Honouliuli WWTP service area. Maintaining a high level of service and reliability in this service area is consistent with CCH’s emphasis on retaining the population concentration within the districts. The environmental documentation in this DEIS evaluates the social, economic and environmental impact of the proposed improvements.

With regard to Objective D, concerning maintaining utility systems, the planned improvements are intended not only to maintain, but to improve, wastewater facilities that would enable Oahu to continue to be a desirable place to live and visit.

7.2.2 Development Plans/Sustainable Communities Plans

Oahu is divided into eight planning areas that are used by the CCH DPP for long-term planning efforts. Three of these planning areas are located partially or completely within the sewer basin: Ewa, Central Oahu, and PUC (Figure 7-2). Development plans (DPs) required by CCH Charter are prepared to guide population and land use growth over a 20+ year time span for these planning areas. The future growth and plans for the areas of Ewa, Central Oahu, and the PUC are vital elements in determining the potential design for the upgrade of the Honouliuli WWTP. A major revision to these plans was completed in 2004, and the revised plans are reviewed every 5 years to revalidate the overall goals and make appropriate adjustments. The revised Ewa DP was adopted in July 2013, a Public Review Draft Central Oahu Sustainable Communities Plan (SCP) is expected to be circulated to the public for review in 2015, and the review of the PUC DP has been postponed indefinitely.

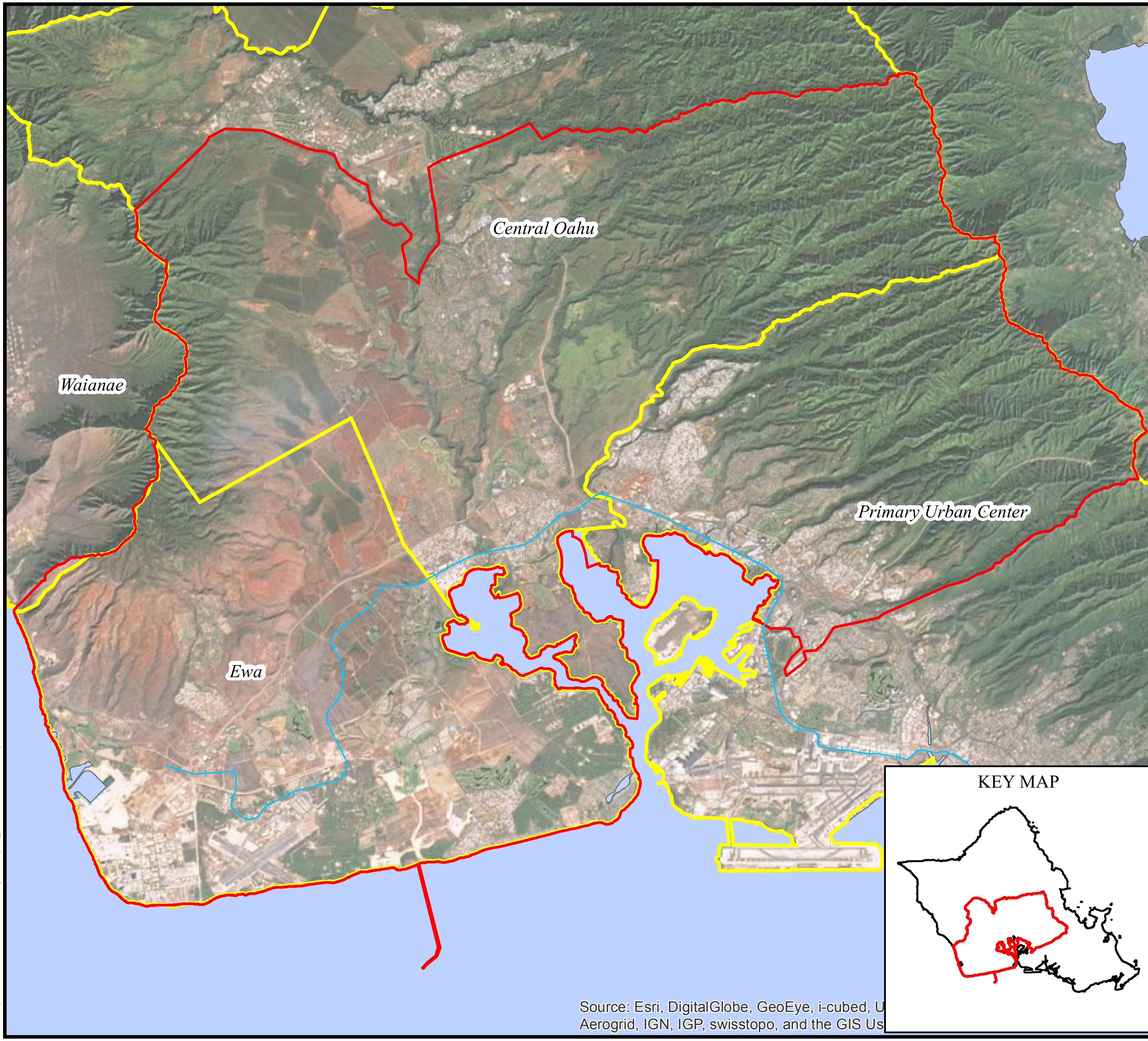
The DPs for Ewa and the PUC are directed toward considerable growth and significant progress to provide a Secondary Urban Center for Oahu, centered in the Kapolei area, and to guide development decisions and actions needed to support the growth. The Central Oahu SCP is a plan with goals directed toward public actions to support the existing population.

Future projects described in these development plans/sustainable communities plans include but are not limited to the Transit Oriented Development Program to expand the transit system in the Aiea-Pearl City, East Kapolei and Waipahu Neighborhoods, pedestrian ways and bike paths, and community centers. The Honouliuli Rail Transit Project will traverse through the Honouliuli sewer basin and possibly encourage higher density, transit oriented development in the vicinity of the proposed stations (a desired effect), as reflected in the transit oriented development plans prepared by DPP for several neighborhoods in the sewer basin (DPP 2013b). The rail project will also help support and connect many of the proposed developments identified in the Ewa DP and Central Oahu Sustainable Communities Plan (DPP 2013a). The proposed alignment for the Honouliuli Rail Transit Project is identified in Figure 7-2.

7.2.2.1 Primary Urban Center DP

The PUC DP, most recently updated in 2004, implements the objectives and policies of the General Plan for the PUC, which is described as the “cultural, governmental and economic center of both Oahu and the State.” The PUC DP is incorporated into Ordinance 04-14 by reference. The proposed project is consistent with the implementation strategies described in the PUC DP, Chapter 5. Particularly pertinent areas are quoted below.

> 5.1 Public Facility Investment Priorities
>
> The vision for the PUC requires the cooperation of both public and private agencies in planning, financing, and improving infrastructure. The City must take an active role in planning infrastructure improvements, such as… improvements to wastewater and stormwater management systems. Of particular importance is the need to achieve a balanced transportation system and upgrade the wastewater system in older, in-town Honolulu neighborhoods. These improvements are needed in order to accommodate new housing and other needed facilities.
>
> 5.2 Development Priorities
>
> Projects to receive priority in the approval process are those that:
>
> - Involve land acquisition and improvements for public projects which are consistent with the DP vision, policies and guidelines; and



City and County of Honolulu

HONOULIULI/ WAIPAHU/ PEARL CITY WASTEWATER FACILITIES PLAN

Legend

- Proposed Mass Transit
- Sewer Basin
- DPP Planning Area

0 12,000
Feet
1 inch = 12,000 feet

FIGURE 7-2

CCH DPP PLANNING AREAS WITHIN HONOULIULI SEWER BASIN

December 2014

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- Involve applications for zoning and other land use permits that are consistent with the DP vision, policies, and guidelines.

> 5.4 Functional Planning
>
> Functional planning is the process through which various City agencies determine needs, assign priorities, phase projects, and propose project financing to implement the vision articulated in the DP. This process may take a variety of forms, depending upon the missions of the various agencies involved, as well as upon requirements imposed from outside the City structure, such as federal requirements for wastewater management planning. Typically, functional planning occurs as a continual or iterative activity within each agency. Through the functional planning process, City agencies are responsible for development and maintenance of infrastructure and public facilities, and the provision of City services review existing functional planning documents and programs. As a result of these reviews, the agencies then update existing plans or prepare new long-range functional plans that address facilities and service system needs. Updates of functional planning documents are also conducted to assure that agency plans would serve to implement the DP as well as to provide for coordination of plans and programs among the various agencies. A typical agency may develop a set of core documents such as:

- A resource-constrained long-range capital improvement program. A long-range financing plan, with identification of necessary new revenue measures or opportunities.
- A development schedule with top priorities for areas designated for earliest development.
- Service and facility design standards, including level of service guidelines for determining adequacy.

Discussion

This project is in line with the priorities and objectives of the PUC DP. With regard to the Plan's Section 5.1, Public Facility Investment Priorities, this project reflects ENV's active role in planning infrastructure improvements for wastewater systems. Regarding Section 5.2, Development Priorities, investment in the improvements proposed in this project is consistent with the PUC DP emphasis on proactive infrastructure planning. Finally, this project implements Section 5.4, Functional Planning, by determining wastewater needs, assigning priorities and phasing requirements of this project. The long term plans developed under this project include capital improvement plans, a development schedule and detailed service and facility standards for the envisioned wastewater system.

7.2.2.2 Central Oahu Sustainable Communities Plan

The Central Oahu SCP, approved in 2002 and currently under revision (anticipated to be circulated for public review in 2014 or 2015), implements the objectives and policies of the General Plan for Central Oahu, which is described as "one of Oahu's principal residential development areas." The proposed project is consistent with the implementation strategies described in the Central Oahu SCP, Chapter 5. A particularly pertinent area is quoted below.

> 5.1.1 Public Facility Investment Priorities
>
> The regional directed growth strategy requires the cooperation of both public and private agencies in planning, financing, and improving infrastructure. The City should take an active role in planning infrastructure and coordinating the expansion of the Honouliuli Wastewater Treatment Plant and reuse of its effluent…

Discussion

This project is consistent with the Central Oahu Sustainable Communities Plan. With regard to the Plan's Section 5.1.1, Public Facility Investment Priorities, this project reflects ENV's active role in planning infrastructure improvements for wastewater systems, particularly the Honouliuli WWTP and the reuse of its treated effluent.

7.2.2.3 Ewa DP

The Ewa DP, most recently updated in 2013, implements the objectives and policies of the General Plan for Ewa. The Ewa DP states:

> In 1977, the Honolulu City Council approved a new General Plan which designated Ewa as the location for a Secondary Urban Center for Oahu to be centered in the Kapolei area. The Secondary Urban Center was to be the focus of major economic activity and housing development, and a center for government services. While the General Plan promotes full development of the Primary Urban Center, it also encourages development of the Secondary Urban Center at Kapolei, and residential development of the urban fringe areas in Ewa and Central Oahu.

The Ewa DP is incorporated into Ordinance 00-16 by reference. The proposed project is consistent with infrastructure and implementation strategies described in the Ewa DP, Chapters 4 and 5. Particularly pertinent areas are quoted below.

> 4.3 WASTEWATER TREATMENT
>
> > …(it is estimated that) the Honouliuli Wastewater Treatment Plant will need to be increased from existing capacity for primary treatment of 38 million gallons per day (mgd) to almost 51 mgd by 2020 to meet projected population and economic growth in Ewa and Central Oahu resulting from implementation of the Development Plans.
> >
> > 4.3.1 GENERAL POLICIES
> >
> > Where feasible, use recycled water recovered from wastewater effluent for irrigation and other uses below the Underground Injection Control line of the State Department of Health and the "No-Pass" Line of the Board of Water Supply.
> >
> > 5.1.2 Public Facility Investment Priorities
> >
> > The regional directed growth strategy requires the cooperation of both public and private agencies in planning, financing, and constructing infrastructure. The City must take an active role in planning infrastructure and coordinating construction of needed infrastructure, such as expansion of the Honouliuli Wastewater Treatment Plant and recovery of nonpotable water from its effluent…
> >
> > Significant Capital Improvement Projects of the highest priority for the Ewa Development Plan are: Expanded wastewater treatment plant capacity, and recycling of non-potable water reclaimed from wastewater effluent at the Honouliuli Wastewater Treatment Plant.

Discussion

This project is consistent with the Ewa DP. With regard to the Plan's Sections 4.3 "Wastewater Treatment", 4.3.1 "General Policies," and 5.1.2 "Public Facility Investment Priorities," this project reflects ENV's active role in planning infrastructure improvements for wastewater systems, particularly the Honouliuli WWTP, and for the reuse of its treated effluent (approximately 13 mgd (approximately 50 percent [%] of the ADF) receives secondary treatment for water reuse at the HWRF). The rated design capacity of the existing Honouliuli WWTP is 38 mgd with one unit on standby and 51 mgd with all units in service. In 2013, the ADF was approximately 26.1 mgd. The proposed secondary treatment upgrades are sized for a projected 2050 design ADF of 45 mgd.

7.3 Zoning

The Land Use Ordinance (LUO), Chapter 21, also referred to as the Zoning Ordinance, regulates land to encourage orderly development in accordance with policies including the Oahu General Plan and development plans. According to the LUO, the proposed improvements "fall" into the land use category of "Utility Installations, Type A".

> "Utility Installations, Type A," means uses or structures, including all facilities, devices, equipment or transmission lines…
>
> Type A utility installations are those with minor impact on adjacent land uses and typically include…sewage pump stations….

Discussion

The project is located within the AG-1 (Restricted Agriculture) and I-2 (Intensive Industrial) zoning districts, as shown in Figure 7-3. According the LUO Master Use Table (Table 21-3), "Utility Installations, Type A" are permitted in both zoning districts, subject to standards in Article 5 of the LUO. A Conditional Use Permit (Minor) is not anticipated to be required, as no potential major impacts are anticipated as a result of the proposed project (this type of permit is typically required for "Utility Installations, Type B" projects where major impacts are anticipated).

7.3.1 Special Management Area

Regulations and procedures within the Special Management Areas pursuant to HRS Chapter 205A are further defined in Chapter 25 of the Revised Ordinances of Honolulu to preserve and protect the natural resources of the coastal zone of Hawaii. No "development" shall be allowed in any county within a special management area without obtaining a permit in accordance with HRS 205A-28.

7.3.1.1 Discussion

None of the proposed alternatives are anticipated to occur within any area designated as a Special Management Area.

7.3.2 Shoreline Setback

Regulations and procedures within the shoreline setback pursuant to HRS Chapter 205A are further defined in Chapter 23 of the Revised Ordinances of Honolulu to protect and preserve the natural shoreline and to reduce hazards to property from coastal floods.

7.3.2.1 Discussion

No development shall be allowed in any county within the shoreline setback without obtaining a shoreline setback variance; however, none of the proposed work is anticipated to occur within the shoreline setback area.

7.4 List of Necessary Approvals

The following is a list of the permits and approvals that may be required for the project prior to construction of the proposed improvements.

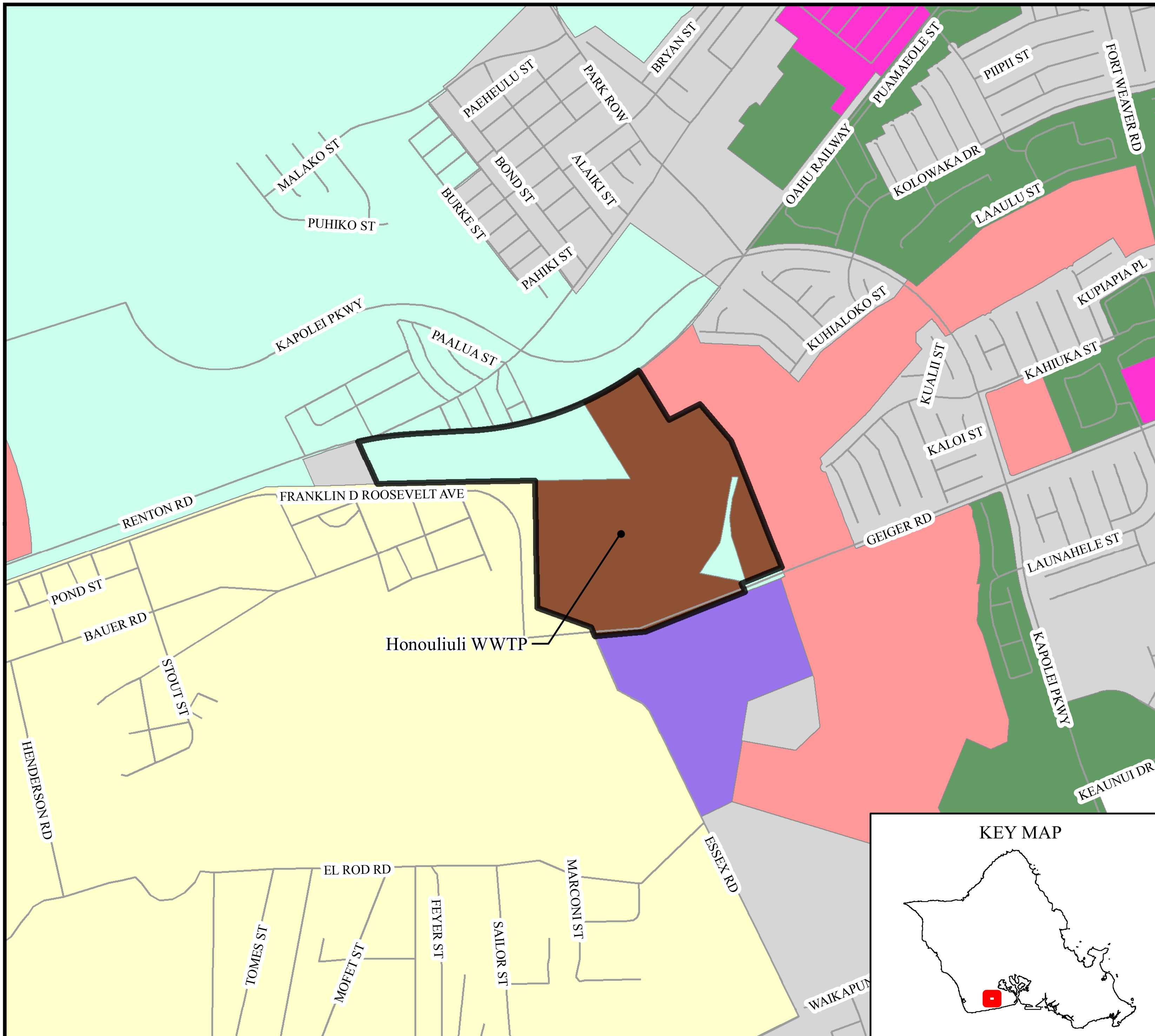
7.4.1 Federal

U.S. Army Corps of Engineers

Department of the Army Permit (CWA Section 404; Rivers and Harbors Act Section 10)

U.S. Environmental Protection Agency

CWA Section 301(h) Review



City and County of Honolulu

HONOULIULI/ WAIPAHU/ PEARL CITY WASTEWATER FACILITIES PLAN

Legend

- Honouliuli WWTP
- Street

Oahu Zones

- A-1 Low-density Apartment District
- AG-1 Restricted Agriculture District
- B-1 Neighborhood Business District
- F-1 Federal and Military Preservation District
- I-2 Intensive Industrial District
- IMX-1 Industrial Mixed Use District
- P-2 General Preservation District
- R-5 Residential District

0 1,200
Feet
1 inch = 1,200 feet

FIGURE 7-3

CITY AND COUNTY OF HONOLULU ZONING

December 2014

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7.4.2 State of Hawaii

Department of Business, Economic Development and Tourism, Office of Planning

Coastal Zone Management Consistency Determination

Department of Health (DOH)

Air Pollution Control Permits (Covered Source Permit and/or Noncovered Source Permit)

Construction Plan Review and Approval

Noise Variance Permit

CWB Individual NPDES Form – Discharge of Municipal Wastewater from New and Existing Publicly Owned Treatment Works (Modification)

CWB Notice of Intent (NOI) Form – Coverage under the NPDES General Permit for Storm Water Discharges Associated with Construction Activities

CWB NOI Form – Coverage under the NPDES General Permit for Discharges Associated with Construction Activity Dewatering (if required)

Department of Land and Natural Resources – Commission on Water Resource Management

Stream Channel Alteration Permit (SCAP)

Historic Preservation – Archeological Monitoring Plan

7.4.3 City and County of Honolulu

Board of Water Supply (BWS)

Water and Water System Requirements

Construction Plan Review and Approval

Department of Transportation

Street Usage Permit for Construction

Department of Environmental Services

EIS Approval

Permission to Discharge into CCH storm drain system (required for CWB NPDES permits)

Department of Planning and Permitting (DPP)

Building Permit

Conditional Use Permit

Construction Plan Review and Approval (One Time Review)

Public Infrastructure Map Revision

Dewatering Permit

Electrical Permit

Flood Certification

Grading and Erosion Control Plan Review

Grading, Grubbing, and Stockpiling Permit

Plumbing Permit

Sidewalk/Driveway Work Permit

Trenching Permit

7.4.4 Others

Utility Companies

Utility Service Requirements

Permit Regarding Work on Utility Lines

Traffic Control Plans

OR&P Plan Review

8 RELATIONSHIP BETWEEN LOCAL AND SHORT-TERM USES OF HUMANITY'S ENVIRONMENT AND THE MAINTENANCE OF LONG-TERM PRODUCTIVITY

8.1 Short-Term Uses

The proposed project alternatives would involve short-term uses of the environment during the construction phase. These uses would have both positive and negative impacts. Construction activities associated with the proposed project alternatives would temporarily require use of resources, including water, energy, fuel, etc.; however, impacts from the increased use of these resources are anticipated to be minimal.

In the short-term, the proposed project alternatives would also result in positive benefits to economic uses in the local area. The economic impacts of project construction would include the impact of expenditures on construction materials, and on earnings of construction workers and professional service providers during construction.

8.2 Long-Term Productivity

In the long-term, the proposed project alternatives and associated improvements would have beneficial impacts on long-term productivity of the Honouliuli wastewater system due to the WWTP expansion for handling flows from future population growth and development.

A substantial amount of financial resources would be required to construct, operate, and maintain the proposed project. The funds would be drawn from a generally limited pool of assessment and operating fees. Therefore, the capital improvement and annual operating costs associated with the proposed facility improvements would result in an increase in sewer rates for the wastewater system customers on Oahu. However, as stated in Section 5.13.1, annual expenditures from operations of the proposed project would result in ongoing increases in economic output, employment, and earnings, and ongoing increases in fiscal revenues. The operation effects from the proposed project would be beneficial, providing regional economic benefits including long-term positive effects on employment, productivity and income in the region.

If the proposed upgrades were not implemented, the result would be failure to comply with the Consent Decree requirement and comply with permit effluent limitations. In addition, wastewater reuse will provide beneficial reduction of the consumptive use of other water resources. Therefore, long-term productivity would be increased by implementation of the proposed project.

9 IRRETRIEVABLE AND IRREVERSIBLE COMMITMENTS OF RESOURCES

Irreversible and irretrievable resource commitments are related to the use of non-renewable resources and the effects that the use of those resources have on future generations. Irretrievable resource commitments involve the loss in value of an affected resource (e.g., extinction of a threatened or endangered species or the disturbance of a cultural site). The proposed project would constitute an irreversible or irretrievable commitment of non-renewable or depletable resources, for the materials, time, money, and energy expended during activities implementing the project.

In the short term, construction activities would require the consumption of fossil fuel and energy, as construction requires equipment that would use fuel, either gasoline or diesel, to operate. Irreversible and irretrievable commitments to resources would be unavoidable (i.e., resulting emissions would contribute to overall air quality of the region) but would be minor and temporary.

The proposed clearing of trees and vegetation in the expansion area of the Honouliuli WWTP property would constitute an irreversible and irretrievable loss of natural resources; however, proposed landscaping plans are recommended to include native vegetation plantings throughout the project area to minimize this loss. As noted previously, although this area is currently vegetated, it is a disturbed site.

Construction activities would require the manufacturing and use of materials. Following construction, unused materials would be reused or recycled whenever possible. Materials that cannot be recycled at the end of the project lifetime would become an irreversible and irretrievable commitment of resources. However, no supplies are considered scarce and thus would not limit other unrelated construction activities in the region. The packaging of construction materials that cannot be reused or recycled, as well as other waste generated during construction activities, would result in an irreversible and irretrievable allocation of landfill or other solid waste disposal capacity.

It is anticipated that the project would have both beneficial and adverse effects on non-residential development and employment in the area. The proposed project would create demand for construction materials and services, and hence direct and indirect (mostly construction- and industrial-related) employment in the project area; however, the use of the additional acreage to provide for additional facilities within the expansion area north of the existing Honouliuli WWTP site may result in loss of long-term development opportunity for other industrial growth. Footprints within the expansion area would be minimized to the extent possible.

In the long term, the upgraded facility would require fossil fuels to generate the energy for heating, cooling and ventilation. However, upgrades would be constructed with modern equipment that incorporates greater efficiencies than those achieved at the existing facilities. Therefore, although irreversible and irretrievable commitments of resources are unavoidable (i.e., using oil for energy production), these impacts are anticipated to be minimal. In addition, there is a potential for energy recovery from digester gas or by utilizing new emerging technology for gasification of sewage sludge. However, at this time, it is not known if the net energy consumption could be feasibly reduced to favorable levels through the implementation of new technologies that are emerging on the market.

Failure to implement the proposed secondary treatment upgrade would result in a failure to comply with the consent decree.

10 PROBABLE ADVERSE ENVIRONMENTAL EFFECTS WHICH CANNOT BE AVOIDED

Adverse impacts can be defined as short- and long-term effects relative to the construction and implementation of a specific use. Short-term impacts are usually construction-related impacts that would occur during the course of construction and cease upon completion of the project. Long-term impacts generally result from the implementation of the proposed project.

10.1 Short-term Effects

The proposed project would result in some unavoidable short-term impacts, as described below. These potential impacts are generally minor and would be further minimized through the implementation of BMPs.

10.1.1 Soils

Construction activities would result in unavoidable impacts to soils in the project area due to grading and excavation activities and due to the potential for localized contamination of soils from construction activities (i.e., accidental release of construction equipment fluids). Construction methods to preserve the integrity of existing facilities would be implemented and construction equipment would be maintained in good working condition to reduce the potential for accidental spills. In addition, erosion and sedimentation controls would be implemented to reduce impacts to the natural environment. Soil which is not immediately used for backfilling would be stockpiled and covered or otherwise protected to prevent erosion or sedimentation. In addition, temporary seeding and mulching may be used to minimize soil erosion and provide soil stabilization on slopes.

10.1.2 Groundwater

Construction activities could potentially impact groundwater if encountered during construction. Mitigation measures would be implemented during construction activities to preserve the integrity of existing infrastructure and keep construction equipment in good working condition to prevent accidental spills. Also, dewatering may be necessary for construction below the groundwater table, if necessary, and the construction contractor would be required to include provisions for dewatering. Appropriate BMPs, monitoring of groundwater and careful site preparation would be utilized to minimize adverse impacts. In addition, construction activities would result in the disturbance of more than one acre; therefore, a NPDES General Permit for Stormwater Discharges from Construction Activities would be required from the DOH Clean Water Branch (CWB). Proposed designs would comply with stormwater runoff requirements, pursuant to the Clean Water Act.

10.1.3 Wetlands

It is anticipated that the abandoned irrigation ditch located on the project site would need to be filled to construct the various site components in that location. All work would be performed in accordance with Federal, State, and CCH regulatory requirements including, but not limited to the Section 404 of the Clean Water Act, if applicable. The project team would consult with the Army Corps of Engineers, U.S. Fish and Wildlife, DLNR Commission on Water Resource Management, CCH, and other regulatory agencies, as necessary, to determine whether filling the former irrigation ditch is jurisdictional under current regulations. If the ditch is determined to be jurisdictional by one or more agencies, then the project team would work with the appropriate agencies to determine acceptable mitigation options.

10.1.4 Flora

Vegetation would need to be removed within the expansion property area for construction activities. Native Hawaiian plants are recommended for landscaping within the project area, including species such as: koʻoloaʻula, kou, ʻilieʻe, and ʻaʻaliʻi to minimize unavoidable impacts to vegetation and trees.

10.1.5 Air Quality

Construction-related air quality impacts would result from site preparation and earth moving activities, the movement of construction vehicles on unpaved areas of the site, emissions from construction equipment, and construction of structures. The construction contractor is responsible for complying with DOH regulations which prohibit visible dust emissions at property boundaries. Although short-term air quality impacts are anticipated to be less than significant, the presence of nearby residences and buildings near most of the affected project sites suggest that open-air areas and naturally ventilated structures could be impacted by dust in spite of compliance with these regulations. BMPs to control dust emissions would be implemented to minimize visible fugitive dust emissions at the property line. The BMPs would include watering of active work areas, using wind screens, keeping adjacent paved roads clean, and covering open-bodied trucks. Measures to control construction emissions from equipment and vehicles can also be considered if necessary, such as using newer equipment and reducing on-site truck idling time. In addition, increased vehicular emissions due to disruption of traffic by construction equipment and/or commuting construction personnel can be alleviated by moving construction materials and workers to the site during off-peak traffic hours.

10.1.6 Noise

Construction noise would be unavoidable during the duration of the respective project construction periods. Short-term increases in noise levels would result from construction activities, vehicles and equipment. The use of muffled equipment, noise barriers, and restrictions on construction hours, as well as adherence to DOH regulations on noise mitigation, would minimize construction and traffic-related noise. For construction work to be performed at night or on weekends and holidays, a Community Noise Variance permit from the DOH would be required if it exceeds regulatory noise levels.

10.1.7 Traffic

An unavoidable slight increase in entering and exiting proposed project traffic is anticipated in some areas during construction activities. Therefore, roadway improvements, including road widening, are recommended at the following five intersections, including intersections 7, 8, 12, 13, and 14 (as shown on Figure 5-7).

- Geiger Road at its intersection with Honouliuli Driveways 1, 2 and 3 (intersections 7, 8, and 12)
- Roosevelt Avenue/Honouliuli Driveway 4 Intersection (intersection 13)
- Renton Road/Honouliuli Driveway 5 Intersection (intersection 14)

10.1.8 Visual and Aesthetic Resources

During construction activities, the presence of cranes and other heavy construction equipment would alter a portion of the viewshed from nearby buildings within the WWTP site. In addition, the proposed improvements would alter the viewshed of the surrounding area by adding new three-dimensional, man-made features. During construction, fencing surrounding the construction site may be provided as needed to provide a visual screen. Any construction impacts regarding visual aesthetics are expected to be short-term and would cease after construction.

10.2 Long-Term Effects

The following unavoidable long-term impacts may result from development of the proposed wastewater facility improvements.

10.2.1 Soils

Following upgrades to the existing WWTP, the potential would still remain for wastewater spills to occur which could result in soil contamination. Soils stability inspections in the vicinity of the foundations of proposed facilities would need to be conducted periodically.

10.2.2 Groundwater

The stormwater detention/infiltration basins proposed at several locations within the project area may have an effect on the local groundwater table. However, these basins would be designed as part of a larger stormwater BMP system and are therefore anticipated to enhance the quality of stormwater recharge to groundwater. In addition, localized effects on groundwater levels may occur due to the potential reduction to local groundwater recharge.

10.2.3 Sludge

There will be an increase in the amount of sludge that is produced, handled, and disposed of due to the upgrade to secondary treatment.

10.2.4 Surface and Coastal Waters

There is a potential for future indirect impacts due to additional development allowed by sewered areas, including an increase in wastewater flow to the Honouliuli WWTP and effluent discharged to Mamala Bay. However, operation of the proposed project is expected to provide for compliance with the consent decree. In addition, this project would minimize the potential of additional SSOs from the existing conveyance and treatment system.

10.2.5 Air Quality

The primary air quality concern associated with the proposed project could be potential odor nuisances. The proposed alternatives include odor control for some of the existing facilities and all new facilities. Compliance with all applicable ambient standards, including odor in terms of H_2S concentration levels, would be demonstrated 1) during the final design stage of the project when the air permit is modified for applicable criteria pollutants and 2) after the completion of construction with an ambient monitoring program for odor. There is potential to increase on-site stationary and mobile source emissions due to an increase in the plant operational capacity. However, the possibility of nuisance odor from the Honouliuli WWTP would likely be reduced by the upgrade to the odor control system, which would help minimize nuisance odor downwind of the Honouliuli WWTP. Operation of the plant under future proposed conditions would involve installation of new standby generators to provide expanded emergency power supply, which may cause potential short-term increase in combustion source emissions. However, given their emergency usage purposes, potential air quality impacts would be short in duration and would be unlikely to cause significant air quality impacts. Thus, mitigation measures in excess of odor control measures would unlikely be necessary during the operational period. If a CHP facility is incorporated at the Honouliuli WWTP, it would need to be permitted according to State and Federal air regulations, as operation of the facility has the potential to produce additional emissions over the long term. The potential air emissions from the facility cannot be defined at this time, since the design is currently conceptual, but would be specified in air quality permit applications.

10.2.6 Traffic

An unavoidable slight increase in entering/exiting project traffic is anticipated during peak hours as a result of the proposed project. Road improvements discussed in Section 10.1.7 are proposed to minimize long term local impacts to traffic.

10.2.7 Noise

The adverse noise impacts resulting from the proposed activity may include increased vehicular noise due to additional vehicles traveling to and from the facilities, and increased stationary noise resulting from new equipment at the facilities. During the operation of the project, compliance with the DOH property line noise limits for fixed machinery would also be required, and it is expected that the long-term noise impacts associated with the proposed improvements would be minimized by the adherence to the DOH rules regarding noise limits for fixed machinery. Mitigation measures include soundproofing or muffling equipment noise such that noise levels remain below the maximum allowable levels. All CCH wastewater facilities must comply with the noise requirements of the DOH, pursuant to Chapter 46, Title 11, Community Noise Control, HAR.

10.2.8 Energy Consumption

Implementation of the proposed improvements would increase demand in energy consumption as all alternatives involve operation of new pumps, blowers, and other equipment required to convey and treat wastewater, which would require use of fuel and electricity. There is a potential for energy recovery from digester gas or by utilizing new emerging technology for gasification of sewage sludge. CCH is currently evaluating alternatives to use the digester gas for energy recovery.

11 SUMMARY OF UNRESOLVED ISSUES

Unresolved issues are invariably associated with projects in the planning and conceptual design stages, as is the case for this proposed project. Consequently, the various planning processes being pursued by the CCH, including the preparation of this DEIS, the Preliminary Engineering Report, and community outreach efforts, are based on the best available information and expertise of those knowledgeable in the design and construction of the proposed types of facilities. The unresolved issues for the proposed project at the time of this DEIS submittal are summarized below along with a discussion of how the issues will be resolved prior to commencement of the project construction and / or operation.

11.1 Design of Secondary Treatment Alternatives and Common Components

The various alternatives and project descriptions presented in this DEIS reflect conceptual designs based on available information. It is likely that adjustments would need to be made as the detailed design of the selected alternative proceeds. As such, the conceptual designs should be regarded as estimates and approximations.

11.2 Site Layout

The site layout presented in this DEIS is intended to conceptualize the potential for land use at the Honouliuli WWTP site for the ultimate build-out in Year 2050. It is understood that some of these functional needs may be met at alternative off site locations in lieu of the Honouliuli WWTP site, in which case additional review would be conducted, if necessary, to analyze associated potential environmental impacts. In addition, several buildings may be restored or demolished; sites of demolished buildings would be made available for future operational needs. It is anticipated that further changes to the site layout, support structures, and buildings will occur as part of later detailed design efforts and results of additional environmental review would be included in future documentation.

11.3 Odor Control

The Honouliuli Wastewater Basin Odor Control Project is ongoing. The project scope addresses odor and corrosion concerns in both the WWTP and tributary collection system. Planning was completed in October 2015. Areas of concern and potential alternatives have been identified in the Preliminary Engineering Report (AECOM 2014b). Pilot testing for collection system and WWTP controls was completed in 2014 and design of improvements is anticipated to be completed by October 2016. An additional environmental review would be conducted and included in documentation for proposed improvements to the WWTP and collection system for improvements not sufficiently included in this DEIS as appropriate.

11.4 System-Wide Improvements to the Honouliuli Wastewater System

The current focus of the Honouliuli Fac Plan is the improvements to the Honouliuli WWTP that are needed to comply with the FACD, which requires that the Honouliuli WWTP be upgraded to a secondary treatment facility by 2024. Meanwhile, the timeline for planning and engineering efforts for other FACD requirements, including improvements to the Honouliuli conveyance system, is independent of the 2024 upgrade deadline, and the recommendations for the conveyance system are still under consideration. Therefore, as previously discussed, the project assessed in this DEIS only concerns the upgrade and expansion of the Honouliuli WWTP to provide secondary treatment and accommodate projected wastewater flows, as well as addresses the potential relocation of non-process facilities (including Administrative support, Central SCADA operations, Laboratory, Ocean Team, Central Shops and the Central Warehouse) that support island-wide wastewater system functions that are currently located at Sand Island WWTP to the Honouliuli WWTP site. The required environmental review associated with the Honouliuli WWTP upgrades, including estimating the flows that will be conveyed to the WWTP, is included in this DEIS. The improvements to the conveyance system will be the subject of separate environmental review documents to be prepared and submitted when the system improvements are better defined.

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14 CONSULTATION

The pre-assessment consultation process included efforts to inform the community and solicit input in scoping the Draft EIS well beyond the requirements of HRS, Chapter 343. This process included formal written consultation pursuant to HRS, Chapter 343 and Title 11, Chapter 200, HAR; meetings with elected officials, agencies, and stakeholders; public informational/scoping meetings; and a core working group process. These outreach efforts are documented below.

14.1 Environmental Impact Statement Preparation Notice Consultation

The following agencies, organizations, and individuals were consulted during the EISPN process. Consultation was conducted to solicit comments from the public regarding their concerns and agency requirements. Notice of availability of the EISPN was published in the July 23, 2010 issue of The Environmental Notice. Copies of all written responses received along with a response to comments matrix (for comment letters warranting a formal response) are reproduced and included in Appendix H. Those who formally replied are highlighted below and responses to comment letters that were included in the response to comments matrix are denoted with a "*" below.

Federal agencies:

- U.S. Congress
  - Daniel Akaka (Ltr and Mtg with his representative)
  - Daniel Inouye (Ltr and Mtg with his representative)
  - Mazie Hirono (Ltr and Mtg with her representative)
  - Charles Djou (Ltr and Mtg with his representative)
- NAVFAC Hawaii (2 Ltrs and Mtg)
- U.S. Army Corp of Engineers (Ltr)
- U.S. Coast Guard, 14th C.G. District (Ltr)
- U.S. Congress
- U.S. Environmental Protection Agency (Ltr)
- U.S. Fish and Wildlife Service, Pacific Division (Ltr and Mtg))
- U.S. National Marine Fisheries Service (Ltr)
- U.S. Natural Resources Conservation Services (Ltr) *
- U.S. Naval Station, Pearl Harbor (Ltr)

State agencies:

- Department of Agriculture (Ltr)
- Department of Accounting and General Services (Ltr and Mtg) *
- Department of Accounting and General Services – Stadium Authority (Ltr and Mtg)
- Department of Business, Economic Development and Tourism (Ltr)
- Department of Business, Economic Development and Tourism – Energy Division (Ltr)
- Department of Business, Economic Development and Tourism – Hawaii Housing Finance and Development Corporation (Ltr)
- Department of Business, Economic Development and Tourism – Office of Planning (Ltr)
- Department of Defense (Ltr) *
- Department of Education (Ltr) *
- Department of Hawaiian Home Lands (Ltr)
- Department of Health (Ltr)
- Department of Health – Clean Water Branch (Ltr and Mtg)
- Department of Health – Environmental Management Div (Ltr)
- Department of Health – OEQC (Ltr)
- Department of Health – Wastewater Branch (Ltr and Mtg)
- Department of Human Services (Ltr)

- Department of Labor and Industrial Relations (Ltr)
- Department of Land and Natural Resources (Ltr and Mtg)
- Department of Land and Natural Resources – Division of Aquatic Resources (Ltr) *
- Department of Land and Natural Resources – Division of Forestry and Wildlife (Ltr)
- Department of Land and Natural Resources – Division of Historic Preservation (Ltr and Mtg)
- Department of Land and Natural Resources – Division of Land Management (Ltr)
- Department of Land and Natural Resources – Land Division (Mtg)
- Department of Land and Natural Resources – Office of Conservation and Coastal Lands (Mtg)
- Department of Land and Natural Resources – Parks Division (Ltr)
- Department of Transportation (Ltr and Mtg)
- Department of Transportation – Highways Division (Ltr) *
- Department of Land and Natural Resources - Commission on Water Resource Management (Ltr)

- House of Representatives
  - District 31 – Linda Ichiyama
  - District 32 – Aaron Johanson
  - District 33 – Blake Oshiro
  - District 34 – Mark Takai
  - District 35 – Henry Aquino
  - District 36 – Roy Takumi
  - District 37 – Ryan Yamane
  - District 38 – Marilyn Lee
  - District 39 – Marcus Oshiro
  - District 40 – Sharon Har
  - District 40 – Ty Cullen
  - District 42 – Rida Cabanilla
  - District 43 – Kymberly Pine
  - District 44 – Karen Awana
  - District 48 – Jon Karamatsu)

- Office of Hawaiian Affairs (Ltr)

- Senate
  - District 14 – Donna Mercado Kim
  - District 15 – Glenn Wakai
  - District 16 – David Ige
  - District 17 – Michelle Kidani
  - District 18 – Clarence Nishihara
  - District 19 – Mike Gabbard
  - District 20 – Will Espero
  - District 21 – Maile Shimabukuro
  - District 22 – Donovan Dela Cruz

City and County of Honolulu agencies:

- Board of Water Supply (Ltr and Mtg) *
- Council Members
  - City Council, District 1 – Tom Berg
  - City Council, District 2 – Ernie Martin
  - City Council, District 5 – Ann Kobayashi
  - City Council, District 7 – Romy Cachola
  - City Council, District 8 – Breene Harimoto
  - City Council, District 9 – Nestor Garcia
- Department of Design and Construction (Ltr and Mtg)
- Department of Facility Maintenance (Ltr and Mtg)

- Department of Parks and Recreation (Ltr) *
- Department of Planning and Permitting (Ltr) *
- Department of Transportation Services (Ltr and Mtg)
- Honolulu Fire Department (Ltr) *
- Police Department (Ltr)
- Emergency Services Department (Ltr)
- Office of Mayor Mufi Hannemann (Ltr)
- Mayor's Office (Ltr)

<u>Other Organizations:</u>

- Ahahui Siwila Hawaii O Kapolei Hawaiian Civic Club (Ltr)
- Coral Creek Golf Course (Mtg)
- Ewa Beach Boys & Girls Club (Ltr)
- Ewa Beach Community Association (Ltr)
- Ewa by Gentry Community Association (Ltr)
- Ewa Task Force (Ltr)
- Hawaii Audubon Society (Ltr)
- Hawaii Farm Bureau Federation (Ltr and Mtg)
- Hawaii Natural Heritage Program (Ltr)
- Hawaii Railway Society (Ltr and Mtg)
- Hawaiian Telecom Company (Ltr)
- Hawaii's Thousand Friends (Ltr)
- Honokai Hale/Nanakai Gardens Community Assn (Ltr)
- Ewa Beach Lions Club (Ltr)
- Kapolei Rotary Club (Ltr)
- Kapolei Chamber of Commerce (Ltr)
- Makakilo Community Association (Ltr)
- Neighborhood Commission Office (Ltr and Mtg)
- Oceanic Cable (Ltr)
- Outdoor Circle (Ltr)
- Palelehua Community Association (Ltr)
- Rotary Club of Kapolei (Ltr)
- UH Environmental Center (Ltr)
- Villages of Kapolei Association (Ltr)
- Waipahu Community Association (Ltr)
- West Loch Estates Homeowner Association (Ltr)
- West Oahu Economic Development Association (Ltr)
- Neighborhood Board
- Aiea Neighborhood Board #20 (Ltr)
- Aliamanu/Salt Lake/Foster Village Neighborhood Board #18 (Ltr)
- Ewa Neighborhood Board #23 (Ltr)
- Makakilo/Kapolei/Honokai Hale Neighborhood Board #34 (Ltr)
- Mililani Mauka/Launani Valley Neighborhood Board #35 (Ltr)
- Mililani/Waipio/Melemanu Neighborhood Board #25 (Ltr)
- Pearl City Neighborhood Board #21 (Ltr)
- Waipahu Neighborhood Board #22 (Ltr)
- Utilities
- Hawaii Electric Company (3 Ltrs and Mtg)
- The GAS Company (Ltr)

14.2 Meetings with Elected Officials, Agencies and Stakeholders

Meetings were held with the following government officials, agencies, and organizations during the EISPN process.

Federal agencies:

- U.S. Congress
  - Daniel Akaka
  - Daniel Inouye
  - Mazie Hirono
  - Charles Djou
- NAVFAC Hawaii
- U.S. Fish and Wildlife Service, Pacific Division

State agencies:

- Department of Accounting and General Services (meeting held on September 29, 2010)
- Department of Accounting and General Services – Stadium Authority
- Department of Health – Clean Water Branch
- Department of Health – Wastewater Branch
- Department of Land and Natural Resources
- Department of Land and Natural Resources – Division of Historic Preservation
- Department of Land and Natural Resources – Land Division
- Department of Land and Natural Resources – Office of Conservation and Coastal Lands
- Department of Transportation

City and County of Honolulu agencies:

- Board of Water Supply
- Department of Design and Construction
- Department of Facility Maintenance
- Department of Transportation Services

Other Organizations:

- Coral Creek Golf Course
- Hawaii Farm Bureau Federation
- Hawaii Railway Society (meeting held on September 1, 2010)
- Neighborhood Commission Office
- HECO

14.3 Draft EIS Consultation

Pursuant to HRS, Chapter 343, and Title 11, Chapter 200, HAR consultation will be conducted during the Draft EIS comment period to solicit comments from public agencies, elected officials, and community organizations regarding their concerns and agency requirements. Due to the change in project scope to only include the upgrade and expansion of the Honouliuli WWTP and to address the potential relocation of non-process facilities to the Honouliuli WWTP site, the list of agencies, organizations, and individuals consulted during the EISPN process included above has been reduced, as follows. Copies of all written comments received along with their respective responses will be reproduced and included in the forthcoming Final EIS.

Federal agencies:

- U.S. Congress
  - Brian Schatz
  - Mazie Hirono
- U.S. Army Corp of Engineers

- U.S. Congress
- U.S. Environmental Protection Agency
- U.S. Fish and Wildlife Service, Pacific Division
- U.S. Natural Resources Conservation Services

State agencies:

- Department of Agriculture
- Department of Accounting and General Services
- Department of Accounting and General Services – Stadium Authority
- Department of Business, Economic Development and Tourism
- Department of Business, Economic Development and Tourism – Energy Division
- Department of Business, Economic Development and Tourism – Hawaii Housing Finance and Development Corporation
- Department of Business, Economic Development and Tourism – Office of Planning
- Department of Defense
- Department of Education
- Department of Hawaiian Home Lands
- Department of Health
- Department of Health – Clean Water Branch
- Department of Health – Environmental Management Div
- Department of Health – OEQC
- Department of Health – Wastewater Branch
- Department of Human Services
- Department of Labor and Industrial Relations
- Department of Land and Natural Resources
- Department of Land and Natural Resources – Division of Aquatic Resources
- Department of Land and Natural Resources – Division of Forestry and Wildlife
- Department of Land and Natural Resources – Division of Historic Preservation
- Department of Land and Natural Resources – Division of Land Management
- Department of Land and Natural Resources – Land Division
- Department of Land and Natural Resources – Office of Conservation and Coastal Lands
- Department of Land and Natural Resources – Parks Division
- Department of Transportation
- Department of Transportation – Highways Division
- Department of Land and Natural Resources - Commission on Water Resource Management
- House of Representatives
  - District 40 – Bob McDermott
  - District 41 – Matthew LoPresti
  - District 43 – Andria Tupola

- Office of Hawaiian Affairs

- Senate
  - District 19 – Will Espero
  - District 20 – Mike Gabbard

City and County of Honolulu agencies:

- Board of Water Supply
- Council Members
  - City Council, District 1 – Kymberly Marcos Pine
  - City Council, District 9 – Ron Menor

- Department of Design and Construction
- Department of Facility Maintenance
- Department of Parks and Recreation
- Department of Planning and Permitting
- Department of Transportation Services
- Honolulu Fire Department
- Police Department
- Emergency Services Department
- Office of Mayor Kirk Caldwell
- Mayor’s Office

<u>Other Organizations:</u>

- Ahahui Siwila Hawaii O Kapolei Hawaiian Civic Club
- Barbers Point Golf Course
- Coral Creek Golf Course
- Ewa Beach Boys & Girls Club
- Ewa Beach Community Association
- Ewa by Gentry Community Association
- Ewa Task Force
- Hawaii Audubon Society
- Hawaii Farm Bureau Federation
- Hawaii Natural Heritage Program
- Hawaii Railway Society
- Hawaiian Telecom Company
- Hawaii’s Thousand Friends
- Honokai Hale/Nanakai Gardens Community Assn
- Ewa Beach Lions Club
- Kapolei Chamber of Commerce
- CCH Neighborhood Commission Office
- Outdoor Circle
- Rotary Club of Kapolei
- UH Environmental Center
- Villages of Kapolei Association
- West Oahu Economic Development Association
- Ewa Neighborhood Board #23
- Makakilo/Kapolei/Honokai Hale Neighborhood Board #34
- Utilities
- Hawaii Electric Company (HECO)
- The GAS Company

Appendices

Appendix A
Honouliuli Fac Plan Work Task 4.F.1 – Updated Basis of Design: Population, Flows, and Loads, Technical Memorandum, June 2012

AECOM **Water**

Submitted to:
City and County of Honolulu
Department of Environmental Services
1001 Uluohia Street Suite 308
Kapolei, Hawaii 96707

Submitted by:
AECOM
1001 Bishop Street, Suite 1600
Honolulu, Hawaii 96813

Honouliuli/Waipahu/Pearl City Wastewater Facilities Plan

Updated Basis of Design Population, Flows, and Loads Item 4.F.1

Work Task 4 – Preliminary Engineering Report

Technical Memorandum-*Final*
June 2012

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List of Acronyms

BOD	Biochemical Oxygen Demand
capita	Population
CCH	The City and County of Honolulu
CIP	Capital Improvement Plan
DBET	Department of Business, Economic Development, and Tourism
DPP	Department of Planning and Permitting
ENV	Department of Environmental Services
EPA	United States Environmental Protection Agency
GIS	Geographic Information System
gpcd	Gallons per Capita Day
GST	Gravity Sewer Tunnel
Hawaii	State of Hawaii
Honouliuli Fac Plan	Honouliuli/Waipahu/Pearl City Wastewater Facilities Plan
I/I	Infiltration and Inflow
IPS	Influent Pump Station
lb	Pound
mgd	Million Gallons per Day
NOAA	National Oceanic and Atmospheric Administration
NH_3-N	Ammonia Nitrogen
Oahu	Honolulu County
PER	Preliminary Engineering Report
Res	Resident
Sewer I/I Plan	Final Sewer Infiltration and Inflow Plan
SSO	Sanitary Sewer Overflows
TAZ	Transportation Analysis Zones
TKN	Total Kjehldahl Nitrogen
TM	Technical Memorandum
TP	Total Phosphorous
TSS	Total Suspended Solids
VU	Visitor Accommodation Units
WWPS	Wastewater Pump Station
WWTP	Wastewater Treatment Plant

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Executive Summary

The City and County of Honolulu (CCH) Department of Environmental Services (ENV) is in the process of developing the Honouliuli/Waipahu/Pearl City Wastewater Facilities Plan (Honouliuli Fac Plan), which covers the Honouliuli sewer basin. The study area for the Honouliuli Fac Plan consists of the Honouliuli Wastewater Treatment Plant (WWTP) and its wastewater service area, including the Ewa and Central Oahu area from Ko Olina to Halawa with the focus on the main conveyance system flowing east to west, from Halawa to Waimalu to Pearl City to Waipahu and to the WWTP. **Figure ES 1** shows the CCH operated WWPSs, Honouliuli WWTP, and the main conveyance system (East Interceptor).

The Honouliuli sewer basin serves a current population of over 300,000 and includes 17 CCH operated wastewater pump stations (WWPSs) and the Honouliuli influent pump station (IPS). The Honouliuli WWTP provides primary treatment to all flow and secondary treatment to approximately half of the total flow received. In 2010, the Honouliuli WWTP treated an average of 25.39 million gallons per day (mgd) of wastewater from the sewer basin.

The 2010 Consent Decree requires the upgrade of the existing Honouliuli WWTP to full secondary treatment by 2024. The population, flow, and load projections conducted under this work task and summarized in this technical memorandum will be used as basis of design criteria for the upgrade of the WWTP.

The scope and purpose of this task is to:

- Update the previous population projections from Task 4.A using 2010 Census data and other population and development data made available since the previous projection effort conducted in 2008;
- Provide population projections through the year 2050, with projections for an intermediate design year of 2035 for design of facilities that could be constructed in phases; and
- Update flow and load projections using the population projections.

The objectives of this task were defined and executed in the following order:

a. Determine 2010 population in each tributary area (Halawa, Waimalu, Pearl City, and Waipahu WWPSs and Honouliuli IPS).

b. Project 2035 and 2050 population in each tributary area.

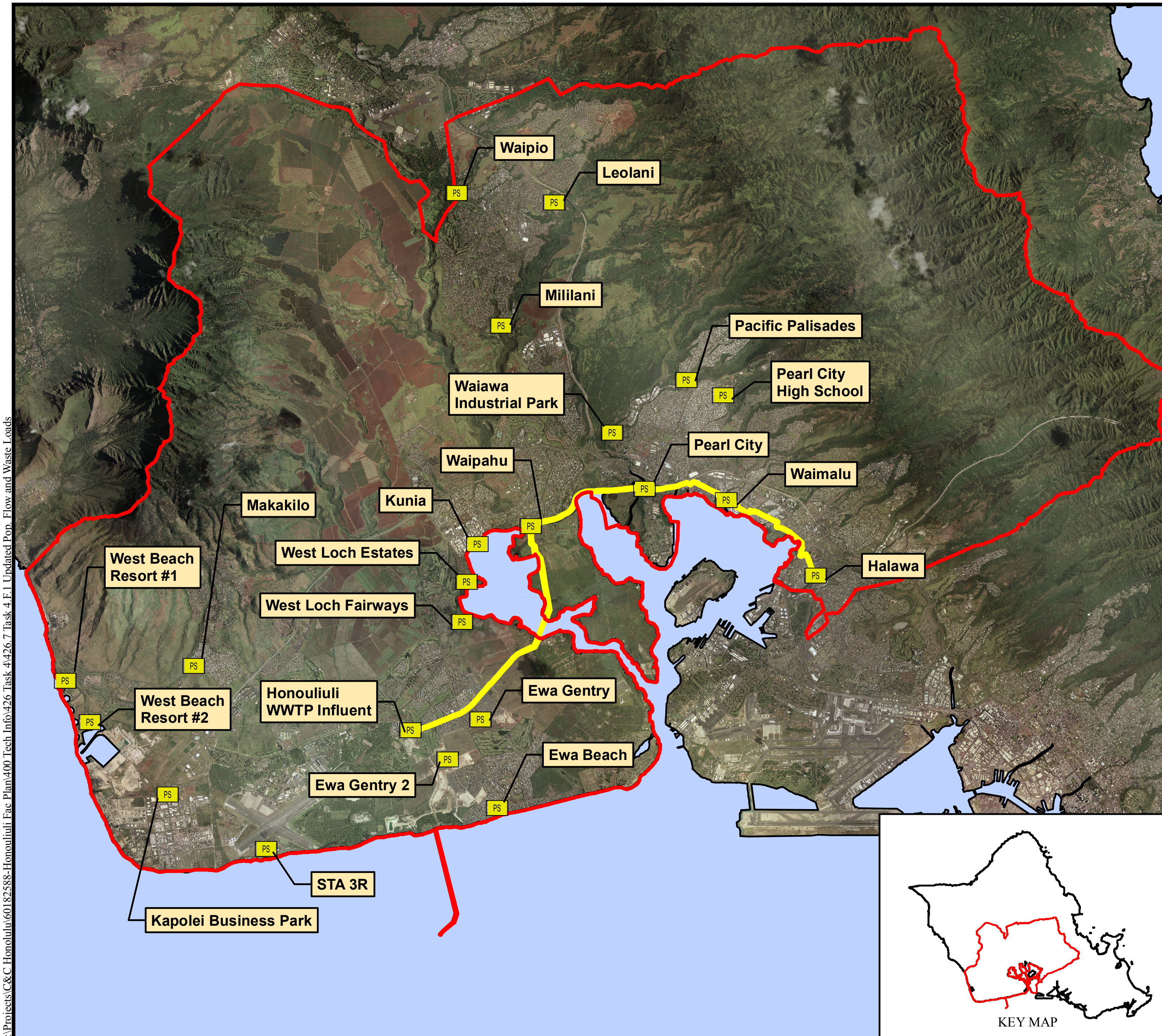
c. Determine 2010 wastewater flows at Halawa, Waimalu, Pearl City, and Waipahu WWPSs and Honouliuli WWTP.

d. Estimate 2010 per capita flow in each tributary area based on 2010 wastewater flows and population.

e. Project 2035 and 2050 wastewater flow in each area using 2010 per capita flow and 2035 and 2050 population, respectively.

f. Determine 2010 loads at Honouliuli WWTP.

g. Project 2035 and 2050 loads at the WWTP using 2010 waste load coefficients and 2035 and 2050 population, respectively.



City and County of Honolulu

HONOULIULI/ WAIPAHU/ PEARL CITY WASTEWATER FACILITIES PLAN

Legend

PS Pump Station
Honouliuli Boundary
East Interceptor

0 12,000
Feet
1 inch = 12,000 feet

Task 4.F.1 Update Basis of Design Population, Flows, and Loads

FIGURE ES-1

HONOULIULI FOCUS AREA

June 2012

AECOM
1001 BISHOP ST, STE 1600
HONOLULU, HAWAII 96813

UPDATED POPULATION PROJECTIONS

Conducting the population projections entailed a substantial data collection effort. Key agencies contacted include the Hawaii Department of Business, Economic Development, and Tourism (DBEDT) and CCH Department of Planning and Permitting (DPP), which are responsible for conducting socioeconomic projections for Hawaii and the island of Oahu, respectively. Also, numerous planning reports and data were reviewed. The projections consider long-term, historic trends for the sewer basin, as well as available data and projections released by CCH and large-scale developments and proposed projects in the area. Previous population and employment projections conducted by AECOM and others were also referenced to assist with the effort. **Table ES 1** shows the results of the updated population projections. Population is projected to decrease slightly in the more mature areas of the sewer basin (such as the Halawa and Waimalu tributary areas), while the majority of growth is projected to occur within the Honouliuli IPS tributary area, where the growing City of Kapolei is located as well as several proposed large-scale developments. Populations in the areas of Pearl City and Waipahu are also projected to increase, due to a number of proposed developments.

Table ES 1. Updated Population Projections Results

Pump Station Tributary Area(1)	Projection Update								
	2010(2)			2035			2050		
	Res	Non-Res	Visitor	Res	Non-Res	Visitor	Res	Non-Res	Visitor
Halawa	15,787	14,193	0	15,562	15,060	0	15,395	15,168	0
Waimalu	32,791	13,213	97	31,695	14,811	92	30,987	15,176	92
Pearl City	39,079	14,503	0	59,956	22,385	0	67,633	26,598	0
Waipahu	128,546	31,492	0	133,979	48,212	0	134,327	50,403	0
Honouliuli Influent	90,214	29,456	1,805	167,042	100,834	11,267	201,082	134,375	14,897
Total	306,417	102,857	1,902	408,234	201,302	11,359	449,424	241,720	14,989
Population Equivalent	325,976(3)			452,938(3)			504,239(3)		

(1) Populations presented are for the areas shown in **Figure 3-2**

(2) Results do not include the following estimated population not served by sewer (based on comparison of aerial photographs and limits of existing collection system): 9,177 Residential; 17,095 Non-Residential.

(3) The following equation was used to arrive at a population value to facilitate computation of per capita sanitary flows/loadings: Population Equivalent = Res Pop. + (11/63) × Non-Res Pop. + (53/63) × Visitor Pop. (63, 11, and 53 are gallons per capita per day wastewater generation values for residential, non-residential, and visitor, respectively, as presented in **Section 3.2.3**).

FLOW PROJECTIONS

Wastewater flows to the Honouliuli WWTP are composed of three components: sanitary flow, dry weather infiltration, and wet weather infiltration/inflow. Development of flow projections for the intermediate design year of 2035 and design year of 2050 involved development of projections for each of the three components of the flow. Flow projections were based initially on measurements of actual flows from flow metering conducted in the 2009-2011 time period as part of the Sewer I/I Assessment and Rehabilitation Program Update project. Projections of future flows were then based on projections of population increase and anticipated areas of new development. A calibrated InfoWorks model was used to route flows through the collection and transport system to generate projected flows at the Honouliuli WWTP. **Table ES 2** shows the typical year flow projections and **Table ES 3** shows the storm flow projections for years 2010, 2035, and 2050.

Table ES 2. Flow Projections from the Honouliuli System Model

Location	Typical Year								
	Peak 1 Hour			Maximum 24 Hour			Annual Average		
	2010	2035	2050	2010	2035	2050	2010	2035	2050
Halawa	3.8	4.9	5.1	2.9	2.9	2.9	1.8	1.9	1.9
Waimalu	10.2	10.3	10.2	7.6	7.6	7.5	5.3	5.3	5.3
Pearl City	16.9	20.0	21.1	12.2	14.7	15.5	8.8	10.8	11.5
Waipahu	20.4	23.0	24.3	13.7	16.1	17.3	11.6	13.2	14.1
WWTP	49.5	69.7	79.5	33.8	50.3	57.0	27.5	39.6	44.4

*All flow values are shown in million gallons per day (mgd)

**This table shows total flow (i.e. sanitary flow, dry weather infiltration, and wet-weather infiltration/inflow)

Table ES 3. Storm Flow Projections from the Honouliuli System Model

Location	2 Year, 6 Hour Storm					
	Peak 1 Hour			Maximum 24 Hour		
	2010	2035	2050	2010	2035	2050
Halawa	5.4	5.5	5.5	3.3	3.4	3.4
Waimalu	18.1	18.1	18.0	10.2	10.2	10.1
Pearl City	30.7	37.7	40.1	16.2	20.4	21.8
Waipahu	24.3	29.7	32.2	15.0	18.3	19.9
WWTP	82.2	114.2	126.4	45.0	65.4	73.5

*All flow values are shown in million gallons per day (mgd)

**This table shows total flow (i.e. sanitary flow, dry weather infiltration, and wet-weather infiltration/inflow)

LOAD PROJECTIONS

The method used to project influent waste loading at Honouliuli WWTP for this TM is the waste load coefficient method. The concentration method was not used because water conservation and water use habits may reduce per capita flow over time, resulting in changing pollutant concentrations. The amount of increase in pollutant concentration is difficult to determine. The per capita waste load coefficient is based on year 2010 data (waste load [lbs/day] and population [capita]). These values are used to estimate waste load coefficients (lbs/capita/day). Industry data shows that waste load coefficients remain relatively constant and are not affected by fluctuations in water usage. The waste load coefficients, along with the 2035 and 2050 population projections are then used to determine mass loadings independent of concentration and flow. **Table ES 4** shows projected influent waste loadings for years 2010, 2035, and 2050.

Table ES 4. Projected Influent Waste Loadings

Contaminants	2010 Concentration (mg/L)	2010 Waste Load Without Imported Sludge (lbs/day)[(3)]	2010 Waste Load Coefficient (lbs/capita/day)[(4)]	2035 Waste Load (lbs/day)[(5)]	2050 Waste Load (lbs/day)[(6)]
BOD	368[(1)]	73,425	0.225	101,911	113,454
TSS	381[(1)]	76,178	0.234	105,987	117,992
TKN	37[(2)]	7,424	0.023	10,418	11,597
NH3	27[(2)]	5,374	0.016	7,247	8,068
TP	4.3[(2)]	858	0.0026	1,178	1,311

(1) From CCH ENV Monitoring and Compliance

(2) From *Wastewater and Process Sampling Analysis for Work Task 12.D Hydraulic Analysis, Process Modeling, and Optimization* (AECOM, 2012)

(3) 2010 Waste Load Without Imported Sludge = 2010 Concentration (mg/L) × 2010 average influent flow (25.39 mgd) × 8.34 (conversion factor) x 94%. (Imported sludge accounts for ~6% of the influent waste load, hence 94%.)

(4) 2010 Waste Load Coefficient = 2010 Waste Load Without Imported Sludge (lbs/day) / 2010 equivalent population (325,976)

(5) 2035 Waste Load (lbs/day) = 2010 Waste Load Coefficient (lbs/capita/day) × 2035 equivalent population (452,938)

(6) 2050 Waste Load (lbs/day) = 2010 Waste Load Coefficient (lbs/capita/day) × 2050 equivalent population (504,239)

If an intermediate design year is desired, such as year 2030, the flow and load projections can be extrapolated from the second order polynomial curves, shown in **Figure ES 2** and **Figure ES 3**.

Figure ES 2. Honouliuli WWTP Flow Projections (with 2030 extrapolation)

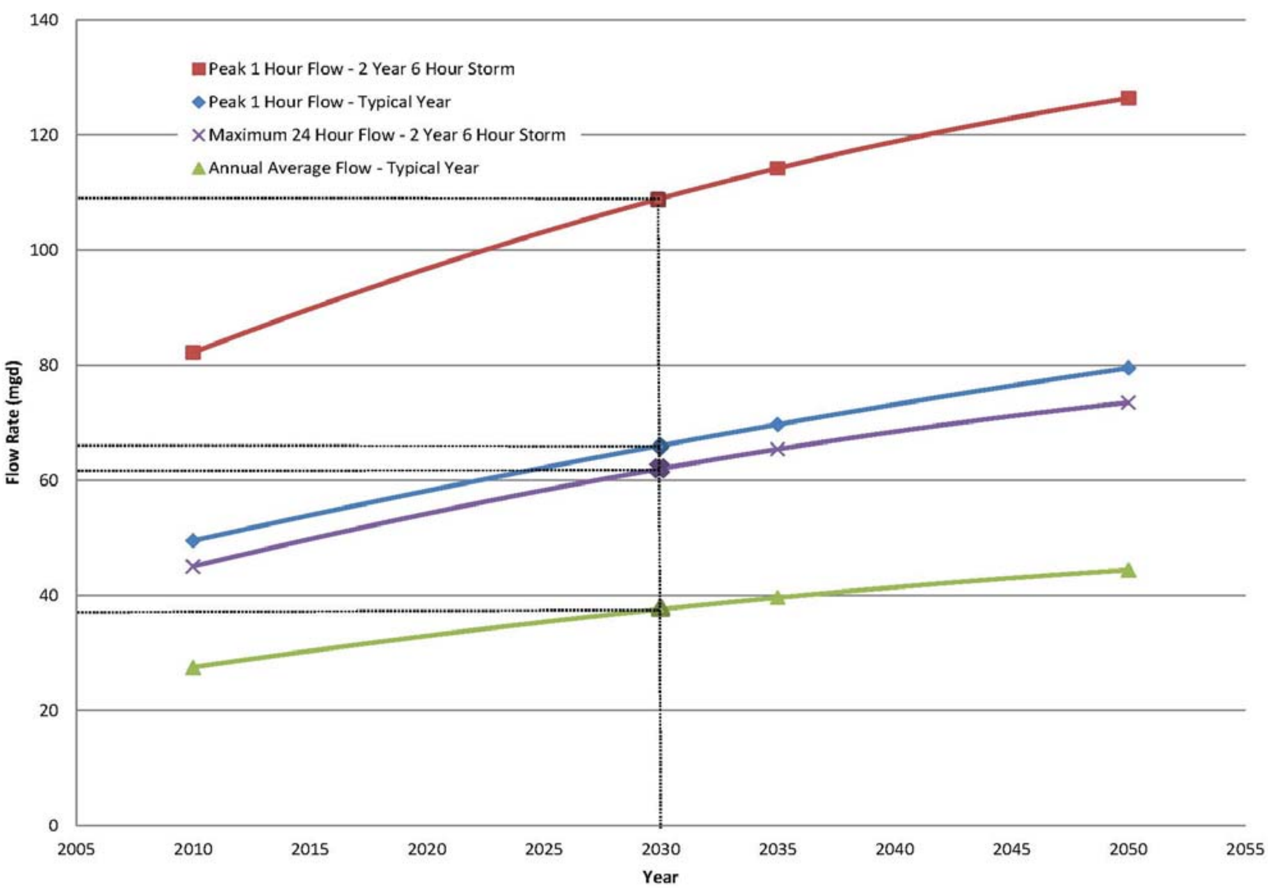
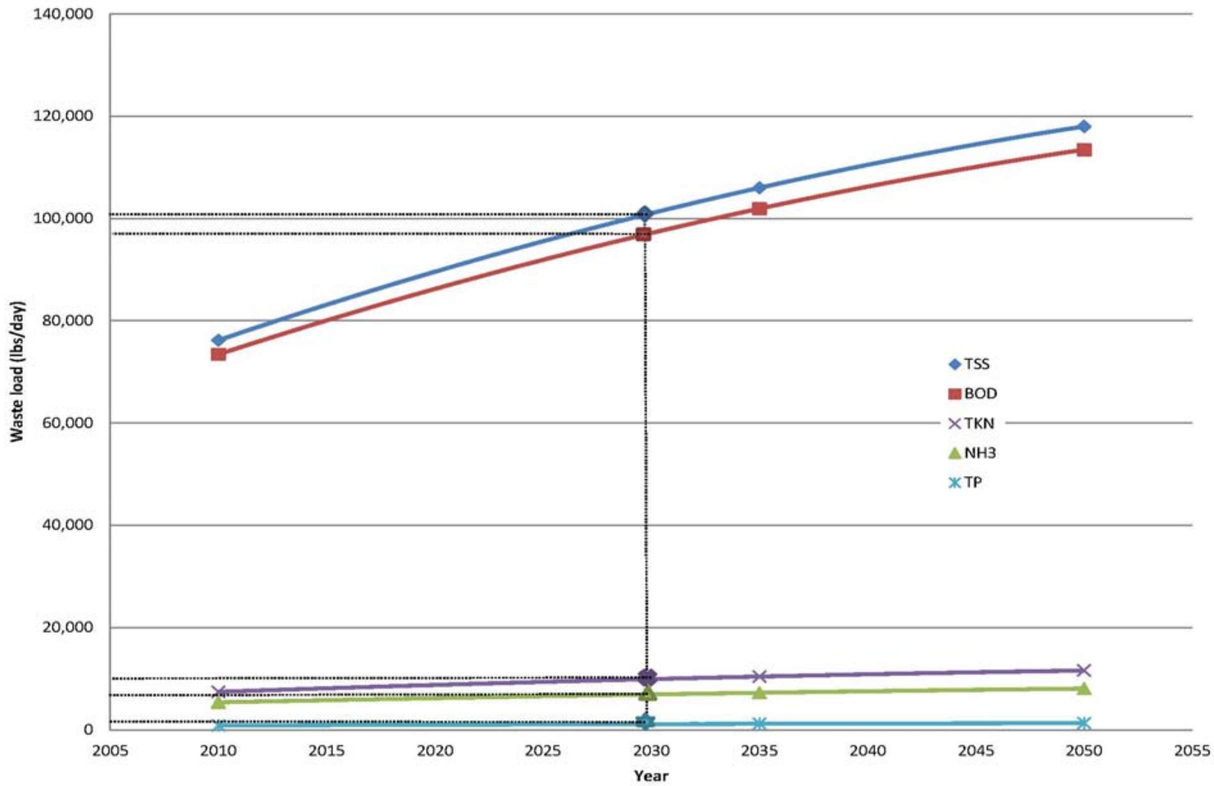


Figure ES 3. Honouliuli WWTP Load Projections (with 2030 extrapolation)



Extrapolated 2030 flow and load results are shown in **Table ES 5** and **Table ES 6**, respectively, for comparison purposes.

Table ES 5. Extrapolated Year 2030 Flow Parameters from the Honouliuli System Model

Flow Parameter	WWTP (mgd)	Waipahu (mgd)	Pearl City (mgd)	Waimalu (mgd)	Halawa (mgd)
Honouliuli Typical Year					
Annual Average	37.6	12.9	10.6	5.3	1.9
Maximum 30-day	38.3	-	-	-	-
Maximum 24-Hour	48.9	15.7	12.9	7.6	2.9
Peak 1-Hour	64.7	22.7	18.1	10.3	4.6
2-Year, 6-Hour Event					
Maximum 24-Hour	62.0	17.8	18.4	10.2	3.4
Peak 1-Hour	107.6	28.9	36.6	18.1	5.5

Table ES 6. Extrapolated Year 2030 Influent Waste Loading

Contaminants	2010 Waste Load Coefficient (lbs/capita/day)(1)	2030 Waste Load (lbs/day)(2)
BOD	0.225	97,140
TSS	0.234	101,007
TKN	0.023	9,921
NH3	0.016	6,922
TP	0.0026	1,124

(1) From **Table ES 4**.

(2) 2030 Waste Load (lbs/day) = Extrapolated from second order polynomial curves shown in Fig ES 2

1 Introduction and Overview

1.1 Background

The City and County of Honolulu (CCH) Department of Environmental Services (ENV) is in the process of developing the Honouliuli/Waipahu/Pearl City Wastewater Facilities Plan (Honouliuli Fac Plan), which covers the Honouliuli sewer basin. The study area for the Honouliuli Fac Plan consists of the Honouliuli Wastewater Treatment Plant (WWTP) and its wastewater service area, including the Ewa and Central Oahu area from Ko Olina to Halawa with the focus on the main conveyance system flowing east to west, from Halawa to Waimalu to Pearl City to Waipahu and to the WWTP.

The Honouliuli sewer basin serves a current population of over 300,000 and includes 17 CCH operated wastewater pump stations (WWPSs) and the Honouliuli influent pump station (IPS). The Honouliuli WWTP provides primary treatment to all flow and secondary treatment to approximately half of the total flow received. In 2010, the Honouliuli WWTP treated an average of 25.39 million gallons per day (mgd) of wastewater from the sewer basin.

CCH is currently operating under a Capital Improvement Plan (CIP) established in the *Final Sewer Infiltration and Inflow (I/I) Plan* (Fukunaga and Associates, 1999), hereafter referred to as the *Sewer I/I Plan*. The purpose of the *Sewer I/I Plan* was to develop the optimal approach to minimize sanitary sewer overflows (SSOs) and fulfill the requirements of the 1995 Consent Decree (Civil No. 94-00765 DAE) between the CCH, the State of Hawaii (Hawaii), and United States Environmental Protection Agency (EPA). Since the completion of the *Sewer I/I Plan*, there have been several population, flow, and load projections including: *Draft Wastewater Long-Term Plan* (CH2M Hill, 2008), *Work Task 1: Population, Flow & Waste Load Projections* (EDAW/AECOM, 2008), and *Work Task 4.A: Design Flows and Waste Load Determination* (AECOM, 2010). In addition, the 2010 Consent Decree includes an update of the 1999 *Sewer I/I Plan.* Currently, there is an ongoing *Sewer I/I Assessment and Rehabilitation Program Update* project which is using flow monitoring and rain data to calibrate a hydraulic model of the collection system.

Additionally, the 2010 Consent Decree requires the upgrade of the existing Honouliuli WWTP to full secondary treatment by 2024. The population, flow, and load projections conducted under this work task and summarized in this technical memorandum will be used as basis of design criteria for the upgrade of the WWTP.

1.2 Scope and Purpose

The scope and purpose of this project is to:

- Update the previous population projections from Task 4.A using 2010 Census data and other population and development data made available since the previous projection effort conducted in 2008;
- Provide population projections through the year 2050, with projections for an intermediate design year of 2035 for design of facilities that could be constructed in phases; and
- Update flow and load projections using the population projections.

The intermediate year of 2035 was chosen to correlate with the *City and County of Honolulu Socioeconomic Projections to 2035* (CCH Department of Planning and Permitting [DPP], September 2009) and the *Population and Economic Projections for the State of Hawaii to 2035* (Hawaii Department of Business, Economic Development, and Tourism [DBEDT], July 2009). Although the 2010 Consent Decree projects use 2030 projections, the 2035 projections are conservative values to use for 2030. The ultimate projection (2050) was chosen based on the fact that construction of the upgraded Honouliuli WWTP is not required to be completed until 2024 and 2024 to 2035 is only 11 years. Typically, WWTPs are designed for 20 to 30 years. *It is recommended* *that the population, flows, and loads be reevaluated prior to the intermediate year to determine if 2050 basis of design values are reasonable as there are many unknowns with upcoming developments.*

This task projects population and wastewater flows at the WWPSs along the East Interceptor (which include the Halawa, Waimalu, Pearl City, and Waipahu WWPSs) and the Honouliuli IPS and loads at Honouliuli WWTP. These wastewater flow projections will determine needs for upgrading and/or expanding the existing collection system along the East Interceptor and the flow and load projections will determine needs for upgrading and/or expanding the existing treatment system at the Honouliuli WWTP. The results of this task will be used as the basis of design criteria for the Halawa, Waimalu, Pearl City, and Waipahu WWPSs and the Honouliuli WWTP.

1.3 Objectives

The objectives of this task were defined and executed in the following order:

a. Determine 2010 population in each tributary area (Halawa, Waimalu, Pearl City, and Waipahu WWPSs and Honouliuli IPS).

b. Project 2035 and 2050 population in each tributary area.

c. Determine 2010 wastewater flows at Halawa, Waimalu, Pearl City, and Waipahu WWPSs and Honouliuli WWTP.

d. Estimate 2010 per capita flow in each tributary area based on 2010 wastewater flows and population.

e. Project 2035 and 2050 wastewater flow in each area using 2010 per capita flow and 2035 and 2050 population, respectively.

f. Determine 2010 loads at Honouliuli WWTP.

g. Project 2035 and 2050 loads at the WWTP using 2010 waste load coefficients and 2035 and 2050 population, respectively.

2 EXISTING COLLECTION SYSTEM

2.1 Honouliuli Sewer Basin

The Honouliuli WWTP provides service to the developed areas in the region around Pearl Harbor, from Halawa in the east to Ko Olina in the west, and extending to Mililani in the north. The Honouliuli WWTP services the communities of Halawa, Aiea, Waimalu, Pearl City, Pacific Palisades, Waiawa, Waipahu, Mililani, Waipio, Village Park, Crestview, Waikele, Kunia, Kapolei, West Loch, Ewa Beach, Makakilo, and Ko Olina. The total service area includes approximately 22,000 acres of developed land and 54,000 acres of undeveloped land.

2.2 Wastewater Pump Stations and Tributary Areas

Within the collection and transport system, wastewater generally flows from east to west and from *mauka* (mountain area) to *makai* (ocean area). Seventeen CCH-operated WWPSs are located throughout the Honouliuli basin, excluding the IPS at the WWTP. The Honouliuli Fac Plan focuses on the area known as the East Interceptor which includes the Halawa, Waimalu, Pearl City and Waipahu WWPSs and their associated sewers and force mains. **Figure 2-1** shows the CCH operated WWPSs, Honouliuli WWTP, and the East Interceptor. A schematic of the connectivity of the tributary areas for each WWPS is shown in **Figure 2-2**.

2.2.1 Honouliuli IPS

The Honouliuli IPS is located on the Honouliuli WWTP site at 91-1000 Geiger Road, adjacent to the Coral Creek Golf Course. The IPS receives wastewater from local tributary areas in the vicinity of the Honouliuli WWTP, as well as flows discharged from the West Beach Resort #1 WWPS (Ko Olina), West Beach Resort #2 WWPS (Ko Olina), Makakilo WWPS, Kapolei Business Park WWPS (privately operated), STA 3R WWPS (military operated), Ewa Gentry WWPS, Ewa Gentry 2 WWPS, Ewa Beach WWPS, and from the East Interceptor (which includes the Waipahu WWPS, Pearl City WWPS, Waimalu WWPS, and Halawa WWPS).

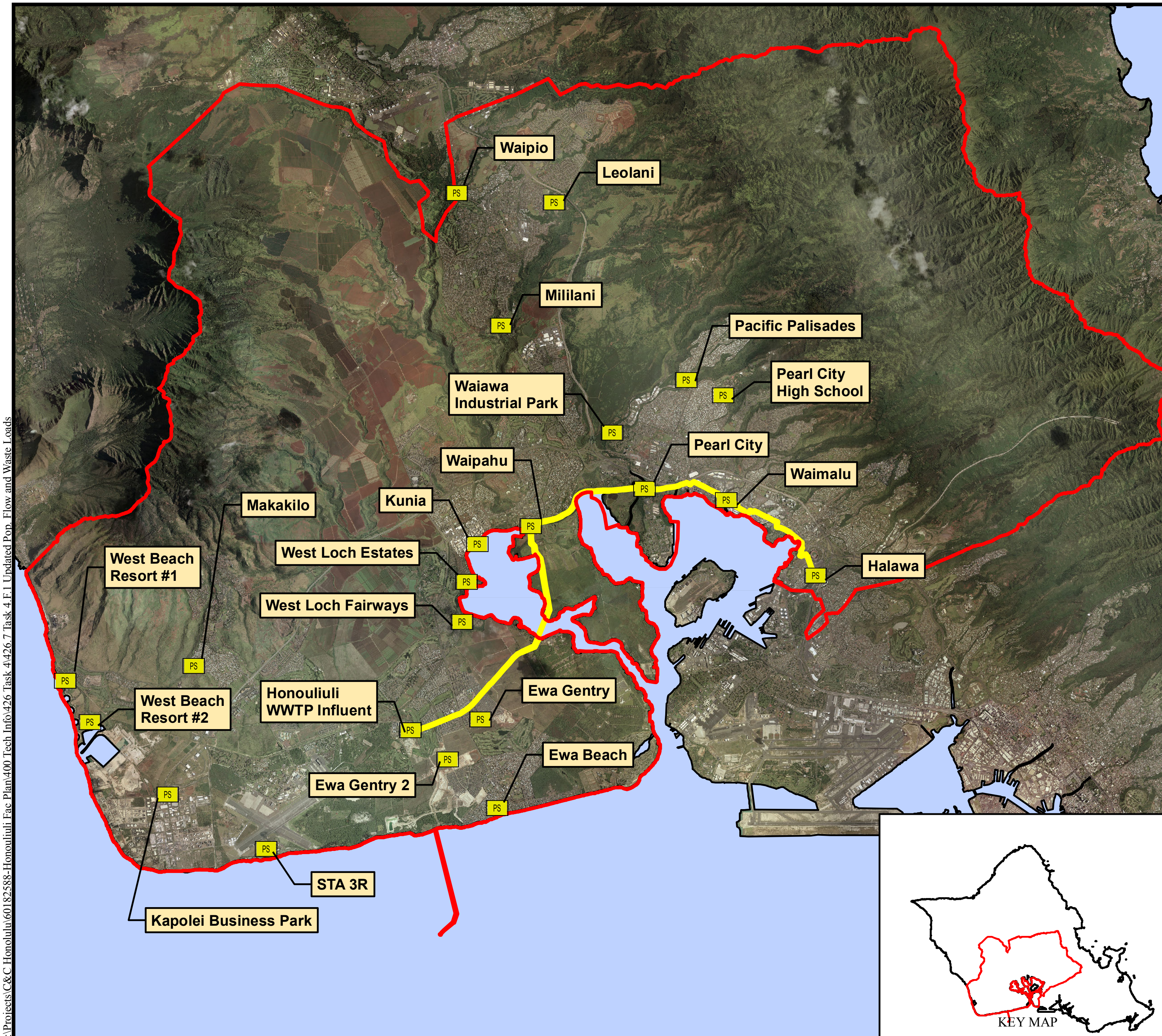
2.2.2 Waipahu WWPS

The Waipahu WWPS is located at 93-065 Waipahu Depot Road near the Waipahu Convenience Center (CCH refuse and recycling center), the Honolulu Fire Department Vehicle Maintenance Facility and Ke Kula Makai (Honolulu Police Academy). The WWPS is located on a portion of two parcels that total approximately 58 acres, although the WWPS footprint is approximately 0.7 acres. The WWPS has been in service since 1963 and receives gravity flow from the local Waipahu tributary area, along with pumped flows from the Kunia WWPS, Waipio WWPS, Leolani WWPS (privately operated), and the Mililani WWPS. The Waipahu WWPS discharges into a dual force main system that conveys flows to the 84-inch diameter sewer tributary to the Honouliuli IPS. The Pearl City WWPS (discussed below) also discharges into the dual force main system.

2.2.3 Pearl City WWPS

The Pearl City WWPS is located on an approximately 0.7 acre site at 790 Lehua Avenue, adjacent to undeveloped land owned by the Federal government. The WWPS has been in service since 1966. The WWPS receives gravity flow from the local Pearl City tributary area, which includes Pearl City High School WWPS (privately operated) along with pumped flows from the Halawa, Waimalu and Waiawa tributary areas. The Pearl City WWPS currently discharges into the dual force main system that also serves the Waipahu WWPS. The dual force main system conveys flows to the 84-inch diameter sewer tributary to the Honouliuli IPS.

The Pearl City WWPS is currently located in the flood zone. The *Sewer I/I Plan* (Fukunaga and Associates, 1999) recommended relocating and upgrading of the Pearl City WWPS; this project is included in the 2010 Consent Decree for evaluation and recommendation to determine the needs of the Pearl City WWPS. The evaluation and recommendation of the Pearl City WWPS is a task included in the Honouliuli/Waipahu/Pearl City Wastewater Facilities Plan.



City and County of Honolulu

HONOULIULI/ WAIPAHU/ PEARL CITY WASTEWATER FACILITIES PLAN

Legend

PS Pump Station
Honouliuli Boundary
East Interceptor

0 12,000
Feet
1 inch = 12,000 feet

Task 4.F.1 Update Basis of Design Population, Flows, and Loads

FIGURE 2-1

HONOULIULI FOCUS AREA

June 2012

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HONOLULU, HAWAII 96813

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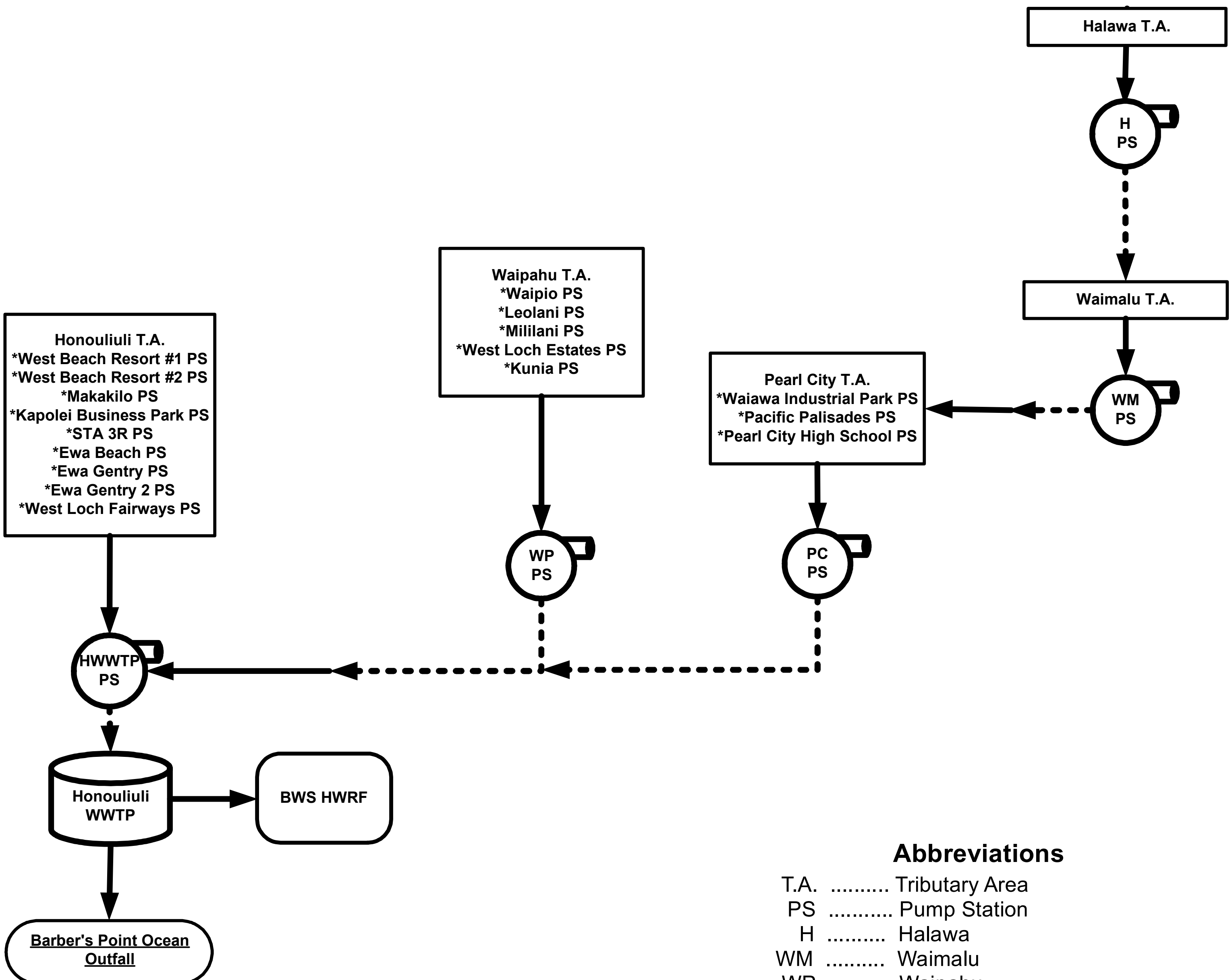
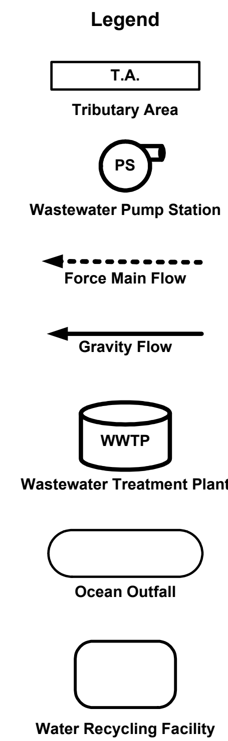
HONOULIULI/ WAIPAHU/ PEARL CITY WASTEWATER FACILITIES PLAN





Abbreviations

T.A. .... Tributary Area
PS .... Pump Station
H .... Halawa
WM .... Waimalu
WP .... Waipahu
PC .... Pearl City
BWS .... Board of Water Supply
HWRF .... Honouliuli Water Recycling Facility
HWWTP .... Honouliuli Wastewater Treatment Plant

Task 4.F.1 Update Basis of Design Population, Flows, and Loads

FIGURE 2-2

HONOULIULI BASIN EXISTING COLLECTION SYSTEM FLOW SCHEMATIC

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2.2.4 Waimalu WWPS

The Waimalu WWPS is located at 245 Kamehameha Highway in the northeast corner of the 21.4 acre Neal Blaisdell Park. The WWPS has been in service since 1968. The WWPS serves the Waimalu tributary area in addition to receiving flows from the Halawa WWPS. The Waimalu WWPS force main discharges flow to the Pearl City WWPS tributary system.

2.2.5 Halawa WWPS

The Halawa tributary area flows are all collected at the Halawa WWPS. The Halawa WWPS is located on an approximately 0.3 acre site at 99-560 Salt Lake Boulevard, adjacent to Halawa Stream and the lower portion of the Aloha Stadium parking lot. The WWPS has been in service since 1970. The Halawa WWPS force main discharges flow to the Waimalu WWPs tributary system.

3 METHODOLOGY

As noted above, population, flow, and load projections for the Honouliuli sewer basin were conducted through the year 2050, including projections for an intermediate design year of 2035. The methodology used to conduct these projections is presented in this section.

3.1 Population Projections

Conducting the population projections entailed a substantial data collection effort. Key agencies contacted include the Hawaii Department of Business, Economic Development, and Tourism (DBEDT) and CCH Department of Planning and Permitting (DPP), which are responsible for conducting socioeconomic projections for Hawaii and the island of Oahu, respectively. Also, numerous planning reports and data were reviewed, including the following (listed chronologically):

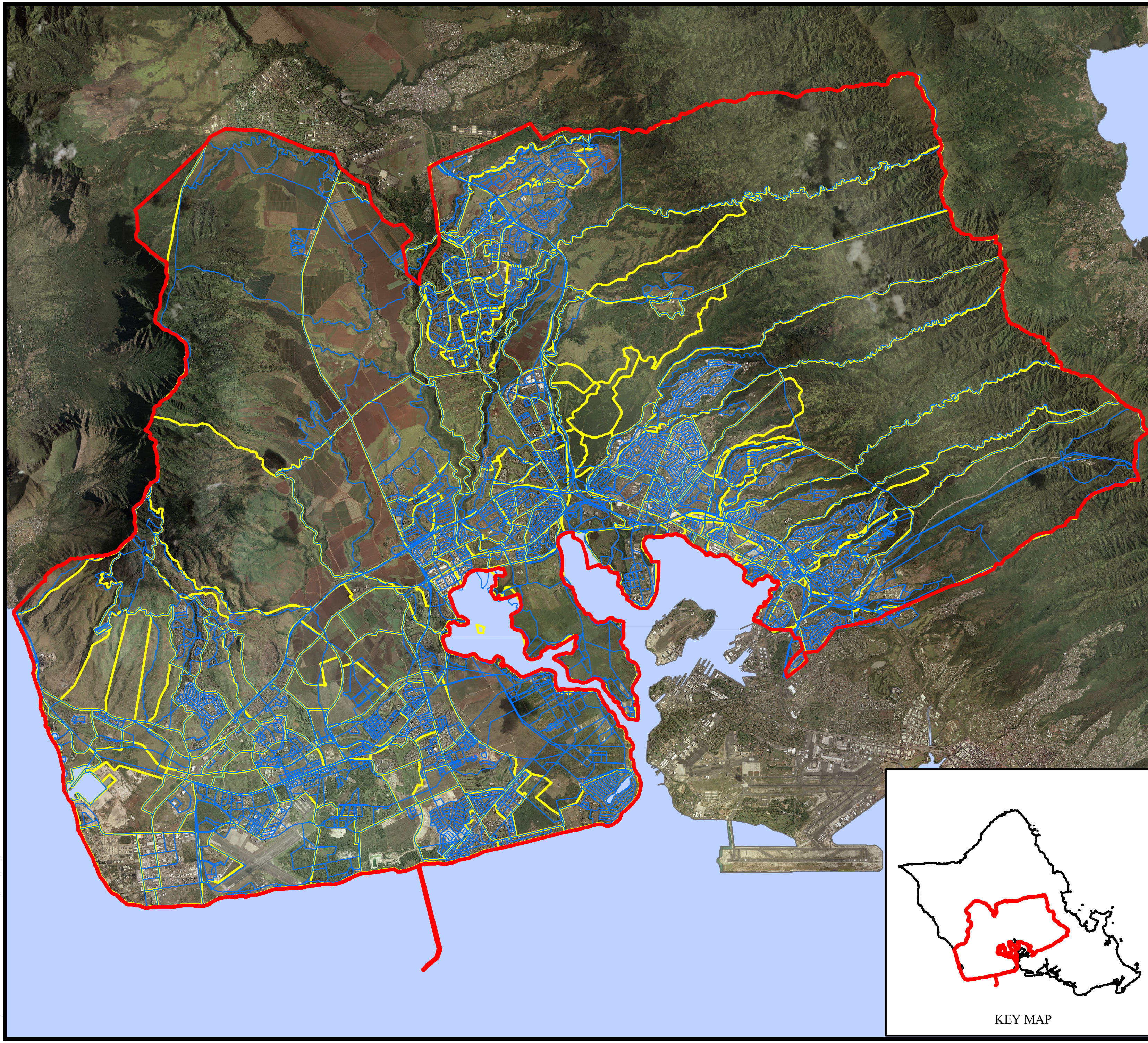
- General Plan: Objectives and Policies, Amended October 2002 (CCH DPP)
- Central Oahu Sustainable Communities Plan, December 2002 (CCH DPP)
- Primary Urban Center Development Plan, June 2004 (CCH DPP)
- Population and Economic Projections for the State of Hawaii to 2035, July 2009 (Hawaii DBEDT)
- City and County of Honolulu Socioeconomic Projections to 2035, September 2009 (CCH DPP)
- Honouliuli High-Capacity Transit Corridor Project Final Environmental Impact Statement/Section 4(f) Evaluation, June 2010 (CCH and US Department of Transportation)
- Annual Report on the Status of Land Use on Oahu: Fiscal Year 2009, August 2010 (CCH DPP)
- Get on Board! Transit Oriented Development Handbook, Spring 2011 (CCH DPP)
- Oahu Regional Transportation Plan 2035, April 2011 (Oahu Metropolitan Planning Organization)
- Proposed Revised Ewa Development Plan, May 2011 (CCH DPP)
- 2010 Census Summary File 1 for Hawaii, June 2011 (US Census Bureau)
- 2010 Annual Visitor Research Report, September 2011 (Hawaii Tourism Authority)

The projections consider long-term, historic trends for the sewer basin, as well as available data and projections released by CCH and large-scale developments and proposed projects in the area. Previous population and employment projections conducted by AECOM and others (identified in **Section 1.1**) were also referenced to assist with the effort.

The source most relied on was the CCH DPP socioeconomic projections to 2035, which are generally used and accepted for county infrastructure planning efforts (AECOM, 2011a). A copy of CCH DPP's 2035 projections is provided as **Appendix A**. CCH DPP's projections are derived from county projections conducted by Hawaii DBEDT. CCH DPP allocates the county projections by Transportation Analysis Zones (TAZ) on Oahu based on local development plans, policies, and development patterns. Each TAZ contains residential, employment (jobs), and visitor accommodation unit data projected through the year 2035.

A total of 764 TAZs comprise the county. To determine the TAZs located within the Honouliuli sewer basin, the TAZ boundaries were overlaid on the sewer basin boundary in GIS. This process resulted in the identification of 201 TAZs within the sewer basin, as illustrated in **Figure 3-1**.

The sewer basin was then divided into tributary areas for the Honouliuli IPS and the Waipahu, Pearl City, Waimalu, and Halawa WWPSs to determine which TAZs (and associated population) are located within each tributary area for the purpose of projecting future tributary area populations. The boundaries of the existing pump



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HONOULIULI/ WAIPAHU/ PEARL CITY WASTEWATER FACILITIES PLAN

Legend

- Sewer Basin
- 2010 Census Blocks
- TAZ Boundaries

0 12,000
Feet
1 inch = 12,000 feet

Task 4.F.1 Update Basis of Design Population, Flows, and Loads

FIGURE 3-1

TRANSPORTATION ANALYSIS ZONES AND US CENSUS BLOCKS

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G:\Projects\MUN\60220849HON\Maps\Figure_3-1.mxd station tributary areas in the sewer basin were estimated in GIS using the current limits of the Honouliuli sewer collection system. In the future, it was assumed that 100% of the population would contribute to the collection system, and the tributary area boundaries were expanded to provide full coverage of the sewer basin (see **Figure 3-2**). The future tributary area boundaries were determined based on review of aerial photography and topographic information. It is understood, however, that future development will not necessarily extend into all parts of the expanded tributary area boundaries. As described in **Section 3.2.4** , the acreage of new development outside of the existing Honouliuli sewer collection system tributary area was estimated based on projected population growth and estimated population densities for those areas.

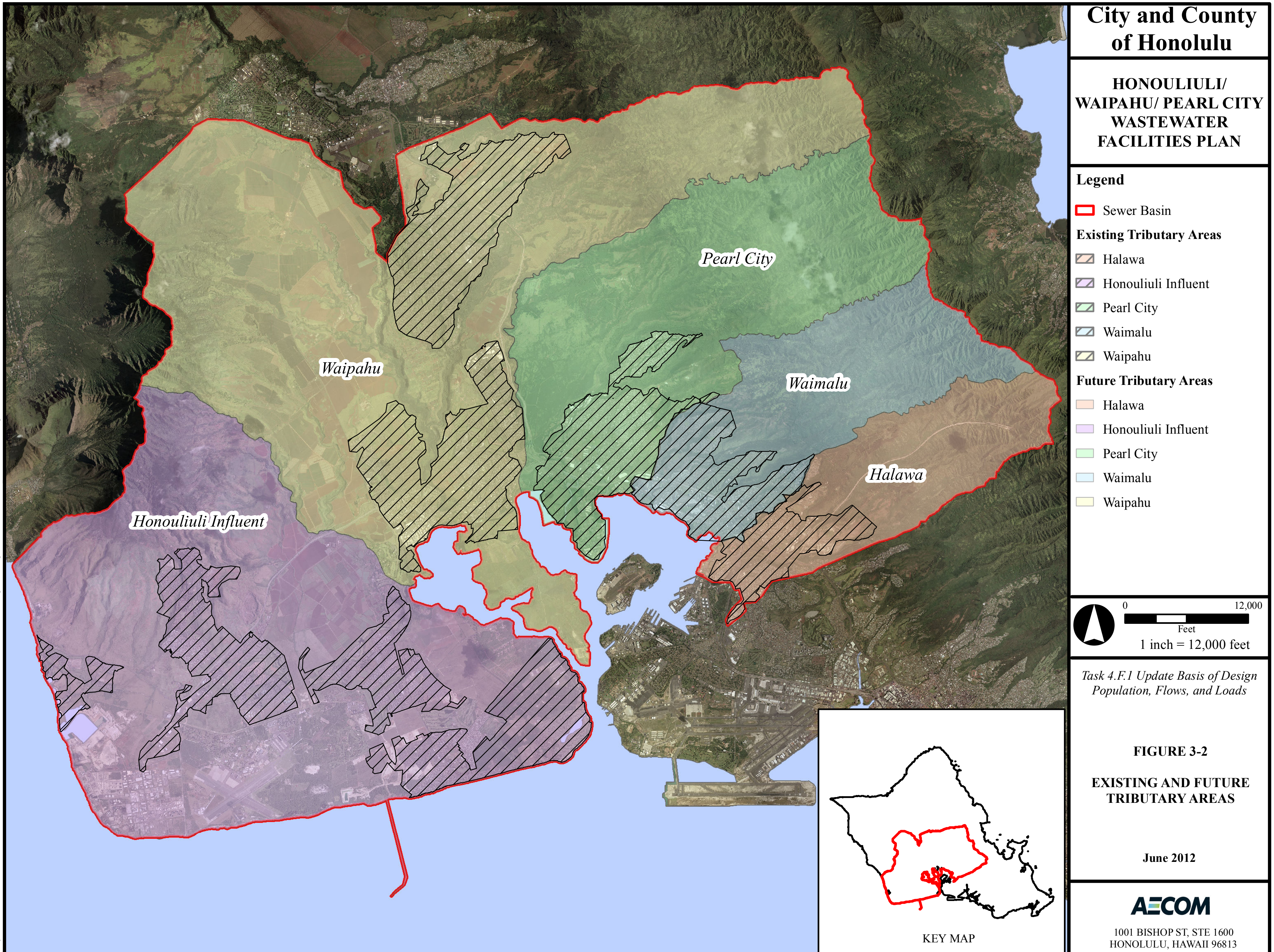
Where the boundaries of the TAZs do not match the boundaries of the tributary areas or sewer basin, the TAZ populations were allocated in proportion to the area within each basin. For example, if only 50% of the area of a given TAZ is within a particular tributary area, only 50% of the TAZ population was assigned to that tributary area. Exceptions were taken in instances where it was evident that population was focused in a certain portion of the TAZ due to development patterns and/or land use conditions.

Three population categories were projected as part of this effort: Residential, Non-Residential, and Visitor. Details on the projection approach for each category is provided below.

3.1.1 Residential Population Projections Approach

Based on communication with CCH DPP, the Hawaii DBEDT has acknowledged that their 2035 projections (on which the CCH DPP projections are based) underestimated the in-migration rate for Oahu, which resulted in a lower 2010 population projection than what was reported by the 2010 Census (AECOM, 2011b). Hawaii DBEDT is in the process of updating their projections to 2040 using the 2010 Census data, but the results are not yet available (AECOM, 2011c). Therefore, AECOM updated the CCH DPP residential projections to reflect the more accurate and more recent 2010 Census data and extended the projections to 2050 using the stepwise approach below:

- Step 1: Determine 2010 TAZ populations based on analysis of 2010 Census data at the block level. For this process, the 2010 Census block GIS shapefiles were overlaid on the TAZ boundaries (see **Figure 3-1**). Where the boundaries of the Census blocks do not match the boundaries of the TAZs, the Census populations were allocated within the TAZs in the same manner described above. The results of Step 1 are provided in **Appendix B** and are the source of the estimated 2010 population.
- Step 2: The projected 2010 TAZ population prepared by the CCH DPP was replaced with the revised 2010 TAZ population based on 2010 Census data (results from Step 1) and used as the starting point for future projections. The 2010 population was adjusted (reduced) to account for non-sewered population located within the Honouliuli sewer basin based on review of the existing tributary area boundaries. Note: This existing non-sewered population was added back into future projections based on the assumption that 100% of the population will ultimately be connected to the sewer system.
- Step 3: Determine 2015 TAZ population. Population growth predicted by the CCH DPP for each TAZ from 2010 to 2015 was added to the revised 2010 TAZ population.
- Step 4: Repeat Step 3 for the remaining period of CCH DPP projections (through 2035) for each five year increment.
- Step 5: For the remaining projection period (2035 through 2050), projections are primarily a continuation of growth rates and trends identified in CCH DPP's 2035 projections for individual TAZs. If a TAZ demonstrated less than 1% annual growth in DPP's projections, then the growth was projected in a linear fashion. If a TAZ demonstrated greater than 1% annual growth in CCH DPP's projections, available development plans and other planning resources were reviewed to determine if the growth rate should be sustained or modified. In most instances, the annual growth rate was decreased for these TAZs but was not allowed to go below 1% annual growth.
- Step 6: The population values for all TAZs located completely or partially within a tributary area boundary were summed to arrive at the estimated 2010 through 2050 populations for each of the tributary areas, and the Honouliuli sewer basin as a whole.



City and County of Honolulu

HONOULIULI/ WAIPAHU/ PEARL CITY WASTEWATER FACILITIES PLAN

Task 4.F.1 Update Basis of Design Population, Flows, and Loads

FIGURE 3-2

EXISTING AND FUTURE TRIBUTARY AREAS

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3.1.2 Non-Residential Population Projections Approach

CCH DPP's non-residential population projections for 2010 through 2035 were used "as is". Non-Residential population is a sum of the following CCH DPP land use forecast variables, which capture all employment/jobs within a TAZ:

- J1 – jobs in military
- J2 – jobs in government
- J3 – jobs in hotel
- J4 – jobs in agriculture
- J5 – jobs in transportation, communication, and utilities
- J6 – jobs in industrial
- J7 – jobs in finance, insurance, and real estate
- J8 – jobs in service
- J9 – jobs in retail
- J10 – jobs in construction (fixed and floating)
- J11 – jobs in construction (floating) Note: Refers to construction workers at job site as opposed to in company office; i.e. not included in J10.

Similar to the 2008 EDAW/AECOM projections effort, it was assumed that the 2035 ratios between Residential population and Non-Residential population for each TAZ would stay the same through the remainder of the projection period (i.e. through 2050), and future Non-Residential population was calculated by applying these ratios. The resulting non-residential population projections are presented in **Appendix C**.

3.1.3 Visitor (Hotel) Population Projections Approach

The main source for estimating Visitor population is CCH DPP's land use forecast variable "VU", which represents the estimated number of visitor accommodation units. These include hotel rooms as well as housing units held for use by visitors. CCH DPP's VU projections for 2010 through 2035 for each TAZ were multiplied by 2 (assuming average occupancy of two people per VU). The 2010 hotel average occupancy rate for Oahu of 78.2%, as reported by the Hawaii Tourism Authority, was then applied to arrive at a projected Visitor population (Hawaii Tourism Authority, 2011).

It was assumed that the 2035 ratios between Residential population and Visitor population for each TAZ would stay the same through the remainder of the projection period (i.e. through 2050), and future Visitor population was calculated by applying these ratios. The resulting visitor population projections are presented in **Appendix C**.

3.1.4 Departures from Previous Population Projection Efforts

As noted above, population projections were conducted by EDAW/AECOM in August 2008 as part of a previous effort for the Honouliuli Fac Plan. Three noteworthy departures from this previous effort are identified below:

- The following data that were not available for the previous effort were incorporated: 2010 Census data and 2035 projections prepared by the DBEDT and CCH DPP.
- Projections for tunnel design / build-out conditions (year 2150) were not conducted since the gravity sewer tunnel (GST) alternatives are not being actively considered for the Honouliuli sewer basin at this time.
- The 2008 EDAW/AECOM report assumed CCH DPP's land use forecast variable "VU" reflects Visitor population. However, per CCH DPP's definition, VU = hotel rooms + housing units held for use by visitors. VU therefore represents the estimated number of visitor accommodation units and not Visitor population. The approach for estimating Visitor population was adjusted for the current effort to reflect this, as described in **Section 3.1.3**.

3.2 Flow Projections

3.2.1 Overview of Approach

Wastewater flows to the Honouliuli WWTP are composed of three components: sanitary flow, dry weather infiltration, and wet weather infiltration/inflow. Development of flow projections for the intermediate design year of 2035 and design year of 2050 involved development of projections for each of the three components of the flow. Flow projections were based initially on measurements of actual flows from flow metering conducted in the 2009-2011 time period as part of the Sewer I/I Assessment and Rehabilitation Program Update project. Projections of future flows were then based on projections of population increase and anticipated areas of new development. A calibrated InfoWorks model was used to route flows through the collection and transport system to generate projected flows at the Honouliuli WWTP. The following sections describe the development and calibration of the InfoWorks model for representing current conditions flows, and the approach for generating sanitary, dry weather infiltration, and wet weather infiltration/inflow components for future flows.

3.2.2 Development and Calibration of InfoWorks Model

Design flows were developed using an InfoWorks model of the collection and transport system tributary to the Honouliuli WWTP. Details on the model development and calibration process are presented in the *Draft Task 4 Wastewater Hydraulic Flow Model Update Technical Memorandum* prepared for the Sewer I/I Assessment and Rehabilitation Program Update project.

The pipe sizes and invert elevations used in the model were generated from the CCH's GIS system. Tributary sub-basins were developed based on data from a GIS geodatabase provided by CCH. This database identified land use by individual property lots, and the model subcatchment delineations were, therefore, developed by individual property lot.

Current conditions base sanitary flows were initially developed from water use records. Infiltration was initially estimated as a percentage of night time low flow from the meter data. Based on meter data, separate diurnal curves were developed for weekdays and weekends. Initial dry weather flows were then adjusted as necessary to match meter data.

Current conditions wet weather flows were developed by adjusting the model parameters that control direct overland flow and wet weather infiltration (the rapid and slow responses to rainfall) to match meter data. The overland flow parameters are related to surface features that define the percentage of rainfall that becomes runoff, and the routing of the runoff. Factors that affect the wet weather infiltration include the degree of soil saturation, and the depth of the water table. The InfoWorks model includes features that can represent changing groundwater saturation and water table depth conditions based on changing rainfall conditions. These features allow the model to simulate seasonal variations to base flow and wet weather infiltration based on seasonal rainfall patterns.

The model was calibrated to 32 flow meters distributed throughout the Honouliuli tributary area. Additional detail on the model development and calibration process is presented in the *Draft Task 4 Wastewater Hydraulic Flow Model Update Technical Memorandum* prepared for the Sewer I/I Assessment and Rehabilitation Program Update project.

3.2.3 Development of Future Dry Weather Flow

The approach to the development of future base sanitary flows included the following steps:

- Define initial wastewater generation rates (in units of gallons per capita-day [gpcd]) from literature values for each of the three categories of population that were used in the population projections presented in Section 3.1 above.
- Using metered flow data from the Honouliuli WWTP and actual 2010 population data, adjust the wastewater generation rates to match actual 2010 data.
- Apply the adjusted wastewater generation rates to future projections of population in each of the three population categories, for 2035 and 2050.

The initial literature values selected for wastewater generation rates were as follows (Metcalf & Eddy, 2003):

– Residential 71 gpcd
– Non-Residential 13 gpcd
– Visitor 60 gpcd

The 2010 average sanitary flow (excluding dry weather groundwater infiltration and wet weather infiltration/inflow) at the Honouliuli WWTP was 20.9 mgd. Applying the above wastewater generation rates to the 2010 population for each of the three categories resulted in a computed sanitary flow at the Honouliuli WWTP of 23.7 mgd. The wastewater generation rates were then reduced by a ratio of 20.9/23.7, so that the resulting computed sanitary flow matched the measured flow of 20.9 mgd. The resulting wastewater generation rates were as follows:

– Residential 63 gpcd
– Non-Residential 11 gpcd
– Visitor 53 gpcd

These rates were then applied to the 2035 and 2050 population projections for each of the three categories of population, to arrive at the projected total sanitary flows. The distribution of sanitary flows by area is described below.

For future dry weather infiltration flows, it was assumed that the ratio of infiltration to sanitary flow would remain constant. Infiltration flows were, therefore, increased in proportion to the increase in sanitary flow.

Trends in water usage data were examined statistically, and indicate a slight reduction in usage in recent years. However, estimating the extent to which water will continue to be conserved leading into years 2035 and 2050 would be very speculative. Therefore, sanitary flows were not adjusted to account for additional per capita reduction in water usage.

3.2.4 Development of Future Wet Weather Infiltration/Inflow

Projecting future wet weather flows required identification of approximate acreages of new developments required to accommodate the projected population within the Honouliuli sewer basin. As described above, population projections were developed for each TAZ in the Honouliuli sewer basin. Some of those TAZs are located within the existing model tributary area, some are located outside of the model tributary area, and some are partially in and partially out of the model tributary area. To estimate the approximate extent of new runoff area to add to the model to account for new development in areas outside of the existing model runoff delineation areas, the following approach was taken:

– GIS was used to classify each TAZ as one of the following to determine its relation to existing tributary area boundaries: fully within existing boundaries (“Within”), partially within and partially outside of existing boundaries (“Partial”), and fully outside existing boundaries (“Outside”).
– Population for each TAZ classification was allocated as follows:
  - Within: Assumed all future population and associated development occurs within the existing tributary areas.
  - Partial: Assumed a portion of future population and associated development occurs within the existing tributary areas (infill, redevelopment, etc.), and the rest occurs outside of the existing tributary areas. The following splits were made based on consideration of geographic features and land availability for the TAZs classified as “Partial”:
    - Waipahu: 40% of future development occurs within existing tributary area, 60% of future development occurs outside the existing tributary area
    - Honouliuli: 30% of future development occurs within existing tributary area, 70% of future development occurs outside the existing tributary area

    · Note – There were no “Partial” TAZs in the Pearl City, Waimalu, and Halawa tributary areas with projected population growth, so no split was applied for these tributary areas.

- Outside: Assumed all future population and associated development occurs outside the existing tributary areas.

To estimate the land area needed to accommodate the projected population in each TAZ classified as “Outside” or the portion of each TAZ classified as “Partial” that was assumed to be outside of the existing tributary area boundaries, the projected population in those areas was divided by the average 2010 population density (persons per acre) for the appropriate major pump station tributary area. For the Honouliuli tributary area, this average density was modified for some TAZs due to land area limitations and the high density development that is anticipated to support the expanding Kapolei area (also known as the “Second City”).

These new areas were added to the model assuming 0.1 percent impervious area, and average values for groundwater infiltration. The assumption regarding 0.1 percent impervious area is based on 0.1 percent impervious area being observed in most of the other areas covered by the collection system model. Further details can be found in the *Draft Task 4 Wastewater Hydraulic Flow Model Update Technical Memorandum* prepared for the Sewer I/I Assessment and Rehabilitation Program Update project.

Dry weather infiltration was added based on an average value of infiltration/acre computed from existing basins. Since the pipe routing from the new development areas is unknown at this time, the new model tributary areas were assumed to be connected to the closest existing pump station.

For future development within existing model tributary areas, the runoff and groundwater characteristics were not changed. Sanitary flows were increased based on the increase in population, and dry weather infiltration was increased in proportion to the increase in sanitary flow.

3.2.5 Development of Design Flows

Versions of the Honouliuli system model were developed as described above to represent conditions for 2010, 2035, and 2050. To determine design flows for those years, the model was further modified to remove upstream hydraulic restrictions. These modifications involved increasing pipe sizes and pump station capacities to eliminate significant surcharging during the 2-year, 6-hour design storm. The CCH, in an agreement with the regulatory agencies, committed to controlling flows for the 2-year, 6-hour storm event.

To develop annual average daily flows, the models were run for a “typical year” annual simulation. Other maximum 24-hour flows (e.g. maximum day, maximum 30-day) were also derived from the results of the typical year annual simulation. To determine peak hour flows, the models were run for the 2-year, 6-hour storm.

The “typical year” rainfall was developed by analyzing rainfall from an approximately 30-year period of record. For each year, the following statistics were calculated:

- Total number of storms
- Total annual rainfall depth
- Number of storms with intensities
    - Larger than a 1 year storm
    - 75-100% of a 1 year storm
    - 50-75% of a 1 year storm
- Number of storms with depths
    - Larger than a 1 year storm
    - 75-100% of a 1 year storm
    - 50-75% of a 1 year storm

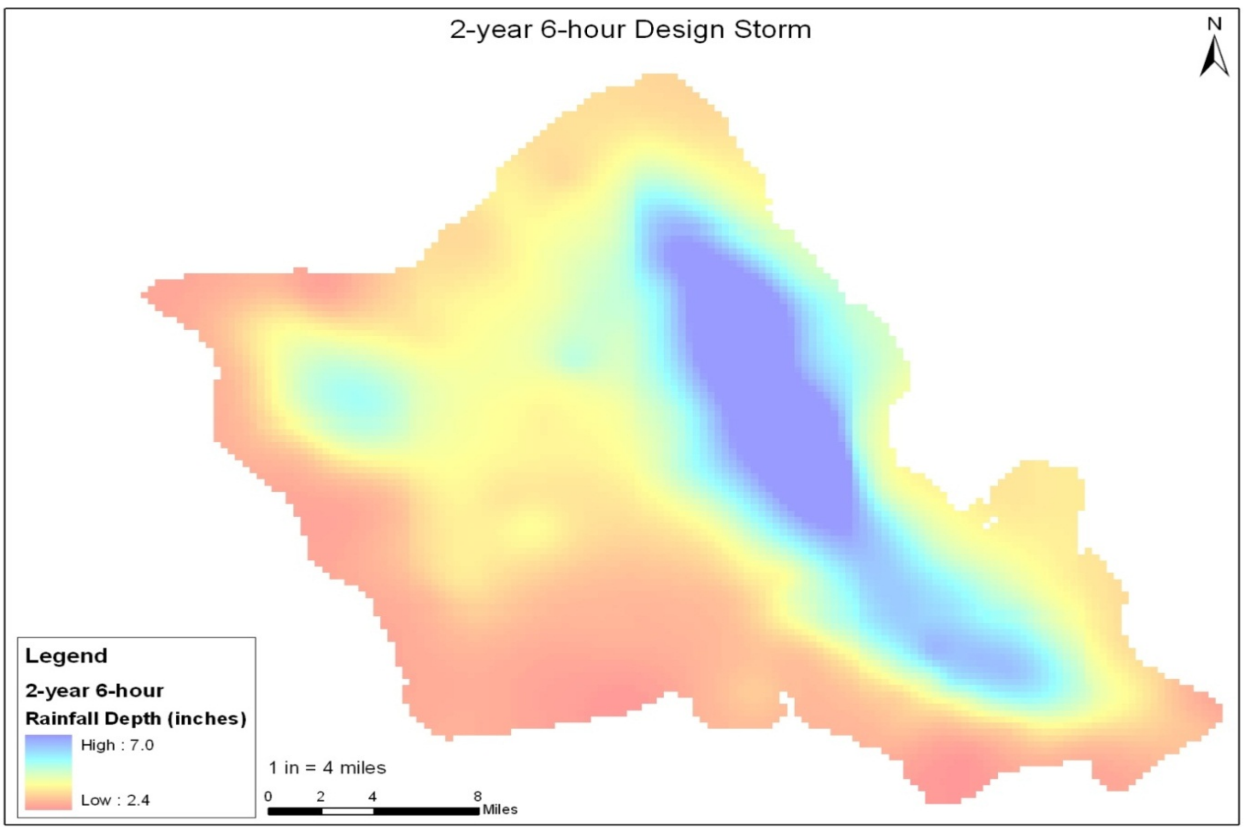
The average of each statistic over the period of record was calculated for each rain gage in the project area. A scoring system was developed to characterize how close each year came to the 30-year average for each statistic. For the year that came closest to the 30-year average, a limited number of individual storms were added and/or subtracted until the 30-year average was matched. For the Honouliuli project area, the “typical year” was based on the 1986 rainfall.

The 2-year, 6-hour storm rainfall was based on data from Atlas 14 developed by the National Oceanic and Atmospheric Administration (NOAA) as the successor to dated rainfall atlases across the nation.

Atlas 14 - Volume 4 provides precipitation frequency estimates for the Hawaiian Islands (NOAA, 2011). **Figure 3-3** presents the distribution of rainfall across Oahu for the 2-year, 6-hour storm based on Atlas 14. Since wet weather flows can be affected by antecedent rainfall conditions, it was important to establish an appropriate antecedent condition for the 2-year, 6-hour design storm. The appropriate antecedent condition was selected based on simulating a long term period (approximately 10 years) and determining what conditions occurred in the 2-year, 6-hour storm to produce a peak flow that would occur at roughly the same frequency, every two years.

Additional details on the development of the typical year and the 2-year, 6-hour rainfall are presented in the *Draft Task 4 Wastewater Hydraulic Flow Model Update Technical Memorandum* prepared for the Sewer I/I Assessment and Rehabilitation Program Update.

Figure 3-3. Depth for the 2-Year 6-Hour Storm on Oahu



3.3 Load Projections

There are two methods available to estimate load projections at the WWTP: waste load coefficient or concentration. The method used for this TM is the waste load coefficient method. The concentration method was not used because water conservation and water use habits may reduce per capita flow over time, resulting in changing pollutant concentration. The per capita waste load coefficient is based on year 2010 data (waste load [lbs/day] and population [capita]). These values are used to estimate waste load coefficients (lbs/capita/day). Industry data shows that waste load coefficients remain relatively constant and are not affected by fluctuations in water usage.

The waste load coefficients, along with the 2035 and 2050 population projections are then used to determine mass loadings independent of concentration and flow.

4 UPDATED POPULATION PROJECTION RESULTS

4.1 2010 Population

CCH DPP's total projected 2010 Residential population of 911,841 for Honolulu County (Oahu) was 4.5% lower than the 2010 Census population of 953,207. Furthermore, CCH DPP's total projected 2010 Residential population of 301,887 for the 201 TAZs located within the Honouliuli sewer basin was 5.2% lower than the 2010 Census population of 317,718 for the same area. This disparity affirms that actual population growth in Oahu, and particularly within the Honouliuli sewer basin, is outpacing the growth projected by Hawaii DBEDT and CCH DPP. A comparison of 2000 and 2010 Residential population for the Honouliuli sewer basin based on US Census data is provided in **Table 4-1** to further demonstrate the strong growth the area has recently experienced.

Table 4-1. 2000 and 2010 Census Population for TAZs within the Honouliuli Sewer Basin

2000 Census Population(1)	2010 Census Population(1)	Increase
267,082	317,718	19.0%

(1) Census population includes both sewered and unsewered population
Sources:
- City and County of Honolulu Socioeconomic Projections to 2035, September 2009 (CCH DPP)
- 2000 and 2010 Census Summary File 1 for Hawaii (US Census Bureau)

Results from the updated 2010 Residential, Non-Residential, and Visitor populations for the Honouliuli sewer basin are provided in **Table 4-2**. As noted in the population methodology section (**Section 3.1**), the updated projections incorporate more accurate Residential population data from the 2010 Census that was not available for previous projection efforts. The 2010 population projections reported in the 2008 EDAW/AECOM Report are also provided in **Table 4-2** for comparison purposes. In addition, **Table 4-2** also shows that in 2010 there are approximately 33% of Non-Residential to Residential Population in the Honouliuli sewer basin.

Table 4-2. Updated Population Projections Results

Pump Station Tributary Area(1)	2008 EDAW/AECOM Report			Projection Update								
	2010(2)			2010(3)			2035			2050		
	Res	Non-Res	Visitor	Res	Non-Res	Visitor	Res	Non-Res	Visitor	Res	Non-Res	Visitor
Halawa	17,562	15,940	0	15,787	14,193	0	15,562	15,060	0	15,395	15,168	0
Waimalu	37,358	15,159	71	32,791	13,213	97	31,695	14,811	92	30,987	15,176	92
Pearl City	36,259	10,229	0	39,079	14,503	0	59,956	22,385	0	67,633	26,598	0
Waipahu	117,713	27,803	0	128,546	31,492	0	133,979	48,212	0	134,327	50,403	0
Honouliuli Influent	96,208	22,347	3,249	90,214	29,456	1,805	167,042	100,834	11,267	201,082	134,375	14,897
Total	305,101	91,479	3,320	306,417	102,857	1,902	408,234	201,302	11,359	449,424	241,720	14,989
Equivalent Population	347,626(4)			325,976(4)			452,938(4)			504,239(4)		

(1)Populations presented are for the areas shown in **Figure 3-2**.
(2) Population for 2010 was interpolated from the 2000 and 2030 estimates reported in the 2008 EDAW/AECOM Report. 2010 population = 2000 population + (10/30) × (2030 population - 2000 population).

(3) Results do not include the following estimated population not served by sewer (based on comparison of aerial photographs and limits of existing collection system): 9,177 Residential; 17,095 Non-Residential.
(4) The following equation was used to arrive at a population value to facilitate computation of per capita sanitary flows/loadings: Population Equivalent = Res Pop + (11/63) × Non-Res Pop + (53/63) × Visitor Pop (63, 11, and 53 are gallons per capita per day wastewater generation values for residential, non-residential, and visitor, respectively, as presented in **Section 3.2.3**).

The updated 2010 Residential population results for the Honouliuli sewer basin are only 0.4% higher than the previous estimate. However, the allocation of the population within the sewer basin varies.

Table 4-3 shows the differences from previous projections. The most populous portion of the sewer basin in 2010 was the Waipahu tributary area, followed by the Honouliuli Influent tributary area.

Table 4-3. Difference in Year 2010 Population Between 2008 and Current Projections(1)

Pump Station Tributary	Res	Non-Res	Visitor
Halawa	-10.1%	-11.0%	0.0%
Waimalu	-12.2%	-12.8%	36.6%
Pearl City	7.8%	41.8%	0.0%
Waipahu	9.2%	13.3%	0.0%
Honouliuli Influent	-6.2%	31.8%	-44.4%
Total	0.4%	12.4%	-42.7%

(1) Percent difference = (2010 Census Population - Previous Projection)/Previous projection

The updated 2010 results for Non-Residential and Visitor populations show a greater departure from the previous estimates as compared to the residential populations (see **Table 4-3**).

These differences are largely attributed to the use of CCH DPP's 2000-2035 socioeconomic projections data that were not available at the time of the preparation of the 2008 EDAW/AECOM projections, which reflect different results and trends in these population categories. Also, as described in **Section 3.1.3**, a different approach was used to estimate the Visitor population for the projection update.

4.2 2035 Basis of Design Population

The results of the 2035 population projections indicate robust growth within the Honouliuli sewer basin, particularly in Non-Residential and Visitor populations. **Table 4-4** shows the projected population increase between 2010 and 2035. Most of this growth is projected to occur within the Honouliuli IPS tributary area, where the growing City of Kapolei is located as well as several proposed master planned communities, resorts, and other developments (see **Table 4-5** and **Figure 4-1**). However, the mature existing areas of Halawa, Waimalu, and Pearl City may experience alternative Residential and Non-Residential growth should delays occur due to permitting, land use impacts, and market issues related to agricultural lands and master planned communities. The main drivers anticipated for alternative growth scenarios are the economics for immediate housing demand. In addition, **Table 4-2** shows that the ratio of Non-Residential to Residential Population increases to nearly 50% in 2035.

Table 4-4. Projected Growth between 2010 and 2035(1)

Pump Station Tributary	Res	Non-Res	Visitor
Halawa	-1.4%	6.1%	0.0%
Waimalu	-3.3%	12.1%	-5.2%
Pearl City	53.4%	54.3%	0.0%
Waipahu	4.2%	53.1%	0.0%
Honouliuli Influent	85.2%	242.3%	524.2%
Total	33.2%	95.7%	497.2%

(1) Percent difference = (Projected 2035 Population - 2010 Census Population)/2010 Census Population

Table 4-5. Status of Known Development Projects witin the Honouliuli Sewer Basin

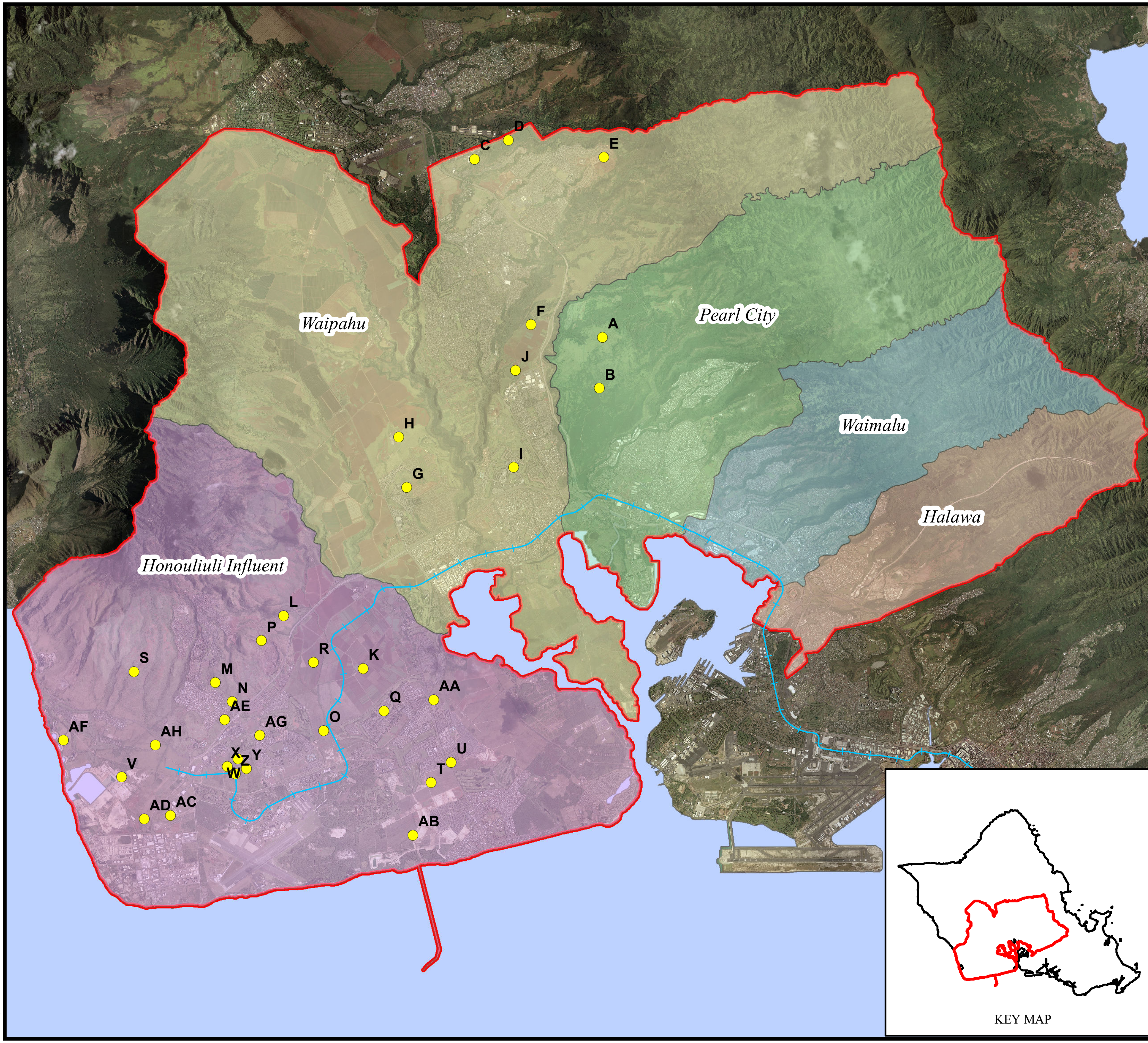
Development Name[1]	Original Land Area (Acres) from Development Plans			Status	Remaining Land Area (Acres) to be Developed		
	Res	Non-Res	Visitor		Res	Non-Res	Visitor
Pearl City Tributary Area							
A. Castle & Cooke Waiawa	150	-	-	Proposed	150	-	-
B. Waiawa by Gentry	500	-	-	Project development rights lapsed in 2009	500	-	-
Subtotal	650	-	-	-	650	-	-
Waipahu Tributary Area							
C. Mililani Technology Park	-	216	-	Majority of Phase I (approx. 79 acres) is developed with some lots available (approx. 26 acres). Phase II land is currently for sale (137 acres). Land is not approved and could be used for commercial or residential.	-	137	-
D. Launani Valley	28	-	-	Complete	-	-	-
E. Mililani Mauka	409	16	-	Complete	-	-	-
F. Koa Ridge	500	-	-	Proposed; development to begin 2013 and completed by 2022.	500	-	-
G. Royal Kunia Phase I	144	1	-	Complete	-	-	-
H. Royal Kunia Phase II	327	123	-	Construction to begin in 2011	327	123	-
I. Waikele	35	-	-	Complete	-		-
J. Wahiawa Hospital Medical Park	-	100	-	Proposed	-	100	-
Subtotal	1,443	456	-	-	827	360	-
Honouliuli Influent Tributary Area							
K. East Kapolei - Ho'opili	925	195	-	Proposed; construction to begin 2013 and last around 20 years.	925	195	-
L. Kapolei North	150	-	-	Proposed	150	-	-
M. Makakilo D2	96	-	-	Proposed	100	-	-
N. Makakilo (C & D)	105	-	-	Complete	-	-	-
O. DHHL East Kapolei	341	67	-	Proposed	341	67	-
P. Kalaeloa (HCDA)	267	693	-	Proposed	267	693	-
Q. Ewa Villages	54	-	-	Proposed	54	-	-

Table 4—5. Status of Known Development Projects witin the Honouliuli Sewer Basin (continued)

Development Name[1]	Original Land Area (Acres) from Development Plans			Status	Remaining Land Area (Acres) to be Developed		
	Res	**Non-Res**	**Visitor**		**Res**	**Non-Res**	**Visitor**
R. UH West Oahu Campus	275	116	-	Under construction	275	116	-
S. Makaiwa Hills (Upper and Lower)	908	31	-	Proposed	908	31	-
T. Laulani Commercial	-	20	-	Proposed	-	20	-
U. Ewa by Gentry Makai (East and West)	172	-	-	Under construction; nearing build-out; approx. 80% complete	34	-	-
V. Kalaeloa Barbers Point Harbor		210	-	Under construction; approx. 50% complete	-	105	-
W. Mehana at City of Kapolei	108	2	-	Under construction; approx. 50% complete; build-out expected by 2015	54	1	-
X. Leihano Senior Community	43	-	-	Proposed; construction to begin 2012	43	-	-
Y. Kapolei Mixed Use	-	91	-	Proposed	-	91	-
Z. Kapolei Commercial	-	91	-	Proposed	-	91	-
AA. Ewa by Gentry	94	64	-	Residential complete; industrial proposed	-	64	-
AB. Ocean Pointe / Hoakalei	269	73	39	Under construction; approx. 50% complete	135	37	20
AC. Kapolei Business Park	-	268	-	Phase I complete; approx. 40% remains for construction	-	107	-
AD. Kapolei Harborside	-	339	-	Proposed	-	339	-
AE. Palailai Residential	30	14	-	Complete	-	-	-
AF. Ko Olina Resort	50	16	42	Under construction; approx. 50% complete	25	8	21
AG. Villages of Kapolei	28	27	-	Under construction; approx. 60% complete	11	11	-
AH. Kapolei West	234	12	-	Proposed	234	12	-
Subtotal	4,149	2,329	81	-	3,556	1,988	41
Total	6,242	2,785	81	-	5,033	2,348	41

(1) Approximate location of developments identified on **Figure 4-1**.
Sources:

– Proposed Revised Ewa Development Plan, May 2011 (CCH DPP)
– Central Oahu Sustainable Communities Plan, December 2002 (CCH DPP)
– Online project status research conducted by AECOM, November 2011



City and County of Honolulu

HONOULIULI/ WAIPAHU/ PEARL CITY WASTEWATER FACILITIES PLAN

Legend

- Sewer Basin
- Proposed Development*
- Proposed Mass Transit

Future Tributary Areas

- Halawa
- Honouliuli Influent
- Pearl City
- Waimalu
- Waipahu

*Note: See Table 4-5 for detail on each proposed development.

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Feet
1 inch = 12,000 feet

Task 4.F.1 Update Basis of Design Population, Flows, and Loads

FIGURE 4-1

KNOWN DEVELOPMENT PROJECTS WITHIN THE HONOULIULI SEWER BASIN

June 2012

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The strong projected growth within the Honouliuli sewer basin is supported by recent growth trends (see **Table 4-1**) as well as CCH DPP planning documents and growth policies. Oahu is divided into eight planning areas that are used by the CCH DPP for long-term planning efforts. Three of these planning areas are located partially or completely within the sewer basin: Ewa, Central Oahu, and Primary Urban Center (see **Figure 4-2**). These three planning areas are identified by the CCH General Plan to experience the majority of growth and development on the island over the next several decades. Also, one of the main objectives identified in the General Plan is to develop a Second Urban Center in the Ewa planning area with its nucleus in the Kapolei area. This objective is supported by several policy statements in the General Plan, such as the following (CCH DPP, 2002a):

- Allocate funds from the City and County's capital-improvement program for public projects that are needed to facilitate development of the secondary urban center at Kapolei.
- Encourage the development of a major residential, commercial, and employment center within the secondary urban center at Kapolei.
- Encourage the continuing development of Barbers Point as a major industrial center.
- Encourage the development of the Ewa Marina Community as a major residential and recreation area emphasizing recreational boating activities through the provision of a major marina and a related maritime commercial center containing light-industrial, commercial, and visitor accommodation uses.

Furthermore, the Honouliuli Rail Transit Project will traverse through the Honouliuli sewer basin and possibly encourage higher density, transit oriented development in the vicinity of the proposed stations, as reflected in the transit oriented development plans prepared by CCH DPP for several neighborhoods in the sewer basin (CCH DPP, 2011a). The rail project will also help support and connect many of the proposed developments identified in the Ewa Development Plan and Central Oahu Sustainable Communities Plan (CCH DPP, 2011b; CCH DPP, 2002b).

4.3 2050 Projected Population

The results of the 2050 population projections indicate continued growth within the Honouliuli sewer basin, albeit at a lower rate than between years 2010 and 2035. **Table 4-6** shows the projected growth in the Honouliuli sewer basin over the 15 years between 2035 and 2050. Similar to the 2035 projections, the majority of this growth is projected to occur within the Honouliuli IPS tributary area, and growth is projected to be negligible in the Halawa and Waimalu tributary areas unless market forces dictate the demand for additional residential population in the area. In addition, **Table 4-2** shows that the ratio of Non-Residential to Residential Population increases to nearly 54% in 2050.

Table 4-6. Projected Growth between 2035 and 2050[1]

Pump Station Tributary	Res	Non-Res	Visitor
Halawa	-1.1%	0.7%	0.0%
Waimalu	-2.2%	2.5%	0.0%
Pearl City	12.8%	18.8%	0.0%
Waipahu	0.3%	4.5%	0.0%
Honouliuli Influent	20.4%	33.3%	32.2%
Total	10.1%	20.1%	32.0%

(1) Percent difference = (Projected 2050 Population - Projected 2035 Population)/Projected 2035 Population

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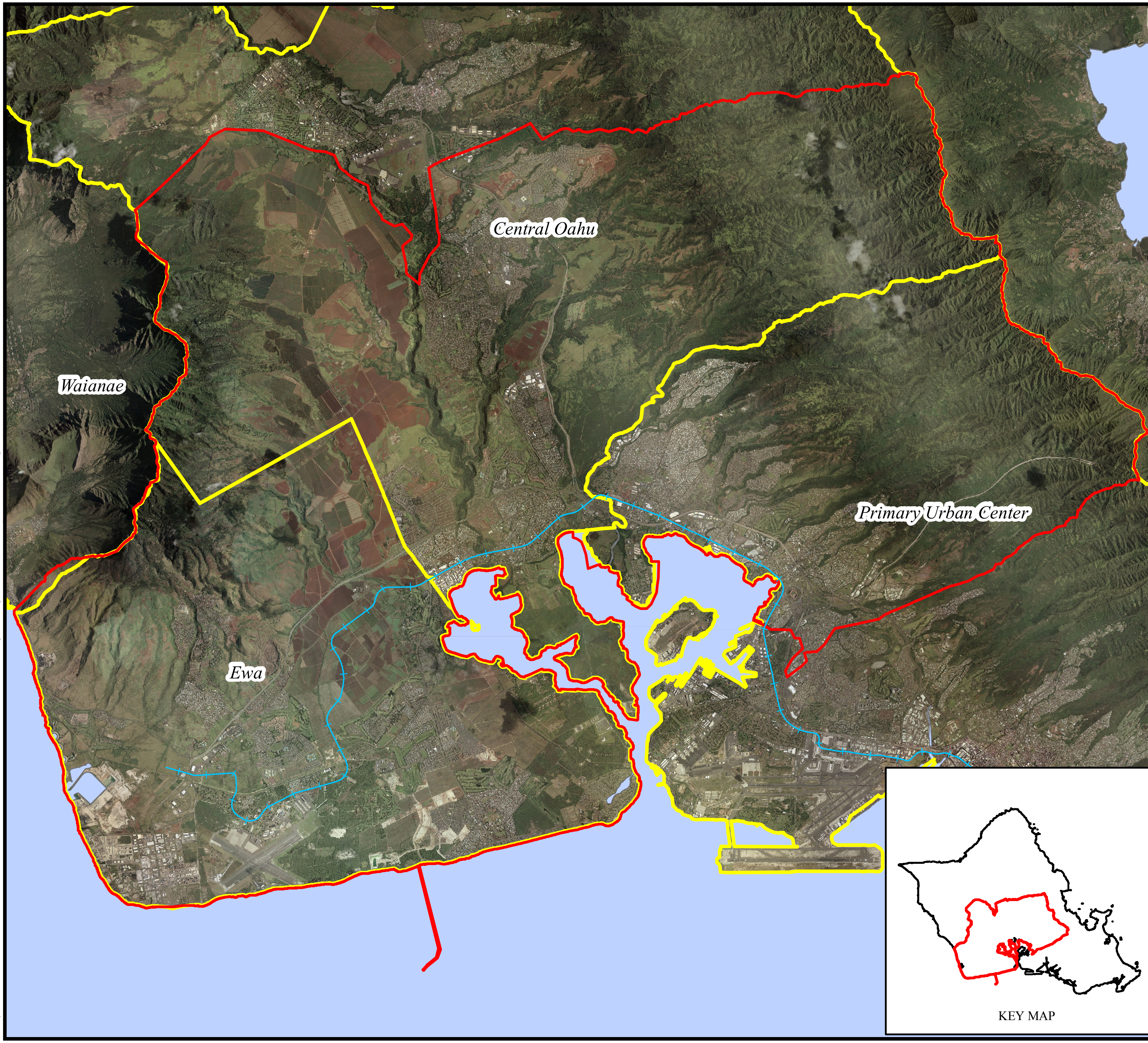

Legend

- Proposed Mass Transit
- Sewer Basin
- DPP Planning Area

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Feet
1 inch = 12,000 feet

Task 4.F.1 Update Basis Of Design Populations, Flows, and Loads

FIGURE 4-2

CCH DPP PLANNING AREAS WITHIN HONOULIULI SEWER BASIN

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5 UPDATED FLOW AND LOAD PROJECTIONS

5.1 Potential Future Development Areas

Figure 4-1 illustrates the approximate location of future developments within the Honouliuli sewer basin as identified in the Ewa Development Plan and Central Oahu Sustainable Communities Plan prepared by the CCH DPP and the existing Honouliuli sewer system tributary areas. As indicated in **Figure 4-1**, future developments were only identified for the Pearl City, Waipahu, and Honouliuli tributary areas. Within the Waipahu and Honouliuli tributary areas, the proposed future developments are expected to occur both within and outside of the existing sewer system tributary area, while for Pearl City, the two proposed developments are located outside of the existing sewer system tributary area. For Halawa and Waimalu, none of the TAZs located fully or partially outside of the existing sewer system tributary area were predicted to experience population growth in 2035 or 2050. As described above, for the TAZs that are predicted to have population growth and are located fully within the existing tributary areas, it was assumed that the growth will primarily involve redevelopment of existing sites and will require minimal conversion of new land area that is not currently sewered. For TAZs that are predicted to have population growth and are located fully outside of the existing tributary areas, the area required for development was estimated by applying an average population density to the predicted new population. For TAZs that are located partially outside of existing tributary areas, a proportion of the new population was assigned to the area outside of the existing tributary area, and the extent of the new area was computed based on an average population density. **Table 5-1** presents the estimated additional total new development area by design year by major tributary area based on the approach described above, and **Figure 4-1** shows the approximate location of the areas receiving the additional development acres. **Appendix E** contains additional information for individual TAZs, including the assigned percent infiltration value. The acreage presented below differs from the acreage presented in *TM 4.A – Design Flows and Waste Load Determination* (AECOM, 2010). The acreage in the previous TM was based on the entire tributary area, and the acreage presented in **Table 5-1** is based on the sewered parcels. By using the acreage of sewered parcels (plus an allowance for area in public rights-of-way) rather than the entire tributary area, the collection system model more appropriately simulates I/I related to new development. Since future flows were estimated based on sanitary flow *and* I/I, accurately estimating the developed acreage should lead to more accurate flow projections. **Figure 5-1** shows the estimated increase of developed acreage for each TAZ. Please note that the additional development symbols on **Figure 5-1** do not indicate exactly where the additional development is expected to occur; rather they represent the estimated increase of developed acreage within each respective TAZ boundary.

Table 5-1. Estimated Total Additional Development Acres by Design Year

Pump Station Tributary Area	Year 2010 (acres)	Year 2035		Year 2050	
		Increase from 2010 (acres)	**Total (acres)**	**Increase from 2010 (acres)**	**Total (acres)**
Halawa	903	0	903	0	903
Waimalu	2,124	0	2,124	0	2,124
Pearl City	2,462	1,603	4,065	2,181	4,643
Waipahu	6,826	1,326	8,152	1,960	8,786
Honouliuli Influent	7,570	4,173	11,743	5,931	13,501
Total	19,885	7,102	26,987	10,072	29,957

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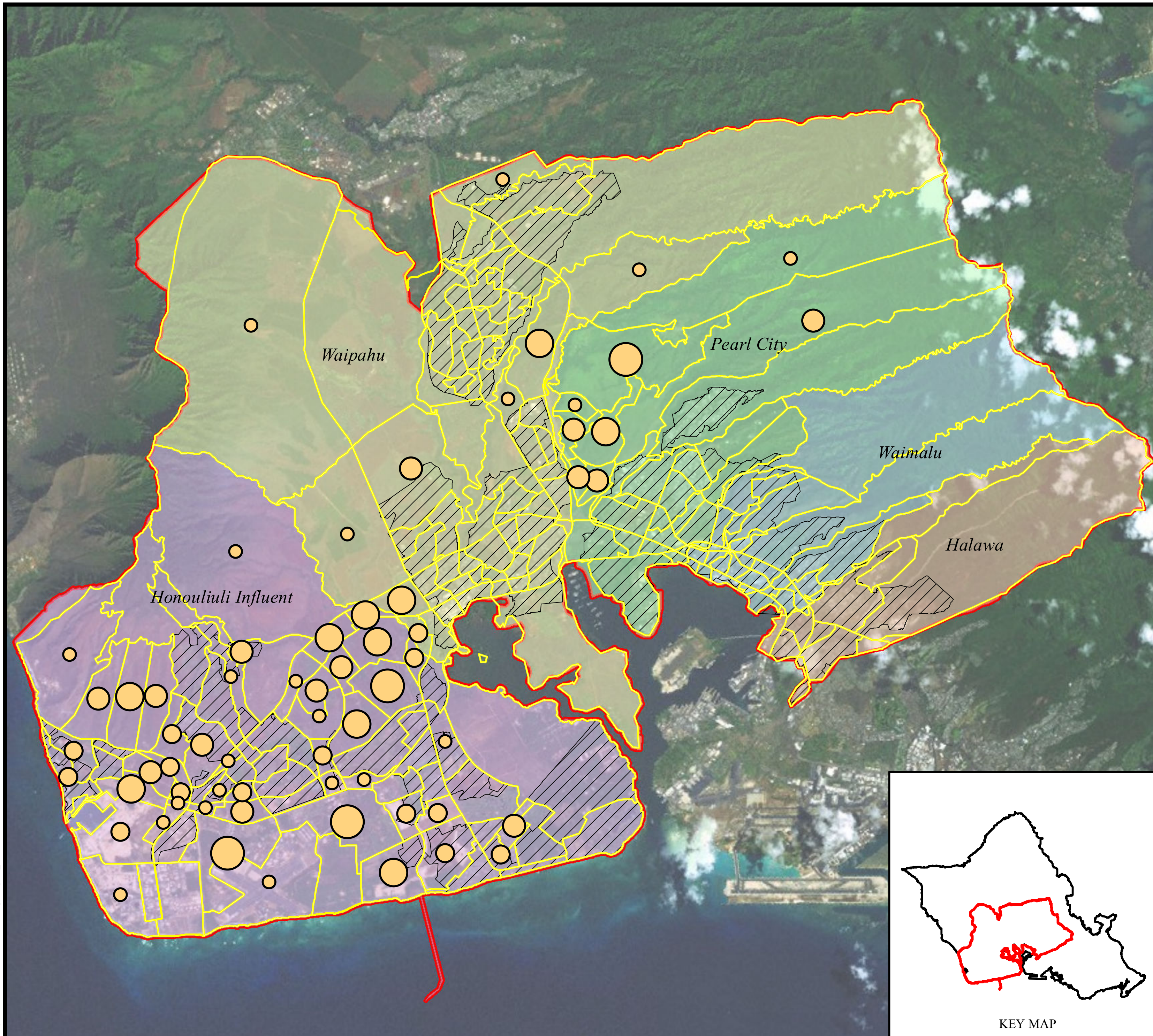

Legend

- Sewer Basin
- TAZ Boundaries
- Existing Tributary Areas

Future Tributary Areas

- Halawa
- Honouliuli Influent
- Pearl City
- Waimalu
- Waipahu

Additional Development Acres by 2050

- < 50
- 50 - 100
- 100 - 200
- 200 - 500
- > 500

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Feet
1 inch = 12,000 feet

Task 4.F.1 Update Basis of Design Population, Flows, and Loads

FIGURE 5-1
TRANSPORTATION ANALYSIS ZONES TO RECEIVE ADDITIONAL DEVELOPMENT ACRES

June 2012

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5.2 2010 Flow and Load

Flow parameters derived from the Honouliuli system model using the typical rainfall year and the 2-year, 6-hour design storm for year 2010 conditions are presented in **Table 5-2**. A range of flow parameters were developed from output from the Honouliuli System Model for review and consideration for use in sizing various components of the Honouliuli WWTP expansion and/or upgrade. Certain WWTP unit processes are sized based on the annual average flow while others are sized on the maximum day, peak 1-hour, or other flow parameter. The basis of computing each of the flow parameters listed in **Table 5-2** is presented below.

The annual average flow was computed by averaging each of the hourly flows derived from the Honouliuli System Model using the typical rainfall year.

Table 5-2. Year 2010 Flow Parameters from the Honouliuli System Model

Flow Parameter	WWTP (mgd)	Waipahu (mgd)	Pearl City (mgd)	Waimalu (mgd)	Halawa (mgd)
Honouliuli Typical Year					
Annual Average	27.5	11.6	8.8	5.3	1.8
Maximum 30-day	27.9	-	-	-	-
Maximum 24-Hour	33.8	13.7	12.2	7.6	2.9
Peak 1-Hour	49.5	20.4	16.9	10.2	3.8
2-Year, 6-Hour Event					
Maximum 24-Hour	45.0	15.0	16.2	10.2	3.3
Peak 1-Hour	82.2	24.3	30.7	18.1	5.4

The maximum 30-day and maximum day flows were computed by first totalizing each of the hourly flows derived from the Honouliuli System Model into total daily flows, from midnight-to-midnight. The maximum day value represents the highest of the 365 total daily flows in the record. The maximum 30-day value was computed by taking 30-day running averages through the entire record and selecting the maximum 30-day running average. This value conservatively represents a maximum month value. As can be seen from inspection of **Table 5-2**, the maximum 30-day flow is only slightly higher than the annual average flow, suggesting that there is not substantial variation in flow from month-to-month at the treatment plant under current conditions.

The maximum 24-hour flow from the typical rainfall year output from the Honouliuli System Model was derived by taking 24-hour running averages through the entire record of hourly flows. As can be seen from inspection of **Table 5-2**, the maximum 24-hour flow is only slightly higher than the maximum day flow. This suggests that no single rain event (including an event that may have occurred over portions of two calendar days) was predominant in defining a maximum 24-hour flow for the typical rainfall year.

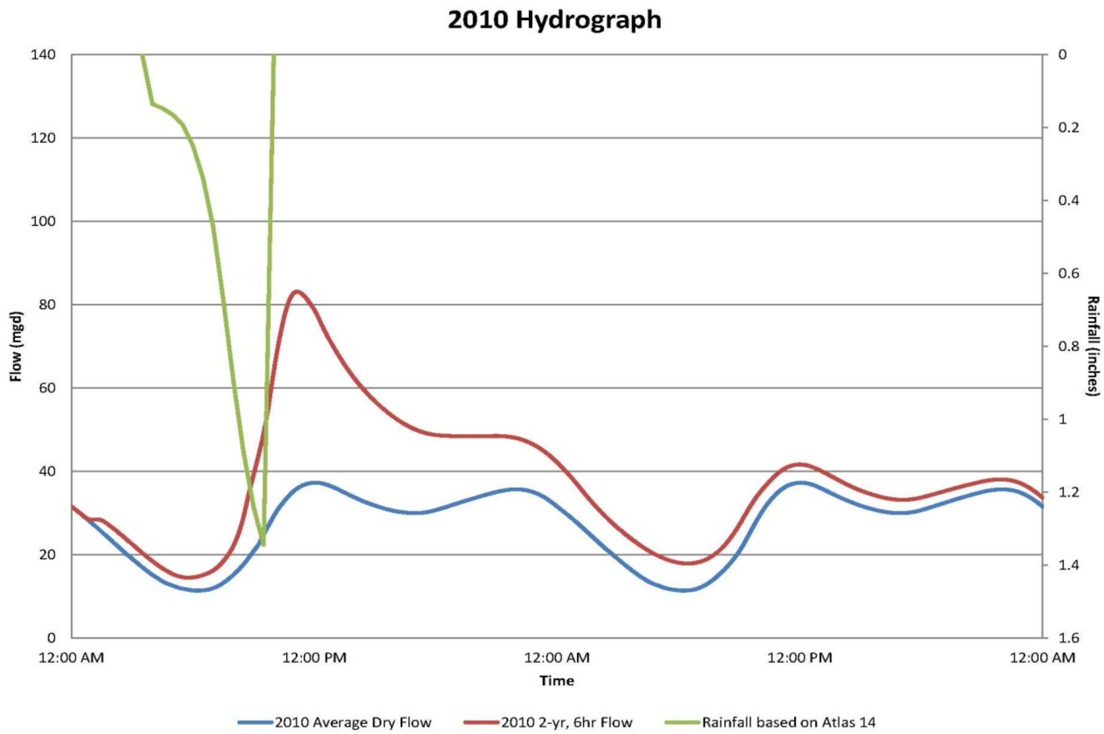
The peak 1-hour flow derived from the typical rainfall year output from the Honouliuli System Model represents the single highest hour flow in the model output.

The maximum 24-hour flow from the 2-year, 6-hour event was derived by taking 24-hour running averages through the record of hourly flows in the model output for the 2-year, 6-hour design storm.

The peak 1-hour flow derived from the 2-year, 6-hour event from the Honouliuli System Model represents the single highest hour flow in the model output for that storm. The peak 1-hour flow was derived by predicting peak 15-minute flows during a 2-year, 6 hour event. The peak 15-minute flows were then used to calculate the maximum possible 2-year, 6-hour event peak hour flows by aligning wet weather peaks and diurnal peaks.

Figure 5-2 shows a plot of the estimated WWTP influent flow for the typical year and 2-year, 6 hour storm using 2010 flow data. As shown, the peak hour flow increases from approximately 37 mgd during an average day up to approximately 82 mgd during the 2-year, 6 hour storm. This is substantially higher than the maximum peak flow of approximately 50 mgd recorded during 2010, but corresponds with high flows that have been periodically recorded at the Honouliuli WWTP in the past.

Figure 5-2. Estimated Honouliuli WWTP Flow – 2-Year, 6-Hour Storm in 2010



Each of these flow values will be evaluated for use in sizing WWTP unit processes under Task 12.C - Secondary Treatment Process Evaluation and Selection of the Honouliuli/Waipahu/Pearl City Wastewater Facilities Plan.

Influent contaminant concentrations were based on full-year 2010 average concentrations for BOD and TSS that were provided by the CCH ENV, Department of Environmental Quality, Monitoring and Compliance Branch. Since full-year 2010 data were not available for Total Kjehldahl nitrogen (TKN), ammonia nitrogen (NH3-N), and total phosphorous (TP), data from the *Wastewater and Process Sampling Analysis for Work Task 12.D Hydraulic Analysis, Process Modeling, and Optimization* (AECOM, 2012) were used. Separate data collected in October 2010 and described in *Analysis of Wastewater and Odor Sampling* (AECOM, 2011) were compared with the 2012 data and found to be reasonably similar.

Currently, sludge is being hauled regularly from Wahiawa WWTP and Paalaa Kai WWTP to Honouliuli WWTP. The sludge is introduced to the influent flow at the septage receiving station. Since CCH has plans to reroute the imported sludge directly to the solids processing stream, sludge loads from Wahiawa and Paalaa Kai were subtracted from the total influent waste load. The contribution of BOD and TSS from the imported sludge was assumed to be a 1:1 ratio, based on total solids by weight. The resulting BOD and TSS contribution from imported sludge was determined to be approximately 6%. The TKN, NH3, and TP contribution from imported sludge, therefore, was assumed to be 6% as well.

The 2010 influent waste load was calculated using the 2010 concentrations and the 2010 average flow recorded at the Honouliuli WWTP of 25.39 mgd. It is noted that the year 2010 average flow recorded at the WWTP is about 8% less than the 27.5 mgd 2010 annual average flow generated from the collection system model and reported in **Table 5-2**. As documented in the Draft Task 4 Wastewater Hydraulic Flow Model Update Technical Memorandum prepared for the Sewer I/I Assessment and Rehabilitation Program Update, the collection system model is well calibrated and appropriately conservative, leading to the slight over-prediction of year 2010 annual average flow. The waste load coefficient was calculated by dividing the daily waste load by the updated 2010 Honouliuli sewer basin equivalent population of 325,976 (see **Table 4-2**). **Table 5-3** summarizes the 2010 influent waste loading values, which will be used to determine years 2035 and 2050 projected waste loadings.

Table 5-3. 2010 Influent Waste Loading

Contaminants	2010 Concentration (mg/L)	2010 Waste Load (lbs/day)(3)	2010 Waste Load Without Imported Sludge (lbs/day)(4)	2010 Waste Load Coefficient (lbs/capita/day)(5)
BOD	368(1)	77,925	73,425(4)	0.225
TSS	381(1)	80,678	76,178(4)	0.234
TKN	37(2)	7,898	7,424(5)	0.023
NH3	27(2)	5,717	5,374(5)	0.016
TP	4.3(2)	913	858(5)	0.0026

(1) From CCH ENV Monitoring and Compliance

(2) From *Wastewater and Process Sampling Analysis for Work Task 12.D Hydraulic Analysis, Process Modeling, and Optimization* (AECOM, 2012)

(3) 2010 Waste Load (lbs/day) = 2010 Concentration (mg/L) × 2010 average influent flow (25.39 mgd) × 8.34 (conversion factor)

(4) 2010 Waste Load Without Imported Sludge = 2010 Waste Load - Average Daily Loading from Wahiawa WWTP and Paalaa Kai WWTP (4,500 lbs/day of BOD and TSS)

(5) 2010 Waste Load Without Imported Sludge = 2010 Waste Load x 94% (Imported sludge accounts for ~6% of the influent waste load, hence 94%)

(6) 2010 Waste Load Coefficient (lbs/capita/day) = 2010 Waste Load Without Imported Sludge (lbs/day) / 2010 equivalent population (325,976)

5.3 2035 Basis of Design Flow and Load

Flow parameters derived from the Honouliuli system model using the typical rainfall year and the 2-year, 6-hour design storm for year 2035 conditions are presented in **Table 5-4**.

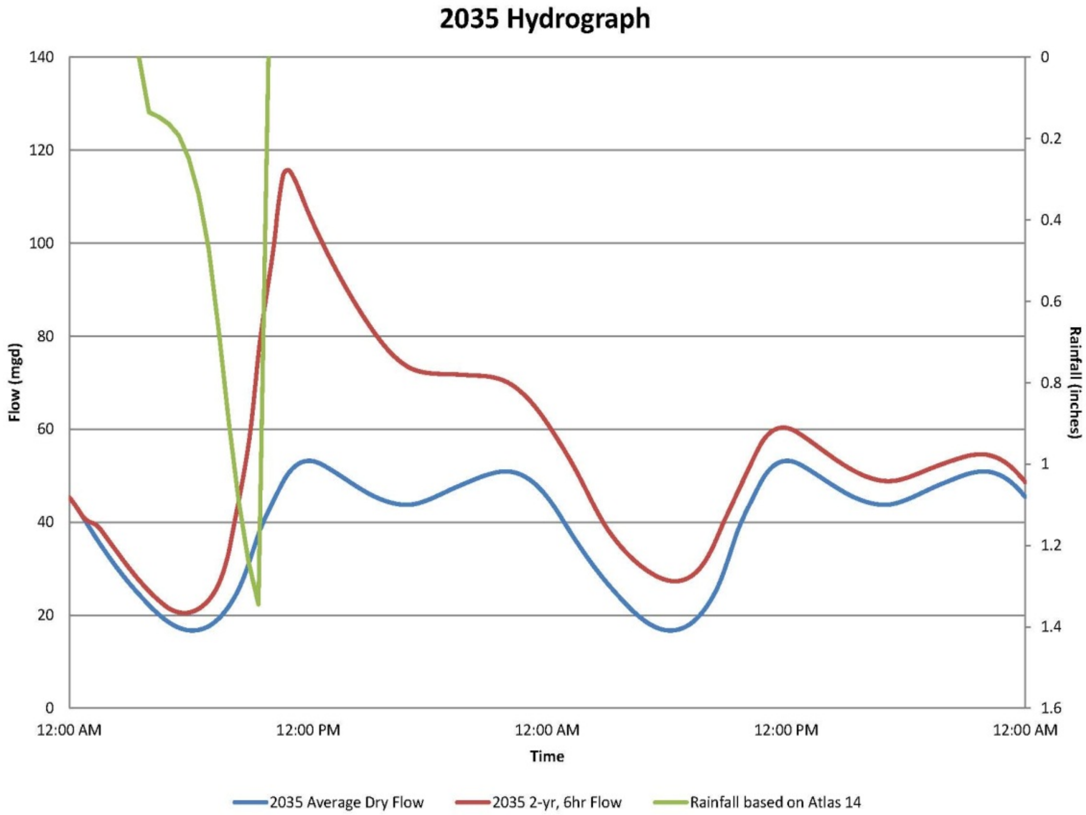
Table 5-4. Year 2035 Flow Parameters from the Honouliuli System Model

Flow Parameter	WWTP (mgd)	Waipahu (mgd)	Pearl City (mgd)	Waimalu (mgd)	Halawa (mgd)
Honouliuli Typical Year					
Annual Average	39.6	13.2	10.8	5.3	1.9
Maximum 30-day	40.3	-	-	-	-
Maximum Day	50.0	-	-	-	-
Maximum 24-Hour	50.3	16.1	14.7	7.6	2.9
Peak 1-Hour	69.7	23.0	20.0	10.3	4.9
2-Year, 6-Hour Event					
Maximum 24-Hour	65.4	18.3	20.4	10.2	3.4
Peak 1-Hour	114.2	29.7	37.7	18.1	5.5

Figure 5-3 shows a plot of the estimated WWTP influent flow for the typical year and 2- year, 6 hour storm using 2035 flow data. The flow range is impacted by the heavy rainfall similar to the year 2010 simulation. The peak hour flow increases from approximately 53 mgd during an average day up to approximately 114 mgd during the 2-year, 6 hour storm.

Each of these flow parameters was developed from output from the Honouliuli System Model as described above for year 2010 and will be evaluated for use in sizing WWTP unit processes under Task 12.C - Secondary Treatment Process Evaluation and Selection of the Honouliuli/Waipahu/Pearl City Wastewater Facilities Plan. The same relationships between the annual average and maximum 30-day flows and the maximum day and maximum 24-hour flows discussed above for year 2010 conditions are observed from inspection of **Table 5-4** for year 2035 conditions.

Figure 5-3. Estimated Honouliuli WWTP Flow – 2-Year, 6-Hour Storm in 2035



The year 2035 influent waste loadings are shown in **Table 5-5.** The 2010 Waste Load Coefficients (**Table 5-3**) were multiplied by the 2035 equivalent population projection of 452,938 (see **Table 4-2**). This projection assumes that the contribution of contaminants per capita will remain constant over time.

Table 5-5. Year 2035 Influent Waste Loading

Contaminants	2010 Waste Load Coefficient (lbs/capita/day)(1)	2035 Waste Load (lbs/day)(2)
BOD	0.225	101,911
TSS	0.234	105,987
TKN	0.023	10,418
NH3	0.016	7,247
TP	0.0026	1,178

(1) From **Table 5-3**

(2) 2035 Waste Load (lbs/day) = 2010 Waste Load Coefficient (lbs/capita/day) × 2035 equivalent population projection (452,938)

5.4 2050 Projected Flow and Load

Flow parameters derived from the Honouliuli system model using the typical rainfall year and the 2-year, 6-hour design storm for year 2050 conditions are presented in **Table 5-6**.

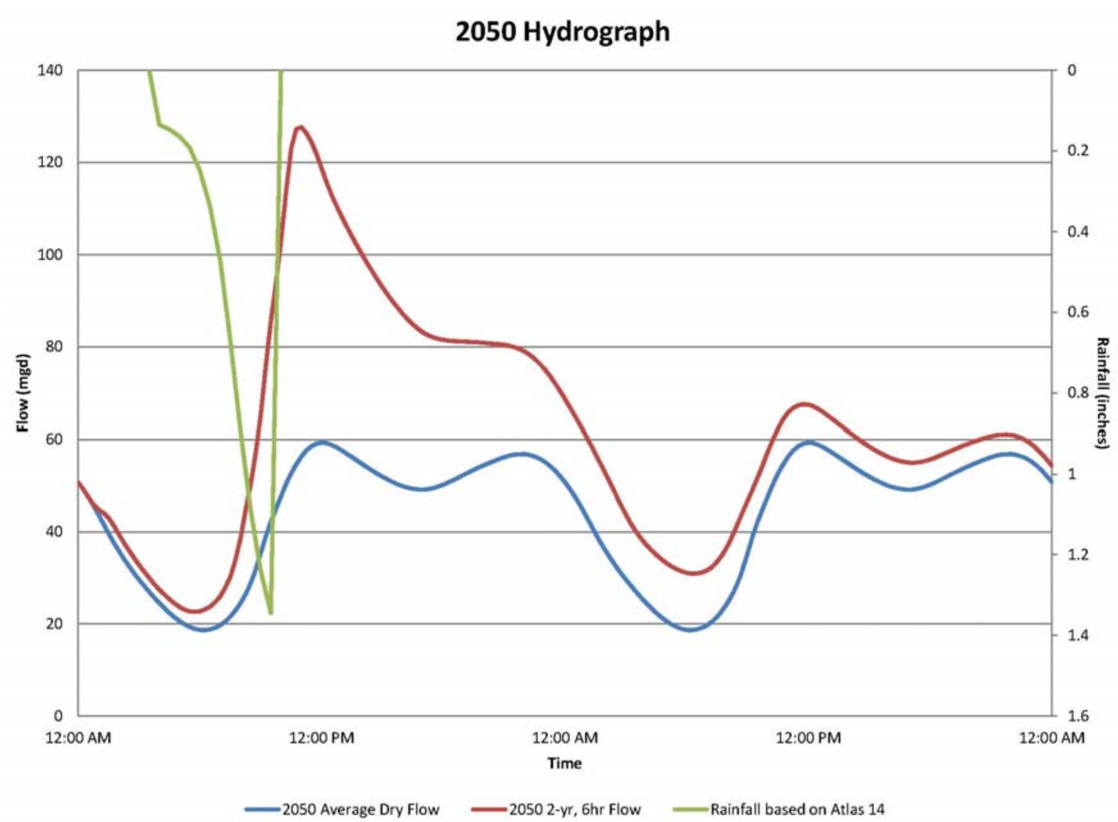
Table 5-6. Year 2050 Flow Parameters from the Honouliuli System Model

Flow Parameter	WWTP (mgd)	Waipahu (mgd)	Pearl City (mgd)	Waimalu (mgd)	Halawa (mgd)
Honouliuli Typical Year					
Annual Average	44.4	14.1	11.5	5.3	1.9
Maximum 30-day	45.1	-	-	-	-
Maximum Day	56.7	-	-	-	-
Maximum 24-Hour	57.0	17.3	15.5	7.5	2.9
Peak 1-Hour	79.5	24.3	21.1	10.2	5.1
2-Year, 6-Hour Event					
Maximum 24-Hour	73.5	19.9	21.8	10.1	3.4
Peak 1-Hour	126.4	32.2	40.1	18.0	5.5

Each of these flow parameters was developed from output from the Honouliuli System Model as described above for year 2010 and will be evaluated for use in sizing WWTP unit processes under Task 12.C - Secondary Treatment Process Evaluation and Selection of the Honouliuli/Waipahu/Pearl City Wastewater Facilities Plan. The same relationships between the annual average and maximum 30-day flows and the maximum day and maximum 24-hour flows discussed above for year 2010 and year 2035 conditions are observed from inspection of **Table 5-6** for year 2050 conditions.

Figure 5-4 shows a plot of the estimated WWTP influent flow for the typical year and 2-year, 6 hour storm using 2050 flow data. The flow range is impacted by the heavy rainfall similar to the year 2010 and 2035 simulations. The peak hour flow increases from approximately 59 mgd during an average day up to approximately 126 mgd during the 2-year, 6 hour storm.

Figure 5-4. Estimated Honouliuli WWTP Flow – 2-Year, 6 Hour Storm in 2050



The year 2050 influent waste loadings are shown in **Table 5-7**. The 2010 Waste Load Coefficients were multiplied by the 2050 equivalent population projection of 504,239 (see **Table 4-2**). This projection assumes that contribution of contaminants per capita will remain constant over time.

Table 5-7. Year 2050 Influent Waste Loading

Contaminants	2010 Waste Load Coefficient (lbs/capita/day)(1)	2050 Waste Load (lbs/day)(2)
BOD	0.225	113,454
TSS	0.234	117,992
TKN	0.023	11,597
NH3	0.016	8,068
TP	0.0026	1,311

(1) From **Table 5-3**

(2) 2050 Waste Load (lbs/day) = 2010 Waste Load Coefficient (lbs/capita/day) × 2050 equivalent population projection (504,239)

5.5 Intermediate Design Year Projections

If an intermediate design year is desired, such as year 2030, the flow and load projections can be extrapolated from the second order polynomial curves, shown in **Figure 5-5** and **Figure 5-6**.

Figure 5-5. Honouliuli WWTP Flow Projections (with 2030 extrapolation)

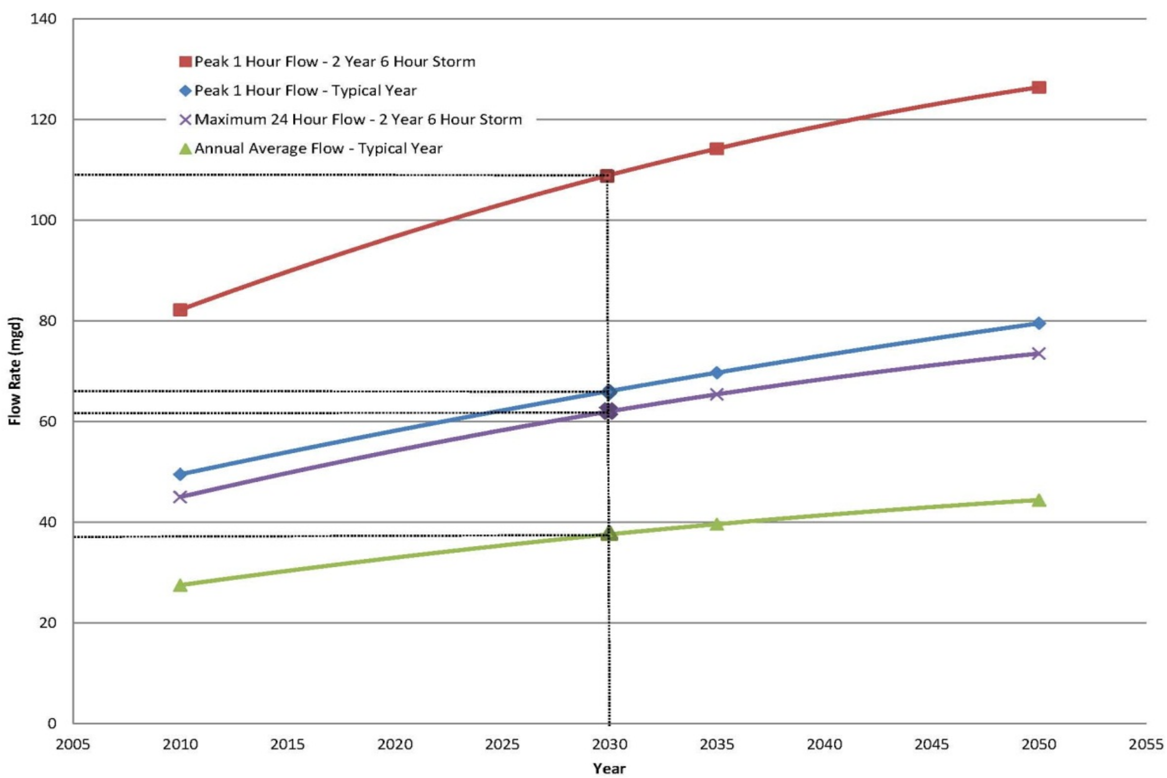
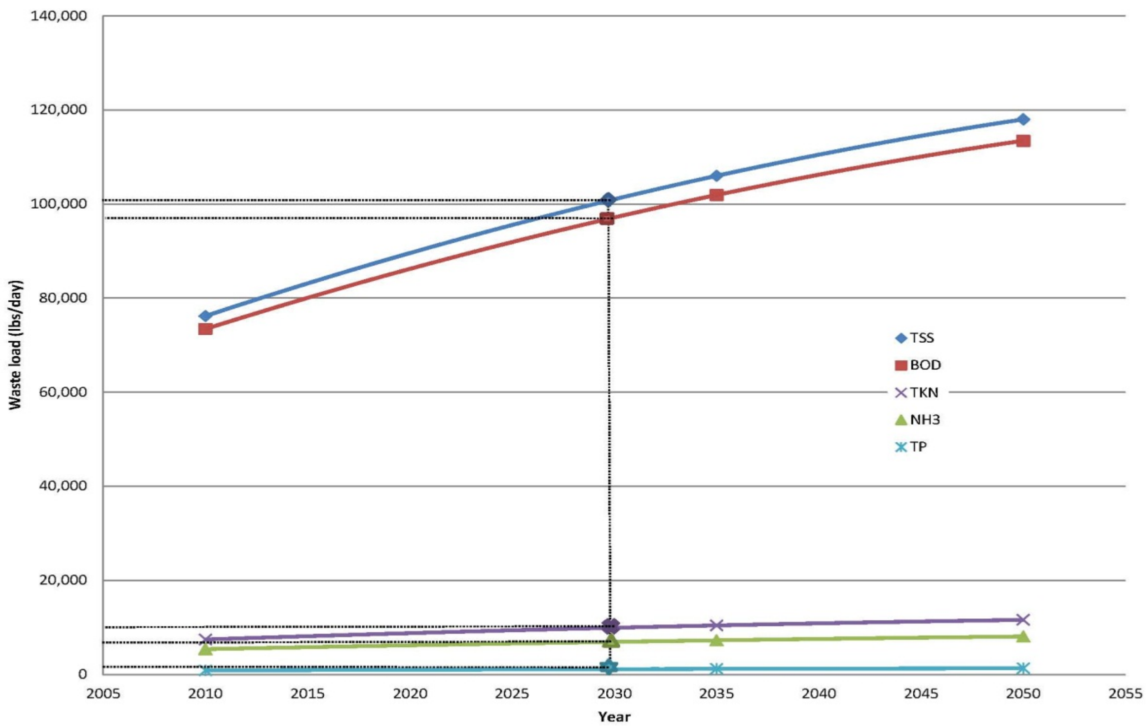


Figure 5-6. Honouliuli WWTP Load Projections (with 2030 extrapolation)



Extrapolated 2030 flow and load results are shown in **Table 5-8** and **Table 5-9**, respectively, for comparison purposes.

Table 5-8. Extrapolated Year 2030 Flow Parameters from the Honouliuli System Model

Flow Parameter	WWTP (mgd)	Waipahu (mgd)	Pearl City (mgd)	Waimalu (mgd)	Halawa (mgd)
Honouliuli Typical Year					
Annual Average	37.6	12.9	10.6	5.3	1.9
Maximum 30-day	38.3	-	-	-	-
Maximum 24-Hour	48.9	15.7	12.9	7.6	2.9
Peak 1-Hour	64.7	22.7	18.1	10.3	4.6
2-Year, 6-Hour Event					
Maximum 24-Hour	62.0	17.8	18.4	10.2	3.4
Peak 1-Hour	107.6	28.9	36.6	18.1	5.5

Table 5-9. Extrapolated Year 2030 Influent Waste Loading

Contaminants	2010 Waste Load Coefficient (lbs/capita/day)(1)	2030 Waste Load (lbs/day)(2)
BOD	0.225	97,140
TSS	0.234	101,007
TKN	0.023	9,921
NH_3	0.016	6,922
TP	0.0026	1,124

(1) From **Table 5-3**

(2) 2030 Waste Load (lbs/day) = Extrapolated from second order polynomial curves shown in Fig. 5-2

Appendix A.
City and County of Honolulu Socioeconomic Projections to Year 2035

Year	DP Area	Total Resident Population	Population in Group Quarters	Visitor Accomm Units	Resident Housing Units	Households: 1 Person	2 Persons	3 Persons	4 Persons	5+ Persons	Total	Average Size	Employment (jobs): Armed Forces	Public Admin	Hotel	Agri-culture	Transp, Comm, Utilities	Industrial	Fin, Ins, & Real Estate	Services	Retail	Constr	Total
Year 2000	Primary Urban Center	419,333	16,995	34,170	171,773	44,066	46,596	25,424	18,634	18,269	**152,989**	2.63	14,780	27,639	15,242	1,392	34,540	24,631	27,673	134,447	70,928	11,568	**362,840**
	Ewa	68,696	420	392	20,797	2,031	4,163	3,731	4,136	4,863	**18,924**	3.61	1,056	1,045	504	356	1,079	2,245	1,075	6,565	2,483	3,530	**19,938**
	Central Oahu	148,208	6,145	207	45,878	5,906	10,976	8,759	8,525	8,630	**42,796**	3.32	12,673	3,465	79	741	2,225	2,296	1,852	14,778	8,382	4,034	**50,525**
	East Honolulu	46,735	149	371	17,099	2,268	5,669	3,461	2,771	2,019	**16,188**	2.88	0	265	188	54	459	230	602	3,454	1,504	807	**7,563**
	Koolaupoko	117,999	5,627	60	36,964	4,814	10,551	7,168	6,468	6,441	**35,442**	3.17	11,318	2,264	25	777	1,376	1,150	1,301	14,974	6,433	1,623	**41,241**
	Koolauloa	14,546	753	595	4,473	602	841	538	517	1,184	**3,682**	3.75	0	146	309	424	244	109	232	3,224	1,020	191	**5,899**
	North Shore	18,380	400	17	6,648	1,023	1,716	1,188	969	997	**5,893**	3.05	511	64	6	465	143	392	155	1,533	1,147	508	**4,924**
	Waianae	42,259	456	509	12,356	1,253	2,127	1,746	1,698	3,711	**10,535**	3.97	100	421	304	552	195	119	249	3,991	1,327	941	**8,199**
	OAHU TOTAL	**876,156**	**30,945**	**36,321**	**315,988**	**61,963**	**82,639**	**52,015**	**43,718**	**46,114**	**286,449**	**2.95**	**40,438**	**35,309**	**16,657**	**4,761**	**40,261**	**31,172**	**33,139**	**182,966**	**93,224**	**23,202**	**501,129**
Year 2005	Primary Urban Center	417,336	16,995	32,819	173,438	54,378	44,305	23,885	16,127	19,392	**158,086**	2.53	15,626	28,657	16,196	856	36,802	24,622	26,464	145,453	73,458	12,711	**380,845**
	Ewa	82,595	420	499	25,404	3,386	5,713	4,524	4,721	5,630	**23,975**	3.43	1,119	1,411	265	219	1,185	1,940	400	17,395	4,054	9,947	**37,935**
	Central Oahu	157,008	6,145	207	49,439	7,911	12,842	9,062	8,450	9,024	**47,289**	3.19	13,398	3,594	107	454	2,367	2,218	1,141	25,588	10,048	5,618	**64,533**
	East Honolulu	49,229	149	371	18,279	2,636	6,227	3,665	2,798	2,070	**17,396**	2.82	0	269	190	34	489	230	602	3,454	1,504	679	**7,451**
	Koolaupoko	117,004	5,627	60	37,174	5,306	10,920	7,050	6,198	6,308	**35,781**	3.11	11,966	2,341	26	477	1,462	1,150	1,295	15,263	6,464	1,089	**41,533**
	Koolauloa	14,482	753	595	4,518	611	822	515	497	1,202	**3,646**	3.77	0	150	305	259	259	109	229	3,274	1,024	118	**5,727**
	North Shore	18,118	400	17	6,648	1,345	1,887	1,160	878	918	**6,190**	2.86	540	64	9	286	147	392	155	1,533	1,147	99	**4,372**
	Waianae	43,923	456	51	13,038	2,036	2,670	1,908	1,698	3,606	**11,918**	3.65	106	438	26	337	207	119	249	3,991	1,327	612	**7,412**
	OAHU TOTAL	**899,695**	**30,945**	**34,619**	**327,938**	**77,609**	**85,387**	**51,767**	**41,367**	**48,150**	**304,282**	**2.86**	**42,755**	**36,924**	**17,124**	**2,922**	**42,918**	**30,780**	**30,535**	**215,951**	**99,026**	**30,873**	**549,808**
Year 2008	Primary Urban Center	416,049	16,995	31,133	177,826	58,229	45,953	24,024	15,754	18,222	**162,181**	2.46	15,727	28,551	15,813	623	37,515	24,611	25,584	151,799	74,673	14,544	**389,440**
	Ewa	90,872	420	941	28,758	4,109	6,786	5,155	5,223	5,875	**27,148**	3.33	1,126	2,062	478	162	1,209	1,716	240	21,506	4,801	9,527	**42,827**
	Central Oahu	158,606	6,145	218	51,387	8,770	13,855	9,399	8,509	8,622	**49,154**	3.10	13,486	3,576	111	337	2,414	2,163	894	28,585	10,068	6,675	**68,309**
	East Honolulu	49,063	149	381	18,738	2,904	6,596	3,732	2,707	1,895	**17,833**	2.74	0	268	193	26	497	230	602	3,454	1,504	178	**6,952**
	Koolaupoko	114,087	5,627	68	37,234	5,694	11,371	7,016	5,977	5,781	**35,839**	3.03	12,043	2,335	38	352	1,496	1,150	1,283	15,402	6,461	867	**41,427**
	Koolauloa	14,142	753	603	4,532	654	859	520	492	1,134	**3,658**	3.66	0	150	307	193	265	109	229	3,287	1,024	86	**5,650**
	North Shore	17,697	400	29	6,675	1,429	1,943	1,152	847	844	**6,215**	2.78	544	64	15	210	149	392	155	1,533	1,147	109	**4,318**
	Waianae	43,776	456	221	13,364	2,590	3,019	1,977	1,707	3,355	**12,648**	3.42	106	435	112	251	219	119	249	3,991	1,327	993	**7,802**
	OAHU TOTAL	**904,292**	**30,945**	**33,594**	**338,514**	**84,379**	**90,380**	**52,974**	**41,216**	**45,727**	**314,677**	**2.78**	**43,032**	**37,441**	**17,067**	**2,154**	**43,764**	**30,490**	**29,236**	**229,557**	**101,005**	**32,979**	**566,725**
Year 2010	Primary Urban Center	418,664	16,995	30,961	178,805	58,356	46,156	24,186	15,867	18,403	**162,968**	2.46	15,243	28,376	15,298	623	37,119	24,602	25,153	151,962	74,219	15,489	**388,084**
	Ewa	94,504	420	1,154	29,883	4,252	7,047	5,365	5,439	6,113	**28,216**	3.33	1,094	2,046	570	162	1,195	1,532	196	22,067	4,681	12,633	**46,176**
	Central Oahu	158,965	6,145	212	51,456	8,758	13,860	9,418	8,533	8,654	**49,223**	3.10	13,066	3,552	105	337	2,392	2,119	835	28,716	9,956	1,537	**62,615**
	East Honolulu	49,129	149	370	18,744	2,899	6,590	3,734	2,714	1,903	**17,840**	2.75	0	266	183	26	495	230	602	3,454	1,504	151	**6,911**
	Koolaupoko	114,209	5,627	68	37,237	5,680	11,355	7,019	5,987	5,802	**35,842**	3.03	11,671	2,323	38	352	1,477	1,150	1,280	15,404	6,436	847	**40,978**
	Koolauloa	14,156	753	586	4,532	653	857	519	492	1,136	**3,658**	3.66	0	150	288	193	262	109	229	3,287	1,024	86	**5,628**
	North Shore	17,724	400	28	6,677	1,426	1,941	1,153	849	847	**6,217**	2.79	527	64	14	210	148	392	155	1,533	1,147	100	**4,290**
	Waianae	44,490	456	217	13,572	2,620	3,064	2,011	1,737	3,412	**12,843**	3.43	103	434	108	251	210	119	249	3,991	1,327	210	**7,002**
	OAHU TOTAL	**911,841**	**30,945**	**33,596**	**340,906**	**84,643**	**90,871**	**53,405**	**41,617**	**46,270**	**316,807**	**2.78**	**41,704**	**37,211**	**16,604**	**2,154**	**43,298**	**30,253**	**28,699**	**230,414**	**100,294**	**31,053**	**561,684**
Year 2015	Primary Urban Center	427,429	16,995	27,452	184,935	60,908	47,837	24,792	16,108	18,415	**168,059**	2.44	15,237	28,552	15,595	646	39,650	24,602	25,153	159,064	76,408	14,318	**399,225**
	Ewa	107,234	420	4,496	34,341	4,959	8,216	6,184	6,206	6,783	**32,349**	3.30	1,095	3,203	1,628	166	1,309	2,657	1,657	27,418	9,212	14,319	**62,664**
	Central Oahu	161,999	6,145	184	53,121	9,272	14,507	9,703	8,686	8,619	**50,786**	3.07	13,069	3,577	105	347	2,557	2,390	1,076	31,138	10,040	4,219	**68,518**
	East Honolulu	51,119	149	321	19,745	3,139	7,036	3,911	2,786	1,910	**18,782**	2.71	0	268	183	26	528	230	602	3,454	1,504	422	**7,217**
	Koolaupoko	115,631	5,627	62	38,185	5,996	11,833	7,166	6,032	5,725	**36,752**	2.99	11,671	2,335	38	362	1,582	1,150	1,280	15,643	6,436	1,299	**41,796**
	Koolauloa	14,592	753	1,276	4,737	745	961	564	522	1,119	**3,911**	3.54	0	150	435	200	280	109	229	3,433	1,038	307	**6,181**
	North Shore	18,325	400	26	6,994	1,523	2,057	1,201	875	852	**6,508**	2.75	527	64	14	219	169	392	155	1,533	1,147	191	**4,411**
	Waianae	45,518	456	189	14,060	2,777	3,223	2,095	1,788	3,429	**13,312**	3.39	103	435	107	256	224	119	249	3,991	1,327	360	**7,171**
	OAHU TOTAL	**941,847**	**30,945**	**34,006**	**356,118**	**89,318**	**95,669**	**55,616**	**43,003**	**46,852**	**330,458**	**2.76**	**41,702**	**38,584**	**18,105**	**2,222**	**46,299**	**31,649**	**30,401**	**245,674**	**107,112**	**35,435**	**597,183**
Year 2020	Primary Urban Center	432,487	16,995	27,175	190,539	64,570	49,420	25,265	16,059	17,941	**173,255**	2.40	15,237	29,269	15,639	646	41,069	24,602	25,274	164,347	77,336	14,924	**408,343**
	Ewa	123,101	420	6,495	40,140	5,894	9,870	7,262	7,156	7,517	**37,699**	3.25	1,094	3,343	2,142	166	1,513	3,330	2,336	32,231	12,352	14,467	**72,974**
	Central Oahu	166,078	6,145	182	55,473	10,013	15,460	10,109	8,893	8,521	**52,996**	3.02	13,067	3,662	105	347	2,647	2,623	1,181	33,656	10,141	5,226	**72,655**
	East Honolulu	51,238	149	318	20,141	3,337	7,319	3,953	2,735	1,811	**19,155**	2.67	0	287	183	26	544	230	602	3,454	1,504	175	**7,005**
	Koolaupoko	116,118	5,627	60	39,037	6,385	12,377	7,275	6,007	5,527	**37,570**	2.94	11,671	2,394	38	362	1,635	1,150	1,282	15,808	6,436	1,309	**42,085**
	Koolauloa	14,899	753	1,263	4,927	755	969	567	527	1,156	**3,975**	3.56	0	153	479	200	290	109	230	3,549	1,068	318	**6,396**
	North Shore	18,770	400	24	7,293	1,640	2,169	1,247	889	837	**6,782**	2.71	527	64	14	219	172	392	155	1,533	1,147	204	**4,427**
	Waianae	46,776	456	186	14,706	2,999	3,445	2,200	1,854	3,431	**13,930**	3.33	103	446	108	256	229	119	249	3,991	1,327	402	**7,230**
	OAHU TOTAL	**969,467**	**30,945**	**35,703**	**372,256**	**95,593**	**101,029**	**57,877**	**44,119**	**46,743**	**345,362**	**2.72**	**41,699**	**39,618**	**18,708**	**2,222**	**48,099**	**32,555**	**31,309**	**258,569**	**111,311**	**37,025**	**621,115**
Year 2025	Primary Urban Center	437,818	16,995	28,315	196,197	68,700	51,118	25,669	15,960	17,462	**178,910**	2.35	15,237	29,855	15,658	653	42,300	24,602	25,323	169,266	78,051	15,177	**416,122**
	Ewa	137,721	420	6,768	45,669	6,894	11,429	8,276	8,034	8,158	**42,791**	3.21	1,093	3,475	2,398	171	1,718	3,867	2,991	37,509	15,388	15,484	**84,094**
	Central Oahu	171,595	6,145	189	58,343	10,862	16,547	10,618	9,170	8,498	**55,695**	2.97	13,067	3,741	105	357	2,722	2,871	1,280	36,274	10,283	5,773	**76,473**
	East Honolulu	50,400	149	331	20,141	3,466	7,455	3,912	2,633	1,688	**19,155**	2.62	0	288	183	26	562	230	602	3,454	1,504	172	**7,021**
	Koolaupoko	114,975	5,627	62	39,280	6,675	12,690	7,285	5,891	5,263	**37,804**	2.89	11,671	2,447	38	373	1,689	1,150	1,283	15,905	6,436	997	**41,989**
	Koolauloa	15,150	753	1,316	5,098	808	1,023	588	541	1,152	**4,112**	3.50	0	157	500	204	299	109	231	3,659	1,103	306	**6,568**
	North Shore	19,126	400	26	7,563	1,753	2,281	1,281	897	818	**7,030**	2.66	527	64	14	225	175	392	155	1,533	1,147	204	**4,436**
	Waianae	47,847	456	193	15,298	3,214	3,656	2,295	1,911	3,419	**14,495**	3.27	103	455	107	267	236	119	249	3,991	1,327	406	**7,260**
	OAHU TOTAL	**994,632**	**30,945**	**37,200**	**387,589**	**102,372**	**106,200**	**59,923**	**45,037**	**46,458**	**359,991**	**2.68**	**41,698**	**40,482**	**19,003**	**2,276**	**49,701**	**33,340**	**32,114**	**271,591**	**115,239**	**38,519**	**643,963**
Year 2030	Primary Urban Center	442,994	16,995	29,235	201,805	72,422	52,684	26,047	15,901	17,056	**184,109**	2.31	15,237	30,332	15,687	653	43,517	24,602	25,388	174,074	78,782	16,042	**424,314**
	Ewa	151,332	420	6,986	51,012	7,919	12,993	9,237	8,842	8,700	**47,691**	3.16	1,094	3,592	2,743	171	1,915	4,276	3,642	42,956	18,062	15,640	**94,091**
	Central Oahu	177,029	6,145	195	61,241	11,739	17,659	11,109	9,432	8,469	**58,409**	2.93	13,067	3,805	105	357	2,804	3,078	1,373	38,838	10,557	6,200	**80,184**
	East Honolulu	49,600	149	342	20,141	3,609	7,541	3,901	2,532	1,572	**19,155**	2.58	0	290	183	26	580	230	602	3,454	1,504	172	**7,041**
	Koolaupoko	113,243	5,627	70	39,280	6,923	12,912	7,247	5,740	4,981	**37,804**	2.85	11,671	2,478	38	373	1,730	1,150	1,283	15,994	6,449	1,008	**42,174**
	Koolauloa	15,336	753	1,358	5,246	857	1,072	605	552	1,144	**4,231**	3.45	0	160	529	204	308	109	231	3,758	1,128	289	**6,716**
	North Shore	19,375	400	26	7,784	1,852	2,378	1,307	899	797	**7,233**	2.62	527	66	14	225	179	392	155	1,533	1,147	189	**4,427**
	Waianae	48,667	456	201	15,812	3,416	3,846	2,376	1,955	3,392	**14,985**	3.22	103	460	107	267	249	119	249	3,991	1,327	375	**7,247**
	OAHU TOTAL	**1,017,576**	**30,945**	**38,413**	**402,321**	**108,739**	**111,086**	**61,828**	**45,852**	**46,110**	**373,616**	**2.64**	**41,699**	**41,183**	**19,406**	**2,276**	**51,282**	**33,956**	**32,923**	**284,598**	**118,956**	**39,915**	**666,194**
Year 2035	Primary Urban Center	447,715	16,995	30,142	207,218	76,113	54,189	26,355	15,820	16,647	**189,126**	2.28	15,237	30,874	15,700	658	44,791	24,602	25,617	178,851	80,189	16,820	**433,339**
	Ewa	164,556	420	7,204	56,344	8,999	14,601	10,188	9,613	9,185	**52,586**	3.12	1,096	3,714	2,914	175	2,092	4,752	4,026	48,604	19,798	16,263	**103,434**
	Central Oahu	181,423	6,145	202	63,784	12,580	18,660	11,539	9,622	8,391	**60,792**	2.88	13,067	3,870	105	364	2,887	3,302	1,443	41,285	11,050	6,213	**83,586**
	East Honolulu	48,843	149	352	20,141	3,738	7,653	3,863	2,435	1,466	**19,155**	2.54	0	292	183	28	595	230	602	3,454	1,504	178	**7,066**
	Koolaupoko	111,594	5,627	71	39,280	7,157	13,137	7,200	5,592	4,718	**37,804**	2.80	11,671	2,530	38	381	1,778	1,150	1,284	16,074	6,485	1,029	**42,420**
	Koolauloa	15,452	753	1,401	5,372	905	1,118	619	560	1,129	**4,332**	3.39	0	163	544	210	316	109	235	3,843	1,151	273	**6,844**
	North Shore	19,517	400	27	7,966	1,948	2,459	1,327	895	771	**7,400**	2.58	527	77	14	230	182	392	155	1,533	1,147	180	**4,437**
	Waianae	49,217	456	206	16,242	3,620	3,991	2,447	1,992	3,346	**15,395**	3.17	103	471	107	273	253	119	249	3,991	1,327	361	**7,254**
	OAHU TOTAL	**1,038,317**	**30,945**	**39,605**	**416,347**	**115,062**	**115,808**	**63,537**	**46,529**	**45,652**	**386,589**	**2.61**	**41,701**	**41,991**	**19,605**	**2,319**	**52,894**	**34,656**	**33,611**	**297,635**	**122,651**	**41,317**	**688,380**

Appendix B.
Populations for Study Areas TAZs as Derived from 2010 Census Data

Populations for Study Area TAZs as Derived from 2010 Census Data

Pump Station Tributary Area	Census Block ID	TAZ	POP
Halawa	150030067011020	370	0
Halawa	150030067021000	370	0
Halawa	150030067021001	370	211
Halawa	150030067021002	370	93
Halawa	150030067021003	370	40
Halawa	150030067021004	370	37
Halawa	150030067021005	370	0
Halawa	150030067021006	370	0
Halawa	150030067021008	370	1608
Halawa	150030067021009	370	0
Halawa	150030067021010	370	0
Halawa	150030074001042	397	0
Halawa	150030074001044	397	15
Halawa	150030074001045	397	0
Halawa	150030074001121	397	0
Halawa	150030074001122	397	0
Halawa	150030074001123	397	0
Halawa	150030074001133	397	0
Halawa	150030074001141	394	0
Halawa	150030074001143	394	0
Halawa	150030074001146	394	0
Halawa	150030074001147	394	0
Halawa	150030074001148	394	131
Halawa	150030074001153	394	4
Halawa	150030074001154	394	0
Halawa	150030074001178	394	0
Halawa	150030074001179	394	0
Halawa	150030074001182	394	0
Halawa	150030074001183	394	0
Halawa	150030074001184	394	0
Halawa	150030074001185	394	0
Halawa	150030074001218	397	0
Halawa	150030075021000	371	0
Halawa	150030075021001	371	0
Halawa	150030075021002	371	0
Halawa	150030075021003	375	5
Halawa	150030075021004	371	0
Halawa	150030075021005	371	0
Halawa	150030075021006	376	0
Halawa	150030075021009	371	0
Halawa	150030075021010	371	0
Halawa	150030075021011	371	0
Halawa	150030075021012	371	0
Halawa	150030075021013	371	0
Halawa	150030075021014	371	0
Halawa	150030075021015	371	0

Populations for Study Area TAZs as Derived from 2010 Census Data

Pump Station Tributary Area	Census Block ID	TAZ	POP
Halawa	150030075021016	371	0
Halawa	150030075021017	371	0
Halawa	150030075021018	371	928
Halawa	150030075021019	371	1
Halawa	150030075021020	371	0
Halawa	150030075021021	371	0
Halawa	150030075021022	371	0
Halawa	150030075021023	371	0
Halawa	150030075021024	371	0
Halawa	150030075021025	371	0
Halawa	150030075021026	371	0
Halawa	150030075021027	371	0
Halawa	150030075021028	371	0
Halawa	150030075021029	371	0
Halawa	150030075021030	371	0
Halawa	150030075021031	370	0
Halawa	150030075021032	370	94
Halawa	150030075021033	370	214
Halawa	150030075021034	376	134
Halawa	150030075021035	376	0
Halawa	150030075021036	376	0
Halawa	150030075021037	376	0
Halawa	150030075021038	376	0
Halawa	150030075021039	376	0
Halawa	150030075021040	376	0
Halawa	150030075021041	376	0
Halawa	150030075021042	376	0
Halawa	150030075021043	376	0
Halawa	150030075021044	376	0
Halawa	150030075021045	376	0
Halawa	150030075021046	376	0
Halawa	150030075021047	376	0
Halawa	150030075021048	376	0
Halawa	150030075021049	376	0
Halawa	150030075021050	376	0
Halawa	150030075021051	376	0
Halawa	150030075021052	376	0
Halawa	150030075021053	376	0
Halawa	150030075021054	376	0
Halawa	150030075021055	376	0
Halawa	150030075021056	376	0
Halawa	150030075021057	376	0
Halawa	150030075021058	376	0
Halawa	150030075021059	375	0
Halawa	150030075031000	375	22
Halawa	150030075031001	375	388

Populations for Study Area TAZs as Derived from 2010 Census Data

Pump Station Tributary Area	Census Block ID	TAZ	POP
Halawa	150030075031002	375	72
Halawa	150030075031004	375	106
Halawa	150030075031006	375	432
Halawa	150030075031007	375	47
Halawa	150030075031008	375	91
Halawa	150030075031009	375	51
Halawa	150030075031010	375	120
Halawa	150030075031011	375	161
Halawa	150030075031014	375	111
Halawa	150030075031015	375	94
Halawa	150030075031016	375	85
Halawa	150030075031017	375	113
Halawa	150030075031018	375	49
Halawa	150030075031019	375	82
Halawa	150030075031020	375	89
Halawa	150030075031021	375	80
Halawa	150030075031022	375	74
Halawa	150030075031023	375	30
Halawa	150030075031024	375	63
Halawa	150030075031025	375	106
Halawa	150030075031026	375	68
Halawa	150030075032000	376	0
Halawa	150030075032001	375	818
Halawa	150030075032002	375	88
Halawa	150030075032003	375	200
Halawa	150030075032004	375	60
Halawa	150030075032005	375	82
Halawa	150030075032006	375	145
Halawa	150030075032007	375	0
Halawa	150030075032008	371	4
Halawa	150030075032009	375	0
Halawa	150030075032010	375	0
Halawa	150030075032011	375	0
Halawa	150030075032012	375	128
Halawa	150030075032013	375	119
Halawa	150030075032014	375	0
Halawa	150030075032015	375	0
Halawa	150030075032016	375	0
Halawa	150030075032017	375	0
Halawa	150030075032018	375	0
Halawa	150030075032019	375	29
Halawa	150030075032020	375	88
Halawa	150030075032021	375	156
Halawa	150030075032022	375	0
Halawa	150030075032023	375	122
Halawa	150030075032024	375	73

Populations for Study Area TAZs as Derived from 2010 Census Data

Pump Station Tributary Area	Census Block ID	TAZ	POP
Halawa	150030075032025	375	0
Halawa	150030075032026	374	0
Halawa	150030075032027	374	0
Halawa	150030075032028	375	0
Halawa	150030075032029	375	0
Halawa	150030075032030	375	0
Halawa	150030075032031	375	0
Halawa	150030075032032	375	0
Halawa	150030075032033	375	0
Halawa	150030075032034	375	0
Halawa	150030075032035	375	0
Halawa	150030075032036	375	0
Halawa	150030075032037	371	0
Halawa	150030075041000	396	0
Halawa	150030075041001	396	0
Halawa	150030075041002	396	0
Halawa	150030075041003	396	0
Halawa	150030075041004	396	0
Halawa	150030075041005	396	0
Halawa	150030075041007	396	0
Halawa	150030075041008	396	0
Halawa	150030075041009	395	67
Halawa	150030075041010	395	247
Halawa	150030075041011	395	91
Halawa	150030075041012	395	84
Halawa	150030075041013	395	199
Halawa	150030075041014	395	727
Halawa	150030075041015	395	93
Halawa	150030075041016	395	0
Halawa	150030075041017	395	0
Halawa	150030075041018	395	0
Halawa	150030075042000	395	295
Halawa	150030075042001	395	1229
Halawa	150030075042002	395	139
Halawa	150030075042003	395	0
Halawa	150030075051000	372	0
Halawa	150030075051001	373	291
Halawa	150030075051002	373	0
Halawa	150030075051003	373	99
Halawa	150030075051004	373	105
Halawa	150030075051005	373	190
Halawa	150030075051006	373	182
Halawa	150030075051007	373	123
Halawa	150030075051008	373	74
Halawa	150030075051009	373	42
Halawa	150030075051010	373	119

Populations for Study Area TAZs as Derived from 2010 Census Data

Pump Station Tributary Area	Census Block ID	TAZ	POP
Halawa	150030075051011	373	120
Halawa	150030075051012	373	92
Halawa	150030075051013	373	108
Halawa	150030075051014	373	144
Halawa	150030075051015	373	95
Halawa	150030075051016	373	42
Halawa	150030075051017	373	85
Halawa	150030075051018	373	116
Halawa	150030075051019	373	103
Halawa	150030075051020	373	62
Halawa	150030075051021	373	214
Halawa	150030075052000	373	0
Halawa	150030075052001	373	416
Halawa	150030075052002	373	0
Halawa	150030075052003	373	0
Halawa	150030075052004	373	0
Halawa	150030075052005	373	0
Halawa	150030075052006	373	0
Halawa	150030075052007	373	48
Halawa	150030075052008	373	800
Halawa	150030075052009	373	54
Halawa	150030075052010	373	82
Halawa	150030075052011	373	38
Halawa	150030075052012	373	0
Halawa	150030075052013	373	0
Halawa	150030075052014	373	0
Halawa	150030075052015	373	278
Halawa	150030075052016	373	216
Halawa	150030075053000	374	1000
Halawa	150030075053001	374	0
Halawa	150030075053002	374	0
Halawa	150030075053003	374	0
Halawa	150030075053004	374	0
Halawa	150030075053005	373	0
Halawa	150030075053006	373	0
Halawa	150030075053007	373	0
Halawa	150030075053008	373	0
Halawa	150030075053009	374	0
Halawa	150030075053010	374	0
Halawa	150030075053011	374	0
Halawa	150030075053012	374	0
Halawa	150030075053013	373	0
Halawa	150030075061000	372	64
Halawa	150030075061001	372	508
Halawa	150030075061002	372	0
Halawa	150030075061003	372	0

Populations for Study Area TAZs as Derived from 2010 Census Data

Pump Station Tributary Area	Census Block ID	TAZ	POP
Halawa	150030075061004	372	29
Halawa	150030075061005	372	0
Halawa	150030075061006	373	0
Halawa	150030075061007	373	0
Halawa	150030075061008	372	140
Halawa	150030075061009	372	16
Halawa	150030075061010	372	0
Halawa	150030075061011	372	0
Halawa	150030075061012	372	0
Halawa	150030075061013	372	176
Halawa	150030077022009	405	0
Halawa	150030077022010	405	102
Halawa	150030077022011	405	73
Halawa	150030077022012	405	69
Halawa	150030077022013	405	22
Halawa	150030077022014	405	160
Halawa	150030103061003	371	0
Halawa Subtotal			*18,029*
Honouliuli Influent	150030083011000	560	0
Honouliuli Influent	150030083011001	560	0
Honouliuli Influent	150030083011002	560	0
Honouliuli Influent	150030083011003	560	0
Honouliuli Influent	150030083011004	560	0
Honouliuli Influent	150030083011005	560	0
Honouliuli Influent	150030083011006	560	0
Honouliuli Influent	150030083011007	560	0
Honouliuli Influent	150030083011008	560	0
Honouliuli Influent	150030083011009	560	0
Honouliuli Influent	150030083011010	560	0
Honouliuli Influent	150030083011011	560	0
Honouliuli Influent	150030083011012	560	0
Honouliuli Influent	150030083011013	560	0
Honouliuli Influent	150030083011014	560	0
Honouliuli Influent	150030083011015	560	0
Honouliuli Influent	150030083011016	560	0
Honouliuli Influent	150030083011017	560	0
Honouliuli Influent	150030083011018	560	0
Honouliuli Influent	150030083011019	560	0
Honouliuli Influent	150030083011020	560	0
Honouliuli Influent	150030083011021	560	0
Honouliuli Influent	150030083011022	560	0
Honouliuli Influent	150030083011023	560	0
Honouliuli Influent	150030083011024	560	0
Honouliuli Influent	150030083011025	560	0
Honouliuli Influent	150030083011026	560	0
Honouliuli Influent	150030083011027	560	0

Populations for Study Area TAZs as Derived from 2010 Census Data

Pump Station Tributary Area	Census Block ID	TAZ	POP
Honouliuli Influent	150030083011028	560	0
Honouliuli Influent	150030083011029	560	0
Honouliuli Influent	150030083011030	560	0
Honouliuli Influent	150030083011031	560	0
Honouliuli Influent	150030083011032	560	0
Honouliuli Influent	150030083011033	560	0
Honouliuli Influent	150030083011034	560	0
Honouliuli Influent	150030083011035	560	0
Honouliuli Influent	150030083011036	560	0
Honouliuli Influent	150030083011037	560	0
Honouliuli Influent	150030083011038	560	0
Honouliuli Influent	150030083011039	560	0
Honouliuli Influent	150030083011040	560	0
Honouliuli Influent	150030083011041	560	0
Honouliuli Influent	150030083011042	560	0
Honouliuli Influent	150030083011043	560	0
Honouliuli Influent	150030083011044	560	0
Honouliuli Influent	150030083011045	560	0
Honouliuli Influent	150030083011046	560	0
Honouliuli Influent	150030083011047	560	0
Honouliuli Influent	150030083011048	560	0
Honouliuli Influent	150030083011049	560	0
Honouliuli Influent	150030083011050	560	0
Honouliuli Influent	150030083011051	560	0
Honouliuli Influent	150030083011052	560	0
Honouliuli Influent	150030083011053	560	0
Honouliuli Influent	150030083011054	560	0
Honouliuli Influent	150030083011055	560	0
Honouliuli Influent	150030083011056	560	0
Honouliuli Influent	150030083011057	560	0
Honouliuli Influent	150030083011058	560	0
Honouliuli Influent	150030083011059	560	0
Honouliuli Influent	150030083011060	560	0
Honouliuli Influent	150030083011061	560	0
Honouliuli Influent	150030083011062	560	0
Honouliuli Influent	150030083011063	560	0
Honouliuli Influent	150030083011064	560	0
Honouliuli Influent	150030083011065	560	0
Honouliuli Influent	150030083011066	560	0
Honouliuli Influent	150030083011067	560	0
Honouliuli Influent	150030083011068	560	0
Honouliuli Influent	150030083011069	560	0
Honouliuli Influent	150030083011070	560	0
Honouliuli Influent	150030083011071	560	0
Honouliuli Influent	150030083011072	560	0
Honouliuli Influent	150030083011073	560	0

Populations for Study Area TAZs as Derived from 2010 Census Data

Pump Station Tributary Area	Census Block ID	TAZ	POP
Honouliuli Influent	150030083011074	560	0
Honouliuli Influent	150030083011075	560	0
Honouliuli Influent	150030083011076	560	0
Honouliuli Influent	150030083011077	560	0
Honouliuli Influent	150030083011078	560	0
Honouliuli Influent	150030083011079	560	0
Honouliuli Influent	150030083011080	560	0
Honouliuli Influent	150030083011081	560	0
Honouliuli Influent	150030083011082	560	0
Honouliuli Influent	150030083011083	560	0
Honouliuli Influent	150030083011084	560	0
Honouliuli Influent	150030083011085	560	0
Honouliuli Influent	150030083011086	560	0
Honouliuli Influent	150030083011087	560	0
Honouliuli Influent	150030083011088	560	0
Honouliuli Influent	150030083011089	560	0
Honouliuli Influent	150030083011090	560	0
Honouliuli Influent	150030083011091	560	0
Honouliuli Influent	150030083011092	560	0
Honouliuli Influent	150030083011093	560	0
Honouliuli Influent	150030083011094	560	0
Honouliuli Influent	150030083011095	560	0
Honouliuli Influent	150030083011096	560	0
Honouliuli Influent	150030083011097	560	0
Honouliuli Influent	150030083011098	560	0
Honouliuli Influent	150030083011099	560	0
Honouliuli Influent	150030083011100	560	0
Honouliuli Influent	150030083012000	560	0
Honouliuli Influent	150030083012001	560	0
Honouliuli Influent	150030083012002	560	0
Honouliuli Influent	150030083012003	560	0
Honouliuli Influent	150030083012004	559	39
Honouliuli Influent	150030083012005	561	479
Honouliuli Influent	150030083012006	561	161
Honouliuli Influent	150030083012007	561	93
Honouliuli Influent	150030083012008	561	515
Honouliuli Influent	150030083013000	560	0
Honouliuli Influent	150030083013001	560	0
Honouliuli Influent	150030083013002	560	0
Honouliuli Influent	150030083013003	560	0
Honouliuli Influent	150030083013004	560	0
Honouliuli Influent	150030083013005	560	0
Honouliuli Influent	150030083013006	560	0
Honouliuli Influent	150030083013007	560	0
Honouliuli Influent	150030083013008	560	0
Honouliuli Influent	150030083013009	560	0

Populations for Study Area TAZs as Derived from 2010 Census Data

Pump Station Tributary Area	Census Block ID	TAZ	POP
Honouliuli Influent	150030083013010	560	0
Honouliuli Influent	150030083013011	560	0
Honouliuli Influent	150030083013012	560	0
Honouliuli Influent	150030083013013	560	0
Honouliuli Influent	150030083013014	560	0
Honouliuli Influent	150030083013015	560	0
Honouliuli Influent	150030083013016	560	0
Honouliuli Influent	150030083013017	560	0
Honouliuli Influent	150030083013018	560	0
Honouliuli Influent	150030083013019	560	0
Honouliuli Influent	150030083013020	560	0
Honouliuli Influent	150030083013022	560	0
Honouliuli Influent	150030083013023	560	0
Honouliuli Influent	150030083013024	561	0
Honouliuli Influent	150030083013025	561	295
Honouliuli Influent	150030083013026	561	76
Honouliuli Influent	150030083013027	561	66
Honouliuli Influent	150030083013028	561	27
Honouliuli Influent	150030083013029	561	87
Honouliuli Influent	150030083013030	561	110
Honouliuli Influent	150030083013031	561	65
Honouliuli Influent	150030083013032	561	140
Honouliuli Influent	150030083013033	561	58
Honouliuli Influent	150030083013034	561	104
Honouliuli Influent	150030083013035	561	166
Honouliuli Influent	150030083013036	561	0
Honouliuli Influent	150030083013037	561	236
Honouliuli Influent	150030083013038	561	75
Honouliuli Influent	150030083013039	561	46
Honouliuli Influent	150030083013040	561	415
Honouliuli Influent	150030083013041	561	85
Honouliuli Influent	150030083013042	561	55
Honouliuli Influent	150030083013043	561	81
Honouliuli Influent	150030083013044	561	73
Honouliuli Influent	150030083013045	561	138
Honouliuli Influent	150030083013046	561	131
Honouliuli Influent	150030083013047	561	123
Honouliuli Influent	150030083013048	561	106
Honouliuli Influent	150030083013049	561	123
Honouliuli Influent	150030083013050	561	117
Honouliuli Influent	150030083013051	561	0
Honouliuli Influent	150030083013052	561	0
Honouliuli Influent	150030083013053	561	0
Honouliuli Influent	150030083013054	560	0
Honouliuli Influent	150030083013055	560	0
Honouliuli Influent	150030083013056	560	0

Populations for Study Area TAZs as Derived from 2010 Census Data

Pump Station Tributary Area	Census Block ID	TAZ	POP
Honouliuli Influent	150030083013057	561	120
Honouliuli Influent	150030083013058	561	51
Honouliuli Influent	150030083013059	561	118
Honouliuli Influent	150030083013060	561	87
Honouliuli Influent	150030083021000	557	335
Honouliuli Influent	150030083021001	560	479
Honouliuli Influent	150030083021002	557	165
Honouliuli Influent	150030083021003	557	243
Honouliuli Influent	150030083021004	560	0
Honouliuli Influent	150030083021005	557	285
Honouliuli Influent	150030083021006	557	154
Honouliuli Influent	150030083021007	557	119
Honouliuli Influent	150030083021008	557	127
Honouliuli Influent	150030083021009	557	235
Honouliuli Influent	150030083022000	557	375
Honouliuli Influent	150030083022001	557	343
Honouliuli Influent	150030083022002	557	276
Honouliuli Influent	150030083022003	557	152
Honouliuli Influent	150030083022004	557	289
Honouliuli Influent	150030083022005	558	378
Honouliuli Influent	150030083022006	557	141
Honouliuli Influent	150030083022007	557	255
Honouliuli Influent	150030083023000	558	172
Honouliuli Influent	150030083023001	558	1142
Honouliuli Influent	150030083023002	558	352
Honouliuli Influent	150030083023003	558	544
Honouliuli Influent	150030083023004	558	188
Honouliuli Influent	150030084021000	562	192
Honouliuli Influent	150030084021001	562	0
Honouliuli Influent	150030084021002	563	569
Honouliuli Influent	150030084021003	562	657
Honouliuli Influent	150030084021004	562	715
Honouliuli Influent	150030084021005	562	68
Honouliuli Influent	150030084021006	562	64
Honouliuli Influent	150030084021007	563	54
Honouliuli Influent	150030084021008	563	107
Honouliuli Influent	150030084021009	563	97
Honouliuli Influent	150030084021010	563	76
Honouliuli Influent	150030084021011	563	60
Honouliuli Influent	150030084022000	563	108
Honouliuli Influent	150030084022001	563	122
Honouliuli Influent	150030084022002	563	125
Honouliuli Influent	150030084022003	563	79
Honouliuli Influent	150030084022004	563	642
Honouliuli Influent	150030084022005	563	72
Honouliuli Influent	150030084022006	563	52

Populations for Study Area TAZs as Derived from 2010 Census Data

Pump Station Tributary Area	Census Block ID	TAZ	POP
Honouliuli Influent	150030084022007	563	118
Honouliuli Influent	150030084022008	563	91
Honouliuli Influent	150030084022009	563	418
Honouliuli Influent	150030084022010	563	101
Honouliuli Influent	150030084022011	563	67
Honouliuli Influent	150030084022012	563	72
Honouliuli Influent	150030084022013	563	280
Honouliuli Influent	150030084022014	563	105
Honouliuli Influent	150030084022015	563	85
Honouliuli Influent	150030084022016	563	93
Honouliuli Influent	150030084023000	556	6
Honouliuli Influent	150030084023001	556	260
Honouliuli Influent	150030084023002	556	126
Honouliuli Influent	150030084023003	556	138
Honouliuli Influent	150030084023004	556	173
Honouliuli Influent	150030084023005	556	234
Honouliuli Influent	150030084023006	556	214
Honouliuli Influent	150030084023007	556	144
Honouliuli Influent	150030084023008	556	129
Honouliuli Influent	150030084023009	556	376
Honouliuli Influent	150030084023010	556	109
Honouliuli Influent	150030084023011	556	234
Honouliuli Influent	150030084023012	556	72
Honouliuli Influent	150030084023013	556	230
Honouliuli Influent	150030084023014	556	199
Honouliuli Influent	150030084023015	556	207
Honouliuli Influent	150030084023016	556	66
Honouliuli Influent	150030084051000	551	77
Honouliuli Influent	150030084051001	551	333
Honouliuli Influent	150030084051002	551	1684
Honouliuli Influent	150030084051003	551	248
Honouliuli Influent	150030084051004	560	0
Honouliuli Influent	150030084051005	551	301
Honouliuli Influent	150030084051006	551	125
Honouliuli Influent	150030084051007	551	1424
Honouliuli Influent	150030084051008	551	105
Honouliuli Influent	150030084051009	551	367
Honouliuli Influent	150030084051010	551	0
Honouliuli Influent	150030084061000	555	38
Honouliuli Influent	150030084061001	555	2514
Honouliuli Influent	150030084061002	555	89
Honouliuli Influent	150030084061003	555	24
Honouliuli Influent	150030084061004	555	45
Honouliuli Influent	150030084061005	555	302
Honouliuli Influent	150030084061006	555	153
Honouliuli Influent	150030084061007	555	73

Populations for Study Area TAZs as Derived from 2010 Census Data

Pump Station Tributary Area	Census Block ID	TAZ	POP
Honouliuli Influent	150030084061008	555	59
Honouliuli Influent	150030084061009	555	232
Honouliuli Influent	150030084061010	555	32
Honouliuli Influent	150030084061011	555	31
Honouliuli Influent	150030084061012	555	51
Honouliuli Influent	150030084061013	555	20
Honouliuli Influent	150030084061014	555	88
Honouliuli Influent	150030084061015	555	89
Honouliuli Influent	150030084061016	555	29
Honouliuli Influent	150030084061017	555	276
Honouliuli Influent	150030084061018	555	35
Honouliuli Influent	150030084061019	555	30
Honouliuli Influent	150030084061020	555	27
Honouliuli Influent	150030084061021	555	30
Honouliuli Influent	150030084061022	555	42
Honouliuli Influent	150030084061023	555	35
Honouliuli Influent	150030084061024	555	20
Honouliuli Influent	150030084061025	555	361
Honouliuli Influent	150030084061026	555	0
Honouliuli Influent	150030084061027	560	0
Honouliuli Influent	150030084061028	555	130
Honouliuli Influent	150030084061029	555	34
Honouliuli Influent	150030084061030	555	61
Honouliuli Influent	150030084061031	555	37
Honouliuli Influent	150030084061032	555	70
Honouliuli Influent	150030084061033	555	81
Honouliuli Influent	150030084061034	555	190
Honouliuli Influent	150030084061035	555	230
Honouliuli Influent	150030084061036	555	86
Honouliuli Influent	150030084061037	555	56
Honouliuli Influent	150030084061038	555	60
Honouliuli Influent	150030084061039	555	126
Honouliuli Influent	150030084061040	555	111
Honouliuli Influent	150030084071000	564	52
Honouliuli Influent	150030084071001	563	73
Honouliuli Influent	150030084071002	564	79
Honouliuli Influent	150030084071003	564	155
Honouliuli Influent	150030084071004	564	82
Honouliuli Influent	150030084071005	564	71
Honouliuli Influent	150030084071006	564	202
Honouliuli Influent	150030084071007	564	74
Honouliuli Influent	150030084071008	564	84
Honouliuli Influent	150030084071009	564	240
Honouliuli Influent	150030084071010	564	76
Honouliuli Influent	150030084071011	564	73
Honouliuli Influent	150030084071012	564	230

Populations for Study Area TAZs as Derived from 2010 Census Data

Pump Station Tributary Area	Census Block ID	TAZ	POP
Honouliuli Influent	150030084071013	564	44
Honouliuli Influent	150030084071014	564	119
Honouliuli Influent	150030084071015	564	91
Honouliuli Influent	150030084071016	564	98
Honouliuli Influent	150030084071017	564	161
Honouliuli Influent	150030084071018	564	125
Honouliuli Influent	150030084071019	564	113
Honouliuli Influent	150030084071020	564	58
Honouliuli Influent	150030084071021	564	108
Honouliuli Influent	150030084071022	564	215
Honouliuli Influent	150030084071023	564	246
Honouliuli Influent	150030084071024	564	129
Honouliuli Influent	150030084071025	564	23
Honouliuli Influent	150030084071026	564	18
Honouliuli Influent	150030084071027	564	5
Honouliuli Influent	150030084071028	564	98
Honouliuli Influent	150030084071029	564	39
Honouliuli Influent	150030084071030	564	144
Honouliuli Influent	150030084081000	564	606
Honouliuli Influent	150030084081001	564	451
Honouliuli Influent	150030084081002	564	98
Honouliuli Influent	150030084081003	564	80
Honouliuli Influent	150030084081004	564	192
Honouliuli Influent	150030084081005	564	468
Honouliuli Influent	150030084081006	564	90
Honouliuli Influent	150030084081007	564	102
Honouliuli Influent	150030084081008	564	103
Honouliuli Influent	150030084081009	564	21
Honouliuli Influent	150030084081010	564	256
Honouliuli Influent	150030084081011	564	277
Honouliuli Influent	150030084081012	564	158
Honouliuli Influent	150030084081013	564	61
Honouliuli Influent	150030084081014	564	162
Honouliuli Influent	150030084081015	564	80
Honouliuli Influent	150030084081016	564	65
Honouliuli Influent	150030084081017	564	79
Honouliuli Influent	150030084081018	564	4
Honouliuli Influent	150030084081019	564	136
Honouliuli Influent	150030084081020	564	115
Honouliuli Influent	150030084081021	564	126
Honouliuli Influent	150030084081022	564	33
Honouliuli Influent	150030084081023	564	74
Honouliuli Influent	150030084081024	564	76
Honouliuli Influent	150030084081025	564	113
Honouliuli Influent	150030084081026	564	31
Honouliuli Influent	150030084081027	564	30

Populations for Study Area TAZs as Derived from 2010 Census Data

Pump Station Tributary Area	Census Block ID	TAZ	POP
Honouliuli Influent	150030084081028	563	17
Honouliuli Influent	150030084082000	565	195
Honouliuli Influent	150030084082001	565	0
Honouliuli Influent	150030084082002	565	53
Honouliuli Influent	150030084082003	565	376
Honouliuli Influent	150030084082004	565	0
Honouliuli Influent	150030084101000	567	91
Honouliuli Influent	150030084101001	544	206
Honouliuli Influent	150030084101002	544	4
Honouliuli Influent	150030084101003	544	19
Honouliuli Influent	150030084101004	554	676
Honouliuli Influent	150030084101005	554	103
Honouliuli Influent	150030084101006	554	79
Honouliuli Influent	150030084101007	554	242
Honouliuli Influent	150030084101008	544	155
Honouliuli Influent	150030084101009	566	29
Honouliuli Influent	150030084101010	544	0
Honouliuli Influent	150030084101011	566	23
Honouliuli Influent	150030084101012	566	14
Honouliuli Influent	150030084101013	554	398
Honouliuli Influent	150030084101014	554	90
Honouliuli Influent	150030084101015	566	175
Honouliuli Influent	150030084101016	566	42
Honouliuli Influent	150030084111000	570	0
Honouliuli Influent	150030084111001	553	1237
Honouliuli Influent	150030084112000	554	174
Honouliuli Influent	150030084112001	554	1161
Honouliuli Influent	150030084112002	554	298
Honouliuli Influent	150030084112003	554	578
Honouliuli Influent	150030084121000	552	1146
Honouliuli Influent	150030084121001	552	65
Honouliuli Influent	150030084121002	552	221
Honouliuli Influent	150030084121003	552	207
Honouliuli Influent	150030084121004	552	99
Honouliuli Influent	150030084121005	552	176
Honouliuli Influent	150030084121006	552	1822
Honouliuli Influent	150030084121007	552	454
Honouliuli Influent	150030084122000	552	531
Honouliuli Influent	150030084122001	552	195
Honouliuli Influent	150030084122002	552	513
Honouliuli Influent	150030084122003	552	151
Honouliuli Influent	150030084122004	552	963
Honouliuli Influent	150030084122005	552	0
Honouliuli Influent	150030085021000	573	0
Honouliuli Influent	150030085021001	574	0
Honouliuli Influent	150030085021002	573	0

Populations for Study Area TAZs as Derived from 2010 Census Data

Pump Station Tributary Area	Census Block ID	TAZ	POP
Honouliuli Influent	150030085021003	574	0
Honouliuli Influent	150030085021004	574	0
Honouliuli Influent	150030085021005	574	0
Honouliuli Influent	150030085021006	574	0
Honouliuli Influent	150030085021007	574	0
Honouliuli Influent	150030085021008	574	0
Honouliuli Influent	150030085021009	574	0
Honouliuli Influent	150030085021010	580	0
Honouliuli Influent	150030085021011	578	0
Honouliuli Influent	150030085021011	579	0
Honouliuli Influent	150030085021013	578	0
Honouliuli Influent	150030085021014	574	0
Honouliuli Influent	150030085021015	574	0
Honouliuli Influent	150030085021017	574	0
Honouliuli Influent	150030085021018	597	0
Honouliuli Influent	150030085021019	571	0
Honouliuli Influent	150030085021020	571	0
Honouliuli Influent	150030085021021	571	0
Honouliuli Influent	150030085021022	571	237
Honouliuli Influent	150030085021023	571	0
Honouliuli Influent	150030085021024	571	0
Honouliuli Influent	150030085021025	571	0
Honouliuli Influent	150030085021026	571	0
Honouliuli Influent	150030085021027	571	0
Honouliuli Influent	150030085021028	571	0
Honouliuli Influent	150030085021029	571	0
Honouliuli Influent	150030085021030	571	0
Honouliuli Influent	150030085021031	571	0
Honouliuli Influent	150030085021032	571	0
Honouliuli Influent	150030085021033	571	0
Honouliuli Influent	150030085021034	571	0
Honouliuli Influent	150030085021035	571	0
Honouliuli Influent	150030085021036	571	0
Honouliuli Influent	150030085021037	571	0
Honouliuli Influent	150030085021038	571	0
Honouliuli Influent	150030085021039	571	0
Honouliuli Influent	150030085021040	571	0
Honouliuli Influent	150030085021041	571	0
Honouliuli Influent	150030085021042	571	0
Honouliuli Influent	150030085021043	571	0
Honouliuli Influent	150030085021044	571	0
Honouliuli Influent	150030085021045	571	0
Honouliuli Influent	150030085021046	571	0
Honouliuli Influent	150030085021047	571	0
Honouliuli Influent	150030085021048	572	0
Honouliuli Influent	150030085021049	571	0

Populations for Study Area TAZs as Derived from 2010 Census Data

Pump Station Tributary Area	Census Block ID	TAZ	POP
Honouliuli Influent	150030085021050	571	0
Honouliuli Influent	150030085021051	571	0
Honouliuli Influent	150030085021052	571	0
Honouliuli Influent	150030085021053	571	0
Honouliuli Influent	150030085021054	571	0
Honouliuli Influent	150030085021055	572	0
Honouliuli Influent	150030085021056	572	0
Honouliuli Influent	150030085021057	572	0
Honouliuli Influent	150030085021058	572	0
Honouliuli Influent	150030085021059	571	0
Honouliuli Influent	150030085021060	571	350
Honouliuli Influent	150030085021061	571	12
Honouliuli Influent	150030085021062	571	0
Honouliuli Influent	150030085021063	571	176
Honouliuli Influent	150030085021064	571	56
Honouliuli Influent	150030085021065	573	0
Honouliuli Influent	150030085021066	573	0
Honouliuli Influent	150030085021067	571	0
Honouliuli Influent	150030085021068	571	0
Honouliuli Influent	150030085021069	571	49
Honouliuli Influent	150030085021070	571	152
Honouliuli Influent	150030085021071	571	67
Honouliuli Influent	150030085021072	571	75
Honouliuli Influent	150030085021073	571	0
Honouliuli Influent	150030085021074	571	0
Honouliuli Influent	150030085021075	571	0
Honouliuli Influent	150030085021076	574	0
Honouliuli Influent	150030085021077	574	0
Honouliuli Influent	150030085021078	574	0
Honouliuli Influent	150030085021079	574	0
Honouliuli Influent	150030085021080	574	0
Honouliuli Influent	150030085021081	574	268
Honouliuli Influent	150030085021082	574	0
Honouliuli Influent	150030085021083	574	0
Honouliuli Influent	150030085021084	574	0
Honouliuli Influent	150030085021085	574	0
Honouliuli Influent	150030085021086	574	0
Honouliuli Influent	150030085021087	574	0
Honouliuli Influent	150030085021088	574	1
Honouliuli Influent	150030085021089	574	0
Honouliuli Influent	150030085021090	574	0
Honouliuli Influent	150030085021091	574	24
Honouliuli Influent	150030085021092	574	0
Honouliuli Influent	150030085021093	574	164
Honouliuli Influent	150030085021094	573	0
Honouliuli Influent	150030085021095	574	0

Populations for Study Area TAZs as Derived from 2010 Census Data

Pump Station Tributary Area	Census Block ID	TAZ	POP
Honouliuli Influent	150030085021096	574	0
Honouliuli Influent	150030085021097	574	194
Honouliuli Influent	150030085021098	574	120
Honouliuli Influent	150030085021099	574	0
Honouliuli Influent	150030085021100	574	0
Honouliuli Influent	150030085021101	574	0
Honouliuli Influent	150030085021102	574	0
Honouliuli Influent	150030085021103	574	0
Honouliuli Influent	150030085021104	574	0
Honouliuli Influent	150030085021105	574	0
Honouliuli Influent	150030085021106	574	0
Honouliuli Influent	150030085021107	574	0
Honouliuli Influent	150030085021108	574	23
Honouliuli Influent	150030085021109	574	0
Honouliuli Influent	150030085021110	574	10
Honouliuli Influent	150030085021111	574	63
Honouliuli Influent	150030085021112	574	94
Honouliuli Influent	150030085021113	573	0
Honouliuli Influent	150030085021114	573	0
Honouliuli Influent	150030085021115	573	0
Honouliuli Influent	150030085021116	573	0
Honouliuli Influent	150030085021117	573	0
Honouliuli Influent	150030085021118	573	0
Honouliuli Influent	150030085021119	573	0
Honouliuli Influent	150030085021120	573	0
Honouliuli Influent	150030085021121	574	0
Honouliuli Influent	150030085021122	573	0
Honouliuli Influent	150030085021123	573	0
Honouliuli Influent	150030085021124	574	0
Honouliuli Influent	150030085021125	574	0
Honouliuli Influent	150030085021126	573	0
Honouliuli Influent	150030085021127	574	0
Honouliuli Influent	150030085021128	574	0
Honouliuli Influent	150030085021129	573	0
Honouliuli Influent	150030085021130	574	0
Honouliuli Influent	150030085021131	574	0
Honouliuli Influent	150030085021132	574	0
Honouliuli Influent	150030085021133	574	0
Honouliuli Influent	150030085021134	573	0
Honouliuli Influent	150030085021135	573	0
Honouliuli Influent	150030085021136	573	0
Honouliuli Influent	150030085021137	572	0
Honouliuli Influent	150030085021138	572	0
Honouliuli Influent	150030085021139	572	0
Honouliuli Influent	150030085021140	572	0
Honouliuli Influent	150030085021141	572	0

Populations for Study Area TAZs as Derived from 2010 Census Data

Pump Station Tributary Area	Census Block ID	TAZ	POP
Honouliuli Influent	150030085021142	572	0
Honouliuli Influent	150030085021143	572	0
Honouliuli Influent	150030085021144	572	0
Honouliuli Influent	150030085021145	572	0
Honouliuli Influent	150030085021146	572	0
Honouliuli Influent	150030085021147	571	0
Honouliuli Influent	150030085021148	572	0
Honouliuli Influent	150030085021149	572	0
Honouliuli Influent	150030085021150	573	0
Honouliuli Influent	150030085021151	573	0
Honouliuli Influent	150030085021152	572	0
Honouliuli Influent	150030085021153	571	0
Honouliuli Influent	150030085021154	572	0
Honouliuli Influent	150030085021155	572	0
Honouliuli Influent	150030085021156	572	0
Honouliuli Influent	150030085021157	572	0
Honouliuli Influent	150030085021158	572	0
Honouliuli Influent	150030085021159	574	0
Honouliuli Influent	150030085021160	574	0
Honouliuli Influent	150030085021161	574	0
Honouliuli Influent	150030085021162	574	0
Honouliuli Influent	150030085021163	574	0
Honouliuli Influent	150030085021164	574	0
Honouliuli Influent	150030085021165	580	0
Honouliuli Influent	150030085021166	574	0
Honouliuli Influent	150030085021167	580	0
Honouliuli Influent	150030085021168	580	1
Honouliuli Influent	150030085021169	574	0
Honouliuli Influent	150030085021170	574	0
Honouliuli Influent	150030085021171	574	0
Honouliuli Influent	150030085021172	575	0
Honouliuli Influent	150030085021173	575	0
Honouliuli Influent	150030085021174	573	0
Honouliuli Influent	150030085021175	573	0
Honouliuli Influent	150030085021176	574	0
Honouliuli Influent	150030085021177	574	0
Honouliuli Influent	150030085021178	574	0
Honouliuli Influent	150030085021179	574	0
Honouliuli Influent	150030085021180	572	0
Honouliuli Influent	150030085021181	574	0
Honouliuli Influent	150030085021182	574	0
Honouliuli Influent	150030085021183	574	0
Honouliuli Influent	150030085021184	574	0
Honouliuli Influent	150030085021185	574	0
Honouliuli Influent	150030085021186	571	0
Honouliuli Influent	150030085021187	574	0

Populations for Study Area TAZs as Derived from 2010 Census Data

Pump Station Tributary Area	Census Block ID	TAZ	POP
Honouliuli Influent	150030085021188	565	0
Honouliuli Influent	150030085021189	572	0
Honouliuli Influent	150030086061000	606	145
Honouliuli Influent	150030086061001	606	820
Honouliuli Influent	150030086061002	606	681
Honouliuli Influent	150030086061003	606	0
Honouliuli Influent	150030086061004	606	254
Honouliuli Influent	150030086061005	606	56
Honouliuli Influent	150030086061006	606	89
Honouliuli Influent	150030086061007	606	597
Honouliuli Influent	150030086061008	606	78
Honouliuli Influent	150030086061009	606	43
Honouliuli Influent	150030086061010	591	0
Honouliuli Influent	150030086061011	591	0
Honouliuli Influent	150030086061012	591	0
Honouliuli Influent	150030086062000	602	316
Honouliuli Influent	150030086062001	602	33
Honouliuli Influent	150030086062002	602	105
Honouliuli Influent	150030086062003	602	251
Honouliuli Influent	150030086062004	602	787
Honouliuli Influent	150030086062005	602	161
Honouliuli Influent	150030086062006	602	317
Honouliuli Influent	150030086062007	602	396
Honouliuli Influent	150030086062008	602	35
Honouliuli Influent	150030086062009	602	124
Honouliuli Influent	150030086062010	602	54
Honouliuli Influent	150030086062011	602	94
Honouliuli Influent	150030086062012	602	539
Honouliuli Influent	150030086062013	602	50
Honouliuli Influent	150030086062014	602	64
Honouliuli Influent	150030086062015	602	573
Honouliuli Influent	150030086063000	599	0
Honouliuli Influent	150030086063001	763	0
Honouliuli Influent	150030086063002	604	525
Honouliuli Influent	150030086063002	763	525
Honouliuli Influent	150030086063003	599	0
Honouliuli Influent	150030086063004	599	0
Honouliuli Influent	150030086063005	605	0
Honouliuli Influent	150030086063006	605	0
Honouliuli Influent	150030086063007	599	0
Honouliuli Influent	150030086063008	599	0
Honouliuli Influent	150030086064000	601	276
Honouliuli Influent	150030086064001	601	1163
Honouliuli Influent	150030086064002	601	118
Honouliuli Influent	150030086064003	601	424
Honouliuli Influent	150030086091000	585	0

Populations for Study Area TAZs as Derived from 2010 Census Data

Pump Station Tributary Area	Census Block ID	TAZ	POP
Honouliuli Influent	150030086091000	588	360
Honouliuli Influent	150030086091001	588	101
Honouliuli Influent	150030086091002	588	158
Honouliuli Influent	150030086091003	588	266
Honouliuli Influent	150030086091004	588	111
Honouliuli Influent	150030086091005	588	128
Honouliuli Influent	150030086091006	581	0
Honouliuli Influent	150030086091006	584	146
Honouliuli Influent	150030086091006	585	147
Honouliuli Influent	150030086091007	588	132
Honouliuli Influent	150030086091008	588	58
Honouliuli Influent	150030086091009	585	0
Honouliuli Influent	150030086091009	587	0
Honouliuli Influent	150030086091010	587	0
Honouliuli Influent	150030086091011	587	0
Honouliuli Influent	150030086092000	581	0
Honouliuli Influent	150030086092001	581	299
Honouliuli Influent	150030086092002	581	160
Honouliuli Influent	150030086092003	584	0
Honouliuli Influent	150030086092004	586	0
Honouliuli Influent	150030086101000	582	0
Honouliuli Influent	150030086101001	582	49
Honouliuli Influent	150030086101002	583	0
Honouliuli Influent	150030086101003	582	2
Honouliuli Influent	150030086101004	583	0
Honouliuli Influent	150030086101005	583	111
Honouliuli Influent	150030086101006	583	627
Honouliuli Influent	150030086101007	583	87
Honouliuli Influent	150030086101008	583	171
Honouliuli Influent	150030086101009	582	0
Honouliuli Influent	150030086101010	582	0
Honouliuli Influent	150030086101012	578	4
Honouliuli Influent	150030086111001	617	32
Honouliuli Influent	150030086111002	615	0
Honouliuli Influent	150030086111003	613	0
Honouliuli Influent	150030086111004	617	0
Honouliuli Influent	150030086111005	617	0
Honouliuli Influent	150030086111006	617	0
Honouliuli Influent	150030086111007	611	52
Honouliuli Influent	150030086111008	611	0
Honouliuli Influent	150030086121000	614	0
Honouliuli Influent	150030086121001	614	0
Honouliuli Influent	150030086121002	614	0
Honouliuli Influent	150030086121003	614	0
Honouliuli Influent	150030086121004	614	0
Honouliuli Influent	150030086121005	614	0

Populations for Study Area TAZs as Derived from 2010 Census Data

Pump Station Tributary Area	Census Block ID	TAZ	POP
Honouliuli Influent	150030086121006	614	0
Honouliuli Influent	150030086121007	614	0
Honouliuli Influent	150030086121008	614	0
Honouliuli Influent	150030086121009	614	0
Honouliuli Influent	150030086121010	614	0
Honouliuli Influent	150030086121011	614	0
Honouliuli Influent	150030086121012	614	0
Honouliuli Influent	150030086121013	614	0
Honouliuli Influent	150030086121014	614	0
Honouliuli Influent	150030086121015	614	0
Honouliuli Influent	150030086121016	614	1119
Honouliuli Influent	150030086121017	614	242
Honouliuli Influent	150030086121018	614	23
Honouliuli Influent	150030086121019	614	46
Honouliuli Influent	150030086121020	614	128
Honouliuli Influent	150030086121021	614	153
Honouliuli Influent	150030086121022	614	249
Honouliuli Influent	150030086121023	614	445
Honouliuli Influent	150030086121024	614	42
Honouliuli Influent	150030086121025	614	49
Honouliuli Influent	150030086121026	614	617
Honouliuli Influent	150030086121027	614	237
Honouliuli Influent	150030086121028	614	489
Honouliuli Influent	150030086121029	614	131
Honouliuli Influent	150030086121030	614	1281
Honouliuli Influent	150030086121031	614	90
Honouliuli Influent	150030086121032	614	27
Honouliuli Influent	150030086121033	614	131
Honouliuli Influent	150030086121034	614	188
Honouliuli Influent	150030086121035	614	330
Honouliuli Influent	150030086131000	610	643
Honouliuli Influent	150030086131001	610	81
Honouliuli Influent	150030086131002	610	51
Honouliuli Influent	150030086131003	610	41
Honouliuli Influent	150030086131004	610	88
Honouliuli Influent	150030086131005	610	0
Honouliuli Influent	150030086141000	608	49
Honouliuli Influent	150030086141001	608	356
Honouliuli Influent	150030086141002	608	315
Honouliuli Influent	150030086142004	618	23
Honouliuli Influent	150030086142005	618	0
Honouliuli Influent	150030086142038	618	0
Honouliuli Influent	150030086143000	607	58
Honouliuli Influent	150030086143001	607	634
Honouliuli Influent	150030086143001	608	634
Honouliuli Influent	150030086143002	607	0

Populations for Study Area TAZs as Derived from 2010 Census Data

Pump Station Tributary Area	Census Block ID	TAZ	POP
Honouliuli Influent	150030086143003	607	33
Honouliuli Influent	150030086143004	607	0
Honouliuli Influent	150030086143005	608	0
Honouliuli Influent	150030086144000	609	317
Honouliuli Influent	150030086144001	609	431
Honouliuli Influent	150030086145000	609	1393
Honouliuli Influent	150030086145001	609	116
Honouliuli Influent	150030086145002	609	162
Honouliuli Influent	150030086146000	609	0
Honouliuli Influent	150030086146001	609	1239
Honouliuli Influent	150030086146002	609	287
Honouliuli Influent	150030086146003	609	0
Honouliuli Influent	150030086147000	614	53
Honouliuli Influent	150030086147001	607	860
Honouliuli Influent	150030086147002	608	117
Honouliuli Influent	150030086147003	608	205
Honouliuli Influent	150030086147004	607	0
Honouliuli Influent	150030086148003	603	0
Honouliuli Influent	150030086148004	603	0
Honouliuli Influent	150030086149000	546	0
Honouliuli Influent	150030086149001	546	0
Honouliuli Influent	150030086149002	546	0
Honouliuli Influent	150030086149003	549	0
Honouliuli Influent	150030086149003	600	0
Honouliuli Influent	150030086149003	764	0
Honouliuli Influent	150030086149004	546	0
Honouliuli Influent	150030086149005	546	0
Honouliuli Influent	150030086149006	549	0
Honouliuli Influent	150030086149008	764	0
Honouliuli Influent	150030086149009	549	0
Honouliuli Influent	150030086149010	547	14
Honouliuli Influent	150030086149010	549	13
Honouliuli Influent	150030086149011	547	157
Honouliuli Influent	150030086149016	546	0
Honouliuli Influent	150030086149017	546	0
Honouliuli Influent	150030086149018	546	0
Honouliuli Influent	150030086149019	546	0
Honouliuli Influent	150030086149020	547	0
Honouliuli Influent	150030086171000	569	1
Honouliuli Influent	150030086171001	569	144
Honouliuli Influent	150030086171002	569	74
Honouliuli Influent	150030086171003	569	0
Honouliuli Influent	150030086171004	569	747
Honouliuli Influent	150030086171005	569	24
Honouliuli Influent	150030086171006	569	0
Honouliuli Influent	150030086171007	569	34

Populations for Study Area TAZs as Derived from 2010 Census Data

Pump Station Tributary Area	Census Block ID	TAZ	POP
Honouliuli Influent	150030086171008	569	46
Honouliuli Influent	150030086171009	569	34
Honouliuli Influent	150030086171010	569	0
Honouliuli Influent	150030086171011	569	67
Honouliuli Influent	150030086171012	569	4
Honouliuli Influent	150030086171013	552	0
Honouliuli Influent	150030086171014	569	77
Honouliuli Influent	150030086171015	569	118
Honouliuli Influent	150030086171016	569	54
Honouliuli Influent	150030086171017	569	121
Honouliuli Influent	150030086171018	569	86
Honouliuli Influent	150030086171019	569	0
Honouliuli Influent	150030086172000	569	0
Honouliuli Influent	150030086172001	598	0
Honouliuli Influent	150030086172002	569	250
Honouliuli Influent	150030086172003	569	29
Honouliuli Influent	150030086172004	569	51
Honouliuli Influent	150030086172005	569	34
Honouliuli Influent	150030086172006	569	46
Honouliuli Influent	150030086172007	569	16
Honouliuli Influent	150030086172008	569	32
Honouliuli Influent	150030086172009	569	39
Honouliuli Influent	150030086172010	569	37
Honouliuli Influent	150030086172011	569	39
Honouliuli Influent	150030086172012	569	46
Honouliuli Influent	150030086172013	569	33
Honouliuli Influent	150030086172014	569	35
Honouliuli Influent	150030086172015	569	22
Honouliuli Influent	150030086172016	597	0
Honouliuli Influent	150030086172017	569	0
Honouliuli Influent	150030086172018	569	0
Honouliuli Influent	150030086172019	569	0
Honouliuli Influent	150030086172020	569	0
Honouliuli Influent	150030086172021	569	0
Honouliuli Influent	150030086172022	569	313
Honouliuli Influent	150030086172023	569	0
Honouliuli Influent	150030086172024	569	48
Honouliuli Influent	150030086172025	569	25
Honouliuli Influent	150030086172026	569	30
Honouliuli Influent	150030086172027	598	0
Honouliuli Influent	150030086172028	570	0
Honouliuli Influent	150030086172029	570	0
Honouliuli Influent	150030086172030	570	1
Honouliuli Influent	150030086172031	570	38
Honouliuli Influent	150030086172032	570	0
Honouliuli Influent	150030086172033	570	7

Populations for Study Area TAZs as Derived from 2010 Census Data

Pump Station Tributary Area	Census Block ID	TAZ	POP
Honouliuli Influent	150030086172034	570	43
Honouliuli Influent	150030086172035	570	26
Honouliuli Influent	150030086172036	570	4
Honouliuli Influent	150030086172037	552	0
Honouliuli Influent	150030086172038	569	39
Honouliuli Influent	150030086172039	570	1
Honouliuli Influent	150030086172040	570	29
Honouliuli Influent	150030086172041	570	0
Honouliuli Influent	150030086172042	569	33
Honouliuli Influent	150030086172043	569	23
Honouliuli Influent	150030086172044	569	22
Honouliuli Influent	150030086172045	569	81
Honouliuli Influent	150030086172046	569	23
Honouliuli Influent	150030086173000	560	0
Honouliuli Influent	150030086173001	550	991
Honouliuli Influent	150030086173002	550	0
Honouliuli Influent	150030086173003	550	0
Honouliuli Influent	150030086173004	547	1
Honouliuli Influent	150030086173005	560	0
Honouliuli Influent	150030086173006	550	25
Honouliuli Influent	150030086173007	550	46
Honouliuli Influent	150030086173008	560	0
Honouliuli Influent	150030086173009	560	0
Honouliuli Influent	150030086173010	550	1241
Honouliuli Influent	150030086173011	550	127
Honouliuli Influent	150030086173012	550	115
Honouliuli Influent	150030086173013	550	145
Honouliuli Influent	150030086173014	550	147
Honouliuli Influent	150030086173015	550	58
Honouliuli Influent	150030086173016	550	171
Honouliuli Influent	150030086173017	550	0
Honouliuli Influent	150030086173018	547	0
Honouliuli Influent	150030086173019	550	0
Honouliuli Influent	150030086174000	568	0
Honouliuli Influent	150030086174001	568	85
Honouliuli Influent	150030086174002	568	0
Honouliuli Influent	150030086174003	568	552
Honouliuli Influent	150030086174004	568	133
Honouliuli Influent	150030086174005	568	476
Honouliuli Influent	150030086174006	568	131
Honouliuli Influent	150030086174007	568	130
Honouliuli Influent	150030086174008	568	117
Honouliuli Influent	150030086174009	568	560
Honouliuli Influent	150030086174010	568	50
Honouliuli Influent	150030086174011	568	95
Honouliuli Influent	150030086174012	568	69

Populations for Study Area TAZs as Derived from 2010 Census Data

Pump Station Tributary Area	Census Block ID	TAZ	POP
Honouliuli Influent	150030086174013	568	99
Honouliuli Influent	150030086174014	568	0
Honouliuli Influent	150030086174015	568	114
Honouliuli Influent	150030086174016	568	108
Honouliuli Influent	150030086174017	568	65
Honouliuli Influent	150030086174018	568	83
Honouliuli Influent	150030086174019	568	115
Honouliuli Influent	150030086174020	552	0
Honouliuli Influent	150030086175000	551	0
Honouliuli Influent	150030086175001	551	189
Honouliuli Influent	150030086175002	551	0
Honouliuli Influent	150030086175003	551	0
Honouliuli Influent	150030086175004	551	0
Honouliuli Influent	150030086175005	551	0
Honouliuli Influent	150030086221000	610	0
Honouliuli Influent	150030086221001	610	245
Honouliuli Influent	150030086221002	610	60
Honouliuli Influent	150030086221003	610	162
Honouliuli Influent	150030086221004	610	197
Honouliuli Influent	150030086221005	610	106
Honouliuli Influent	150030086222000	610	164
Honouliuli Influent	150030086222001	610	167
Honouliuli Influent	150030086222002	610	59
Honouliuli Influent	150030086222003	610	136
Honouliuli Influent	150030086222004	610	2
Honouliuli Influent	150030086222005	610	40
Honouliuli Influent	150030086222006	610	136
Honouliuli Influent	150030086222007	610	110
Honouliuli Influent	150030086222008	610	125
Honouliuli Influent	150030086222009	610	113
Honouliuli Influent	150030086222010	610	112
Honouliuli Influent	150030086222011	610	42
Honouliuli Influent	150030086222012	610	160
Honouliuli Influent	150030086222013	610	66
Honouliuli Influent	150030086222014	610	116
Honouliuli Influent	150030086222015	610	181
Honouliuli Influent	150030086222016	610	138
Honouliuli Influent	150030086222017	610	354
Honouliuli Influent	150030086222018	610	57
Honouliuli Influent	150030086222019	610	94
Honouliuli Influent	150030086223000	610	0
Honouliuli Influent	150030086223001	610	0
Honouliuli Influent	150030086223001	611	0
Honouliuli Influent	150030086223002	610	0
Honouliuli Influent	150030086223003	610	375
Honouliuli Influent	150030086223004	610	149

Populations for Study Area TAZs as Derived from 2010 Census Data

Pump Station Tributary Area	Census Block ID	TAZ	POP
Honouliuli Influent	150030086223005	610	57
Honouliuli Influent	150030086223006	610	145
Honouliuli Influent	150030086223007	610	200
Honouliuli Influent	150030086223008	612	0
Honouliuli Influent	150030086223009	612	0
Honouliuli Influent	150030086223010	585	0
Honouliuli Influent	150030086223011	610	0
Honouliuli Influent	150030086223012	610	0
Honouliuli Influent	150030086223013	610	0
Honouliuli Influent	150030087031012	560	0
Honouliuli Influent	150030087031014	560	0
Honouliuli Influent	150030115001000	592	0
Honouliuli Influent	150030115001001	590	4
Honouliuli Influent	150030115001002	590	0
Honouliuli Influent	150030115001003	592	121
Honouliuli Influent	150030115001003	593	120
Honouliuli Influent	150030115001003	594	0
Honouliuli Influent	150030115001003	595	0
Honouliuli Influent	150030115001003	596	0
Honouliuli Influent	150030115001004	589	0
Honouliuli Influent	150030115001005	593	0
Honouliuli Influent	150030115001006	593	0
Honouliuli Influent	150030115002000	597	862
Honouliuli Influent	150030115002001	597	28
Honouliuli Influent	150030115002002	597	390
Honouliuli Influent	150030115002003	597	113
Honouliuli Influent	150030115002004	597	174
Honouliuli Influent	150030115002005	599	0
Honouliuli Influent	150030115002006	599	0
Honouliuli Influent	150030115002007	599	0
Honouliuli Influent	150030115002008	597	114
Honouliuli Influent	150030115002009	599	0
Honouliuli Influent	150030115002010	597	33
Honouliuli Influent	150030115002011	597	180
Honouliuli Influent	150030115002012	597	37
Honouliuli Influent	150030115002013	597	33
Honouliuli Influent	150030115002014	597	144
Honouliuli Influent	150030115002015	597	0
Honouliuli Influent	150030115002016	597	0
Honouliuli Influent	150030115002017	597	40
Honouliuli Influent	150030115002018	597	30
Honouliuli Influent	150030115002019	598	0
Honouliuli Influent	150030115002020	570	0
Honouliuli Influent	150030115003000	601	102
Honouliuli Influent	150030115003001	601	0
Honouliuli Influent	150030115003002	601	369

Populations for Study Area TAZs as Derived from 2010 Census Data

Pump Station Tributary Area	Census Block ID	TAZ	POP
Honouliuli Influent	150030115003003	601	0
Honouliuli Influent	150030115003004	601	0
Honouliuli Influent	150030115003005	601	608
Honouliuli Influent	150030115003006	601	74
Honouliuli Influent	150030115003007	601	73
Honouliuli Influent	150030115003008	601	0
Honouliuli Influent	150030115003009	601	64
Honouliuli Influent	150030115003010	601	139
Honouliuli Influent	150030115003011	601	207
Honouliuli Influent	150030115003012	601	56
Honouliuli Influent	150030115003013	601	88
Honouliuli Influent	150030115003014	601	343
Honouliuli Influent	150030115003015	601	372
Honouliuli Influent	150030115003016	601	310
Honouliuli Influent	150030115003017	601	115
Honouliuli Influent	150030115003018	601	0
Honouliuli Influent	150030115003019	601	0
Honouliuli Influent	150030115003020	601	45
Honouliuli Influent	150030115003021	601	105
Honouliuli Influent	150039400021004	614	0
Honouliuli Influent	150039803001001	577	0
Honouliuli Influent	150039803001003	578	0
Honouliuli Influent	150039803001004	578	0
Honouliuli Influent	150039803001005	577	0
Honouliuli Influent	150039803001006	576	0
Honouliuli Influent	150039803001007	575	0
Honouliuli Influent	150039803001008	575	0
Honouliuli Influent	150039803001009	575	0
Honouliuli Influent	150039803001010	575	0
Honouliuli Influent	150039803001011	576	0
Honouliuli Influent	150039803001012	576	0
Honouliuli Influent	150039803001013	576	0
Honouliuli Influent	150039803001014	575	0
Honouliuli Influent	150039803001015	575	0
Honouliuli Influent	150039803001016	578	0
Honouliuli Influent Subtotal			*99,009*
Pearl City	150030078041000	422	29
Pearl City	150030078041001	422	122
Pearl City	150030078041002	422	79
Pearl City	150030078041003	416	130
Pearl City	150030078041004	416	128
Pearl City	150030078041005	422	256
Pearl City	150030078041006	422	113
Pearl City	150030078041007	422	147
Pearl City	150030078041008	422	66
Pearl City	150030078041009	422	110

Populations for Study Area TAZs as Derived from 2010 Census Data

Pump Station Tributary Area	Census Block ID	TAZ	POP
Pearl City	150030078041010	422	180
Pearl City	150030078041011	422	93
Pearl City	150030078041012	422	71
Pearl City	150030078041013	422	94
Pearl City	150030078041014	422	0
Pearl City	150030078041015	422	120
Pearl City	150030078041016	422	169
Pearl City	150030078051000	421	93
Pearl City	150030078051001	421	178
Pearl City	150030078051002	421	104
Pearl City	150030078051003	421	95
Pearl City	150030078051004	421	92
Pearl City	150030078051005	421	232
Pearl City	150030078051006	421	93
Pearl City	150030078051007	421	98
Pearl City	150030078051008	421	106
Pearl City	150030078051009	421	171
Pearl City	150030078051010	421	785
Pearl City	150030078051011	421	798
Pearl City	150030078051012	421	0
Pearl City	150030078052007	421	1523
Pearl City	150030078052008	421	0
Pearl City	150030078052009	421	0
Pearl City	150030078052010	421	0
Pearl City	150030078052011	421	0
Pearl City	150030078101006	418	133
Pearl City	150030078103000	417	0
Pearl City	150030078103001	417	9
Pearl City	150030078103003	416	1948
Pearl City	150030078103004	416	127
Pearl City	150030080011000	430	474
Pearl City	150030080011001	430	78
Pearl City	150030080011002	430	32
Pearl City	150030080011003	430	0
Pearl City	150030080011006	430	0
Pearl City	150030080011007	430	0
Pearl City	150030080011008	430	66
Pearl City	150030080011009	430	9
Pearl City	150030080011010	429	0
Pearl City	150030080011011	430	45
Pearl City	150030080012000	431	0
Pearl City	150030080012001	431	234
Pearl City	150030080012002	431	0
Pearl City	150030080012003	431	62
Pearl City	150030080012004	431	0
Pearl City	150030080012005	431	0

Populations for Study Area TAZs as Derived from 2010 Census Data

Pump Station Tributary Area	Census Block ID	TAZ	POP
Pearl City	150030080012006	431	183
Pearl City	150030080012007	431	90
Pearl City	150030080012008	431	82
Pearl City	150030080012009	431	68
Pearl City	150030080021001	426	1
Pearl City	150030080021002	426	0
Pearl City	150030080021003	425	0
Pearl City	150030080021004	425	0
Pearl City	150030080021005	424	0
Pearl City	150030080021006	424	75
Pearl City	150030080021007	424	14
Pearl City	150030080021008	424	81
Pearl City	150030080021009	424	43
Pearl City	150030080021018	425	37
Pearl City	150030080021019	424	83
Pearl City	150030080021020	424	144
Pearl City	150030080021021	424	67
Pearl City	150030080022000	424	0
Pearl City	150030080022001	423	178
Pearl City	150030080022002	423	97
Pearl City	150030080022003	423	108
Pearl City	150030080022004	423	93
Pearl City	150030080022005	423	58
Pearl City	150030080022006	423	59
Pearl City	150030080022007	423	69
Pearl City	150030080022008	423	72
Pearl City	150030080022009	423	122
Pearl City	150030080022010	423	104
Pearl City	150030080022011	423	109
Pearl City	150030080022012	424	322
Pearl City	150030080022013	423	45
Pearl City	150030080022014	423	38
Pearl City	150030080022015	423	27
Pearl City	150030080022016	424	71
Pearl City	150030080022017	424	35
Pearl City	150030080022018	424	47
Pearl City	150030080031000	433	0
Pearl City	150030080031001	433	64
Pearl City	150030080031002	433	8
Pearl City	150030080031003	434	508
Pearl City	150030080031004	434	102
Pearl City	150030080031005	434	90
Pearl City	150030080031006	434	51
Pearl City	150030080031007	434	82
Pearl City	150030080031008	434	172
Pearl City	150030080031009	434	116

Populations for Study Area TAZs as Derived from 2010 Census Data

Pump Station Tributary Area	Census Block ID	TAZ	POP
Pearl City	150030080031010	433	9
Pearl City	150030080031011	433	419
Pearl City	150030080031012	433	208
Pearl City	150030080031013	433	108
Pearl City	150030080031014	433	133
Pearl City	150030080031015	433	17
Pearl City	150030080032000	433	0
Pearl City	150030080032001	438	0
Pearl City	150030080032002	433	1012
Pearl City	150030080032003	433	98
Pearl City	150030080032004	433	0
Pearl City	150030080032005	433	0
Pearl City	150030080032006	433	14
Pearl City	150030080032007	433	25
Pearl City	150030080032008	433	0
Pearl City	150030080032009	433	807
Pearl City	150030080032010	433	625
Pearl City	150030080032011	433	0
Pearl City	150030080051000	439	105
Pearl City	150030080051001	439	945
Pearl City	150030080051002	439	830
Pearl City	150030080051003	439	140
Pearl City	150030080051004	439	112
Pearl City	150030080051005	439	72
Pearl City	150030080051006	439	129
Pearl City	150030080051007	439	69
Pearl City	150030080051008	439	0
Pearl City	150030080051009	439	105
Pearl City	150030080051010	439	80
Pearl City	150030080051011	439	75
Pearl City	150030080051012	439	104
Pearl City	150030080052000	439	101
Pearl City	150030080052001	439	71
Pearl City	150030080052002	439	512
Pearl City	150030080052003	439	108
Pearl City	150030080052004	439	82
Pearl City	150030080052005	439	142
Pearl City	150030080052006	439	92
Pearl City	150030080052007	439	45
Pearl City	150030080052008	439	119
Pearl City	150030080052009	439	135
Pearl City	150030080052010	439	70
Pearl City	150030080052011	439	53
Pearl City	150030080052012	439	87
Pearl City	150030080052013	439	62
Pearl City	150030080052014	439	629

Populations for Study Area TAZs as Derived from 2010 Census Data

Pump Station Tributary Area	Census Block ID	TAZ	POP
Pearl City	150030080052015	439	96
Pearl City	150030080052016	439	66
Pearl City	150030080052017	439	67
Pearl City	150030080052018	439	68
Pearl City	150030080052019	439	116
Pearl City	150030080053000	439	109
Pearl City	150030080053001	439	382
Pearl City	150030080053002	439	153
Pearl City	150030080053003	439	120
Pearl City	150030080053004	439	0
Pearl City	150030080053005	439	55
Pearl City	150030080053006	439	163
Pearl City	150030080053007	439	154
Pearl City	150030080053008	439	241
Pearl City	150030080053009	439	0
Pearl City	150030080061000	438	1
Pearl City	150030080061001	438	34
Pearl City	150030080061002	437	213
Pearl City	150030080061003	438	0
Pearl City	150030080061004	438	5
Pearl City	150030080061005	438	0
Pearl City	150030080061006	438	0
Pearl City	150030080061007	437	454
Pearl City	150030080061008	437	111
Pearl City	150030080061009	437	87
Pearl City	150030080061010	437	119
Pearl City	150030080061011	437	289
Pearl City	150030080061012	437	106
Pearl City	150030080061013	437	71
Pearl City	150030080061014	437	94
Pearl City	150030080061015	437	112
Pearl City	150030080061016	437	123
Pearl City	150030080061017	437	122
Pearl City	150030080061018	437	129
Pearl City	150030080061019	437	85
Pearl City	150030080061020	437	56
Pearl City	150030080061021	437	106
Pearl City	150030080061022	437	82
Pearl City	150030080061023	437	190
Pearl City	150030080062000	437	31
Pearl City	150030080062001	437	35
Pearl City	150030080062002	437	241
Pearl City	150030080062003	437	114
Pearl City	150030080062004	437	175
Pearl City	150030080062005	437	150
Pearl City	150030080062006	437	66

Populations for Study Area TAZs as Derived from 2010 Census Data

Pump Station Tributary Area	Census Block ID	TAZ	POP
Pearl City	150030080062007	437	142
Pearl City	150030080062008	437	94
Pearl City	150030080062009	437	101
Pearl City	150030080062010	437	85
Pearl City	150030080062011	437	122
Pearl City	150030080062012	437	145
Pearl City	150030080062013	437	174
Pearl City	150030080062014	437	125
Pearl City	150030080062015	437	162
Pearl City	150030080062016	437	154
Pearl City	150030080062017	437	56
Pearl City	150030080062018	437	97
Pearl City	150030080071000	436	151
Pearl City	150030080071001	436	132
Pearl City	150030080071002	436	181
Pearl City	150030080071003	436	106
Pearl City	150030080071004	436	68
Pearl City	150030080071005	436	87
Pearl City	150030080071006	436	74
Pearl City	150030080071007	436	55
Pearl City	150030080071008	436	87
Pearl City	150030080071009	436	243
Pearl City	150030080071010	436	207
Pearl City	150030080071011	436	84
Pearl City	150030080071012	436	107
Pearl City	150030080071013	436	185
Pearl City	150030080071014	436	154
Pearl City	150030080071015	436	52
Pearl City	150030080071016	436	92
Pearl City	150030080071017	436	135
Pearl City	150030080071018	436	78
Pearl City	150030080071019	436	176
Pearl City	150030080071020	436	104
Pearl City	150030080072000	435	189
Pearl City	150030080072001	435	111
Pearl City	150030080072002	435	276
Pearl City	150030080072003	435	69
Pearl City	150030080072004	435	149
Pearl City	150030080072005	435	124
Pearl City	150030080072006	435	232
Pearl City	150030080072007	435	102
Pearl City	150030080072008	435	186
Pearl City	150030080072009	435	121
Pearl City	150030080072010	435	136
Pearl City	150030080072011	435	214
Pearl City	150030080072012	435	75

Populations for Study Area TAZs as Derived from 2010 Census Data

Pump Station Tributary Area	Census Block ID	TAZ	POP
Pearl City	150030080072013	435	198
Pearl City	150030080072014	435	95
Pearl City	150030080072015	435	99
Pearl City	150030080072016	435	94
Pearl City	150030080072017	435	72
Pearl City	150030080072018	435	164
Pearl City	150030080072019	435	42
Pearl City	150030087012001	440	0
Pearl City	150030087012002	440	0
Pearl City	150030087012003	440	9
Pearl City	150030087012004	440	0
Pearl City	150030087012005	440	0
Pearl City	150030087012006	440	0
Pearl City	150030087012007	440	0
Pearl City	150030087012008	440	0
Pearl City	150030087012009	440	0
Pearl City	150030087012010	440	0
Pearl City	150030087012013	440	0
Pearl City	150030087012014	440	0
Pearl City	150030087012015	440	0
Pearl City	150030087012016	440	0
Pearl City	150030087012019	440	0
Pearl City	150030087012020	440	3
Pearl City	150030087012021	440	0
Pearl City	150030087012022	440	0
Pearl City	150030087012023	440	0
Pearl City	150030087012024	440	33
Pearl City	150030087012025	440	0
Pearl City	150030087012026	440	0
Pearl City	150030087012027	440	0
Pearl City	150030087012028	440	0
Pearl City	150030087012029	440	0
Pearl City	150030087012030	440	408
Pearl City	150030087012031	440	0
Pearl City	150030087012032	440	0
Pearl City	150030087012033	440	32
Pearl City	150030087012034	440	125
Pearl City	150030087012035	440	0
Pearl City	150030087012036	440	0
Pearl City	150030087012037	440	0
Pearl City	150030087012038	440	0
Pearl City	150030087012039	440	0
Pearl City	150030087012040	440	0
Pearl City	150030087012041	440	0
Pearl City	150030087012042	440	0
Pearl City	150030089203000	465	0

Populations for Study Area TAZs as Derived from 2010 Census Data

Pump Station Tributary Area	Census Block ID	TAZ	POP
Pearl City	150030089203003	466	0
Pearl City	150030089211011	464	0
Pearl City	150030089211012	464	0
Pearl City	150030089211013	464	0
Pearl City	150030089211014	464	0
Pearl City	150030089211015	464	0
Pearl City	150030089211016	464	0
Pearl City	150030089211017	464	0
Pearl City	150030089211018	464	0
Pearl City	150030089211022	464	0
Pearl City	150030089312000	464	0
Pearl City	150030089312001	464	0
Pearl City	150030089312002	475	276
Pearl City	150030089312003	475	0
Pearl City	150030089312004	475	0
Pearl City	150030089312005	475	1
Pearl City	150030089312006	475	0
Pearl City	150030089312007	475	0
Pearl City	150030114002000	432	0
Pearl City	150030114002001	432	812
Pearl City	150030114002002	432	111
Pearl City	150030114002003	432	0
Pearl City	150030114002004	432	0
Pearl City	150030114002005	432	0
Pearl City	150030114002006	432	0
Pearl City	150030114002007	432	0
Pearl City	150030114002008	432	2
Pearl City	150030114002009	432	0
Pearl City	150030114002010	432	0
Pearl City	150030114002011	432	0
Pearl City	150030114003000	432	87
Pearl City	150030114003001	432	0
Pearl City	150030114003002	432	92
Pearl City	150030114003003	432	457
Pearl City	150030114003004	432	41
Pearl City	150030114003005	432	85
Pearl City	150030114003006	432	116
Pearl City	150030114003007	432	48
Pearl City	150030114003008	432	31
Pearl City	150030114003009	432	123
Pearl City	150030114003010	432	0
Pearl City	150030114003011	432	44
Pearl City	150030114003012	432	0
Pearl City	150030114003013	432	3241
Pearl City	150030114003014	432	0
Pearl City	150030114003015	440	0

Populations for Study Area TAZs as Derived from 2010 Census Data

Pump Station Tributary Area	Census Block ID	TAZ	POP
Pearl City	150030114003017	432	0
Pearl City	150030114003018	432	0
Pearl City	150030114003019	432	0
Pearl City Subtotal			*39,987*
Waimalu	150030074001043	397	0
Waimalu	150030074001046	397	0
Waimalu	150030074001047	397	0
Waimalu	150030075031001	375	97
Waimalu	150030075031003	405	54
Waimalu	150030075031004	375	160
Waimalu	150030075031005	375	45
Waimalu	150030075031010	375	119
Waimalu	150030075031012	375	0
Waimalu	150030075031013	375	39
Waimalu	150030075041006	396	0
Waimalu	150030077011000	403	289
Waimalu	150030077011001	403	6
Waimalu	150030077011002	403	39
Waimalu	150030077011003	403	30
Waimalu	150030077011004	403	45
Waimalu	150030077011005	403	38
Waimalu	150030077011006	403	68
Waimalu	150030077011007	403	54
Waimalu	150030077011008	403	143
Waimalu	150030077011009	403	52
Waimalu	150030077011010	403	0
Waimalu	150030077011011	403	32
Waimalu	150030077011012	403	29
Waimalu	150030077011013	403	27
Waimalu	150030077011014	403	29
Waimalu	150030077011015	403	35
Waimalu	150030077011016	403	43
Waimalu	150030077011017	403	56
Waimalu	150030077011018	403	18
Waimalu	150030077011019	403	136
Waimalu	150030077011020	403	96
Waimalu	150030077011021	403	0
Waimalu	150030077011022	403	0
Waimalu	150030077011023	403	58
Waimalu	150030077011024	403	33
Waimalu	150030077012000	401	160
Waimalu	150030077012001	402	0
Waimalu	150030077012002	402	11
Waimalu	150030077012003	402	14
Waimalu	150030077012004	403	0
Waimalu	150030077012005	402	0

Populations for Study Area TAZs as Derived from 2010 Census Data

Pump Station Tributary Area	Census Block ID	TAZ	POP
Waimalu	150030077012006	401	11
Waimalu	150030077012007	401	512
Waimalu	150030077012008	402	90
Waimalu	150030077012009	401	166
Waimalu	150030077012010	401	260
Waimalu	150030077012011	401	90
Waimalu	150030077012012	401	27
Waimalu	150030077012013	402	83
Waimalu	150030077012014	402	66
Waimalu	150030077012015	402	0
Waimalu	150030077012016	402	135
Waimalu	150030077012017	402	114
Waimalu	150030077012018	401	14
Waimalu	150030077012019	401	53
Waimalu	150030077012020	401	0
Waimalu	150030077012021	402	13
Waimalu	150030077012022	402	0
Waimalu	150030077013000	399	82
Waimalu	150030077013001	399	74
Waimalu	150030077013002	400	20
Waimalu	150030077013003	400	239
Waimalu	150030077013004	400	62
Waimalu	150030077013005	400	60
Waimalu	150030077013006	399	0
Waimalu	150030077013007	399	528
Waimalu	150030077013008	399	0
Waimalu	150030077013009	399	0
Waimalu	150030077013010	399	0
Waimalu	150030077013011	399	0
Waimalu	150030077013012	399	0
Waimalu	150030077013013	399	0
Waimalu	150030077013014	399	0
Waimalu	150030077013015	399	0
Waimalu	150030077013016	399	0
Waimalu	150030077013021	399	0
Waimalu	150030077013022	399	0
Waimalu	150030077013023	399	0
Waimalu	150030077021000	404	105
Waimalu	150030077021001	404	61
Waimalu	150030077021002	404	15
Waimalu	150030077021003	404	81
Waimalu	150030077021004	407	0
Waimalu	150030077021005	404	53
Waimalu	150030077022000	405	304
Waimalu	150030077022001	405	0
Waimalu	150030077022002	405	399

Populations for Study Area TAZs as Derived from 2010 Census Data

Pump Station Tributary Area	Census Block ID	TAZ	POP
Waimalu	150030077022003	405	512
Waimalu	150030077022004	405	116
Waimalu	150030077022005	405	115
Waimalu	150030077022006	405	241
Waimalu	150030077022007	405	100
Waimalu	150030077022008	405	50
Waimalu	150030077022015	405	158
Waimalu	150030077022016	405	80
Waimalu	150030077022017	405	49
Waimalu	150030077022018	405	0
Waimalu	150030077022019	405	39
Waimalu	150030077022020	405	36
Waimalu	150030077023000	405	256
Waimalu	150030077023001	405	508
Waimalu	150030077023002	405	61
Waimalu	150030077023003	405	45
Waimalu	150030077023004	405	26
Waimalu	150030077023005	405	228
Waimalu	150030077023006	405	61
Waimalu	150030077023007	405	54
Waimalu	150030077023008	405	34
Waimalu	150030077023009	405	69
Waimalu	150030077023010	405	36
Waimalu	150030077023011	405	163
Waimalu	150030077023012	405	121
Waimalu	150030077023013	405	55
Waimalu	150030077023014	405	49
Waimalu	150030077023015	405	72
Waimalu	150030077023016	405	10
Waimalu	150030077023017	405	0
Waimalu	150030077023018	405	94
Waimalu	150030077023019	405	61
Waimalu	150030077023020	405	45
Waimalu	150030077023021	405	78
Waimalu	150030077023022	405	32
Waimalu	150030078052000	421	56
Waimalu	150030078052001	421	313
Waimalu	150030078052002	421	4
Waimalu	150030078052003	421	0
Waimalu	150030078052004	419	0
Waimalu	150030078052005	421	0
Waimalu	150030078052006	421	79
Waimalu	150030078052012	421	33
Waimalu	150030078052013	421	240
Waimalu	150030078052014	421	43
Waimalu	150030078071000	407	440

Populations for Study Area TAZs as Derived from 2010 Census Data

Pump Station Tributary Area	Census Block ID	TAZ	POP
Waimalu	150030078072000	407	812
Waimalu	150030078073000	407	1000
Waimalu	150030078074000	408	0
Waimalu	150030078074001	408	1113
Waimalu	150030078075000	407	594
Waimalu	150030078075001	407	168
Waimalu	150030078075002	407	165
Waimalu	150030078076000	407	1113
Waimalu	150030078081000	410	61
Waimalu	150030078081001	410	53
Waimalu	150030078081002	410	245
Waimalu	150030078081003	410	111
Waimalu	150030078081004	410	33
Waimalu	150030078081005	410	72
Waimalu	150030078081006	410	143
Waimalu	150030078081007	410	99
Waimalu	150030078081008	410	126
Waimalu	150030078081009	410	102
Waimalu	150030078081010	411	456
Waimalu	150030078081011	411	0
Waimalu	150030078081012	412	0
Waimalu	150030078082000	413	0
Waimalu	150030078082001	413	5
Waimalu	150030078082002	409	755
Waimalu	150030078082003	409	147
Waimalu	150030078082004	409	836
Waimalu	150030078082005	413	0
Waimalu	150030078082006	413	102
Waimalu	150030078082007	413	0
Waimalu	150030078082008	413	0
Waimalu	150030078091000	414	264
Waimalu	150030078091001	414	602
Waimalu	150030078091002	414	267
Waimalu	150030078091003	414	87
Waimalu	150030078092000	414	329
Waimalu	150030078092001	414	58
Waimalu	150030078092002	414	1457
Waimalu	150030078092003	419	174
Waimalu	150030078092004	414	45
Waimalu	150030078092005	419	38
Waimalu	150030078092006	419	56
Waimalu	150030078092007	421	0
Waimalu	150030078101000	418	95
Waimalu	150030078101001	418	160
Waimalu	150030078101002	418	387
Waimalu	150030078101003	418	507

Populations for Study Area TAZs as Derived from 2010 Census Data

Pump Station Tributary Area	Census Block ID	TAZ	POP
Waimalu	150030078101004	418	73
Waimalu	150030078101005	418	121
Waimalu	150030078101006	418	310
Waimalu	150030078101007	418	172
Waimalu	150030078101008	418	137
Waimalu	150030078101009	418	99
Waimalu	150030078102000	415	136
Waimalu	150030078102001	415	234
Waimalu	150030078102002	415	253
Waimalu	150030078102003	415	103
Waimalu	150030078102004	415	182
Waimalu	150030078102005	415	99
Waimalu	150030078102006	415	84
Waimalu	150030078102007	415	81
Waimalu	150030078103002	416	0
Waimalu	150030078111000	420	470
Waimalu	150030078111001	420	101
Waimalu	150030078111002	420	4
Waimalu	150030078111003	420	134
Waimalu	150030078111004	420	0
Waimalu	150030078111005	420	61
Waimalu	150030078111006	420	174
Waimalu	150030078111007	406	1145
Waimalu	150030078111008	406	81
Waimalu	150030078111009	406	129
Waimalu	150030078111010	406	32
Waimalu	150030078111011	406	118
Waimalu	150030078111012	406	85
Waimalu	150030078111013	406	41
Waimalu	150030078111014	420	0
Waimalu	150030078111015	406	0
Waimalu	150030078112000	406	137
Waimalu	150030078112001	406	2099
Waimalu	150030078112002	406	109
Waimalu	150030078112003	406	59
Waimalu	150030078112004	406	11
Waimalu	150030078112005	406	0
Waimalu	150030080011004	429	417
Waimalu	150030080011005	429	165
Waimalu	150030080011012	428	0
Waimalu	150030080011013	428	0
Waimalu	150030080021000	426	0
Waimalu	150030080021010	427	165
Waimalu	150030080021011	426	0
Waimalu	150030080021012	426	0
Waimalu	150030080021013	426	0

Populations for Study Area TAZs as Derived from 2010 Census Data

Pump Station Tributary Area	Census Block ID	TAZ	POP
Waimalu	150030080021014	427	0
Waimalu	150030080021015	425	87
Waimalu	150030080021016	425	158
Waimalu	150030080021017	425	191
Waimalu	150030080021018	425	37
Waimalu Subtotal			*31,765*
Waipahu	150030086142000	618	0
Waipahu	150030086142001	618	0
Waipahu	150030086142002	618	0
Waipahu	150030086142003	618	0
Waipahu	150030086142004	618	23
Waipahu	150030086142006	618	0
Waipahu	150030086142007	539	17
Waipahu	150030086142008	539	0
Waipahu	150030086142009	539	0
Waipahu	150030086142010	539	30
Waipahu	150030086142011	539	36
Waipahu	150030086142012	539	87
Waipahu	150030086142013	539	122
Waipahu	150030086142014	539	26
Waipahu	150030086142015	539	0
Waipahu	150030086142017	539	0
Waipahu	150030086142018	539	0
Waipahu	150030086142019	539	0
Waipahu	150030086142020	539	0
Waipahu	150030086142021	539	0
Waipahu	150030086142022	539	40
Waipahu	150030086142023	539	60
Waipahu	150030086142024	539	0
Waipahu	150030086142025	539	0
Waipahu	150030086142026	539	0
Waipahu	150030086142027	539	39
Waipahu	150030086142028	539	0
Waipahu	150030086142029	539	0
Waipahu	150030086142030	539	0
Waipahu	150030086142031	618	0
Waipahu	150030086142032	618	0
Waipahu	150030086142033	618	0
Waipahu	150030086142034	618	0
Waipahu	150030086142035	618	0
Waipahu	150030086142036	618	0
Waipahu	150030086142037	539	0
Waipahu	150030086148000	545	0
Waipahu	150030086148001	545	0
Waipahu	150030086148002	545	0
Waipahu	150030086149007	547	60

Populations for Study Area TAZs as Derived from 2010 Census Data

Pump Station Tributary Area	Census Block ID	TAZ	POP
Waipahu	150030086149011	547	104
Waipahu	150030086149012	547	122
Waipahu	150030086149013	545	0
Waipahu	150030086149014	548	0
Waipahu	150030086149015	548	0
Waipahu	150030087011000	440	0
Waipahu	150030087011001	440	0
Waipahu	150030087011002	441	699
Waipahu	150030087011003	441	110
Waipahu	150030087011004	441	242
Waipahu	150030087011005	441	223
Waipahu	150030087011006	441	312
Waipahu	150030087011007	441	207
Waipahu	150030087011008	441	240
Waipahu	150030087011009	441	254
Waipahu	150030087011010	441	397
Waipahu	150030087011011	441	284
Waipahu	150030087012000	440	0
Waipahu	150030087012011	440	0
Waipahu	150030087012012	440	0
Waipahu	150030087012017	441	0
Waipahu	150030087012018	442	0
Waipahu	150030087013000	442	805
Waipahu	150030087013001	442	149
Waipahu	150030087013002	442	119
Waipahu	150030087013003	442	150
Waipahu	150030087013004	442	171
Waipahu	150030087013005	442	108
Waipahu	150030087013006	442	81
Waipahu	150030087013007	442	238
Waipahu	150030087013008	442	262
Waipahu	150030087013009	442	146
Waipahu	150030087013010	442	109
Waipahu	150030087014000	441	67
Waipahu	150030087014001	441	182
Waipahu	150030087014002	441	192
Waipahu	150030087014003	441	94
Waipahu	150030087014004	441	65
Waipahu	150030087014005	441	289
Waipahu	150030087014006	441	398
Waipahu	150030087014007	441	298
Waipahu	150030087014008	441	178
Waipahu	150030087014009	441	33
Waipahu	150030087014010	441	87
Waipahu	150030087014011	441	174
Waipahu	150030087014012	441	221

Populations for Study Area TAZs as Derived from 2010 Census Data

Pump Station Tributary Area	Census Block ID	TAZ	POP
Waipahu	150030087014013	441	343
Waipahu	150030087014014	441	250
Waipahu	150030087021000	447	10
Waipahu	150030087021001	447	0
Waipahu	150030087021002	447	111
Waipahu	150030087021003	448	1097
Waipahu	150030087021004	448	231
Waipahu	150030087021005	447	236
Waipahu	150030087021006	447	222
Waipahu	150030087021007	447	155
Waipahu	150030087021008	447	1068
Waipahu	150030087021009	447	0
Waipahu	150030087021010	445	26
Waipahu	150030087021011	447	0
Waipahu	150030087021012	447	0
Waipahu	150030087021013	445	177
Waipahu	150030087021014	445	86
Waipahu	150030087021015	445	62
Waipahu	150030087022000	444	657
Waipahu	150030087022001	444	39
Waipahu	150030087022002	446	0
Waipahu	150030087022003	446	1027
Waipahu	150030087022004	446	117
Waipahu	150030087022005	446	182
Waipahu	150030087022006	446	90
Waipahu	150030087031000	560	0
Waipahu	150030087031001	560	0
Waipahu	150030087031002	548	104
Waipahu	150030087031003	548	278
Waipahu	150030087031004	548	692
Waipahu	150030087031005	548	0
Waipahu	150030087031006	548	5
Waipahu	150030087031007	548	362
Waipahu	150030087031008	548	788
Waipahu	150030087031009	560	0
Waipahu	150030087031010	560	0
Waipahu	150030087031011	560	0
Waipahu	150030087031013	560	0
Waipahu	150030087031015	560	0
Waipahu	150030087032000	454	583
Waipahu	150030087032001	454	783
Waipahu	150030087032002	454	318
Waipahu	150030087032003	454	276
Waipahu	150030087032004	454	36
Waipahu	150030087033000	548	0
Waipahu	150030087033001	455	12

Populations for Study Area TAZs as Derived from 2010 Census Data

Pump Station Tributary Area	Census Block ID	TAZ	POP
Waipahu	150030087033002	455	0
Waipahu	150030087033003	454	0
Waipahu	150030087033004	454	135
Waipahu	150030087033005	454	969
Waipahu	150030087033006	454	0
Waipahu	150030087033007	455	0
Waipahu	150030087033008	455	2
Waipahu	150030087033009	455	0
Waipahu	150030087033010	455	156
Waipahu	150030087033011	548	6
Waipahu	150030087034000	453	1332
Waipahu	150030088001000	451	0
Waipahu	150030088001001	450	9
Waipahu	150030088001002	450	326
Waipahu	150030088001003	450	268
Waipahu	150030088001004	450	192
Waipahu	150030088001005	450	147
Waipahu	150030088001006	450	216
Waipahu	150030088001007	450	225
Waipahu	150030088001008	450	272
Waipahu	150030088001009	450	132
Waipahu	150030088001010	450	58
Waipahu	150030088002000	451	0
Waipahu	150030088002001	451	0
Waipahu	150030088002002	451	1059
Waipahu	150030088002003	451	238
Waipahu	150030088002004	451	365
Waipahu	150030088002005	451	180
Waipahu	150030088002006	451	163
Waipahu	150030088002007	451	248
Waipahu	150030088002008	451	0
Waipahu	150030088002009	450	0
Waipahu	150030088003000	451	0
Waipahu	150030088003001	452	0
Waipahu	150030088003002	452	572
Waipahu	150030088003003	452	239
Waipahu	150030088003004	452	174
Waipahu	150030088003005	452	69
Waipahu	150030088003006	452	203
Waipahu	150030088003007	451	0
Waipahu	150030088003008	451	312
Waipahu	150030088003009	451	544
Waipahu	150030088003010	452	102
Waipahu	150030088003011	452	44
Waipahu	150030088004000	450	174
Waipahu	150030088004001	450	304

Populations for Study Area TAZs as Derived from 2010 Census Data

Pump Station Tributary Area	Census Block ID	TAZ	POP
Waipahu	150030088004002	450	325
Waipahu	150030088004003	450	189
Waipahu	150030088004004	450	287
Waipahu	150030088004005	450	316
Waipahu	150030088004006	450	102
Waipahu	150030089061000	506	63
Waipahu	150030089061001	506	807
Waipahu	150030089061002	506	12
Waipahu	150030089061003	506	111
Waipahu	150030089062000	504	193
Waipahu	150030089062001	504	310
Waipahu	150030089062002	504	243
Waipahu	150030089062003	504	160
Waipahu	150030089063000	504	555
Waipahu	150030089063001	505	430
Waipahu	150030089063002	505	51
Waipahu	150030089063003	505	77
Waipahu	150030089063004	505	37
Waipahu	150030089063005	505	64
Waipahu	150030089063006	505	26
Waipahu	150030089063007	505	423
Waipahu	150030089063008	505	108
Waipahu	150030089063009	505	30
Waipahu	150030089063010	505	52
Waipahu	150030089063011	505	19
Waipahu	150030089071000	500	0
Waipahu	150030089071001	500	0
Waipahu	150030089071002	500	0
Waipahu	150030089071003	500	229
Waipahu	150030089071004	500	98
Waipahu	150030089071005	500	231
Waipahu	150030089071006	500	16
Waipahu	150030089071007	500	7
Waipahu	150030089071008	500	133
Waipahu	150030089071009	500	384
Waipahu	150030089071010	500	42
Waipahu	150030089071011	500	375
Waipahu	150030089072000	503	140
Waipahu	150030089072001	503	154
Waipahu	150030089072002	503	31
Waipahu	150030089072003	503	853
Waipahu	150030089072004	503	0
Waipahu	150030089072005	503	0
Waipahu	150030089073000	501	418
Waipahu	150030089073001	501	69
Waipahu	150030089073002	501	117

Populations for Study Area TAZs as Derived from 2010 Census Data

Pump Station Tributary Area	Census Block ID	TAZ	POP
Waipahu	150030089073003	501	226
Waipahu	150030089074000	502	60
Waipahu	150030089074001	502	344
Waipahu	150030089074002	502	36
Waipahu	150030089074003	502	57
Waipahu	150030089074004	502	63
Waipahu	150030089074005	502	143
Waipahu	150030089074006	502	6
Waipahu	150030089081000	483	315
Waipahu	150030089081001	483	54
Waipahu	150030089081002	483	1321
Waipahu	150030089081003	483	83
Waipahu	150030089081004	483	58
Waipahu	150030089081005	483	65
Waipahu	150030089081006	483	73
Waipahu	150030089081007	483	75
Waipahu	150030089081008	481	0
Waipahu	150030089082000	482	54
Waipahu	150030089082001	482	66
Waipahu	150030089082002	482	161
Waipahu	150030089082003	482	108
Waipahu	150030089082004	482	221
Waipahu	150030089082005	482	121
Waipahu	150030089082006	482	267
Waipahu	150030089082007	482	77
Waipahu	150030089083000	484	44
Waipahu	150030089083001	484	977
Waipahu	150030089083002	484	133
Waipahu	150030089083003	484	63
Waipahu	150030089083004	484	62
Waipahu	150030089083005	484	59
Waipahu	150030089083006	484	380
Waipahu	150030089083007	484	40
Waipahu	150030089083008	484	89
Waipahu	150030089083009	484	84
Waipahu	150030089083010	484	110
Waipahu	150030089083011	484	127
Waipahu	150030089083012	484	281
Waipahu	150030089083013	484	84
Waipahu	150030089083014	484	185
Waipahu	150030089091000	485	82
Waipahu	150030089091001	485	382
Waipahu	150030089091002	485	90
Waipahu	150030089091003	485	51
Waipahu	150030089091004	485	930
Waipahu	150030089091005	485	140

Populations for Study Area TAZs as Derived from 2010 Census Data

Pump Station Tributary Area	Census Block ID	TAZ	POP
Waipahu	150030089091006	486	289
Waipahu	150030089091007	486	204
Waipahu	150030089091008	486	238
Waipahu	150030089091009	486	94
Waipahu	150030089091010	486	83
Waipahu	150030089091011	486	69
Waipahu	150030089091012	486	142
Waipahu	150030089092000	485	97
Waipahu	150030089092001	485	198
Waipahu	150030089092002	485	353
Waipahu	150030089092003	485	97
Waipahu	150030089092004	485	143
Waipahu	150030089092005	485	124
Waipahu	150030089121000	449	0
Waipahu	150030089121001	449	199
Waipahu	150030089121002	449	161
Waipahu	150030089121003	449	30
Waipahu	150030089121004	449	248
Waipahu	150030089121005	449	117
Waipahu	150030089121006	449	232
Waipahu	150030089121007	449	194
Waipahu	150030089121008	449	880
Waipahu	150030089121009	449	161
Waipahu	150030089121010	449	155
Waipahu	150030089121011	449	26
Waipahu	150030089121012	449	167
Waipahu	150030089131000	458	97
Waipahu	150030089131001	458	116
Waipahu	150030089131002	458	178
Waipahu	150030089131003	458	195
Waipahu	150030089131004	458	139
Waipahu	150030089131005	458	261
Waipahu	150030089131006	458	195
Waipahu	150030089131007	458	177
Waipahu	150030089131008	458	226
Waipahu	150030089131009	458	93
Waipahu	150030089131010	458	360
Waipahu	150030089131011	458	118
Waipahu	150030089131012	458	176
Waipahu	150030089132000	459	0
Waipahu	150030089132001	459	377
Waipahu	150030089132002	459	304
Waipahu	150030089132003	459	102
Waipahu	150030089132004	459	279
Waipahu	150030089132005	459	172
Waipahu	150030089132006	459	69

Populations for Study Area TAZs as Derived from 2010 Census Data

Pump Station Tributary Area	Census Block ID	TAZ	POP
Waipahu	150030089132007	545	0
Waipahu	150030089132008	459	204
Waipahu	150030089132009	459	220
Waipahu	150030089132010	459	58
Waipahu	150030089141000	457	1346
Waipahu	150030089141001	457	951
Waipahu	150030089141002	457	296
Waipahu	150030089141003	457	60
Waipahu	150030089141004	457	0
Waipahu	150030089141005	457	101
Waipahu	150030089141006	457	234
Waipahu	150030089141007	457	145
Waipahu	150030089142000	456	1938
Waipahu	150030089142001	456	0
Waipahu	150030089142002	456	20
Waipahu	150030089142003	456	7
Waipahu	150030089142004	545	0
Waipahu	150030089142005	545	0
Waipahu	150030089142006	456	0
Waipahu	150030089151000	499	67
Waipahu	150030089151001	497	429
Waipahu	150030089151002	497	113
Waipahu	150030089151003	497	112
Waipahu	150030089151004	497	92
Waipahu	150030089151005	496	0
Waipahu	150030089151006	497	209
Waipahu	150030089151007	499	350
Waipahu	150030089151008	499	0
Waipahu	150030089151009	499	13
Waipahu	150030089151010	499	110
Waipahu	150030089151011	499	91
Waipahu	150030089151012	499	62
Waipahu	150030089151013	494	0
Waipahu	150030089151014	498	0
Waipahu	150030089151015	498	356
Waipahu	150030089151016	498	156
Waipahu	150030089151017	498	62
Waipahu	150030089151018	498	307
Waipahu	150030089151019	497	102
Waipahu	150030089151020	497	72
Waipahu	150030089151021	497	147
Waipahu	150030089151022	498	0
Waipahu	150030089152000	496	412
Waipahu	150030089152001	496	0
Waipahu	150030089152002	496	0
Waipahu	150030089152003	496	0

Populations for Study Area TAZs as Derived from 2010 Census Data

Pump Station Tributary Area	Census Block ID	TAZ	POP
Waipahu	150030089152004	496	1270
Waipahu	150030089152005	496	3
Waipahu	150030089152006	496	701
Waipahu	150030089152007	496	0
Waipahu	150030089171000	492	0
Waipahu	150030089171001	492	0
Waipahu	150030089171002	492	234
Waipahu	150030089171003	492	169
Waipahu	150030089171004	492	330
Waipahu	150030089171005	492	146
Waipahu	150030089171006	492	109
Waipahu	150030089171007	492	0
Waipahu	150030089171008	492	0
Waipahu	150030089171009	492	664
Waipahu	150030089171010	492	23
Waipahu	150030089171011	492	74
Waipahu	150030089171012	492	277
Waipahu	150030089171013	492	62
Waipahu	150030089171014	492	64
Waipahu	150030089172000	491	101
Waipahu	150030089172001	491	42
Waipahu	150030089172002	492	635
Waipahu	150030089172003	492	63
Waipahu	150030089172004	491	46
Waipahu	150030089172005	491	102
Waipahu	150030089172006	491	87
Waipahu	150030089172007	491	61
Waipahu	150030089172008	491	69
Waipahu	150030089172009	491	278
Waipahu	150030089172010	491	124
Waipahu	150030089172011	490	421
Waipahu	150030089172012	490	32
Waipahu	150030089172013	490	113
Waipahu	150030089172014	490	83
Waipahu	150030089172015	490	112
Waipahu	150030089172016	490	0
Waipahu	150030089172017	491	33
Waipahu	150030089172018	490	0
Waipahu	150030089181000	488	37
Waipahu	150030089181001	488	256
Waipahu	150030089181002	488	782
Waipahu	150030089181003	488	8
Waipahu	150030089181004	488	33
Waipahu	150030089181005	488	432
Waipahu	150030089181006	488	113
Waipahu	150030089181007	488	84

Populations for Study Area TAZs as Derived from 2010 Census Data

Pump Station Tributary Area	Census Block ID	TAZ	POP
Waipahu	150030089181008	488	161
Waipahu	150030089181009	488	85
Waipahu	150030089181010	488	111
Waipahu	150030089182000	487	476
Waipahu	150030089182001	487	123
Waipahu	150030089182002	487	32
Waipahu	150030089182003	489	125
Waipahu	150030089182004	487	0
Waipahu	150030089182005	489	0
Waipahu	150030089182006	489	0
Waipahu	150030089182007	489	0
Waipahu	150030089182008	489	0
Waipahu	150030089182009	489	0
Waipahu	150030089182010	489	0
Waipahu	150030089182011	489	0
Waipahu	150030089182012	487	51
Waipahu	150030089182013	487	30
Waipahu	150030089182014	487	10
Waipahu	150030089183000	487	57
Waipahu	150030089183001	487	351
Waipahu	150030089183002	487	115
Waipahu	150030089183003	487	295
Waipahu	150030089184000	489	264
Waipahu	150030089184001	489	827
Waipahu	150030089184002	489	110
Waipahu	150030089184003	489	26
Waipahu	150030089184004	487	59
Waipahu	150030089184005	487	96
Waipahu	150030089184006	489	59
Waipahu	150030089184007	489	89
Waipahu	150030089184008	487	76
Waipahu	150030089184009	487	56
Waipahu	150030089201000	469	0
Waipahu	150030089201001	469	0
Waipahu	150030089201002	472	0
Waipahu	150030089201003	472	0
Waipahu	150030089201004	472	0
Waipahu	150030089201005	472	0
Waipahu	150030089201006	472	0
Waipahu	150030089201007	472	0
Waipahu	150030089201008	472	0
Waipahu	150030089201009	472	0
Waipahu	150030089201010	472	0
Waipahu	150030089201011	472	0
Waipahu	150030089201012	472	0
Waipahu	150030089201013	472	0

Populations for Study Area TAZs as Derived from 2010 Census Data

Pump Station Tributary Area	Census Block ID	TAZ	POP
Waipahu	150030089201014	469	0
Waipahu	150030089201015	469	0
Waipahu	150030089201016	469	0
Waipahu	150030089201017	469	0
Waipahu	150030089201018	469	0
Waipahu	150030089201019	469	0
Waipahu	150030089201020	469	1252
Waipahu	150030089201021	486	2
Waipahu	150030089201022	486	4
Waipahu	150030089201023	486	0
Waipahu	150030089201024	486	27
Waipahu	150030089201025	486	0
Waipahu	150030089201026	469	99
Waipahu	150030089202000	466	104
Waipahu	150030089202001	466	975
Waipahu	150030089203001	465	142
Waipahu	150030089203002	466	0
Waipahu	150030089203004	465	122
Waipahu	150030089203005	465	0
Waipahu	150030089203006	465	81
Waipahu	150030089203007	465	315
Waipahu	150030089203008	465	17
Waipahu	150030089204000	466	933
Waipahu	150030089204001	466	223
Waipahu	150030089211000	464	87
Waipahu	150030089211001	464	45
Waipahu	150030089211002	464	126
Waipahu	150030089211003	464	104
Waipahu	150030089211004	464	138
Waipahu	150030089211005	464	163
Waipahu	150030089211006	464	143
Waipahu	150030089211007	464	848
Waipahu	150030089211008	464	127
Waipahu	150030089211009	464	115
Waipahu	150030089211010	464	140
Waipahu	150030089211019	464	0
Waipahu	150030089211020	464	0
Waipahu	150030089211021	464	0
Waipahu	150030089211023	464	146
Waipahu	150030089211024	464	130
Waipahu	150030089211025	464	72
Waipahu	150030089211026	464	198
Waipahu	150030089211027	464	86
Waipahu	150030089221000	463	0
Waipahu	150030089221001	463	0
Waipahu	150030089221002	486	0

Populations for Study Area TAZs as Derived from 2010 Census Data

Pump Station Tributary Area	Census Block ID	TAZ	POP
Waipahu	150030089221003	463	1634
Waipahu	150030089221004	463	101
Waipahu	150030089221005	463	0
Waipahu	150030089221006	463	65
Waipahu	150030089221007	463	34
Waipahu	150030089221008	463	86
Waipahu	150030089221009	463	0
Waipahu	150030089222000	461	1605
Waipahu	150030089223000	440	0
Waipahu	150030089223001	449	0
Waipahu	150030089223002	449	0
Waipahu	150030089223003	461	38
Waipahu	150030089223003	462	717
Waipahu	150030089223004	462	87
Waipahu	150030089223005	462	152
Waipahu	150030089223006	462	637
Waipahu	150030089223007	464	0
Waipahu	150030089223008	440	0
Waipahu	150030089223009	449	0
Waipahu	150030089224000	460	0
Waipahu	150030089224001	460	1015
Waipahu	150030089224002	460	0
Waipahu	150030089224003	460	0
Waipahu	150030089224004	460	106
Waipahu	150030089224005	460	0
Waipahu	150030089224006	460	11
Waipahu	150030089224007	460	0
Waipahu	150030089224008	463	0
Waipahu	150030089224009	460	0
Waipahu	150030089224010	460	0
Waipahu	150030089224011	460	0
Waipahu	150030089224012	452	0
Waipahu	150030089224013	451	0
Waipahu	150030089224014	451	0
Waipahu	150030089224015	460	750
Waipahu	150030089224016	460	221
Waipahu	150030089224017	460	70
Waipahu	150030089224018	460	150
Waipahu	150030089231000	467	0
Waipahu	150030089231001	467	25
Waipahu	150030089231002	467	50
Waipahu	150030089231003	467	1570
Waipahu	150030089231004	467	99
Waipahu	150030089231005	467	233
Waipahu	150030089231006	467	144
Waipahu	150030089231007	467	700

Populations for Study Area TAZs as Derived from 2010 Census Data

Pump Station Tributary Area	Census Block ID	TAZ	POP
Waipahu	150030089231008	467	74
Waipahu	150030089232000	467	0
Waipahu	150030089232001	467	1011
Waipahu	150030089233000	465	65
Waipahu	150030089233001	465	766
Waipahu	150030089241000	543	18
Waipahu	150030089241001	541	0
Waipahu	150030089241002	540	0
Waipahu	150030089241003	540	0
Waipahu	150030089241004	540	0
Waipahu	150030089241005	540	0
Waipahu	150030089241006	540	0
Waipahu	150030089241007	540	0
Waipahu	150030089241008	540	0
Waipahu	150030089241009	540	0
Waipahu	150030089241010	540	0
Waipahu	150030089241011	541	216
Waipahu	150030089241012	541	0
Waipahu	150030089241013	541	0
Waipahu	150030089241014	540	0
Waipahu	150030089241015	540	0
Waipahu	150030089241016	541	49
Waipahu	150030089241017	541	1550
Waipahu	150030089241017	543	82
Waipahu	150030089241018	541	151
Waipahu	150030089241019	541	21
Waipahu	150030089241019	543	21
Waipahu	150030089241020	541	443
Waipahu	150030089241021	543	126
Waipahu	150030089241022	541	163
Waipahu	150030089241023	540	0
Waipahu	150030089241024	541	0
Waipahu	150030089241025	541	298
Waipahu	150030089241026	541	0
Waipahu	150030089241027	541	0
Waipahu	150030089241028	541	136
Waipahu	150030089241029	541	74
Waipahu	150030089241030	541	43
Waipahu	150030089242000	543	130
Waipahu	150030089242001	543	97
Waipahu	150030089242002	543	152
Waipahu	150030089242003	543	43
Waipahu	150030089242004	543	1021
Waipahu	150030089242005	543	256
Waipahu	150030089242006	543	144
Waipahu	150030089242007	543	178

Populations for Study Area TAZs as Derived from 2010 Census Data

Pump Station Tributary Area	Census Block ID	TAZ	POP
Waipahu	150030089242008	458	0
Waipahu	150030089242009	543	53
Waipahu	150030089243000	543	140
Waipahu	150030089243001	543	165
Waipahu	150030089243002	543	182
Waipahu	150030089243003	543	187
Waipahu	150030089243004	543	206
Waipahu	150030089243005	543	327
Waipahu	150030089243006	543	166
Waipahu	150030089243007	543	136
Waipahu	150030089243008	543	157
Waipahu	150030089243009	543	135
Waipahu	150030089243010	543	357
Waipahu	150030089251000	542	61
Waipahu	150030089251001	541	205
Waipahu	150030089251001	542	307
Waipahu	150030089251002	542	75
Waipahu	150030089251003	542	65
Waipahu	150030089251004	542	70
Waipahu	150030089251005	542	94
Waipahu	150030089251006	541	156
Waipahu	150030089251006	542	156
Waipahu	150030089251007	542	1654
Waipahu	150030089251008	542	8
Waipahu	150030089251009	542	161
Waipahu	150030089251010	542	44
Waipahu	150030089251011	542	480
Waipahu	150030089252000	544	0
Waipahu	150030089252001	544	4
Waipahu	150030089252002	544	294
Waipahu	150030089252003	544	108
Waipahu	150030089252004	544	247
Waipahu	150030089252005	544	164
Waipahu	150030089252006	544	148
Waipahu	150030089252007	544	154
Waipahu	150030089252008	544	55
Waipahu	150030089252009	544	158
Waipahu	150030089252010	544	82
Waipahu	150030089252011	544	50
Waipahu	150030089252012	544	68
Waipahu	150030089252013	544	151
Waipahu	150030089252014	544	155
Waipahu	150030089252015	458	0
Waipahu	150030089253000	544	0
Waipahu	150030089253001	544	265
Waipahu	150030089253002	544	309

Populations for Study Area TAZs as Derived from 2010 Census Data

Pump Station Tributary Area	Census Block ID	TAZ	POP
Waipahu	150030089253003	544	122
Waipahu	150030089253004	544	252
Waipahu	150030089253005	544	250
Waipahu	150030089253006	618	0
Waipahu	150030089253007	544	0
Waipahu	150030089253008	459	0
Waipahu	150030089253009	618	0
Waipahu	150030089253010	544	0
Waipahu	150030089253011	544	330
Waipahu	150030089261000	494	0
Waipahu	150030089261001	495	1385
Waipahu	150030089261002	495	0
Waipahu	150030089261004	495	0
Waipahu	150030089261005	495	0
Waipahu	150030089261006	495	0
Waipahu	150030089261007	494	187
Waipahu	150030089271000	494	0
Waipahu	150030089271001	494	357
Waipahu	150030089271002	494	649
Waipahu	150030089271003	494	85
Waipahu	150030089271004	494	81
Waipahu	150030089271005	494	705
Waipahu	150030089271006	494	0
Waipahu	150030089271007	494	666
Waipahu	150030089271008	494	313
Waipahu	150030089271009	494	145
Waipahu	150030089271010	494	1833
Waipahu	150030089271011	494	198
Waipahu	150030089271012	494	65
Waipahu	150030089271013	494	0
Waipahu	150030089271014	494	61
Waipahu	150030089271015	493	22
Waipahu	150030089281000	494	0
Waipahu	150030089281001	494	0
Waipahu	150030089281002	494	1221
Waipahu	150030089281003	494	297
Waipahu	150030089281004	494	200
Waipahu	150030089281005	493	143
Waipahu	150030089281005	494	144
Waipahu	150030089281006	494	474
Waipahu	150030089281007	494	75
Waipahu	150030089281008	494	440
Waipahu	150030089281009	494	34
Waipahu	150030089281010	494	97
Waipahu	150030089281011	494	0
Waipahu	150030089281012	494	0

Populations for Study Area TAZs as Derived from 2010 Census Data

Pump Station Tributary Area	Census Block ID	TAZ	POP
Waipahu	150030089281013	494	180
Waipahu	150030089281014	494	75
Waipahu	150030089281015	494	97
Waipahu	150030089281016	494	56
Waipahu	150030089281017	494	81
Waipahu	150030089281018	494	99
Waipahu	150030089281019	493	171
Waipahu	150030089291000	493	0
Waipahu	150030089291001	493	344
Waipahu	150030089291002	493	0
Waipahu	150030089291003	493	727
Waipahu	150030089291004	493	208
Waipahu	150030089291005	493	30
Waipahu	150030089291006	494	355
Waipahu	150030089291007	494	178
Waipahu	150030089291008	493	390
Waipahu	150030089292000	493	681
Waipahu	150030089292001	493	127
Waipahu	150030089292002	493	457
Waipahu	150030089292002	494	457
Waipahu	150030089292003	493	98
Waipahu	150030089292004	493	52
Waipahu	150030089292005	493	54
Waipahu	150030089292006	493	678
Waipahu	150030089301000	493	0
Waipahu	150030089301001	493	1403
Waipahu	150030089301002	493	27
Waipahu	150030089301003	493	374
Waipahu	150030089301004	493	42
Waipahu	150030089301005	493	47
Waipahu	150030089301006	493	37
Waipahu	150030089301007	493	62
Waipahu	150030089301008	493	301
Waipahu	150030089301009	493	21
Waipahu	150030089301010	493	23
Waipahu	150030089301011	493	93
Waipahu	150030089301012	493	44
Waipahu	150030089301013	493	41
Waipahu	150030089301014	493	45
Waipahu	150030089311000	493	0
Waipahu	150030089311001	493	26
Waipahu	150030089311002	493	957
Waipahu	150030089311003	493	0
Waipahu	150030089311004	493	64
Waipahu	150030089311005	493	16
Waipahu	150030089311006	493	128

Populations for Study Area TAZs as Derived from 2010 Census Data

Pump Station Tributary Area	Census Block ID	TAZ	POP
Waipahu	150030089311007	493	0
Waipahu	150030089311008	493	0
Waipahu	150030089311009	493	286
Waipahu	150030089311010	493	48
Waipahu	150030089311011	493	461
Waipahu	150030089311012	493	154
Waipahu	150030089311013	493	84
Waipahu	150030089311014	493	366
Waipahu	150030089311015	493	182
Waipahu	150030089311016	493	4
Waipahu	150030089311017	493	257
Waipahu	150030089312008	471	0
Waipahu	150030089312009	470	0
Waipahu	150030114001000	443	0
Waipahu	150030114001001	443	0
Waipahu	150030114001002	443	0
Waipahu	150030114001003	443	0
Waipahu	150030114001004	443	0
Waipahu	150030114001005	443	0
Waipahu	150030114001006	443	0
Waipahu	150030114001009	443	0
Waipahu	150030114001012	443	0
Waipahu	150030114001013	443	0
Waipahu	150030114001014	443	50
Waipahu	150030114001015	443	0
Waipahu	150030114001016	444	0
Waipahu	150030114001017	443	0
Waipahu	150030114001018	443	0
Waipahu	150030114001019	443	0
Waipahu	150030114001020	443	0
Waipahu	150030114001021	443	0
Waipahu	150030114001022	443	0
Waipahu	150030114001023	443	0
Waipahu	150030114001024	443	0
Waipahu	150030114001025	443	0
Waipahu	150030114001026	443	0
Waipahu	150030114001027	443	0
Waipahu	150030114001028	443	0
Waipahu	150030114001029	443	0
Waipahu	150030114001030	443	0
Waipahu	150030114001031	443	0
Waipahu	150030114001032	443	0
Waipahu	150030114001033	443	0
Waipahu	150030114001034	443	0
Waipahu	150030114001035	443	0
Waipahu	150030114001036	443	0

Populations for Study Area TAZs as Derived from 2010 Census Data

Pump Station Tributary Area	Census Block ID	TAZ	POP
Waipahu	150030114001037	443	0
Waipahu	150030114001038	443	0
Waipahu	150030114001039	443	0
Waipahu	150030114001040	443	0
Waipahu	150030114001041	443	0
Waipahu	150030114001042	443	0
Waipahu	150030114001043	443	0
Waipahu	150030114001044	443	0
Waipahu	150030114001045	443	0
Waipahu	150030114001046	443	0
Waipahu	150030114001047	443	0
Waipahu	150030114001048	443	0
Waipahu	150030114001049	443	0
Waipahu	150030114001050	444	0
Waipahu	150030114001051	442	0
Waipahu	150030114001052	442	0
Waipahu	150030114001053	443	0
Waipahu	150030114001054	443	0
Waipahu	150030114001055	443	0
Waipahu	150030114001056	443	32
Waipahu	150030114001057	443	0
Waipahu	150030114001058	443	0
Waipahu	150030114001059	443	0
Waipahu	150039807001057	495	0
Waipahu Subtotal			*128,928*
TOTAL			**317,718**

Appendix C. Projected Residential, Non-Residential, and Visitor Populations by Tributary Area and Individual TAZs

Updated Residential, Non-Residential, and Visitor Population Projection Results

Pump Station Tributary Area	TAZ	Projection Update								
		2010[1]			2035			2050		
		Res	Non-Res	Visitor	Res	Non-Res	Visitor	Res	Non-Res	Visitor
Halawa	370	459	33	0	439	46	0	426	45	0
Halawa	371	933	2865	0	933	2979	0	933	2979	0
Halawa	372	647	0	0	600	0	0	572	0	0
Halawa	373	4338	940	0	4144	1037	0	4026	1008	0
Halawa	374	1000	197	0	948	262	0	919	254	0
Halawa	375	4907	2031	0	4780	2147	0	4692	2108	0
Halawa	376	134	0	0	132	0	0	129	0	0
Halawa	394	135	7358	0	145	7677	0	148	7838	0
Halawa	395	3171	619	0	3380	722	0	0	746	0
Halawa	396	0	150	0	0	190	0	0	190	0
Halawa	397	15	0	0	13	0	0	10	0	0
Halawa	405	48	0	0	48	0	0	47	0	0
Halawa Total		*15,787*	*14,193*	*0*	*15,562*	*15,060*	*0*	*11,902*	*15,168*	*0*
Honouiliuli Influent	545	0	0	0	708	626	0	1147	1015	0
Honouiliuli Influent	546	0	0	0	3846	913	0	5500	1306	0
Honouiliuli Influent	547	0	0	0	393	325	0	473	391	0
Honouiliuli Influent	549	0	0	0	7312	1415	0	10270	1987	0
Honouiliuli Influent	550	3066	87	0	2882	98	0	2768	94	0
Honouiliuli Influent	551	4853	441	0	5257	424	0	5379	434	0
Honouiliuli Influent	552	6543	76	0	6268	87	0	6097	85	0
Honouiliuli Influent	553	1237	377	0	1218	720	0	1197	708	0
Honouiliuli Influent	554	3799	249	0	3567	285	0	3424	274	0
Honouiliuli Influent	555	5997	1123	0	5746	940	0	5590	914	0
Honouiliuli Influent	556	2917	299	0	2772	383	0	2687	371	0
Honouiliuli Influent	557	0	0	0	3288	570	0	3171	550	0
Honouiliuli Influent	558	1388	439	0	2632	960	0	2550	930	0
Honouiliuli Influent	559	39	340	0	38	404	0	38	404	0
Honouiliuli Influent	560	479	0	0	471	0	0	465	0	0
Honouiliuli Influent	561	4622	205	0	4423	220	0	4299	214	0
Honouiliuli Influent	562	1696	94	6	1610	128	9	1549	123	9
Honouiliuli Influent	563	3683	949	0	3572	1094	0	3495	1070	0
Honouiliuli Influent	564	7339	750	0	7999	532	0	8200	545	0

Updated Residential, Non-Residential, and Visitor Population Projection Results

Pump Station Tributary Area	TAZ	Projection Update 2010(1) Res	2010(1) Non-Res	2010(1) Visitor	2035 Res	2035 Non-Res	2035 Visitor	2050 Res	2050 Non-Res	2050 Visitor
Honouiliuli Influent	565	624	483	0	3429	2607	1486	4359	3314	1889
Honouiliuli Influent	566	283	264	0	1094	1112	0	1391	1414	0
Honouiliuli Influent	567	91	432	0	990	506	0	1348	689	0
Honouiliuli Influent	568	2982	474	0	3189	517	0	3250	527	0
Honouiliuli Influent	569	2977	965	0	3935	1067	0	4359	1182	0
Honouiliuli Influent	570	149	46	0	168	55	0	184	60	0
Honouiliuli Influent	571	0	0	0	4226	2279	0	7108	3833	0
Honouiliuli Influent	572	0	0	0	0	1376	0	0	1376	0
Honouiliuli Influent	573	0	0	0	50	2193	0	112	4934	0
Honouiliuli Influent	574	0	0	0	5941	3762	0	10658	6749	0
Honouiliuli Influent	575	0	0	0	0	2207	0	0	2207	0
Honouiliuli Influent	576	0	0	0	0	1825	0	0	1825	0
Honouiliuli Influent	577	0	0	0	19	1386	0	24	1721	0
Honouiliuli Influent	578	0	0	0	698	4659	0	929	6198	0
Honouiliuli Influent	579	0	0	0	156	2123	0	208	2824	0
Honouiliuli Influent	580	0	0	0	204	1486	0	290	2115	0
Honouiliuli Influent	581	459	211	2	711	240	3	824	278	4
Honouiliuli Influent	582	51	1551	1797	860	3643	9769	1144	4846	12995
Honouiliuli Influent	583	996	775	0	1595	949	0	1843	1097	0
Honouiliuli Influent	584	73	0	0	1984	164	0	2557	211	0
Honouiliuli Influent	585	147	86	0	1798	291	0	2232	361	0
Honouiliuli Influent	586	0	162	0	891	1305	0	1268	1857	0
Honouiliuli Influent	587	0	294	0	501	1984	0	704	2786	0
Honouiliuli Influent	588	1314	0	0	1263	0	0	1231	0	0
Honouiliuli Influent	589	0	1577	0	135	2075	0	180	2760	0
Honouiliuli Influent	590	4	2143	0	43	2400	0	52	2911	0
Honouiliuli Influent	591	0	681	0	0	736	0	0	736	0
Honouiliuli Influent	592	121	1239	0	265	1212	0	307	1403	0
Honouiliuli Influent	593	120	6540	0	327	10875	0	399	13260	0
Honouiliuli Influent	594	0	557	0	553	1135	0	710	1456	0
Honouiliuli Influent	595	0	195	0	3024	686	0	4023	913	0
Honouiliuli Influent	596	0	203	0	2330	704	0	3100	937	0

Updated Residential, Non-Residential, and Visitor Population Projection Results

Pump Station Tributary Area	TAZ	Projection Update								
		2010[1]			2035			2050		
		Res	Non-Res	Visitor	Res	Non-Res	Visitor	Res	Non-Res	Visitor
Honouiliuli Influent	597	2178	2186	0	2105	2369	0	2049	2306	0
Honouiliuli Influent	598	0	0	0	93	5585	0	132	7948	0
Honouiliuli Influent	599	0	0	0	755	1189	0	1074	1692	0
Honouiliuli Influent	600	0	0	0	7816	7621	0	11882	11585	0
Honouiliuli Influent	601	5051	499	0	5832	472	0	6095	493	0
Honouiliuli Influent	602	3899	118	0	3795	110	0	3709	108	0
Honouiliuli Influent	603	0	0	0	2754	872	0	7171	2271	0
Honouiliuli Influent	604	0	0	0	6001	4716	0	7948	6246	0
Honouiliuli Influent	605	0	0	0	79	3078	0	121	4699	0
Honouiliuli Influent	606	2763	335	0	2618	350	0	2527	338	0
Honouiliuli Influent	607	1585	357	0	3591	570	0	4197	666	0
Honouiliuli Influent	608	1676	158	0	2071	151	0	2222	162	0
Honouiliuli Influent	609	3945	357	0	4249	426	0	4343	435	0
Honouiliuli Influent	610	4972	627	0	6235	927	0	6737	1002	0
Honouiliuli Influent	611	26	1	0	823	140	0	1100	187	0
Honouiliuli Influent	612	0	237	0	670	1919	0	895	2564	0
Honouiliuli Influent	613	0	0	0	1290	194	0	1820	274	0
Honouiliuli Influent	614	6070	274	0	5777	201	0	5589	194	0
Honouiliuli Influent	615	0	0	0	2694	334	0	3801	471	0
Honouiliuli Influent	616	0	0	0	1568	139	0	2212	196	0
Honouiliuli Influent	617	0	0	0	28	335	0	25	302	0
Honouiliuli Influent	618	0	0	0	0	0	0	0	0	0
Honouiliuli Influent	763	0	0	0	525	0	0	525	0	0
Honouiliuli Influent	764	0	0	0	1292	1453	0	1815	2041	0
Honouiliuli Influent Total		*90,214*	*29,456*	*1,805*	*167,042*	*100,834*	*11,267*	*201,082*	*134,375*	*14,897*
Pearl City	416	2333	257	0	2269	316	0	2230	311	0
Pearl City	417	9	599	0	9	667	0	9	667	0
Pearl City	418	166	0	0	154	0	0	147	0	0
Pearl City	421	3465	76	0	3295	103	0	3192	100	0
Pearl City	422	1649	0	0	1558	0	0	1502	0	0
Pearl City	423	1179	64	0	1127	95	0	1098	93	0
Pearl City	424	982	1168	0	940	1265	0	914	1229	0

Updated Residential, Non-Residential, and Visitor Population Projection Results

Pump Station Tributary Area	TAZ	Projection Update								
		2010[1]			2035			2050		
		Res	Non-Res	Visitor	Res	Non-Res	Visitor	Res	Non-Res	Visitor
Pearl City	425	0	39	0	0	44	0	0	43	0
Pearl City	426	0	376	0	6	415	0	12	810	0
Pearl City	429	0	343	0	0	395	0	0	385	0
Pearl City	430	704	903	0	1271	1047	0	1514	1247	0
Pearl City	431	719	725	0	824	980	0	884	1051	0
Pearl City	432	5290	107	0	5221	146	0	5179	145	0
Pearl City	433	3547	3099	0	3776	4724	0	3892	4870	0
Pearl City	434	1121	0	0	1065	0	0	1033	0	0
Pearl City	435	2748	419	0	2615	483	0	2539	469	0
Pearl City	436	2558	240	0	2428	296	0	2355	287	0
Pearl City	437	4818	283	0	4612	360	0	4485	350	0
Pearl City	438	40	1581	0	40	1662	0	40	1662	0
Pearl City	439	6864	317	0	6586	402	0	6415	392	0
Pearl City	440	610	739	0	1420	915	0	1768	1139	0
Pearl City	464	0	0	0	0	0	0	0	0	0
Pearl City	465	0	0	0	0	0	0	0	0	0
Pearl City	473	0	0	0	0	0	0	0	0	0
Pearl City	474	0	0	0	1583	228	0	2077	299	0
Pearl City	475	277	1328	0	9334	2453	0	12248	3219	0
Pearl City	476	0	0	0	136	1510	0	187	2077	0
Pearl City	477	0	759	0	2183	1553	0	3590	2554	0
Pearl City	478	0	271	0	1985	567	0	2731	780	0
Pearl City	479	0	680	0	4304	1452	0	5921	1997	0
Pearl City	480	0	130	0	1215	307	0	1671	422	0
Pearl City Total		*39,079*	*14,503*	*0*	*59,956*	*22,385*	*0*	*67,633*	*26,598*	*0*
Waimalu	375	200	83	0	195	88	0	191	86	0
Waimalu	396	0	50	0	0	63	0	0	63	0
Waimalu	397	0	0	0	0	0	0	0	0	0
Waimalu	399	684	40	0	654	65	0	633	63	0
Waimalu	400	381	190	0	377	258	0	374	256	0
Waimalu	401	1293	554	0	1312	642	0	1318	645	0
Waimalu	402	526	857	0	531	955	0	537	966	0

Updated Residential, Non-Residential, and Visitor Population Projection Results

Pump Station Tributary Area	TAZ	Projection Update								
		2010(1)			2035			2050		
		Res	Non-Res	Visitor	Res	Non-Res	Visitor	Res	Non-Res	Visitor
Waimalu	403	1356	737	0	1327	845	0	1300	828	0
Waimalu	404	315	124	0	303	164	0	294	159	0
Waimalu	405	4789	804	0	4706	917	0	4648	906	0
Waimalu	406	4046	261	0	3843	317	0	3714	306	0
Waimalu	407	4292	156	0	4119	209	0	4013	204	0
Waimalu	408	1113	195	0	1058	246	0	1023	238	0
Waimalu	409	1738	341	0	1663	424	0	1616	412	0
Waimalu	410	1045	248	0	1008	312	0	987	306	0
Waimalu	411	456	1399	0	448	1577	0	448	1577	0
Waimalu	412	0	828	97	0	918	92	0	918	92
Waimalu	413	107	4399	0	106	4535	0	103	4409	0
Waimalu	414	3109	31	0	3027	57	0	2968	56	0
Waimalu	415	1172	28	0	1124	50	0	1095	49	0
Waimalu	416	0	0	0	0	0	0	0	0	0
Waimalu	418	2028	0	0	1878	0	0	1789	0	0
Waimalu	419	268	294	0	252	347	0	246	339	0
Waimalu	420	944	30	0	944	54	0	938	54	0
Waimalu	421	1671	37	0	1589	50	0	1539	48	0
Waimalu	425	510	350	0	508	394	0	499	387	0
Waimalu	426	1	560	0	9	618	0	18	1208	0
Waimalu	427	165	579	0	157	662	0	154	650	0
Waimalu	428	0	0	0	0	0	0	0	0	0
Waimalu	429	582	38	0	557	44	0	542	43	0
Waimalu Total		*32,791*	*13,213*	*97*	*31,695*	*14,811*	*92*	*30,987*	*15,176*	*92*
Waipahu	440	0	0	0	0	0	0	0	0	0
Waipahu	441	5839	1312	0	5515	1432	0	5333	1385	0
Waipahu	442	2338	458	0	2262	571	0	2206	557	0
Waipahu	443	82	251	0	82	301	0	82	301	0
Waipahu	444	696	331	0	746	426	0	777	444	0
Waipahu	445	351	316	0	330	401	0	315	383	0
Waipahu	446	1416	487	0	1336	588	0	1292	569	0
Waipahu	447	1802	1118	0	1648	1282	0	1558	1212	0

Updated Residential, Non-Residential, and Visitor Population Projection Results

Pump Station Tributary Area	TAZ	Projection Update								
		2010[1]			2035			2050		
		Res	Non-Res	Visitor	Res	Non-Res	Visitor	Res	Non-Res	Visitor
Waipahu	448	1328	124	0	1278	187	0	1243	182	0
Waipahu	449	2570	469	0	2468	564	0	2415	552	0
Waipahu	450	3542	120	0	3315	172	0	3189	165	0
Waipahu	451	3109	674	0	3104	1092	0	3089	1087	0
Waipahu	452	1403	90	0	1307	143	0	1252	137	0
Waipahu	453	1332	281	0	1338	360	0	1332	358	0
Waipahu	454	3100	912	0	2943	1040	0	2855	1009	0
Waipahu	455	170	1438	0	145	1603	0	131	1448	0
Waipahu	456	1965	1165	0	2278	1302	0	2438	1394	0
Waipahu	457	3133	717	0	2934	851	0	2823	819	0
Waipahu	458	2331	199	0	2181	266	0	2093	255	0
Waipahu	459	1785	317	0	1676	397	0	1615	382	0
Waipahu	460	2323	210	0	2155	296	0	2062	283	0
Waipahu	461	1643	1329	0	1546	1575	0	1488	1515	0
Waipahu	462	1593	1900	0	1477	2062	0	1410	1969	0
Waipahu	463	1920	207	0	1780	284	0	1701	271	0
Waipahu	464	2668	60	0	2649	160	0	2625	159	0
Waipahu	465	1508	130	0	1401	194	0	1340	186	0
Waipahu	466	2235	81	0	2065	128	0	1972	122	0
Waipahu	467	3906	290	0	3620	369	0	3460	353	0
Waipahu	468	0	1105	0	89	3205	0	117	4206	0
Waipahu	469	1351	1354	0	1518	2189	0	1602	2310	0
Waipahu	470	0	0	0	0	0	0	0	0	0
Waipahu	471	0	0	0	0	0	0	0	0	0
Waipahu	472	0	0	0	5570	666	0	7309	874	0
Waipahu	473	0	0	0	498	320	0	653	420	0
Waipahu	481	0	0	0	0	0	0	0	0	0
Waipahu	482	1075	298	0	987	381	0	938	362	0
Waipahu	483	2044	0	0	1885	0	0	1798	0	0
Waipahu	484	2718	399	0	2529	465	0	2421	445	0
Waipahu	485	2687	327	0	2517	413	0	2421	397	0
Waipahu	486	1152	195	0	1069	263	0	1022	252	0

Updated Residential, Non-Residential, and Visitor Population Projection Results

Pump Station Tributary Area	TAZ	Projection Update								
		2010[1]			2035			2050		
		Res	Non-Res	Visitor	Res	Non-Res	Visitor	Res	Non-Res	Visitor
Waipahu	487	1827	311	0	1673	392	0	1589	372	0
Waipahu	488	2102	124	0	1943	181	0	1853	173	0
Waipahu	489	1500	0	0	1395	0	0	1337	0	0
Waipahu	490	761	1679	0	699	1822	0	667	1739	0
Waipahu	491	943	118	0	872	176	0	829	167	0
Waipahu	492	2850	54	0	2635	89	0	2516	85	0
Waipahu	493	9775	445	0	8967	640	0	8518	608	0
Waipahu	494	9905	689	0	9355	1021	0	9047	987	0
Waipahu	495	1385	2799	0	1573	4202	0	1676	4478	0
Waipahu	496	2386	196	0	2298	294	0	2242	287	0
Waipahu	497	1276	54	0	1191	89	0	1141	85	0
Waipahu	498	881	0	0	816	0	0	778	0	0
Waipahu	499	693	132	0	664	188	0	646	183	0
Waipahu	500	1515	234	0	1427	315	0	1369	302	0
Waipahu	501	830	1858	0	794	2050	0	773	1997	0
Waipahu	502	709	54	0	672	89	0	651	86	0
Waipahu	503	1178	408	0	1087	491	0	1035	467	0
Waipahu	504	1461	54	0	1355	89	0	1294	85	0
Waipahu	505	1317	236	0	1220	313	0	1165	299	0
Waipahu	506	993	279	0	977	367	0	965	363	0
Waipahu	539	0	0	0	411	1061	0	385	994	0
Waipahu	540	0	130	0	0	184	0	0	184	0
Waipahu	541	3505	921	0	6900	3772	0	8102	4429	0
Waipahu	542	3175	1056	0	2910	1224	0	2765	1163	0
Waipahu	543	4479	78	0	4226	124	0	4082	120	0
Waipahu	544	3750	377	0	3495	491	0	3352	471	0
Waipahu	545	0	0	0	1566	1386	0	2540	2247	0
Waipahu	547	0	0	0	458	379	0	550	455	0
Waipahu	548	2235	542	0	2114	586	0	2038	565	0
Waipahu	618	0	0	0	45	249	0	45	249	0
Waipahu Total		*128,546*	*31,492*	*0*	*133,979*	*48,212*	*0*	*134,327*	*50,403*	*0*
Total		**306,417**	**102,857**	**1,902**	**408,234**	**201,302**	**11,359**	**445,931**	**241,720**	**14,989**

Updated Residential, Non-Residential, and Visitor Population Projection Results

Pump Station Tributary Area	TAZ	Projection Update								
		2010(1)			2035			2050		
		Res	Non-Res	Visitor	Res	Non-Res	Visitor	Res	Non-Res	Visitor

Notes:

1. Results do not include the following estimated population not served by sewer (based on comparison of aerial photographs and limits of existing collection system): 9,177 Residential; 17,095 Non-Residential.

Appendix D.
Application of Residential Population Projection Approach to Sample TAZ

Appendix D: Application of Residential Population Projection Approach to Sample TAZ

Conducted for TAZ 610 (located within the Honouliuli Influent tributary area)

Step 1: Determine 2010 TAZ population based on analysis of 2010 Census data at the block level.

2010 Census blocks located within TAZ 610	Block population	% of block within TAZ 610	Block population within TAZ 610
150030086131000	643	100%	643
150030086131001	81	100%	81
150030086131002	51	100%	51
150030086131003	41	100%	41
150030086131004	88	100%	88
150030086131005	0	100%	0
150030086221000	0	100%	0
150030086221001	245	100%	245
150030086221002	60	100%	60
150030086221003	162	100%	162
150030086221004	197	100%	197
150030086221005	106	100%	106
150030086222000	164	100%	164
150030086222001	167	100%	167
150030086222002	59	100%	59
150030086222003	136	100%	136
150030086222004	2	100%	2
150030086222005	40	100%	40
150030086222006	136	100%	136
150030086222007	110	100%	110
150030086222008	125	100%	125
150030086222009	113	100%	113
150030086222010	112	100%	112
150030086222011	42	100%	42
150030086222012	160	100%	160
150030086222013	66	100%	66
150030086222014	116	100%	116
150030086222015	181	100%	181
150030086222016	138	100%	138
150030086222017	354	100%	354
150030086222018	57	100%	57
150030086222019	94	100%	94
150030086223000	0	100%	0
150030086223001	0	100%	0
150030086223002	0	100%	0
150030086223003	375	100%	375
150030086223004	149	100%	149
150030086223005	57	100%	57
150030086223006	145	100%	145
150030086223007	200	100%	200
150030086223011	0	100%	0
150030086223012	0	100%	0
150030086223013	0	100%	0
Total	*4,972*		*4,972*

Step 2: Replace 2010 TAZ population prepared by the CCH DPP with the revised 2010 TAZ population based on 2010 Census data, and adjust to account for non-sewered population.

2010 TAZ population prepared by CCH DPP (4,881) replaced with estimate based on 2010 Census data (4,972).

All population assumed to be sewered within TAZ 610; no adjustment required.

Step 3: Determine 2015 TAZ population

2010 TAZ population based on 2010 Census data + (2015 CCH DPP population - 2010 CCH DPP population) = 2015 TAZ population

4,972 + (5,499 - 4,881) = 5,590   Average annual growth rate: 2.49%

Step 4: Determine populations through 2035 for each five year increment.

<u>2020 Population</u>
2015 TAZ population + (2020 CCH DPP population - 2015 CCH DPP population) = 2020 TAZ population

5,590 + (5,689 - 5,499) = 5,780   Average annual growth rate: 0.68%

<u>2025 Population</u>
2020 TAZ population + (2025 CCH DPP population - 2020 CCH DPP population) = 2025 TAZ population

5,780 + (5,842 - 5,689) = 5,933   Average annual growth rate: 0.53%

<u>2030 Population</u>
2025 TAZ population + (2030 CCH DPP population - 2025 CCH DPP population) = 2030 TAZ population

5,933 + (5,985 - 5,842) = 6,076   Average annual growth rate: 0.48%

<u>2035 Population</u>
2030 TAZ population + (2035 CCH DPP population - 2030 CCH DPP population) = 2035 TAZ population

6,076 + (6,144 - 5,985) = 6,235   Average annual growth rate: 0.52%

Step 5: Determine populations through 2050 for each five year increment.

Since TAZ 610 demonstrated less than 1% annual growth between 2030 and 2035, future growth was projected in a linear fashion.

<u>2040 Population</u>
2035 TAZ population + (2035 TAZ population * (average annual growth rate between 2030 and 2035 * 5)) = 2040 TAZ population

6,235 + (6,235 * (0.52% * 5)) = 6,398   Average annual growth rate: 0.52%

<u>2045 Population</u>
2040 TAZ population + (2040 TAZ population * (average annual growth rate between 2035 and 2040 * 5)) = 2045 TAZ population

6,398 + (6,398 * (0.52% * 5)) = 6,566   Average annual growth rate: 0.52%

<u>2050 Population</u>
2045 TAZ population + (2045 TAZ population * (average annual growth rate between 2040 and 2045 * 5)) = 2050 TAZ population

6,566 + (6,566 * (0.52% * 5)) = 6,737   Average annual growth rate: 0.52%

Appendix E. Additional Development Acres and Infiltration Values by Individual TAZs

Potential Future Development Area Detail by TAZ

		Year 2010				Year 2035					Year 2050				
TAZ	**Tributary Area**	Population	Total Developed Land Area (acres)	Population Density	Infiltration During Wet Weather (%)	Population	Additional Developed Acres	Total Developed Land Area (acres)	Population Density	Infiltration During Wet Weather (%)	Population	Additional Developed Acres	Total Developed Land Area (acres)	Population Density	Infiltration During Wet Weather (%)
370	Halawa	37	2.8	13.4	4.0	37	0.0	2.8	13.4	4.0	37	0.0	2.8	13.4	4.0
371	Halawa	1,336	101.8	13.1	3.0	1,349	0.0	101.8	13.3	3.0	1,349	0.0	101.8	13.3	3.0
372	Halawa	1	0.2	7.4	3.0	1	0.0	0.2	7.4	3.0	1	0.0	0.2	7.4	3.0
373	Halawa	3,968	212.9	18.6	3.7	4,240	0.0	212.9	19.9	3.7	4,142	0.0	212.9	19.5	3.7
374	Halawa	0	2.3	0.0	4.0	0	0.0	2.3	0.0	4.0	0	0.0	2.3	0.0	4.0
375	Halawa / Waimalu	4,670	403.4	11.6	3.0	4,685	0.0	403.4	11.6	3.0	4,619	0.0	403.4	11.5	3.0
376	Halawa	11	6.3	1.7	3.0	11	0.0	6.3	1.7	3.0	11	0.0	6.3	1.7	3.0
394	Halawa	255	45.5	5.6	4.0	300	0.0	45.5	6.6	4.0	321	0.0	45.5	7.1	4.0
395	Halawa	1,706	94.2	18.1	3.2	1,860	0.0	94.2	19.8	3.2	1,934	0.0	94.2	20.5	3.2
396	Halawa	428	96.8	4.4	3.1	434	0.0	96.8	4.5	3.1	434	0.0	96.8	4.5	3.1
397	Halawa / Waimalu	0	1.1	0.0	3.0	0	0.0	1.1	0.0	3.0	0	0.0	1.1	0.0	3.0
399	Waimalu	139	63.8	2.2	4.9	123	0.0	63.8	1.9	4.9	110	0.0	63.8	1.7	4.9
400	Waimalu	297	20.2	14.7	3.9	302	0.0	20.2	15.0	3.9	300	0.0	20.2	14.9	3.9
401	Waimalu	1,051	51.4	20.5	3.0	1,073	0.0	51.4	20.9	3.0	1,077	0.0	51.4	21.0	3.0
402	Waimalu	411	34.3	12.0	3.0	426	0.0	34.3	12.4	3.0	432	0.0	34.3	12.6	3.0
403	Waimalu	796	90.2	8.8	1.8	791	0.0	90.2	8.8	1.8	772	0.0	90.2	8.6	1.8
404	Waimalu	1,193	26.5	45.0	2.9	1,190	0.0	26.5	44.9	2.9	1,184	0.0	26.5	44.7	2.9
405	Halawa / Waimalu	3,736	437.8	8.5	2.1	3,697	0.0	437.8	8.4	2.1	3,658	0.0	437.8	8.4	2.1
406	Waimalu	2,378	422.9	5.6	4.0	2,255	0.0	422.9	5.3	4.0	2,171	0.0	422.9	5.1	4.0
407	Waimalu	1,481	57.1	26.0	3.5	1,377	0.0	57.1	24.1	3.5	1,308	0.0	57.1	22.9	3.5
408	Waimalu	655	17.8	36.8	4.9	626	0.0	17.8	35.1	4.9	603	0.0	17.8	33.8	4.9
409	Waimalu	1,285	47.0	27.4	4.7	1,247	0.0	47.0	26.5	4.7	1,216	0.0	47.0	25.9	4.7
410	Waimalu	855	41.8	20.4	4.0	839	0.0	41.8	20.1	4.0	825	0.0	41.8	19.7	4.0
411	Waimalu	628	34.3	18.3	4.4	645	0.0	34.3	18.8	4.4	645	0.0	34.3	18.8	4.4
412	Waimalu	359	11.7	30.6	5.0	352	0.0	11.7	30.0	5.0	352	0.0	11.7	30.0	5.0
413	Waimalu	511	73.8	6.9	4.1	527	0.0	73.8	7.1	4.1	510	0.0	73.8	6.9	4.1
414	Waimalu	2,190	176.1	12.4	2.4	2,140	0.0	176.1	12.2	2.4	2,103	0.0	176.1	11.9	2.4
415	Waimalu	799	83.2	9.6	2.4	771	0.0	83.2	9.3	2.4	752	0.0	83.2	9.0	2.4
416	Waimalu / Pearl City	2,324	166.5	14.0	3.8	2,290	0.0	166.5	13.8	3.8	2,265	0.0	166.5	13.6	3.8
417	Pearl City	26	88.5	0.3	0.7	35	0.0	88.5	0.4	0.7	35	0.0	88.5	0.4	0.7
418	Waimalu / Pearl City	1,523	144.7	10.5	2.6	1,419	0.0	144.7	9.8	2.6	1,357	0.0	144.7	9.4	2.6
419	Waimalu	286	42.2	6.8	2.4	282	0.0	42.2	6.7	2.4	277	0.0	42.2	6.6	2.4
420	Waimalu	649	44.7	14.5	4.0	652	0.0	44.7	14.6	4.0	648	0.0	44.7	14.5	4.0
421	Waimalu / Pearl City	2,381	213.8	11.1	3.7	2,224	0.0	213.8	10.4	3.7	2,126	0.0	213.8	9.9	3.7
422	Pearl City	967	87.5	11.1	1.5	909	0.0	87.5	10.4	1.5	873	0.0	87.5	10.0	1.5
423	Pearl City	711	66.2	10.7	1.5	682	0.0	66.2	10.3	1.5	663	0.0	66.2	10.0	1.5
424	Pearl City	794	84.8	9.4	3.1	778	0.0	84.8	9.2	3.1	757	0.0	84.8	8.9	3.1

Potential Future Development Area Detail by TAZ

TAZ	Tributary Area	Year 2010 Population	Year 2010 Total Developed Land Area (acres)	Year 2010 Population Density	Year 2010 Infiltration During Wet Weather (%)	Year 2035 Population	Year 2035 Additional Developed Acres	Year 2035 Total Developed Land Area (acres)	Year 2035 Population Density	Year 2035 Infiltration During Wet Weather (%)	Year 2050 Population	Year 2050 Additional Developed Acres	Year 2050 Total Developed Land Area (acres)	Year 2050 Population Density	Year 2050 Infiltration During Wet Weather (%)
425	Waimalu / Pearl City	1,086	47.0	23.1	4.0	1,090	0.0	47.0	23.2	4.0	1,084	0.0	47.0	23.0	4.0
426	Waimalu / Pearl City	270	29.8	9.1	3.3	290	0.0	29.8	9.7	3.3	418	0.0	29.8	14.0	3.3
427	Waimalu	437	28.2	15.5	3.2	442	0.0	28.2	15.7	3.2	439	0.0	28.2	15.6	3.2
428	Waimalu	22	21.4	1.0	4.0	22	0.0	21.4	1.0	4.0	22	0.0	21.4	1.0	4.0
429	Waimalu / Pearl City	446	16.7	26.7	4.0	437	0.0	16.7	26.1	4.0	426	0.0	16.7	25.5	4.0
430	Pearl City	814	37.6	21.6	2.8	1,194	0.0	37.6	31.7	2.8	1,373	0.0	37.6	36.5	2.8
431	Pearl City	771	78.5	9.8	3.0	869	0.0	78.5	11.1	3.0	916	0.0	78.5	11.7	3.0
432	Pearl City	22	12.7	1.7	5.3	0	0.0	12.7	0.0	5.3	0	0.0	12.7	0.0	5.3
433	Pearl City	1,123	279.0	4.0	2.0	1,465	0.0	279.0	5.3	2.0	1,557	0.0	279.0	5.6	2.0
434	Pearl City	936	39.5	23.7	2.0	900	0.0	39.5	22.8	2.0	880	0.0	39.5	22.3	2.0
435	Pearl City	2,018	196.8	10.3	0.8	1,941	0.0	196.8	9.9	0.8	1,890	0.0	196.8	9.6	0.8
436	Pearl City	1,743	169.8	10.3	0.6	1,666	0.0	169.8	9.8	0.6	1,619	0.0	169.8	9.5	0.6
437	Pearl City	3,438	295.0	11.7	0.5	3,316	0.0	295.0	11.2	0.5	3,233	0.0	295.0	11.0	0.5
438	Pearl City	348	94.1	3.7	1.9	375	0.0	94.1	4.0	1.9	384	0.0	94.1	4.1	1.9
439	Pearl City	4,097	439.4	9.3	0.5	4,443	0.0	439.4	10.1	0.5	4,443	0.0	439.4	10.1	0.5
440	Waipahu / Pearl City	742	107.4	6.9	5.9	574	0.0	107.4	5.3	5.9	463	0.0	107.4	4.3	5.9
441	Waipahu	4,361	174.7	25.0	0.8	4,900	0.0	174.7	28.0	0.8	5,150	0.0	174.7	29.5	0.8
442	Waipahu	1,649	99.8	16.5	0.8	1,456	0.0	99.8	14.6	0.8	1,334	0.0	99.8	13.4	0.8
443	Waipahu	59	201.4	0.3	2.3	24	0.0	201.4	0.1	2.3	0	0.0	201.4	0.0	2.3
444	Waipahu	208	38.8	5.4	3.5	214	0.0	38.8	5.5	3.5	214	0.0	38.8	5.5	3.5
445	Waipahu	312	33.5	9.3	3.5	355	0.0	33.5	10.6	3.5	377	0.0	33.5	11.3	3.5
446	Waipahu	1,177	35.9	32.8	2.0	1,174	0.0	35.9	32.7	2.0	1,162	0.0	35.9	32.4	2.0
447	Waipahu	810	50.2	16.1	2.2	770	0.0	50.2	15.3	2.2	740	0.0	50.2	14.7	2.2
448	Waipahu	874	32.6	26.9	0.8	795	0.0	32.6	24.4	0.8	729	0.0	32.6	22.4	0.8
449	Waipahu	2,005	96.4	20.8	0.8	1,981	0.0	96.4	20.5	0.8	1,958	0.0	96.4	20.3	0.8
450	Waipahu	2,061	81.6	25.3	0.8	2,007	0.0	81.6	24.6	0.8	1,971	0.0	81.6	24.2	0.8
451	Waipahu	3,309	164.9	20.1	2.2	3,170	0.0	164.9	19.2	2.2	3,088	0.0	164.9	18.7	2.2
452	Waipahu	1,138	61.4	18.5	2.4	1,185	0.0	61.4	19.3	2.4	1,174	0.0	61.4	19.1	2.4
453	Waipahu	1,031	15.9	64.9	4.6	976	0.0	15.9	61.5	4.6	940	0.0	15.9	59.2	4.6
454	Waipahu	2,524	87.4	28.9	1.1	2,537	0.0	87.4	29.0	1.1	2,533	0.0	87.4	29.0	1.1
455	Waipahu	343	76.9	4.5	1.0	258	0.0	76.9	3.4	1.0	198	0.0	76.9	2.6	1.0
456	Waipahu	1,072	45.1	23.8	1.0	1,076	0.0	45.1	23.9	1.0	1,048	0.0	45.1	23.3	1.0
457	Waipahu	1,284	73.4	17.5	1.0	1,501	0.0	73.4	20.5	1.0	1,614	0.0	73.4	22.0	1.0
458	Waipahu	1,720	95.2	18.1	1.0	1,609	0.0	95.2	16.9	1.0	1,534	0.0	95.2	16.1	1.0
459	Waipahu	1,434	76.2	18.8	1.0	1,346	0.0	76.2	17.7	1.0	1,288	0.0	76.2	16.9	1.0
460	Waipahu	2,202	116.3	18.9	0.7	2,142	0.0	116.3	18.4	0.7	2,101	0.0	116.3	18.1	0.7
461	Waipahu	1,317	130.2	10.1	1.0	1,220	0.0	130.2	9.4	1.0	1,159	0.0	130.2	8.9	1.0

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462	Waipahu	1,725	137.5	12.5	1.0	1,692	0.0	137.5	12.3	1.0	1,648	0.0	137.5	12.0	1.0
463	Waipahu	1,008	327.8	3.1	0.9	953	0.0	327.8	2.9	0.9	899	0.0	327.8	2.7	0.9
464	Waipahu / Pearl City	1,867	108.5	17.2	0.8	1,786	0.0	108.5	16.5	0.8	1,734	0.0	108.5	16.0	0.8
465	Waipahu / Pearl City	600	74.4	8.1	0.9	600	0.0	74.4	8.1	0.9	584	0.0	74.4	7.9	0.9
466	Waipahu	1,161	73.8	15.7	0.9	1,100	0.0	73.8	14.9	0.9	1,060	0.0	73.8	14.4	0.9
467	Waipahu	2,697	157.9	17.1	0.9	2,594	0.0	157.9	16.4	0.9	2,534	0.0	157.9	16.1	0.9
468	Waipahu	392	41.8	9.4	0.9	272	3.6	45.5	6.0	1.0	184	1.1	46.6	4.0	1.0
469	Waipahu	1,307	119.5	10.9	0.9	1,582	0.0	119.5	13.2	0.9	1,710	0.0	119.5	14.3	0.9
472	Waipahu	0	1.7	0.0	0.9	5,570	378.9	380.7	14.6	2.0	7,309	118.3	499.0	14.6	2.0
473	Waipahu / Pearl City	0	0.0	0.0	0.0	498	33.9	33.9	14.7	2.0	653	10.5	44.4	14.7	2.0
474	Pearl City	0	0.0	0.0	0.0	1,583	149.3	149.3	10.6	2.0	2,077	46.6	195.9	10.6	2.0
475	Pearl City	0	0.0	0.0	0.0	9,057	854.4	854.4	10.6	2.0	11,971	274.9	1129.3	10.6	2.0
476	Pearl City	0	0.0	0.0	0.0	136	12.8	12.8	10.6	2.0	187	4.8	17.6	10.6	2.0
477	Pearl City	0	0.0	0.0	0.0	2,183	114.9	114.9	19.0	2.0	3,590	74.1	188.9	19.0	2.0
478	Pearl City	0	0.0	0.0	0.0	1,985	75.2	75.2	26.4	2.0	2,731	28.3	103.4	26.4	2.0
479	Pearl City	0	0.0	0.0	0.0	4,304	298.9	298.9	14.4	2.0	5,921	112.3	411.2	14.4	2.0
480	Pearl City	0	0.0	0.0	0.0	1,215	110.5	110.5	11.0	2.0	1,671	41.5	151.9	11.0	2.0
481	Waipahu	18	11.2	1.6	0.0	18	0.0	11.2	1.6	1.0	18	0.0	11.2	1.6	1.0
482	Waipahu	1,213	61.1	19.9	0.0	1,167	0.0	61.1	19.1	1.0	1,133	0.0	61.1	18.6	1.0
483	Waipahu	1,639	124.7	13.1	0.0	1,538	0.0	124.7	12.3	1.0	1,482	0.0	124.7	11.9	1.0
484	Waipahu	2,682	179.5	14.9	0.0	2,569	0.0	179.5	14.3	1.0	2,498	0.0	179.5	13.9	1.0
485	Waipahu	1,343	127.4	10.5	0.0	1,244	0.0	127.4	9.8	1.0	1,181	0.0	127.4	9.3	1.0
486	Waipahu	889	79.9	11.1	0.0	844	0.0	79.9	10.6	1.0	813	0.0	79.9	10.2	1.0
487	Waipahu	1,615	112.3	14.4	0.0	1,526	0.0	112.3	13.6	0.8	1,470	0.0	112.3	13.1	0.8
488	Waipahu	843	104.3	8.1	0.0	748	0.0	104.3	7.2	0.8	689	0.0	104.3	6.6	0.8
489	Waipahu	1,178	97.7	12.1	0.0	1,111	0.0	97.7	11.4	0.5	1,073	0.0	97.7	11.0	0.5
490	Waipahu	885	60.6	14.6	0.0	862	0.0	60.6	14.2	0.6	832	0.0	60.6	13.7	0.6
491	Waipahu	825	55.9	14.8	0.0	787	0.0	55.9	14.1	0.4	758	0.0	55.9	13.6	0.4
492	Waipahu	2,524	174.7	14.4	0.0	2,390	0.0	174.7	13.7	0.4	2,314	0.0	174.7	13.2	0.4
493	Waipahu	6,903	470.3	14.7	0.0	6,409	0.0	470.3	13.6	0.9	6,118	0.0	470.3	13.0	0.9
494	Waipahu	3,628	424.4	8.5	0.0	3,316	0.0	424.4	7.8	0.9	3,115	0.0	424.4	7.3	0.9
495	Waipahu	947	110.8	8.5	0.0	1,349	7.7	118.5	11.4	1.1	1,510	4.2	122.7	12.3	1.1
496	Waipahu	266	62.8	4.2	0.0	221	0.0	62.8	3.5	1.0	185	0.0	62.8	2.9	1.0
497	Waipahu	911	78.0	11.7	0.0	861	0.0	78.0	11.0	1.0	828	0.0	78.0	10.6	1.0
498	Waipahu	571	41.1	13.9	0.0	529	0.0	41.1	12.9	0.5	505	0.0	41.1	12.3	0.5
499	Waipahu	441	32.4	13.6	0.0	429	0.0	32.4	13.2	1.0	417	0.0	32.4	12.9	1.0
500	Waipahu	920	83.1	11.1	0.0	874	0.0	83.1	10.5	1.0	835	0.0	83.1	10.0	1.0

Potential Future Development Area Detail by TAZ

TAZ	Tributary Area	Year 2010				Year 2035					Year 2050				
		Population	Total Developed Land Area (acres)	Population Density	Infiltration During Wet Weather (%)	Population	Additional Developed Acres	Total Developed Land Area (acres)	Population Density	Infiltration During Wet Weather (%)	Population	Additional Developed Acres	Total Developed Land Area (acres)	Population Density	Infiltration During Wet Weather (%)
501	Waipahu	691	35.3	19.6	0.0	691	0.0	35.3	19.6	1.0	671	0.0	35.3	19.0	1.0
502	Waipahu	531	38.8	13.7	0.0	511	0.0	38.8	13.2	1.0	497	0.0	38.8	12.8	1.0
503	Waipahu	1,108	124.5	8.9	0.0	1,060	0.0	124.5	8.5	1.0	1,024	0.0	124.5	8.2	1.0
504	Waipahu	886	72.9	12.2	0.0	822	0.0	72.9	11.3	1.0	783	0.0	72.9	10.7	1.0
505	Waipahu	1,186	90.1	13.2	0.0	1,133	0.0	90.1	12.6	1.0	1,097	0.0	90.1	12.2	1.0
506	Waipahu	490	220.0	2.2	0.0	490	0.0	220.0	2.2	1.0	482	0.0	220.0	2.2	1.0
539	Waipahu	0	0.0	0.0	0.0	411	28.0	28.0	14.7	2.0	385	-1.8	26.2	14.7	2.0
541	Waipahu	3,120	292.7	10.7	0.0	6,368	138.6	431.3	14.8	1.3	7,535	49.1	480.4	15.7	1.4
542	Waipahu	1,494	98.5	15.2	0.0	1,344	0.0	98.5	13.6	1.0	1,244	0.0	98.5	12.6	1.0
543	Waipahu	3,093	230.1	13.4	0.0	2,936	0.0	230.1	12.8	1.0	2,843	0.0	230.1	12.4	1.0
544	Waipahu	3,054	170.6	17.9	0.0	2,904	0.0	170.6	17.0	1.0	2,810	0.0	170.6	16.5	1.0
545	Honouliuli Influent / Waipahu	0	0.0	0.0	0.0	2,274	167.0	167.0	13.6	2.0	3,687	103.8	270.8	13.6	2.0
546	Honouliuli Influent	0	48.5	0.0	0.0	3,846	274.7	323.2	11.9	2.5	5,500	118.1	441.4	12.5	2.3
547	Honouliuli Influent / Waipahu	0	0.0	0.0	0.0	864	64.7	64.7	13.3	2.0	1,039	13.1	77.8	13.3	2.0
548	Waipahu	1,795	129.5	13.9	0.0	1,723	0.0	129.5	13.3	1.0	1,672	0.0	129.5	12.9	1.0
549	Honouliuli Influent	1	7.5	0.1	0.0	7,497	625.0	632.4	11.9	2.0	10,528	252.8	885.3	11.9	2.0
550	Honouliuli Influent	1,990	163.9	12.1	0.0	1,873	0.0	163.9	11.4	1.5	1,800	0.0	163.9	11.0	1.5
551	Honouliuli Influent	4,803	181.6	26.4	0.0	5,161	24.2	205.8	25.1	4.3	5,271	7.3	213.1	24.7	4.2
552	Honouliuli Influent	2,181	131.2	16.6	0.0	2,006	0.0	131.2	15.3	2.7	1,896	0.0	131.2	14.5	2.7
553	Honouliuli Influent	865	44.7	19.4	0.0	894	0.0	44.7	20.0	5.0	879	0.0	44.7	19.7	5.0
554	Honouliuli Influent	2,138	129.7	16.5	0.0	3,734	0.0	129.7	28.8	4.8	4,215	0.0	129.7	32.5	4.8
555	Honouliuli Influent	2,532	142.3	17.8	0.0	2,700	0.0	142.3	19.0	5.0	2,645	0.0	142.3	18.6	5.0
556	Honouliuli Influent	2,541	112.3	22.6	0.0	2,358	0.0	112.3	21.0	1.0	2,255	0.0	112.3	20.1	1.0
557	Honouliuli Influent	122	4.3	28.6	0.0	3,327	144.2	148.5	22.4	2.0	3,171	-5.1	143.4	22.1	2.0
558	Honouliuli Influent	1,469	119.3	12.3	0.0	2,426	76.0	195.3	12.4	2.0	2,424	0.0	195.3	12.4	2.0
559	Honouliuli Influent	26	86.7	0.3	0.0	259	0.0	86.7	3.0	1.0	244	0.0	86.7	2.8	1.0
560	Honouliuli Influent	81	256.9	0.3	0.0	156	0.0	256.9	0.6	1.0	152	0.0	256.9	0.6	1.0
561	Honouliuli Influent	207	1087.6	0.2	0.0	202	0.0	1087.6	0.2	1.0	198	0.0	1087.6	0.2	1.0
562	Honouliuli Influent	1,664	77.2	21.6	0.0	1,539	0.0	77.2	19.9	1.0	1,459	0.0	77.2	18.9	1.0
563	Honouliuli Influent	2,899	198.1	14.6	0.0	2,849	0.0	198.1	14.4	2.9	2,809	0.0	198.1	14.2	2.9
564	Honouliuli Influent	5,354	343.8	15.6	0.0	5,762	39.5	383.3	15.0	0.6	5,851	12.0	395.3	14.8	0.6
565	Honouliuli Influent	0	56.3	0.0	0.0	1,964	167.8	224.1	8.8	1.6	2,615	55.6	279.8	9.3	1.7
566	Honouliuli Influent	0	0.0	0.0	0.0	811	69.3	69.3	11.7	2.0	1,108	25.4	94.7	11.7	2.0
567	Honouliuli Influent	61	105.3	0.6	0.0	872	53.8	159.1	5.5	3.9	1,214	21.4	180.5	6.7	3.7
568	Honouliuli Influent	1,637	100.4	16.3	0.0	1,775	0.0	100.4	17.7	1.5	1,815	0.0	100.4	18.1	1.5
569	Honouliuli Influent	2,113	172.9	12.2	0.0	2,839	0.0	172.9	16.4	4.5	3,124	0.0	172.9	18.1	4.5

Potential Future Development Area Detail by TAZ

TAZ	Tributary Area	Year 2010				Year 2035					Year 2050				
		Population	Total Developed Land Area (acres)	Population Density	Infiltration During Wet Weather (%)	Population	Additional Developed Acres	Total Developed Land Area (acres)	Population Density	Infiltration During Wet Weather (%)	Population	Additional Developed Acres	Total Developed Land Area (acres)	Population Density	Infiltration During Wet Weather (%)
570	Honouliuli Influent	0	0.0	0.0	0.0	19	1.6	1.6	11.7	2.0	35	1.4	3.0	11.7	2.0
571	Honouliuli Influent	0	88.5	0.0	0.0	4,226	361.2	449.7	9.4	2.6	7,108	246.3	696.0	10.2	2.4
573	Honouliuli Influent	0	991.5	0.0	0.0	50	4.3	995.7	0.1	5.0	112	5.3	1001.0	0.1	5.0
574	Honouliuli Influent	0	159.4	0.0	0.0	5,561	475.3	634.7	8.8	2.8	9,976	377.4	1012.1	9.9	2.5
577	Honouliuli Influent	0	0.0	0.0	0.0	19	1.6	1.6	11.7	2.0	24	0.4	2.1	11.7	2.0
578	Honouliuli Influent	0	0.0	0.0	0.0	698	59.7	59.7	11.7	2.0	929	19.7	79.4	11.7	2.0
579	Honouliuli Influent	0	0.0	0.0	0.0	156	13.3	13.3	11.7	2.0	208	4.4	17.8	11.7	2.0
580	Honouliuli Influent	760	179.6	4.2	0.0	1,069	0.0	179.6	6.0	0.8	1,200	0.0	179.6	6.7	0.8
581	Honouliuli Influent	447	93.9	4.8	0.0	583	0.0	93.9	6.2	0.8	648	0.0	93.9	6.9	0.8
582	Honouliuli Influent	1,253	196.0	6.4	0.0	2,135	48.4	244.4	8.7	1.0	2,411	17.0	261.4	9.2	1.1
583	Honouliuli Influent	108	90.5	1.2	0.0	4,968	35.8	126.4	39.3	1.1	7,083	14.8	141.2	50.2	1.2
584	Honouliuli Influent	0	0.0	0.0	0.0	1,985	163.3	163.3	12.2	2.0	2,600	49.0	212.3	12.2	2.0
585	Honouliuli Influent	0	0.0	0.0	0.0	1,651	141.1	141.1	11.7	2.0	2,208	37.1	178.2	12.4	2.0
586	Honouliuli Influent	0	22.8	0.0	0.0	891	18.3	41.1	21.7	1.3	1,268	7.7	48.8	26.0	1.4
587	Honouliuli Influent	0	0.0	0.0	0.0	501	41.8	41.8	12.0	2.0	704	16.9	58.7	12.0	2.0
588	Honouliuli Influent	1,983	54.6	36.3	0.0	1,951	0.0	54.6	35.7	0.8	1,930	0.0	54.6	35.3	0.8
589	Honouliuli Influent	749	57.5	13.0	0.0	895	0.0	57.5	15.6	0.8	1,006	0.0	57.5	17.5	0.8
590	Honouliuli Influent	358	19.4	18.4	0.0	424	2.3	21.8	19.5	0.9	493	0.5	22.3	22.1	0.9
591	Honouliuli Influent	0	0.6	0.0	0.0	0	0.0	0.6	0.0	3.5	0	0.0	0.6	0.0	3.5
592	Honouliuli Influent	1,188	65.1	18.3	0.0	1,277	0.0	65.1	19.6	0.7	1,327	0.0	65.1	20.4	0.7
593	Honouliuli Influent	890	45.8	19.4	0.0	1,595	12.4	58.2	27.4	1.0	1,963	4.3	62.5	31.4	1.1
594	Honouliuli Influent	0	57.4	0.0	0.0	387	33.1	90.5	4.3	1.2	545	9.4	99.9	5.5	1.3
595	Honouliuli Influent	0	56.4	0.0	0.0	3,024	129.8	186.1	16.2	1.6	4,102	42.9	229.0	17.9	1.7
596	Honouliuli Influent	2	6.1	0.4	0.0	2,331	61.0	67.1	34.7	1.9	3,179	20.2	87.2	36.4	1.9
597	Honouliuli Influent	2,337	160.8	14.5	0.0	2,398	0.0	160.8	14.9	3.6	2,426	0.0	160.8	15.1	3.6
598	Honouliuli Influent	0	0.1	0.0	0.0	93	7.9	8.1	11.5	2.0	132	3.3	11.4	11.6	2.0
599	Honouliuli Influent	0	0.1	1.1	0.0	1,670	64.5	64.6	25.8	2.0	2,464	27.3	91.9	26.8	2.0
600	Honouliuli Influent	0	0.0	0.0	0.0	7,816	294.9	294.9	26.5	2.0	11,882	153.4	448.4	26.5	2.0
601	Honouliuli Influent	2,529	174.7	14.5	0.0	3,199	0.0	174.7	18.3	3.5	3,483	0.0	174.7	19.9	3.5
602	Honouliuli Influent	2,587	132.9	19.5	0.0	2,519	0.0	132.9	19.0	3.5	2,464	0.0	132.9	18.5	3.5
603	Honouliuli Influent	0	0.0	0.0	0.0	2,754	82.7	82.7	33.3	2.0	7,171	132.6	215.3	33.3	2.0
604	Honouliuli Influent	0	0.0	0.0	0.0	6,526	148.9	148.9	43.8	2.0	8,643	48.3	197.2	43.8	2.0
605	Honouliuli Influent	0	0.0	0.0	0.0	79	6.8	6.8	11.7	2.0	121	3.6	10.3	11.7	2.0
606	Honouliuli Influent	2,836	330.9	8.6	0.0	2,745	0.0	330.9	8.3	3.5	2,685	0.0	330.9	8.1	3.5
607	Honouliuli Influent	519	66.0	7.9	0.0	2,334	120.0	186.0	12.6	1.5	2,961	36.3	222.2	13.3	1.6
608	Honouliuli Influent	1,105	150.5	7.3	0.0	1,456	23.6	174.1	8.4	0.8	1,591	9.0	183.2	8.7	0.9
609	Honouliuli Influent	1,440	251.0	5.7	0.0	1,643	0.0	251.0	6.5	0.6	1,704	0.0	251.0	6.8	0.6

Potential Future Development Area Detail by TAZ

TAZ	Tributary Area	Year 2010				Year 2035					Year 2050				
		Population	Total Developed Land Area (acres)	Population Density	Infiltration During Wet Weather (%)	Population	Additional Developed Acres	Total Developed Land Area (acres)	Population Density	Infiltration During Wet Weather (%)	Population	Additional Developed Acres	Total Developed Land Area (acres)	Population Density	Infiltration During Wet Weather (%)
610	Honouliuli Influent	2,600	275.8	9.4	0.0	3,780	75.6	351.4	10.8	0.9	4,236	30.0	381.4	11.1	1.0
611	Honouliuli Influent	0	0.0	0.0	0.0	797	68.1	68.1	11.7	2.0	1,074	23.7	91.8	11.7	2.0
612	Honouliuli Influent	0	0.0	0.0	0.0	670	57.3	57.3	11.7	2.0	895	19.2	76.5	11.7	2.0
613	Honouliuli Influent	0	0.0	0.0	0.0	1,290	110.3	110.3	11.7	2.0	1,820	45.3	155.6	11.7	2.0
614	Honouliuli Influent	3,728	271.0	13.8	0.0	3,532	0.0	271.0	13.0	0.6	3,411	0.0	271.0	12.6	0.6
615	Honouliuli Influent	0	0.0	0.0	0.0	2,694	230.3	230.3	11.7	2.0	3,801	94.6	324.9	11.7	2.0
616	Honouliuli Influent	0	0.0	0.0	0.0	1,568	134.0	134.0	11.7	2.0	2,212	55.0	189.1	11.7	2.0
617	Honouliuli Influent	0	0.0	0.0	0.0	28	2.4	2.4	11.7	2.0	25	-0.3	2.1	11.7	2.0
618	Honouliuli Influent / Waipahu	0	0.0	0.0	0.0	45	3.1	3.1	14.7	2.0	45	0.0	3.1	14.7	2.0
763	Honouliuli Influent	0	0.0	0.0	0.0	1,050	44.9	44.9	23.4	2.0	1,050	0.0	44.9	23.4	2.0
764	Honouliuli Influent	0	0.0	0.0	0.0	1,292	110.4	110.4	11.7	2.0	1,815	44.7	155.1	11.7	2.0

Appendix B
Biological Resource Assessment,
SWCA Environmental Consultants, June 2015

SWCA ENVIRONMENTAL CONSULTANTS

Sound Science. Creative Solutions.®

Biological Resources Assessment for Honouliuli Wastewater Treatment Plant Upgrade and Expansion Project

Prepared for

AECOM

Prepared by

SWCA Environmental Consultants

June 2015

BIOLOGICAL RESOURCES ASSESSMENT FOR HONOULIULI WASTEWATER TREATMENT PLANT UPGRADE AND EXPANSION PROJECT

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SWCA Project No. 16822

June 8, 2015

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1. INTRODUCTION

AECOM is preparing a draft environmental impact statement (DEIS) pursuant to Chapter 343, Hawaiʻi Revised Statutes (HRS), and Title 11, Chapter 200, Administrative Rules, State of Hawaiʻi Department of Health (DOH). The City and County of Honolulu Department of Environmental Services proposes to upgrade the Honouliuli Wastewater Treatment Plant (Honouliuli facility) on the Island of Oʻahu to provide secondary treatment and to expand the facility to accommodate future projected wastewater flow.

This upgrade will include the potential relocation of non-process facilities from the Sand Island Wastewater Treatment Plant to the Honouliuli facility. These facilities support island-wide wastewater treatment plants and wastewater pump stations. Although the final environmental assessment/environmental impact statement preparation notice submitted for this project and published in *The Environmental Notice* in July 2010 discusses potential impacts associated with proposed upgrades to and/or expansion of the Honouliuli major conveyance system in addition to the Honouliuli facility, itself, the current Honouliuli facility plan focuses only on the Honouliuli facility (AECOM 2010). The alternatives considered in the DEIS include only upgrades and expansions of the Honouliuli facility.

AECOM has asked SWCA Environmental Consultants (SWCA) to conduct a biological resources assessment to support the DEIS for the proposed project and to prepare a report that summarizes findings and provides recommendations to minimize impacts to sensitive natural resources. The survey area for this assessment consists of the existing Honouliuli facility at 91-1000 Geiger Road and the expansion property to the north and east, adjacent to the Coral Creek Golf Course (Figure 1).

1.1. Location and Vicinity

The survey area is at 91-1000 Geiger Road in ʻEwa Beach on the Island of Oʻahu. The survey area consists of two components: the currently operating Honouliuli facility and its expansion area, which is proposed on predominately undeveloped land immediately to the north and east (see Figure 1). The survey area is accessed by Geiger Road. It is bounded by the Coral Creek Golf Course to the east, the Oʻahu Railway and Land easement to the north, and Roosevelt Avenue/Geiger Road to the west and south. A portion of the expansion area is currently leased to Steel Tech Inc., a local construction company, as a storage area. Soils in the survey area are classified primarily as Mamala stony silty clay loam, 0%–12% slopes (MnC). Small percentages of Honouliuli clay, 0%–2% slopes (HxA); ʻEwa silty clay loam, 0%–2% slopes; and Waialua silty clay, 0%–3% slopes (WkA) occur in the southeast corner of the survey area.

2. METHODS

SWCA reviewed available scientific and technical literature regarding natural resources in and near the survey area. This literature review encompassed a thorough search of refereed scientific journals, technical journals and reports, environmental assessments and environmental impact statements, relevant government documents, and unpublished data that provide insight into the natural history and ecology of the area. SWCA also reviewed available geospatial data, aerial photographs, and topographic maps of the survey area.

SWCA Biologist Jason Cantley conducted flora and fauna pedestrian surveys of the entire survey area on November 16, 2014. Vegetation types and observed fauna were documented and described. Moreover, special attention was given to the documentation of threatened, endangered, or candidate species.

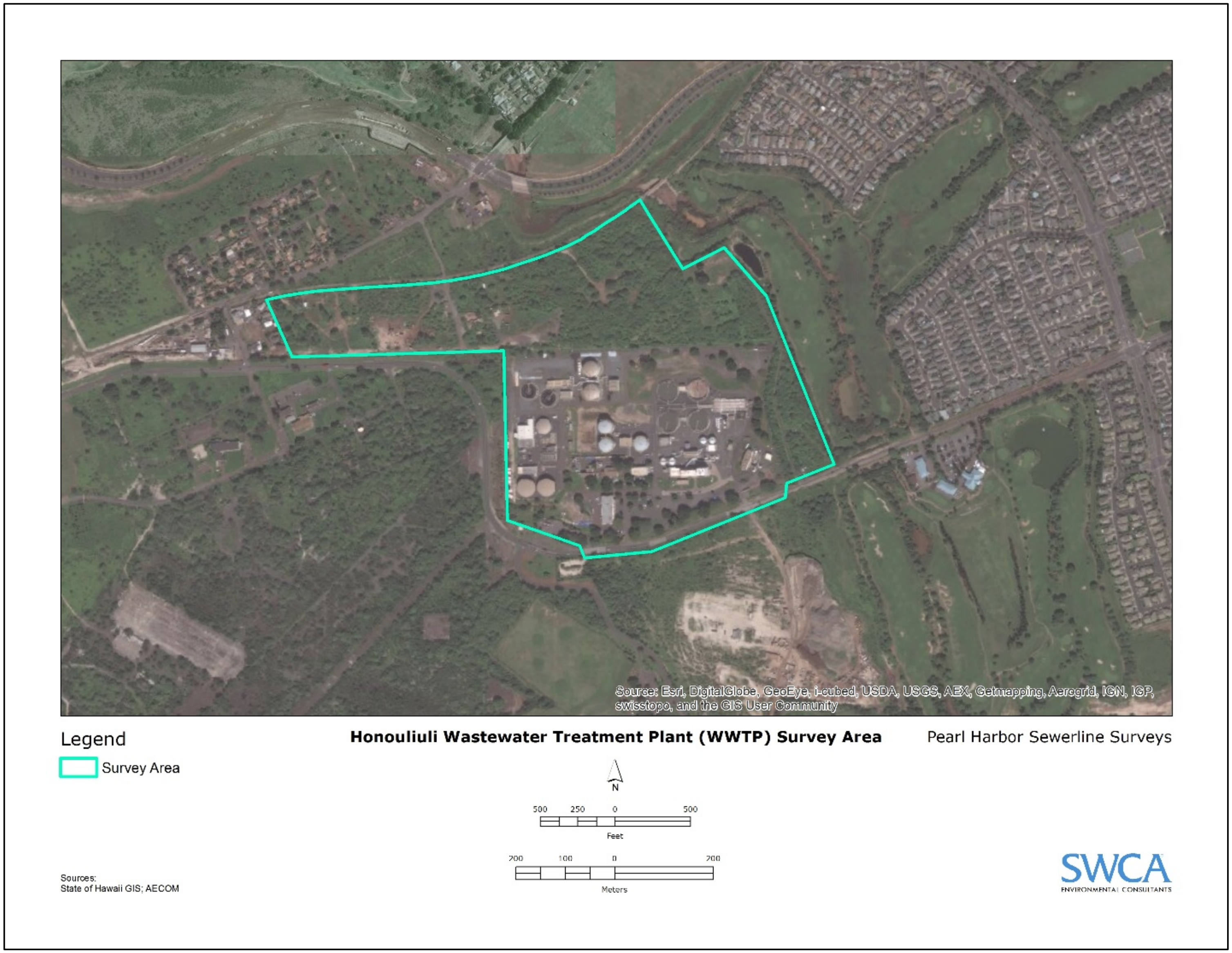

Figure 1. Survey area location.

2.1. Flora

Common plant species and vegetation types, as well as rare or listed species, were recorded during the flora survey. Areas more likely to support native plants (e.g., rocky outcrops and shady areas) were more intensively examined. A comprehensive list of all plant species present in the survey area was not within the scope of this survey.

Plants recorded during the survey are indicative of the season ("rainy" vs. "dry") and the environmental conditions at the time of the survey. As environmental conditions change, it is likely that species and plant abundances also undergo temporal or seasonal changes.

2.2. Fauna

Fauna surveys occurred *before* 11 am or *after* 4 pm when wildlife was most likely to be active. Field observations of birds were conducted using 8 × 30–millimeter binoculars. Visual and auditory observations were included in the survey. All observed birds, mammals, reptiles, amphibians, fish, and invertebrate species were noted during the survey.

Field surveys for the endangered Hawaiian hoary bat or ‘ōpe‘ape‘a (*Lasiurus cinereus semotus*) were not conducted; however, areas of suitable habitat for foraging and roosting were noted when present.

2.3. Aquatic and Marine Flora and Fauna

Surveys for aquatic flora and fauna were not performed under this scope of work; however, a literature review of available data was done to determine species likely to be present in the Mamala Bay area.

2.4. Aquatic Environment

SWCA intensively reviewed available literature and previous field surveys of the potentially affected areas. SWCA identified amphidromous, estuarine, and itinerant marine species because they are the primary focus of discussion and assessment due to their importance to traditional Hawaiian gathering practices and lore, significance as indicators of ecosystem health, and the available literature concerning their biology.

3. RESULTS

In general, the plant and animal species assemblages are typical of those found in disturbed and urban areas on O‘ahu. The survey area does not encompass any designated or proposed critical habitat for threatened or endangered species.

No state or federally listed threatened, endangered, or candidate plant species were observed in the survey area during the survey. The survey area does not contain critical habitat for threatened or endangered species.

3.1. Flora

In all, 79 plant taxa were recorded during the flora survey (Appendix A). Of these, four are native to the Hawaiian Islands: ‘a‘ali‘i (Dodonaea viscosa), hinahina (*Vitex rotundifolia*), ma‘o hau hele (*Hibiscus* *brackenridgei*), and ʻuhaloa (*Waltheria indica*). Hinahina, ʻaʻaliʻi, and ʻuhaloa are not federally listed and are not considered endangered or at risk of extinction. However, maʻo hau hele, the Hawaiian state flower, is a federally listed species and was observed next to a facility building in a cultivated and maintained garden. The maʻo hau hele likely originated from a cultivated source and was not naturally occurring. Two additional species observed were of known Polynesian introduction: niu (*Cocos nucifera*) and kou (*Cordia subcordata*).

Overall, the vegetation in the expansion area is highly disturbed by past and current land uses. Open areas with extensive patches of bare ground exist in the northern portion, which is likely due to grazing by ungulates, vehicle traffic, and the deposition of trash and large debris. Metal scraps and debris are present in the western portion of the expansion area. Extensive graveled and asphalted areas also occur in the northern section of the expansion area. Existing vegetation is primarily characterized as a kiawe (*Prosopis pallida*) forest that covers approximately 47.8 acres, with sparse Guinea grass (*Urochloa maxima*) cover in the understory due to the presence of leaf litter, dry conditions, and grazing by ungulates (Figure 2). The kiawe trees range from 4.5 to 8.0 m (15 to 26 feet) tall and comprise roughly 70% of the tree cover throughout the expansion area. Large koa haole (*Leucaena leucocephala*) and Manila tamarind (*Pithecellobium dulce*) trees sparsely scattered throughout the kiawe forest make up most of the remaining tree cover. Two herbaceous species—lion's ear (*Leonotis nepetifolia*) and golden crown-beard (*Verbesina encelioides*)—are widely distributed throughout the understory. Other non-native herbaceous and shrub species scattered sparsely throughout the expansion area or in isolated patches include khaki weed (*Alternanthera pungens*), spiny amaranth (*Amaranthus spinosus*), wild bean (*Macroptilium lathyroides*), hairy abutilon (*Abutilon grandifolium*), *Sida ciliaris*, and *Sida rhombifolia*. The non-native, parasitic western field dodder (*Cuscuta campestris*) was also found climbing in larger trees throughout the expansion area.

The existing vegetation at the Honouliuli facility is primarily a manicured landscape with non-native grasses and herbs. Cultivated trees occur sporadically as planted individuals across the landscape and include monkey pod (*Samanea saman*), cannonball tree (*Couroupita guianensis*) and *Ficus* sp. trees. Much of the ground area is maintained entirely by mowing within the fenced area. The mowed vegetation is characterized by numerous weedy species that are common in abundance throughout the survey area. These include buffelgrass (*Cenchrus ciliaris*), common sandbur (*Cenchrus echinatus*), Guinea grass, khaki weed (*Alternanthera pungens*), coat buttons (*Tridax procumbens*), hairy garden spurge (*Euphorbia hirta*), buffalo clover (*Alysicarpus vaginalis*), *Macroptilium atropurpureum* and *M. lathyroides*, and false mallow (*Malvastrum coromandelianum* subsp. *coromandelianum).* Many other species were uncommon or rare (see Appendix A).

Figure 2. Kiawe (*Prosopis pallida*) forest at the Honouliuli facility expansion area with sparse Guinea grass (*Urochloa maxima*) cover in the understory.

Figure 3. Monkey pod (*Samanea saman*) and *Ficus sp.* trees at the Honouliuli facility with a weedy manicured ground cover in the understory.

3.2. Fauna

3.2.1. Avifauna

Ten introduced and one indigenous bird species were recorded during the survey in the survey area which includes Honouliuli facility expansion area and the currently operating Honouliuli facility (Table 1). The common myna (*Acridotheres tristis*) was the most abundant bird observed during the survey with 35 sightings. The cattle egret (*Bubulcus ibis*), zebra dove (*Geopelia striata*), and spotted dove (*Streptopelia chinensis*) were also common. All of these species are common to the main Hawaiian Islands, particularly in urban or disturbed areas (Hawai‘i Audubon Society 2005). Only one indigenous species, the Pacific golden-plover, was observed in this area. A number of ducks could have been hybrids of the native koloa and mallard ducks, both of which are protected under the Migratory Bird Treaty Act (MBTA).

Table 1. Birds Observed by SWCA in and near the Survey Area

Common Name	Scientific Name	Status*	Count	MBTA
Cattle egret	*Bubulcus ibis*	NN	15	X
Common myna	*Acridotheres tristis*	NN	35	
Domestic duck	*Anas platyrhynchos domesticus*	NN	1	
House finch	*Haemorhous mexicanus*	NN	3	X
House sparrows	*Passer domesticus*	NN	3	
Koloa hybrid	*Anas wyvilliana* x *platyrhynchos*	HN	6	X
Pacific golden-plover, kolea	*Pluvialis fulva*	IM	3	X
Saffron finch	*Sicalis flaveola*	NN	1	
Spotted dove	*Streptopelia chinensis*	NN	6	
Zebra dove	*Geopelia striata*	NN	10	
	Total	**10**		

**Notes*: HN = hybrid native permanent resident, NN = non-native permanent resident; IM = indigenous and migratory.

3.2.1.1. ENDANGERED BIRDS

No threatened or endangered birds were observed during surveys in the survey area. O‘ahu supports the largest number of Hawaiian stilts (*Himantopus mexicanus knudseni*) in the state, with an estimated 35%–50% of the population residing on the island (U.S. Fish and Wildlife Service [USFWS] 2011). Hawaiian stilts favor open wetland habitats with minimal vegetative cover and water depths of less than 24 centimeters (9.4 inches), as well as tidal mudflats (Robinson et al. 1999). Portions of the survey area appear to hold standing water after periods of extended heavy rainfall, which could attract the Hawaiian stilt and other endangered water birds such as nēnē (*Branta sandvicensis*), Hawaiian coot (*Fulica alai*), Hawaiian moorhen (*Gallinula chloropus*), and Hawaiian duck (*Anas wyvilliana*). Additionally, nearby developments and golf courses contain water features that may be attractive to these species, which increases the likelihood of them being present in the survey area. It should be noted that it is very unlikely that nēnē, Hawaiian coot, Hawaiian moorhen, and Hawaiian duck would be present on the site as they are all listed as endangered and have small populations on Oahu.

The survey area does not contain suitable habitat for most endangered birds on O‘ahu because most are known to occur at higher altitudes; however, pueo (*Asio flammeus sandwichensis*), which is listed as endangered on Oʻahu by the State of Hawaiʻi, occupies wet and dry forests, grasslands, shrublands, and urban areas and could be present in the survey area because it contains this type of habitat.

3.2.2. Hawaiian Hoary Bat

Hawaiian hoary bats are known to occur on Oʻahu in native, non-native, agricultural, and developed landscapes (U.S. Department of Agriculture 2009; USFWS 1998). Hawaiian hoary bats were not observed in the survey area; however, they have been documented roosting in trees that were present in the survey area, specifically coconut trees (*Cocos nucifera*), kiawe, christmasberry (*Schinus terebinthifolius*), and Chinese banyan (*Ficus macrocarpa*).

3.2.3. Other Mammals

Other fauna species observed during the survey were feral cats (*Felis catus*) and small Asian mongooses (*Herpestes javanicus*). It is likely that dogs (*Canis familiaris*) and cats (*Felis catus*) could enter the survey area due to the nearby residences. Other mammals that can be expected on-site include mice (*Mus musculus*) and rats (*Rattus* spp.).

3.2.4. Reptiles and Amphibians

No reptiles or amphibians were seen during the survey. None of the terrestrial reptiles or amphibians in Hawaiʻi are native to the islands.

3.2.5. Invertebrates

Only one native invertebrate—the indigenous globe skimmer (*Pantala flavescens*)—was seen during the survey. Two species of butterflies were observed in the survey area during the survey: Gulf fritillary (*Agraulis vanillae*) and the western pygmy blue butterfly (*Brephidium exilis*). Both are non-native to the Hawaiian Islands.

3.3. Aquatic and Marine Flora and Fauna

Surveys for aquatic flora and fauna were not performed under this scope of work; however, a literature review of available data was done to determine species likely to be present in the Mamala Bay area.

The National Oceanic and Atmospheric Administration (NOAA 2014) lists seven protected marine animals: humpback whales (*Megaptera novaeangliae*), spinner dolphins (*Stenella longirostris*), Pacific white-sided dolphins (*Lagenorhynchus obliquidens*), Hawaiian monk seals (*Monachus schauinslandi*), hawksbill sea turtles (*Eretmochelys imbricata*), leatherback sea turtles (*Dermochelys coriacea*), and green sea turtles (*Chelonia mydas*). The Hawaiian monk seal, green sea turtle, spinner dolphin, and humpback whale may occur in Mamala Bay in limited numbers on occasion.

3.4. Aquatic Environment

3.4.1. Groundwater and Surface Water

Streams from the Waiʻanae Mountains are intermittent and discharge only during freshets (Nichols et al. 1997). The natural drainage of the ʻEwa Plain is mostly infiltrated. The area does not have many surface streams discharging into the ocean or Mamala Bay. There are no perennial streams close to the Honouliuli facility; however, Kaloi Gulch, which is part of the natural drainage system, runs along the eastern border of the survey area.

Kaloi Gulch originates at the southeastern end of the Waiʻanae Mountains as a culmination of several gulches along the southeastern side of the Waiʻanae Mountains. The drainage basin at the south boundary of ʻEwa Villages, which is adjacent to the northern boundary of the Honouliuli facility expansion area, was calculated to be 20.2 square kilometers (7.78 square miles) with a 100-year flood interval between 199.6 and 203.8 cubic meters (m^3) per second (7,050 and 7,200 cubic feet per second) (Belt Collins & Associates 1987). Near the Honouliuli facility, Kaloi Gulch is at an elevation slightly below the surrounding lands, and throughout the lower ʻEwa Plain, the gulch consists mostly of a human-made ditch. A human-made outlet exists on either side of Oneʻula Beach Park, but these appear to rarely have surface water.

The Honouliuli facility discharges into Mamala Bay, which is south of the facility between KoʻOlina and Pearl Harbor. It is classified as a Class A marine water and is permitted for recreational use, aesthetic enjoyment, and propagation of fish, shellfish, and wildlife (Hawaiʻi Administrative Rules [HAR] 11-54). Mamala Bay is on the DOH's Section 303D list, which is a list of waters that do not meet the state's water quality standards for one or more parameters. Mamala Bay was placed on this list for non-attainment of total nitrogen and chlorophyll *a* (DOH 2014). The closest site monitored by DOH is in ʻEwa Beach and is monitored for *Enterococci* and *Clostridium perfringens* periodically. Monitoring results from 2009 to 2014 were reviewed, and results were within the water quality standards for both parameters. No other water quality data were available near Mamala Bay.

The Honouliuli facility is within the Pearl Harbor sector of a Department of Land and Natural Resources aquifer. It is located above the underground injection control well line, which is a boundary between the exempted aquifer and underground source of drinking water. Groundwater near the Honouliuli facility is a source of drinking water; however, no public wells are located within 1-mile of the survey area.

3.4.1.1. WETLANDS

The National Wetland Inventory (NWI) indicates the presence of wetlands on land adjacent to the survey area on the north and east sides; however, no wetlands were identified in the survey area. The presence of facultative, facultative upland, and facultative wetland plant species in the survey area was noted. These species can occur in wetland and non-wetland environments and do not necessarily indicate the presence of wetlands in the survey area. Three criteria—wetland hydrology, hydric soils, and the presence hydrophytic vegetation—must be met to make a wetland determination. Wetland hydrology and hydric soils were not analyzed under this scope of work.

3.4.2. Water Quality and Effluent

The effluent from the Honouliuli facility is conveyed 2,670 meters (m) (8,760 feet) offshore to a depth of approximately 61 m (200 feet) where it is dispersed by a 533-m-long (1,750-foot-long) diffuser pipe at the Barbers Point Deep Ocean Outfall. Because the effluent is of a lower density than seawater, it rises into the water column where ocean currents dilute and disperse it.

The current effluent discharge rate at the Barbers Point Deep Ocean Outfall is approximately 1 m^3 per second (22.8 million gallons per day [mgd]) (Table 2) (Shuai et al. 2014). The average daily flow to the Honouliuli facility was 1.13 $m^3 s^{-1}$ (25.8 mgd) in 2012. This annual average is expected to rise to 1.7 $m^3 s^{-1}$ (39.6 mgd) by 2035 and to 1.95 $m^3 s^{-1}$ (44.4 mgd) by 2050 (AECOM 2010). The peak flow capacity of the Barbers Point Deep Ocean Outfall is 4.9 $m^3 s^{-1}$ (112 mgd).

Table 2. Current parameters at the Barbers Point Deep Ocean Outfall

Wastewater Treatment Plant	Average Flow Rate ($m^3 s^{-1}$)	Average Concentration of Total Suspended Solids (grams m^{-3})	Average Solid Loading Rate (grams s^{-1})
Honouliuli facility	0.99	44.7	44.2

Source: Shuai et al. (2014)

Under the current conditions, the effluent contains not only the primary treated sewage, but some fraction of secondary treated sewage (the amount depending on the export of recycled water (R-1 water) which is used for irrigation, from the Honouliuli facility to the Hawai‘i Water Recycling Facility [HWRF], as well as the brine byproduct of the reverse osmosis system used to produce R-O industrial freshwater supplied to customers).

If the water column at the site of the diffuser is stratified, which can occur in warmer summer months, the upper extent of the plume can be held below the surface, making it essentially invisible. In general, as submergence increases (i.e., the top of the plume is held further below the sea surface), diffusion decreases. In the design of the Barbers Point diffuser, high dilution was considered to be more important than submergence of the sewage field with the concomitant reduction in visual impact.

There are three stages in the hydrodynamic fate of the sewage plume from the diffuser. First, the effluent rises as a buoyant plume. This process is governed by the difference in density between the effluent and the ambient seawater. The second phase of transport is horizontal spreading. The direction and velocity are determined by the ocean currents integrated along the depth gradient where the plume occurs. Finally, turbulent mixing continually dilutes and disperses the effluent.

If flow in the outfall delivery pipe and the diffuser is too low, deposition of solids in the system occurs. This can partly be avoided in the design of the diffuser. The diameter of the diffuser is reduced along its length to maintain adequate velocity of the effluent as the volume is reduced by loss to the ocean. Also, deposition of solids in the system can be controlled by maintaining a minimum flow. If the flow to the diffuser pipe is 5 $m^3 s^{-1}$ (112 mgd), the velocity at the end of the diffuser pipe would be approximately 1.4 $m s^{-1}$ (4.5 feet per second [fps]), but if the total effluent flow fell to 1 $m^3 s^{-1}$ (23 mgd), the velocity at the end of the diffuser pipe would be only approximately 0.2 $m s^{-1}$ (0.7 fps).

At the other end of the flow spectrum is the ability of the system to handle high flows resulting from stormwater runoff. Peak 1-hour storm flow from a large (2-year recurrence interval) 6-hour storm for 2010 is projected to be 3.6 $m^3 s^{-1}$ (82.2 mgd). This would rise to 5 $m^3 s^{-1}$ (114 mgd) by 2035 and to 5.5 $m^3 s^{-1}$ (126 mgd) by 2050. The current design peak flow capacity for the system is 4.9 $m^3 s^{-1}$ (112 mgd).

The Barbers Point Deep Ocean Outfall currently discharges effluent partly comprising primary treated sewage. The City and County of Honolulu were required to obtain a Clean Water Act 301(h) waiver permit to allow this. As part of the maintenance of this permit, a continuous long-term monitoring study was required. This permit also covered three other wastewater treatment plants on O‘ahu, and the monitoring has been ongoing at these sites as well. A concern triggering the requirement for this monitoring program was that discharged organic particles might cause organic enrichment of the sediment near the diffuser and reduce biodiversity. Early studies of the sediments near the Barbers Point Deep Ocean Outfall show that benthic fluxes of dissolved nutrients in the zone of initial dilution (ZID) were higher than control areas in the 2 years of the study (1984 and 1985), and that organic flocs of sewage origin were seen within 50 m (164 feet) of the diffuser (Smith and Dollar 1987). However, when the biodiversity of the sediment infauna was assessed, there was no difference between samples from the ZID and the control sites, although the biomass of infaunal organisms was greater. To assure that the effects of the outfall were not increasing, a long-term monitoring program was initiated. This program samples the sediments at and near the outfalls and determines the diversity and abundance of polychaete worms, micromollusks, and crustaceans. These have been quantified for over 20 years. Additionally, samples of fishes near the discharge plumes have been monitored for pathologies. The data from these samples are stored in the U.S. Environmental Protection Agency’s Storet data storage system (EPA 2014), and annual summaries are available through the University of Hawai‘i Water Resources Research Center site (University of Hawai‘i at Manoa 2015). A more in-depth analysis of the polychaete results was recently published using samples taken from 1990 to 2010 (Shuai et al. 2014). The conclusions of the benthic sampling at the Barbers Point Deep Ocean Outfall is that there is more year-to-year variation at any one site than between the ZID and control sites.

In summary, the effects of the sewage effluent delivered to the ocean by the Barbers Point diffuser is negligible under the existing conditions, even though a substantial fraction of the effluent consists of primary treated sewage. The question of whether this might change under future conditions (elimination of primary treated effluent and increase volume) is addressed below. Tables 3 and 4 present the projected parameters for the Barbers point diffuser.

Table 3. Projections for the Barbers Point Diffuser (million gallons per day)

Flows MGD	**2000**	**2030**	**2150**
Dry weather infiltration	9.26 (0.41 $m^3 s^{-1}$)	13.29 (0.58 $m^3 s^{-1}$)	13.29 (0.58 $m^3 s^{-1}$)
Sanitary flow	19.64 (0.86 $m^3 s^{-1}$)	30.59 (1.34 $m^3 s^{-1}$)	45.73 (2.00 $m^3 s^{-1}$)
Sanitary flow peaking factor	2	2	2
WWI/I peak daily	12.52 (0.55 $m^3 s^{-1}$)	23.73 (1.04 $m^3 s^{-1}$)	23.73 (1.04) $m^3 s^{-1}$
WWI/I peak hourly	60.61 (2.66 $m^3 s^{-1}$)	108.41 (4.75 $m^3 s^{-1}$)	108.41 (4.75 $m^3 s^{-1}$)
Design Flows	**2000**	**2030**	**2150**
Average dry weather daily flow	28.90 (1.27) $m^3 s^{-1}$	43.88 (1.92 $m^3 s^{-1}$) $m^3 s^{-1}$	59.02 (2.59 $m^3 s^{-1}$)
Peak dry weather daily flow	48.54 (2.13 $m^3 s^{-1}$)	74.48 (74.48 $m^3 s^{-1}$)	104.76 (4.59 $m^3 s^{-1}$)
Average wet weather daily flow	41.42 (1.81 $m^3 s^{-1}$)	67.61 (2.96 $m^3 s^{-1}$)	82.76 (3.63 $m^3 s^{-1}$)
Peak wet weather daily flow	61.06 (2.68 $m^3 s^{-1}$)	98.21 (4.30 $m^3 s^{-1}$)	128.49 (5.63) $m^3 s^{-1}$
Peak wet weather hourly flow	109.15 (4.78 $m^3 s^{-1}$)	182.89 (8.01) $m^3 s^{-1}$	213.17 (9.33 $m^3 s^{-1}$)

Notes: Sanitary flow = average daily flow - dry weather infiltration; WWI/I = wet weather infiltration and inflow.

Note that neither this table, nor Table 4, presents projections of volume, composition, or density of effluent produced from the diffuser.

Table 4. Waste Load Projections for Average Conditions at Barbers Point Deep Ocean Outfall

Parameter	Biochemical Oxygen Demand	Total Suspended Solids
Concentration (mg/ml)	280	300
Present waste load coefficient	0.19	0.20
Waste load 2007 (pounds/day)	62,580	67,050
Waste load 2030 (pounds/day)	80,898	86,676
Waste load 2150 (pounds/day)	127,275	136,366

Source: M & E Pacific (2008).

Note that neither this table, nor Table 3, presents projections of volume, composition, or density of effluent produced from the diffuser.

The volume of secondary effluent being discharged would be expected to increase by the amount of projected flow minus the amount going to the HWRF. There is insufficient Information on how much more R-1 water the HWRF may plan to accept. The HWRF brine water along with excess R-1 and reverse osmosis (RO) water will continue to be discharged through the outfall. HWRF currently takes 0.57 $m^3 s^{-1}$ (13 mgd) each day, of that 0.043 $m^3 s^{-1}$ (1 mgd) would be discharged as brine. Upgrades or improvements to the HWRF were not included in the scope of work, and therefore it is not known how the amount or quality may change.

4. DISCUSSION AND RECOMMENDATIONS

4.1. Flora

No naturally occurring threatened or endangered plants were found during the survey. One individual of ma‘o hau hele was observed. Because of its presence in a maintained garden on historically disturbed land, this individual was likely cultivated then planted as an ornamental. Therefore, this plant is not considered to be of conservation value because it does not originate from a naturally occurring, wild population. For these reasons, there are no legal ramifications impeding its removal. Although the ‘Ewa area is within the historical range of the endangered ko‘oloa‘ula (*Abutilon menziesii*), the species is not known to have been recently documented in survey area (personal communication, Greg Mansker, Horticulturist, Hawai‘i Department of Land and Natural Resources, October 31, 2014) and has not been seen during recent surveys in the vicinity (AECOS 2010, 2011; SWCA 2012, 2013). Approximately 95% of the plant species seen during the survey are not native to Hawai‘i. The native species present are common throughout the Hawaiian Islands. Therefore, the proposed project is not expected to have a significant, adverse impact on native botanical resources.

The removal of native vegetation should be avoiding, if possible. Additionally, some plants may provide food or habitat for endangered species listed in the fauna section below. These species should be considered when removing vegetation. Removal of shade trees is permitted; however, removal of trees taller than 4.6 m (15 feet) should be avoided between June 1 and September 15 to avoid impacts to the endangered Hawaiian hoary bat.

SWCA recommends that native Hawaiian plants be employed for landscaping around the survey area to the maximum extent possible. Potential native species that may be appropriate for landscaping at the survey area include ko‘oloa‘ula, kou, ‘ilie‘e (*Plumbago zeylanica*), and ‘a‘ali‘i.

Additional information on selecting appropriate (non-invasive) plants for landscaping can be obtained from the following websites:

- http://www.nativeplants.Hawaii.edu/
- http://www.plantpono.org/non-invasive-plants.php
- http://www.hear.org/alternativestoinvasives/pdfs/mcaac_hpwra_a2i_list.pdf
- http://www.hear.org/oisc/oahuearlydetectionproject/pdfs/oedposterwhatnottoplant.pdf

4.2. Fauna

4.2.1. Federally Listed Species

No federally listed species were observed during the surveys; however, water features present in and near the survey area may attract the endangered Hawaiian stilt and other waterbirds. Additionally, Hawaiian hoary bats have been known to roost in vegetation observed in the survey area and could be present. The pueo could potentially be present within the survey area. The following recommendations could minimize impacts to waterbirds, pueo, and Hawaiian hoary bat.

Waterbirds

During construction, minor alterations of local topography in low-lying areas to prevent water from ponding could reduce attraction of Hawaiian stilt and other waterbirds. Additionally, the following best management practices would avoid and minimize impacts to the Hawaiian stilt and other waterbirds should they occur on-site before or during construction:

- In areas where Hawaiian waterbirds have been observed, nest searches will be conducted by a qualified biologist before work begins and after any subsequent delay in work of 3 or more days (during which birds may attempt nesting). Hawaiian stilts nest from middle February through late August, with variable peak nesting from year to year (Robinson et al. 1999).
- If a nest with eggs is discovered, work will cease within 46 m (150 feet) of the nest for a minimum of 70 days (10 weeks); if a nest with chicks is discovered, work will cease for a minimum of 49 days (7 weeks). These guidelines are intended to protect chicks, and may be shortened if monitoring is conducted often enough to note when chicks have fledged (usually 5–6 weeks after hatching). Work will not begin in the area until 2 weeks after chicks have fledged.
- If an endangered Hawaiian waterbird is found in the area during ongoing management activities, all activity within 15 m (50 feet) of the bird will cease; the bird will also not be approached within 15 m (50 feet). Work may continue after the bird leaves the area of its own accord.

Pueo

Suitable habitat for the state-listed pueo appears to be present in the survey area, so it is possible that they could be present. Mitigations measures can be taken to reduce disturbance to pueo. These include suspending work (particularly with machinery or vehicles) within 91 m (300 feet) of any area where distraction displays, vocalizations, or other indications of nesting by adult pueo are seen or heard, and only resume activity when it is apparent that the young have fledged or there is other confirmation that pueo nesting is no longer occurring. With these measures, there is not likely to be any adverse effect on the pueo.

Hawaiian hoary bats

Although the chances of adversely affecting Hawaiian hoary bats as a result of the proposed project are likely small, the following measures are recommended as a conservative impact avoidance measure:

- Any fences that are erected as part of the project should have barbless top-strand wire to prevent entanglements of the Hawaiian hoary bat on barbed wire. No fences in the survey area were observed with barbed wire during the survey; however, if fences are present, the top strand of barbed wire should be removed or replaced with barbless wire.
- No trees taller than 4.6 m (15 feet) should be trimmed or removed as a result of this project between June 1 and September 15, when juvenile bats that are not yet capable of flying may be roosting in the trees.

Implementation of these guidelines, which have been promulgated by the USFWS (1998), is expected to avoid all direct impacts to Hawaiian hoary bats.

4.2.2. Migratory Bird Treaty Act

SWCA observed the following four bird species federally protected under the MBTA during this survey: the cattle egret, Hawaiian duck–mallard hybrids, house finch (*Haemorhous mexicanus*), and Pacific golden-plover. Construction in the survey area may temporarily displace some of these bird species, but long-term impacts are not expected. These birds (likely limited to a few individuals) are expected to find suitable foraging habitat in nearby areas. The temporary displacement of these individuals in the survey area is not expected to affect an individual's survival or the overall species' populations. The Pacific golden-plover was the only species observed known to migrate from Hawai'i to elsewhere. However, its presence should not be of concern, because they do not nest in Hawai'i. It is expected that these birds would return when construction is complete; no long-term impacts are expected.

4.3. Aquatic and Marine Flora and Fauna

Surveys were not specifically conducted for rare, threatened, or endangered fauna found in streams or coastal waters; however based on literature review, it is not expected that the proposed project impact will have this species.

4.4. Aquatic Environment

Impacts to water quality from construction or operations at the Honouliuli facility and from the Barbers Point Deep Ocean Outfall may occur. During proposed construction, storm runoff can carry increased sediment into surface waters, potentially impacting water and benthic habitat quality at the margins of the estuary. Construction and ground disturbance should comply with the conditions of the Clean Water Act as well as HAR 11-54 and HAR 11-55. Permitting under the National Pollution Discharge Elimination System program may be required, which may include filing a notice of intent with DOH for general permit coverage for Stormwater Discharges Associated with Construction Activities (HAR 11-55 Appendix C), Discharges of Hydrotesting Waters (HAR 11-55 Appendix F), and Discharges Associated with Construction Activity Dewatering (HAR 11-55 Appendix G). During construction, the contractor should develop a stormwater pollution prevention plan (SWPPP) that complies with the Clean Water Act, HAR 11-54, and HAR 11-55, and that implement best management practices to minimize impacts to water quality in the Kaloi Gulch and other surface waters. Based on long-term studies, temporal differences in benthic organisms within sites are larger than between ZID and control sites, indicating that under current conditions, the effects of diffused effluent are negligible and will have no impact on coastal waters. Impacts to groundwater as a result of construction are unlikely to occur.

Upgrades at the Honouliuli facility will effect operations at the plant, resulting in increases in effluent flow volumes. Despite this increase in flow volumes, pollutant loading for biochemical oxygen demand (BOD) and total suspended solids (TSS) is expected to decrease as a result of upgrades from primary to secondary treatment; therefore, impacts to coastal waters should not be affected significantly. Groundwater and surface waters will not be impacted.

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APPENDIX A. CHECKLIST OF PLANT SPECIES OBSERVED AT HONOULIULI WASTEWATER TREATMENT FACILITY ON NOVEMBER 16, 2014

The following checklist is an inventory of all the plant species observed by the SWCA biologist on November 16, 2014, during surveys at the Honouliuli facility, on the Island of Oʻahu, Hawaiʻi. The plant names are arranged alphabetically by family and then by species into three groups: Gymnosperms, Monocots, and Dicots. The taxonomy and nomenclature are in accordance with Palmer (2003), Evenhuis and Eldredge (2011), Wagner et al. (1999), Wagner and Herbst (2003), and Staples and Herbst (2005). Recent name changes are those recorded in Wagner et al. (2012)..

Table Notes

Status:

E = endemic = native only to the Hawaiian Islands.
I = indigenous= native to the Hawaiian Islands and elsewhere.
P = Polynesian = introduced by Polynesians.
X =introduced/ alien = all those plants brought to the Hawaiian Islands by humans, intentionally or accidentally, after Western contact (Cook's arrival in the islands in 1778).

Relative Site Abundance:

A = Abundant = forming a major part of the vegetation within the survey area.
C = Common = widely scattered throughout the area or locally abundant within a portion of it.
U = Uncommon = scattered sparsely throughout the area or occurring in a few small patches.
R = Rare = only a few isolated individuals within the survey area.

Scientific Name	Common and Hawaiian Name(s)	Status	Honouliuli Facility	
			Manicured Lawn	Facility Expansion Site
GYMNOSPERMS				
Cupressaceae				
Juniperus sp.	juniper	X	R	
MONOCOT				
Aloaceae				
Aloe vera (L.) Burm.f.	aloe	X	R	R
Agavaceae				
Cordyline fruticosa (L.) A. Chev.	tī, kī	X	R	
Arecaceae				
Cocos nucifera L.	niu, ololani, coconut	P/I?	R	
Muscaceae				
Musa X paradisiaca L.	banana	X	R	
Poaceae				
Axonopus compressus (Sw.) Beauv.		X	R	

Scientific Name	Common and Hawaiian Name(s)	Status	Honouliuli Facility	
			Manicured Lawn	Facility Expansion Site
Bothriochloa pertusa (L.) A.Camus	pitted beardgrass	X	U	
Cenchrus ciliaris L.	buffelgrass	X	C	A
Cenchrus echinatus L.	common sand burr	X	C	
Chloris barbata Sw.	swollen fingergrass	X	U	
Chloris radiata (L.) Sw.	radiate fingergrass	X	U	
Cynodon dactylon (L.) Pers.	Bermuda grass	X	U	
Melinis repens (Willd.) Zizka	Natal redtop, Natal grass	X	U	
Paspalum conjugatum P.J.Bergius	Hilo grass	X	R	
Paspalum dilatatum Poir.	dallis grass	X	R	
Urochloa maxima (Jacq.) R. Webster	Guinea grass	X	C	A
DICOT				
Acanthaceae				
Asystasia gangetica (L.) T.Anderson	Chinese violet	X	U	
Amaranthaceae				
Alternanthera pungens Kunth	khaki weed	X	C	R
Alternanthera sessilis (L.) R.Br. ex DC.	sessile joyweed	X	U	
Amaranthus spinosus L.	spiny amaranth	X	U	R
Amaranthus viridis L.	slender amaranth, pakai	X	U	
Anacardiaceae				
Schinus terebinthifolius Raddi	Christmas berry, wilelaiki	X		UC
Apocynaceae				
Plumeria sp.	plumeria	X	R	
Asteraceae				
Bidens pilosa L.	Spanish needles			U
Calyptocarpus vialis Less.	nodeweed	X	U	
Dyssodia tenuiloba (DC.) B. L. Rob.	Dahlberg daisy	X	R	
Pluchea carolinensis (Jacq.) G. Don	sourbush, marsh fleabane	X		R
Sonchus oleraceus L.	sow thistle, pualele	X	R	
Synedrella nodiflora (L.) Gaertn.	nodeweed	X	U	
Tridax procumbens L.	coat buttons	X	C	
Verbesina encelioides (Cav.) Benth. & Hook.	golden crown-beard	X		
Boraginaceae				
Carmona retusa (Vahl) Masam.	Fukien tea tree, Philippine tea tree	X	R	
Cordia subcordata Lam.	kou	P/I?	R	
Heliotropium procumbens var. *depressum* (Cham.) Fosberg		X	R	
Capparaceae				
Cleome gynandra L.	cleome	X	R	

Scientific Name	Common and Hawaiian Name(s)	Status	Honouliuli Facility	
			Manicured Lawn	Facility Expansion Site
Chenopodiaceae				
Chenopodium murale L.	goosefoot, pigweed, lamb's quarters	X	R	
Convolvulaceae				
Ipomoea obscura (L.) Ker Gawl.	morning glory	X	U	
Ipomoea triloba L.	little bell	X	U	
Merremia aegyptia (L.) Urb.	hairy merremia, koali kua hulu	X	R	
Cucurbitaceae				
Cucumis dipsaceus Ehrenb. ex Spach	hedgehog gourd, teasel gourd	X	R	
Momordica charantia L.	balsam pear, bitter melon	X	U	R
Cuscutaceae				
Cuscuta campestris Yunck.	western field dodder	X		U
Euphorbiaceae				
Euphorbia hirta L.	hairy garden spurge	X	C	
Euphorbia hypericifolia (L.) Millsp.	graceful spurge	X	U	
Euphorbia hyssopifolia (L.) Small			R	
Euphorbia prostrata Aiton	Prostrate spurge	X	R	
Ricinus communis L.	castor bean	X	R	
Fabaceae				
Alysicarpus vaginalis (L.) DC.	buffalo clover	X	C	
Cassia fistula L.	golden shower tree	X	R	
Delonix regia (Bojer ex Hook.) Raf.	royal poinciana	X	R	
Desmodium tortuosum (Sw.) DC.	Florida beggarweed	X	R	
Leucaena leucocephala (Lam.) de Wit	koa haole	X	R	C
Macroptilium atropurpureum (DC.) Urb.		X	C	
Macroptilium lathyroides (L.) Urb.	wild bean, cow pea	X	C	
Prosopis pallida (Humb. & Bonpl. ex Willd.) Kunth	kiawe, algaroba, mesquite,	X		A
Pithecellobium dulce (Roxb.) Benth.	Manila tamarind, ʻopiuma	X	U	C
Senna alata (L.) Roxb.	candle bush	X	R	U
Samanea saman (Jacq.) Merr.	monkeypod, rain tree	X	A	
Lamiaceae				
Leonotis nepetifolia (L.) R. Br	lion's ear	X	R	C
Lecythidaceae				
Couroupita guianensis Aubl.	cannonball tree	X	R	
Malvaceae				
Abutilon grandifolium (Willd.) Sweet	hairy abutilon, maʻo	X	U	U
Hibiscus brackenridgei A. Gray	maʻo hau hele	E	R	
Hibiscus rosa-sinensis L.	Hibiscus	X	R	

Scientific Name	Common and Hawaiian Name(s)	Status	Honouliuli Facility	
			Manicured Lawn	Facility Expansion Site
Malva neglecta Wallr.	common mallow	X	R	
Malvastrum coromandelianum subsp. *coromandelianum* (L.) Garcke	false mallow	X	C	
Sida acuta Burm. f.		X	U	U
Sida ciliaris L.		X	R	
Sida rhombifolia L.		X	U	R
Moraceae				
Ficus microcarpa L. f.	Chinese banyan	X	R	
Nyctaginaceae				
Boerhavia coccinea Mill.	scarlet spiderling	X	U	
Passifloraceae				
Passiflora foetida	love-in-a-mist	X	R	
Solanaceae				
Caspsicum sp. L.	chili pepper	X	R	
Solanum melongena L.	eggplant	X	R	
Rubiaceae				
Gardenia jasminoides J. Ellis	common gardenia	X	R	
Rutaceae				
Citrus x limon	lemon	X	R	
Murraya paniculata (L.) Jack	mock orange	X	R	
Sapindaceae				
Dodonaea viscosa Jacq.	‘a‘ali‘i	I	R	
Sterculiaceae				
Waltheria indica L.	‘uhaloa	I	U	
Verbenaceae				
Vitex rotundifolia L. *f.*	hinahina, beach vitex	I	R	

Appendix C
Archaeological Assessment for the Honouliuli WWTP Secondary Treatment and Facilities Project, Cultural Surveys Hawai‘i, Inc. (CSH)
December 2015

Final

Archaeological Assessment for the Honouliuli Wastewater Treatment Plant (WWTP) Secondary Treatment and Facilities Project, Honouliuli Ahupua‘a, ‘Ewa District, O‘ahu TMK: [1] 9-1-013:007

Prepared for
AECOM Pacific, Inc.

Prepared by
Trevor M. Yucha, B.S.,
Joanne DeMaio Starr, M.A.,
David W. Shideler, M.A.,
and
Hallett H. Hammatt, Ph.D.

Cultural Surveys Hawai‘i, Inc.
Kailua, Hawai‘i
(Job Code: HONOULIULI 105)

December 2015

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Management Summary

Reference	Archaeological Assessment* for the Honouliuli Wastewater Treatment Plant (WWTP) Secondary Treatment and Facilities Project, Honouliuli Ahupua‘a, ‘Ewa District, O‘ahu TMK: [1] 9-1-013:007 (Yucha et al. 2015)
Date	December 2015
Project Number(s)	Cultural Surveys Hawai‘i, Inc. (CSH) Job Code: HONOULIULI 105
Investigation Permit Number	CSH completed the fieldwork component of this study under archaeological permit number 14-04, issued by the Hawai‘i State Historic Preservation Division (SHPD) per Hawai‘i Administrative Rules (HAR) §13-13-282.
Agencies	SHPD
Land Jurisdiction	City and County of Honolulu – Department of Environmental Services
Project Funding	City and County of Honolulu
Project Location	The project area is located immediately south of the ‘Ewa Villages in central Honouliulii Ahupua‘a in southwest O‘ahu and is bounded by Geiger Road on the south, Roosevelt Avenue on the south and west, Kalo‘i Gulch on the east, and the Oahu Railway and Land (OR&L) Right-of-Way on the north. The project area encompasses two adjacent recently consolidated parcels (TMKs: [1] 9-1-013:007 and the former TMK [1] 9-1-069:003) that have now been combined to comprise TMK: [1] 9-1-013:007. The project area includes the current heavily built-out waste water treatment plant and relatively undeveloped areas to the north and east of the facility. The project area is depicted on the 1998 Ewa and 1999 Pearl Harbor U.S. Geological Survey (USGS) 7.5-minute topographic quadrangles.
Project Description	The City and County of Honolulu is updating their West Mamala Bay Facilities Plan. This project proposes to upgrade and expand the existing Honouliuli WWTP to provide secondary treatment and accommodate projected wastewater flows. Regardless of which treatment alternative is selected, additional improvements at the Honouliuli WWTP are proposed for the following existing facilities: Central Laboratory, Ocean Team Facilities, Administration Building, Operations Building, Leeward Region Maintenance, Central Shops, Warehouse, Truck Wash, Process Supervisory Control and Data Acquisition, Septage Receiving Station, Odor Control, Groundskeeping, Janitorial Service and Security, and Honouliuli Water Recycling Facility. It will also address the potential siting of new facilities at the Honouliuli WWTP to help consolidate island-wide wastewater treatment services.

Project Acreage	The project area includes approximately 101.0 acres (40.9 ha). The 48.18 acre (19.50 hectare) northern and eastern relatively undeveloped portions of the project area (the former TMK [1] 9-1-069:003) was previously addressed an *Archaeological Assessment of the ʻEwa Industrial Park Project, Honouliuli Ahupuaʻa, ʻEwa District, Oʻahu Island*, (O'Hare et al. 2007) that was reviewed and accepted in an SHPD § 6E-42 Historic Preservation Review dated 10 February 2009 (LOG NO.: 2009.0664, DOC NO.: 0902WT22; included here as Appendix A) and the main, built-up area of the Honouliuli Wastewater Treatment Plant of approximately 52.82 acres (21.38 hectares) is newly addressed.
Historic Preservation Regulatory Context	The northern and eastern relatively undeveloped portions of the project area amounting to an area of 48.18 acres was the subject of an *Archaeological Assessment of the ʻEwa Industrial Park Project, Honouliuli Ahupuaʻa, ʻEwa District, Oʻahu Island*, (O'Hare et al. 2007) that was reviewed and accepted in an SHPD §6E-42 Historic Preservation Review dated 10 February 2009 (LOG NO.: 2009.0664, DOC NO.: 0902WT22; included here as Appendix A). The present study included a reconnaissance of the O'Hare et al. (2007) project area but only for the purpose of documenting present conditions. No historic properties were identified. The remaining southwestern portion of the project area including the heavily built-out wastewater treatment plant was subject to 100% pedestrian survey coverage during the current study. No historic properties were identified. This document was prepared to support the proposed project's historic preservation review under Hawaiʻi Revised Statutes (HRS) §6E-42 and HAR §13-13-284. In consultation with SHPD, the archaeological inventory survey investigation was designed to fulfill the State requirements for an archaeological inventory survey per HAR §13-13-276. Because no historic properties were identified within the project area, this investigation is termed an archaeological assessment. This study was revised to address requested revisions to a November 2014 draft supplied in a Chapter 6E-8 Historic Preservation Review dated October 22, 2015 (LOG. NO. 2014.05307, DOC. NO. 1509AEM02)
Fieldwork Effort	Fieldwork was accomplished on 24 October 2014 by Trevor Yucha, B.S. and David W. Shideler, M.A. under the general supervision of Principal Investigator, Hallett H. Hammatt Ph.D. This work required approximately 1 person-day to complete.
Number of Historic Properties Identified	None

Effect Recommendation	No historic properties were identified within the approximately 100-acre project area. Consequently, CSH’s effect recommendation for the proposed project is “no historic properties effected.”
Mitigation Recommendations	No further cultural resource management work is recommended for the current project.

* CSH completed an archaeological inventory survey, which due to the lack of historic properties is reported as an archaeological assessment.

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Section 1 Introduction

1.1 Project Background

At the request of AECOM Pacific, Inc., Cultural Surveys Hawai‘i, Inc. (CSH) completed an archaeological inventory survey, which due to the lack of historic properties is reported as an archaeological assessment for the Honouliuli Wastewater Treatment Plant (WWTP) Secondary Treatment and Facility, Honouliuli Ahupua‘a, ‘Ewa District, O‘ahu TMK: [1] 9-1-013:007.

The project area is located immediately south of the ‘Ewa Villages in central Honouliulii Ahupua‘a in southwest O‘ahu and is bounded by Geiger Road on the south, Roosevelt Avenue on the south and west, Kalo‘i Gulch on the east, and the Oahu Railway and Land (OR&L) Right-of-Way on the north. The project area encompasses two adjacent recently consolidated parcels (TMKs: [1] 9-1-013:007 and the former TMK [1] 9-1-069:003) that have now been combined to comprise TMK: [1] 9-1-013:007. The project area includes the current heavily built-out waste water treatment plant and relatively undeveloped areas to the north and east of the facility. The project area is depicted on the 1998 Ewa and 1999 Pearl Harbor U.S. Geological Survey (USGS) 7.5-minute topographic quadrangles (Figure 1), tax map plats (Figure 2 and Figure 3), and a 2013 aerial photograph (Figure 4).

Of this 101.0 acre (40.9 ha) project area, the 48.18 acre (19.50 hectare) northern and eastern relatively undeveloped portions of the project area (the former TMK [1] 9-1-069:003) was previously addressed an *Archaeological Assessment of the ‘Ewa Industrial Park Project, Honouliuli Ahupua‘a, ‘Ewa District, O‘ahu Island*, (O’Hare et al. 2007) that was reviewed and accepted in an SHPD § 6E-42 Historic Preservation Review dated 10 February 2009 (LOG NO.: 2009.0664, DOC NO.: 0902WT22; included here as Appendix A) and the main, built-up area of the Honouliuli Wastewater Treatment Plant of approximately 52.82 acres (21.38 hectares) is newly addressed.

The City and County of Honolulu is updating their West Mamala Bay Facilities Plan. This project proposes to upgrade and expand the existing Honouliuli WWTP to provide secondary treatment and accommodate projected wastewater flows. Regardless of which treatment alternative is selected, additional improvements at the Honouliuli WWTP are proposed for the following existing facilities: Central Laboratory, Ocean Team Facilities, Administration Building, Operations Building, Leeward Region Maintenance, Central Shops, Warehouse, Truck Wash, Process Supervisory Control and Data Acquisition, Septage Receiving Station, Odor Control, Groundskeeping, Janitorial Service and Security, and Honouliuli Water Recycling Facility. The project will also address the potential siting of new facilities at the Honouliuli WWTP to help consolidate island-wide wastewater treatment services.

1.2 Historic Preservation Regulatory Context

The northern and eastern relatively undeveloped portions of the project area amounting to an area of 48.18 acres was the subject of an *Archaeological Assessment of the ‘Ewa Industrial Park Project, Honouliuli Ahupua‘a, ‘Ewa District, O‘ahu Island*, (O’Hare et al. 2007) that was reviewed and accepted in an SHPD §6E-42 Historic Preservation Review dated 10 February 2009 (LOG NO.: 2009.0664, DOC NO.: 0902WT22; included here as Appendix A). The present study

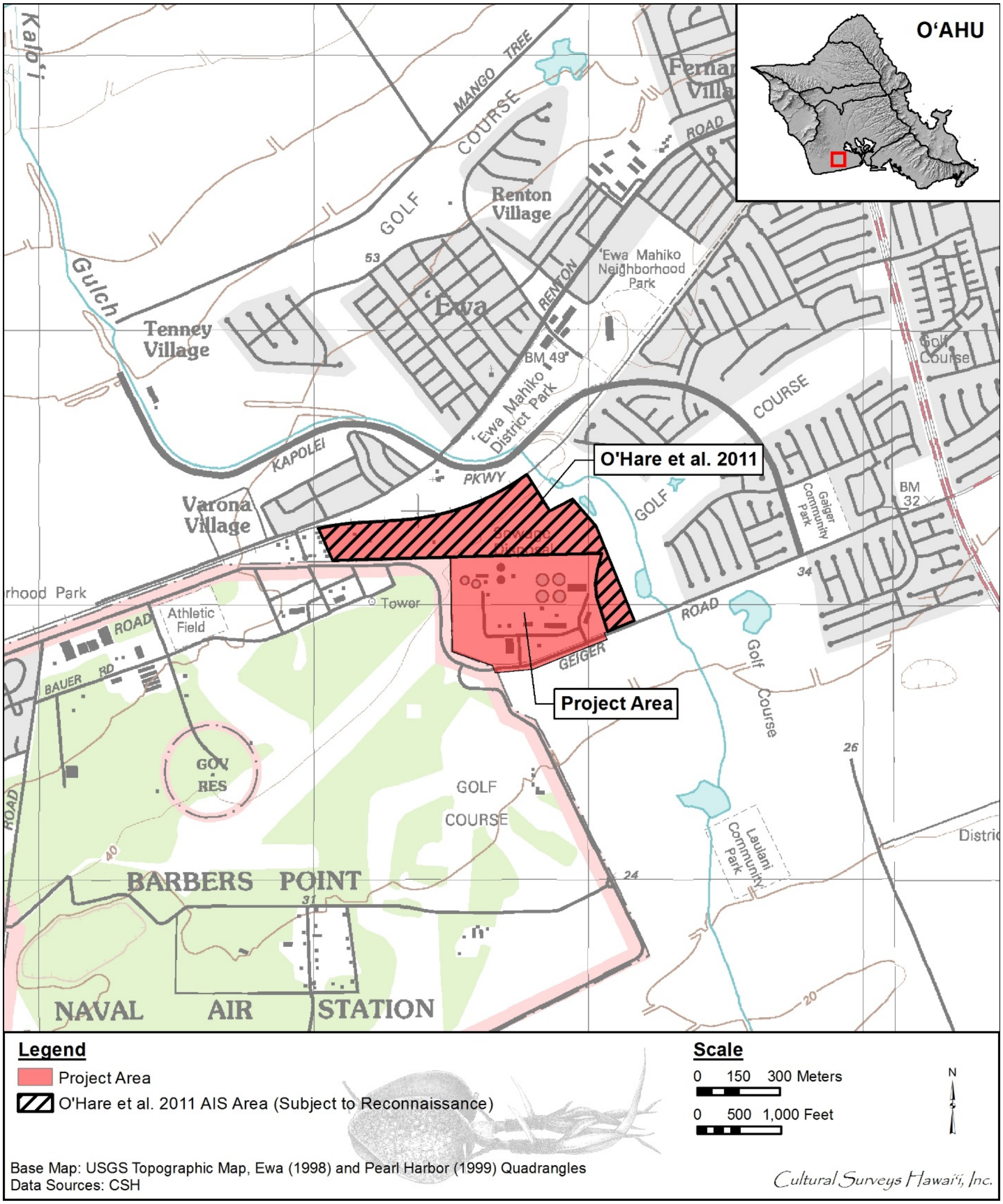

Figure 1. Portion of the 1998 Ewa and 1999 Pearl Harbor USGS 7.5-minute topographic quadrangles showing the location of the project area

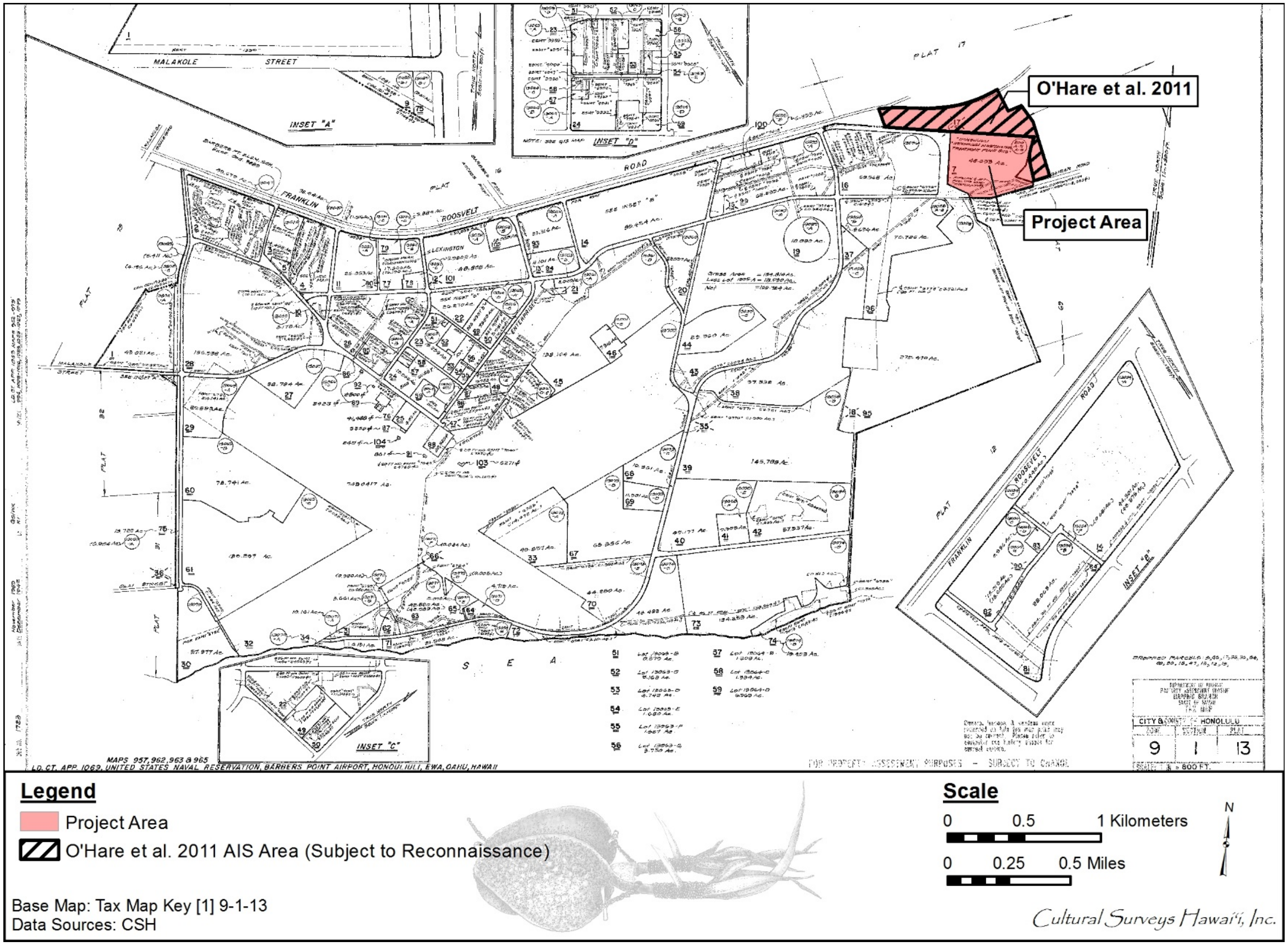

Figure 2. Tax Map Key (TMK) [1] 9-1-013 showing project area

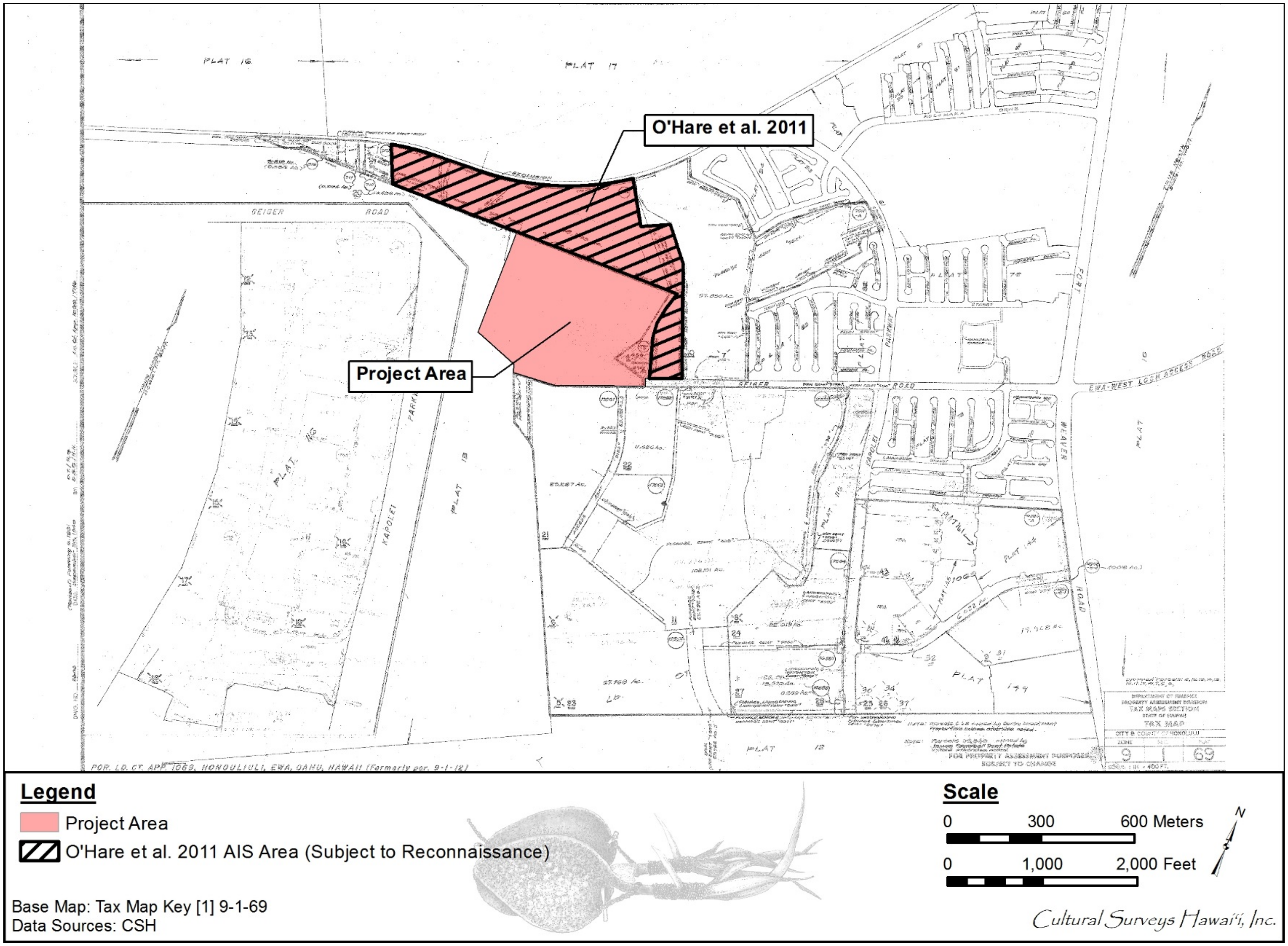

Figure 3. TMK: [1] 9-1-069 showing project area

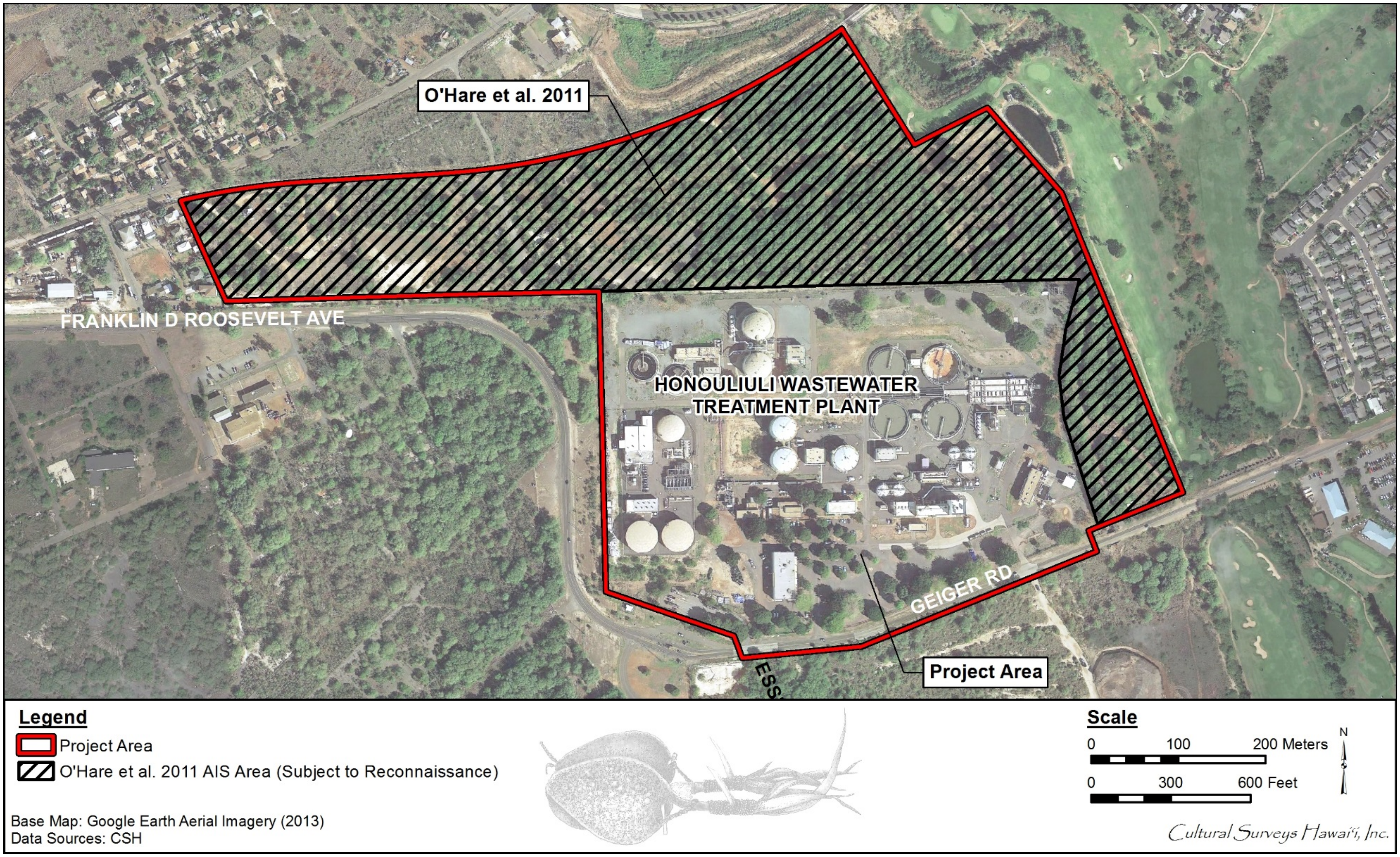

Figure 4. 2013 aerial photograph showing project area (Google Earth 2013)

included a reconnaissance of the O'Hare et al. (2007) project area but only for the purpose of documenting present conditions. No historic properties were identified.

The remaining southwestern portion of the project area including the heavily built-out wastewater treatment plant was subject to 100% pedestrian survey coverage during the current study. No historic properties were identified.

This document was prepared to support the proposed project's historic preservation review under Hawaiʻi Revised Statutes (HRS) §6E-42 and Hawaiʻi Administrative Rules (HAR) §13-13-284. In consultation with SHPD, the archaeological inventory survey investigation was designed to fulfill the State requirements for an archaeological inventory survey per HAR §13-13-276.Because no historic properties were identified within the project area, this investigation is termed an archaeological assessment.

1.3 Environmental Setting

1.3.1 Natural Environment

Honouliuli Ahupuaʻa is the largest traditional land unit on Oʻahu, extending from the West Loch of Pearl Harbor in the east, to the border of Nānākuli Ahupuaʻa at Pili o Kahe in the west. Honouliuli Ahupuaʻa includes approximately 19 km, or 12 miles, of open coastline from Oneʻula westward to Pili o Kahe. The *ahupuaʻa* (land division) extends *mauka* (inland) from West Loch nearly to Schofield Barracks in Wahiawā. The western boundary is the Waiʻanae Mountain crest running north as far as Puʻu Hāpapa (or to the top of Kaʻala Mountain, according to some).

Not only is there a long coastline fronting the normally calm waters of leeward Oʻahu, but there are also 4 miles of waterfront along West Loch.

The project area is located on the ʻEwa Plain, which is a Pleistocene (>38,000 years old) reef platform overlain by alluvium from the southern end of the Waiʻanae Mountain Range. The land immediately *mauka* of the Pacific coast consists of a flat karstic raised limestone reef forming a level nearly featureless "desert" plain marked in pre-Contact times (previous to alluviation caused by sugar cultivation) by a thin or non-existent soil mantle. The microtopography is notable for containing countless sinkholes in some areas caused by chemical weathering (dissolution) of the limestone shelf.

Along the eastern flank of the Waiʻanae Mountains, numerous gulches have contributed to the alluvial deposits over the coastal limestone shelf. The largest of the gulches is Honouliuli Gulch, which drains into West Loch. The gulches are generally steep-sided in the uplands and generally of a high gradient until they emerge onto the flat ʻEwa plain. The alluvium they have carried has spread out in delta fashion over the *mauka* portions of the plain, which comprises a dramatic depositional environment at the stream gradient change. These gulches are generally dry, but during seasonal Kona storms carry immense quantities of runoff onto the plain and into the ocean. As typical drainages in arid slopes, they are either raging uncontrollably, or are dry and, as such, do not form stable water sources for traditional agriculture in their upper reaches. The Honouliuli gulches generally do not have valleys suitable for extensive irrigated agriculture; however, this lack is more than compensated for by the rich watered lowlands near West Loch

Lying in the lee of the Waiʻanae mountain range, the project area is one of the driest areas of Oʻahu with most of the area averaging about 18 inches of rainfall annually (Juvik and Juvik

1998:56). Temperatures range between 60° to 90°F through the year; the highest temperatures are in August and September (Armstrong 1973). Elevation in the project area ranges from 30-50 ft, or 10 to 15 m AMSL (above mean sea level).

The distance from the coast (and generally from fresh water) made these little used areas in the pre-Contact period. The intensive land disturbance of a century of commercial cane cultivation probably removed most of what little evidence of pre-Contact use there ever was. The archaeological sensitivity of these areas is generally regarded as low.

In pre-Contact Hawaiʻi, the project area would have been mostly lowland dry shrub and grassland, dominated by species such as *wiliwili* (*Erythrina sandwicensis*), *lama* (*Diospyros ferrea*), sandalwood (*Santalum* sp.), *ʻaʻaliʻi* (*Dodonea eriocarpa*), scrub *ʻōhiʻa* (*Metrosideros collina*) and *pili* grass (*Heteropogon contortus*) (Cuddihy and Stone 1990:12-15). In contrast, the non-cleared portions of the project area are currently dominated by introduced species such as *kiawe* and the prickly Lions Ear (*Leonotis nepaetaefolia*).

According to the U.S. Department of Agriculture (USDA) Soil Survey Geographic (SSURGO) database (2001) and soil survey data gathered by Foote et al. (1972), soils within the project area primarily consist of Mamala stony silty clay loam, 0 to 12% slopes (MnC) with Ewa silty clay loam, moderately shallow, 0 to 2% slopes (EmA), Honouliuli clay, 0 to 2% slopes (HxA), and Waialua silty clay, 0 to 3% slopes (WkA) within the southeast corner (Figure 5).

Soils of the Mamala Series are described as follows:

> This series consists of shallow, well-drained soils along the coastal plains in the islands of Oahu and Kauai. These soils formed in alluvium deposited over coral limestone and consolidated calcareous sand. They are nearly level to moderately sloping. Elevations range from nearly sea level to 100 feet on Oahu but extend to 850 feet on Kauai. The annual rainfall amounts to 18 to 25 inches, most of which occurs between November and April. [Foote et al. 1972:93]

Soils of the Ewa Series are described as follows:

> This series consists of well-drained soils in basins and on alluvial fans on the islands of Maui and Oahu. These soils developed in alluvium derived from basic igneous rock. They are nearly level to moderately sloping. Elevations range from near sea level to 150 feet. The annual rainfall amounts to 10 to 30 inches. Most of it occurs between November and April. [Foote et al. 1972:29]

Soils of the Honouliuli Series are described as follows:

> This series consists of well drained soils on coastal plains on the island of Oahu in the Ewa area. These soils developed in alluvium derived from basic igneous material. They are nearly level and gently sloping. Elevations range from 15 to 125 feet. The annual rainfall amounts to 18 to 30 inches and occurs mainly between November and April. [Foote et al 1972:43]

Soils of the Waialua Series are described as follows:

> This series consists of moderately well drained soils on alluvial fans on the island of Oahu. These soils developed in alluvium weathered from basic igneous rock.

> They are nearly level to steep. Elevations range from 10 to 100 feet. The annual rainfall amounts to 25 to 50 inches; most of it occurs between November and April. [Foote et al. 1972:128]

This alluvium supported commercial sugar cane cultivation for over a century.

The project area lies on sedimentary deposits (Holocene and Pleistocene caprock) within the designated Southern Oahu Regional Aquifer System with ground-water flow to the SSW (Hunt 1996:B3, B33, B42). A review of historic maps shows the Kalo‘i Gulch natural drainage way arcing around the project area to the east but historic maps (see Figure 8 and Figure 11 through Figure 13) often show Kalo‘i Gulch as having no clear origin or clear end point. This may be accounted for by Hunt's comment that:

> The permeability of calcareous rocks commonly is moderate to very high and results from primary depositional textures, as well as from development of secondary porosity by solution. (Hunt 1996:B-26).

Do to this relatively high permeability Kalo‘i Gulch was not a well-developed surface drainage.

1.3.2 Built Environment

The southern portion of the project area is currently occupied by the Honouliuli Wastewater Treatment Plant and facilities. The northern portion of the project area is currently located in vacant land. The project area is bordered by the OR&L ROW to the north, Geiger Road on the south, Kalo‘i Gulch on the east, and Roosevelt Avenue on the south and west.

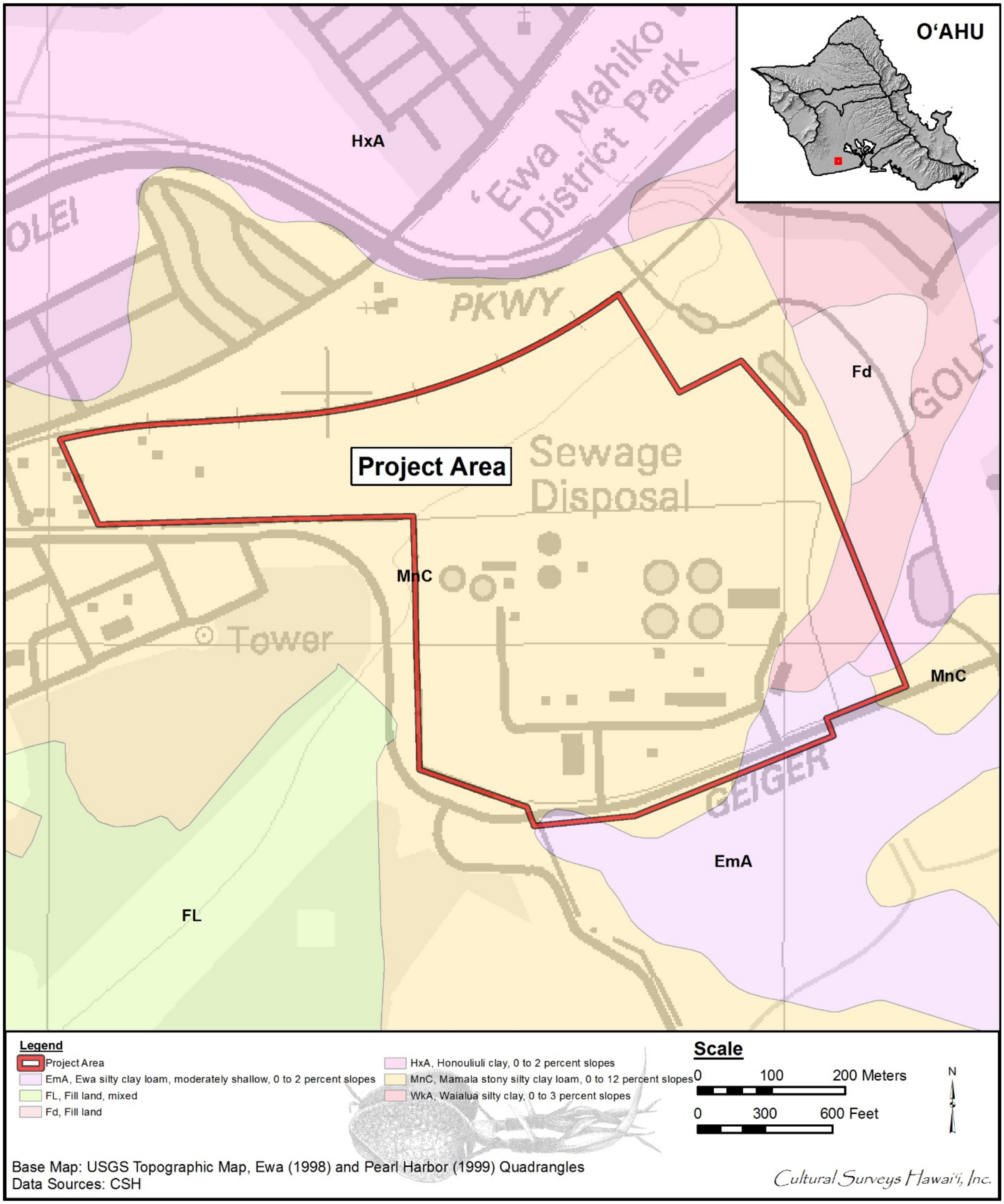

Figure 5. Overlay of a soil survey of the State of Hawaiʻi (U.S. Department of Agriculture 2001) indicating sediment types within and surrounding the current project area

Section 2 Methods

2.1 Methods Used to Address the Two Different Areas of the Project

The northern and eastern relatively undeveloped portions of the project area (formerly designated TMK [1] 9-1-069:003) amounting to an area of 48.18 acres (19.50 hectares) was the subject of an *Archaeological Assessment of the ʻEwa Industrial Park Project, Honouliuli Ahupuaʻa, ʻEwa District, Oʻahu Island, TMK: (1) 9-1-069:003* (O'Hare et al. 2007) that was reviewed and accepted in an SHPD §6E-42 Historic Preservation Review dated 10 February 2009 (LOG NO.: 2009.0664, DOC NO.: 0902WT22; included here as Appendix A). The present study included a further reconnaissance of the O'Hare et al. (2007) project area but only for the purpose of documenting present conditions. No historic properties were identified.

The previously unsurveyed built-up area of the Honouliuli Wastewater Treatment Plant of approximately 52.82 acres (21.38 hectares) is newly addressed and was subject to the field methods and literature and map review described below.

2.2 Field Methods

2.2.1 Pedestrian Inspection

CSH completed an archaeological inventory survey, which due to the lack of historic properties is reported as an archaeological assessment. The fieldwork was carried out under archaeological research permit number 14-04, issued by the Hawaiʻi SHPD per HAR §13-13-282. Fieldwork was accomplished on 24 October 2014 by Trevor Yucha, B.S. and David W. Shideler, M.A. under the general supervision of Principal Investigator, Hallett H. Hammatt Ph.D. This work required approximately 1 person-day to complete.

Fieldwork included a pedestrian inspection of the entire project area, GPS data collection, and general documentation. The remaining southwestern portion of the project area including the heavily built-out wastewater treatment plant was subject to 100% pedestrian survey coverage during the current study. Because of the extensive infrastructure of the operating wastewater treatment plant standard, parallel, pedestrian sweeps were not possible. Rather the archaeologists attempted to investigate all portions of the facility that were not built upon by walking around the existing infrastructure (see Figure 16 in the Section 4 Results of Fieldwork section). No historic properties were identified.

General documentation included general view photographs of the project area, notes, a track log taken (see Figure 16) with a Garmin model GPSMAP 60CSx with an accuracy: +/- 3-5 m and a photographic log.

2.2.2 Rationale for No Subsurface Testing

Background research produced no evidence of traditional Hawaiian use of the project area which is far from the sea or perennial streams in an area of low rainfall. Field inspection indicated very extensive land disturbance associated with the construction of the existing WWTP.

2.3 Literature and Map Review

Background research included a review of previous archaeological studies on file at the 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 Bishop Museum Archives; study of historic photographs at the Hawaiʻi State Archives and the Bishop Museum Archives; 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 from the Waihona ʻAina database (Waihona ʻAina 2000) were examined.

This research provided the environmental, cultural, historic, and archaeological background for the project area. The sources studied were used to formulate a predictive model regarding the expected types and locations of historic properties in the project area.

Section 3 Background Research

3.1 Traditional and Historical Background

Hawaiians recognize several land divisions in varying scales, including the *moku* (district or island), the *kalana* (smaller land division than a *moku*), the *ahupuaʻa* (land division usually extending from the uplands to the sea), and the *ʻili* (smaller land divisions within an *ahupuaʻa*) (Malo 1976:16). S.K. Kuhano wrote in 1873 (cited in Kameʻeleihiwa 1992:330) that Oʻahu was divided into six *kalana* (although later scholars refer to these same divisions as *moku*)—Kona, ʻEwa, Waiʻanae, Waialua, Koʻolau Loa and Koʻolau Poko—that were further divided into 86 *ahupuaʻa*. Within ʻEwa, there were 12 *ahupuaʻa* including (from west to east) Honouliuli, Hōʻaeʻae, Waikele, Waipiʻo, Waiawa, Mānana, Waimano, Waiau, Waimalu, Kalauao, ʻAiea, and Hālawa (Kameʻeleihiwa 1992:330). Modern maps and land divisions still generally follow the ancient system and use the same land divisions.

ʻEwa is depicted as an abundant and populated land where chiefs of distinguished lineages were born and resided (Cordy 1996:1-6). The land was fertile and well fed by mountain streams that helped sustain the agricultural lifestyle needed to support the chiefs, their households, and their people. An examination of place names reveals that water was a very important factor in this *moku*. Six of the 12 *ahupuaʻa* in ʻEwa Moku—Waikele, Waipiʻo, Waiawa, Waimano, Waiau, and Waimalu— begin with *wai*, the Hawaiian word for water. The fact that there were so many fishponds in ʻEwa, more than any other *moku* on Oʻahu, indicates agricultural and aquacultural intensification was a direct link to the chiefs who resided there and to the increasing needs of the population.

One translation of the name for this district is given as "unequal" (*Saturday Press*, 11 August 1883). Others translate the word as "strayed" and associate it with the legends of the gods, Kāne and Kanaloa.

> When Kane and Kanaloa were surveying the islands they came to Oahu and when they reached Red Hill saw below them the broad plains of what is now Ewa. To mark boundaries of the land they would throw a stone and where the stone fell would be the boundary line. When they saw the beautiful land lying below them, it was their thought to include as much of the flat level land as possible. They hurled the stone as far as the Waianae range and it landed somewhere in the Waimanalo section. When they went to find it, they could not locate the spot where it fell. So Ewa (strayed) became known by the name. The stone that strayed. [Told to E.S. by Simeon Nawaa, 22 March 1954 in Sterling and Summers 1978:1]

Honouliuli is the largest *ahupuaʻa* in the *moku* of ʻEwa. The name Honouliuli means "dark water," "dark bay," or "blue harbor" (Pukui et al. 1974:51) and was named for the waters of Pearl Harbor (Jarrett 1930:22), which marks the eastern boundary of the *ahupuaʻa*. The Hawaiians called Pearl Harbor, Puʻuloa (*lit*. long hill). Another explanation for the names comes from the "Legend of Lepeamoa," the chicken-girl of Pālama. In this legend, Honouliuli is the name of the husband of the chiefess Kapālama and grandfather of Lepeamoa. The land district Honouliuli was named for the grandfather of Lepeamoa (Westervelt 1923:164-184).

3.1.1 *Moʻolelo* (Stories) of ʻEwa

The *moʻolelo* (stories) of ʻEwa invoke the deep Hawaiian past. Some *moʻolelo* make connections with Kahiki, the traditional homeland of Hawaiians in central Polynesia. Most notably, the chief Kahaʻi left from Kalaeloa (coastal area in Honouliuli Ahupuaʻa) for a trip to Kahiki, and on his return to the Hawaiian Islands, brought back the first breadfruit (Kamakau 1991a:110) and planted it near the waters of Puʻuloa (long hill), now known as Pearl Harbor (Beckwith 1940:97). In addition, several *moʻolelo* associate places in ʻEwa with the gods Kāne and Kanaloa, the pig god Kamapuaʻa, the Hina family, and with the sisters of the Hawaiian volcano goddess Pele, all of whom have strong connections with Kahiki (Kamakau 1991a:111; Pukui et al. 1974:200).

ʻEwa literally means "crooked" or "unequal" (Pukui and Elbert 1986:42). Others interpret it as "strayed" in association with a story about the gods Kāne and Kanaloa, who threw a stone to determine the boundary of the district (see previous section).

3.1.2 *Moʻolelo* (Stories) of Honouliuli

3.1.2.1 The Coastal Plains of Kaupeʻa and Puʻuokapolei

Puʻuokapolei was the primary landmark for travelers on the cross-*ahupuaʻa* trail that ran from Pearl Harbor in the east to Waiʻanae in the west (ʻĪʻī 1959:27, 29; Nakuina 1992:54; E.M. Nakuina 1904 in Sterling and Summers 1978:34). The plain southwest of the hill was called Kaupeʻa.

3.1.2.2 Puʻuokapolei, Astronomical Marker and Heiau

Puʻu means hill and Kapolei means "beloved Kapo," a reference to the sister of the Hawaiian volcano goddess, Pele. Samuel Kamakau (1976:14) says that ancient Hawaiians used Puʻuokapolei as an astronomical marker to designate the seasons.

> [T]he Oʻahu people who reckoned the time (*Oahu pōʻe helu*) called the season Kau for the setting of the sun from Puʻuokapolei, a hill in Honouliuli, ʻEwa, to the opening of Mahinaona (*i ke kawaha o Mahinaona*). When the sun moved south from Puʻuokapolei—and during the season of the sun in the south—for the coming of coolness and for the sprouting of new buds on growing things—the season was called Hoʻoilo [winter, rainy, season]. [Kamakau 1976:14]

A *heiau* was once on Puʻuokapolei, but had been destroyed by the time of McAllister's (1933:108) survey of the island in the early 1930s. The hill was used as a point of solar reference or as a place for making astronomical observations (Fornander 1919:4(2):292). Puʻuokapolei may have been regarded as the gate of the setting sun, just as Kumukahi in Puna is regarded as the eastern gate of the rising sun; both places are associated with the Hawaiian goddess Kapo (Emerson 1993:41). This somewhat contradicts other Hawaiian cosmologies, in which Kū was the god of the rising sun and Hina, the mother of Kamapuaʻa, was associated with the setting sun. Fornander (1919:4(2):292) states that Puʻuokapolei may have been a jumping off place (also connected with the setting sun) and associated with the wandering souls who roamed the plains of Kaupeʻa and Kānehili, *makai* (inland) of the hill.

3.1.2.3 Puʻuokapolei and Kamapuaʻa

Puʻuokapolei was the home of Kamapuaʻa's grandmother, Kamaunuaniho, one of the three migrants from Kahiki that were ancestors to the people of Oʻahu (Fornander 1919:5(2):318; Kahiolo 1978:81, 107). Kamapuaʻa, the Hawaiian pig god, once lived in Kaluanui on the windward side of Oʻahu, but he escaped to ʻEwa when he was pursued by the chief Olopana.

> Kamapuaʻa subsequently conquered most of the island of Oʻahu, and, installing his grandmother [Kamaunuaniho] as queen, took her to Puʻuokapolei, the lesser of the two hillocks forming the southeastern spur of the Waiʻanae Mountain Range, and made her establish her court there. This was to compel the people who were to pay tribute to bring all the necessities of life from a distance, to show his absolute power over all. [Nakuina 1904:50-51]

Emma Nakuina goes on to note: "A very short time ago [prior to 1904] the foundations of Kamaunuaniho's house could still be seen at Puʻuokapolei." Another account (*Ka Loea Kālaiʻāina* 13 January 1900 in Sterling and Summers 1978:34) speaks of Kekeleaiku, the older brother of Kamapuaʻa, who also lived on Puʻuokapolei.

3.1.2.4 Puʻuokapolei and the Plains of Kaupeʻa and Kānehili

Pele's sister Hiʻiaka sang this bitter chant addressed to Lohiau and Wahine-ʻōmaʻo, which uses the association of the Plains of Kaupeʻa as a place for the wandering of lost souls:

> *Kuʻu aikana i ke awa lau o Puʻuloa,*
> *Mai ke kula o Peʻe-kaua, ke noho oe,*
> *E noho kaua e kui, e lei i ka pua o ke kaunoʻa,*
> *I ka pua o ke akuli-kuli, o ka wili-wili;*
> *O ka ihoʻna o Kau-peʻe i Kane-hili,*
> *Ua hili au; akahi no ka hili o ka la pomaikaʻi;*
> *E Lohiau ipo, e Wahine-omaʻo,*
> *Hoe ʻa mai ka waʻa i aʻe aku au.*
>
> We meet at Ewa's leaf-shaped lagoon, friends;
> Let us sit, if you will on this lea
> And bedeck us with wreaths of Kaunoʻa,
> Of *akuli-kuli* and *wili-wili*,
> My soul went astray in this solitude;
> It lost the track for once, in spite of luck,
> As I came down the road to Kau-peʻa.
> No nightmare dream was that which tricked my soul.
> This way, dear friends; turn the canoe this way;
> Paddle hither and let me embark.
> [Emerson 1993:162-163]

Several other Honouliuli places are mentioned in this chant, including Peʻe-kaua, which may be a variation of Kau-peʻe or Kaupeʻa, and the plains of Kānehili, the last of which again refers to wandering, as the word *hili* means "to go astray" (Emerson 1993:162). In the chant, Hiʻiaka is moving downhill from Kaupe‘a, probably the plains adjacent to Pu‘uokapolei, toward the coast, the plain of Kānehili.

3.1.2.5 The Plains of Kaupe‘a, Pu‘uokapolei, and the Realm of Homeless Souls

There are several places on the ‘Ewa coastal plain associated with *ao kuewa*, the realm of the homeless souls. Samuel Kamakau (1991b:47-49) explains Hawaiian beliefs in the afterlife:

> There were three realms (*ao*) for the spirits of the dead. . . . There were, first, the realm of the homeless souls, the *ao kuewa*; second, the realm of the ancestral spirits, the *ao ‘aumakua*; and third, the realm of Milu, *ke ao o Milu* . . . [Kamakau 1991b:47-49]

The *ao kuewa*, the realm of homeless souls, was also called the *ao ‘auwana*, the realm of wandering souls. When a man who had no rightful place in the *‘aumakua* realm (*kanaka kuleana ‘ole*) died, his soul would wander about and stray amongst the underbrush on the plain of Kama‘oma‘o on Maui, or in the *wiliwili* grove of Kaupe‘a on O‘ahu. If his soul came to Leilono (in Hālawa, ‘Ewa near Red Hill), there he would find the breadfruit tree of Leiwalo, *ka‘ulu o Leiwalo*. If it was not found by an *‘aumakua* soul who knew it (*i ma‘a mau iaia*), or one who would help it, the soul would leap upon the decayed branch of the breadfruit tree and fall down into endless night, *the pō pau ‘ole o Milu*. Or, a soul that had no rightful place in the *‘aumakua* realm, or who had no relative or friend (*makamaka*) there “who would watch out for it and welcome it, would slip over the flat lands like a wind, until it came to a leaping place of souls, a *leina a ka ‘uhane*. . . . “ (Kamakau 1991b:47).

> On the plain of Kaupe‘a beside Pu‘uloa [Pearl Harbor], wandering souls could go to catch moths (*pulelehua*) and spiders (*nanana*). However, wandering souls could not go far in the places mentioned earlier before they would be found catching spiders by *‘aumakua* souls, and be helped to escape. [Kamakau 1991b:49]

The breadfruit tree Leilono was said to have been located on the ‘Ewa-Kona border, above Āliamanu. In another section of his account of the dead, Kamakau (1991b:29) calls the plain of wandering souls the “plain at Pu‘uokapolei.”

> There are many who have died and have returned to say that they had no claim to an *‘aumakua* [realm] (*kuleana‘ole*). These are the souls, it is said, who only wander upon the plain of Kama‘oma‘o on Maui or on the plain at Pu‘uokapolei on Oahu. Spiders and moths are their food. (Kamakau 1991b:29)

This association of Pu‘uokapolei and Kānehili with wandering souls is also illustrated in a lament on the death of Kahahana, the paramount chief of O‘ahu, who was killed by his foster father, the Maui chief Kahekili, after Kahahana became treacherous and killed the high priest Ka‘opulupulu.

E newa ai o hea make i ka la,	Go carefully lest you fall dead in the sun,
Akua noho la i Puuokapolei.	The god that dwells on Kapolei hill
E hanehane mai ana ka la i na wahine o Kamao,	The sun is wailing on account of the women of Kamao,
Akua pee,	A hiding god, blossoming
pua ohai o ke kaha,	*ohai* of the banks,

I walea wale i ke a-	Contented among the stones—
I ka ulu kanu a Kahai.	Among the breadfruit planted by Kahai.
Haina oe e ka oo—	Thou wast spoken of by the *oo*—
E ka manu o Kanehili.	By the bird of Kanehili.
[Fornander 1919:6(2):297]	

Fornander provides some notes on this lament. The god dwelling at Kapolei is Kahahana, stating that this is where his soul has gone. Kamao is one of the names of the door to the underworld. This lament draws an association with wandering souls and the place where the first breadfruit tree was planted by Kahaʻi at Puʻuloa (Fornander 1919:6(2):304).

Pukui (1983:180) offers this Hawaiian saying, which places the wandering souls in a *wiliwili* grove at Kaupeʻa.

Ka wiliwili of Kaupeʻa. The *wiliwili* grove of Kaupeʻa.
In ʻEwa, Oʻahu. Said to be where homeless ghosts wander among the trees.

Beckwith (1940:154) has stressed that "the worst fate that could befall a soul was to be abandoned by its *ʻaumakua* and left to stray, a wandering spirit (*kuewa*) in some barren and desolate place." These wandering spirits were often malicious, so the places where they wandered were avoided.

3.1.2.6 The Plain of Pukaua

The Hawaiian language newspaper *Ka Loea Kālaiʻāina*, (13 January 1900) relates that near Puʻuokapolei, on the plain of Pukaua, on the *mauka* side of the road, there was a large rock. This legend suggests the plain around Puʻuokapolei was called Pukaua. The legend is as follows:

> If a traveler should go by the government road to Waianae, after leaving the village of gold, Honouliuli, he will first come to the plain of Puu-ainako and when that is passed, Ke-one-ae. Then there is a straight climb up to Puu-o-Kapolei and there look seaward from the government road to a small hill, That is Puu-Kapolei . . . You go down some small inclines, then to a plain. This plain is Pukaua and on the mauka side of the road, you will see a large rock standing on the plain . . . There were two supernatural old women or rather peculiar women with strange powers and Puukaua belonged to them. While they were down fishing at Kualakaʻi [near Barbers Point] in the evening, they caught these things, *ʻaʻama* crabs, *pipipi* shellfish, and whatever they could get with their hands. As they were returning to the plain from the shore and thinking of getting home while it was yet dark, they failed for they met a one-eyed person [bad omen]. It became light as they came near to the plain, so that passing people were distinguishable. They were still below the road and became frightened lest they be seen by men. They began to run—running, leaping, falling, sprawling, rising up and running on, without a thought of the *ʻaʻama* crabs and seaweeds that dropped on the way, so long as they would reach the upper side of the road. They did not go far for by then it was broad daylight. One woman said to the other, 'Let us hide lest people see us,' and so they hid. Their bodies turned into stone and that is one of the famous things on this plain to this day, the stone body. This is the end of these strange women. When one visits the plain, it will do no harm to glance on the upper side of the road and see them

standing on the plain. [*Ka Loea Kālaiʻāina*, 13 January 1900, translation in Sterling and Summers 1978:39]

In another version of this story, the two women met Hiʻiaka as she journeyed toward the ʻEwa coast. The women were *moʻo* (supernatural beings) and were afraid that Hiʻiaka would kill them, so they changed into their lizard form. One of the lizards hid in a little space on a stone beside the coastal trail, and the other hid nearby (*Ka Hōkū o Hawaiʻi*, 15 February 1927, translated in Maly 1997:19). From that time on the stone was known as *peʻe-kāua*, meaning "we two hidden." Hiʻiaka greeted the two women but did not harm them, and passed on.

When she reached Puʻuokapolei, she also greeted two old women who lived at an *ʻohai* grove on the hill. These women were named Puʻuokapolei and Nāwaineokamaʻomaʻo (*Ka Hōkū o Hawaiʻi*, 22 February 1927, translated in Maly 1997:19). As she continued her travels, she looked to the ocean and saw the canoe carrying Lohiʻau.

Kuʻu kāne i ke awa lau o Puʻuloa	My man on the many harbored sea of Puʻuloa
Mai ke kula o Peʻekāua ke noho	As seen from the plain of Peʻekāua
E noho kāua i ke kaha o ka ʻōhai	Let us dwell upon the ʻohai covered shore
I ka wiliwili i ka pua o ka lau noni	Where the noni blossoms are twisted together
O ka ihona i Kānehili la	Descending along Kānehili
Ua hili hoʻi au-e	I am winding along.

[*Ka Hōkū o Hawaiʻi*, 22 February 1927, translated in Maly 1997:20]

3.1.2.7 Legend of Nāmakaokapaoʻo

Nāmakaokapaoʻo was a Hawaiian hero of legendary strength. Nāmakaokapaoʻo's mother was Pokai and his father was Kaulukahai, a great chief of Kahiki, the ancestral home of the Hawaiians. The two met in Hōʻaeʻae and conceived their child there. The father returned to his home in Kahiki before the birth of his son, leaving his Oʻahu family destitute. A man named Pualiʻi saw Pokai and married her. The couple then resided on the plains of Keahumoa, planting sweet potatoes. Nāmakaokapaoʻo was a small, brave child who took a dislike to his stepfather, and pulled up the sweet potatoes Pualiʻi had planted at their home in Keahumoa. When Pualiʻi came after Nāmakaokapaoʻo with an axe, Nāmakaokapaoʻo delivered a death prayer against him, and slew Pualiʻi, hurling his head into a cave in Waipouli, near the beach at Honouliuli (Fornander 1919:5(2):274-276).

3.1.2.8 Legend of Pikoi

Pikoi was a legendary hero, the son of a crow (*ʻalalā*) and brother to five god-sisters in the form of rats. He was famous for his ability to shoot arrows, and often made bets that he could hit rats from a long distance (Fornander 1917:4(3):450-463). Pikoi's skill was commemorated in a saying (Pukui 1983:200):

Ku aku la i ka pana a	Shot by the arrow of Pikoi-[son]
Pikoi-a-ka-ʻalalā, keiki pana	of-the-crow, the expert rat-shooter
ʻiole o ke kula o Keahumoa.	Of the plain of Keahumoa.

3.1.2.9 Story of Palila

In the legend of the hero Palila, the famous warrior had a supernatural war club. He could throw the club a long distance, hang on to the end of it, and fly along the club's path. Using this power, he touched down in several places in Honouliuli, Waipiʻo, and Waikele. One day he used his supernatural war club to carry himself to Kaʻena Point at Waiʻanae, and from there east across the district of ʻEwa.

> *Haʻalele keia ia Kaʻena, hele mai la a Kalena, a Pōhākea, Maunauna, Kānehoa, a ke kula o Keahumoa, nana ia ʻEwa. Kū kēia i laila nānā i ke kū a ka ea o ka lepo i nā kānaka, e pahu aku ana kēia i ka laʻau palau aia nei i kai o Honouliuli, kū ka ea o ka lepo, nu lalo o ka honua, me he olai la, makau nā kānaka holo a hiki i Waikele. A hiki o Palila, i laila, e paʻapu ana nā kānaka i ka nānā lealea a ke ʻliʻi o Oʻahu nei, oai o Ahuapau.*
>
> After leaving Kaʻena, he came to Kalena, then on to Pōhākea, then to Manuauna [a peak in Honouliuli], then to Kānehoa [a peak in Honouliuli], then to the plain of Keahumoa [upland plain from Honouliuli to Waipiʻo] and looked toward ʻEwa. At this place he stood and looked at the dust as it ascended into the sky caused by the people who had gathered there; he then pushed his war club toward Honouliuli. When the people heard something roar like an earthquake they were afraid and they all ran to Waikele. When Palila arrived at Waikele he saw the people gathered there to witness the athletic games that were being given by the king of Oʻahu, Ahupau by name. [Fornander 1918:5(1):142-143]

3.1.2.10 The Demi-god Māui

In the stories of the demi-god Māui, Keahumoa is the home of Māuiʻs grandfather, Kuolokele (Kū-honeycreeper). One day, Māui's wife, Kumulama, was stolen by the chief Peapeamakawalu, called eight-eyed-Pea-Pea, who is identified in the creation chant *Kumulipo* as the octopus god (Beckwith 1951:136). The chief disappeared with Kumulama in the sky beyond the sea, and escaped so quickly that Māui could not catch him. To recover his wife, Māui's mother advised him to visit the hut of his grandfather at Keahumoa:

> Maui went as directed until he arrived at the hut; he peeped in but there was no one inside. He looked at the potato field on the other side of Poha-kea, toward Hono-uli-uli, but could see no one. He then ascended a hill, and while he stood there looking, he saw a man coming toward Waipahu with a load of potato leaves, one pack of which, it is said, would cover the whole land of Keahumoa. [Thrum 1923:253-254]

Kuolokele made a *moku-manu* ("bird-ship") for Māui, who entered the body of the bird and flew to Moanaliha, the land of the chief Peapeamakawalu. This chief claimed the bird as his own when it landed on a sacred box, and took it with him into the house he shared with Māui's wife. When Peapeamakawalu fell asleep, Māui killed him, cut off his head, and flew away back to Oʻahu with his wife and the chief's head (Thrum 1923:252-259).

A man named Kaopele, born in Waipiʻo, had a tendency to fall into deep trances for months at a time. While awake, he would create plantations of supernatural proportions. However, he was never able to enjoy the fruits of his labors because he would always fall into another deep sleep. During one profound slumber, Kaopele was believed to be dead; he was taken to Wailua, Kauaʻi to be offered as a sacrifice. Upon awakening, he married a woman named Makalani and stayed on Kauaʻi. They had a son named Kalelealuaka, who was also blessed with supernatural powers.

Kaopele instructed the boy in the arts of war and combat, which Kalelealuaka exhibited during two challenges with kings of Kaua'i. One day, Kalelealuaka decided to travel to O'ahu. A boy, Kaluhe, accompanied him and they paddled to Wai'anae. There, he met another companion who he later named Keinoho'omanawanui, the sloven. The three traveled toward the old plantation called Keahumoe (Keahumoa), in the *mauka* regions of Waipi'o, formerly planted by Kaopele.

> [T]he three turned inland and journeyed till they reached a plain of soft, whitish rock, where they all refreshed themselves with food. They kept on ascending, until Keahumoe lay before them, dripping with hoary moisture from the mist of the mountain, yet as if smiling through its tears. Here were standing bananas with ripened, yellow fruit, upland *kalo*, and sugar cane, rusty and crooked with age, while the sweet potatoes had crawled out of the earth and were cracked and dry. [Emerson 1998:86-87]

To determine the best settlement location, Kalelealuaka shot an arrow to see where it would land. He then built a mountain house and called it "Lelepua" (meaning "arrow flight"). One night, Kalelealuaka makes known his wish:

> The beautiful daughters of Kakuhihewa to be my wives; his fatted pigs and dogs to be baked for us; his choice *kalo*, sugar cane, and bananas to be served up for us; that Kakuhihewa himself send and get timber and build a house for us; that he pull the famous *awa* of Kahuone; that the King send and fetch us to him; that he chew the *awa* for us in his own mouth, strain and pour it for us, and give us to drink until we are happy, and then take us to our house. [Emerson 1998:89]

Upon hearing such a request, the *mō'ī* (high chief) Kākuhihewa confers with his priests and instead of killing Kalelealuaka, decides to test him in battle with Kūali'i. Kalelealuaka proves worthy in battle and is given charge of Kākuhihewa's kingdom.

3.1.2.11 Hi'iaka, Sister to the Hawaiian Volcano Goddess, Pele

The goddess Hi'iaka, sister of the volcano goddess Pele, passed through 'Ewa and met women stringing *ma'o* flowers to make lei. Hi'iaka offered a chant, making known her wish for a lei around her own neck.

E lei ana ke kula o Ke'ahumoa i ka ma'o	The plains of Keahumoa are garlanded with *ma'o*
'Ohu'ohu wale nā wāhine kui lei o ka nahele	The lei-stringing women of the forest are festively adorned

(Ho'oumāhiehiemalie 2006a:287; 2006b:268)

3.1.3 Traditional Settlement and Agricultural Patterns

Various Hawaiian legends and early historical accounts indicate 'Ewa was once widely inhabited by pre-Contact populations, including the Hawaiian *ali'i* (chiefly class). This would be due for the most part to the plentiful marine and estuarine resources available at the coast, where several sites interpreted as permanent habitations and fishing shrines have been located. Other attractive subsistence-related features of the district include irrigated lowlands suitable for wetland taro cultivation, as well as the lower forest area of the mountain slopes for the procurement of forest resources. Handy and Handy (1972) report the following:

> The lowlands, bisected by ample streams, were ideal terrain for the cultivation of irrigated taro. The hinterland consisted of deep valleys running far back into the Koʻolau range. Between the valleys were ridges, with steep sides, but a very gradual increase of altitude. The lower part of the valley sides were excellent for the cultivation of yams and bananas. Farther inland grew the ʻawa for which the area was famous. [Handy and Handy 1972:429]

In addition, breadfruit, coconuts, *wauke* (paper mulberry, *Broussonetia papyrifera*, used to make *kapa* for clothing), bananas, and *olonā* (*Touchardia latifoli*, used to make cordage) and other plants were grown in the interior. ʻEwa was known as one of the best areas to grow gourds and was famous for its *māmaki* (*Pipterus* spp.; used to make *kapa* for clothing). It was also famous for a rare taro called the *kāī o ʻEwa*, which was grown in mounds in marshy locations (Handy and Handy 1972:471). The cultivation of this prized and delicious taro led to the saying:

Ua ʻai i ke kāī-koi o ʻEwa. He has eaten the Kāī-koi taro of ʻEwa.

> Kāī is Oʻahu's best eating taro; one who has eaten it will always like it. Said of a youth of a maiden of ʻEwa, who, like the Kāī taro, is not easily forgotten. [Pukui 1983:305]

The lochs of Pearl Harbor were ideal for the construction of fishponds and fish traps. Forest resources along the slopes of the Waiʻanae Range probably acted as a viable subsistence alternative during times of famine and/or low rainfall (Handy 1940:211; Handy and Handy 1972:469-470). The upper valley slopes may have also been a resource for sporadic quarrying of basalt used in the manufacturing of stone tools. At least one probable quarrying site (SIHP # 50-80-12-4322) is present in Makaīwa Gulch at 152 m (500 ft) above mean sea level (Hammatt et al. 1990) in Honouliuli.

3.1.4 Māweke and Overview of the Reign of *Aliʻi* in ʻEwa

Many references document that chiefs resided in ʻEwa and that it was a political center in its day. Oral accounts of *aliʻi* recorded by noted Hawaiian historian Samuel Kamakau date back to at least the twelfth century.

> The chiefs of Līhuʻe [upland area in ʻEwa], Wahiawā, and Halemano on Oʻahu were called *lō aliʻi*. Because the chiefs at these places lived there continually and guarded their *kapu*, they were called *lō aliʻi* [from whom a 'guaranteed' chief might be obtained, *loaʻa*]. They were like gods, unseen, resembling men. [Kamakau 1991a:40]

In the mid-eleventh century, Māweke, a direct lineal descendant of the illustrious Nanaulu (ancestor of Hawaiian royalty), was a chief of Oʻahu (Fornander 1996:47). Keaunui, the second of his three sons, became the head of the powerful ʻEwa chiefs. Tradition tells of him cutting a navigable channel through the Pearl River using his canoe. Keaunui's son, Lakona, became the progenitor of the ʻEwa chiefs around 1400 (Fornander 1996:224-226). Chiefs within his line, the Māweke-Kumuhonua line, reigned until about 1520-1540, with their major royal center in Līhuʻe in ʻEwa (Cordy 2002:24). Haka was the last chief of the Māweke-Kumuhonua line. He was slain by his men at the fortress of Waewae near Līhuʻe (Fornander 1996:88; Kamakau 1991a:54). Power shifted between the chiefs of different districts from the 1500s until the early 1700s, when Kūaliʻi achieved control of all of Oʻahu by defeating the Kona chiefs. He then defeated the ʻEwa chiefs and expanded his control on windward Kauaʻi. Peleihōlani, the heir of Kūaliʻi, gained control of Oʻahu about 1740, and later conquered parts of Molokaʻi. He ruled Oʻahu until his death in about 1778 when Kahahana, of the ʻEwa line of chiefs, was selected as the ruler of Oʻahu (Cordy 2002:24-41). Somewhere between 1783 and 1785, Kahahana was killed by Kahekili of Maui. The subsequent rebellion amongst the chiefs resulted in a near genocide of the line of monarchy on Oʻahu. Oral reports also tell of how the stream of Hōʻaiʻai in ʻEwa was choked with the bodies of the slain (Fornander 1996:224-226). Kahekili and the Maui chiefs retained control of Oʻahu until the 1790s. Kahekili died at Waikīkī in 1794. His son, Kalanikūpule, was defeated the following year at the Battle of Nuʻuanu by Kamehameha (Kamakau 1992:376-377). Thus, the supremacy of the ʻEwa chiefs came to a final end.

3.1.5 Kaʻihikapu and Chiefly Rivalry

Around 1600-1620, the entire island of Oʻahu was united under the rule of one woman, an *aliʻi* named Kalaʻimanuia (Cordy 2002:30). Before her death, she divided her kingdom between four of her children: She gave the districts of Kona and Koʻolaupoko to Kū-a-Manuia; the *ahupuaʻa* of Kalauao, ʻAiea, Moanalua, and Hālawa to Kaʻihikapu-a-Manuia; the districts of ʻEwa and Waiʻanae to Haʻo; and the districts of Waialua and Koʻolauloa to her daughter Kekela. To Kū, she passed on her title of *mōʻī* so that the other three were still subject to their eldest brother. Kū, however, was greedy and began to try to take the lands allotted to his siblings away from them. Haʻo joined with his brother Kaʻihikapu in a battle defending against an attack by Kū, a battle in which Kū was slain. Kaʻihikapu then became *mōʻī* and was a benevolent king, taking care of his subjects and making frequent tours around the island to observe the people. On one of these circuits, he visited his brother Haʻo at his court in Waikele and grew jealous of the riches of his brother's home in ʻEwa. Kaʻihikapu sent the carcass of a large man-eating shark that had been caught near his court in Waikīkī to his brother as a gift so that Haʻo could use it as a sacrifice to the gods at his *heiau* in Waikele. Kaʻihikapu's forces attacked Haʻo and his priests at the temple as they were unarmed and busy with the dedication ceremonies (Fornander 1996:270-271).

There are other versions of this *moʻolelo* that describe the shark as similar to the gift of the Trojan Horse, but Fornander (1996:271) believes these "embellishments" may have been made in the post-Contact period. In one version of this *moʻolelo* (Pukui 1983:191), Kaʻihikapu took Haʻo's lands from him.

> The chiefs of Waikīkī and Waikele were brothers. The former wished to destroy the latter and laid his plot. He went fishing and caught a large niuhi [man-eating shark], whole skin he stretched over a framework. Then he sent a messenger to ask his brother if he would keep a fish for him. Having gained his consent, the chief left Waikīkī hidden with his best warriors in the 'fish.' Other warriors joined them along the way until there was a large army. They surrounded the residence of the chief of Waikele and linked arms to form a wall, while the Waikīkī warriors poured out of the 'fish' and destroyed those of Waikele. [Pukui 1983:191]

There is a saying concerning this rivalry between the two brothers, "*Ke one kuilima laula o ʻEwa*. The sand on which there was a linking of arms [*kuilima*] on the breadth of ʻEwa" (Pukui 1983:191).

In a different version of this *moʻolelo* (Kamakau 1991a:61-67), Kaʻihikapu cut open the shark captured from the Waikīkī waters, removed all the meat, and left the skin and bones. He sent a messenger to his brother, Haʻo, chief of Waikele, offering the shark to him. Haʻo quickly agreed, and waited for the shark to be delivered to Waikele, where he planned to place it at his *heiau* as an offering to the gods. When the shark was placed on the altar, Kaʻihikapu and his men jumped out and slaughtered his brother and all of the priests. The slain men were then put into the shark and offered as a sacrifice at the former *heiau* of his brother at Waikele. Kamakau (1991a:67) says that the name of this place of slaughter in Waikele was called Paumakua. Thrum (1922:665) translates this place name as "all fiery eyed." McAllister (1933:106) located this destroyed *heiau*, called Hapupu, at the site then occupied by the Waipahu plantation stables.

Oʻahu was unified once more when Kaʻihikapuʻs son, Kākuhihewa, married his aunt's (Kekela) daughter, Nāpūlānahu. Kākuhihewa had royal residences at Waikīkī, Kailua, and ʻEwa. His descendants lost most of this unified power to the district chiefs over the next three generations (Cordy 2002:31).

3.1.6 Kūaliʻi's Defeat of the ʻEwa *Aliʻi*

In the first half of the eighteenth century, the island of Oʻahu was ruled by the chief Kūaliʻi, who consolidated his supreme power over the entire island by defeating the Kona chiefs and then the ʻEwa chiefs in battle (Cordy 2002:32). Kūaliʻi met ʻEwa's competing army on the plains of Keahumoa, but the ʻEwa chiefs surrendered when they saw Kūaliʻi's overwhelming forces, and they ceded the lands of Koʻolauloa, Koʻolaupoko, Waialua, and Waiʻanae to him (Fornander 1917:4(2):366, 400).

3.1.7 The Overthrow of Kahahana and the Rule of Kahekili

Oʻahu was ruled by Kūaliʻi's son and grandson, and then by Kahahana, the son of the ʻEwa chief Elani and the sister of Kūaliʻi's son Peleiōhalani (Fornander 1919:6(2):282). Kahahana had been raised in the court of the powerful Maui chief, Kahekili.

Thomas Thrum (1998:203-214) translates the legend of the *kahuna* Kaʻōpulupulu, who lived in Waimea. Kahekili, the king of Maui sent his foster son, Kahahana to rule Oʻahu, around the year 1779 (Cordy 2002:42). Kahahana set up his royal compound in Waikīkī and commanded the priest Kaʻōpulupulu to attend him there. At first Kahahana valued the wisdom of this wise priest, but after several years, Kahahana began to be cruel to the people, and in protest Kaʻōpulupulu left Waikīkī to return to his home in Waimea. This angered the king, who sent messengers to order Kaʻōpulupulu and his son Kahulupue to come to Waiʻanae where Kahahana then resided. They were placed into a special grass hut, one tied to the end post and one tied to the corner post of the house. The next day, Kahahana ordered his men to torture the son, stabbing his eyes and stoning him while his father watched. When Kaʻōpulupulu saw this, he commanded his son to flee into the sea, saying these words (Pukui 1983), which contained a prophecy.

E nui ke aho, e kuʻu keiki, *a moe i ke kai, no ke kai la* *hoʻi ka ʻāina.* [Pukui 1983:44]	Take a deep breath, my son, and lay yourself in the sea, for then the land shall belong to the sea.

When Kahekili heard of this outrage, he sent an army to Oʻahu to depose Kahahana. The Oʻahu force was defeated around the year 1795 (Cordy 2002:19), and Kahahana, his wife, Kekuapoi, and his friend Alapai, fled westward, hiding at many places in ʻEwa.

> Upon the arrival here at Oahu of Kahekili, Kahahana fled, with his wife Kekuapoi, and friend Alapai, and hid in the shrubbery of the hills. They went to Aliomanu, Moanalua, to a place called Kinimakalehua; then moved along to Keanapuaa and Kepookala, at the lochs of Puuloa, and then from there to upper Waipio; thence to Wahiawa, Helemano, and on to Lihue [upper plain of Honouliuli, Hō‘ae‘ae, and Waipi‘o]; thence they came to Poohilo, at Honouliuli, where they first showed themselves to the people and submitted themselves to their care. [Thrum 1998:213-214]

Through treachery, Kahahana was induced to leave Pō‘ohilo, Honouliuli and was killed on the plains of Hō‘ae‘ae. While hiding in Pō‘ohilo, and *‘ili* of Honouliuli:

> . . . report thereof was made to Kahekili, the king, who thereupon sent Kekuamanoha, elder brother of Kekuapoi, the wife of Kahahana, with men in double canoes from Waikiki, landing first at Kupahu, Hanapouli, Waipio, and had instructions to capture and put to death Kahahana, as also his friend Alapai, but to save alive Kekuapoi. When the canoes touched at Hanapouli, they proceeded thence to Waikele and Hoaeae, and from there to Poohilo, Honouliuli, where they met with Kahahana and party in conference. At the close of the day Kekuamanoha sought by enticing words to induce his brother-in-law to go on with him and see the father king and be assured of no death condemnation, and by skilled flattery he induced Kahahana to consent to his proposition, whereupon preparation was made for the return. On the following morning, coming along and reaching the plains of Hoaeae, they fell upon and slew Kahahana and Alapai there, and bore their lifeless bodies to Halaulani, Waipio, where they were placed in the canoes and brought up to Waikiki and placed up in the coconut trees by King Kahekili and his priests from Maui, as Kaopulupulu had been. Thus was fulfilled the famous saying of the Oahu priest in ‘all its truthfulness.’ According to the writings of S.M. Kamakau and David Malo, recognized authorities, the thought of Kaopulupulu as expressed to his son Kahulupue, ‘This land is the sea’s,’ was in keeping with the famous prophetic vision of Kekiopilo that ‘the foreigners possess the land,’ as the people of Hawaii now realize. [Manu 1904:112-113]

Somewhere between 1783 and 1785, Kahahana was killed by Kahekili of Maui. Kahahana’s father ‘Elani, along with other O‘ahu chiefs, plotted to kill Kahekili and his chiefs who were residing at Kailua, O‘ahu, as well as his chiefs residing at ‘Ewa and Waialua. The plot was discovered by Kahekili, and a messenger was sent to warn Hū‘eu at Wai‘alua. For some reason, the messenger never reached Hū‘eu and he and his retinue were killed. The murderers of Hū‘eu were found in Waipi‘o, “therefore Ewa became famed as a land of deadly plots” (*Ka Nūpepa Kū‘oko‘a,* 5 December 1868 translated in Sterling and Summers 1978:3). This slaughter became known as the Waipi‘o *kīmopō,* or the Waipi‘o assassination because it originated there. Kahekili avenged the death of Hū‘eu by pillaging and destroying the districts of Kona and ‘Ewa. It is said that the streams of Makaho and Niuhelewai in Kona as well as Hō‘ae‘ae in ‘Ewa were “choked with the bodies of the slain, and their waters became bitter to the taste, as eyewitnesses say, from the brains that turned the water bitter” (Kamakau 1992:138). It was during this time that the O‘ahu chiefly lines were nearly exterminated. It is said that one of the Maui chiefs, Kalaikoa, used the bones of the slain to build a wall around his house at Lapakea in Moanalua. The house was known as Kauwalua and could be seen as one passed by the “old upper road to ‘Ewa” (Fornander 1996:290).

3.1.8 Early Historic Period

Captain James Cook landed in the Hawaiian Islands in 1778, and ten years later the first published description of Pearl Harbor appeared. Captain Nathaniel Portlock, observing the coast of Honolulu for Great Britain, recorded the investigation of a “fine, deep bay running well to the northward” around the west point of “King George’s Bay” in his journal (Portlock 1789:74). Portlock’s description matches the entire crescent-shaped shoreline from Barbers Point to Diamond Head.

Captain George Vancouver made three voyages to the Hawaiian Islands between 1792 and 1794. In 1793, the British captain recorded the name of the harbor opening as “O-poo-ro-ah” and sent several boats across the sand bar to venture into the harbor proper (Vancouver 1798:884). The area known as “Pu‘u-loa” was comprised of the eastern bank at the entrance to Pearl River. George Vancouver anchored off the entrance to West Loch in 1793, and the Hawaiians told him of the area at “a little distance from the sea, [where] the soil is rich and all the necessaries of life are abundantly produced” (Vancouver 1798 in Sterling and Summers 1978:36). Mr. Whitbey, one of Vancouver’s crew, observed, “from the number of houses within the harbor it should seem to be very populous; but the very few inhabitants who made their appearance were an indication of the contrary” (Vancouver 1798 in Sterling and Summers 1978:36).

Captain Vancouver sailed by Kalaeloa (Barbers Point) in 1792, and recorded his impression of the small coastal village of Kualaka‘i and the arid Honouliuli coast.

> The point is low flat land, with a reef round it . . . Not far from the S.W. point is a small grove of shabby cocoa-nut trees, and along these shores are a few struggling fishermen’s huts. [Vancouver 1798:1:167]
>
> . . . from the commencement of the high land to the westward of Opooroah [Pu‘uloa], was composed of one very barren rocky waste, nearly destitute of verdure, cultivation or inhabitants, with little variation all the way to the west point of the island . . . [Vancouver 1798:2:217]
>
> This tract of land was of some extent but did not seem to be populous, nor to possess any great degree of fertility; although we were told that at a little distance from the sea, the soil is rich, and all necessaries of life are abundantly produced . . . [Vancouver 1798:3:361-363]

The reports left by Artemas Bishop of the Ewa Protestant Station in Waiawa shed light on the massive impact disease was having on the Hawaiian people in the ‘Ewa district. The 1831-1832 census of O‘ahu recorded a population of 4,015 within the ‘Ewa district. Four years later in 1836, the ‘Ewa population had dropped to 3,423 (Schmitt 1973:9, 36), “a decrease of 592 in 4 years” (Ewa Station Report 1836). Reverend Lowell Smith noted the following:

> The people of Ewa are a dying people. I have not been able to obtain an exact count of all the deaths & births since the last general meeting. But my impression is that there have been as many as 8 or 10 deaths to one birth. I have heard of but 4 births

> on Waiawa during the year, & all of these children are dead. I have attended about 20 funerals on that one land, & 16 of these were adults. [Ewa Station Report 1836]

The population stabilized in the 1830s and early 1840s. In January 1849, the population was 2,386 people but the population dropped with a measles epidemic in October 1849. Although Bishop made an attempt to vaccinate as many individuals as possible, the smallpox epidemic of 1853-1854 killed upwards of 400 people in the ‘Ewa District. The comments of Artemas Bishop reflect the destitution people were suffering district wide:

> It is not necessary that I go into detail of that season of sorrow and trial which we passed through, and from which I did not myself escape without feeling its influence in my own person. Let it suffice here, that not a house or family in Ewa escaped. In many cases, whole families were cut off. Husbands and wives parents and children, were separated by death. The whole state of society became disorganized, almost every family was broken up. In the whole district between July and October inclusive, upwards of half of the people died and of those who escaped, many are still enfeebled in consequence. In the church we have lost upwards of 400 members, including several of my best men. We feel ourselves very much crippled in consequence. Many sad and affected feelings, mingled with discouragement have followed my labors through the year, and that to a degree far beyond what I ever before suffered. [Ewa Station Report 1854]

Sereno Bishop also remembered his father’s efforts to save his congregation, but with limited success in ‘Ewa.

> The greatest destruction of Hawaiian population took place in the summer of 1853, by an invasion of small-pox. This broke out in Honolulu. Rev. A. Bishop immediately procured a supply of vaccine matter, which proved to be spurious. He then proceeded to inoculate the people with small-pox, thus saving hundreds of lives, and himself coming down with varioloid, having formerly been vaccinated. But more than half of the population of Ewa perished in a few weeks. The earliest cases were pathetic. A young woman in Kalauao was visiting in Honolulu, and contracted the malady. She hastened home in terror and summoned her friends and kindred from all the villages of Ewa to bid her farewell. They all came and kissed her, then returned to their homes and all died. The young woman herself recovered. [Bishop 1916:46]

In 1860, Artemas Bishop reported,

> The people of the district are rapidly diminishing, and whole neighborhoods where in former years were numerous families and cultivated lands, there are now no inhabitants, and the land is left to run to waste. The fathers have died off, and the children wander into other parts, and there are none to fill their places. [Ewa Station Report 1860]

Sereno Bishop, recollecting his life at the mission station in ‘Ewa in the mid-eighteenth century, commented on the population decline: “Throughout the district of Ewa the common people were generally well fed. Owing to the decay of population great breadths of taro marsh had fallen into disuse, and there was a surplus of soil and water for raising food” (Bishop 1916:44).

At Contact, the most populous *ahupua‘a* on the island was Honouliuli, with the majority of the population centered on Pearl Harbor. In 1832, a missionary census of Honouliuli recorded the population as 1,026. Within four years, the population was down to 870 (Schmitt 1973:19, 22). In 1835, there were eight to ten deaths for every birth (Kelly 1991:157-158). Between 1848 and 1853, there was a series of epidemics of measles, influenza, and whooping cough that often wiped out whole villages. In 1853, the population of ‘Ewa and Wai‘anae combined was 2,451 people. In 1872, it was 1,671 (Schmitt 1968:71). The inland area of ‘Ewa was probably abandoned by the mid-nineteenth century, due to population decline and consolidation of the remaining people in the towns of Honouliuli, Waipahu, and Waiawa.

3.1.9 The Māhele and the Kuleana Act

In 1845, the Board of Commissioners to Quiet Land Titles, also called the Land Commission, was established “for the investigation and final ascertainment or rejection of all claims of private individuals, whether natives or foreigners, to any landed property” (Chinen 1958:8). This led to the Māhele, the division of lands among the king of Hawai‘i, the *ali‘i* (chiefs), and the common people, which introduced the concept of private property into Hawaiian society. Kamehameha III divided the land into four categories: certain lands to be reserved for the king and the royal house were known as Crown Lands; lands set aside to generate revenue for the government were known as Government Lands; lands claimed by *ali‘i* and their *konohiki* (supervisors) were called Konohiki Lands; and habitation and agricultural plots claimed by the common people were called *kuleana* (Chinen 1958:8-15).

In 1848, the crown and the *ali‘i* received their land titles, known as Land Commission Awards (LCA). Members of the royal family were awarded entire *ahupua‘a*, while high-ranking *ali‘i* were awarded entire *‘ili*, and lesser *konohiki* were awarded half of an *‘ili* (Kame‘eleihiwa 1992:269, 279). Title to an *ahupua‘a* or *‘ili* typically included ownership of the area’s fishpond and offshore fishing rights (Devaney et al. 1982:143). The lands awarded as Crown Lands and Konohiki Lands, as well as lands designated as Government Lands, were “subject to the rights of native tenants.” The Kuleana Act of 1850 “authorized the Land Commission to award fee simple titles to all native tenants who occupied and improved any portion of Crown, Government, or Konohiki Lands” (Chinen 1958:29). It is through records for Land Commission Awards (LCA) generated during the Māhele that the first specific documentation of life in ‘Ewa, as it had evolved up to the mid-nineteenth century, come to light. There are no LCAs located within or in the vicinity of the current project area.

In 1855 the Land Commission awarded all of the unclaimed lands in Honouliuli, 43,250 acres, to Miriam Ke‘ahikuni Kekau‘ōnohi (Royal Patent #6971 in 1877; Parcel #1069 in the Land Court office), a granddaughter of Kamehameha I, and the heir of Kalanimōkū, who had been given the land by Kamehameha after the conquest of O‘ahu (Indices of Awards 1929; Kame‘eleihiwa 1992). Kekau‘ōnohi was also awarded the *ahupua‘a* of Pu‘uloa, but she sold this land in 1849 to a man named Isaac Montgomery, a British lawyer.

> Kekau‘ōnohi was one of Liholiho’s (Kamehameha II’s) wives, and after his death, she lived with her half-brother, Luanu‘u Kahalai‘a, who was governor of Kaua‘i (Hammatt and Shideler 1990:19-20:20). Subsequently, Kekau‘ōnohi ran away with Queen Ka‘ahumanu’s stepson, Keli‘iahonui, and then became the wife of Chief Levi Ha‘alelea. Upon her death on June 2, 1851, all her property was

> passed on to her husband and his heirs. A lawsuit (Civil Court Case No. 348) was brought by Haʻalelea in 1858, to reclaim the fishing rights of the Puʻuloa fisheries from Isaac Montgomery, and the court ruled in Haʻalaea's favor. In 1863, the owners of the *kuleana* lands deeded their lands back to Haʻalelea to pay off debts owed to him (Frierson 1972:12). In 1864, Haʻalealea died, and his second wife, Anadelia Amoe, transferred ownership of the land to her sister's husband, John Coney (Yoklavich et al 1995:16). [Souza et al. 2006]

3.1.10 Early Ranching

3.1.10.1 Ranching in Lower Honouliuli

In 1871, John Coney rented the lands of Honouliuli to James Dowsett and John Meek, who used the land for cattle grazing. An 1873 map of Honouliuli depicts the project area within undeveloped Honouliuli in relation to Puʻuloa and the West Loch of Pearl Harbor (Figure 6). In 1877, James Campbell purchased most of Honouliuli Ahupuaʻa—except the *ʻili* of Puʻuloa—for a total of $95,000. He then drove off 32,347 head of cattle belonging to Dowsett, Meek, and James Robinson, and constructed a fence around the outer boundary of his property (Bordner and Silva 1983:C-12). He let the land rest for one year and then began to restock the ranch, so that he had 5,500 head after a few years (Dillingham 1885 in Frierson 1972:14).

In 1881, a medical student touring the island to provide smallpox vaccinations to the population viewed Campbell's property, called the Honouliuli Ranch:

> I took a ride over the Honouliuli Ranch which is quite romantic. The soil is a deep, reddish loam, up to the highest peaks, and the country is well-grassed. Springs of water abound. The *ʻilima*, which grows in endless quantities on the plains of this ranch, is considered excellent for feeding cattle; beside it grows the indigo plant, whose young shoots are also good fodder, of which the cattle are fond. Beneath these grows the manieizie grass, and Spanish clover and native grasses grow in the open; so there is abundant pasturage of various kinds here. As I rode, to the left were towering mountains and gaping gorges; ahead, undulating plains, and to the right, creeks and indentations from the sea. A wide valley of fertile land extends between the Nuuanu Range and the Waianae Mountains and thence to the coast of Waialua. There are many wild goats in this valley, which are left more or less undisturbed because they kill the growth of mimosa bushes, which would otherwise overrun the country and destroy the pasturage for cattle. [Briggs 1926:62-63]

In 1880-1881, the Honouliuli ranch was described as follows:

> Acreage, 43,250, all in pasture, but possessing fertile soils suitable for agriculture; affords grazing for such valuable stock. The length of this estate is no less than 18 miles. It extends to within less than a mile of the sea coast, to the westward of the Pearl River inlet. . . . There are valuable fisheries attached to this estate . . . [Bowser 1880:489]

> From Mr. Campbell's veranda, looking eastward, you have one of the most splendid sights imaginable. Below the house there are two lochs, or lagoons, covered with water fowl, and celebrated for their plentiful supply of fish, chiefly mullet. . . . Besides Mr. Campbell's residence, which is pleasantly situated and surrounded

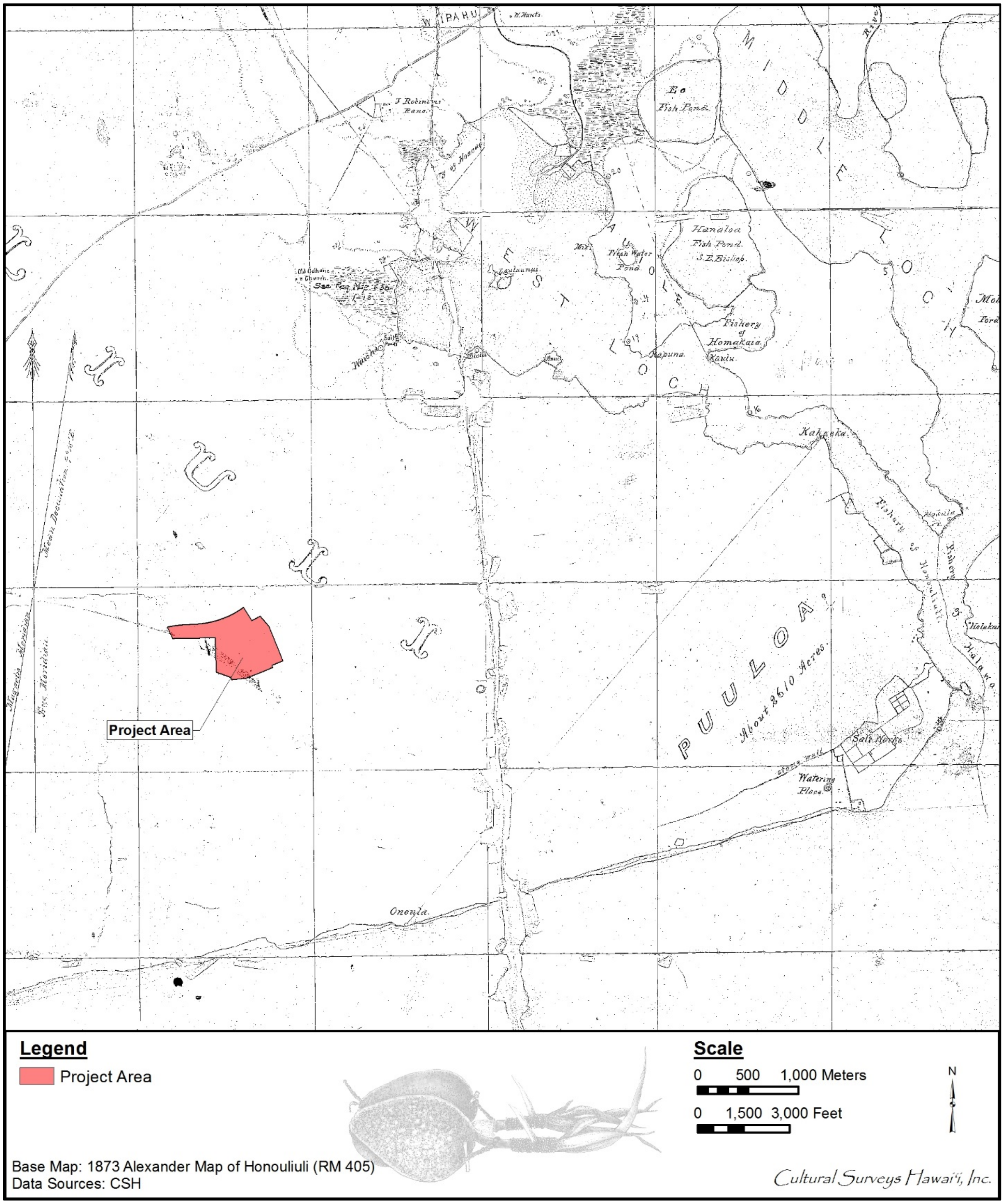

Figure 6. 1873 Alexander map of Honouliuli showing project

> with ornamental and shade trees, there are at Honouliuli two churches and a school house, with a little village of native huts. [Bowser 1880:495]

Most of Campbell's lands in Honouliuli were used exclusively for cattle ranching. At that time, one planter remarked "the country was so dry and full of bottomless cracks and fissures that water would all be lost and irrigation impracticable" (Ewa Plantation Company 1923:6-7). In 1879, Campbell brought in a well-driller from California to search the ʻEwa plains for water, and the well, drilled to a depth of 240 ft near Campbell's home in ʻEwa, resulted in "a sheet of pure water flowing like a dome of glass from all sides of the well casing" (The Legacy of James Campbell n.d. cited in Pagliaro 1987:3). Following this discovery, plantation developers and ranchers drilled numerous wells in search of the valuable resource.

Between the years of 1861 and 1873, parcels of Waiawa were leased to Valdemar Knudsen for use as grazing lands for livestock. A 50-year lease and leaseholds were granted to James Robinson in 1868. After James Robinson's death in 1890, his son, Mark P. Robinson, acquired a 25-year lease. Overwritten on the lease was the "permission granted to assign the lease to the Oahu Railway and Land Company" (Hawaii Bureau of Land Conveyances 1855-1883:115:496). This lease was subleased from Oahu Railway and Land Company (OR&L) to the Oahu Sugar Company for 43 years on 1 January 1897. It is probable that much of the upper grasslands of Hōʻaeʻae, Waikele, Waipiʻo, and Waiawa were all used for cattle pasture.

3.1.10.2 Ranching in the Uplands of ʻEwa

Sereno Bishop stated that his father was the first to bring cows to ʻEwa:

> Waiawa valley above us lay knee deep with the richest of grass, where our cows rioted. Our goats took to the higher ground, where they flourished, being driven in and penned at night. . . . The herd gradually multiplied and in a few years became large. [Bishop 1916:42]

These herds contributed to the deforestation of the upper valley, as noted by Bishop:

> There was a very passable road down Ewa and Waianae way. Once while making the trip down to Waialua, to which there was a good horse trial, I discovered that even at that early day [ca. 1858] that cattle had made great inroads into the forests of ti plants which had theretofore clad the foothills and upland pasturages, even to the highest tracts. [Bishop 1916:60]

Subsequent to Western Contact in the area, the landscape of the ʻEwa plains was damaged by the removal of the sandalwood forest and the introduction of domesticated animals and new vegetation species. Domesticated animals including goats, sheep and cattle, were brought to the Hawaiian Islands by Vancouver in the early 1790s and allowed to graze freely about the land for some time after. It is unclear when domesticated animals were brought to Oʻahu; however, L.A. Henke reports the existence of a longhorn cattle ranch in Waiʻanae by at least 1840 (Frierson 1972:10). During this same time, perhaps as early as 1790, exotic vegetation species were introduced to the area. These typically included vegetation best suited to a terrain disturbed by the logging of sandalwood forest and eroded by animal grazing. Within the current project area, the majority of the (non-cultivated) vegetation is comprised of introduced species, mainly grasses.

3.1.11 Pineapple Cultivation

In the early decades of the twentieth century, lands in the *mauka* portion of the central and eastern sections of ʻEwa were being acquired for pineapple cultivation. Records show attempted pineapple irrigation utilizing water from shallow wells in Waiawa Gulch in 1893. Later attempts were made in Waiawa and Honouliuli. James Dole founded the Hawaiian Pineapple Company in 1901. The previous year, Dole had purchased 61 acres of land in Wahiawa for growing pineapple. Prior to 1913, most of the upland plateau areas in Waiawa were planted in pineapple (Goodman and Nees 1991:59) and in several ʻEwa *ahupuaʻa* small plots along gullies not appropriate for sugar cane cultivation were planted in pineapple. Many of these small plots were cultivated by independent farmers who sold the crops at markets or to larger companies. In 1901, the Hawaiian Pineapple Company obtained 61 acres in Waiawa through public auction. Initially, most pineapple was shipped to California for packing. In an attempt to speed up processing, save money, and produce a fresher product, a cannery was constructed in Waiawa. This cannery was constructed by the Pearl City Fruit Company but it became a part of the Hawaiian Pineapple Company operations after the Pearl City Fruit Company went bankrupt. The cannery was in operation from 1905 to 1935.

A 1908 lease from the John ʻĪʻī Estate, Ltd. to Yoshisuke Tanimoto and Kintaro Izumi led to the formation of the Waipio Pineapple Company, which cleared and cultivated approximately 223 acres in portions of Kīpapa Gulch. In 1909, the government appropriated the Waipiʻo peninsula from the ʻĪʻī estate. The land was valued at $10,000 for purposes of fair compensation (Hawaiʻi Department of Land and Natural Resources 1909:228-235). In 1915, Libby, McNeill & Libby took over Waipio Pineapple Company's leases and continued to cultivate pineapple in the area. By the late 1920s, James Dole's Hawaiian Pineapple Company, incorporated in 1901, was cultivating pineapple on thousands of acres leased from the ʻĪʻī estate in the *mauka* area of Waipiʻo.

Pineapples were handpicked, graded, boxed, and loaded into trucks before the introduction of machinery into the harvesting process. The introduction of the mechanical field fruit harvester in 1947 eliminated the labor-intensive process of grading, boxing, and loading. The pineapple industry employed both male and female Japanese and Filipino workers in the fields and in the cannery. Camps were set up throughout ʻEwa to be used as housing for the workers and their families (Goodman and Ness 1991:165). In the 1920s, pineapple was abandoned and by 1935, much of the former pineapple lands were planted in sugar cane.

3.1.12 Other Agricultural Enterprises

Taro and other traditional plants continued to be cultivated in some areas. John Papa ʻĪʻī associated Waiawa, ʻEwa with the brewing of intoxicants in the early 1800s and gives an account of the making of *ʻōkolehao,* an alcoholic drink made from brewing the roots of the native *ti* plant (*Cordyline fruticosa*).

> It was interesting to see how ti root was converted into a strong liquor. When the root was boiled on a stove, the liquid came forth like the flowing of sweat from a bud. The hand was wetted with the first drippings and then waved over the flames, when the drippings burned brightly. The first brew was called *loko*, the second *kawai*, and the last *kawai hemo*. [ʻĪʻī 1959:85]

An additional agricultural trial was conducted in the Honouliuli area for the cultivation of sisal, a plant used to make fibers for rope and other material. Some sisal was planted before 1898 and production continued until the 1920s (Frierson 1972:16). This was grown mainly on the coastal plain of Honouliuli in Kānehili, just *mauka* of Kualakaʻi Beach (now Nimitz Beach). An article in the *Paradise of the Pacific* in 1902 described this venture in glowing terms.

> The venture was made and a tract of land containing a large percentage of disintegrated coral, in the neighborhood of Ewa Plantation, where nothing else would grow, was chosen for the planting. . . . The Hawaiian Fiber Co., which Mr. Turner organized, and of which he is now manager, has 755 acres under fence, two and a half miles of which is stone wall with good gates at convenient places. . . . In a large field containing 130 acres, mauka of the Oahu Railway & Land Co. track, the first harvest is to be gathered in a few months. . . . Out of this section of 130 acres the company has figured on securing 50 tons of clean fiber, for which it is offered eight cents per pound in Honolulu or nine cents per pound in San Francisco. (*Paradise of the Pacific* March 1902:17)

As in Honouliuli, the cultivation of sisal was attempted on other arid lands in ʻEwa. Thrum's *Hawaiian Almanac and Annual* speaks of the prospect of sisal cultivation glowingly from 1904 to 1913, but the greater profits to be made from sugar cane cultivation eventually led to the decline of this industry. Upper Hōʻaeʻae seems to have been the focus for sisal cultivation in central ʻEwa, as shown in excerpts from the 1909 and 1913 annuals.

> The Hawaiian Fiber Co. increases its capital stock to $150,000, over 500 acres of new planting having been set out on their recently acquired Hoaeae land, and work being pushed to cover the entire tract of some 1,800 acres. [Thrum 1909:167]
>
> New and enlarged machinery for the sisal decorticating mill has been installed at the Pouhala station of the company on the upper Hoaeae lands, with which to care for the fibre product from their enlarging area. Some 1750 acres are now planted out, including the fields of Sisal. [Thrum 1913:170-171]

An attempt to grow cotton was made on "the semiarid uplands at Kunia and Waipahu" in the early twentieth century, but the enterprise was not profitable (Krause 1911:66).

Besides sisal, cotton, and pineapples, other crops were grown in central ʻEwa, such as macadamia nuts.

> At Hoaeae, in the Ewa district, is another tract of about six acres on the Robinson estate, reported to be in fine condition. . . Mr. Grant Bailey, manager of the Hoaeae Ranch, kindly furnishes the following data on the infant industry. . . 'Our planting is about six acres. Apparently one would have to wait about ten years before expecting commercial results on the planting. Our oldest trees are seven years old and they are just now beginning to bear.' [Thrum 1927:96]

In spite of these many introduced crops, some Hawaiian families continued to live in ʻEwa and preserve the traditional lifestyle into the early twentieth century, including at the fishing village of Kualakaʻi in Honouliuli. One resident, Mrs. Eli Williamson, recalled the following:

> In the Honouliuli area the train stopped among the *kiawe* (algaraboa) trees and *malina* (sisal) thickets. We disembarked with the assorted food bundles and water containers. Some of the Kualakaʻi *ʻohana* (family) met us to help carry the *ʻukana* (bundles) along a sandstone pathway through the *kiawe* and *malina*. The distance to the frame house near the shore seemed long. When we departed our *ʻukana* contained fresh lobsters, *limu* (algae), fish and *iʻa maloʻo* (dried fish) . . . [Williamson in Kelly 1985:160]

3.1.13 History of the Oahu Railway and Land Company (OR&L)

In 1886, Campbell and B.F. Dillingham put together the “Great Land Colonization Scheme,” which was an attempt to sell Honouliuli land to homesteaders (Thrum 1887:74). This homestead idea failed; two factors for the failure were the lack of water and the distance from ʻEwa to Honolulu. The water problem was solved by the drilling of artesian wells, and Dillingham decided that the area could be used instead for large-scale cultivation (Pagliaro 1987:4). The transportation problem was to be solved by the construction of a railroad, which B. Franklin Dillingham soon began to finance under the company name of the Oahu Railway and Land Company (OR&L).

During the last decade of the nineteenth century, the railroad reached from Honolulu to Pearl City in 1890, to Waiʻanae in 1895, to Waialua Plantation in 1898, and to Kahuku in 1899 (Kuykendall 1967:3:100). This railroad line eventually ran across the center of the ʻEwa Plain at the lower boundary of the sugar fields (Figure 7 and Figure 8). To attract business to his new railroad system, Dillingham subleased all land below 200 ft to William Castle, who in turn sublet the area to the newly formed Ewa Plantation Company (Frierson 1972:15). Dillingham’s Honouliuli lands above 200 ft that were suitable for sugar cane cultivation were sublet to the Oahu Sugar Company. Throughout this time, and continuing into modern times, cattle ranching continued in the area, and Honouliuli Ranch—established by Dillingham was—the “fattening” area for the other ranches (Frierson 1972:15).

Operations at the OR&L began to slow down in the 1920s, when electric streetcars were built for public transportation within the city of Honolulu and automobiles began to be used by families for transportation outside the city (Chiddix and Simpson (2004:185). The build-up to World War II turned this decline around, as the U.S. military utilized the OR&L lines to transport materials to build defense projects around the island. Historians have noted that one of the most serious mistakes made by the Japanese in their 1941 attack on Pearl Harbor was their decision not to bomb the railway infrastructure. Soon after the attack, the OR&L operated 24 hours a day, transporting war materials and troops from Honolulu to the new and expanded army, naval, and air bases. The huge navy base at Pearl Harbor had its own rail lines that connected to the OR&L rail lines.

In August 1945 the war ended, and so did OR&L’s heyday as a military transport line.

> She had served her country well and proudly during the war, but operating round-the-clock on what little maintenance could be squeezed in, had taken a prodigious hit on the locomotives and track. Traffic stayed steady for a short time, but soon dropped precipitously as soldiers and sailors went home, military posts were shrunk or razed, and civilians could again get tires, gasoline and new cars. [Chiddix and Simpson 2004:257]

Figure 7. 1890 photograph of Pearl Harbor with OR&L railroad tracks along the coast (*Honolulu Advertiser* Archives)

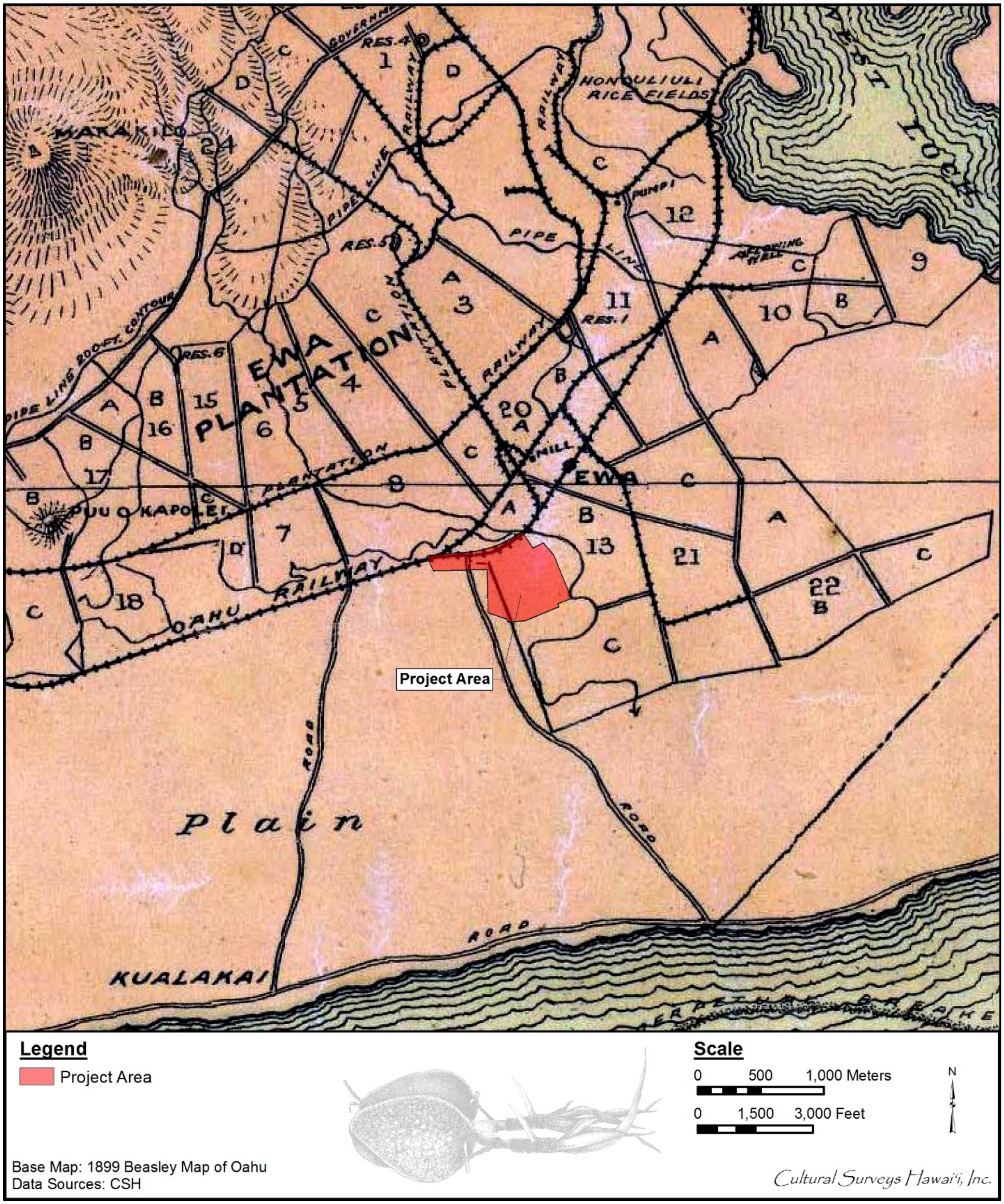

Figure 8. 1899 Beasley map of O'ahu depicting the OR&L railway corridor and the Ewa Plantation Company fields in relation to the current project area

There was no choice but to abandon the OR&L main line and in 1946 Water F. Dillingham, son of B.F. Dillingham, wrote,

> The sudden termination of the war with Japan changed not only the character of our transportation, but cut the freight tonnage to a third and the passenger business to a little above the pre-war level. With the increased cost of labor and material and the shrinkage in freight tonnage and passenger travel, it was definite that the road could not be operated as a common carrier. With no prospect of increased tonnage, and the impossibility of increasing rates against truck competition, your management has applied to the Interstate Commerce for authority to abandon its mainline. [Walter Dillingham in Chiddix and Simpson 2004:257]

After the war, most of the 150+ miles of OR&L track were pried up, locomotives were sold to businesses on the U.S. mainland, and railway cars were scrapped. In 1947, the U.S. Navy took over a section of the OR&L track for their own use to transport bombs, ammunition, and torpedoes from the ammunition magazines at Lualualei, West Loch in Pearl Harbor, and Waikele on OR&L's Wahiawā Branch to Pearl Harbor Naval Base (Treiber 2005:25-26). The track to Waipahu was abandoned in the 1950s, but the line from the magazines in Lualualei to the wharves in West Loch at Pearl Harbor remained open until 1968.

3.1.14 History of the Sugar Plantations of ʻEwa

Although sugar cane was already being grown as far back as the early 1800s, the industry revealed its economic potential in 1879 when the first artesian well was drilled in ʻEwa (Ellis 1995:22). The availability of subsurface water resources enabled greater irrigation possibilities for expanding plantations besides the use of water diversions from the surrounding stream systems. This prompted the drilling of many other wells throughout the Hawaiian Islands, thereby commencing the Hawaiʻi sugar plantation era. By the early 1900s, all the main Hawaiian islands had land devoted to the production of sugar cane.

Agricultural field systems, railroads, and residential areas in ʻEwa were developed by three sugar cane companies: the Ewa Plantation, located largely in the *ahupuaʻa* of Honouliuli and Hōʻaeʻae in the western section of ʻEwa; the Oahu Sugar Company, extending in the areas upland of the Ewa Plantation in central ʻEwa, including a portion of the uplands of Waiawa; and the Honolulu Plantation Company, with fields extending through Mānana to Hālawa in the eastern section of ʻEwa.

The Ewa Plantation Company was incorporated in 1890 for sugar cane cultivation (see Figure 8). The first crop, 2,849 tons of sugar, was harvested in 1892 at the Ewa Plantation (Figure 9). Ewa was the first all-artesian plantation, and it gave an impressive demonstration of the part artesian wells were to play in the later history of the Hawaiian sugar industry (Kuykendall 1967:3:69). As a means to generate soil deposition on the coral plain and increase arable land in the lowlands, the Ewa Plantation Company installed ditches running from the lower slopes of the mountain range to the lowlands. When the rainy season began, they plowed ground perpendicular to the slope so that soil would be carried down the drainage ditches into the lower coral plain. After a few years, about 373 acres of coral wasteland were reclaimed in this manner (Immisch 1964:3). By the 1920s, Ewa Plantation was generating large profits and was the "richest sugar plantation in the world" (*Paradise of the Pacific,* December 1902:19-22 in Kelly 1985:171).

Figure 9. Ewa Plantation Company sugar cane fields, Filipino Camp area, ca. 1925 (University of Hawaiʻi at Mānoa Digital Photograph Collection)

During the twentieth century, the Ewa Plantation continued to grow and by the 1930s, encompassed much of the eastern half of Honouliuli Ahupuaʻa, including the current project area (Figure 10). This growth impelled the creation of plantation villages to house the growing immigrant labor force working the fields. After the outbreak of World War II, which siphoned off much of the plantation's manpower, along with the changeover to almost complete reliance on mechanical harvesting in 1938, the plantation no longer supported the large multi-racial (Japanese, Chinese, Okinawan, Korean, Portuguese, Spanish, Hawaiian, Filipino, European) labor force that had characterized most of the early history of the plantation. The Oahu Sugar Company took control over the Ewa Plantation lands in 1970 and continued operations until 1995, when they decided to shut down sugar cane production in the combined plantation areas (Dorrance and Morgan 2000:45, 50).

3.1.15 The Military Development of ʻEwa

Major land use changes came to Honouliuli when the U.S. military began development in the area. Military installations were constructed both near the coast, as well as in the foothills and upland areas. Military development within the Honouliuli area included Barbers Point Military Reservation (a.k.a. Battery Barbers Point from 1937–1944). Located at Barbers Point Beach, it was used beginning in 1921 as a training area for firing 155 mm guns (Payette 2003). Also in the vicinity was Gilbert Military Reservation, used from 1922–1944. Barbers Point Naval Air Station, in operation from 1942 into the 1990s, was the largest and most significant base built in the area. It housed numerous naval and defense organizations, including maritime surveillance and anti-submarine warfare aircraft squadrons, a U.S. Coast Guard Air Station, and components of the U.S. Pacific Fleet. Fort Barrette (a.k.a. Kapolei Military Reservation and Battery Hatch), located atop Puʻu Kapolei, was in use from 1931 to 1948 for housing four 3-inch (7.6 cm) anti-aircraft batteries (Payette 2003). In the 1950s, the site was used as a NIKE missile base. Palailai Military Reservation, located atop Puʻu Pālailai in Makakilo, was in service from 1921, housing Battery Palailai and Fire Control Station B (Payette 2003).

In 1932, the U.S. government leased 206 acres from the Campbell Estate to construct a mooring mast to receive the dirigible aircraft, the *Akron*. The airship was built in 1931 and was the largest helium filled airship in the world at the time. Before it could arrive on Oʻahu, the *Akron* crashed during flight in a storm. The next landing for a large airship was scheduled to be the *Macon*. Like the *Akron*, *Macon* also crashed in a storm. After the disaster, the Navy scaled back its large dirigible program (Tuggle and Tomonari-Tuggle 1997).

The area remained largely unused until 1940, when the Marine Corps Air Station, Ewa, was constructed on the land. The mooring mast that was never used was refitted by the Marines to be a control tower, which gave the field its name, the Ewa Mooring Mast Field. The mast was finally dismantled in 1942 to make room for additional runway expansions and air support. In 1941, the airfield was relatively sparse—two runways, two hangers, 12 buildings, housing, a mess, and some tents (Department of Navy BRAC PMO 2006). By early 1941, units started to arrive in anticipation of possible war. In October 1941, the Pacific Naval Air Command commissioned a station on Barbers Point, thus making it home to two air stations. Although the Marines had been using Mooring Mast Field as emergency support since 1940, Ewa Marine Corps Air Station was officially established on 1 September 1942 and the Naval Air Station Barbers Point was commissioned on 15 April 1942 (Department of Navy BRAC PMO 2006).

Figure 10. 1939 map of the Ewa Plantation Company depicting the location of the current project area

On 7 December 1941, 49 planes were stationed at Ewa Mooring Mast Field, intended as auxiliary support for Naval Air Station Ford Island. When the Japanese attacked Pearl Harbor, they also destroyed nearly half the planes stationed at Barbers Point Station. After the attack and with the United States heading to war, Barbers Point became an important area for staging war in the Pacific theater. Base operations intensified and more hangers, quarters, and administrative buildings were constructed. The main mission for the Air Station was to maintain the Naval aircraft and personnel, train personnel, and store and repair aircraft (Tuggle and Tomonari-Tuggle 1997).

Barbers Point Naval Air Station was eventually decommissioned by the Navy in 1998 as part of the large scale base realignment and closure (BRAC) action. The station was turned over to the state of Hawaiʻi and renamed Kalaeloa Airport (Department of Navy BRAC PMO 2006).

3.1.16 Residential and Commercial Development in ʻEwa

Three topographic maps show the extensive changes in commercial and residential development in the twentieth century. On a 1919 U.S. War Department map, the proposed Honouliuli Wastewater Facilities project area crosses mainly through undeveloped sugar cane fields, crossed only by the OR&L railroad and its stations, and the numerous railroad track sections of the Ewa Plantation Company, which extended from the inland fields to the sugar mills (Figure 11). On the 1953 topographic map, the crisscross of railroad tracks is missing, replaced with numerous roads and dense residential neighborhoods at ʻEwa Villages (Figure 12). The Barbers Point Naval Air Station can also be seen on this map. By 1968, the buildings in the location of the wastewater treatment plant have been removed, most likely due to construction of the plant (Figure 13). On the 1998 topographic map, many of these naval reservation lands have shrunk, replaced by golf courses, large shopping complexes, and new neighborhoods that extend inland (see Figure 1).

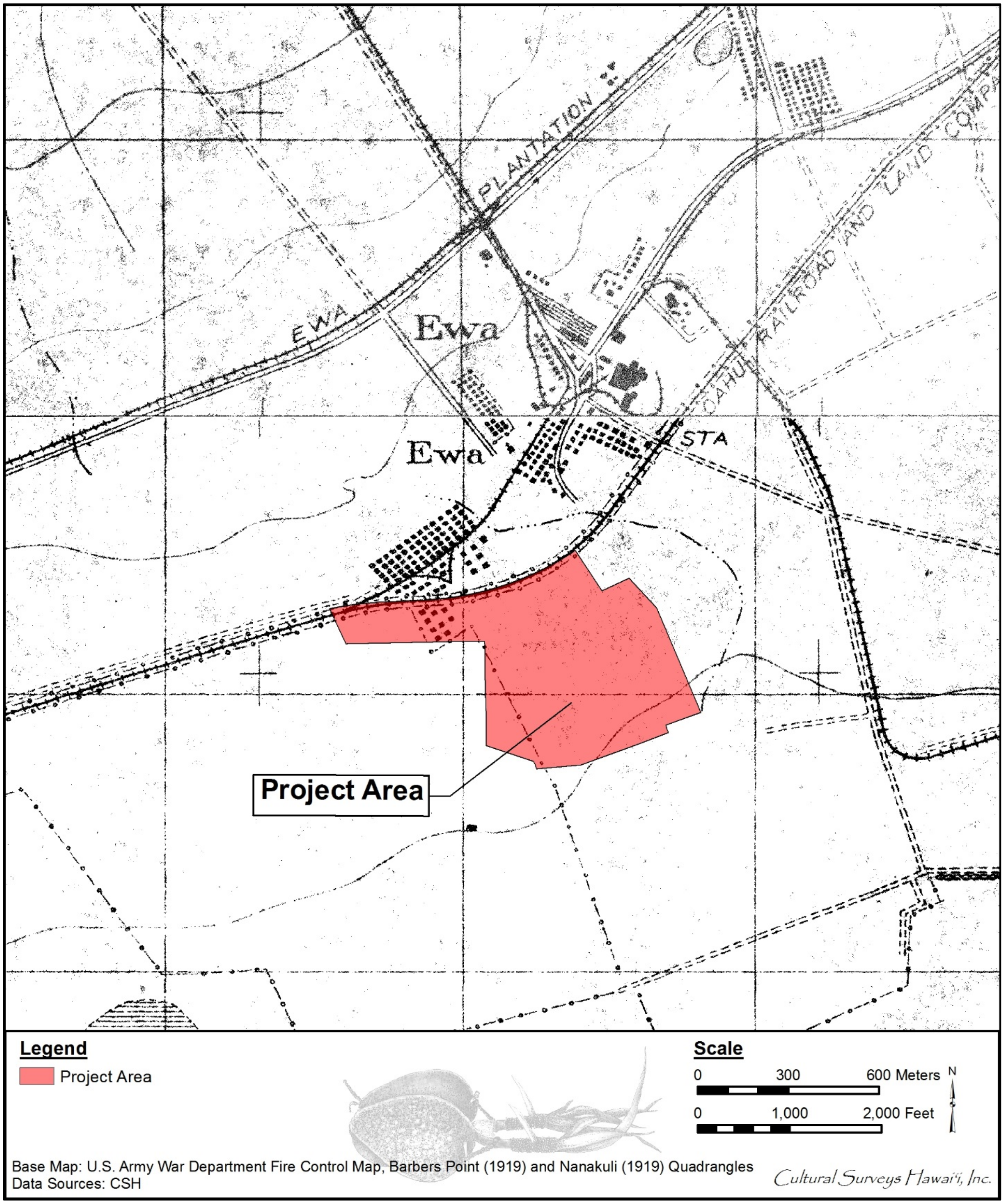

Figure 11. U.S. Army War Department Fire Control map, Barbers Point (1919) and Nanakuli (1919) quadrangles, showing the project area

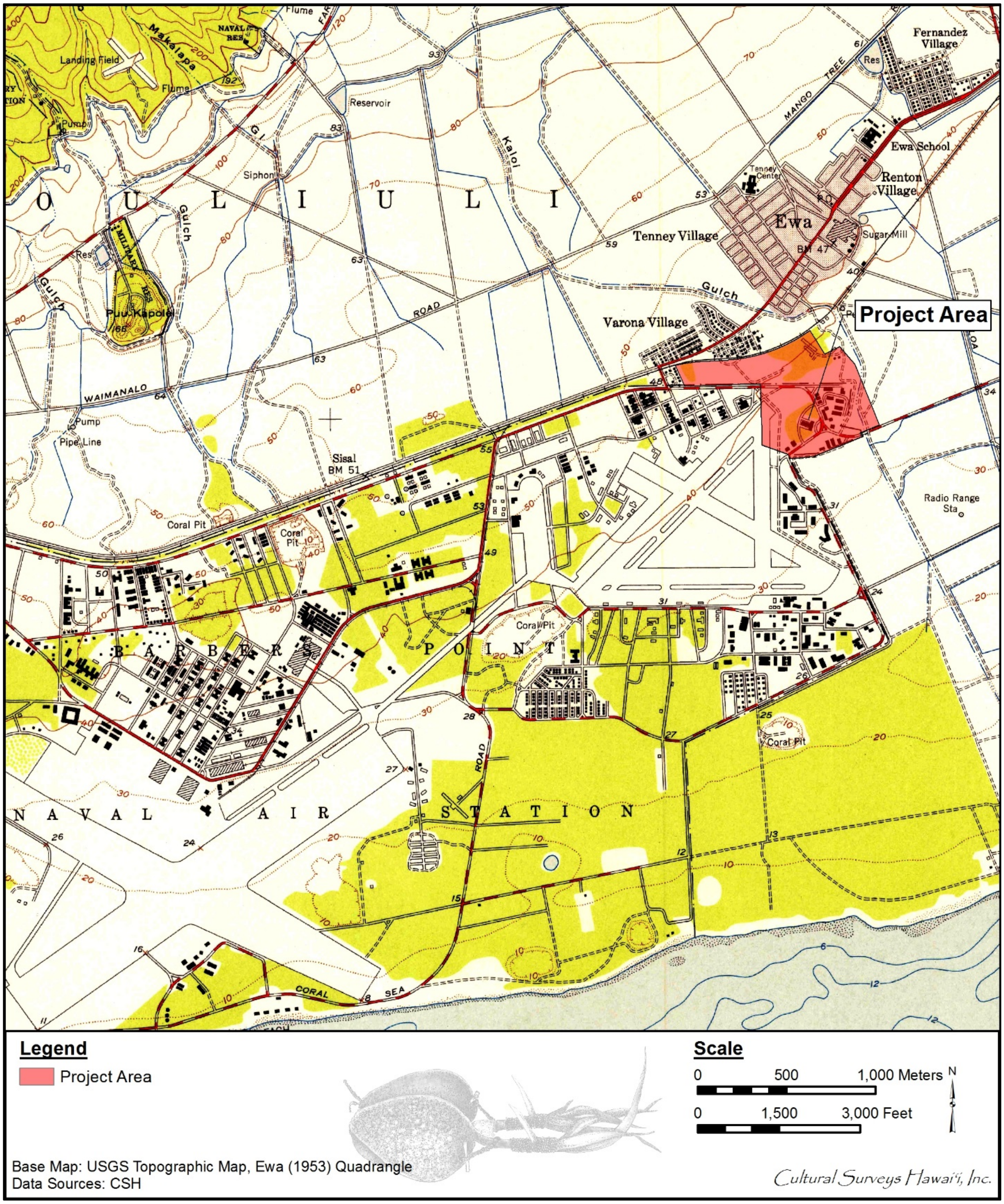

Figure 12. Portion of 1953 Ewa USGS topographic quadrangle, showing project area

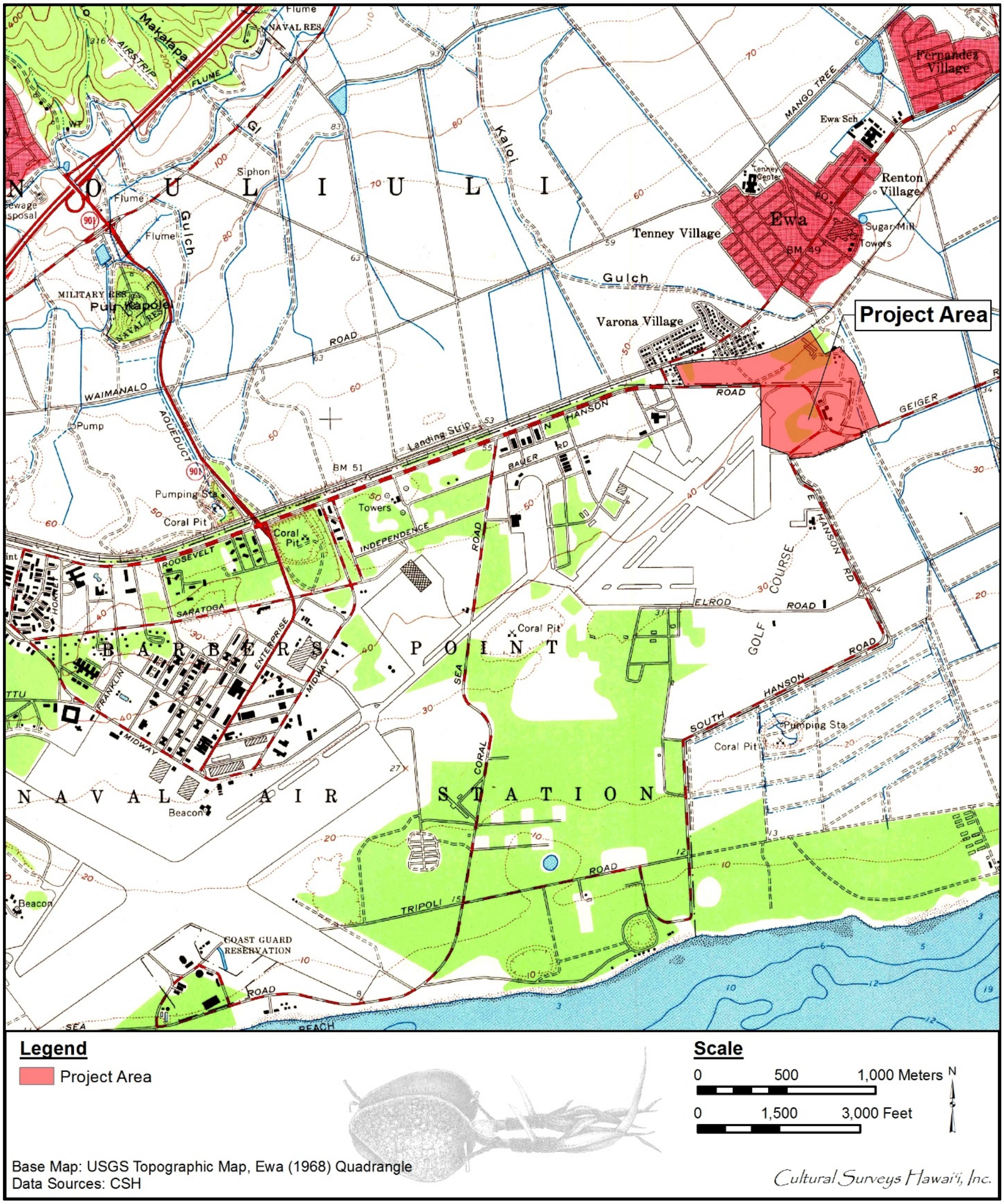

Figure 13. 1968 Ewa USGS 7.5-Minute topographic quadrangle, showing project area

3.2 Previous Archaeological Research

Previous archaeological studies conducted within a 0.8 km (0.5 mile) radius of the current project area are listed in Table 1 and depicted on Figure 14. Previously recorded historic properties are depicted on Figure 15 and listed in Table 2. A discussion of the projects conducted within and in the immediate vicinity of the project area is listed below.

Table 1. Previous Archaeological Studies in the Vicinity of the Project Area

Reference	**Type of Study**	**Location**	**Results (SIHP # 50-80-12)**
Welch 1987	Archaeological reconnaissance survey	Ewa Marine Corps Air Station at Barbers Point Naval Air Station	Two sites, SIHP #s -3721 and -3722, documented; both sites recommended eligible for National Register
Davis 1988	Sub-surface survey	‘Ewa Gentry	No historic properties recorded; no additional work recommended
Kennedy 1988	Archaeological reconnaissance survey	‘Ewa Gentry	No potential for subsurface properties; no additional work recommended
Hammatt and Shideler 1989	Archaeological and paleontological assessment	‘Ewa Marina	No cultural features recorded; recommended intensive archaeological survey for Phase I lands
Hammatt et al. 1990	Archaeological reconnaissance survey	‘Ewa Village	No additional sites documented, ‘Ewa Village Historic District confirmed and recommended eligible for National Register
Jones 1993	Phase I archaeological survey	Barbers Point Naval Air Station	Recorded 274 sites, only seven not recommended for further study
Spear 1996	Archaeological reconnaissance	North and west of ‘Ewa	No cultural resources documented and no additional recommendations
Hammatt and Chiogioji 1997a, b	Archaeological reconnaissance survey	Proposed corridor connecting H-1 to *makai* portions of ‘Ewa	No further work recommended; consultation needed for two historic properties, SIHP #s -9786 (‘Ewa Village Historic District) and -9814 (OR&L ROW)
Tuggle and Tomonari-Tuggle 1997	Cultural resource inventory	Barbers Point Naval Air Station	Recorded 101 sites and 107 buildings; all recommended eligible for National Register

Reference	**Type of Study**	**Location**	**Results (SIHP # 50-80-12)**
McIntosh and Cleghorn 1999	Archaeological archival research report	Honouliuli Wastewater Treatment Plant	Determined little likelihood of encountering surface resources, but subsurface resources in form of sinkholes or burials possible
O’Hare et al. 2007	Archaeological assessment	Ewa Industrial Park, TMK: [1] 9-1-069:003	Identified no historic properties in area adjacent to north and east sides of Honouliuli Wastewater Treatment Plant (considered for shafts 1A, 1B, and 1C)
Runyon et al. 2010	Archaeological monitoring	North-South Rd (H-1 to Kapolei Pkwy)	No archaeological cultural deposits identified
O’Hare et al. 2011	Archaeological field inspection and literature review	Honouliuli Wastewater Treatment Plant and incoming pipe easements	Inspected 67 acres over entire Ewa and central portions of Honouliuli, Hōʻaeʻae, Waikele, Waiawa, Mānana, Waimalu, and Hālawa Ahupuaʻa; recommended on-call and inventory survey for various locations
Hammatt and Shideler 2012	Archaeological field inspection and literature review	Coral Sea Rd intersections and Roosevelt Ave at Philippine Sea Rd	No historic properties; monitoring plan recommended due to potential for historic properties

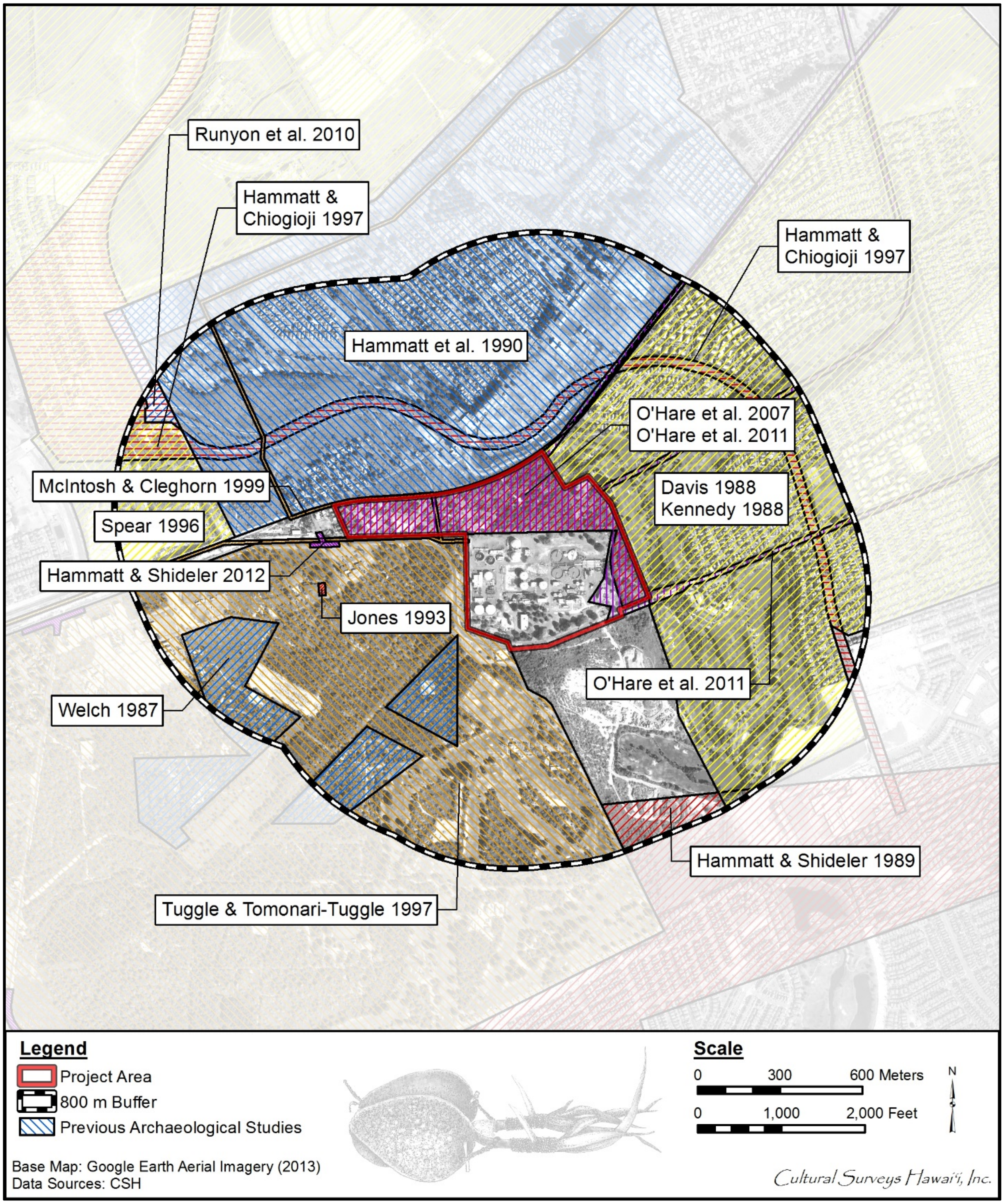

Figure 14. Previous archaeological investigations in Honouliuli in the vicinity of the Honouliuli WWTP

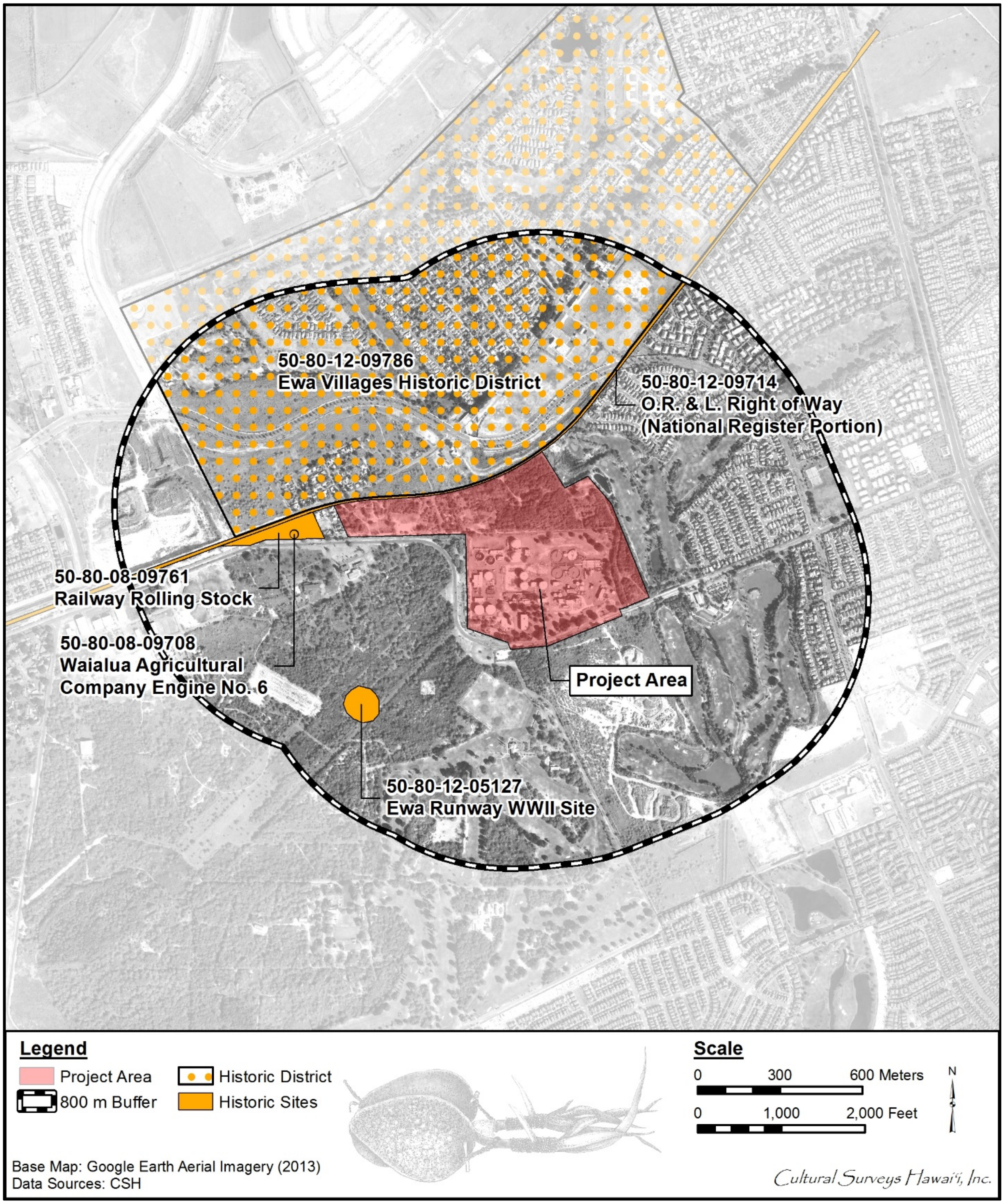

Figure 15. Previously recorded archaeological sites within a 0.8 km (0.5 mile) radius of the project area

Table 2. Sites Located within a 0.8 km (0.5 mile) Radius of the Project Area

SIHP # 50-80-12-	**Site type**	**Description**	**Significance**	**Reference**
5127	Military	7 December 1941 WWII ‘Ewa runway site	A and D, per HAR §13-284-6	Tuggle and Tomonari-Tuggle 1997
9708	Sugar plantation Infrastructure	Waialua agricultural company Engine No. 6	On National Register	NRHP nomination form
9714	Sugar plantation Infrastructure	OR&L ROW	On National Register	Hammatt and Chiogioji 1997
9761	Sugar plantation Infrastructure	Railway rolling stock	On Hawai‘i Register	HRHP nomination form
9786	Sugar plantation Infrastructure	‘Ewa Village Historic District	On National Register	Hammatt and Chiogioji 1997

3.2.1 Barbers Point (Ewa Marine Corps Air Station and Naval Air Station Barbers Point) (Welch 1987; Jones 1993; Tuggle and Tomonari-Tuggle 1997)

In 1987, International Archaeological Research Institute, Inc. (IARII) (Welch 1987) conducted an archaeological reconnaissance at the former Ewa Marine Corps Air Station for a proposed light anti-aircraft missile battalion. Fieldwork included pedestrian survey of the 100-acre project area. Two archaeological sites were recorded, SIHP #s -3721 and -37722. SIHP # -3721 consists of a complex of five traditional Hawaiian features including walls and C-shape shelters. SIHP #-3722 consists of a coral wall related to early historic ranching and farming. Both sites were determined eligible for inclusion in the National Register and mitigation in the form of intensive survey and data recovery was recommended.

In 1993, IARII conducted a Phase I archaeological inventory survey of proposed Barbers Point family housing (Jones 1993). A 100% pedestrian survey was conducted of the area. This survey was supplemented with targeted excavations of archaeological features. In total, 274 archaeological features were recorded, with five sites previously recorded by the Bishop Museum confirmed. Of the 247 sites recorded, only seven were recommended as not eligible for the National Register and no further work was recommended.

In 1997, IARII conducted a cultural resource inventory for the Naval Station at Barbers Point (Tuggle and Tomonari-Tuggle 1997). The report is part of a larger inventory of archaeological, paleontological, and paleoenvironmental studies of the area. As a result of the survey, 101 archaeological sites and 107 historic buildings were recommended eligible for the National Register and all were recommended for further work.

3.2.2 ‘Ewa Marina (Hammatt and Shideler 1989)

In 1989, CSH conducted an archaeological and paleontological assessment of the Phase II ‘Ewa Marina Lands in Honouliuli (Hammatt and Shideler 1989). The result of the survey determined that a vast majority of the land had been intensively cultivated for many years. No cultural resources were recorded within Phase II lands, but based on prior recommendations from Davis (1979), it was recommended that the Phase I lands be subjected to intensive survey prior to construction.

3.2.3 ‘Ewa Village (Hammatt et al. 1990; Spear 1996)

In 1990, CSH (Hammatt et al. 1990) conducted an archaeological reconnaissance survey of the 616-acre ‘Ewa Villages project area, which is adjacent to the northern border of the current project area. The project area included three extant plantation villages (Renton Village, Tenney Village, and Varona Village), the sites of three former plantation villages (C Village, Mill Village, and Middle Village), and several other sites associated with the ‘Ewa Plantation infrastructure, (the Plantation Cemetery, the ‘Ewa Japanese School, ‘Ewa Depot, the site of a previous Buddhist temple burned down in World War II, and a former reservoir site), and fields then under sugar cane cultivation. The surface survey of the land found no evidence of any prehistoric features within the project area and concluded that no further archaeological research in association with concerns for Hawaiian prehistory was necessary. However, because of the historic preservation concern ‘Ewa Villages has merited, further documentation of some of the ruined historic sites was recommended.

In 1996, Scientific Consultant Services (Spear 1996) conducted an archaeological survey in an area west of the Tenney and Varona plantation villages and north of the Honouliuli Treatment Plant. No archaeological sites were identified.

The northeast boundary of the project area (outside the fenced area) is the alignment of the OR&L ROW. This railroad bed, from the intersection with Fort Weaver Road to the intersection of Farrington Highway and Lualualei Road in Nānākuli is currently listed on the National Register of Historic Places (Site 50-80-12-9714).

3.2.4 ‘Ewa Gentry (Kennedy 1988; Davis 1988; McIntosh and Cleghorn 2003)

In the initial reconnaissance of the 1,016 acre ‘Ewa Gentry survey area (Kennedy 1988), no surface evidence of potentially significant pre-Contact remains was found. The old OR&L railroad bed/ROW (Site 50-80-12-9714) did form a portion of the *mauka* boundary. According to historic maps, a Filipino Camp for sugar cane workers once existed near the intersection of the OR&L bed and a cane road near Fort Weaver Road, but the archaeologists did not find any surface remains for this camp. A subsequent subsurface exploration was undertaken. Eighteen backhoe trenches were excavated; however, “no evidence of past in situ cultural activity was found anywhere in the ‘Ewa Gentry project area” (Davis 1988). The archaeologists found that soil was only about 1 m deep over a coral substrate, and that their project area was “apparently situated on an ancient upper rim of Hono‘uli‘uli Valley” (Davis 1988:4).

In 2003, Pacific Legacy (McIntosh and Cleghorn 2003) conducted an archaeological survey of the proposed ‘Ewa Gentry Makai Development project area, which is adjacent to the southern (*makai*) boundary of the ‘Ewa Gentry project area for the 1988 surface and subsurface inventory surveys (Kennedy 1988; Davis 1988). No surface pre-Contact features were noted.

3.2.5 North-South H-1 Connection (Hammatt and Chiogioji 1997; Runyon et al. 2011)

In 1997, CSH conducted an archaeological reconnaissance survey of a 8,872 m (20,100 ft) alignment of a proposed connection from ‘Ewa to the H-1 interstate (Hammatt and Chiogioji 1997). No prehistoric or early historic Hawaiian archaeological sites or surface finds were encountered during the archaeological reconnaissance within the project area. Plantation constructions—remnants of flumes and a ditch—and roadways were observed within portions of the corridor that have not been developed since the sugar cane era. No further archaeological investigations were recommended for the entire project area corridor and on-site or on-call monitoring was not justified during future construction activities.

In 2010, CSH conducted archaeologic monitoring for the construction of the north-south connection from Kapolei Parkway to the H-1 (Runyon et al. 2010). Ground disturbance included filling, grading, for the new road, trenching for subsurface utilities, excavation of a flood control canal along the eastern side of the roadway, trenching for drainage culverts beneath the roadbed, and the excavation of large drainage basins at the *makai* end of the project area. No archaeological cultural deposits were identified as a result of the project’s monitoring program. Due to heavy commercial use of the project area and extensive construction work conducted in association with the current project, archaeological monitoring for future projects within the current project area was not recommended.

3.2.6 Ewa Industrial Park (O'Hare et al. 2007)

In 2007, CSH (O'Hare et al. 2007) conducted an assessment of the proposed Ewa Industrial Park. The project area was in a 48.18-acre fenced lot, bound on the north by the ROW along the existing track of the OR&L, which runs parallel to the *makai* side of Renton Road. The parcel was bound on all other sides by existing properties; a southern dog-leg section extends south to Geiger Road. The western portion of the project area (and a portion of the eastern section) was open, with livestock pastures and paddocks, houses and out-buildings. The central section had been extensively cleared of all vegetation and large rocks; this area was leased to private parties (such as for graduation parties, overnight scout troops, and the bon dance). Everywhere, there are large piles of rocks, trash and beer bottle piles, concrete, piled brush, and other evidence of extreme ground disturbance. No traditional surface Hawaiian features were found, and with the evidence of extreme ground disturbance in mind, it is highly unlikely there are any subsurface Hawaiian features intact. No sinkholes were found. There was also little evidence of post-Contact use by the Ewa Plantation, the OR&L Company, or the military.

3.2.7 Honouliuli Wastewater Treatment Plant (O'Hare et al. 2011)

In 2011, CSH (O'Hare et al. 2011) conducted an archaeological literature review and field inspection for various long-term improvements to the wastewater collection and disposal systems for the Honouliuli Wastewater Treatment Plant. The project took place in the Honouliuli, Waipahu, and Pearl City areas, within the Honouliuli, Hōʻaeʻae, Waikele, Waiawa, Manana, Waimalu, and Hālawa *ahupuaʻa*. Because of the large and expansive project area, various recommendations were made for different areas of the project. For the areas concerning the current project area, it was recommend that on-call monitoring take place. It is noted that the area is of relatively low archaeological concern and has been extensively disturbed by prior infrastructure construction (O'Hare et al. 2011).

3.2.8 Kalaeloa Life Safety Improvements (Hammatt and Shideler 2012)

In 2012, CSH conducted a field inspection and literature review for the proposed improvements to five separate sections of the Kalaeloa Life Safety Improvements (Hammatt and Shideler 2012). These five sections include the intersection of Coral Sea Road and Roosevelt Avenue, the intersection of Coral Sea Road and San Jacinto Street, the intersection of Coral Sea Road and Tripoli Street, the intersection of Coral Sea Road and Eisenhower Road, and the intersection of Roosevelt Avenue and Philippine Sea Road (approximately 1 km east of the intersection of Coral Sea Road and Roosevelt Avenue). These study areas are located on the eastern side of the former Barbers Point Naval Air Station. No archaeological sites were recorded during the course of the survey.

3.3 Background Summary and Predictions

The *ahupuaʻa* of Honouliuli is the largest traditional land unit on the island of Oʻahu. Honouliuli includes all the land from the western boundary of Pearl Harbor (West Loch) westward to the ʻEwa/Waiʻanae District Boundary with the exception of the west side of the harbor entrance, which is in the *ahupuaʻa* of Puʻuloa (the ʻEwa Beach/Iroquois Point area). This comprises approximately 12 miles of open coastline from Oneʻula westward to Pili O Kahe. The *ahupuaʻa* extends *mauka* (almost pie-shaped) from West Loch nearly to Schofield Barracks, and the western boundary is the Waiʻanae Mountain crest running *makai* to the east ridge of Nānākuli Valley.

Not only is there a long coastline fronting the normally calm waters of leeward O‘ahu, but there are also 4 miles of waterfront along West Loch. The land immediately *mauka* of the Pacific coast consists of a flat karstic raised limestone reef forming a level nearly featureless “desert” plain marked in pre-Contact times (previous to alluviation caused by sugar cultivation) by a thin or non-existent soil mantle. The microtopography is notable for containing countless sinkholes in some areas caused by chemical weathering (dissolution) of the limestone shelf.

Along the eastern flank of the Wai‘anae Mountains, numerous gulches have contributed to the alluvial deposits over the coastal limestone shelf. The largest of the gulches is Honouliuli Gulch, which drains into West Loch. The gulches are generally steep-sided in the uplands and generally of a high gradient until they emerge onto the flat ‘Ewa plain. The alluvium they have carried has spread out in delta fashion over the *mauka* portions of the plain, which comprises a dramatic depositional environment at the stream gradient change. These gulches are generally dry, but during seasonal Kona storms carry immense quantities of runoff onto the plain and into the ocean. As typical drainages in arid slopes, they are either raging uncontrollably, or are dry and, as such, do not form stable water sources for traditional agriculture in their upper reaches. The Honouliuli gulches generally do not have valleys suitable for extensive irrigated agriculture; however, this lack is more than compensated for by the rich watered lowlands near West Loch

In inland areas of concern, including the vicinity of the Honouliuli WWTP, there are no commoner Land Commission Awards and previous archaeological studies in these vicinities have indicated no concerns. The distance from the coast (and generally from fresh water) made these little used areas in the pre-Contact period.

As noted above (Figure 15 and Table 2), all of the previously recorded archaeological sites within a 0.8 km (0.5 mile) radius of the project area are post-contact in origin relating to sugar plantation Infrastructure, the OR&L or mid-twentieth century military activities.

The intensive land disturbance of a century of commercial cane cultivation probably removed most of what little evidence of pre-Contact use there ever was. The archaeological sensitivity of these areas is generally regarded as low.

Section 4 Results of Fieldwork

Fieldwork was accomplished on 24 October 2014 by Trevor Yucha, B.S. and David W. Shideler, M.A. under the general supervision of Principal Investigator, Hallett H. Hammatt, Ph.D. This work required approximately 1 person-day to complete.

4.1 Pedestrian Inspection Results

The northern and eastern relatively undeveloped portions of the project area amounting to an area of 48.18 acres was the subject of an archaeological assessment of the ‘Ewa Industrial Park project, Honouliuli Ahupua‘a, ‘Ewa District, O‘ahu (O’Hare et al. 2007) that was reviewed and accepted in an SHPD §6E-42 Historic Preservation Review dated 10 February 2009 (LOG NO.: 2009.0664, DOC NO.: 0902WT22; included here as Appendix A). The present study included a reconnaissance of the O’Hare et al. (2007) project area (Figure 16) but only for the purpose of documenting present conditions.

Presently, the northern and eastern undeveloped portions of the project area are overgrown with *kiawe* (*Prosopis pallida*), *koa haole* (*Leucaena leucocephala*), and exotic grasses. An unimproved access road extends roughly northwest-southeast within the eastern portion of the project area along the boundary of the current project area (Figure 17). In certain locations, features of the adjacent golf course are present along the access road and adjacent to the project area, including a plastic-lined retention pond and modern roofed structure (Figure 18). At the northernmost point of the project area, the OR&L ROW was observed on the north side of a chain link fence. The OR&L ROW extends along the entirety of the northern project area boundary (Figure 19). The modern agricultural structures noted by O’Hare et al. (2007) were confirmed and observed to be abandoned (Figure 20). These structures are constructed of plastic and wire fencing with plywood walls and cinder block foundations. These structures appear to be modern construction and are not considered historic properties. A modern gravel road was observed west of the agricultural structures extending from the north over the OR&L ROW and into the project area (Figure 21). The modern road appears to access an electrical substation and base yard area (Figure 22). No historic properties were identified within the undeveloped portions of the current project area.

The remaining southwestern portion of the project area including the heavily built-out wastewater treatment plant was subject to 100% pedestrian survey coverage during the current study (Figure 16). The wastewater treatment plant includes office and personnel buildings near the entrance off Geiger Road (Figure 23). Behind these buildings are various tanks, pools, and above-ground piping associated with the wastewater treatment process (Figure 24 and Figure 25). Asphalt paved access roads and parking areas are present throughout the facility. A dry drainage basin was observed on the southwestern corner of the project area (Figure 26). A storage shed with a nearby scatter of modern midden was observed along the western edge of the project area, just outside the treatment plant facilities (Figure 27). The entire facility is surrounded by chain link fence. No historic properties were identified within the wastewater treatment plant portion of the project area.

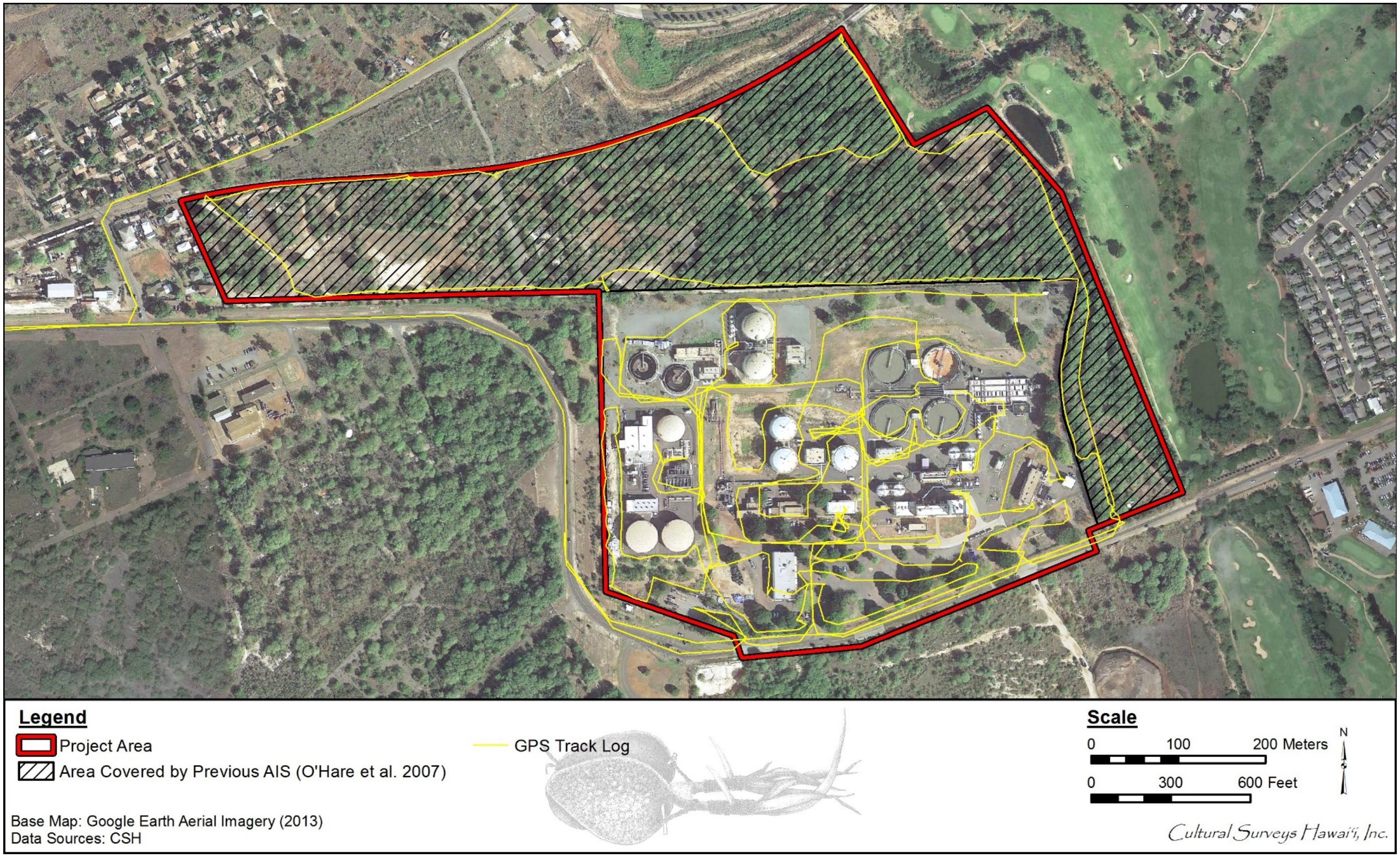

Figure 16. Track log of one of the two archaeologists during the pedestrian inspection

Figure 17. Overview of an unimproved access road in the eastern portion of the project area, view to northwest

Figure 18. View of portions of the adjacent golf course showing a retention pond and roofed structure, view to east

Figure 19. View of the OR&L ROW from the northernmost corner of the project area, view to north

Figure 20. View of the abandoned modern agricultural structures observed within the northern portion of the project area, view to southeast

Figure 21. View of gravel road extending northwest-southeast within the project area, view to southeast

Figure 22. View of electrical substation along gravel road, view to southeast

Figure 23. View of office or personnel buildings near the plant entrance off Geiger Road, view to northwest

Figure 24. Overview of wastewater treatment plant infrastructure, view to northeast

Figure 25. Overview of wastewater treatment plant infrastructure, view to south

Figure 26. View of dry drainage basin in the southwestern corner of the project area, view to west

Figure 27. View of storage shed with modern midden scatter (‘*opihi*), view to west

Section 5 Summary

At the request of AECOM Pacific, Inc., CSH completed an archaeological inventory survey, which due to the lack of historic properties is reported as an archaeological assessment, for the Honouliuli Wastewater Treatment Plant (WWTP) Secondary Treatment and Facility, Honouliuli Ahupuaʻa, ʻEwa District, Oʻahu TMK: [1] 9-1-013:007.

The northern and eastern relatively undeveloped portions of the project area amounting to an area of 48.18 acres was the subject of an *Archaeological Assessment of the ʻEwa Industrial Park Project, Honouliuli Ahupuaʻa, ʻEwa District, Oʻahu Island* (O'Hare et al. 2007) that was reviewed and accepted in an SHPD §6E-42 Historic Preservation Review dated 10 February 2009 (LOG NO.: 2009.0664, DOC NO.: 0902WT22; included here as Appendix A).

The fieldwork component of this archaeological inventory survey, which due to the lack of historic properties is reported as an archaeological assessment, was carried out under archaeological research permit number 14-04 issued by the Hawaiʻi SHPD per HAR §13-13-282. Fieldwork was accomplished on 24 October 2014 by Trevor Yucha, B.S. and David W. Shideler, M.A. under the general supervision of Principal Investigator, Hallett H. Hammatt Ph.D. This work required approximately 1 person-day to complete. Fieldwork included a pedestrian inspection of the entire project area, GPS data collection, and general documentation. No historic properties were identified within the project area.

Section 6 Project Effect and Mitigation Recommendations

6.1 Project Effect

No historic properties were identified within the approximately 100-acre project area. Consequently, CSH's effect recommendation for the proposed project is "no historic properties affected."

6.2 Mitigation Recommendations

No historic properties were identified within the current project area. The northern and eastern portions of the project area consist of undeveloped land initially surveyed by O'Hare et al. (2007) and inspected again during the current archaeological inventory survey, which due to the lack of historic properties is reported as an archaeological assessment. The southern portion of the project area has been entirely developed with infrastructure related to the Honouliuli Wastewater Treatment Plant. No further cultural resource management work is recommended for the project area.

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Appendix A SHPD Acceptance of Prior Archaeological Assessment for the North and East Portions of the Project Area

LINDA LINGLE
GOVERNOR OF HAWAII

LAURA H. THIELEN
CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES
COMMISSION ON WATER RESOURCE MANAGEMENT

RUSSELL Y. TSUJI
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AQUATIC RESOURCES
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CONSERVATION AND RESOURCES ENFORCEMENT
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HISTORIC PRESERVATION
KAHOOLAWE ISLAND RESERVE COMMISSION
LAND
STATE PARKS

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES

STATE HISTORIC PRESERVATION DIVISION
601 KAMOKILA BOULEVARD, ROOM 555
KAPOLEI, HAWAII 96707

February 10, 2009

Mr. David Shideler
Cultural Surveys Hawai'i
P. O. Box 1114
Kailua, Hawai'i 96734

LOG NO: 2009.0664
DOC NO: 0902WT22
Archaeology

Dear Mr. Shideler:

SUBJECT: 6E-42 Historic Preservation Review--
Archaeological Assessment--
of the ‘Ewa Industrial Park Project, Hono‘uli‘uli, ‘Ewa District, O‘ahu Island, Hawai‘i.
TMK: (1) 9-1-069: 003

Thank you for the opportunity to review this DRAFT Archaeological Assessment (*Archaeological Assessment of the ‘Ewa Industrial Park Project, Hono‘uli‘uli, ‘Ewa District, O‘ahu Island, Hawai‘i. TMK: (1) 9-1-069: 003 [O'Hare, Shideler and Hammatt PhD, March 2007]).* The survey area is 48.18 acres. The proposed project is the construction of an industrial park. No historic properties were recorded.

The initial communication from our office (LOG NO: 2006.3755/DOC NO: 0611amj12) requested some revisions. They included changes in wording in the Scope of Work, a clarification of the distance between crew members during pedestrian survey, an update of Figures 5 and 6, and a discussion on karstic sinkholes. The report was resubmitted and more revisions were requested by Lauren Morawski. These changes are clarification on the need for subsurface testing in the Introduction section; the distance between parallel sweeps in the Methods section; the addition of "View toward" in the captions for two photos, and a sinkhole discussion.

This report is accepted and it meets the minimum requirements for compliance with 6E-8 and Hawaii Administrative Rules (HAR) §13-13-276 *Rules Governing Standards for Archaeological Inventory Studies and Reports.*

The complete, finalized report should be free of errors, contain good quality color photographs, color maps and assigned State site numbers. Once this subject archaeological assessment survey report has received final acceptance pursuant to HAR §13-276, please send one hardcopy of the document, clearly marked FINAL, along with a copy of this review letter and a text-searchable PDF version on CD to the attention of Wendy Tolleson "**SHPD Library**" at the Kapolei SHPD office.

Mr. David Shideler
Page 2

Please call Wendy Tolleson at (808) 692-8024 if there are any questions or concerns regarding this letter.

Aloha,

Nancy A. McMahon

Nancy A. McMahon (Deputy SHPO)
State Historic Preservation Officer

Appendix D
Air Quality Analysis, Technical Memorandum, AECOM, November 2014

Water

Submitted to:
City and County of Honolulu
Department of Environmental Services
1001 Uluohia Street Suite 308
Kapolei, Hawaii 96707

Prepared by:
AECOM
1001 Bishop Street, Suite 1600
Honolulu, Hawaii 96813

Honouliuli/Waipahu/Pearl City Wastewater Facilities Plan

Air Quality Analysis

Technical Memorandum-*Final*
November 2014

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List of Acronyms

AS	activated sludge
BTU	British thermal units
CAA	Clean Air Act
CCH	City and County of Honolulu
cfm	cubic feet per minute
CH_4	methane
CHP	combined heat and power
CO	carbon monoxide
DBEDT	Hawaii Department of Business, Economic Development, and Tourism
DOH	Department of Health, State of Hawaii
EPA	Environmental Protection Agency, United States
GHG	greenhouse gas
HAPS	hazardous air pollutants
H_2S	hydrogen sulfide
HWBOCP	Honouliuli Wastewater Basin Odor Control Project
HWRF	Honouliuli Water Recycling Facility
kW	kilowatt
mgd	million gallons per day
NAAQS	National Ambient Air Quality Standards
NO_2	nitrogen dioxide
NO_x	nitrogen oxides
N_2O	nitrous oxide
NSPS	new source performance standards
NSR	new source review
O_3	ozone
O&M	operation and maintenance
Pb	lead
PM	particulate matter
ppm	parts per million
ppmV	parts per million by volume
PSD	prevention of significant deterioration
ROG	reactive organic gases
SC	solids contact
SO_2	sulfur dioxide
TPY	tons per year
TF	Trickling Filter
WWTP	wastewater treatment plant

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Executive Summary

An air quality analysis was conducted to evaluate the potential for impact as a result of the proposed upgrade and expansion of the existing Honouliuli Wastewater Treatment Plant (WWTP) to provide secondary treatment and accommodate projected wastewater flows, as well as the potential relocation of non-process facilities that support island-wide WWTPs and wastewater pump stations that are currently located at Sand Island WWTP to the Honouliuli WWTP site. This project is part of the Honouliuli/ Waipahu/Pearl City Wastewater Facilities Plan (Honouliuli Fac Plan) that is currently being prepared by the City and County of Honolulu (CCH) Department of Environmental Services (ENV). This analysis was conducted as part of an Environmental Impact Statement in accordance with the Hawaii Environmental Quality Control Act, codified as Chapter 341, Hawaii Revised Statutes (HRS) and Chapter 343, HRS, Environmental Impact Statement Law. The EPA is the federal agency that develops and enforces the regulations that help govern air quality on a national level and provides guidance at the state level. Air quality impacts are typically evaluated against the National Ambient Air Quality Standards (NAAQS), which were established as part of the 1970 federal Clean Air Act (CAA) in 1970 to protect the public health.

Since the facility expansion as incorporated in the Honouliuli Fac Plan would involve construction and operational activities that have potential air quality impacts, this assessment includes impact evaluation of:

- Construction activities focusing on the usage of equipment during varying phases
- Operation activities focusing on the addition of new stationary and mobile sources
- Odor effects identifying the change from existing to the proposed condition.

Under the full build plan condition,

- Construction duration could last 72, 108, or 144 months depending on the selection of contracts. Since the scale of project remains the same, the usage of equipment during varying phases would be greater under short-duration schedule as compared to longer construction period, resulting in greater short-term air quality impacts. However, the equipment to be utilized remains typical for infrastructure development projects in urban areas. Given the spreading of the construction activity over the years, hot spot air quality concerns associated with concentrated equipment operations would be limited and mobile, therefore construction impacts are anticipated to be less than significant.

- Operation of the plant under future proposed condition would involve installation of new standby generators to provide expanded emergency power supply from existing 3.8 MW to 12.55 MW causing a potential short-term increase in combustion source emissions on an annual basis. However, given their emergency usage purposes, potential air quality impacts would be short in duration unlikely causing significant air quality impacts. If these generators would also provide power shaving purposes during peak loading condition, greater air quality impacts would occur. The future CAA air permitting process would further ensure compliance with the NAAQS as a result of increasing stationary source operational emissions on site. Therefore, the proposed project would unlikely result in significant air quality impacts.

- Odor releasing points at the facility would increase in the secondary treatment area in comparison to the existing condition. The affected residences would likely include those located close to Renton Road and around the Coral Creek Golf Course. However, with consideration of the on-going and future odor control measures to be implemented at the facility's major odor generating sources, adverse ambient odor impacts would likely be reduced. The future ambient odor monitoring plan to be implemented would ensure the measured hydrogen sulfide concentration levels would be below the Hawaii ambient standard.

As a result, no significant air quality impacts are anticipated as a result of the proposed project. Therefore, no construction and operational air quality mitigation measures are required.

1 Introduction

1.1 Project Description

The City and County of Honolulu (CCH) Department of Environmental Services is in the process of developing the Honouliuli/Waipahu/Pearl City Wastewater Facilities Plan (Honouliuli Fac Plan) for the Honouliuli sewer basin. The intent of the Honouliuli Fac Plan is to define necessary improvements to the collection and treatment facilities to meet future flow demands and permit compliance.

The 2010 Consent Decree (Civil Number (No.) 94-00765 DAE-KSC) is an agreement between CCH, the State of Hawaii Department of Health (DOH), and the United States Environmental Protection Agency (EPA) that requires CCH to meet certain requirements with respect to its wastewater collection system and wastewater treatment plants (WWTPs). The 2010 Consent Decree mandates that the Honouliuli and Sand Island WWTPs be upgraded to secondary treatment facilities by 2024 and 2035, respectively.

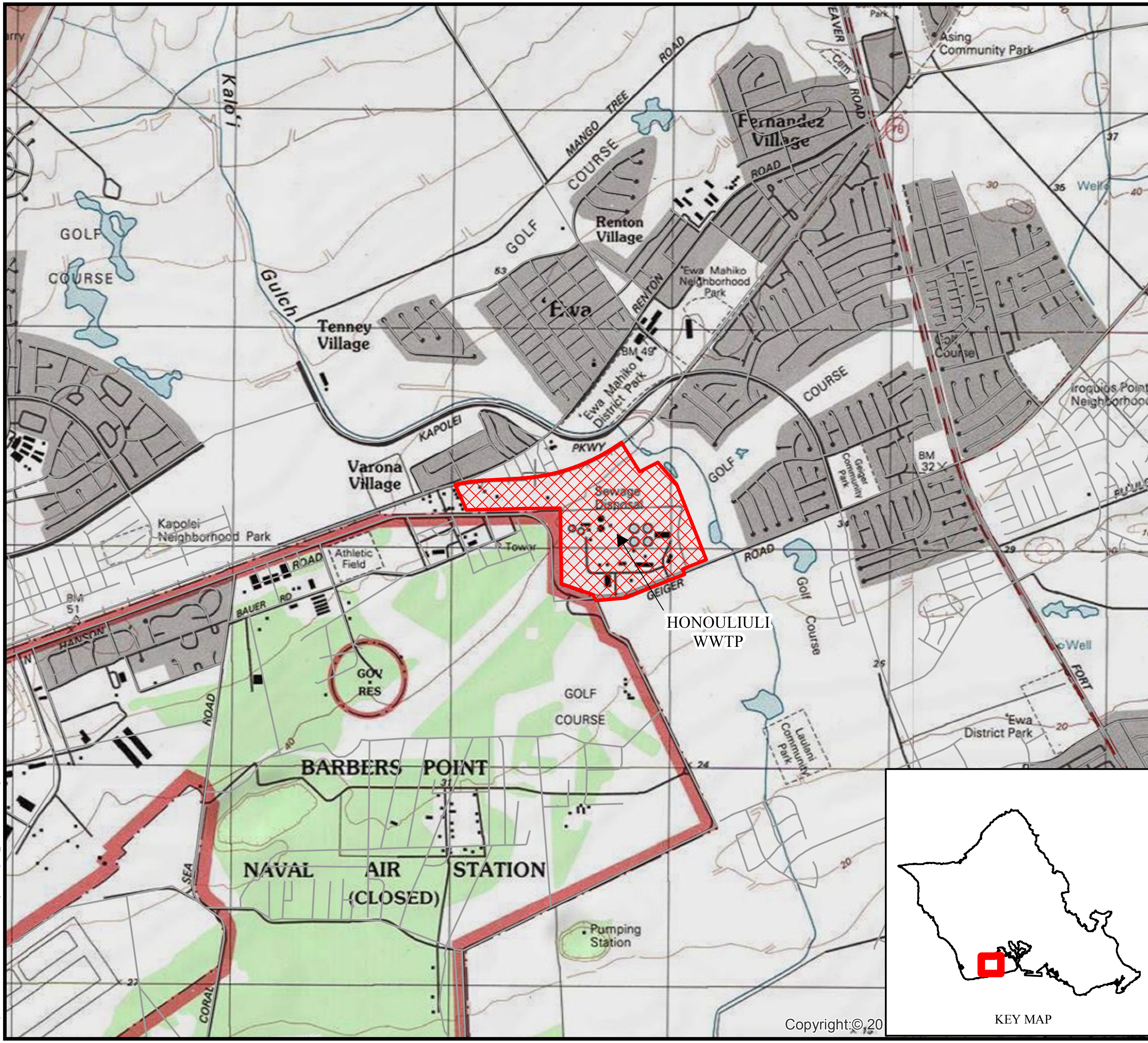
The WWTP was originally built in 1978 as a primary plant and became fully operational in 1984. The Honouliuli WWTP is the second-largest WWTP on Oahu, and has undergone numerous expansions and upgrades due to growth within the service area and additional treatment needs. The average daily flow to the WWTP was approximately 25.8 million gallons per day (mgd) in 2012. The rated design capacity is 38 mgd with one unit out of service and 51 mgd with all units in service according to the *Honouliuli WWTP Facility-Wide Operations Manual* (O&M Manual) (Fukunaga and Associates, Inc. and HDR Engineering, Inc., 2011). The WWTP provides primary treatment to all flow received. Approximately 13 mgd undergoes further secondary treatment. A portion of the secondary effluent is treated for water reuse at the CCH Board of Water Supply Honouliuli Water Recycling Facility (HWRF). The solids stream has a rated design capacity of solids generated from 42 mgd of primary treatment and 26 mgd of secondary treatment according to the *O&M Manual*.

In addition to the regulatory requirements established for secondary treatment, it is anticipated that there will be a future increased demand for reclaimed water from the HWRF. The *Ewa Non-Potable Water Master Plan* projected future non-potable maximum daily demand to be 24.6 mgd beyond 2015. Planning for the existing secondary treatment system began in 1990 as a first step toward reclamation of effluent for reuse through irrigation. The existing secondary treatment system was constructed in 1996, specifically for water reclamation purposes.

In 2011, CCH acquired 48.4 acres of land abutting the north and east boundaries of the existing Honouliuli WWTP to provide sufficient space for treatment and associated facilities to comply with the 2010 Consent Decree mandates. The Honouliuli WWTP site area is currently 100.5 acres.

The study area includes the existing Honouliuli WWTP located at 91-1000 Geiger Road and expansion property to the north and east, adjacent to the Coral Creek Golf Course. The Honouliuli WWTP project site is identified on **Figure 1-1**.

The proposed project assessed in this analysis concerns the upgrade and expansion of the Honouliuli WWTP to provide secondary treatment and accommodate projected wastewater flows, as well as addresses the potential location of non-process facilities to accommodate current needs that are not adequately met, future needs that will arise from upgrading Honouliuli and Sand Island WWTFs to secondary treatment, and other treatment and collection system support facilities that may currently be decentralized. Additional improvements at the Honouliuli WWTP are proposed for the following existing facilities: Central Laboratory, Ocean Team Facilities, Administration Building, Operations Building, Leeward Region Maintenance, Central Shops, Warehouse, truck wash, process Supervisory Control and Data Acquisition, septage receiving station, odor control, grounds keeping, janitorial service and security, and Honouliuli Water Recycling Facility.



City and County of Honolulu

HONOULIULI/ WAIPAHU/ PEARL CITY WASTEWATER FACILITIES PLAN

Legend

Honouliuli WWTP

Street

0 2,000

Feet

1 inch = 2,000 feet

FIGURE 1-1

PROJECT LOCATION MAP

December 2014

AECOM

1001 BISHOP ST, STE 1600
HONOLULU, HAWAII 96813

G:\Projects\MUNI\60220849HON\Maps\EI\Figure_1-1 Location Map.mxd

2 Air Quality Regulatory Settings

Air quality is defined by ambient air concentrations of specific pollutants of concern with respect to the health and welfare of the general public. Air quality can be affected by air pollutants produced by mobile sources, such as vehicular traffic, aircraft, or non-road equipment used for construction activities; and by fixed or immobile facilities, referred to as “stationary sources.” Stationary sources can include combustion and industrial stacks and exhaust vents. Potential air quality effects in the vicinity of the WWTP would occur from both construction and operational activities associated with implementation of the proposed improvements.

2.1 Definition of Resource

2.1.1 National and Hawaiian Ambient Air Quality Standards

As required by the Clean Air Act, federal standards have been established to maintain ambient air quality. The regulatory framework includes the National Ambient Air Quality Standards (NAAQS) for six major air pollutants. These pollutants, known as criteria pollutants, are: particulate matter (PM_{10} and $PM_{2.5}$), sulfur dioxide (SO_2), hydrogen sulfide (H_2S), nitrogen dioxide (NO_2), carbon monoxide (CO), ozone (O_3) and lead (Pb) as shown in Table 2-1. Hawaii air quality standards are similar to the national standards, although the Hawaii standards for carbon monoxide and nitrogen dioxide are more stringent than the national standards. In addition, Hawaii has a standard for hydrogen sulfide (Table 2-1).

The “primary” standards have been established to protect the public health. The “secondary” standards are intended to protect the nation's welfare and account for air pollutant effects on soil, water, visibility, materials, vegetation and other aspects of the general welfare.

Hydrogen sulfide (H_2S) is the primary compound in wastewater collection and treatment systems that causes odor and corrosion. Problems with odor and corrosion are attributed to high wastewater sulfide levels and the resulting generation of hydrogen sulfide. As shown in Table 2-1, Hawaii has an ambient air standard for H_2S of 0.025 parts per million by volume (ppmV) in any 1-hour period at the property line of a facility. This standard provides a measure of odor impacts from a wastewater treatment plant. Presently there is no federal ambient air quality standard for H_2S. The DOH also regulates emissions discharged from odor control systems.

Areas where concentration levels are below the NAAQS for a criteria pollutant are designated as being in “attainment.” Areas where a criteria pollutant level equals or exceeds the NAAQS are designated as being in “nonattainment.”

2.1.2 Stationary Sources

Stationary sources of air emissions at the various sites that could be affected by the proposed action include combustion turbines, boilers, generators, flares, and fuel tanks. The CAA set permit rules and emission standards for pollution sources of certain sizes. An air permit application is submitted by the prospective owner or operator of an emitting source in order to obtain approval of the source construction permit. A construction permit generally specifies a time period within which the source must be constructed. Permits should be reviewed for any modifications to the site or the air emissions sources to determine permit applicability. USEPA oversees the programs that grant stationary source operating permits (Title V) and new or modified major stationary source construction and operation permits. The New Source Review (NSR) program requires new major stationary sources or major modification of existing major stationary sources of pollutants to obtain permits before initiating construction. The New Source Performance Standards (NSPS) apply to sources emitting criteria pollutants, while the National Emission Standards for Hazardous Air Pollutants apply to sources emitting Hazardous Air Pollutants (HAPs).

Table 2-1. Hawaiian and National Ambient Air Quality Standards (NAAQS)

Pollutant		Primary/ Secondary[1]	Averaging Time	National Standard	Hawaii Standard	Form
Carbon Monoxide (CO)		Primary	8-hour	9 ppm	4.4 ppm	Not to be exceeded more than once per year
			1-hour	35 ppm	9 ppm	
Lead (Pb)		Primary and secondary	Rolling 3-month average	0.15 µg/m^3[2]	0.15 µg/m^3 (calendar quarter)	Not to be exceeded
Nitrogen Dioxide (NO_2)		Primary	1-hour	100 ppb	None	98th percentile, averaged over 3 years
		Primary and secondary	Annual	53 ppb[3]	0.04 ppb	Annual mean
Ozone (O_3)		Primary and secondary	8-hour	0.075 ppm[4]	0.08 ppm	Annual fourth-highest daily maximum 8-hr concentration, averaged over 3 years
Particle Pollution	$PM_{2.5}$	Primary	Annual	12 µg/m^3	None	Annual mean, averaged over 3 years
		Secondary	Annual	15 µg/m^3	None	Annual mean, averaged over 3 years
		Primary and secondary	24-hour	35 µg/m^3	None	98th percentile, averaged over 3 years
	PM_{10}	Primary and secondary	24-hour	150 µg/m^3	150 µg/m^3	Not to be exceeded more than once per year on average over 3 years
		None	Annual	None	50 µg/m^3	Annual average
Sulfur Dioxide (SO_2)		Primary	1-hour	0.075 ppm[5]	None	99th percentile of 1-hour daily maximum concentrations, averaged over 3 years
		Secondary	3-hour	0.5 ppm	0.5 ppm	Not to be exceeded more than once per year
		None	24-hour	None	0.14 ppm	24-hour average
		None	Annual	None	0.03 ppm	Annual average
Hydrogen Sulfide (H_2S)		None	1-hour	None	0.025 ppm	1-hour average

Notes:
(1) Primary standards set limits to protect public health, including the health of "sensitive" populations such as asthmatics, children and the elderly and secondary standards set limits to protect public welfare, including protection against decreased visibility, damage to animals, crops, vegetation, and buildings.
(2) Final rule signed October 15, 2008. The 1978 lead standard (1.5 µg/m3 as a quarterly average) remains in effect until one year after an area is designated for the 2008 standard, except that in areas designated nonattainment for the 1978 standard, the 1978 standard remains in effect until implementation plans to attain or maintain the 2008 standard are approved.
(3) The official level of the annual NO_2 standard is 0.053 ppm, equal to 53 ppb, which is shown here for the purpose of clearer comparison to the 1-hour standard.
(4) Final rule signed March 12, 2008. The 1997 ozone standard (0.08 ppm, annual fourth-highest daily maximum 8-hour concentration, averaged over 3 years) and related implementation rules remain in place. In 1997, EPA revoked the 1-hour ozone standard (0.12 ppm, not to be exceeded more than once per year) in all areas, although some areas have continued obligations under that standard ("anti-backsliding"). The 1-hour ozone standard is attained when the expected number of days per calendar year with maximum hourly average concentrations above 0.12 ppm is less than or equal to 1.
(5) Final rule signed June 2, 2010. The 1971 annual and 24-hour SO_2 standards were revoked in the same rulemaking. However, these standards remain in effect until one year after an area is designated for the 2010 standard, except in areas designated nonattainment for the 1971 standards, where the 1971 standards remain in effect until implementation plans to attain or maintain the 2010 standard are approved.
Sources: http://www.epa.gov/air/criteria.html and http://health.hawaii.gov/cab/files/2013/05/naaqs_jan_2013.pdf.

HAPs, also known as toxic air pollutants, are chemicals that can cause adverse effects to human health or the environment. The CAAA directed USEPA to set standards for all major sources of air toxics. USEPA established a list of 187 HAPs that includes substances that cause cancer, neurological, respiratory, and reproductive effects. The Title V major source thresholds for pollutant emissions that are applicable to Hawaii are:

- 100 tons per year (TPY) for any criteria pollutant
- 25 TPY total HAPs
- 10 TPY for any one HAP

USEPA also established Prevention of Significant Deterioration (PSD) regulations to ensure that air quality in attainment areas does not significantly deteriorate as a result of construction and operation of major stationary sources, and to allow future industrial growth to occur. A typical major PSD source is classified as anything with the potential to emit 250 TPY of any regulated pollutant in an attainment area. However, for several types of major source operations, including fossil fuel–fired steam electric plants of more than 250 million British Thermal Units (Btu) per hour heat input, 100 TPY is the major PSD source threshold.

Since Hawaii is in an attainment area, major new sources or major modifications to existing major sources must meet the PSD requirements.

The DOH has adopted the USEPA-established stationary source regulations discussed previously and acts as the administrator to enforce stationary source air pollution control regulations in Hawaii (DOH, Title 11, Chapter 60.1, Air Pollution Control). DOH grants an air permit to applicable facilities for not only federal enforceable major sources but also non-major sources in the state.

2.1.3 Mobile Sources

Typical mobile sources include on-road and non-road vehicles, and construction equipment. The emissions from these mobile sources are regulated under the CAA Title II that establishes emission standards that manufacturers must achieve. Therefore, unlike stationary sources, no permitting requirements exist for operating mobile sources.

2.2 Criteria Pollutants and Hydrogen Sulfide Health Effects

The sources of criteria pollutants and hydrogen sulfide, their effects on human health and the nation's welfare, and their final deposition in the atmosphere vary considerably. A brief description of each criteria pollutant and hydrogen sulfide is given below.

Ozone. O_3, a colorless toxic gas, enters the blood stream and interferes with the transfer of oxygen, depriving sensitive tissues in the heart and brain of oxygen. O_3 also damages vegetation by inhibiting their growth. Although O_3 is not directly emitted, it forms in the atmosphere through a chemical reaction between reactive organic gases (ROG) and nitrogen oxides (NO_x), which are emitted from industrial sources and from automobiles. Substantial O_3 formations generally require a stable atmosphere with strong sunlight.

Particulate Matter. Particulate pollution is composed of solid particles or liquid droplets that are small enough to remain suspended in the air. In general, particulate pollution can include dust, soot, and smoke; these can be irritating but usually are not poisonous.

Particulate pollution also can include bits of solid or liquid substances that can be highly toxic. Of particular concern are those particles that are smaller than, or equal to, 10 microns (PM_{10}) and 2.5 microns ($PM_{2.5}$) in size.

PM_{10}. PM_{10} refers to particulate matter less than 10 microns in diameter, about one/seventh the thickness of a human hair. Major sources of PM_{10} include motor vehicles; wood burning stoves and fireplaces; dust from construction, landfills, and agriculture; wildfires and brush/waste burning; industrial sources; windblown dust from open lands; and atmospheric chemical and photochemical reactions. Suspended particulates produce haze and reduce visibility. Additionally, PM_{10} poses a greater health risk than larger- sized particles. When inhaled, these tiny particles can penetrate the human respiratory system's natural defenses and damage the respiratory tract.

PM_{10} can increase the number and severity of asthma attacks, cause or aggravate bronchitis and other lung diseases, and reduce the body's ability to fight infections.

$PM_{2.5}$. A small portion of particulate matter is the product of fuel combustion processes. In the case of $PM_{2.5}$, the combustion of fossil fuels accounts for a significant portion of this pollutant. The main health effect of airborne particulate matter is on the respiratory system. $PM_{2.5}$ refers to particulates that are 2.5 microns or less in diameter, roughly 1/28th the diameter of a human hair. $PM_{2.5}$ results from fuel combustion (from motor vehicles, power generation, and industrial facilities), residential fireplaces, and wood stoves. In addition, $PM_{2.5}$ can be formed in the atmosphere from gases such as sulfur dioxide, nitrogen oxides, and volatile organic compounds. Like PM_{10}, $PM_{2.5}$ can penetrate the human respiratory system's natural defenses and damage the respiratory tract when inhaled. Whereas, particles 2.5 to 10 microns in diameter tend to collect in the upper portion of the respiratory system, particles 2.5 microns or less are so tiny that they can penetrate deeper into the lungs and damage lung tissues.

Carbon Monoxide. CO, a colorless gas, interferes with the transfer of oxygen to the brain. CO is emitted almost exclusively from the incomplete combustion of fossil fuels. Prolonged exposure to high levels of CO can cause headaches, drowsiness, loss of equilibrium, or heart disease. CO concentrations can vary greatly over relatively short distances. Relatively high concentrations of CO are typically found near congested intersections, along heavily used roadways carrying slow-moving traffic, and in areas where atmospheric dispersion is inhibited by urban “street canyon” conditions. Consequently, CO concentrations must be predicted on a localized, or microscale, basis.

Nitrogen Dioxide. NO_2, a brownish gas, irritates the lungs. It can cause breathing difficulties at high concentrations. Like O_3, NO_2 is not directly emitted, but is formed through a reaction between nitric oxide (NO) and atmospheric oxygen. NO and NO_2 are collectively referred to as nitrogen oxides (NO_x) and are major contributors to ozone formation. NO_2 also contributes to the formation of PM_{10}, small liquid and solid particles that are less than 10 microns in diameter (see discussion of PM_{10} above). At atmospheric concentration, NO_2 is only potentially irritating. In high concentrations, the result is a brownish-red cast to the atmosphere and reduced visibility. There is some indication of a relationship between NO_2 and chronic pulmonary fibrosis. Some increase in bronchitis in children (two and three years old) has also been observed at concentrations below 0.3 parts per million (ppm).

Lead. Pb is a stable element that persists and accumulates both in the environment and in animals. Its principal effects in humans are on the blood-forming, nervous, and renal systems. Lead levels in the urban environment from mobile sources have significantly decreased due to the federally mandated switch to lead-free gasoline.

Sulfur Dioxide. SO_2 is a product of high-sulfur fuel combustion. The main sources of SO_2 are coal and oil used in power stations, industry and for domestic heating. Industrial chemical manufacturing is another source of SO_2. SO_2 is an irritant gas that attacks the throat and lungs. It can cause acute respiratory symptoms and diminished ventilator function in children. SO_2 can also yellow plant leaves and erode iron and steel.

Hydrogen Sulfide. H_2S is a colorless gas that is soluble in liquids such as water. It has a distinctive odor of rotten eggs. It can be formed under conditions of deficient oxygen, in the presence of organic material and sulfate. Most of the atmospheric hydrogen sulfide has natural origins. In areas of natural occurrence, such as such as in geothermal areas and sulfur springs the unpleasant smell of H_2S can be a nuisance. At concentrations of 20 ppm or higher it can cause eye irritation and beginning at concentrations of 50 ppm or higher it can also cause respiratory tract irritation. The H_2S concentration level is commonly used as a measure of potential odor impact for a wastewater treatment plant.

2.3 Climate Change and Greenhouse Gases

Climate change is an important national and global concern. While the earth has gone through many natural changes in climate in its history, there is general agreement that the earth’s climate is currently changing at an accelerated rate and will continue to do so for the foreseeable future. Anthropogenic (human-caused) greenhouse gas (GHG) emissions contribute to this rapid change. Carbon dioxide (CO_2) makes up the largest component of these GHG emissions. Other prominent transportation GHGs include methane (CH_4) and nitrous oxide (N_2O).

Many GHGs occur naturally. Water vapor is the most abundant GHG and makes up approximately two thirds of the natural greenhouse effect. However, the burning of fossil fuels and other human activities are adding to the concentration of GHGs in the atmosphere. Many GHGs remain in the atmosphere for time periods ranging from decades to centuries. GHGs trap heat in the earth's atmosphere. Because atmospheric concentration of GHGs continues to climb, our planet will continue to experience climate-related phenomena. For example, warmer global temperatures can cause changes in precipitation and sea levels.

To date, no national standards have been established regarding GHGs, nor has EPA established criteria or thresholds for ambient GHG emissions pursuant to its authority to establish motor vehicle emission standards for CO_2 under the Clean Air Act. However, there is a considerable body of scientific literature addressing the sources of GHG emissions and their adverse effects on climate, including reports from the Intergovernmental Panel on Climate Change, the US National Academy of Sciences, EPA, and other federal agencies. GHGs are different from other air pollutants evaluated in federal environmental reviews because their impacts are not localized or regional due to their rapid dispersion into the global atmosphere, which is characteristic of these gases. The affected environment for CO_2 and other GHG emissions is the entire planet. In addition, from a quantitative perspective, global climate change is the cumulative result of numerous and varied emissions sources (in terms of both absolute numbers and types), each of which makes a relatively small addition to global atmospheric GHG concentrations. In contrast to broad scale actions such as actions involving an entire industry sector or very large geographic areas, it is difficult to isolate and understand the GHG emissions impacts for a particular infrastructure project. Furthermore, presently there is no scientific methodology for attributing specific climatological changes to a particular infrastructure project's emissions.

Although there are currently no greenhouse gas (GHG) emission limits for CCH WWTPs, in 2007 the Hawaii State Legislature passed Act 234, "Global Warming Solutions Act" which was signed into law by the governor. Act 234 required the Hawaii Department of Business, Economic Development, and Tourism (DBEDT) and DOH to update their Inventory of Greenhouse Gas Emissions Estimates for 1990 by December 31, 2008. The *Hawaii Greenhouse Gas Inventory: 1990 and 2007* was completed on time in December 2008 by ICF International for DBEDT. Act 234 also requires a reduction in the amount of GHG emissions in Hawaii to levels at or below 1990 levels by 2020.

3 Existing Air Quality Conditions

3.1 Climate

Regional and local climate together with the amount and type of human activity generally dictate the air quality of a given location. The climate of the project area is very much affected by its leeward and coastal situation. Winds are predominantly trade winds from the east northeast except for occasional periods when Kona storms (seasonal cyclones) may generate strong winds from the south or when the trade winds are weak and land breeze-sea breeze circulations may develop. Wind speeds typically vary between about 5 and 15 miles per hour providing relatively good ventilation much of the time. Temperatures in leeward areas of Oahu are generally very moderate with average daily temperatures ranging from about 70°F to 84°F. The extreme minimum temperature recorded at Honolulu Airport is 54°F, while the extreme maximum temperature is 95°F. This area of Oahu is one of the drier locations in the state with rainfall often highly variable from one year to the next. Monthly rainfall has been measured to vary from as little as a trace to as much as 10 inches. Average annual rainfall amounts to about 20 to 30 inches with summer months being the driest.

3.2 Current Air Quality

Based on air quality data collected and published by the EPA and DOH, the State of Hawaii complies with the standards of the CAA, including the NAAQS and State Ambient Air Quality Standards. The air in Hawaii is clean and low in pollutants, and the area where the project is located is in attainment of all air quality standards. Consistent trade winds also contribute to the clean air in Hawaii.

The present good air quality of the project area can be represented based on ambient air quality monitoring data in the state. Collected at the closest monitoring station 3.6 miles east of the project site as provided in **Table 3-1**. Both national and Hawaii ambient air quality standards are currently being met.

Table 3-1. 2013 Monitored Ambient Air Quality Conditions

Pollutant	Location	Units	Averaging Period	Concentration	NAAQS
CO	2052 Lauwiliwili Street, Honolulu, HI	ppm	8-hour	1	9
			1-hour	1	35
Lead (Pb)	2052 Lauwiliwili Street, Honolulu, HI	µg/m3	3 - month Avg	-	0.15
			24-hour	0.001	-
SO_2	2052 Lauwiliwili Street, Honolulu, HI	µg/m^3	1-hour	16	75
			3-hour	-	1300
			24-hour	5	140
PM10	2052 Lauwiliwili Street, Honolulu, HI	ug/m3	24-hour	39	150
$PM_{2.5}$	2052 Lauwiliwili Street, Honolulu, HI	µg/m^3	Annual	3	15
			24-hour	10	35
NO_2	2052 Lauwiliwili Street, Honolulu, HI	µg/m^3	1-hour	23	100
			Annual	-	53
Ozone	2052 Lauwiliwili Street, Honolulu, HI	ppm	8-hour	0.051	0.075

Notes:
CO and Pb levels are the first-highest.
SO_2 levels are the 99-percenrile for 1-hour average and highest for 24-hour average.
$PM_{2.5}$ 24-hour level is the 98th percentile level.
NO_2 1-hour level the 98th percentile.
Ozone 8-hour average level is the 4th highest-daily value.

3.3 Existing Facility Air Permit

The Honouliuli WWTP is minor source for criteria pollutants and HAPs and is operating under a noncovered source permit (No. 0215-020N) issued by the DOH, and therefore not subject to CAA Title V permitting. Various plant stationary sources emitting criteria pollutants, H_2S, and HAPs that are covered by this permit include:

- Cleaver Brooks boiler – 2.5 million Btu/hour heat input, 60 horsepower.
- Various tanks and odor control systems.
- Flares.

With respect to the H_2S emission concentration from the outlet stacks, the following limits were established in the permit for the following odor control systems:

- 2.0 parts per million by volume (ppmv) for the Central Odor Control System;
- 3.0 ppmv for the Headworks Odor Control System;
- 1.0 ppmv for the Secondary Odor Control System;
- 3.0 ppmv for the Biofilter Odor Control System; and
- 3.0 ppmv for the Chemical Scrubber Odor Control System.

3.4 Odor Control System

The Honouliuli WWTP has six separate odor control systems that collect and treat foul air consisting of:

- Preliminary Odor Control System – collects and treats foul air from the influent sewers, influent screens, and influent pump station wet well. This foul air is conveyed to two activated carbon scrubbers, which are run in parallel. The total capacity of the activated carbon scrubbers is 7,000 cubic feet per minute (cfm).
- Primary Odor Control System – collects and treats foul air from the aerated grit chambers, preaeration tanks, and primary clarifier weirs. This system consists of two-stage treatment that includes two catalytic scrubbers that have been converted into caustic scrubbers, followed by five dual-bed activated carbon scrubbers. The total capacity of the system is 24,000 cfm.
- Secondary Odor Control System – collects and treats foul air from the secondary treatment processes including the biotower pump station and trickling filter/solids contact (TF/SC) process. Like the primary odor control system, the Secondary Odor Control System consists of a two-stage treatment system that includes two catalytic scrubbers that have been converted into caustic scrubbers, followed by five dual-bed activated carbon scrubbers. The total capacity of the secondary odor control system is 25,000 cfm.
- Primary Sludge Odor Control System – consists of a four-cell stone media biofilter system that collects and treats foul air from the gravity thickeners and sludge blend tanks. The total capacity of the Primary Sludge Odor Control System is 16,400 cfm.
- Secondary Sludge Odor Control System – consists of an activated carbon system with two units that collect and treat foul air from the gravity belt thickeners. The capacity of the Secondary Sludge Odor Control System is 3,000 cfm.
- Solids Dewatering Odor Control System – consists of a multistage chemical unit that collects and treats foul air from the centrifuge dewatering building. The Solids Dewatering Odor Control System has a treatment capacity of 22,000 cfm.

The existing wastewater pumping stations and force mains generally are not significant sources of air pollution emissions or nuisance odor issues (AECOM, 2010). Odorous emissions may occasionally occur with outgassing leaks from the conveyance system and/or from wastewater upset or overflow situations. Odor Control System Permit No. 0215-02-N limits the H_2S concentrations at each individual odor control system outlet. Detailed Honouliuli Wastewater Basin Odor Control Project (HWBOCP) performance monitoring results from each of the existing odor control systems are provided in the Odor Control Strategy (AECOM, April 2013) and summarized in

Table 3-2. Ongoing monitoring is conducted at 13 fence line monitoring locations along the original property line and at the outlet stacks of each odor control system to meet permit requirements.

Table 3-2. HWBOCP Performance Monitoring

Odor Control System	Location of Monitoring	Test Duration (days)	Average Removal Efficiency	Average Inlet H_2S (ppmV)	Peak Inlet H_2S (ppmV)	Average outlet H_2S (ppmV)	Peak outlet H_2S (ppmV)
Preliminary	Influent Junction Box	12	n/a	86	213	n/a	n/a
	IPS Wetwell	12	n/a	21	46	n/a	n/a
	GAC 1	8	n/a *	26	134	n/a *	>2.0*
	GAC 2	8	n/a *	13	65	n/a *	>2.0*
Primary	Caustic Scrubber	8	98%	59	154	2 **	11**
	GAC 1	8	99%	2	11	0.024	0.049
Secondary	Caustic Scrubber	7	>99%	1	3	0.01	0.12
	GAC 1	7	75%	0.02	0.11	0.005	0.015
Primary Sludge	Biofilter	7	>99%	33	55	0.00	0.04
Secondary Sludge	GAC 1	8	98%	0.04	0.27	0.001	0.004
Solids Dewatering	Chemical Scrubber 1 ***	10	<70%	<1	3	0.31	0.58
	Chemical Scrubber 2 ***	10	85%	1	1	0.15	0.31

*A reading of >2.0 is over scale for the low range Odalogs, which indicates an unknown value that is greater than 2 ppmV.

**A low range logger was used for the Primary Caustic Scrubber outlet. H2S concentration was too high for the logger type. At nearly the same location, a standard logger was used for the Primary GAC 1 inlet. Therefore, the Primary GAC 1 inlet results are also used for the Primary Caustic Scrubber outlet.

***Water only, chemicals are not presently used in these units.

Source: Honouliuli Wastewater Basin Odor Control Project (HWBOCP), 2013

It should be noted that odor complaints may occur even when the Hawaii standard of 0.025 ppm for H_2S is met because people's odor thresholds are variable and range from about 0.001 to 0.02 ppm for detection of H_2S. Also, the Hawaii standard for hydrogen sulfide relates to 1-hour averaging periods, while odor can typically be detected by individuals when concentrations are present for only a few seconds to a few minutes. Due to the nature of atmospheric dispersion, concentrations averaged over a few minutes will be higher than concentrations averaged over 1 hour.

The existing Honouliuli WWTP odor control systems are presently being evaluated under a separate CCH project entitled *Honouliuli Wastewater Basin Odor Control*. The purpose of this on-going project is to identify deficiencies in the odor control systems at the Honouliuli WWTP; identify odor sources from within the Honouliuli Wastewater Basin; and provide recommendations for effective and economical improvements to address current odor control needs. Results of the HWBOCP will be incorporated as a baseline for development of recommendations to control odors from future wastewater treatment process that are being addressed under the Honouliuli WWTP Facility Plan and Conceptual Design (AECOM, April 2013).

4 Construction Impacts

4.1 Sources of Emissions

The major potential short-term air quality impact of the project will occur from the emission of fugitive dust during construction operations. During construction phases, emissions from engine exhausts will also occur both from on-site construction equipment and from vehicles used by construction workers and from trucks traveling to and from the project construction sites. Increased vehicular emissions due to disruption of traffic by construction equipment and/or commuting construction workers can be alleviated by moving equipment and personnel to the site during off-peak traffic hours.

4.2 Construction Impacts

Three action alternatives are considered for secondary treatment upgrades and modifications to the Honouliuli WWTP to meet future flow and water quality requirements as well as the No Action Alternative. In addition, four primary alternatives and the No Action Alternative for site layouts are also evaluated in the DEIS. However, construction air quality impacts from the site layout alternatives are considered to be the same and therefore analyses of the different site layouts were not performed.

4.2.1 On-site Equipment Impacts

The proposed upgrades to the Honouliuli Wastewater Treatment Plant will require a variety of heavy construction equipment to implement. Generally, for heavy construction such as that proposed for the Honouliuli WWTP, construction equipment will include a variety of cranes (ranging from smaller tire-mount units for unloading of delivered materials, to large crawler cranes for lifting in place and setting large pieces of equipment and structural steel), earthmoving equipment, hydraulic rams, concrete delivery trucks and pumpers, and a variety of gasoline- and pneumatically-powered hand tools.

Because the scope of the proposed program is well-defined in terms of what is to be constructed, the primary variable in determining equipment needs is the construction phasing. The contracting approaches considered call for the letting of one, two or four separate construction contract packages, with the latter two options corresponding to a two-phase approach to the construction. Different phases of construction would not overlap under any of the proposed approaches, although the total length of active construction differs with the alternatives. The shortest duration alternative is the single-phase/single-contract approach, which would result in peak construction equipment. Accordingly, for purposes of this estimate, the single-phase/single-contract approach is considered the primary option; other alternatives would generate less intense scheduling.

A detailed construction and equipment schedule would be developed by the contractor(s). However, it is possible to estimate the approximate needs and schedule for large equipment based on the currently-available project descriptions. The work proposed is heavy civil work, and while not defined in the *Facilities Plan*, it is assumed that significant effort will be ultimately expended in foundation work. This will likely include installation of piles at key support locations. Significant concreting operations occur as part of both the foundation construction and superstructure construction. In parallel, structural steel work will likely be a significant phase of work for most major scope items. Finally, equipment installation will occur at the various process structures.

Based on the construction conceptual plan and past construction project experience, equipment requirements for these various demolition and construction stages would likely include:

- A combination of backhoes, bulldozers, cranes, compressors, pile drivers, dump trucks, etc. as necessary, during heavy earth-moving/foundation demolition and construction phases over the first 48-month period.
- Concrete pump and mix trucks, compressors, certain hand-held pieces of equipment such as slab smoothing, etc. over the first 48-month duration.

- Cranes, compressors, and some hand-held equipment during the building/facility erection phases between Month 12 and Month 72.
- Cranes, forklifts, compressors, etc., during final equipment installation stage between Month 48 and Month 70.

Alternate phasing (e.g., the two- or four-contract approaches) would have similar equipment requirements over a longer duration (108 months for the 2-contract option, 144 months for the 4-contract option). The extension in schedule would be driven more by inefficiencies inherent in subdividing the work, such as multiple mobilizations and demobilizations, as opposed to duplicative work. Since the scale of project remains the same, the usage of equipment under varied scenarios would differ with worse short-term air quality impacts under the compressed construction schedule. However, given the spreading of the construction activity over the years, hot spot air quality concerns associated with concentrated equipment operations would be limited. Moreover these construction equipment are typical of routine infrastructure development projects in urban areas, short-term emissions from the small number of construction equipment would be inconsequential compared to the regional emissions, factoring in the substantially greater number of unrelated on-road vehicles and associated emissions that constitute the majority of baseline mobile emissions. Therefore construction equipment operational impacts are anticipated to be less than significant.

4.2.2 On-road Vehicle Impacts

According to the worst-case construction year, 2021, trip generation, it is anticipated that 185 construction workers would arrive to the site during the AM peak hour and 185 construction workers would exit the site during the PM peak, in addition to 8 total trips (4 entering and 4 exiting) generated by cement trucks during each of the AM and PM peak hours of traffic.

Based on the level of service comparison between Future Year 2021 (with project) and Base Year 2021 (without project), the majority of traffic congestion at analyzed affected intersections would continue operating at similar levels of service with or without construction activities. Therefore, the on-road mobile source air quality impacts would be temporary and comparable to the 2021 baseline condition causing no significant impacts.

4.3 Best Management Practices

Short-term impacts to air quality would result from the demolition of old facilities and construction of the secondary treatment upgrades and modifications. Regardless of the alternative, there would be temporary impacts to air quality due to fugitive dust during construction, exhaust emissions from stationary and mobile construction equipment, from the disruption of traffic, and from workers' vehicles that may also affect air quality during the period of construction.

The best management practices to control construction emissions would be implemented in accordance with state air pollution control regulations which require that there be no visible fugitive dust emissions at the property line.

Fugitive dust emissions can be controlled to a large extent by watering of active work areas, using wind screens, keeping adjacent paved roads clean, and by covering of open-bodied trucks. Other dust control measures could include limiting the area that can be disturbed at any given time and/or mulching or chemically stabilizing inactive areas that have been worked. Dirt-hauling trucks should be covered when traveling on roadways to prevent loss of dirt. A routine road cleaning and/or tire washing program can also help to reduce fugitive dust emissions that may occur as a result of trucks tracking dirt onto paved roadways in the project area. Paving and landscaping of project areas early in the construction schedule would also reduce dust emissions.

Monitoring dust at the project boundaries during periods of construction could be considered as a means to evaluate the effectiveness of the project dust control program and to adjust the program if necessary. Localized effects of exhaust emissions can be reduced by using newer construction equipment, reducing truck on-site idling time, and moving construction materials and workers to and from the project sites during off-peak traffic hours.

5 Operation Impacts

Potential operational impacts with the implementation of the proposed project would include an upgrade on the standby power capacity, possible introduction of a new energy saving combined and heat (CHP) system by burning currently flared digested gas, and increase in mobile source operation. This section discusses the evaluation of potential operational air quality including odor impacts from the proposed plant expansion.

5.1 Stationary Source Impacts

5.1.1 Standby Power Upgrade

The WWTP standby power system provides power to the WWTP when the utility feed is interrupted.

The existing configuration of standby power has a total of 4 diesel generators with a capacity of 1.25 MW, 1 MW, 0.65 MW and 0.9 MW, respectively.

Under the improvement plan, it is recommended that three smaller existing generators that are still in good shape would continue to provide power to the current load and a central 10 MW diesel powered medium voltage generator plant would provide standby power to the new loads. Given their emergency use, these generators are exempt from obtaining air permit.

The emissions standards for diesel generators are governed by the EPA as well as any state requirements. Standby/emergency generators above 2 MW are currently required to meet the EPA Tier 2 emissions requirements. To meet this requirement, the generator must be used as a standby/emergency generator which limits its operation to only during a utility outage and for some testing purposes for a maximum of 500 hours per year. However, at the time when these generators are installed, the emissions control requirement could be more stringent since the installation of these generators may not occur until 2021. Table 5-1 summarizes the net increase in potential annual standby generator emissions assuming each generator has a potential to operate for a maximum of 500 hours per year.

Table 5-1. Emergency Diesel Generator Emissions

Generator Power (kW)	Annual Hours	Diesel Generator Annual Emissions (TPY)							
		VOC	NOx	CO	PM_{10}	$PM_{2.5}$	SOx	HAPs	CO_2e
Existing									
3,800	500	0.90	30.57	7.01	0.44	0.43	0.02	0.04	1344
Future									
12,550	500	2.89	98.56	22.59	1.46	1.41	0.05	0.13	4441
Net Increase Under the Improvement Plan		**2.0**	**68.0**	**15.6**	**1.0**	**1.0**	**0.03**	**0.1**	**3096**

Notes
1. USEPA AP-42 emission factors for large diesel engines
2. Uncontrolled NOx emission factor
3. VOC emissions use TOC (as CH_4) emission factor
4. ULSD 15 ppm (0.0015%)

However, given their emergency usage purposes, potential air quality impacts would be short in duration unlikely causing significant air quality impacts. If these generators would be used for peak power shaving purposes as compared to emergency use, they would have to comply with more stringent emissions requirement, i.e., EPA Tier 4 requirements involving treatment of exhaust emissions and greater air quality impacts would occur. Under this circumstance, the future CAA air permitting process would ensure the compliance of the NAAQS as a result of increasing stationary source operational emissions on site when a final design plan is available. Therefore, the proposed project would be unlikely to result in significant air quality impacts.

5.1.2 New Combined Heat and Power Facility

A combined heat and power (CHP) facility may be incorporated at Honouliuli WWTP to make beneficial use of digester biogas. The most common CHP systems for medium size wastewater treatment plants are reciprocating engines or microturbines. If a CHP facility is incorporated at Honouliuli WWTP, it would need to be permitted according to state and federal air regulations. Since this facility would be a new stationary source and the emissions at Honouliuli WWTP would increase resulting in adverse air quality impacts on the local level. However, because the feasibility of constructing such facility is still under evaluation and has no design specifics, the potential air emissions from the facility cannot be reasonably estimated. If the CHP facility option is elected in the future, the CHP facility would need to be considered for future air permitting in conjunction with the biosolids disposal process during the design stage. During the air permitting process, it is anticipated that a separate air quality impact modeling analysis would be conducted to address potential air quality impact significance from the CHP facility.

5.2 Mobile Source Impacts

With an anticipated 55 peak hour vehicles entering the project site under the future operational condition, the on-road traffic induced air quality impacts are anticipated to be minimal.

Based on the level of service comparison between Future Year 2030 and Baseline Year 2030 conditions, the congestions at each affected intersection will operate at similar levels of service with minimal impacts. Therefore, the mobile source air quality impacts under the plant improvement plan would not be significant.

5.3 Odor Impacts

The operation of the Honouliuli WWTP generates odors under current conditions (No Action Alternative) and would also generate odors under all upgrade options. The Honouliuli Wastewater Basin Odor Control Project evaluated and recommended improvements to the odor control systems at the Honouliuli WWTP to be incorporated into upgrades to the facilities Under the proposed project, the existing Preliminary and Primary Odor Control Systems would be replaced with a combined new treatment system and no upgrades would be required for the existing Secondary Odor Control System, Primary Sludge Odor Control System, Secondary Sludge Odor Control System, and Dewatering Odor Control System. These improvements would consider future needs and allow for expansion of the system, as needed.

The proposed project recommends replacing the existing Primary Odor Control System with biofilters. In addition, odor control will be provided to the new treatment facilities with biofilters. The odor control improvements can be centralized or decentralized. In addition to the biofilters, grit covers, primary clarifier covers, and primary effluent channel covers are recommended for odor containment. These project activities and upgrades for components are common to each of the secondary treatment options. Under the No Action Alternative, there would be no upgrades to the current system.

Covers keep foul odors contained within the headspace of process units. By ventilating the headspace, odorous air can be exhausted and treated. Several proposed new process units would be covered or enclosed to contain foul air for the Phase 1 Secondary Treatment Improvements Odor Control System as described in the Odor Control Strategy *Technical Memorandum 12.G* (AECOM, 2013).

All three of the secondary treatment alternatives would result in improvements in the long-term air quality of the project area in terms of the nuisance odor that could occur from sewer overflows. The improvements would also likely result in a reduced number of incidents of offsite odor near the plant as compared to the No Action Alternative.

Therefore, compounded with the improvements on existing Primary Odor Control System and the proposed secondary treatment alternative, the odor impacts under the proposed plant improvement plan would be unlikely significant. The ambient odor monitoring program to be implemented after the completion of the project would demonstrate the compliance of the DOH ambient odor standard in terms of H_2S concentration levels.

5.4 Conclusion

After construction activities are completed, the potential long-term air quality impacts to the project area would be unlikely significant although there is a potential to increase on-site stationary and mobile source emissions due to an increase in operational capacity. However, the possibility of nuisance odor from the sewer system would likely be reduced by the upgrade odor control system causing lower nuisance odor downwind of the Honouliuli WWTP. The compliance of all applicable ambient standards including odor in terms of ambient H_2S concentration levels would be further demonstrated 1) during the final design stage of the project when the air permit is modified for applicable criteria pollutants and 2) after the completion of construction with an ambient monitoring program for odor.

Although the proposed project is not expected to cause or promote population growth or any associated secondary air quality impacts, population growth in the project area is expected to occur at an annual rate of about 1.2 percent through the year 2030. Despite the expected population growth, it appears likely that the overall good cumulative air quality of the project area would be maintained. Higher levels of emission control, both from industrial sources (including Honouliuli WWTP) and from motor vehicles, would likely largely offset the potentially higher emissions from a larger population.

Similar to the criteria pollutants, it is anticipated that an increase in the GHG would occur associated with the WWTP expansion project. However, such an increase would be further evaluated during the final design stage when each improvement element is well defined and such emissions can be reasonably forecasted. Given its global effects, such a typical infrastructure development project in an urban area would unlikely cause any meaningful global warming effects.

Appendix E
Noise Study, Ebisu & Associates, January 2015

Y. Ebisu & Associates
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YEA Job #52.029
January 5, 2015

AECOM
1001 Bishop Street, Suite 1600
Honolulu, Hawaii 96813

Attention: Mr. Lambert Yamashita, P.E.

Subject: Final Results of Noise Study for the Proposed Honouliuli Wastewater Treatment Plant (WWTP) Development

Dear Mr. Yamashita:

I am providing this letter report to present our findings regarding potential noise impacts associated with the proposed Honouliuli Wastewater Treatment Plant (WWTP) Development. We have reviewed the draft Traffic Impact Assessment Report (TIAR dated 10/27/14) and the Phase II development plan of future facilities at the Honouliuli WWTP, and have completed our noise measurements of existing conditions at the plant. We have also completed our modeling of existing and future traffic noise levels, and have completed our noise modeling of future plant facilities.

<u>Existing Background Noise Levels</u>. Daytime and nighttime noise measurements were obtained at or near the boundary lines of the Honouliuli WWTP to determine if the facility is in compliance with State Department of Health (DOH) noise limits. Because the facility is located on lands which are zoned I-2 and AG-1, the applicable DOH noise limit for noise emissions from WWTP equipment at or beyond the WWTP property boundaries is 70 dBA, for both daytime and nighttime periods.

Figure 1 and Table 1 depict the noise measurements at or near the property boundary lines which were obtained on October 22 and 23, 2014. The measured sound levels at the various locations during the daytime and nighttime are also shown in the figure and table. In Figure 1, the measured L10 values (or levels exceeded 10 percent of the time) are shown, since this is the metric used by the State DOH. The nighttime measurements were used to determine if the steady noise levels from the facility exceeded the 70 dBA DOH noise limit, and it was clear that the facility is in full compliance with the 70 dBA DOH noise limit. The daytime noise measurement results were typically controlled by non-plant noise sources, such as motor vehicle traffic and aircraft. The daytime noise measurement results also confirmed the conclusion that the Honouliuli WWTP is currently in compliance with the 70 dBA DOH noise limit.

At measurement Locations B and C, the dominant noise source during the night was an audible low frequency source which appeared to be originating from beyond the

WWTP toward the east. At all other measurement locations, the steady (L50) nighttime background noise levels were less than 50 dBA, indicating that the Honouliuli WWTP noise sources were well below the 70 dBA limit along the property lines of the WWTP. At Locations F and G, where the closest residences are located, measured steady (L50) background noise levels at night were less than 41 dBA.

During the daytime, motor vehicle traffic and aircraft noise become the dominant noise sources along the Honouliuli WWTP's property lines. Measured daytime background noise levels (L10) along the Honouliuli WWTP's property lines ranged from 52 to 71 dBA, and were influenced by off-site noise sources rather than by WWTP noise sources.

Close-in noise measurements of five of the louder noise sources at the existing Honouliuli WWTP were also obtained to confirm that their noise levels could not exceed the 70 dBA DOH limit at the facility's property boundaries when operating singly or together. These noise sources are shown in Figure 2, and were the: Dewatering Building Centrifuge; Influent Pump Station; Blower Building #1 (Primary); BioTower Pump Station Booster Fan; and Caustic Scrubber Odor Control Blower. These five noise sources should remain at their present general locations through 2030, but may increase in noise levels due to increases in their future capacity. The measured existing noise levels of these five sources were: 63 dBA at 50 feet from the Centrifuge; 73 dBA at 25 feet from the Influent Pump Station; 65 dBA at 50 feet from the Blower Building #1; 67 dBA at 25 feet from the Booster Fan; and 75 dBA at 25 feet from the Odor Control Blower. Using these measured noise levels, the calculated combined noise levels from these five noise sources ranged from 31 to 48 dBA along the facility's property boundaries. The results of these calculations at the various noise measurement locations at or near the facility's boundaries are shown in Table 2. The calculated noise levels shown in Table 2 for the existing WWTP's noise sources are very low, and consistent with the conclusion that the noise levels from existing plant sources do not exceed the 70 dBA DOH noise limit. At the closest residences (Locations F and G), calculated noise levels from existing plant equipment were less than 35 dBA, and well below the nighttime average (or Leq) noise levels of 39 to 47 dBA measured at those two locations.

<u>Existing Road Traffic Noise Levels</u>. Table 3 and Figure 3 present the results and locations of traffic noise level measurements which were performed on December 2, 2014. We have reviewed the existing and forecasted traffic volumes from the project's draft TIAR and utilized that data and the results of the traffic noise measurements to develop our conclusions regarding potential traffic noise impacts associated with the project. Table 4 presents the calculated hourly average [or Leq(h)] traffic noise levels at 50, 75, and 100 feet setback distances from the roadways' centerlines in the immediate environs of the project during the pm peak traffic hour. The Federal Highway

Administration Traffic Noise Model (TNM Version 2.5) was used to calculate existing and future traffic noise levels using the Loose Soil ground feature. The Hawaii State Department of Transportation considers traffic noise levels less than 66 Leq to be acceptable for noise sensitive land uses. This criteria level was exceeded at 50 feet from the centerlines of Geiger Road and Roosevelt Avenue.

The U.S. Department of Housing and Urban Development (HUD) uses the Day-Night Average Sound Level (or DNL) descriptor in evaluating acceptable noise levels at noise sensitive locations. The DNL descriptor incorporates a 24-hour average of daytime and nighttime noise levels, with the nighttime noise levels increased by 10 decibels (or dB) prior to computing the 24-hour average. A noise level of 65 DNL is considered to be acceptable for noise sensitive uses by HUD. For the Honouliuli WWTP project, the traffic noise levels in DNL may be estimated by adding 1 unit to the peak hour Leq, so a traffic noise level of 66 Leq during the pm peak hour will result in a 67 DNL value, or 2 DNL units above the HUD noise standard. For the roadways evaluated in this noise study, traffic volumes and hourly traffic noise levels were highest during the pm peak hour.

Table 5 presents the existing setback distances to the 65, 70, and 75 DNL traffic noise contour lines for unobstructed line-of-sight conditions along the roadways in the immediate environs of the project. As indicated in Table 5, setback distances in the order of 68 to 70 feet from the centerlines of Geiger Road and Roosevelt Avenue are required to not exceed the HUD 65 DNL noise standard.

Future Road Traffic Noise Levels. Table 6 presents the calculated hourly average [or Leq(h)] traffic noise levels at 50, 75, and 100 feet setback distances from the roadways' centerlines in the immediate environs of the project by year 2030 with the implementation of the proposed project. Table 5 depicts the forecasted setback distances to the 65, 70, and 75 DNL traffic noise contours by 2030 with the implementation of the project. Exceedances of the 66 Leq and 65 DNL acceptability thresholds are expected to continue along Geiger Road and Roosevelt Avenue.

Table 7 presents the calculated increases in traffic noise by year 2030 due to both non-project and project related roadway traffic. By 2030, traffic noise level increases attributable to project traffic should be less than 1.0 dB at all roadways in the project environs, except along the section of Renton Road between Kapolei Parkway and proposed WWTP entrance road, hereinafter referred to as “Honouliuli Driveway 5 (DW5)”. The estimated increases in future traffic noise levels along this section of Renton Road are 0.9 dB due to non-project traffic and 2.0 dB due to project traffic. Because existing traffic volumes along this section of roadway are relatively low (approximately 343 vehicles per hour), and because this area is currently undeveloped within 50 feet of the roadway's centerline, these increases in future traffic noise levels are not expected to result in exceedances of traffic noise level criteria along this roadway section.

Along Renton Road west of project entrance road DW5 where existing residences are located, future traffic noise level increases associated with the project are not expected to occur. Also, along Roosevelt Avenue in the vicinity of Philippine Sea, future traffic noise level increases associated with project traffic are anticipated to be less than 0.2 dB by year 2030.

Along Geiger Road and Roosevelt Avenue where existing traffic noise levels currently exceed the 66 Leq and 65 DNL noise impact thresholds, future increases in traffic noise levels due to project traffic are lower than the increases associated with non-project traffic, and are predicted to be less than 0.8 Leq or DNL. These increases are not considered to be significant, and will probably not be perceivable over the 16 year period between 2014 and 2030.

Future Plant Noise Sources. Estimates of future plant noise levels for the Phase II Development were made by modeling the source levels of the plant equipment expected to be operating through the Phase II Development as described in the Honouliuli WWTP Conceptual Design Report Item 12.0 dated November 2014. Figure 4 depicts the locations of the future noise sources which were included in the noise modeling, and Table 8 presents the assumed noise levels of these sources at 50 feet distance. Special sound attenuation measures such as enclosures, the addition of silencers or mufflers or acoustical louvers, the use of sound absorptive interior finishes, or the use of sound rated doors were not included in the noise modeling assumptions. Although outdoor air conditioning units were not included in the November 2014 Conceptual Design Report, 30 ton air cooled air conditioning units were arbitrarily located at the administration, lab, and maintenance buildings as shown in Table 8 and Figure 4. The large emergency generators in the Main Electrical Building were not included in the noise modeling because of their intermittent operation during testing or emergencies, and because they will probably be sound attenuated separately so as to not exceed the DOH noise limit of 70 dBA at the property boundaries of the WWTP during their operation. The noise levels of other WWTP noise sources should not affect the generators' allowable noise limit along the mauka property line.

Table 9 presents the results of the calculations of predicted plant noise levels at the perimeter Locations A through J of the WWTP without special sound attenuation treatments applied to the various noise sources. The results in Table 9 were controlled by the dominant noise sources located in Building #033I, the Blower Building, and Building #201F. The utilization of special sound attenuation treatments to all noise sources (except for the emergency generators) will probably not be required to comply with the 70 dBA DOH noise limit along the property boundaries of the WWTP.

Construction Noise Impacts. Audible construction noise will probably be unavoidable during the entire project construction period. The total time period for construction of the project is not known. It is expected that actual construction work will performed in phases and be moving from one location on the project site to another during that period. Actual length of exposure to construction noise at any receptor location will probably be less than the total construction period for the entire project. Figure 5 depicts the range of noise levels of various types of construction equipment when measured at 50 feet distance from the equipment.

Typical levels of exterior noise from construction activity (excluding pile driving activity) at various distances from the job sites are shown in Figure 6. Figure 6 is useful for predicting exterior noise levels at short distances from the work when visual line of sight exists between the construction equipment and the receptor. Direct line-of-sight distances from the construction equipment to existing residential buildings will range from 250 feet to 500+ feet, with corresponding average noise levels of 71 to 64 dBA (plus or minus 5 dBA). For receptors along a cross-street, the construction noise level vs. distance curve of Figure 6 should be reduced by approximately 8 dBA when the work is occurring at the intersection with the cross street, and should be reduced by 15 dBA when work is occurring at least 100 feet from the intersection (and the visual line-of-sight is blocked by intervening buildings). Typical levels of construction noise inside naturally ventilated and air conditioned structures are approximately 10 and 20 dB less, respectively, than the levels shown in Figure 6.

Noise sensitive residences who are predicted to experience the highest noise levels during construction activities are located along Philippine Sea and along Renton Road near Philippine Sea when work occurs at the northwest corner of the WWTP. Predicted construction noise levels at these residences during the site preparation phase of the work in this area ranged from 71 to 62 dBA (plus or minus 5 dBA). The highest noise levels during construction are expected to occur at the Coral Creek Golf Course during infrastructure improvements along the east boundary of the WWTP. Across the golf course to the east, the closest residences should experience construction noise levels of 65 dBA or less (plus or minus 5 dBA). Adverse impacts from construction noise are not expected to be in the "public health and welfare" category due to the temporary nature of the work, and due to the administrative controls available for regulation of construction noise. Instead, these impacts will probably be limited to the temporary degradation of the quality of the acoustic environment in the immediate vicinity of the project site.

The State DOH, regulates noise associated with construction activities so as to minimize risks of adverse impacts to public health and welfare. The DOH would utilize a construction noise permit system for all construction activities on the project site. Typically, noise from construction activities can be expected to exceed the allowable noise limits for stationary equipment which are not associated with construction activities. Therefore, the DOH's administrative rules for construction activities include nighttime, Sunday, and holiday curfews, so as to limit noisy construction activities to the normal workday periods. Additional curfew periods are typically used for pile driving or other rock or pavement breaking equipment.

Mitigation of construction noise to inaudible levels will not be practical in all cases due to the intensity of construction noise sources (80 to 90+ dB at 50 feet distance), and due to the exterior nature of the work (excavation, grading, trenching, concrete pouring, hammering, etc.). The use of properly muffled construction equipment should be required at the various job sites. The incorporation of State DOH construction noise limits and curfew times, which are applicable throughout the State of Hawaii, is another noise mitigation measure which is normally applied to construction activities. Figure 7 depicts the normally permitted hours of construction. Noisy construction activities are not allowed on Sundays and holidays, during the early morning, and during the late evening and nighttime periods under the DOH permit procedures.

The project's draft TIAR investigated the potential traffic during year 2021, which is expected to be the peak year of construction. The predicted increases in traffic noise levels attributable to project related traffic during 2021 were also evaluated, and it was concluded that these increases would not exceed 1 dB along Renton Road between Kapolei Parkway and the proposed WWTP site entrance road DW5. Along all other roadways in the immediate environs of the project, increases in traffic noise levels associated with project traffic were expected to be less than 0.5 dB. Risks of adverse traffic noise impacts during the peak year of project construction were considered to be very low.

Summary and Recommendations. Traffic noise impacts resulting from the proposed development of the Honouliuli WWTP are not expected at noise sensitive receptors within the immediate environs of the facility. Increases in project related traffic noise levels of less than 1 dB between 2014 and 2030 will be difficult to perceive or accurately measure. At locations well beyond the immediate project environs, these project related traffic noise level increases should be even smaller due to the greater percentage contribution of non-project traffic to total traffic noise levels as distances from the WWTP increase.

The noise levels from existing and future WWTP noise sources should not cause compliance problems with the 70 dBA DOH limit during the daytime or nighttime periods. However, there are existing residences who are relatively close to the WWTP property lines at the west end of the WWTP, and a continuous sound level of 70 dBA (which is equivalent to 76 DNL) at these residences would not be compatible with residential or other noise sensitive uses. The proposed development plan appears to be cognizant of this, and has located the quieter administrative and non-processing facilities at the west end of the WWTP. Risks of complaints from neighboring residents have been minimized by the proposed future configuration of the WWTP.

As the new facilities and equipment are added to the WWTP, it is recommended that sound attenuation treatments be considered for the louder noise sources listed in Table 8. These sound attenuation treatments will probably involve containment of the noise emissions using enclosures or the building envelope, the addition of absorptive interior ceiling and wall panels, the addition of duct silencers or mufflers, or the addition of mechanical ventilation or acoustical louvers. Acoustical treatments of these louder noise sources will reduce their contributions to the total plant noise levels at the various plant boundary locations listed in Table 9, and will minimize the areas where risks of hearing loss to WWTP employees need to considered in hearing conservation programs. Near existing and any future residences to the WWTP, whenever feasible, attempts should be made to minimize the increases in preexisting background noise levels when new facilities and equipment are added to the WWTP. Doing so should minimize risks of noise complaints from neighboring residents or any other noise sensitive uses near the WWTP.

Sound attenuation treatment to the emergency generators in Building #201E will probably be mandatory to comply with the 70 dBA DOH limit along the mauka boundary of the WWTP. The use of a concrete and/or masonry building envelope, the addition of interior acoustical ceiling and wall panels, the inclusion of radiator discharge and fresh air duct silencers, the use of sound rated exterior doors, and the use of high attenuation exhaust silencers will all be required at this building. These methods of quieting emergency generator facilities have been used in the past and are not considered to be extraordinary.

Based on the above evaluations, it was concluded that risks of adverse noise impacts from the proposed Honouliuli WWTP development are very low, and that sound attenuation measures are not required but may be applied as deemed feasible as the improvements and additions occur at the WWTP.

Sincerely,

Yoichi Ebisu, P.E.

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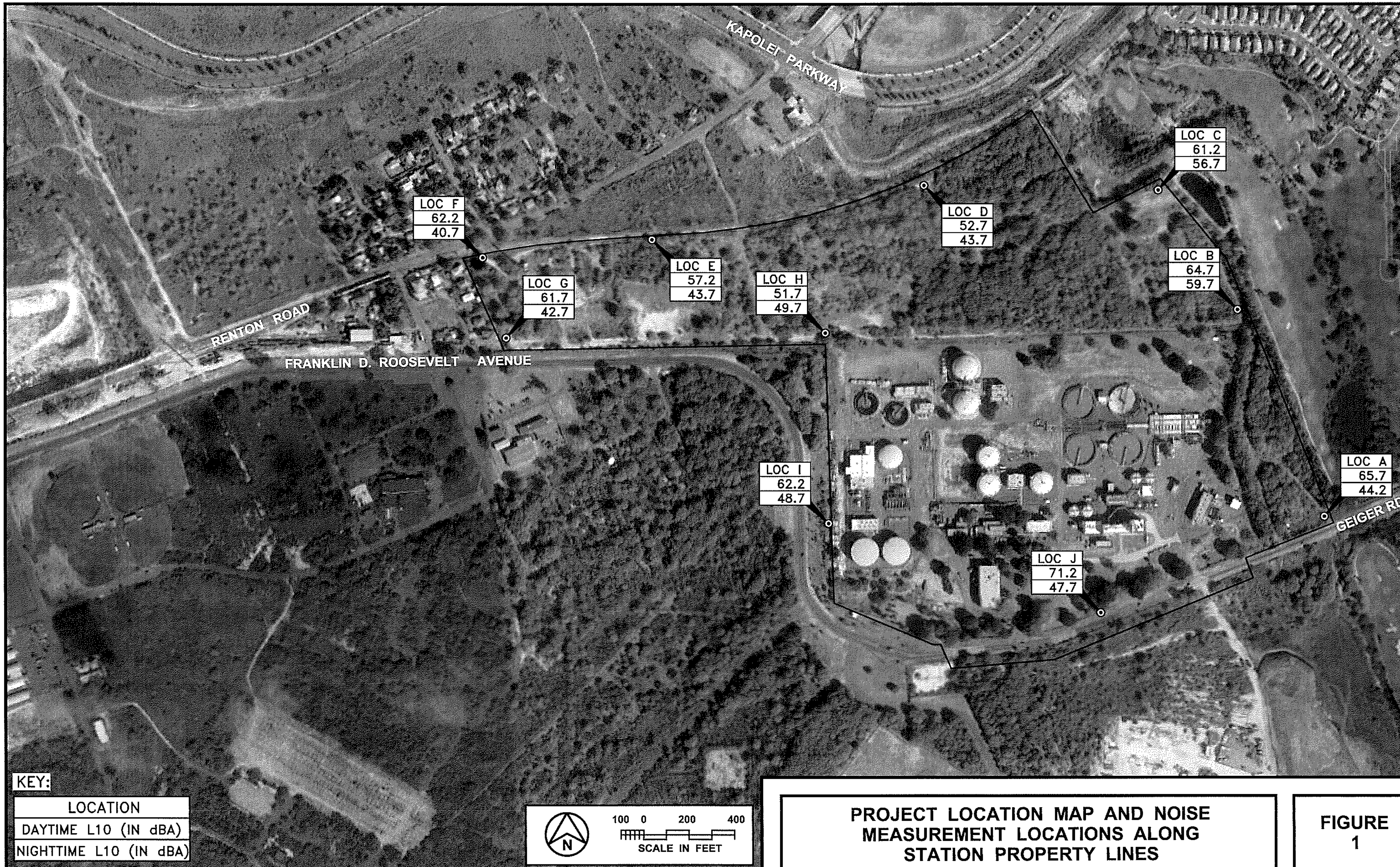


PROJECT LOCATION MAP AND NOISE MEASUREMENT LOCATIONS ALONG STATION PROPERTY LINES

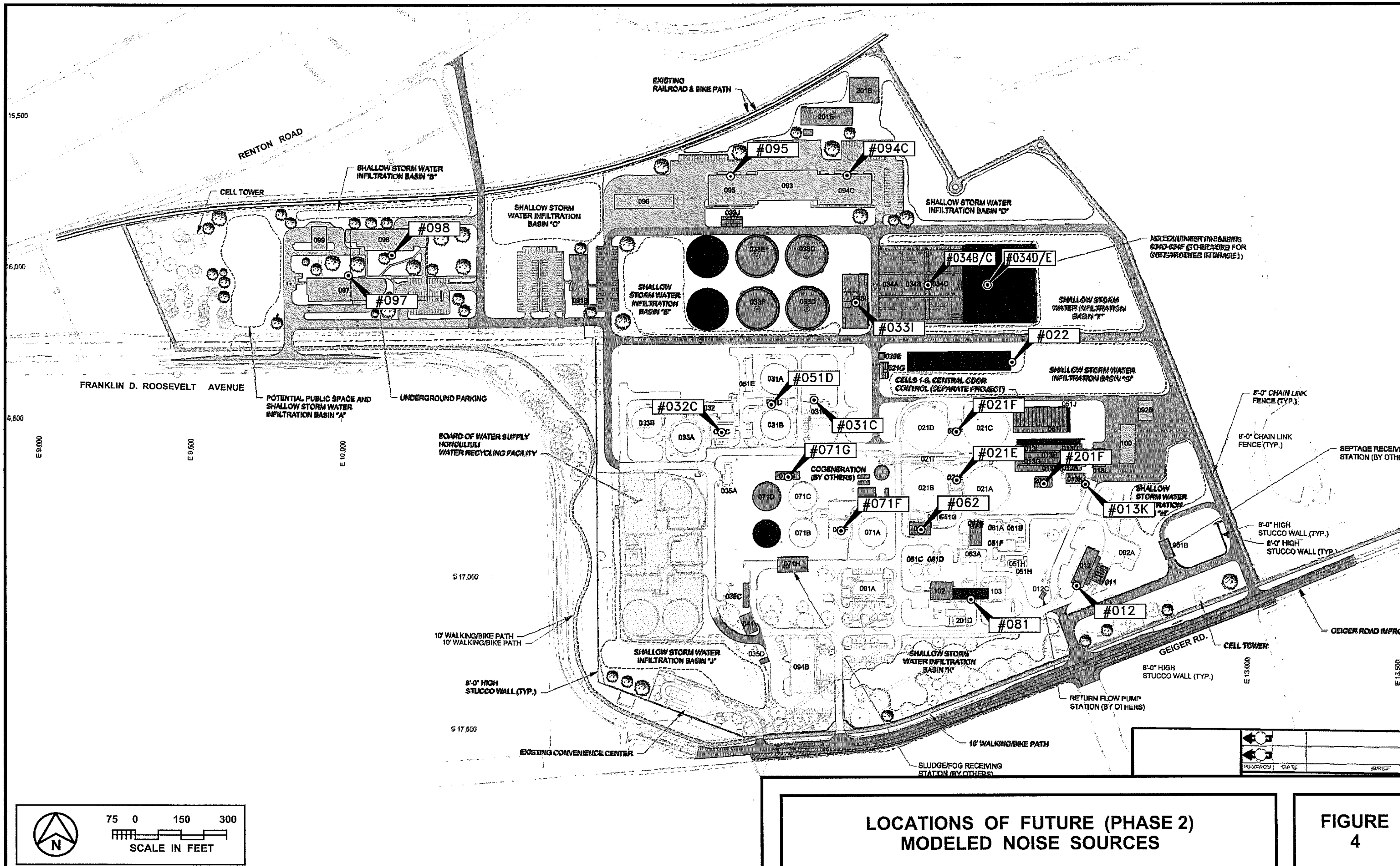
FIGURE 1

CALCULATED SOUND LEVELS OF FIVE DOMINANT EXISTING NOISE SOURCES AT HONOULIULI WWTP

FIGURE 2

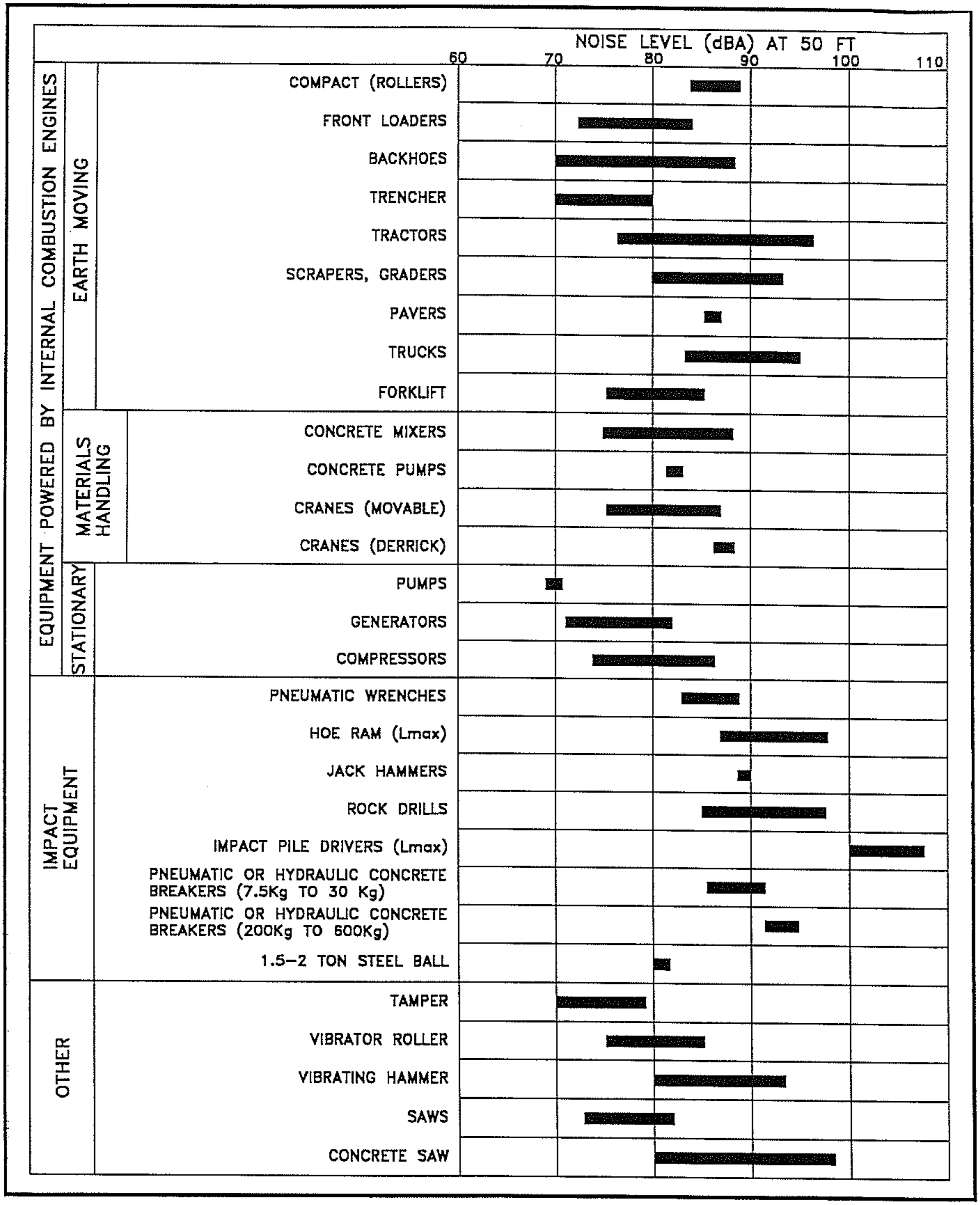
PROJECT LOCATION MAP AND TRAFFIC NOISE MEASUREMENT LOCATIONS

FIGURE 3



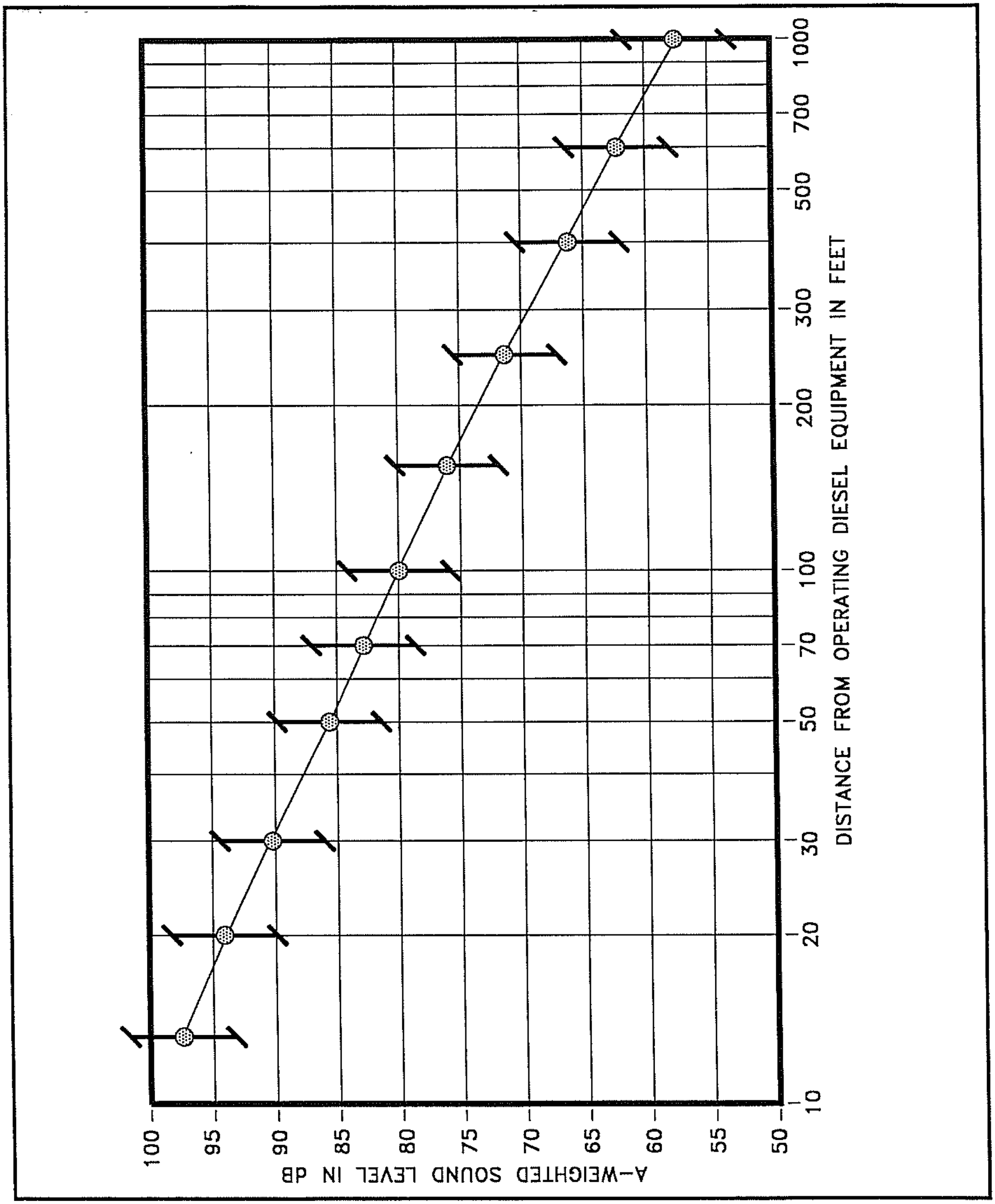
LOCATIONS OF FUTURE (PHASE 2) MODELED NOISE SOURCES

FIGURE 4



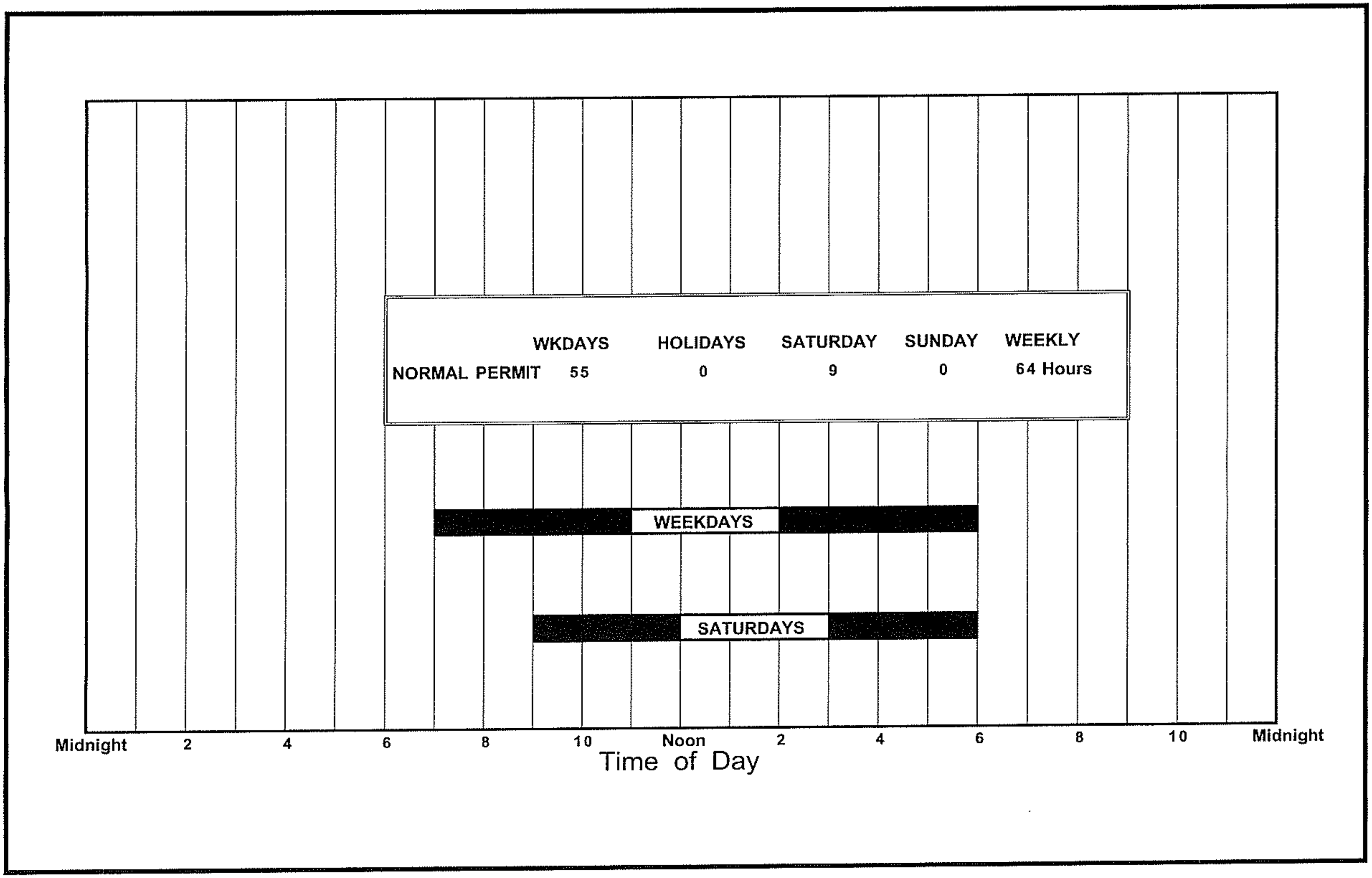
RANGES OF CONSTRUCTION EQUIPMENT NOISE LEVELS

FIGURE 5



ANTICIPATED RANGE OF CONSTRUCTION NOISE LEVELS VS. DISTANCE

FIGURE 6



AVAILABLE WORK HOURS UNDER DOH PERMIT PROCEDURES FOR CONSTRUCTION NOISE

FIGURE 7

TABLE 1
SUMMARY OF MEASURED BACKGROUND NOISE LEVELS AT VARIOUS LOCATIONS

PROJECT: HONOULIULI WWTP FUTURE DEVELOPMENT
DATE: October 22-23, 2014

Date	Start Time	End Time	Leq	Lmax	Lmin	L1	L10	L50	L90	L99	Event Description
Location	"A"										
Oct 22	1343	1358	61.7	76.9	42.3	70.2	65.7	58.2	45.7	43.2	
Oct 23	0243	0303	43.1	50.7	40.7	45.7	44.2	43.2	42.2	41.2	
Location	"B"										
Oct 22	1014	1029	62.5	81.6	44.4	75.7	64.7	48.7	45.7	45.2	50 dBA Transformer Hum.
Oct 22	2242	2257	56.6	68.9	42.7	60.7	59.7	57.2	44.2	43.2	57 dBA Low Freq. Noise
Location	"C"										
Oct 22	1040	1055	56.1	73.2	42.6	66.7	61.2	47.2	44.2	43.2	
Oct 22	2306	2321	52.0	57.3	36.4	57.2	56.7	48.7	40.7	37.2	Intermittent Low Freq. Noise
Location	"D"										
Oct 22	1108	1123	53.1	72.5	42.4	66.2	52.7	46.7	44.7	43.7	
Oct 22	2341	2356	40.8	50.5	35.6	46.7	43.7	39.2	37.2	36.2	
Location	"E"										
Oct 22	1136	1151	53.4	68.4	41.6	64.2	57.2	47.2	44.2	42.7	
Oct 23	0015	0030	42.3	50.8	39.6	46.2	43.7	41.7	40.7	40.2	
Location	"F"										
Oct 22	1200	1215	58.0	71.4	42.5	67.2	62.2	53.2	47.7	44.2	
Oct 23	0043	0100	39.3	55.3	34.7	44.7	40.7	39.2	36.2	35.2	
Location	"G"										
Oct 22	1224	1239	59.5	74.9	40.6	71.7	61.7	53.7	47.2	42.7	
Oct 23	0109	0128	47.3	77.1	37.9	54.2	42.7	40.7	39.2	38.7	
Location	"H"										
Oct 22	1259	1315	50.7	68.5	44.3	63.2	51.7	47.2	45.7	45.2	
Oct 23	0138	0153	49.0	54.0	46.9	50.7	49.7	49.2	48.2	47.7	
Location	"I"										
Oct 22	1417	1432	60.5	83.3	47.2	71.7	62.2	56.2	50.7	48.2	
Oct 23	0330	0352	47.8	51.9	46.1	49.7	48.7	47.7	47.2	46.7	
Location	"J"										
Oct 22	1444	1559	67.6	81.8	46.1	76.7	71.2	64.7	52.7	47.2	
Oct 23	0206	0223	46.5	53.5	44.2	48.7	47.7	46.2	45.2	44.7	

Notes:

a. Leq = Average A-Weighted Sound Level (in dBA)
b. Lmax = Maximum A-Weighted Sound Level (in dBA)
c. Lmin = Minimum A-Weighted Sound Level (in dBA)
d. L50 = A-Weighted Sound Level (in dBA) which was exceeded 50 percent of the time.

TABLE 2
PREDICTED VS. MEASURED EXISTING PLANT NOISE LEVELS

PERIMETER LOCATION	MEASURED EXISTING DAYTIME LAEQ (dBA)	MEASURED EXISTING NIGHTTIME LAEQ (dBA)	CALCULATED PLANT NOISE LAEQ (dBA)
A	61.7	43.1	46.0
B	62.5	56.6	45.0
C	56.1	52.0	41.4
D	53.1	40.8	42.9
E	53.4	42.3	36.8
F	58.0	39.3	30.8
G	59.5	47.3	33.3
H	50.7	49.0	46.2
I	60.5	47.8	43.8
J	67.6	46.5	48.4

TABLE 3

TRAFFIC AND BACKGROUND NOISE MEASUREMENT RESULTS

LOCATION	Time of Day (HRS)	Ave. Speed (MPH)	-------- Hourly Traffic Volume -------- AUTO	M.TRUCK	H.TRUCK	Measured Leq (dB)	Predicted Leq (dB)
K1. 50 FT from the center-line of Geiger Rd. (12/2/14)	0720 TO 0820	38	707	15	38	67.1	65.5
K2. 100 FT from the center-line of Geiger Rd. (12/2/14)	0720 TO 0820	38	707	15	38	58.9	60.3
K1. 50 FT from the center-line of Geiger Rd. (12/2/14)	1440 TO 1540	35	750	15	30	66.7	64.4
K2. 100 FT from the center line of Geiger Rd. (12/2/14)	1440 TO 1540	35	750	15	30	57.2	59.4
L1. 50 FT from the center-line of Renton Rd. (12/2/14)	0845 TO 0945	36	101	6	8	57.6	57.5
L2. 100 FT from the center-line of Renton Rd. (12/2/14)	0845 TO 0945	36	101	6	8	54.3	52.8

TABLE 3 (CONTINUED)

TRAFFIC AND BACKGROUND NOISE MEASUREMENT RESULTS

LOCATION	Time of Day (HRS)	Ave. Speed (MPH)	-------- Hourly Traffic Volume -------- AUTO	M.TRUCK	H.TRUCK	Measured Leq (dB)	Predicted Leq (dB)
L1. 50 FT from the center-line of Renton Rd. (12/2/14)	1600 TO 1700	34	290	6	4	58.8	58.8
L2. 100 FT from the center-line of Renton Rd. (12/2/14)	1600 TO 1700	34	290	6	4	54.1	53.5
M. 50 FT from the center-line of Philippine Sea St (12/2/14)	1046 TO 1146	25	118	3	12	58.1	56.7
N. 50 FT from the center-line of Franklin D Roosevelt Ave. (12/2/14	1207 TO 1307	35	507	7	26	63.1	63.0

TABLE 4

EXISTING (CY 2014) TRAFFIC VOLUMES AND NOISE LEVELS ALONG ROADWAYS IN PROJECT AREA (PM PEAK HOUR)

LOCATION	SPEED (MPH)	TOTAL VPH	****** VOLUMES (VPH) ******** AUTOS	M TRUCKS	H TRUCKS	50' Leq	75' Leq	100' Leq
Geiger Rd. Between Kapolei Pkwy. and DW3	38	1,031	965	21	45	66.6	63.5	61.5
Geiger Rd. Between DW3 and DW2	38	1,002	938	20	44	66.4	63.4	61.3
Geiger Rd. Between DW2 and DW1	38	998	934	20	44	66.4	63.3	61.3
Geiger Rd. Between DW1 and ECRC	38	985	922	20	43	66.3	63.3	61.3
Geiger Rd. Between ECRC and Essex	38	985	922	20	43	66.3	63.3	61.3
Roosevelt Ave. Between Essex and DW4	35	968	909	15	44	65.5	62.5	60.5
Roosevelt Ave. Between DW4 and Philippine Sea	35	968	909	15	44	65.5	62.5	60.5
Roosevelt Ave. W. of Philippine Sea	35	1,209	1,137	18	54	66.4	63.4	61.4
Philippine Sea N. of Roosevelt Ave.	25	326	290	7	29	60.5	57.5	55.4
Philippine Sea S. of Renton Rd.	25	337	299	8	30	60.6	57.6	55.6
Renton Rd. Between Kapolei Pkwy. and DW5	34	343	317	12	14	61.1	58.1	56.0
Renton Rd. Between DW5 and Philippine Sea	34	343	317	12	14	61.1	58.1	56.0
Renton Rd. W. of Philippine Sea	34	13	12	0	1	46.9	44.2	42.6

TABLE 5

EXISTING AND CY 2030 DISTANCES TO 65, 70, AND 75 DNL CONTOURS

STREET SECTION	65 DNL SETBACK (FT)		70 DNL SETBACK (FT)		75 DNL SETBACK (FT)	
	EXISTING	CY 2030	EXISTING	CY 2030	EXISTING	CY 2030
Geiger Rd. Between Kapolei Pkwy. and DW3	70	87	37	44	19	23
Geiger Rd. Between DW3 and DW2	69	83	35	43	18	23
Geiger Rd. Between DW2 and DW1	68	81	36	42	19	22
Geiger Rd. Between DW1 and ECRC	68	79	35	41	18	21
Geiger Rd. Between ECRC and Essex	68	79	35	41	18	21
Roosevelt Ave. Between Essex and DW4	61	71	31	36	16	18
Roosevelt Ave. Between DW4 and Philippine Sea	61	69	31	35	16	18
Roosevelt Ave. W. of Philippine Sea	69	79	35	40	18	20
Philippine Sea N. of Roosevelt Ave.	31	35	16	18	< 12	< 12
Philippine Sea S. of Renton Rd.	32	35	16	18	< 12	< 12
Renton Rd. Between Kapolei Pkwy. and DW5	34	50	17	25	< 12	13
Renton Rd. Between DW5 and Philippine Sea	34	35	17	18	< 12	< 12
Renton Rd. W. of Philippine Sea	< 12	< 12	< 12	< 12	< 12	< 12

Notes:

(1) All setback distances are from the roadways' centerlines.
(2) See Tables 4 and 6 for traffic volume, speed, and mix assumptions.
(3) Setback distances are for ground level receptors.
(4) "Loose Soil" conditions assumed along all roadways.

TABLE 6

FUTURE (CY 2030) TRAFFIC VOLUMES AND NOISE LEVELS ALONG ROADWAYS IN PROJECT AREA (AM OR PM PEAK HOUR, BUILD)

	SPEED	TOTAL	****** VOLUMES (VPH) ********					
LOCATION	(MPH)	VPH	AUTOS	M TRUCKS	H TRUCKS	50' Leq	75' Leq	100' Leq
Geiger Rd. Between Kapolei Pkwy. and DW3	38	1,485	1,390	30	65	68.1	65.1	63.0
Geiger Rd. Between DW3 and DW2	38	1,398	1,309	28	61	67.9	64.8	62.8
Geiger Rd. Between DW2 and DW1	38	1,330	1,244	27	59	67.7	64.6	62.6
Geiger Rd. Between DW1 and ECRC	38	1,280	1,198	26	56	67.5	64.4	62.4
Geiger Rd. Between ECRC and Essex	38	1,280	1,198	26	56	67.5	64.4	62.4
Roosevelt Ave. Between Essex and DW4	35	1,263	1,187	19	57	66.6	63.6	61.6
Roosevelt Ave. Between DW4 and Philippine Sea	35	1,213	1,140	18	55	66.4	63.4	61.4
Roosevelt Ave. W. of Philippine Sea	35	1,520	1,429	23	68	67.4	64.4	62.4
Philippine Sea N. of Roosevelt Ave.	25	390	346	9	35	61.3	58.3	56.3
Philippine Sea S. of Renton Rd.	25	405	360	9	36	61.4	58.4	56.4
Renton Rd. Between Kapolei Pkwy. and DW5	34	715	660	26	29	64.0	61.0	59.0
Renton Rd. Between DW5 and Philippine Sea	34	398	368	14	16	61.4	58.4	56.4
Renton Rd. W. of Philippine Sea	34	25	23	1	1	49.1	46.3	44.5

TABLE 7

CALCULATIONS OF PROJECT AND NON-PROJECT TRAFFIC NOISE CONTRIBUTIONS (CY 2030) (PEAK HOUR LEQ OR DNL)

	NOISE LEVEL INCREASE DUE TO:	
STREET SECTION	NON-PROJECT TRAFFIC	PROJECT TRAFFIC
Geiger Rd. Between Kapolei Pkwy. and DW3	0.9	0.7
Geiger Rd. Between DW3 and DW2	0.8	0.6
Geiger Rd. Between DW2 and DW1	0.9	0.4
Geiger Rd. Between DW1 and ECRC	0.9	0.2
Geiger Rd. Between ECRC and Essex	0.9	0.2
Roosevelt Ave. Between Essex and DW4	0.8	0.3
Roosevelt Ave. Between DW4 and Philippine Sea	0.8	0.1
Roosevelt Ave. W. of Philippine Sea	0.9	0.1
Philippine Sea N. of Roosevelt Ave.	0.8	0.0
Philippine Sea S. of Renton Rd.	0.8	0.0
Renton Rd. Between Kapolei Pkwy. and DW5	0.9	2.0
Renton Rd. Between DW5 and Philippine Sea	0.9	-0.6
Renton Rd. W. of Philippine Sea	2.1	0.0

TABLE 8
ASSUMED FUTURE SOURCE NOISE LEVELS

FUTURE NOISE SOURCE	BLDG. LOCATION	SOUND LEVEL AT 50' (dBA)
Solids Dewatering	#081	69.6
Influent Pump Station	#012	61.5
Blower Building No. 1	#013K	79.3
BioTower Pump Station	#031C	62.0
Caustic Scrubbers (Sec.)	#051D	64.5
Grit Building	#201F	74.5
Primary Sludge Pump Station 1	#021E	63.8
Primary Sludge Pump Station 2	#021F	63.8
Mixed Liquor Recirculation Pump 1	#034 B/C	65.8
Mixed Liquor Recirculation Pump 2	#034 D/E	65.8
Aeration Blowers	#033I	89.4
RAS Pumps	#033I	70.6
WAS Pumps	#033I	60.6
Digester Control Building 1	#071F	62.8
Digester Control Building 2	#071G	62.8
Admin. Building 30T AC Unit	#097	59.2
Lab. Building 30T AC Unit	#098	59.2
Central Shops 30T AC Unit	#095	59.2
Maintenance Building 30T AC Unit	#094C	59.2
4 Roof Exhaust Fans (BPS)	#031C	40.7
Roof Exhaust Fan (BLW Bldg. 2)	#032C	37.0
Roof Exhaust Fan (BLW Bldg. 3)	#032C	37.0
Roof Exhaust Fan (BLW Bldg. 4)	#032C	37.0
Roof Exhaust Fan (BLW Bdlg. 5)	#032C	37.0
4 Roof Exhaust Fans (Sec. Thick.)	#062	40.0
Wet Weather Pumps	#022	64.8

TABLE 9
EXISTING AND FUTURE PLANT NOISE LEVELS

PERIMETER LOCATION	MEASURED EXISTING NIGHTTIME LAEQ (dBA) *	CALCULATED EXISTING PLANT NOISE LAEQ (dBA) *	CALCULATED FUTURE PLANT NOISE LAEQ (dBA) *
A	43.1	46.0	59.6
B	56.6	45.0	63.6
C	52.0	41.0	64.3
D	40.8	43.0	65.8
E	42.3	37.0	57.2
F	39.3	31.0	51.4
G	47.3	33.0	53.0
H	49.0	46.0	63.4
I	47.8	44.0	59.7
J	46.5	49.0	60.4

Note:

* Existing Noise Levels are from Table 2.

Appendix F
Traffic Impact Analysis Report (TIAR), Austin Tsutsumi & Associates, Inc. (ATA), November 2014

TRAFFIC IMPACT ANALYSIS REPORT HONOULIULI WASTEWATER TREATMENT PLANT

KAPOLEI, O‘AHU, HAWAI‘I

DRAFT FINAL

November 25, 2014

Prepared for:

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TRAFFIC IMPACT ANALYSIS REPORT
HONOULIULI WASTEWATER TREATMENT PLANT

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November 25, 2014

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TRAFFIC IMPACT ANALYSIS REPORT
HONOULIULI WASTEWATER TREATMENT PLANT
Kapolei, Oahu, Hawai‘i

1. INTRODUCTION

This report documents the findings of a traffic study conducted by Austin, Tsutsumi & Associates, Inc. (ATA) to evaluate the potential traffic impacts resulting from the proposed improvements to the Honouliuli Wastewater Treatment Plant (hereinafter referred to as the “Project”).

1.1 Location

The Project is located in Kapolei on the island of Oahu on a parcel of land more specifically identified as TMK: 9-1-069:003 and 9-1-013:007. The Project site is bound to the south by Geiger Road with Roosevelt Ave to the west, Renton Road to the north, and Coral Creek Golf Course to the east. Figure 1 shows the Project location.

1.2 Project Description

The Project proposes to upgrade and expand the facility, which will include the potential relocation of non-process facilities currently located at the Sand Island Wastewater Treatment Plant to the Project site. This TIAR will analyze two benchmark years; Year 2021, which corresponds to the peak year of construction for the Project and Year 2030, which corresponds to the build-out of the Project.

Figure 2 shows the Project site plan.

1.3 Study Methodology

This study will address the following:

1. Existing traffic operations at key locations within the study area.
2. Traffic projections for Base Years 2021 and 2030 without the Project including traffic generated by a defacto growth rate as well as traffic generated by other known developments in the vicinity of the Project.

3. Trip generation and assignment for the proposed Project.
4. Traffic projections for Years 2021 and 2030 with the Project conditions, which include Base Years 2021 and 2030 traffic volumes in addition to traffic volumes generated by the Project.
5. Recommendations for roadway improvements or other traffic mitigative measures, as appropriate, to reduce or eliminate the adverse impacts resulting from traffic generated by the Project.
6. This TIAR is prepared according to accepted industry practices. Selection and application of analysis methods are appropriate.

1.4 Analysis Methodology

Level of Service (LOS) is a qualitative measure used to describe the conditions of traffic flow at intersections, with values ranging from free-flow conditions at LOS A to congested conditions at LOS F. The Highway Capacity Manual – Special Report 209 (HCM), dated 2010, includes methods for calculating volume to capacity ratios, delays, and corresponding Levels of Service that were utilized in this study. LOS definitions for signalized and unsignalized intersections are provided in Appendix B.

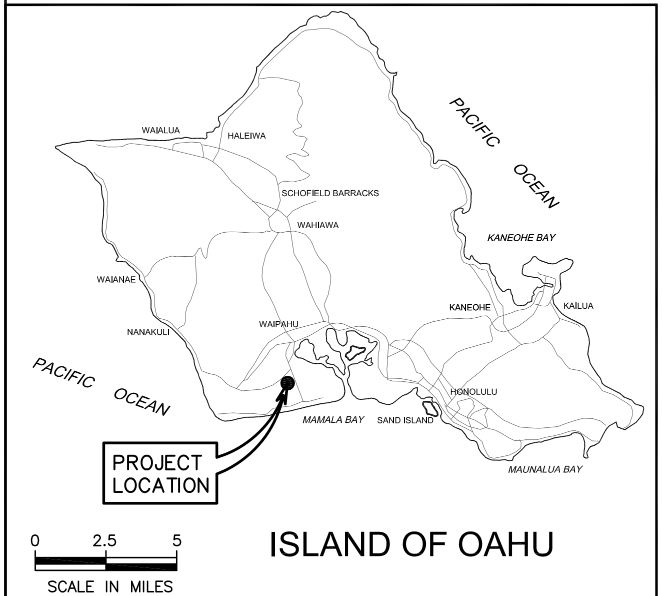
Analyses for the study intersections were performed using the traffic analysis software Synchro, which is able to prepare reports based on the methodologies described in the HCM. These reports contain control delay results as based on intersection lane geometry, signal timing, and hourly traffic volumes. Based on the vehicular delay at each intersection, a LOS is assigned to each approach and intersection movement as a qualitative measure of performance. These results, as confirmed or refined by field observations, constitute the technical analysis that will form the basis of the recommendations outlined in this report.

NORTH

NOT TO SCALE

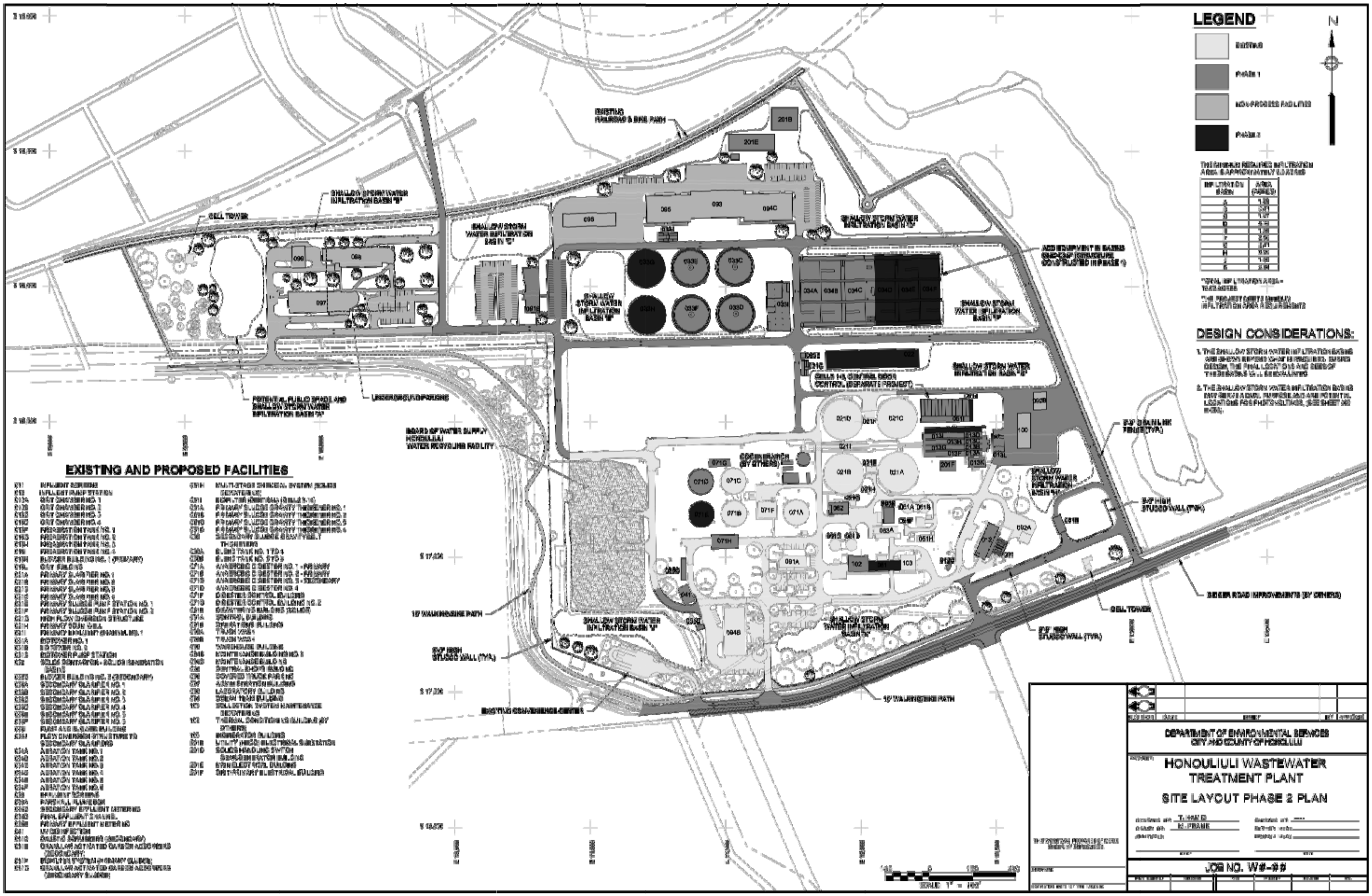
LIST OF PROJECT INTERSECTIONS:

1. KAPOLEI PARKWAY/KUALAKAI PARKWAY
2. KAPOLEI PARKWAY/RENTON ROAD
3. PHILLIPINE SEA/RENTON ROAD
4. PHILLIPINE SEA/ROOSEVELT AVENUE
5. ESSEX ROAD/ROOSEVELT AVENUE/GEIGER ROAD
6. GEIGER ROAD/EWA REFUSE CONVENIENCE CENTER
7. GEIGER ROAD/HONOULIULI DRIVEWAY 1
8. GEIGER ROAD/HONOULIULI DRIVEWAY 2
9. KAPOLEI PARKWAY/GEIGER ROAD
10. FORT WEAVER ROAD/GEIGER ROAD/IROQUOIS ROAD
11. FORT WEAVER ROAD/RENTON ROAD



ISLAND OF OAHU

HONOULIULI WASTEWATER TREATMENT PLANT TIAR	AUSTIN, TSUTSUMI & ASSOCIATES, INC. ENGINEERS, SURVEYORS • HONOLULU, HAWAII	FIGURE
	PROJECT LOCATION	1



HONOULIULI WASTEWATER TREATMENT PLANT TIAR

AUSTIN, TSUTSUMI & ASSOCIATES, INC.
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PROJECT SITE PLAN

FIGURE 2

2. EXISTING CONDITIONS

2.1 Roadway System

The following are brief descriptions of the existing roadways in the vicinity of the Project:

Kualakai Parkway is generally a north-south, two-way, four-lane, divided arterial roadway. This roadway begins to the north as a full diamond interchange with the H-1 Freeway and ends to the south at a T-intersection with Kapolei Parkway. The posted speed limit along Kualakai Parkway is 35 miles per hour (mph).

Renton Road is generally an east-west, two-way, collector roadway that begins at Kihi Street to the west as a two-lane, undivided roadway and extends to the east becoming a four-lane, divided roadway terminating in Asing Park. The posted speed limit along Renton Road is 25 mph.

Kapolei Parkway is generally an east-west, two-way, six-lane, divided arterial roadway in the vicinity of the Project. This roadway begins in the west near the Kapolei Target Store and extends east until it crosses Renton Road and turns to the south. Kapolei Parkway continues past its intersection with Papipi Road as Hailipo Street. The posted speed limit along this roadway in the vicinity of the Project is 30 mph.

Roosevelt Avenue is generally an east-west, two-way, two-lane, undivided collector roadway in the vicinity of the Project. This roadway begins in the west near its intersection with Boxer Road and extends east until it terminates at its intersection with Essex Road and continues as Geiger Road. The posted speed limit along this roadway is 25 mph.

Phillipine Sea is generally a north-south, two-way, two-lane, undivided restricted private local roadway. This roadway begins to the north at a T-intersection with Renton Road and terminates to the south at its intersection with Vinson Road. The posted speed limit is 15 mph.

Geiger Road is generally an east-west, two-lane, undivided two-way collector roadway in the vicinity of the Project. This roadway begins in the west where Roosevelt Ave becomes Geiger Road at the intersection with Essex Road and terminates to the east where Geiger Road becomes Iroquois Road at its intersection with Fort Weaver Road. The posted speed limit in the vicinity of the project is 30 mph.

Fort Weaver Road is generally a north-south, two-way, six-lane, divided arterial roadway in the vicinity of the Project. This roadway begins to the north at the H-1 Freeway interchange, and terminates in the south at its intersection with Popoi Place near Ewa Beach Park. The posted speed limit in the vicinity of the Project is 35 mph.

Essex Road is generally a north-south, two-way, two-lane, undivided private local roadway that primarily serves to provide access to Barbers Point Golf Course. This roadway begins in the north at a T-intersection with Geiger Road, becomes a restricted roadway to the south of Barbers Point Golf Course, and terminates to the south at White Plains Beach Park. The posted speed limit along this roadway is 10 mph.

Ewa Refuse Convenience Center Driveway is approximately 450 feet east of the Geiger Road/Essex Road intersection and provides access to the refuse center.

Honouliuli Driveway 1 is the westernmost Project driveway along Geiger Road and provides direct access to the Honouliuli WWTP.

Honouliuli Driveway 2 is the easternmost Project driveway along Geiger Road and provides direct access to the Honouliuli WWTP.

2.2 Existing Traffic Volumes

Due to their proximity to the Project, the following intersections and Project access driveways were studied:

- Kualakai Parkway/Kapolei Parkway
- Renton Road/Phillipine Sea
- Roosevelt Avenue/Phillipine Sea
- Fort Weaver Road/Geiger Road/Iroquois Road
- Geiger Road/Kapolei Parkway
- Renton Road/Kapolei Parkway
- Renton Road/Fort Weaver Road
- Roosevelt Avenue/Geiger Road/Essex Road
- Geiger Road/Ewa Refuse Convenience Center Driveway
- Geiger Road/Honouliuli Driveway 1
- Geiger Road/Honouliuli Driveway 2

The weekday morning (AM) and afternoon (PM) peak hour turning movement data utilized in this report was collected on Wednesday, September 3, 2014. Based on this traffic count data, the weekday AM peak hour of traffic was determined to be from 7:00 AM to 8:00 AM and the PM peak hour of traffic was determined to be from 4:00 PM to 5:00 PM. The traffic count data is provided in Appendix A.

2.3 Existing Intersection Analysis

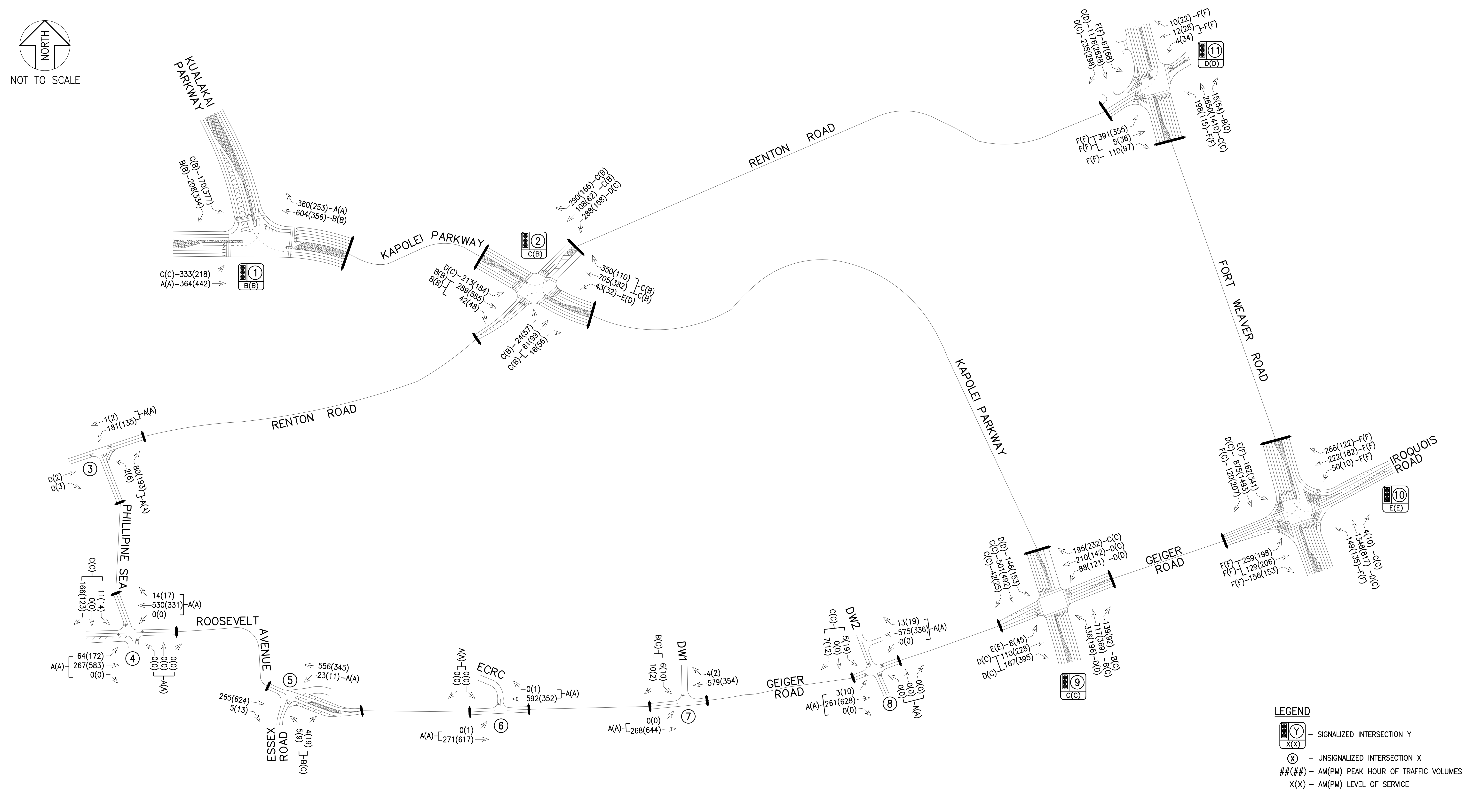
At all signalized study intersections, with the exception of Fort Weaver Road intersections, most vehicles typically cleared each intersection within one signal cycle without any heavy queuing or congestion. All study intersections operate at LOS D or better with adequate capacity except for the following intersections:

Kapolei Parkway/Renton Road
All movements of this intersection currently operate at LOS D or better during the AM and PM peak hours of traffic with the exception of the northbound left-turn movement, which operates at LOS E during the AM peak hour of traffic. Although the northbound left-turn movement operates at LOS E during the AM peak hour of traffic, adequate capacity is provided.

Kapolei Parkway/Geiger Road
The eastbound left-turn movement operates at LOS E(E) during the AM(PM) peak hours, but is generally low volume movements of only 8(45) vehicles, respectively. All remaining movements of this intersection operate at LOS D or better during the AM and PM peak hour of traffic.

Fort Weaver Road/Geiger Road/Iroquois Road & Fort Weaver Road/Renton Road
The majority of movements at these intersections currently operate at LOS E/F conditions during the AM and PM peak hours of traffic mainly due to long delays as a result of requisite long cycle lengths (approximately 4 minutes long). These two intersections also provide split-phase signal operation on the side streets and long pedestrian crossing times across Fort Weaver Road, which contribute to the long delays. During the AM peak hour, the northbound traffic is generally heavier, while during the PM peak hour, traffic is heavier in the southbound direction.

Existing traffic volumes, lane configuration and movement LOS are illustrated in Figure 3. Table 1 shows the existing delay, volume to capacity (v/c) ratio, and LOS for the study intersections, with the full LOS summary table provided in Appendix C.



HONOULIULI WASTEWATER TREATMENT PLAN TIAR

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FIGURE 3

EXISTING LANE CONFIGURATION, VOLUME, AND LOS

T.1: Existing Intersection Level of Service Summary

Intersection	Existing Conditions					
	AM			PM		
	HCM Delay	v/c Ratio	LOS	HCM Delay	v/c Ratio	LOS
1: Kapolei Pkwy & Kualakai Pkwy						
EB LT	21.8	0.66	C	21.9	0.64	C
EB TH	3.7	0.12	A	5.8	0.18	A
EB RT	-	-	-	-	-	-
WB LT	-	-	-	-	-	-
WB TH	12.3	0.36	B	12.8	0.26	B
WB RT	7.9	0.28	A	6.3	0.19	A
NB LT	-	-	-	-	-	-
NB TH	-	-	-	-	-	-
NB RT	-	-	-	-	-	-
SB LT	21.3	0.41	C	16.9	0.55	B
SB TH	-	-	-	-	-	-
SB RT	14.4	0.28	B	12.6	0.40	B
Overall	12.5	-	B	12.2	-	B
2: Kapolei Pkwy & Renton Rd						
EB LT	26.5	0.07	C	17.5	0.14	B
EB TH/RT	23.9	0.14	C	17.1	0.31	B
WB LT	36.6	0.73	D	22.1	0.46	C
WB TH	24.4	0.21	C	16.0	0.13	B
WB RT	24.1	0.17	C	15.7	0.08	B
NB LT	62.9	0.77	E	40.7	0.66	D
NB TH	25.3	0.60	C	17.0	0.34	B
NB TH/RT	25.9	0.61	C	17.2	0.35	B
SB LT	45.2	0.85	D	28.5	0.77	C
SB TH	13.9	0.14	B	12.5	0.34	B
SB TH/RT	14.0	0.14	B	12.7	0.34	B
Overall	27.9	-	C	17.5	-	B
3: Phillipine Sea & Renton Rd						
EB TH/RT	-	-	-	-	-	-
WB LT/TH	7.5	0.12	A	7.5	0.09	A
NB LT/RT	8.7	0.08	A	9.3	0.21	A
4: Phillipine Sea & Roosevelt Ave						
EB LT/TH/RT	8.9	0.07	A	8.6	0.16	A
WB LT/TH/RT	0.0	-	A	0.0	-	A
NB LT/TH/RT	0.0	-	A	0.0	-	A
SB LT/TH/RT	18.0	0.41	C	18.0	0.35	C
5: Essex Rd & Roosevelt Ave/Geiger Rd						
EB TH/RT	-	-	-	-	-	-
WB LT	7.9	0.02	A	9.0	0.01	A
WB TH	-	-	-	-	-	-
NB LT/RT	14.4	0.03	B	16.3	0.09	C
6: Geiger Rd & Ewa Refuse Convenience Center						
EB LT/TH/RT	0.0	-	A	8.1	0.00	A
WB LT/TH/RT	7.9	0.01	A	8.9	0.00	A
NB LT/TH/RT	11.8	0.04	B	12.9	0.01	B
SB LT/TH/RT	0.0	-	A	0.0	-	A
7: Geiger Rd & Honouliuli Drwy 1						
EB LT/TH	0.0	-	A	0.0	-	A
WB TH/RT	-	-	-	-	-	-
SB LT/RT	14.6	0.04	B	19.2	0.05	C
8: Geiger Rd & Honouliuli Drwy 2						
EB LT/TH/RT	8.8	0.00	A	8.1	0.01	A
WB LT/TH/RT	0.0	-	A	0.0	-	A
NB LT/TH/RT	0.0	-	A	0.0	-	A
SB LT/TH/RT	15.8	0.04	C	20.4	0.13	C
9: Kapolei Pkwy & Geiger Rd						
EB LT	67.8	0.56	E	56.4	0.78	E
EB TH	35.2	0.35	D	30.5	0.63	C
EB TH/RT	35.2	0.36	D	31.1	0.66	C
EB RT	-	-	-	-	-	-
WB LT	46.9	0.77	D	42.2	0.78	D
WB TH	35.6	0.73	D	23.7	0.32	C
WB RT	29.4	0.15	C	22.4	0.14	C
NB LT	36.3	0.88	D	38.5	0.81	D
NB TH	18.2	0.53	B	23.3	0.41	C
NB RT	14.6	0.10	B	20.7	0.04	C
SB LT	42.2	0.79	D	40.1	0.79	D
SB TH	24.5	0.52	C	26.7	0.60	C
SB RT	20.5	0.01	C	22.1	0.01	C
Overall	27.9	-	C	30.3	-	C

Note:
* = over-capacity, v/c > 1

T.1: Existing Intersection Level of Service Summary (continued)

Intersection	Existing Conditions					
	AM			PM		
	HCM Delay	v/c Ratio	LOS	HCM Delay	v/c Ratio	LOS
10: Ft Weaver Rd & Geiger Rd/Iroquois Rd						
EB LT	107.0	0.65	**F**	106.7	0.65	**F**
EB LT/TH	101.9	0.63	**F**	102.5	0.65	**F**
EB RT	97.2	0.39	**F**	99.1	0.48	**F**
WB LT	85.3	0.18	**F**	90.3	0.05	**F**
WB TH	105.2	0.75	**F**	116.8	0.78	**F**
WB RT	85.2	0.19	**F**	90.4	0.06	**F**
NB LT	111.0	0.61	**F**	111.1	0.59	**F**
NB TH	35.9	0.53	D	33.2	0.33	C
NB RT	26.0	0.00	C	28.2	0.01	C
SB LT	77.0	0.63	E	119.0	0.80	**F**
SB TH	50.1	0.34	D	29.3	0.54	C
SB RT	141.5	0.08	**F**	32.3	0.17	C
Overall	65.2	0.60	E	57.8	0.64	E
11: Ft Weaver Rd & Renton Rd						
EB LT	111.0	0.79	**F**	112.4	0.79	**F**
EB LT/TH	109.3	0.77	**F**	111.6	0.79	**F**
EB RT	86.5	0.16	**F**	86.3	0.09	**F**
WB LT/TH	118.6	0.34	**F**	121.2	0.63	**F**
WB RT	111.6	0.01	**F**	104.5	0.02	**F**
NB LT	120.7	0.81	**F**	100.3	0.70	**F**
NB TH	21.8	0.87	C	28.7	0.48	C
NB RT	14.9	0.01	B	40.0	0.05	D
SB LT	123.1	0.58	**F**	111.9	0.59	**F**
SB TH	31.3	0.44	C	54.6	0.95	D
SB RT	45.8	0.17	D	34.6	0.21	C
Overall	39.8	0.84	D	53.9	0.88	D

Note:
* = over-capacity, v/c > 1

3. BASE YEAR WITHOUT PROJECT SCENARIOS

The year 2021 was selected as the base year to reflect the anticipated peak year of construction activity, which was assumed to occur during Phase 1 construction of the Honouliuli WWTP.

3.1 Defacto Growth Rate

The Oahu Regional Transportation Plan 2035 (ORTP) was prepared in 2011, and serves as the basis for future traffic projections of future conditions throughout this TIAR. The ORTP uses existing data from 2007 as its baseline before assigning land uses and socioeconomic data to Traffic Analysis Zones (TAZ's) to generate and assign traffic across the roadway network. Although island wide projects are accounted for in the ORTP, the economic environment and housing demand would be the main driver for the pace of development to occur.

The ORTP Model takes into account island wide projects and generates and distributes the generated trips throughout the roadway network. The growth rates derived from 2007 and 2035 traffic projections were applied linearly to existing 2014 traffic volume to determine year 2021 and 2030 Base Year conditions. In some cases, growth rates were derived from a comparison of the existing collected 2014 traffic counts and 2035 model traffic projections. With the inclusion of other known developments shown below, some growth rates were adjusted to account for the manual inclusion of trips on the roadway network. Calculated defacto growth rates ranging from 0.5-3.5 percent were used to generate Base Year 2021 and 2030 traffic projections.

3.2 Other Known Developments

The surrounding projects traffic studies – University of Hawaii at West Oahu (UHWO), Ka Makana Alii, Ho'opili and East Kapolei developments – were used to determine turning movement volumes at various study intersection and were reconciled with the ORTP, which does not provide individual turning movement volumes. Other projects' trip contributions to the background traffic were assumed to be implicit to the ORTP.

- UHWO – This project is currently located adjacent and to the west of Kualakai Parkway and south of Farrington Highway. The UHWO currently provides an enrollment for approximately 2,400. Future expansion of the UHWO campus anticipates 7,600 enrollment with residential dwelling units and Village Mixed-Use (VMX) space. This project was assumed to be completed by Year 2021.
- Ka Makana Alii – This project is proposed to be located adjacent and to the south of the Kualakai Parkway/Kapolei Parkway intersection. Ka Makana Alii is a planned shopping center, consisting of approximately 1.4 million square feet (SF) of retail commercial space. This project was assumed to be completed by Year 2021.
- Hoopili –This project is located north of the Project, to the east of Kualakai Parkway and west of Fort Weaver Road. Upon full build-out, Hoopili will include 2,300 single family dwelling units, 9,520 multi-family dwelling units, over 3 million SF of commercial/retail space, over 800,000 SF of industrial space, over 70 acres of parks, approximately 200 acres of a commercial farm, three elementary schools, one middle school, and one high school. Only a percentage of traffic was assumed to be completed, for the Base Year 2021 and Base Year 2030 scenarios, since the full build-out is anticipated to occur by Year 2035.

- East Kapolei II – This project is proposed to be located adjacent and to the west of Kualakai Parkway and will consist of approximately 2,100 dwelling units. This project was assumed to be completed by Year 2021.

3.3 Base Year 2021 Analysis

It is anticipated that by year 2021, traffic will have increased significantly over existing conditions due to the continuing development of the Ewa-Kapolei region.

Upon build-out of the Ka Makana Alii Shopping Center, one of the proposed accesses to the shopping center is anticipated to be provided as a new south leg extension from the existing Kapolei Parkway/Kualakai Parkway intersection, ultimately providing a 4-legged intersection. This improvement was triggered by the Ka Makana Alii TIAR, identified on the STIP and assumed to be a joint effort implemented by Ka Makana Alii and HDOT. The following proposed lane configuration is anticipated to be constructed for the Kapolei Parkway/Kualakai Parkway intersection by Base Year 2021:

Kapolei Parkway/Kualakai Parkway

1. Northbound Approach
   a. Provide a new approach that includes one left-turn lane, one through lane and one shared through/right-turn lane.

2. Southbound Approach
   a. Provide two through lanes.

3. Eastbound Approach
   a. Convert three through lanes to two through lanes and one shared through/right-turn lane.

4. Westbound Approach
   a. Provide two new left-turn lanes.

With the improvements at the intersection the low volume northbound left-turn movement is projected to operate at LOS F during the AM peak hour with only 5 vehicles anticipated to make the left-turn onto Kapolei Parkway. During the PM peak hour, all left-turn movements will operate at LOS E conditions. All LOS E/F movements are provided with adequate capacity with a v/c ratio under 1.0.

Kapolei Parkway/Renton Road
This intersection is forecast to operate similar to existing conditions during the AM and PM peak hours of traffic. However, the southbound left-turn movement will worsen to LOS E during the AM peak hour of traffic and the northbound left-turn movement will worsen to LOS E during the PM peak hour of traffic.

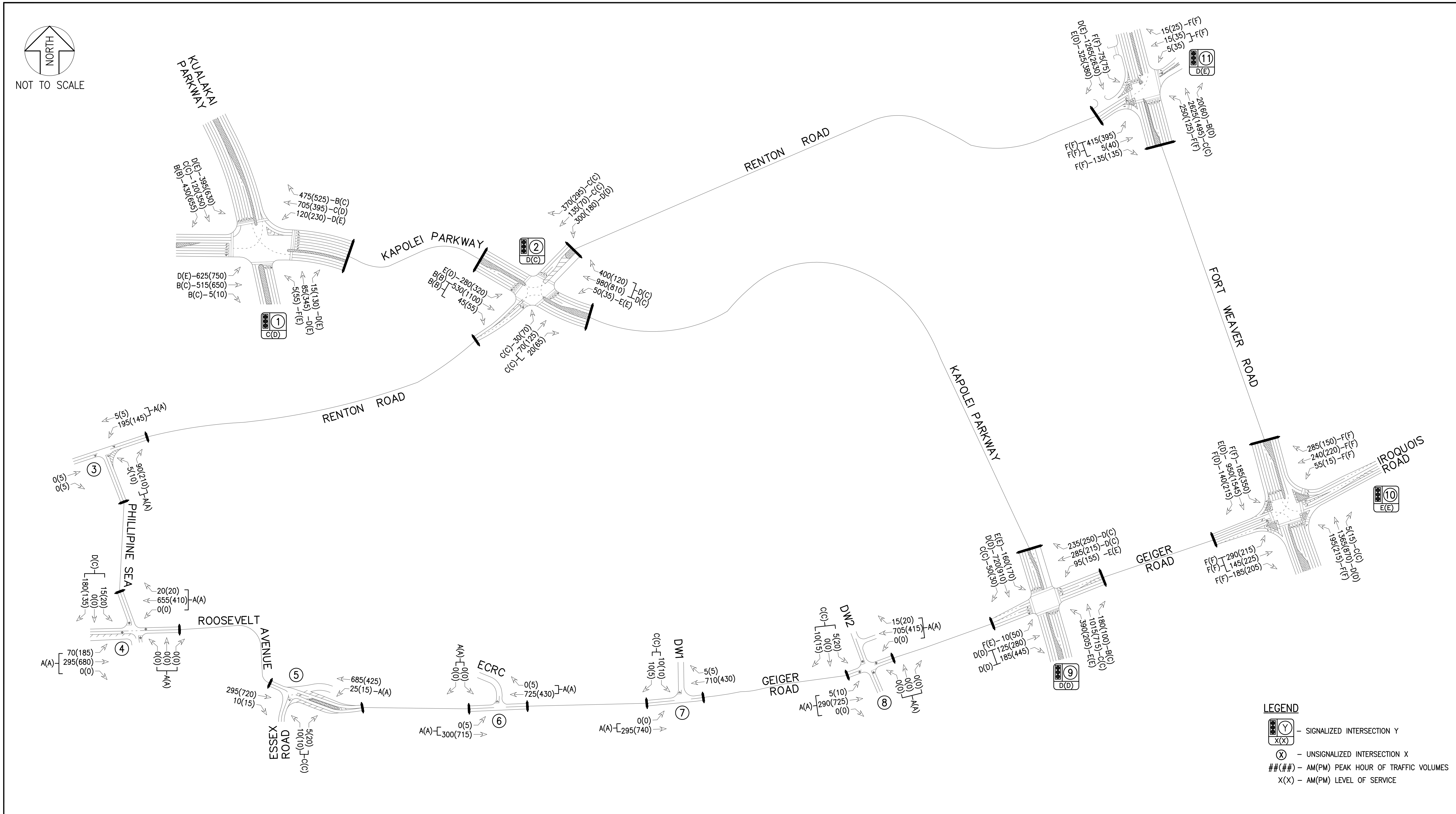
Kapolei Parkway/Geiger Road
The intersection is anticipated to operate overall at LOS D during the AM and PM peak hours of traffic. Due to increased traffic, all left-turn movements are anticipated to operate at LOS E during both peak hours, with the low volume eastbound left-turn movement of 10 vehicles,

operating at LOS F. All LOS E/F movements are provided with adequate capacity with a v/c ratio under 1.0.

Fort Weaver Road/Geiger Road/Iroquois Road & Fort Weaver Road/Renton Road
Similar to Existing conditions, the intersections along Fort Weaver Road through the Ewa region will continue to experience LOS F at some movements. However, this is generally ascribed to requisite long traffic signal cycle lengths, split phase operation and generally long crosswalk lengths across Fort Weaver Road. Further widening of Fort Weaver Road is not prescribed by the ORTP 2035, and is generally considered infeasible due to insufficient ROW.

All unsignalized study intersections will continue operating at LOS D or better during the AM and PM peak hours of traffic.

Figure 4 illustrates the forecast traffic volumes, lane configuration and movement LOS for Base Year 2021 conditions. Table 2 shows the Existing and Base Year 2021 LOS at the study intersections, with the full LOS summary table provided in Appendix C.



HONOULIULI WASTEWATER TREATMENT PLAN TIAR

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FIGURE 4

BASE YEAR 2021 LANE CONFIGURATION, VOLUME, AND LOS

Table 2: Existing and Base Year 2021 (no mit) Intersection Level of Service Summary

Intersection	Existing Conditions						BY 2021 (No Mit)					
	AM			PM			AM			PM		
Intersection	HCM Delay	v/c Ratio	LOS	HCM Delay	v/c Ratio	LOS	HCM Delay	v/c Ratio	LOS	HCM Delay	v/c Ratio	LOS
1: Kapolei Pkwy & Kualakai Pkwy												
EB LT	21.8	0.66	C	21.9	0.64	C	37.0	0.84	D	57.4	0.91	E
EB TH	3.7	0.12	A	5.8	0.18	A	16.7	0.24	B	31.4	0.38	C
EB RT	-	-	-	-	-	-	16.8	0.24	B	31.6	0.38	C
WB LT	-	-	-	-	-	-	46.1	0.61	D	62.6	0.78	E
WB TH	12.3	0.36	B	12.8	0.26	B	30.3	0.56	C	47.2	0.44	D
WB RT	7.9	0.28	A	6.3	0.19	A	19.8	0.44	B	28.3	0.45	C
NB LT	-	-	-	-	-	-	88.5	0.54	**F**	76.5	0.77	E
NB TH	-	-	-	-	-	-	41.3	0.29	D	56.2	0.71	E
NB TH/RT							41.2	0.29	D	56.2	0.71	E
SB LT	21.3	0.41	C	16.9	0.55	B	42.8	0.82	D	63.2	0.91	E
SB TH	-	-	-	-	-	-	28.7	0.15	C	33.4	0.33	C
SB RT	14.4	0.28	B	12.6	0.40	B	14.7	0.21	B	13.3	0.27	B
Overall	12.5	-	B	12.2	-	B	29.1	-	C	44.4	-	D
2: Kapolei Pkwy & Renton Rd												
EB LT	26.5	0.07	C	17.5	0.14	B	34.8	0.10	C	26.8	0.19	C
EB TH/RT	23.9	0.14	C	17.1	0.31	B	30.1	0.16	C	26.1	0.37	C
WB LT	36.6	0.73	D	22.1	0.46	C	49.2	0.78	D	36.3	0.61	D
WB TH	24.4	0.21	C	16.0	0.13	B	31.2	0.25	C	24.0	0.14	C
WB RT	24.1	0.17	C	15.7	0.08	B	30.5	0.19	C	23.9	0.13	C
NB LT	62.9	0.77	E	40.7	0.66	D	73.2	0.77	E	67.6	0.79	E
NB TH	25.3	0.60	C	17.0	0.34	B	40.2	0.82	D	28.5	0.65	C
NB TH/RT	25.9	0.61	C	17.2	0.35	B	44.6	0.82	D	29.3	0.65	C
SB LT	45.2	0.85	D	28.5	0.77	C	60.7	0.90	E	51.9	0.90	D
SB TH	13.9	0.14	B	12.5	0.34	B	17.1	0.24	B	16.0	0.49	B
SB TH/RT	14.0	0.14	B	12.7	0.34	B	17.2	0.24	B	16.2	0.49	B
Overall	27.9	-	C	17.5	-	B	38.7	-	D	26.8	-	C
3: Phillipine Sea & Renton Rd												
EB TH/RT	-	-	-	-	-	-	-	-	-	-	-	-
WB LT/TH	7.5	0.12	A	7.5	0.09	A	7.6	0.13	A	7.5	0.09	A
NB LT/RT	8.7	0.08	A	9.3	0.21	A	9.0	0.10	A	9.3	0.21	A
4: Phillipine Sea & Roosevelt Ave												
EB LT/TH/RT	8.9	0.07	A	8.6	0.16	A	9.5	0.09	A	8.6	0.16	A
WB LT/TH/RT	0.0	-	A	0.0	-	A	0.0	-	A	0.0	-	A
NB LT/TH/RT	0.0	-	A	0.0	-	A	0.0	-	A	0.0	-	A
SB LT/TH/RT	18.0	0.41	C	18.0	0.35	C	26.6	0.57	D	18.0	0.35	C
5: Essex Rd & Roosevelt Ave/Geiger Rd												
EB TH/RT	-	-	-	-	-	-	-	-	-	-	-	-
WB LT	7.9	0.02	A	9.0	0.01	A	8.0	0.02	A	9.0	0.01	A
WB TH	-	-	-	-	-	-	-	-	-	-	-	-
NB LT/RT	14.4	0.03	B	16.3	0.09	C	18.2	0.06	C	16.3	0.09	C
6: Geiger Rd & Ewa Refuse Convenience Center												
EB LT/TH/RT	0.0	-	A	8.1	0.00	A	0.0	-	A	8.1	0.00	A
WB LT/TH/RT	7.9	0.01	A	8.9	0.00	A	0.0	-	A	8.9	0.00	A
NB LT/TH/RT	11.8	0.04	B	12.9	0.01	B	0.0	-	A	12.9	0.01	B
SB LT/TH/RT	0.0	-	A	0.0	-	A	0.0	-	A	0.0	-	A
7: Geiger Rd & Honouliuli Drwy 1												
EB LT/TH	0.0	-	A	0.0	-	A	0.0	-	A	0.0	-	A
WB TH/RT	-	-	-	-	-	-	-	-	-	-	-	-
SB LT/RT	14.6	0.04	B	19.2	0.05	C	18.1	0.07	C	19.2	0.05	C
8: Geiger Rd & Honouliuli Drwy 2												
EB LT/TH/RT	8.8	0.00	A	8.1	0.01	A	9.3	0.01	A	8.1	0.01	A
WB LT/TH/RT	0.0	-	A	0.0	-	A	0.0	-	A	0.0	-	A
NB LT/TH/RT	0.0	-	A	0.0	-	A	0.0	-	A	0.0	-	A
SB LT/TH/RT	15.8	0.04	C	20.4	0.13	C	18.1	0.06	C	20.4	0.13	C
9: Kapolei Pkwy & Geiger Rd												
EB LT	67.8	0.56	E	56.4	0.78	E	87.1	0.61	**F**	73.6	0.77	E
EB TH	35.2	0.35	D	30.5	0.63	C	47.1	0.31	D	46.5	0.75	D
EB TH/RT	35.2	0.36	D	31.1	0.66	C	47.2	0.32	D	47.5	0.77	D
EB RT	-	-	-	-	-	-	-	-	-	-	-	-
WB LT	46.9	0.77	D	42.2	0.78	D	67.9	0.80	E	71.9	0.86	E
WB TH	35.6	0.73	D	23.7	0.32	C	52.3	0.84	D	34.7	0.42	C
WB RT	29.4	0.15	C	22.4	0.14	C	39.5	0.13	D	31.3	0.13	C
NB LT	36.3	0.88	D	38.5	0.81	D	61.5	0.93	E	65.7	0.88	E
NB TH	18.2	0.53	B	23.3	0.41	C	24.5	0.66	C	35.0	0.64	C
NB RT	14.6	0.10	B	20.7	0.04	C	17.7	0.14	B	27.0	0.06	C
SB LT	42.2	0.79	D	40.1	0.79	D	66.6	0.86	E	62.0	0.86	E
SB TH	24.5	0.52	C	26.7	0.60	C	35.1	0.67	D	46.1	0.87	D
SB RT	20.5	0.01	C	22.1	0.01	C	26.8	0.02	C	28.3	0.02	C
Overall	27.9	-	C	30.3	-	C	39.5	-	D	46.3	-	D

Note:
* = over-capacity, v/c > 1

Table 2: Existing and Base Year 2021 (no mit) Intersection Level of Service Summary (continued)

Intersection	Existing Conditions						BY 2021 (No Mit)					
	AM			PM			AM			PM		
	HCM Delay	v/c Ratio	LOS	HCM Delay	v/c Ratio	LOS	HCM Delay	v/c Ratio	LOS	HCM Delay	v/c Ratio	LOS
10: Ft Weaver Rd & Geiger Rd/Iroquois Rd												
EB LT	107.0	0.65	**F**	106.7	0.65	**F**	107.2	0.68	**F**	104.6	0.65	**F**
EB LT/TH	101.9	0.63	**F**	102.5	0.65	**F**	101.8	0.66	**F**	100.0	0.65	**F**
EB RT	97.2	0.39	**F**	99.1	0.48	**F**	102.9	0.61	**F**	106.7	0.68	**F**
WB LT	85.3	0.18	**F**	90.3	0.05	**F**	85.0	0.19	**F**	86.7	0.06	**F**
WB TH	105.2	0.75	**F**	116.8	0.78	**F**	109.3	0.80	**F**	117.9	0.83	**F**
WB RT	85.2	0.19	**F**	90.4	0.06	**F**	85.4	0.23	**F**	87.5	0.12	**F**
NB LT	111.0	0.61	**F**	111.1	0.59	**F**	110.9	0.67	**F**	110.8	0.69	**F**
NB TH	35.9	0.53	D	33.2	0.33	C	39.0	0.56	D	38.6	0.38	D
NB RT	26.0	0.00	C	28.2	0.01	C	28.0	0.00	C	32.3	0.01	C
SB LT	77.0	0.63	E	119.0	0.80	**F**	82.7	0.67	**F**	123.1	0.80	**F**
SB TH	50.1	0.34	D	29.3	0.54	C	56.6	0.39	E	37.2	0.62	D
SB RT	141.5	0.08	**F**	32.3	0.17	C	215.0	0.10	**F**	36.0	0.20	D
Overall	65.2	0.60	E	57.8	0.64	E	72.6	0.63	E	64.4	0.70	E
11: Ft Weaver Rd & Renton Rd												
EB LT	111.0	0.79	**F**	112.4	0.79	**F**	113.0	0.81	**F**	114.2	0.83	**F**
EB LT/TH	109.3	0.77	**F**	111.6	0.79	**F**	110.8	0.80	**F**	112.8	0.82	**F**
EB RT	86.5	0.16	**F**	86.3	0.09	**F**	87.6	0.27	**F**	87.2	0.26	**F**
WB LT/TH	118.6	0.34	**F**	121.2	0.63	**F**	118.9	0.39	**F**	122.3	0.66	**F**
WB RT	111.6	0.01	**F**	104.5	0.02	**F**	111.2	0.01	**F**	103.4	0.02	**F**
NB LT	120.7	0.81	**F**	100.3	0.70	**F**	124.9	0.85	**F**	100.3	0.74	**F**
NB TH	21.8	0.87	C	28.7	0.48	C	22.4	0.87	C	32.0	0.53	C
NB RT	14.9	0.01	B	40.0	0.05	D	15.4	0.02	B	41.3	0.05	D
SB LT	123.1	0.58	**F**	111.9	0.59	**F**	126.9	0.66	**F**	113.6	0.62	**F**
SB TH	31.3	0.44	C	54.6	0.95	D	37.2	0.51	D	64.5	0.99	E
SB RT	45.8	0.17	D	34.6	0.21	C	56.2	0.23	E	40.3	0.27	D
Overall	39.8	0.84	D	53.9	0.88	D	44.3	0.85	D	60.5	0.90	E

Note:
* = over-capacity, v/c > 1

3.4 Base Year 2030 Analysis

The year 2030 was selected as the base year to reflect the anticipated build-out of the Honouliuli WWTP. By year 2030, traffic will continue to increase due to the continuing development of the Ewa-Kapolei region. Based on a LOS comparison between Base Year 2021 and Base Year 2030, the majority of individual movements that are projected to operate at LOS E/F for Base Year 2021 conditions will continue operating at similar levels of service for Base Year 2030 conditions during the AM and PM peak hours of traffic except for the following:

<u>Kapolei Parkway/Kualakai Parkway</u>

The low volume northbound left-turn movement will operate at LOS F during the PM peak hour. All LOS E/F movements will continue to be provided with adequate capacity with a v/c ratio under 1.0.

<u>Kapolei Parkway/Renton Road</u>

During the AM peak hour, the northbound approach will worsen to LOS E conditions, with the mainline through movement along Kapolei Parkway nearing its capacity. In addition, the westbound and southbound left-turn movements will operate at LOS E during the PM peak hour of traffic. In order to mitigate the deficiencies of the intersection, dual southbound left-turn lanes were recommended to accommodate the relatively high 275(320) southbound left-turn vehicles during the AM(PM) peak hours.

With the dual southbound left-turn lanes, all movements at the intersection are forecast to operate similar to Base Year 2021 conditions.

<u>Phillipine Sea/Roosevelt Avenue</u>

The southbound shared left/through/right-turn lane is anticipated to worsen from LOS D to LOS E. With a low 15(20) vehicles making the southbound left-turn movement, the heavier southbound right-turn movement should not be heavily impacted. Based on existing observations, the southbound queues did extend beyond four vehicles, with the majority of queues typically consisting of only one vehicle.

<u>Kapolei Parkway/Geiger Road</u>

During the AM peak hour, the westbound and southbound left-turn movements will worsen to LOS F. In addition, northbound left-turn movement will worsen to LOS F at overcapacity conditions. During the PM peak hour, the westbound left-turn movement will worsen to LOS F, and the southbound through movement along Kapolei Parkway will operate near capacity. In order to mitigate the deficiencies of the intersection, dual northbound left-turn lanes were recommended to accommodate the high 470(215) northbound left-turn vehicles during the AM(PM) peak hours. Also, the eastbound approach along Geiger Road was restriped from one left-turn, one through and one shared through/right to one left-turn, one through and one right-turn.

With the dual northbound left-turn lanes and eastbound restriping, all movements are forecast to operate similar to Base Year 2021 conditions.

<u>Fort Weaver Road/Geiger Road/Iroquois Road & Fort Weaver Road/Renton Road</u>

The intersections along Fort Weaver Road through the Ewa region will experience LOS F and over-capacity conditions at some movements. However, this is generally ascribed to requisite long traffic signal cycle lengths, split phase operation and generally long crosswalk lengths across Fort Weaver Road. Further widening of Fort Weaver Road is not prescribed by the ORTP 2035, and is generally considered infeasible due to insufficient ROW.

Figure 5 illustrates the forecast traffic volumes, lane configuration and movement LOS for Base Year 2030 conditions. Table 3 shows the Base Year 2021 and Base Year 2030 LOS at the study intersections, with the full LOS summary table provided in Appendix C.

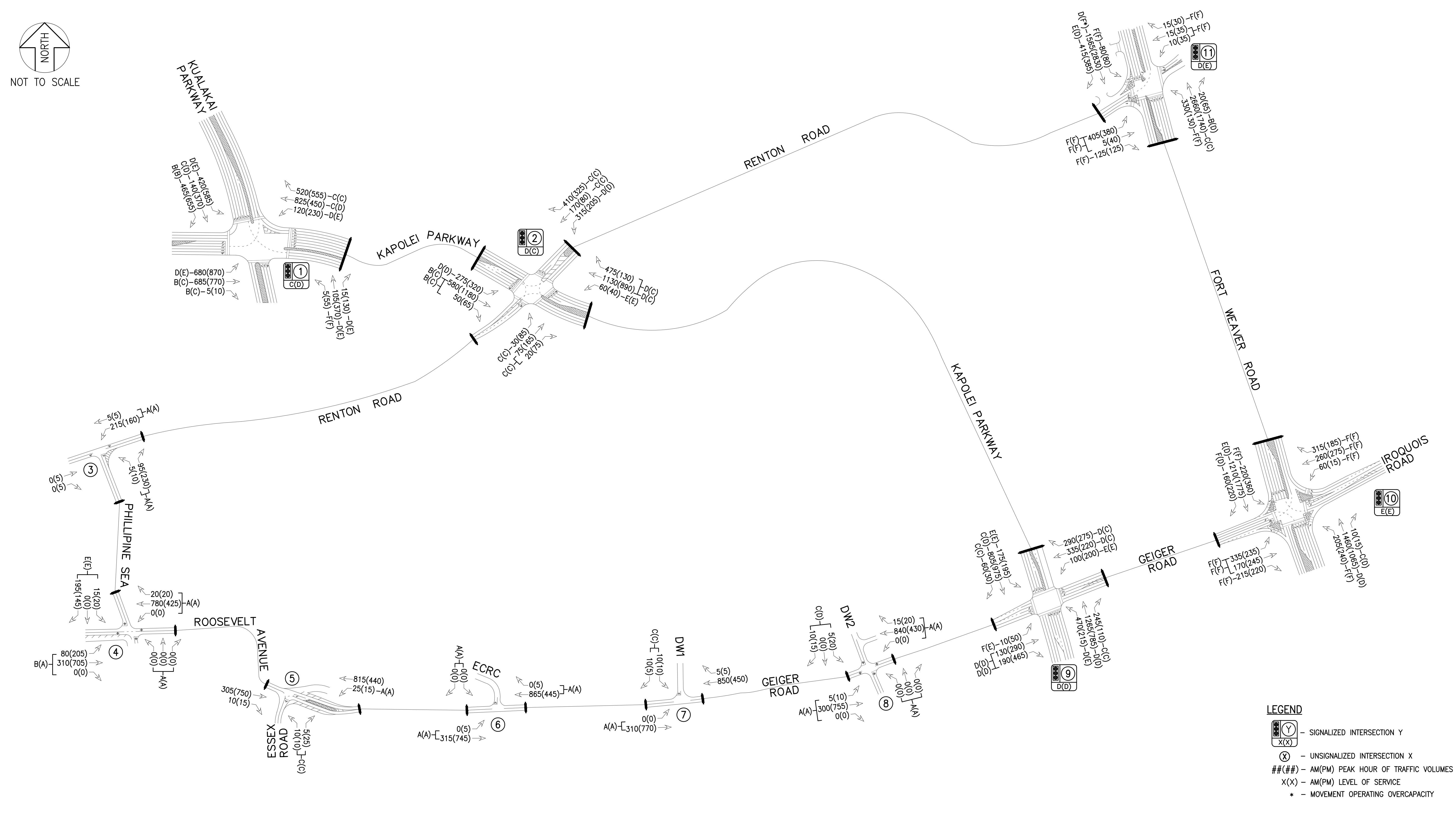

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FIGURE 5

BASE YEAR 2030 WITH MITIGATION LANE CONFIGURATION, VOLUME, AND LOS

Table 3: Base Year 2021 (no mit), Base Year 2030 (no mit) and Base Year 2030 (with mit) Intersection Level of Service Summary

	BY 2021 (No Mit)						BY 2030 (No Mit)						BY 2030 WITH MITIGATION					
	AM			PM			AM			PM			AM			PM		
Intersection	HCM Delay	v/c Ratio	LOS	HCM Delay	v/c Ratio	LOS	HCM Delay	v/c Ratio	LOS	HCM Delay	v/c Ratio	LOS	HCM Delay	v/c Ratio	LOS	HCM Delay	v/c Ratio	LOS
1: Kapolei Pkwy & Kualakai Pkwy																		
EB LT	37.0	0.84	D	57.4	0.91	E	41.3	0.86	D	59.7	0.92	E						
EB TH	16.7	0.24	B	31.4	0.38	C	18.1	0.32	B	31.5	0.40	C						
EB RT	16.8	0.24	B	31.6	0.38	C	18.2	0.32	B	31.6	0.40	C						
WB LT	46.1	0.61	D	62.6	0.78	E	50.5	0.63	D	70.7	0.80	E						
WB TH	30.3	0.56	C	47.2	0.44	D	34.6	0.67	C	53.4	0.49	D						
WB RT	19.8	0.44	B	28.3	0.45	C	22.0	0.48	C	34.1	0.50	C						
NB LT	88.5	0.54	F	76.5	0.77	E	93.3	0.54	F	84.9	0.77	F						
NB TH	41.3	0.29	D	56.2	0.71	E	44.8	0.33	D	65.3	0.77	E						
NB TH/RT	41.2	0.29	D	56.2	0.71	E	44.7	0.34	D	65.3	0.78	E						
SB LT	42.8	0.82	D	63.2	0.91	E	48.9	0.84	D	76.1	0.93	E						
SB TH	28.7	0.15	C	33.4	0.33	C	30.6	0.17	C	40.6	0.37	D						
SB RT	14.7	0.21	B	13.3	0.27	B	14.8	0.23	B	13.8	0.26	B						
Overall	29.1	-	C	44.4	-	D	31.8	-	C	49.4	-	D						
2: Kapolei Pkwy & Renton Rd																		
EB LT	34.8	0.10	C	26.8	0.19	C	37.1	0.11	D	31.5	0.23	C	31.3	0.10	C	24.4	0.20	C
EB TH/RT	30.1	0.16	C	26.1	0.37	C	30.7	0.17	C	31.0	0.45	C	26.0	0.16	C	24.0	0.40	C
WB LT	49.2	0.78	D	36.3	0.61	D	53.9	0.81	D	56.0	0.77	E	42.8	0.77	D	36.1	0.64	D
WB TH	31.2	0.25	C	24.0	0.14	C	32.5	0.31	C	27.6	0.15	C	27.5	0.30	C	21.4	0.13	C
WB RT	30.5	0.19	C	23.9	0.13	C	33.1	0.35	C	27.7	0.16	C	26.9	0.24	C	21.6	0.16	C
NB LT	73.2	0.77	E	67.6	0.79	E	73.5	0.77	E	73.9	0.78	E	65.3	0.77	E	67.0	0.78	E
NB TH	40.2	0.82	D	28.5	0.65	C	59.5	0.97	E	34.3	0.67	C	36.3	0.86	D	28.6	0.64	C
NB TH/RT	44.6	0.82	D	29.3	0.65	C	71.3	0.97	E	35.7	0.68	C	42.0	0.86	D	29.8	0.65	C
SB LT	60.7	0.90	E	51.9	0.90	D	65.0	0.90	E	66.4	0.92	E	50.8	0.78	D	43.1	0.77	D
SB TH	17.1	0.24	B	16.0	0.49	B	19.2	0.27	B	19.1	0.52	B	18.7	0.28	B	21.4	0.60	C
SB TH/RT	17.2	0.24	B	16.2	0.49	B	19.3	0.27	B	19.3	0.52	B	18.8	0.29	B	21.7	0.60	C
Overall	38.7	-	D	26.8	-	C	50.1	-	D	33.1	-	C	35.1	-	D	27.6	-	C
3: Phillipine Sea & Renton Rd																		
EB TH/RT	-	-	-	-	-	-	-	-	-	-	-	-						
WB LT/TH	7.6	0.13	A	7.5	0.09	A	7.6	0.15	A	7.5	0.11	A						
NB LT/RT	9.0	0.10	A	9.3	0.21	A	9.0	0.11	A	9.6	0.25	A						
4: Phillipine Sea & Roosevelt Ave																		
EB LT/TH/RT	9.5	0.09	A	8.6	0.16	A	10.2	0.11	B	9.2	0.21	A						
WB LT/TH/RT	0.0	-	A	0.0	-	A	0.0	-	A	0.0	-	A						
NB LT/TH/RT	0.0	-	A	0.0	-	A	0.0	-	A	0.0	-	A						
SB LT/TH/RT	26.6	0.57	D	18.0	0.35	C	43.8	0.74	E	41.9	0.67	E						
5: Essex Rd & Roosevelt Ave/Geiger Rd																		
EB TH/RT	-	-	-	-	-	-	-	-	-	-	-	-						
WB LT	8.0	0.02	A	9.0	0.01	A	8.0	0.02	A	9.6	0.02	A						
WB TH	-	-	-	-	-	-	-	-	-	-	-	-						
NB LT/RT	18.2	0.06	C	16.3	0.09	C	21.2	0.07	C	20.1	0.14	C						
6: Geiger Rd & Ewa Refuse Convenience Center																		
EB LT/TH/RT	0.0	-	A	8.1	0.00	A	0.0	-	A	8.4	0.01	A						
WB LT/TH/RT	0.0	-	A	8.9	0.00	A	0.0	-	A	0.0	-	A						
NB LT/TH/RT	0.0	-	A	12.9	0.01	B	0.0	-	A	0.0	-	A						
SB LT/TH/RT	0.0	-	A	0.0	-	A	0.0	-	A	0.0	-	A						
7: Geiger Rd & Honouliuli Drwy 1																		
EB LT/TH	0.0	-	A	0.0	-	A	0.0	-	A	0.0	-	A						
WB TH/RT	-	-	-	-	-	-	-	-	-	-	-	-						
SB LT/RT	18.1	0.07	C	19.2	0.05	C	21.7	0.09	C	22.4	0.07	C						
8: Geiger Rd & Honouliuli Drwy 2																		
EB LT/TH/RT	9.3	0.01	A	8.1	0.01	A	9.9	0.01	A	8.4	0.01	A						
WB LT/TH/RT	0.0	-	A	0.0	-	A	0.0	-	A	0.0	-	A						
NB LT/TH/RT	0.0	-	A	0.0	-	A	0.0	-	A	0.0	-	A						
SB LT/TH/RT	18.1	0.06	C	20.4	0.13	C	21.6	0.07	C	27.5	0.19	D						
9: Kapolei Pkwy & Geiger Rd																		
EB LT	87.1	0.61	F	73.6	0.77	E	99.4	0.62	F	77.6	0.77	E	83.7	0.60	F	74.6	0.77	E
EB TH	47.1	0.31	D	46.5	0.75	D	52.5	0.28	D	52.4	0.81	D	44.1	0.46	D	53.2	0.82	D
EB TH/RT	47.2	0.32	D	47.5	0.77	D	52.5	0.29	D	54.2	0.83	D	-	-	-	-	-	-
EB RT	-	-	-	-	-	-	-	-	-	-	-	-	40.5	0.09	D	48.3	0.70	D
WB LT	67.9	0.80	E	71.9	0.86	E	86.9	0.83	F	87.3	0.90	F	67.9	0.81	E	67.9	0.88	E
WB TH	52.3	0.84	D	34.7	0.42	C	68.2	0.89	E	35.4	0.41	D	50.0	0.85	D	34.7	0.42	C
WB RT	39.5	0.13	D	31.3	0.13	C	44.9	0.23	D	32.2	0.15	C	35.2	0.16	D	31.5	0.16	C
NB LT	61.5	0.93	E	65.7	0.88	E	97.9	1.03	F*	73.4	0.89	E	53.2	0.86	D	59.4	0.77	E
NB TH	24.5	0.66	C	35.0	0.64	C	34.4	0.81	C	41.7	0.74	D	39.2	0.91	D	40.0	0.75	D
NB RT	17.7	0.14	B	27.0	0.06	C	21.6	0.23	C	30.2	0.06	C	21.1	0.24	C	28.9	0.05	C
SB LT	66.6	0.86	E	62.0	0.86	E	86.3	0.89	F	70.9	0.88	E	70.5	0.87	E	61.4	0.87	E
SB TH	35.1	0.67	D	46.1	0.87	D	46.2	0.78	D	61.6	0.96	E	30.5	0.66	C	37.9	0.80	D
SB RT	26.8	0.02	C	28.3	0.02	C	32.8	0.03	C	30.9	0.02	C	22.4	0.03	C	24.5	0.02	C
Overall	39.5	-	D	46.3	-	D	53.3	-	D	55.9	-	E	41.9	-	D	45.2	-	D

Note:
* = over-capacity, v/c > 1

Table 3: Base Year 2021 (no mit), Base Year 2030 (no mit) and Base Year 2030 (with mit) Intersection Level of Service Summary (continued)

	BY 2021 (No Mit)						BY 2030 (No Mit)						BY 2030 WITH MITIGATION					
	AM			PM			AM			PM			AM			PM		
Intersection	HCM Delay	v/c Ratio	LOS	HCM Delay	v/c Ratio	LOS	HCM Delay	v/c Ratio	LOS	HCM Delay	v/c Ratio	LOS	HCM Delay	v/c Ratio	LOS	HCM Delay	v/c Ratio	LOS
10: Ft Weaver Rd & Geiger Rd/Iroquois Rd																		
EB LT	107.2	0.68	**F**	104.6	0.65	**F**	108.7	0.73	**F**	103.8	0.67	**F**						
EB LT/TH	101.8	0.66	**F**	100.0	0.65	**F**	101.9	0.71	**F**	99.8	0.67	**F**						
EB RT	102.9	0.61	**F**	106.7	0.68	**F**	106.8	0.70	**F**	107.7	0.72	**F**						
WB LT	85.0	0.19	**F**	86.7	0.06	**F**	84.0	0.20	**F**	81.4	0.05	**F**						
WB TH	109.3	0.80	**F**	117.9	0.83	**F**	112.4	0.83	**F**	121.1	0.89	**F**						
WB RT	85.4	0.23	**F**	87.5	0.12	**F**	85.1	0.28	**F**	83.7	0.19	**F**						
NB LT	110.9	0.67	**F**	110.8	0.69	**F**	110.8	0.68	**F**	110.4	0.72	**F**						
NB TH	39.0	0.56	D	38.6	0.38	D	44.8	0.62	D	46.8	0.50	D						
NB RT	28.0	0.00	C	32.3	0.01	C	31.1	0.01	C	36.8	0.01	D						
SB LT	82.7	0.67	**F**	123.1	0.80	**F**	97.7	0.73	**F**	125.8	0.81	**F**						
SB TH	56.6	0.39	E	37.2	0.62	D	63.7	0.52	E	47.4	0.78	D						
SB RT	215.0	0.10	**F**	36.0	0.20	D	130.3	0.13	**F**	38.8	0.22	D						
Overall	72.6	0.63	E	64.4	0.70	E	74.6	0.69	E	69.5	0.80	E						
11: Ft Weaver Rd & Renton Rd																		
EB LT	113.0	0.81	**F**	114.2	0.83	**F**	113.1	0.81	**F**	113.6	0.81	**F**						
EB LT/TH	110.8	0.80	**F**	112.8	0.82	**F**	111.5	0.79	**F**	113.3	0.81	**F**						
EB RT	87.6	0.27	**F**	87.2	0.26	**F**	87.5	0.22	**F**	87.2	0.22	**F**						
WB LT/TH	118.9	0.39	**F**	122.3	0.66	**F**	119.6	0.46	**F**	122.3	0.66	**F**						
WB RT	111.2	0.01	**F**	103.4	0.02	**F**	110.5	0.01	**F**	103.5	0.02	**F**						
NB LT	124.9	0.85	**F**	100.3	0.74	**F**	126.8	0.90	**F**	98.8	0.75	**F**						
NB TH	22.4	0.87	C	32.0	0.53	C	23.0	0.88	C	34.6	0.61	C						
NB RT	15.4	0.02	B	41.3	0.05	D	15.5	0.02	B	40.8	0.06	D						
SB LT	126.9	0.66	**F**	113.6	0.62	**F**	127.5	0.68	**F**	115.2	0.64	**F**						
SB TH	37.2	0.51	D	64.5	0.99	E	48.5	0.69	D	86.0	1.06	**F***						
SB RT	56.2	0.23	E	40.3	0.27	D	63.5	0.29	E	38.6	0.27	D						
Overall	44.3	0.85	D	60.5	0.90	E	49.1	0.87	D	70.4	0.95	E						

Note:
* = over-capacity, v/c > 1

4. FUTURE YEAR WITH PROJECT SCENARIOS

4.1 Future Year 2021 Trip Generation

Future year 2021 trip generation is the anticipated peak year of construction activity, which was assumed to occur during Phase 1 construction of the Honouliuli WWTP. A Technical Memorandum provided by AECOM, dated September 18, 2014, shown in Appendix E, was used to estimate the number of vehicular trips generated by construction activity for the Future Year 2021 scenario. It was estimated that the Project would generate 185 construction workers to/from the site, with the assumption of 1 vehicle trip per construction worker. Therefore, 185 construction workers would arrive to the site during the AM peak hour and 185 construction workers would exit the site during the PM peak hour. This was assumed to be a relatively conservative estimate, since carpooling would likely occur, with some workers traveling outside the studied peak hours of traffic.

In addition to the 185 construction workers, 8 total trips (4 entering and 4 exiting) were assumed to be generated by cement trucks during each of the AM and PM peak hours of traffic. This was also a conservative estimate, since it is likely that these trucks would probably avoid peak hours of traffic.

Trips generated for the peak year of construction, 2021 are shown below in Table 4.

Table 4: Future Year 2021 Project Generated Traffic

Independent Variable	AM Peak Hour			PM Peak Hour		
	Enter	Exit	Total	Enter	Exit	Total
Construction Worker Trips	185	0	185	0	185	185
Concrete Truck Trips	4	4	8	4	4	8
TOTAL	189	4	193	4	189	193

4.2 Trip Distribution/Assignment

Trip distribution is based on existing traffic flow patterns throughout the study area. Future Year 2021 Project trips were assigned to all existing driveways in addition to three (3) new proposed accesses; one access along Roosevelt Avenue, one access along Geiger Road and one access along Renton Road. The first access is proposed to be located approximately 600 feet east of the existing Geiger Road/Driveway 2 intersection and will hereinafter be referred to as “Honouliuli Driveway 3”. The second access is proposed to be located approximately 600 feet east of the existing Roosevelt Avenue/Phillipine Sea intersection and will hereinafter be referred to as “Honouliuli Driveway 4”. The third access is proposed to be located along Renton Road adjacent to the Mailo Street intersection. The new access is proposed near Mailo Street. For purposes of this study, this new access along Renton Road will hereinafter be referred to as “Honouliuli Driveway 5”.

4.3 Future Year 2021 Analysis

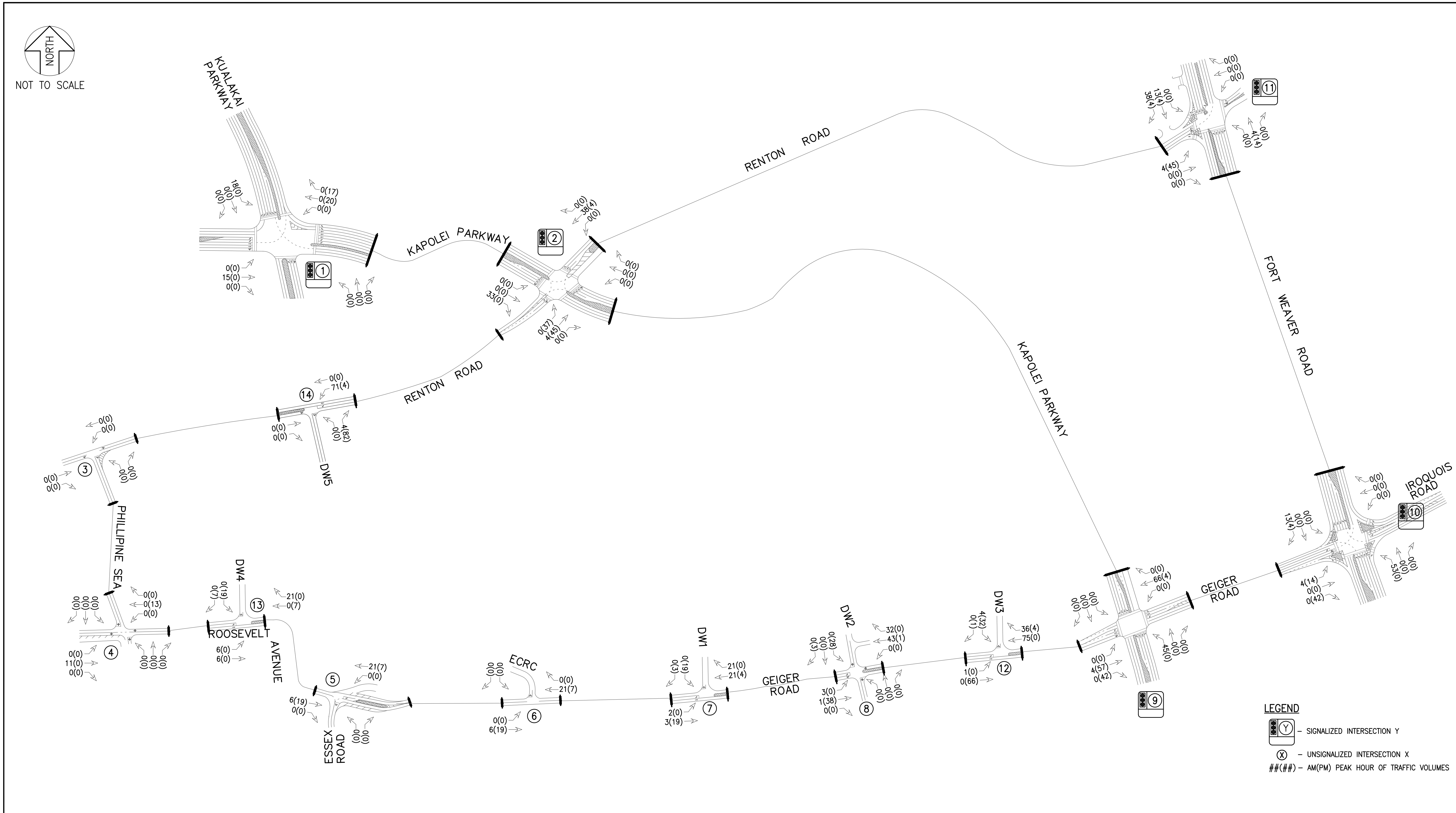
Based on a LOS comparison between Future Year 2021 and Base Year 2021, the majority of individual movements that are projected to operate at LOS E/F for Base Year 2021 conditions will continue operating at similar levels of service for Future Year 2021 conditions during the AM and PM peak hours of traffic except for the following:

Fort Weaver Road/Geiger Road/Iroquois Road & Fort Weaver Road/Renton Road
The intersections along Fort Weaver Road through the Ewa region will experience LOS F and over-capacity conditions at some movements. However, this is generally ascribed to requisite long traffic signal cycle lengths, split phase operation and generally long crosswalk lengths across Fort Weaver Road. Further widening of Fort Weaver Road is not prescribed by the ORTP 2035, and is generally considered infeasible due to insufficient ROW.

Honouliuli Driveways along Geiger Road, Roosevelt Avenue and Renton Road
At the Geiger Road/Honouliuli Driveway 2, the southbound shared left/through/right-turn lane is anticipated to operate at LOS E during the PM peak hour. The southbound left-turn movement currently operates with 20 vehicles and queues were not observed to extend beyond a couple vehicles long. An additional 30 left-turn vehicles generated by construction worker trips should have minimal impacts to the queues along the southbound approach. All movements at the three new Project driveway intersections will operate adequately at LOS D or better during the AM and PM peak hours of traffic.

Although entering traffic volumes at the Project driveways are anticipated to operate with adequate LOS, A Policy on Geometric Design of Highways and Streets, prepared by American Association of State Highway and Transportation Officials (AASHTO), (hereinafter referred to as the “AASHTO Green Book”) provides guidance on implementation of left-turn lanes. In the AASHTO Green Book, page 9-131, it suggests that “left-turning traffic should be removed from the through lanes, whenever practical….Ideally, left-turn lanes should be provided at driveways and street intersections along major arterial and collector roads, wherever left-turns are permitted.” Therefore, eastbound left-turn lanes are recommended along Geiger Road and Roosevelt Avenue at its intersection with Honouliuli Driveway 1, 2, 3 and 4 and a westbound left-turn lane is recommended at the Renton Road/Driveway 5 intersection. Based on AASHTO guidance, due to relatively low projected left-turn volume along Geiger Road and Roosevelt Avenue, the left-turn lanes entering the Honouliuli Driveways should provide for a minimum storage of at least 50 feet, while the Renton Road/Driveway 5 intersection should provide a minimum of at least 125 feet of storage.

Figure 6 illustrates the Project Generated Traffic Volumes for Year 2021. Figure 7 illustrates the forecast traffic volumes, lane configuration, and LOS for Future Year 2021 conditions. Table 5 summarizes the delay, V/C, and LOS at the study intersections for Base Year 2021 and Future Year 2021 conditions. The full LOS summary table is provided in Appendix C.



HONOULIULI WASTEWATER TREATMENT PLAN TIAR

AUSTIN, TSUTSUMI & ASSOCIATES, INC.
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FIGURE 6

YEAR 2021 PROJECT ONLY VOLUMES

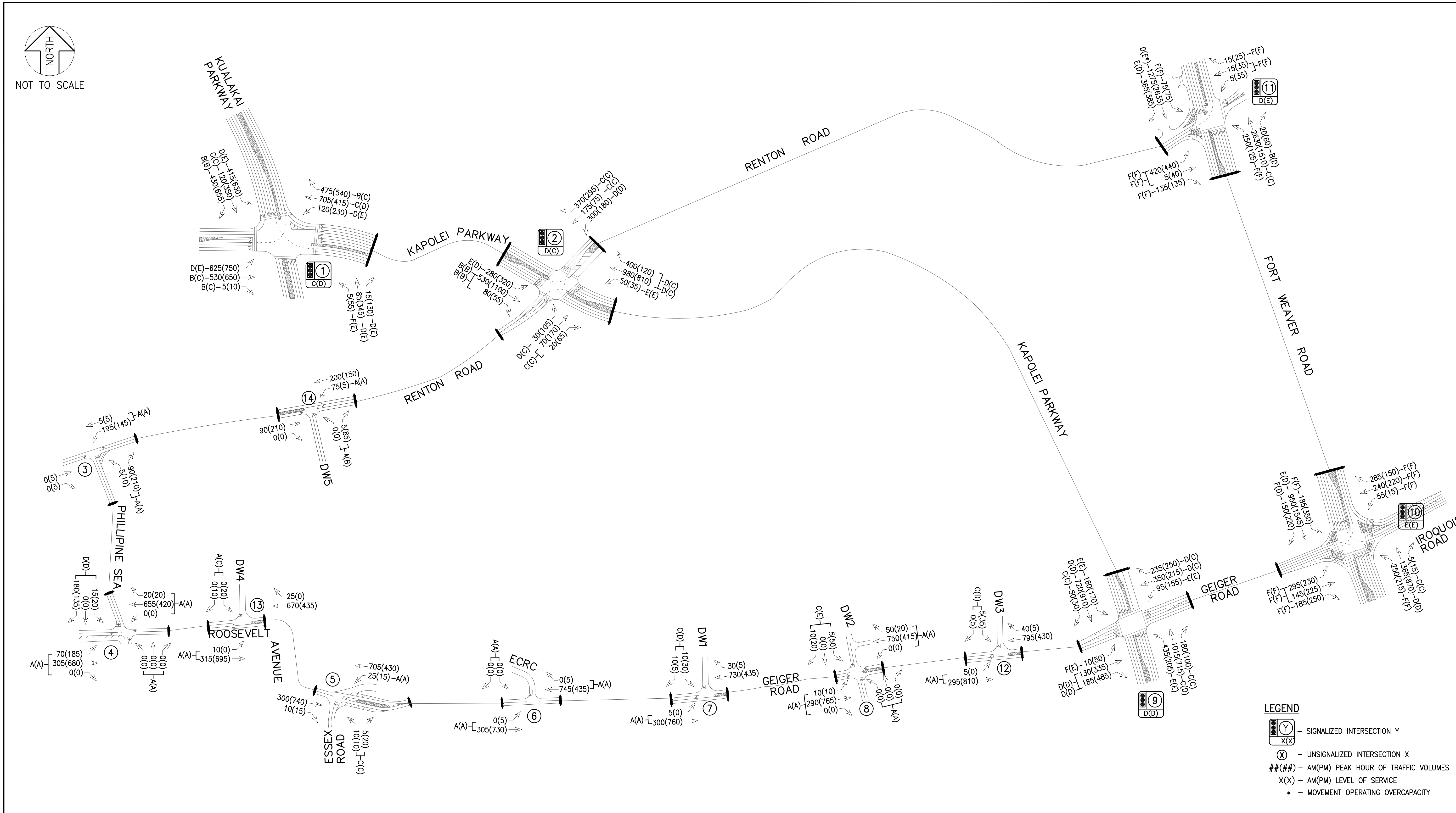

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FIGURE 7

FUTURE YEAR 2021 LANE CONFIGURATION, VOLUME, AND LOS

Table 5: Base Year 2021 (no mit) and Future Year 2021 (no mit) Intersection Level of Service Summary

	BY 2021 (No Mit)						FY 2021 (No Mit)						FY 2021 (With Mit)					
	AM			PM			AM			PM			AM			PM		
Intersection	HCM Delay	v/c Ratio	LOS	HCM Delay	v/c Ratio	LOS	HCM Delay	v/c Ratio	LOS	HCM Delay	v/c Ratio	LOS	HCM Delay	v/c Ratio	LOS	HCM Delay	v/c Ratio	LOS
1: Kapolei Pkwy & Kualakai Pkwy																		
EB LT	37.0	0.84	D	57.4	0.91	E	37.4	0.84	D	58.1	0.91	E						
EB TH	16.7	0.24	B	31.4	0.38	C	17.1	0.25	B	31.3	0.38	C						
EB RT	16.8	0.24	B	31.6	0.38	C	17.2	0.25	B	31.4	0.38	C						
WB LT	46.1	0.61	D	62.6	0.78	E	46.6	0.61	D	63.1	0.78	E						
WB TH	30.3	0.56	C	47.2	0.44	D	30.8	0.57	C	47.4	0.45	D						
WB RT	19.8	0.44	B	28.3	0.45	C	19.7	0.44	B	28.4	0.46	C						
NB LT	88.5	0.54	F	76.5	0.77	E	89.1	0.54	F	77.0	0.77	E						
NB TH	41.3	0.29	D	56.2	0.71	E	41.7	0.29	D	57.0	0.72	E						
NB TH/RT	41.2	0.29	D	56.2	0.71	E	41.7	0.29	D	57.0	0.72	E						
SB LT	42.8	0.82	D	63.2	0.91	E	43.8	0.82	D	64.0	0.91	E						
SB TH	28.7	0.15	C	33.4	0.33	C	28.5	0.15	C	33.9	0.33	C						
SB RT	14.7	0.21	B	13.3	0.27	B	14.6	0.21	B	13.6	0.27	B						
Overall	29.1	-	C	44.4	-	D	29.5	-	C	44.8	-	D						
2: Kapolei Pkwy & Renton Rd																		
EB LT	34.8	0.10	C	26.8	0.19	C	36.7	0.10	D	27.8	0.26	C						
EB TH/RT	30.1	0.16	C	26.1	0.37	C	30.2	0.16	C	26.9	0.42	C						
WB LT	49.2	0.78	D	36.3	0.61	D	49.2	0.78	D	38.9	0.61	D						
WB TH	31.2	0.25	C	24.0	0.14	C	32.1	0.33	C	23.9	0.14	C						
WB RT	30.5	0.19	C	23.9	0.13	C	30.5	0.19	C	23.9	0.13	C						
NB LT	73.2	0.77	E	67.6	0.79	E	73.4	0.77	E	72.2	0.79	E						
NB TH	40.2	0.82	D	28.5	0.65	C	40.4	0.83	D	34.8	0.70	C						
NB TH/RT	44.6	0.82	D	29.3	0.65	C	44.9	0.83	D	36.9	0.71	C						
SB LT	60.7	0.90	E	51.9	0.90	D	61.0	0.90	E	44.8	0.89	D						
SB TH	17.1	0.24	B	16.0	0.49	B	17.3	0.25	B	18.9	0.51	B						
SB TH/RT	17.2	0.24	B	16.2	0.49	B	17.4	0.25	B	19.2	0.51	B						
Overall	38.7	-	D	26.8	-	C	38.7	-	D	29.5	-	C						
3: Phillipine Sea & Renton Rd																		
EB TH/RT	-	-	-	-	-	-	-	-	-	-	-	-						
WB LT/TH	7.6	0.13	A	7.5	0.09	A	7.6	0.13	A	7.5	0.10	A						
NB LT/RT	9.0	0.10	A	9.3	0.21	A	9.0	0.10	A	9.5	0.23	A						
4: Phillipine Sea & Roosevelt Ave																		
EB LT/TH/RT	9.5	0.09	A	8.6	0.16	A	9.5	0.09	A	9.1	0.19	A						
WB LT/TH/RT	0.0	-	A	0.0	-	A	0.0	-	A	0.0	-	A						
NB LT/TH/RT	0.0	-	A	0.0	-	A	0.0	-	A	0.0	-	A						
SB LT/TH/RT	26.6	0.57	D	18.0	0.35	C	26.7	0.57	D	34.4	0.59	D						
5: Essex Rd & Roosevelt Ave/Geiger Rd																		
EB TH/RT	-	-	-	-	-	-	-	-	-	-	-	-						
WB LT	8.0	0.02	A	9.0	0.01	A	8.0	0.02	A	9.5	0.02	A						
WB TH	-	-	-	-	-	-	-	-	-	-	-	-						
NB LT/RT	18.2	0.06	C	16.3	0.09	C	18.8	0.06	C	20.2	0.12	C						
6: Geiger Rd & Ewa Refuse Convenience Center																		
EB LT/TH/RT	0.0	-	A	8.1	0.00	A	0.0	-	A	8.3	0.01	A						
WB LT/TH/RT	0.0	-	A	8.9	0.00	A	0.0	-	A	0.0	-	A						
NB LT/TH/RT	0.0	-	A	12.9	0.01	B	0.0	-	A	0.0	-	A						
SB LT/TH/RT	0.0	-	A	0.0	-	A	0.0	-	A	0.0	-	A						
7: Geiger Rd & Honouliuli Drwy 1																		
EB LT	-	-	-	-	-	-	-	-	-	-	-	-	9.5	0.0	A	0.0	-	A
EB LT/TH	0.0	-	A	0.0	-	A	9.5	0.01	A	0.0	-	A	-	-	-	-	-	-
WB TH/RT	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SB LT/RT	18.1	0.07	C	19.2	0.05	C	19.1	0.08	C	27.6	0.19	D	19.0	0.1	C	27.6	0.2	D
8: Geiger Rd & Honouliuli Drwy 2																		
EB LT	-	-	-	-	-	-	-	-	-	-	-	-	9.7	0.01	A	8.3	0.01	A
EB LT/TH/RT	9.3	0.01	A	8.1	0.01	A	9.7	0.01	A	8.3	0.01	A	-	-	-	-	-	-
WB LT/TH/RT	0.0	-	A	0.0	-	A	0.0	-	A	0.0	-	A	0.0	-	A	0.0	-	A
NB LT/TH/RT	0.0	-	A	0.0	-	A	0.0	-	A	0.0	-	A	0.0	-	A	0.0	-	A
SB LT/TH/RT	18.1	0.06	C	20.4	0.13	C	19.8	0.06	C	41.9	0.45	E	19.8	0.06	C	41.6	0.44	E
9: Kapolei Pkwy & Geiger Rd																		
EB LT	87.1	0.61	F	73.6	0.77	E	90.5	0.61	F	76.7	0.77	E						
EB TH	47.1	0.31	D	46.5	0.75	D	44.9	0.25	D	50.2	0.81	D						
EB TH/RT	47.2	0.32	D	47.5	0.77	D	45.0	0.26	D	53.8	0.85	D						
EB RT	-	-	-	-	-	-	-	-	-	-	-	-						
WB LT	67.9	0.80	E	71.9	0.86	E	67.8	0.80	E	77.3	0.86	E						
WB TH	52.3	0.84	D	34.7	0.42	C	54.1	0.86	D	33.9	0.39	C						
WB RT	39.5	0.13	D	31.3	0.13	C	38.5	0.21	D	30.9	0.14	C						
NB LT	61.5	0.93	E	65.7	0.88	E	67.7	0.94	E	70.7	0.89	E						
NB TH	24.5	0.66	C	35.0	0.64	C	29.2	0.70	C	38.5	0.67	D						
NB RT	17.7	0.14	B	27.0	0.06	C	20.7	0.15	C	29.5	0.06	C						
SB LT	66.6	0.86	E	62.0	0.86	E	67.8	0.86	E	66.1	0.86	E						
SB TH	35.1	0.67	D	46.1	0.87	D	45.7	0.80	D	53.2	0.91	D						
SB RT	26.8	0.02	C	28.3	0.02	C	32.8	0.03	C	30.9	0.02	C						
Overall	39.5	-	D	46.3	-	D	45.2	-	D	51.0	-	D						

Note:
* = over-capacity, v/c > 1

Table 5: Base Year 2021 (no mit), Future Year 2021 (no mit), and Future Year 2021 (with mit) Intersection Level of Service Summary (continued)

	BY 2021 (No Mit)						**FY 2021 (No Mit)**						**FY 2021 (With Mit)**					
	AM			PM			AM			PM			AM			PM		
Intersection	HCM Delay	v/c Ratio	LOS	HCM Delay	v/c Ratio	LOS	HCM Delay	v/c Ratio	LOS	HCM Delay	v/c Ratio	LOS	HCM Delay	v/c Ratio	LOS	HCM Delay	v/c Ratio	LOS
10: Ft Weaver Rd & Geiger Rd/Iroquois Rd																		
EB LT	107.2	0.68	F	104.6	0.65	F	107.4	0.68	F	99.7	0.62	F						
EB LT/TH	101.8	0.66	F	100.0	0.65	F	101.4	0.66	F	96.7	0.62	F						
EB RT	102.9	0.61	F	106.7	0.68	F	102.4	0.60	F	114.6	0.80	F						
WB LT	85.0	0.19	F	86.7	0.06	F	85.3	0.19	F	87.6	0.06	F						
WB TH	109.3	0.80	F	117.9	0.83	F	110.1	0.80	F	122.6	0.85	F						
WB RT	85.4	0.23	F	87.5	0.12	F	85.6	0.23	F	88.5	0.12	F						
NB LT	110.9	0.67	F	110.8	0.69	F	112.9	0.75	F	110.8	0.69	F						
NB TH	39.0	0.56	D	38.6	0.38	D	39.1	0.56	D	39.9	0.39	D						
NB RT	28.0	0.00	C	32.3	0.01	C	28.1	0.0	C	33.3	0.01	C						
SB LT	82.7	0.67	F	123.1	0.80	F	82.7	0.67	F	123.7	0.80	F						
SB TH	56.6	0.39	E	37.2	0.62	D	59.5	0.40	E	39.0	0.63	D						
SB RT	215.0	0.10	F	36.0	0.20	D	236.8	0.10	F	37.9	0.20	D						
Overall	72.6	0.63	E	64.4	0.70	E	75.2	0.65	E	66.3	0.73	E						
11: Ft Weaver Rd & Renton Rd																		
EB LT	113.0	0.81	F	114.2	0.83	F	111.3	0.81	F	112.9	0.84	F						
EB LT/TH	110.8	0.80	F	112.8	0.82	F	109.2	0.79	F	113.6	0.84	F						
EB RT	87.6	0.27	F	87.2	0.26	F	86.9	0.26	F	84.5	0.25	F						
WB LT/TH	118.9	0.39	F	122.3	0.66	F	118.9	0.39	F	122.3	0.66	F						
WB RT	111.2	0.01	F	103.4	0.02	F	111.2	0.01	F	103.4	0.02	F						
NB LT	124.9	0.85	F	100.3	0.74	F	125.7	0.85	F	100.5	0.74	F						
NB TH	22.4	0.87	C	32.0	0.53	C	22.8	0.87	C	33.7	0.54	C						
NB RT	15.4	0.02	B	41.3	0.05	D	15.6	0.02	B	44.2	0.05	D						
SB LT	126.9	0.66	F	113.6	0.62	F	128.3	0.67	F	113.8	0.62	F						
SB TH	37.2	0.51	D	64.5	0.99	E	37.8	0.52	D	73.1	**1.01**	E*						
SB RT	56.2	0.23	E	40.3	0.27	D	58.3	0.26	E	42.4	0.27	D						
Overall	44.3	0.85	D	60.5	0.90	E	44.8	0.86	D	65.5	0.92	E						
12: Geiger Rd & Honouliuli Drwy 3																		
EB LT							-	-	-	-	-	-	9.8	0.01	A	0.0	-	A
EB LT/TH							9.8	0.01	A	0.0	-	A	-	-	-	-	-	-
WB TH/RT							-	-	-	-	-	-	-	-	-	-	-	-
SB LT/RT							23.8	0.03	C	30.9	0.24	D	23.7	0.03	C	30.9	0.24	D
13: Roosevelt Ave & Honouliuli Drwy 4																		
EB LT							-	-	-	-	-	-	9.3	0.01	A	0.0	-	A
EB LT/TH							9.3	0.01	A	0.0	-	A	-	-	-	-	-	-
WB TH/RT							-	-	-	-	-	-	-	-	-	-	-	-
SB LT/RT							0.0	-	A	21.3	0.13	C	0.0	-	A	21.3	0.13	C
14: Honouliuli Drwy 5 & Renton Rd																		
EB TH/RT							-	-	-	-	-	-	-	-	-	-	-	-
WB LT							7.5	0.06	A	7.7	0.00	A	7.5	0.06	A	7.7	0.00	A
WB TH							-	-	-	-	-	-	-	-	-	-	-	-
NB LT/RT							8.8	0.01	A	10.0	0.11	B	8.8	0.01	A	10.0	0.11	B

Note:
* = over-capacity, v/c > 1

4.4 Future Year 2030 Trip Generation

The trip generation for the Future year 2030 scenario was based on the full build-out of the Project. The Technical Memorandum provided by AECOM, dated September 18, 2014, shown in Appendix E, was used to estimate the number of vehicular trips generated by the build-out of the Project for the Future Year 2030 scenario. The memorandum evaluated the current and future projected staffing level based on full-time equivalent (FTE) positions, which is a calculated unit of measurement that gauges the number of full-time and part-time employees at the Honouliuli WWTP based on collective work hours. It was estimated that the current staffing level at the Honouliuli WWTP is at 39 FTE positions, while the build-out of the Project will increase the staffing to an estimated 320 FTE positions. This results in an eight-fold increase to the number of employees at the Honouliuli WWTP. In order to determine the growth in traffic generated by this increase to 320 FTE, all existing traffic turning movements were increased linearly by a factor of 8. The Future Year 2030 Project Generated Traffic is shown below in Table 6.

Table 6: Future Year 2030 Project Generated Traffic

	FTE Positions	AM Peak Hour			PM Peak Hour		
		Enter	Exit	Total	Enter	Exit	Total
Estimate Trips Accessing the WWTP in 2014							
Existing 2014 Traffic[1]	39 FTE	20	28	48	33	43	76
New Proposed Trips Accessing the WWTP in 2030 Multiplier: 820 percent							
Future Year 2030 Traffic	320 FTE	164	230	394	271	353	624
Existing 2014 Traffic		(20)	(28)	(48)	(33)	(43)	(76)
TOTAL NEW TRIPS[2]		144	202	346	238	310	548

Notes:

1. Existing 2014 Traffic shows all entering/exiting traffic accessing the existing Honouliuli driveways determined by the traffic counts conducted for this TIAR.
2. Since the eight-fold multiplier includes existing 2014 traffic, the existing traffic was removed to determine the Total New Trips for Future Year 2030 scenario.

4.5 Trip Distribution/Assignment

Trip distribution is based on existing traffic flow patterns throughout the study area. Future Year 2030 Project trips were assigned to all existing driveways in addition to three (3) new accesses described in Section 4.3.

4.6 Future Year 2030 Analysis

Based on a LOS comparison between Future Year 2030 and Base Year 2030/Future Year 2021, the majority of individual movements projected to operate at LOS E/F for Base Year 2030/Future Year 2021 conditions will continue operating at similar levels of service for Future Year 2030 conditions during the AM and PM peak hours of traffic except for the following:

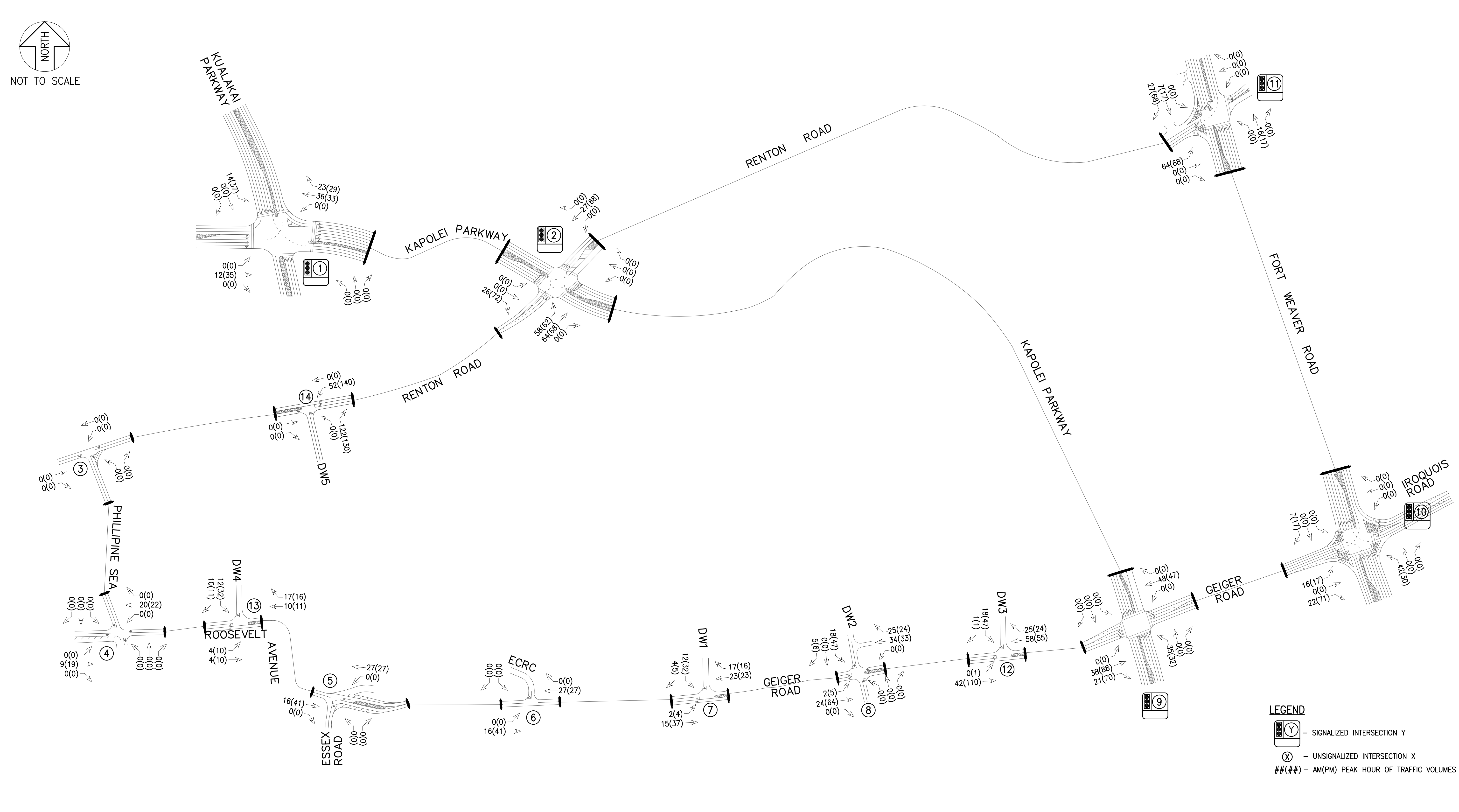
<u>Geiger Road/Honouliuli Driveway 1</u>
This intersection is forecast to operate similar to Base Year 2030 conditions with the exception of the southbound shared left/through/right movement which is projected to operate at LOS E during the PM peak hours of traffic. The southbound left-turn movement currently operates with only 10 vehicles and queues were not observed to extend beyond one vehicle long. An additional 35 left-turn vehicles generated by the Project should have minimal impacts to the queues along the southbound approach.

<u>Geiger Road/Honouliuli Driveway 2</u>
The southbound shared left/through/right movement is projected to operate at LOS E(F) during the AM(PM) peak hours of traffic, respectively. The southbound approach will continue to operate at a low 20 vehicle right-turn movement and 70 vehicle left-turn movement during the more critical PM peak hour. With an average of only 1 southbound left-turn vehicle arriving every minute, the increase in southbound traffic should have minimal impacts on southbound queues.

<u>Geiger Road/Honouliuli Driveway 3</u>
This new proposed access is forecast to operate at LOS D or better during the AM and PM peak hours of traffic with the exception of the southbound shared left/right-turn movement which is projected to operate at LOS F during the PM peak hour of traffic. The southbound left-turn movement will operate at a low 50 vehicles during the PM peak hour. With an average of less than 1 southbound left-turn vehicle arriving every minute, the movement should not experience heavy southbound queues.

<u>Fort Weaver Road/Geiger Road/Iroquois Road & Fort Weaver Road/Renton Road</u>
As discussed in Section 4.3, intersections along Fort Weaver Road through the Ewa region will continue to experience LOS F and over-capacity conditions at some movements. However, this is generally ascribed to requisite long traffic signal cycle lengths, split phase operation and generally long crosswalk lengths across Fort Weaver Road. Further widening of Fort Weaver Road is not prescribed by the ORTP 2035, and is generally considered infeasible due to insufficient ROW.

Figure 8 illustrates the Project Generated Traffic volumes for Year 2030. Figure 9 illustrates the forecast traffic volumes, lane configuration, and LOS for Future Year 2030 conditions. Table 7 summarizes the delay, v/c, and LOS at the study intersections for Base Year 2030 and Future Year 2030 conditions. The full LOS summary table is provided in Appendix C.



HONOULIULI WASTEWATER TREATMENT PLAN TIAR

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FIGURE 8

YEAR 2030 PROJECT ONLY VOLUMES

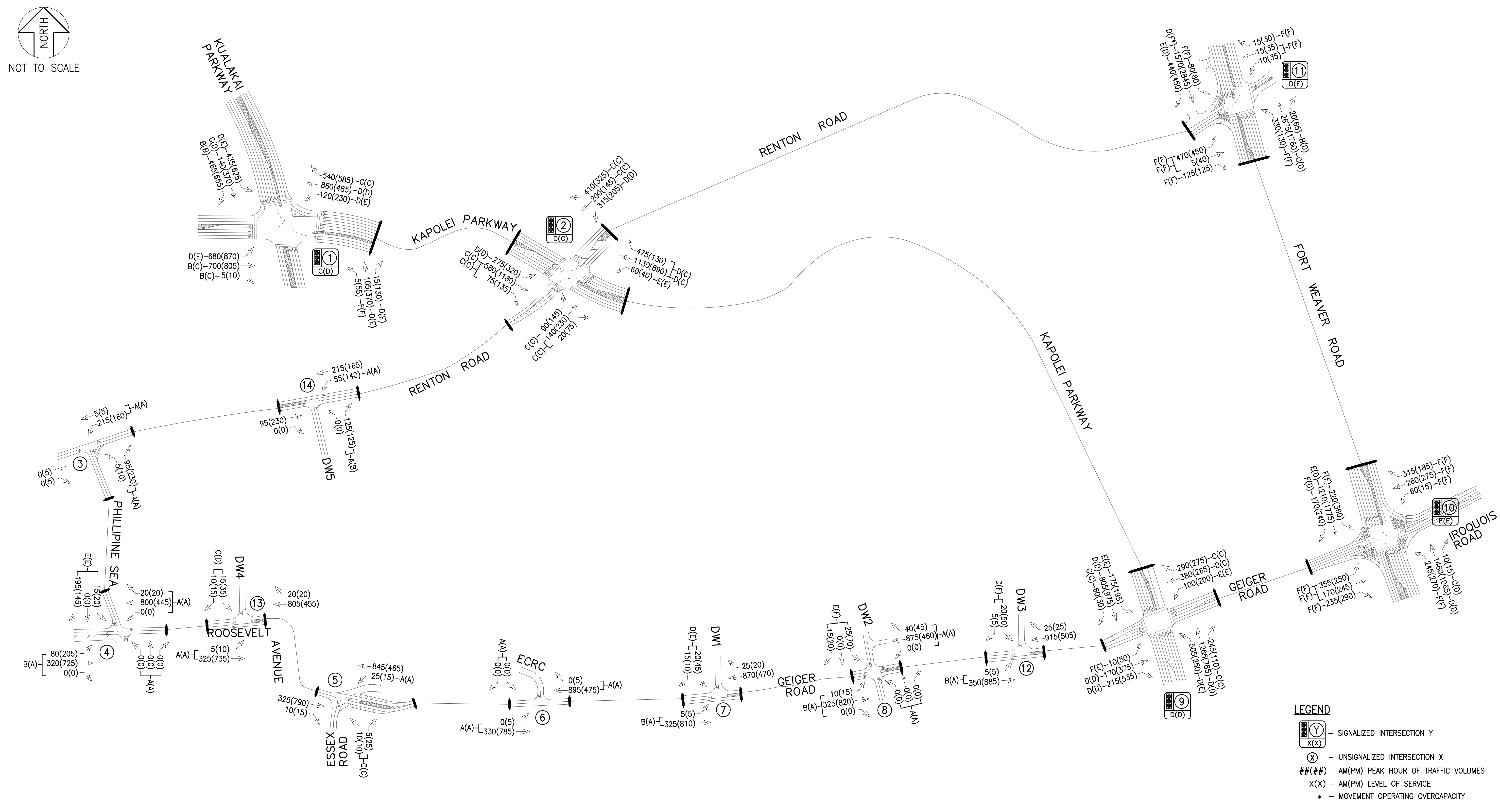

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FIGURE 9

FUTURE YEAR 2030 LANE CONFIGURATION, VOLUME, AND LOS

Table 7: Base Year 2030 (no mit), Base Year 2030 (with mit) and Future Year 2030 (no mit) Intersection Level of Service Summary

Intersection	BY 2030 (No Mit)						BY 2030 WITH MITIGATION						FY 2030 (No Mit)					
	AM			PM			AM			PM			AM			PM		
	HCM Delay	v/c Ratio	LOS	HCM Delay	v/c Ratio	LOS	HCM Delay	v/c Ratio	LOS	HCM Delay	v/c Ratio	LOS	HCM Delay	v/c Ratio	LOS	HCM Delay	v/c Ratio	LOS
1: Kapolei Pkwy & Kualakai Pkwy																		
EB LT	41.3	0.86	D	59.7	0.92	E							42.6	0.86	D	72.6	0.96	E
EB TH	18.1	0.32	B	31.5	0.40	C							18.4	0.32	B	33.5	0.43	C
EB RT	18.2	0.32	B	31.6	0.40	C							18.5	0.32	B	33.7	0.43	C
WB LT	50.5	0.63	D	70.7	0.80	E							51.7	0.63	D	72.7	0.81	E
WB TH	34.6	0.67	C	53.4	0.49	D							35.4	0.69	D	54.6	0.52	D
WB RT	22.0	0.48	C	34.1	0.50	C							22.1	0.49	C	33.7	0.51	C
NB LT	93.3	0.54	F	84.9	0.77	F							94.7	0.55	F	86.7	0.77	F
NB TH	44.8	0.33	D	65.3	0.77	E							45.9	0.34	D	65.7	0.74	E
NB TH/RT	44.7	0.34	D	65.3	0.78	E							45.9	0.34	D	65.5	0.74	E
SB LT	48.9	0.84	D	76.1	0.93	E							50.8	0.85	D	78.0	0.94	E
SB TH	30.6	0.17	C	40.6	0.37	D							31.0	0.17	C	40.1	0.36	D
SB RT	14.8	0.23	B	13.8	0.26	B							15.0	0.23	B	14.1	0.25	B
Overall	31.8	-	C	49.4	-	D							32.6	-	C	52.7	-	D
2: Kapolei Pkwy & Renton Rd																		
EB LT	37.1	0.11	D	31.5	0.23	C	31.3	0.10	C	24.4	0.20	C	34.1	0.28	C	27.9	0.36	C
EB TH/RT	30.7	0.17	C	31.0	0.45	C	26.0	0.16	C	24.0	0.40	C	26.4	0.26	C	24.5	0.46	C
WB LT	53.9	0.81	D	56.0	0.77	E	42.8	0.77	D	36.1	0.64	D	51.5	0.81	D	40.1	0.66	D
WB TH	32.5	0.31	C	27.6	0.15	C	27.5	0.30	C	21.4	0.13	C	27.1	0.32	C	21.7	0.22	C
WB RT	33.1	0.35	C	27.7	0.16	C	26.9	0.24	C	21.6	0.16	C	26.2	0.24	C	21.3	0.17	C
NB LT	73.5	0.77	E	73.9	0.78	E	65.3	0.77	E	67.0	0.78	E	68.9	0.77	E	71.4	0.78	E
NB TH	59.5	0.97	E	34.3	0.67	C	36.3	0.86	D	28.6	0.64	C	44.1	0.90	D	33.9	0.68	C
NB TH/RT	71.3	0.97	E	35.7	0.68	C	42.0	0.86	D	29.8	0.65	C	52.3	0.91	D	35.7	0.69	C
SB LT	65.0	0.90	E	66.4	0.92	E	50.8	0.78	D	43.1	0.77	D	54.4	0.79	D	48.0	0.79	D
SB TH	19.2	0.27	B	19.1	0.52	B	18.7	0.28	B	21.4	0.60	C	21.7	0.31	C	26.5	0.67	C
SB TH/RT	19.3	0.27	B	19.3	0.52	B	18.8	0.29	B	21.7	0.60	C	21.9	0.31	C	27.2	0.67	C
Overall	50.1	-	D	33.1	-	C	35.1	-	D	27.6	-	C	40.3	-	D	31.6	-	C
3: Phillipine Sea & Renton Rd																		
EB TH/RT	-	-	-	-	-	-							-	-	-	-	-	-
WB LT/TH	7.6	0.15	A	7.5	0.11	A							-	-	-	7.5	0.11	A
NB LT/RT	9.0	0.11	A	9.6	0.25	A							-	-	-	9.6	0.25	A
4: Phillipine Sea & Roosevelt Ave																		
EB LT/TH/RT	10.2	0.11	B	9.2	0.21	A							10.3	0.11	B	9.3	0.21	A
WB LT/TH/RT	0.0	-	A	0.0	-	A							0.0	-	A	0.0	-	A
NB LT/TH/RT	0.0	-	A	0.0	-	A							0.0	-	A	0.0	-	A
SB LT/TH/RT	43.8	0.74	E	41.9	0.67	E							48.1	0.77	E	49.0	0.72	E
5: Essex Rd & Roosevelt Ave/Geiger Rd																		
EB TH/RT	-	-	-	-	-	-							-	-	-	-	-	-
WB LT	8.0	0.02	A	9.6	0.02	A							8.1	0.02	A	9.8	0.02	A
WB TH	-	-	-	-	-	-							-	-	-	-	-	-
NB LT/RT	21.2	0.07	C	20.1	0.14	C							22.5	0.07	C	21.6	0.15	C
6: Geiger Rd & Ewa Refuse Convenience Center																		
EB LT/TH/RT	0.0	-	A	8.4	0.01	A							0.0	-	A	8.5	0.01	A
WB LT/TH/RT	0.0	-	A	0.0	-	A							0.0	-	A	0.0	-	A
NB LT/TH/RT	0.0	-	A	0.0	-	A							0.0	-	A	0.0	-	A
SB LT/TH/RT	0.0	-	A	0.0	-	A							0.0	-	A	0.0	-	A
7: Geiger Rd & Honouliuli Drwy 1																		
EB LT	`												10.1	0.01	B	8.5	0.01	A
EB LT/TH	0.0	-	A	0.0	-	A												
WB TH/RT	-	-	-	-	-	-							-	-	-	-	-	-
SB LT/RT	21.7	0.09	C	22.4	0.07	C							25.7	0.18	D	36.1	0.34	E
8: Geiger Rd & Honouliuli Drwy 2																		
EB LT													10.3	0.02	B	8.6	0.02	A
EB LT/TH/RT	9.9	0.01	A	8.4	0.01	A												
WB LT/TH/RT	0.0	-	A	0.0	-	A							0.0	-	A	0.0	-	A
NB LT/TH/RT	0.0	-	A	0.0	-	A							0.0	-	A	0.0	-	A
SB LT/TH/RT	21.6	0.07	C	27.3	0.19	D							35.2	0.27	E	85.8	0.74	F
9: Kapolei Pkwy & Geiger Rd																		
EB LT	99.4	0.62	F	77.6	0.77	E	83.7	0.60	F	74.6	0.77	E	86.5	0.60	F	78.4	0.77	E
EB TH	52.5	0.28	D	52.4	0.81	D	44.1	0.46	D	53.2	0.82	D	44.5	0.53	D	52.3	0.85	D
EB TH/RT	52.5	0.29	D	54.2	0.83	D	-	-	-	-	-	-	-	-	-	-	-	-
EB RT	-	-	-	-	-	-	40.5	0.09	D	48.3	0.70	D	39.9	0.10	D	54.6	0.86	D
WB LT	86.9	0.83	F	87.3	0.90	F	67.9	0.81	E	67.9	0.88	E	72.0	0.81	E	77.9	0.89	E
WB TH	68.2	0.89	E	35.4	0.41	D	50.0	0.85	D	34.7	0.42	C	54.1	0.87	D	32.7	0.43	C
WB RT	44.9	0.23	D	32.2	0.15	C	35.2	0.16	D	31.5	0.16	C	34.9	0.20	C	29.1	0.17	C
NB LT	97.9	1.03	F*	73.4	0.89	E	53.2	0.86	D	59.4	0.77	E	49.7	0.85	D	66.2	0.82	E
NB TH	34.4	0.81	C	41.7	0.74	D	39.2	0.91	D	40.0	0.75	D	46.4	0.95	D	50.7	0.84	D
NB RT	21.6	0.23	C	30.2	0.06	C	21.1	0.24	C	28.9	0.05	C	23.1	0.24	C	34.1	0.05	C
SB LT	86.3	0.89	F	70.9	0.88	E	70.5	0.87	E	61.4	0.87	E	74.8	0.87	E	73.9	0.88	E
SB TH	46.2	0.78	D	61.6	0.96	E	30.5	0.66	C	37.9	0.80	D	35.7	0.72	D	54.4	0.92	D
SB RT	32.8	0.03	C	30.9	0.02	C	22.4	0.03	C	24.5	0.02	C	25.7	0.03	C	30.2	0.02	C
Overall	53.3	-	D	55.9	-	E	41.9	-	D	45.2	-	D	46.1	-	D	54.5	-	D

Note:
* = over-capacity, v/c > 1

Table 7: Base Year 2030 (no mit), Base Year 2030 (with mit) and Future Year 2030 (no mit) Intersection Level of Service Summary (continued)

	BY 2030 (No Mit)						BY 2030 WITH MITIGATION						FY 2030 (No Mit)					
	AM			PM			AM			PM			AM			PM		
Intersection	HCM Delay	v/c Ratio	LOS	HCM Delay	v/c Ratio	LOS	HCM Delay	v/c Ratio	LOS	HCM Delay	v/c Ratio	LOS	HCM Delay	v/c Ratio	LOS	HCM Delay	v/c Ratio	LOS
10: Ft Weaver Rd & Geiger Rd/Iroquois Rd																		
EB LT	108.7	0.73	F	103.8	0.67	F							110.7	0.76	F	97.0	0.61	F
EB LT/TH	101.9	0.71	F	99.8	0.67	F							101.9	0.72	F	94.3	0.62	F
EB RT	106.8	0.70	F	107.7	0.72	F							112.5	0.77	F	122.9	0.88	F
WB LT	84.0	0.20	F	81.4	0.05	F							84.3	0.20	F	85.3	0.06	F
WB TH	112.4	0.83	F	121.1	0.89	F							113.7	0.84	F	150.4	0.99	F
WB RT	85.1	0.28	F	83.7	0.19	F							85.4	0.28	F	87.7	0.20	F
NB LT	110.8	0.68	F	110.4	0.72	F							112.3	0.74	F	111.2	0.75	F
NB TH	44.8	0.62	D	46.8	0.50	D							45.1	0.63	D	46.8	0.50	D
NB RT	31.1	0.01	C	36.8	0.01	D							31.3	0.01	C	36.8	0.01	D
SB LT	97.7	0.73	F	125.8	0.81	F							98.0	0.73	F	125.1	0.81	F
SB TH	63.7	0.52	E	47.4	0.78	D							65.2	0.53	E	50.0	0.79	D
SB RT	130.3	0.13	F	38.8	0.22	D							133.7	0.14	F	41.2	0.25	D
Overall	74.6	0.69	E	69.5	0.80	E							76.4	0.71	E	73.4	0.85	E
11: Ft Weaver Rd & Renton Rd																		
EB LT	113.1	0.81	F	113.6	0.81	F							107.9	0.81	F	113.6	0.85	F
EB LT/TH	111.5	0.79	F	113.3	0.81	F							110.0	0.82	F	114.3	0.85	F
EB RT	87.5	0.22	F	87.2	0.22	F							82.7	0.20	F	83.2	0.21	F
WB LT/TH	119.6	0.46	F	122.3	0.66	F							119.6	0.46	F	122.3	0.66	F
WB RT	110.5	0.01	F	103.5	0.02	F							110.5	0.01	F	103.5	0.02	F
NB LT	126.8	0.90	F	98.8	0.75	F							139.8	0.95	F	99.4	0.75	F
NB TH	23.0	0.88	C	34.6	0.61	C							27.0	0.91	C	37.7	0.64	D
NB RT	15.5	0.02	B	40.8	0.06	D							17.3	0.02	B	44.1	0.06	D
SB LT	127.5	0.68	F	115.2	0.64	F							131.7	0.71	F	115.1	0.64	F
SB TH	48.5	0.69	D	86.0	1.06	F*							51.1	0.71	D	105.5	1.10	F*
SB RT	63.5	0.29	E	38.6	0.27	D							68.7	0.31	E	44.0	0.32	D
Overall	49.1	0.87	D	70.4	0.95	E							53.3	0.90	D	80.9	0.98	F
12: Geiger Rd & Honouliuli Drwy 3																		
EB LT													10.3	0.01	B	8.6	0.01	A
WB TH/RT													-	-	-	-	-	-
SB LT/RT													30.2	0.16	D	50.8	0.44	F
13: Roosevelt Ave & Honouliuli Drwy 4																		
EB LT													9.8	0.01	A	8.5	0.01	A
WB TH/RT													-	-	-	-	-	-
SB LT/RT													22.7	0.12	C	27.3	0.25	D
14: Honouliuli Drwy 5 & Renton Rd																		
EB LT													-	-	-	-	-	-
WB LT													7.5	0.04	A	8.1	0.12	A
WB TH													-	-	-	-	-	-
NB LT/RT													9.4	0.14	A	10.6	0.19	B

Note:
* = over-capacity, v/c > 1

5. CONCLUSION

The Honouliuli Wastewater Treatment Plant proposes to upgrade and expand the facility, which will include the potential relocation of non-process facilities currently located at the Sand Island Wastewater Treatment Plant to the Project site. This TIAR analyzed two benchmark years; Year 2021, which corresponds to the peak year of construction for the Project and Year 2030, which corresponds to the build-out of the Project.

5.1 Existing Conditions

All study intersections operate at LOS D or better with adequate capacity except along Kapolei Parkway and Fort Weaver Road at its intersections with Renton Road and Geiger Road/Iroquois Road. Although some movements operated at LOS E conditions along Kapolei Parkway, no heavy queues were observed at its intersections with Kualakai Parkway, Renton Road and Geiger Road, with most vehicles typically clearing the intersection within one signal cycle.

Along Fort Weaver Road, the majority of movements at these intersections currently operate at LOS E/F conditions during the AM and PM peak hours of traffic mainly due to long delays as a result of requisite long cycle lengths (approximately 4 minutes long). These two intersections also provide split-phase signal operation on the side streets and long pedestrian crossing times across Fort Weaver Road, which contribute to the long delays. During the AM peak hour, the northbound traffic is generally heavier, while during the PM peak hour, traffic is heavier in the southbound direction. Further widening of Fort Weaver Road is not prescribed by the ORTP 2035, and is generally considered infeasible due to insufficient ROW. Therefore, no mitigation was recommended for any Base Year or Future Year scenarios.

5.2 Base Year WITHOUT Project Scenario

The year 2021 was selected as the base year to reflect the anticipated peak year of construction activity, which was assumed to occur during Phase 1 construction of the Honouliuli WWTP. The year 2030 was selected as the base year to reflect the anticipated build-out of the Honouliuli WWTP.

The Oahu Regional Transportation Plan 2035 (ORTP) model, which was prepared in 2011, serves as the basis for future traffic projections of future conditions throughout this TIAR. Calculated defacto growth rates ranging from 0.5-3.5 percent were used to generate Base Year 2021 and 2030 traffic projections. In addition to the defacto growth, the following developments were supplemented for additional traffic growth along the roadway network: University of Hawaii at West Oahu (UHWO), Ka Makana Alii Shopping Center, Ho'opili and East Kapolei developments. Upon build-out of the Ka Makana Alii Shopping Center, one of the proposed accesses is anticipated to be provided as a new south leg extension from the existing Kapolei Parkway/Kualakai Parkway intersection, ultimately providing a 4-legged intersection, described in further detail in Section 3.3. This improvement was assumed to be completed by Year 2021.

5.2.1 Base Year 2021 Analysis

Based on a LOS comparison between Base Year 2021 and existing conditions, the majority of individual movements that are projected to operate at LOS E/F for existing conditions will continue operating at similar levels of service for Base Year 2021 conditions during the AM and PM peak hours of traffic.

5.2.2 Base Year 2030 Analysis

Due to increased regional growth along the major thoroughfares, the Roosevelt Avenue/Phillipine Sea unsignalized intersection will operate at LOS E conditions along its southbound approach but should not experience heavy queuing due to its low volume.

Based on a LOS comparison between Base Year 2021 and Base Year 2030 conditions, the majority of individual movements that are projected to operate at LOS E/F for Base Year 2021 will continue operating at similar levels of service for Base Year 2030 conditions during the AM and PM peak hours of traffic except at the Kapolei Parkway/Geiger Road intersection and Kapolei Parkway/Renton Road intersection.

The Kapolei Parkway/Geiger Road intersection is anticipated to operate overall at LOS E during the PM peak hour. In addition, all turning movements are forecast to operate at LOS E/F conditions during the AM and PM peak hours of traffic, while the shared eastbound through/right-turn lane is anticipated to operate at LOS D during the PM peak hour due to a relatively high 190(465) vehicle right-turn movement. In order to improve the eastbound approach it is recommended that the shared through/right lane be restriped to an exclusive right-turn lane, while the northbound approach is recommended to be widened to provide two left-turn lanes.

The Kapolei Parkway/Renton Road intersection is forecast to operate with increased delays compared to Base Year 2021 as a result of growth from surrounding development and ambient growth. In order to mitigate the deficiencies of the intersection, dual southbound left-turn lanes were recommended to accommodate the relatively high 275(320) southbound left-turn vehicles during the AM(PM) peak hours. With the dual southbound left-turn lanes, all movements at the intersection are forecast to operate similar to Base Year 2021 conditions.

5.3 Future Year WITH Project Scenario

5.3.1 Future Year Trip Generation and Distribution

A Technical Memorandum provided by AECOM, dated September 18, 2014, shown in Appendix E, was used to estimate the number of vehicular trips generated by construction activity for the Future Year 2021 scenarios. Future year 2021 trip generation is the anticipated peak year of construction activity, and estimated to generate 185 construction workers arriving to the site during the AM peak hour and 185 construction workers exiting the site during the PM peak in addition to 8 total trips (4 entering and 4 exiting) generated by cement trucks during each of the AM and PM peak hours of traffic. The memorandum also estimated the number of vehicular trips generated by the build-out of the Project for the Future Year 2030 scenario and was based on a comparison of existing vs. projected 2030 Full-Time Equivalent (FTE) positions. Based on this comparison, it was estimated that existing traffic accessing the current site will increase eight-fold.

Trip distribution was generally based on existing traffic flow patterns throughout the study area. Future Year Project trips were assigned to all existing driveways in addition to three (3) new accesses described in Section 4.3.

5.3.2 Future Year 2021 Analysis

Based on a LOS comparison between Future Year 2021 and Base Year 2021, the majority of individual movements that are projected to operate at LOS E/F for Base Year 2021 conditions will continue operating at similar levels of service for Future Year 2021 conditions during the AM and PM peak hours of traffic.

Due to increased regional growth along the major thoroughfares and slight increase in exiting Project traffic, the Geiger Road/Honouliuli Driveway 2 intersection will operate at LOS E conditions along its southbound approach but should not experience heavy queuing due to its low volume. Although entering traffic volumes at the Project driveways are anticipated to operate with adequate LOS, based on guidance from the AASHTO Green Book, eastbound left-turn lanes are recommended along Geiger Road and Roosevelt Avenue at its intersection with Honouliuli Driveway 1, 2, 3 and 4 and a westbound left-turn lane is recommended at the Renton Road/Driveway 5 intersection.

5.3.3 Future Year 2030 Analysis

Due to increased regional growth along the major thoroughfares and slight increase in exiting Project traffic, various unsignalized intersection will operate at LOS E/F conditions along its exiting approach but should not experience heavy queuing due to its low volume.

Based on a LOS comparison between Future Year 2030 and Base Year 2030/Future Year 2021, the majority of individual movements projected to operate at LOS E/F for Base Year 2030/Future Year 2021 conditions will continue operating at similar levels of service for Future Year 2030 conditions during the AM and PM peak hours of traffic.

6. RECOMMENDATIONS

The following mitigation at the Kapolei Parkway/Kualakai Parkway intersection was triggered by the Ka Makana Alii Shopping Center and was assumed to be completed by the developer prior to the Base Year 2021 conditions. Ka Makana Alii has already broken ground on the shopping center and portions of the improvement are currently listed on the Statewide Transportation Improvement Program (STIP):

Kapolei Parkway/Kualakai Parkway

1. Northbound Approach
   a. Provide a new approach that includes one left-turn lane, one through lane and one shared through/right-turn lane.

2. Southbound Approach
   a. Provide two through lanes.

3. Eastbound Approach
   a. Convert three through lanes to two through lanes and one shared through/right-turn lane.

4. Westbound Approach
   a. Provide two new left-turn lanes.

The following roadway improvements are recommended for the Base Year 2030 and Future Year 2021 scenarios.

6.1 Base Year 2030 WITHOUT Project

Kapolei Parkway/Geiger Road Intersection

1. Eastbound Approach
   a. Restripe and convert the shared through/right lane to an exclusive right-turn lane.

2. Northbound Approach
   a. Widen to provide two left-turn lanes.

Kapolei Parkway/Renton Road Intersection

1. Southbound Approach
   a. Widen to provide two left-turn lanes.

6.2 Future Year 2021 WITH Project

Geiger Road at its intersection with Honouliuli Driveway 1, 2 and 3

1. Eastbound Approach
   a. Widen to provide a left-turn storage lane.
   b. Provide for a minimum storage of at least 50 feet.

Roosevelt Avenue/Honouliuli Driveway 4 Intersection

1. Eastbound Approach
   a. Widen to provide a left-turn storage lane.
   b. Provide for a minimum storage of at least 50 feet.

Renton Road/Honouliuli Driveway 5 Intersection

1. Westbound Approach
   a. Widen to provide a left-turn storage lane.
   b. Provide for a minimum storage of at least 125 feet.

REFERENCES

1. Institute of Transportation Engineers, Trip Generation, 9th Edition, 2012.
2. Julian Ng, Traffic Impact Analysis Report for East Kapolei II, November 2007.
3. Transportation Research Board, Highway Capacity Manual, 2010.
4. Parsons Brinckerhoff Quade & Douglas Inc., Traffic Study for University of Hawaii – West Oahu, October 2006.
5. PB Americas Inc., Traffic Evaluation for Ka Makana Alii, June 2011.

Y:\2010\10-085.001\Report\Honouliuli Report 10.20.2014.doce

A P P E N D I C E S

APPENDIX A

Traffic Count Data

Austin Tsutsumi & Associates

501 Sumner Street, Suite 521
Honolulu, HI 96817-5031
Phone: (808) 533-3646 Fax: (808) 526-1267

File Name : AM_Essex Rd - Geiger Rd
Site Code : 00000000
Start Date : 9/3/2014
Page No : 1

Groups Printed- Class 1

	From North				GEIGER RD From East				ESSEX RD From South				GEIGER RD From West				
Start Time	Rght	Thru	Left	Other	Rght	Thru	Left	Other	Rght	Thru	Left	Other	Rght	Thru	Left	Other	Int. Total
06:00 AM	0	0	0	0	0	67	1	0	0	0	0	0	1	37	0	0	106
06:15 AM	0	0	0	0	0	97	3	0	0	0	0	0	4	48	0	0	152
06:30 AM	0	0	0	0	0	120	5	0	2	0	0	0	6	62	0	0	195
06:45 AM	0	0	0	0	0	112	7	0	3	0	0	0	2	68	0	0	192
Total	0	0	0	0	0	396	16	0	5	0	0	0	13	215	0	0	645
07:00 AM	0	0	0	0	0	112	5	0	0	0	2	0	0	57	0	0	176
07:15 AM	0	0	0	0	0	155	6	0	2	0	1	0	2	74	0	0	240
07:30 AM	0	0	0	0	0	153	5	0	2	0	2	0	1	71	0	0	234
07:45 AM	0	0	0	0	0	136	7	0	0	0	0	0	2	63	0	0	208
Total	0	0	0	0	0	556	23	0	4	0	5	0	5	265	0	0	858
Grand Total	0	0	0	0	0	952	39	0	9	0	5	0	18	480	0	0	1503
Apprch %	0	0	0	0	0	96.1	3.9	0	64.3	0	35.7	0	3.6	96.4	0	0	
Total %	0	0	0	0	0	63.3	2.6	0	0.6	0	0.3	0	1.2	31.9	0	0	

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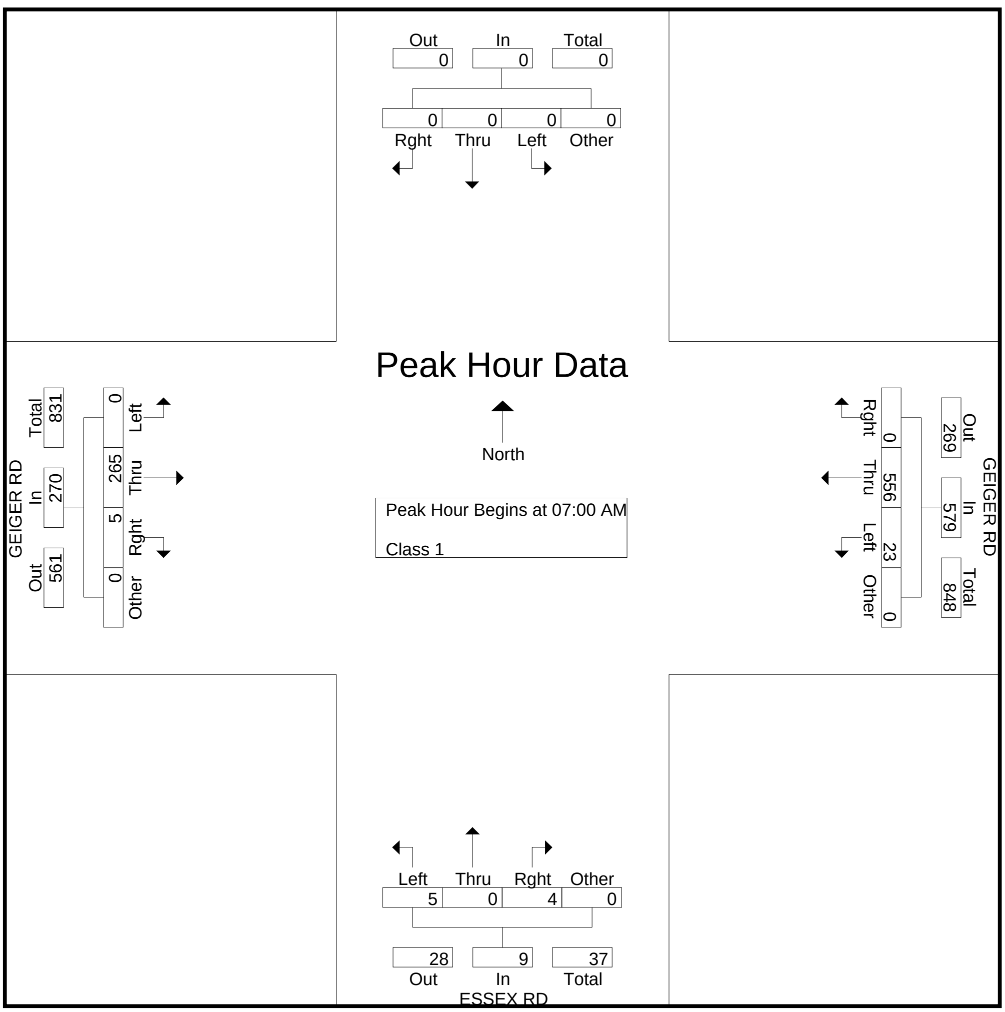
Site Code : 00000000
Start Date : 9/3/2014

	From North					GEIGER RD From East					ESSEX RD From South					GEIGER RD From West					
Start Time	Rght	Thru	Left	Other	App. Total	Rght	Thru	Left	Other	App. Total	Rght	Thru	Left	Other	App. Total	Rght	Thru	Left	Other	App. Total	Int. Total
Peak Hour Analysis From 07:00 AM to 07:45 AM - Peak 1 of 1																					
Peak Hour for Entire Intersection Begins at 07:00 AM																					
07:00 AM	0	0	0	0	0	0	112	5	0	117	0	0	2	0	2	0	57	0	0	57	176
07:15 AM	0	0	0	0	0	0	155	6	0	161	2	0	1	0	3	2	74	0	0	76	240
07:30 AM	0	0	0	0	0	0	153	5	0	158	2	0	2	0	4	1	71	0	0	72	234
07:45 AM	0	0	0	0	0	0	136	7	0	143	0	0	0	0	0	2	63	0	0	65	208
Total Volume	0	0	0	0	0	0	556	23	0	579	4	0	5	0	9	5	265	0	0	270	858
% App. Total	0	0	0	0		0	96	4	0		44.4	0	55.6	0		1.9	98.1	0	0		
PHF	.000	.000	.000	.000	.000	.000	.897	.821	.000	.899	.500	.000	.625	.000	.563	.625	.895	.000	.000	.888	.894



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File Name : AM_Ft Weaver Rd - Geiger Rd
Site Code : 00000000
Start Date : 9/3/2014
Page No : 1

Groups Printed- Unshifted

	FT WEAVER RD From North					GEIGER RD From East				FT WEAVER RD From South					GEIGER RD From West				
Start Time	Right	Thru	Left	U-Turns	Peds	Right	Thru	Left	Peds	Right	Thru	Left	U-Turns	Peds	Right	Thru	Left	Peds	Int. Total
06:00 AM	28	97	31	0	0	63	43	2	1	1	364	11	2	5	11	12	62	2	735
06:15 AM	28	153	51	0	0	77	31	3	0	3	275	25	2	4	12	16	49	2	731
06:30 AM	38	196	39	0	0	65	36	5	1	0	343	9	0	9	13	29	58	3	844
06:45 AM	29	217	36	0	0	87	37	5	3	1	356	20	0	8	30	17	56	2	904
Total	123	663	157	0	0	292	147	15	5	5	1338	65	4	26	66	74	225	9	3214
07:00 AM	27	223	55	0	0	64	46	13	2	1	336	24	1	8	41	24	69	8	942
07:15 AM	26	219	43	1	0	74	68	22	1	3	276	30	1	18	49	42	59	7	939
07:30 AM	38	250	27	0	0	57	55	10	2	0	348	32	0	9	48	39	76	7	998
07:45 AM	29	183	35	1	0	71	53	5	4	0	388	60	1	6	18	24	55	5	938
Total	120	875	160	2	0	266	222	50	9	4	1348	146	3	41	156	129	259	27	3817
Grand Total	243	1538	317	2	0	558	369	65	14	9	2686	211	7	67	222	203	484	36	7031
Apprch %	11.6	73.2	15.1	0.1	0	55.5	36.7	6.5	1.4	0.3	90.1	7.1	0.2	2.2	23.5	21.5	51.2	3.8	
Total %	3.5	21.9	4.5	0	0	7.9	5.2	0.9	0.2	0.1	38.2	3	0.1	1	3.2	2.9	6.9	0.5	

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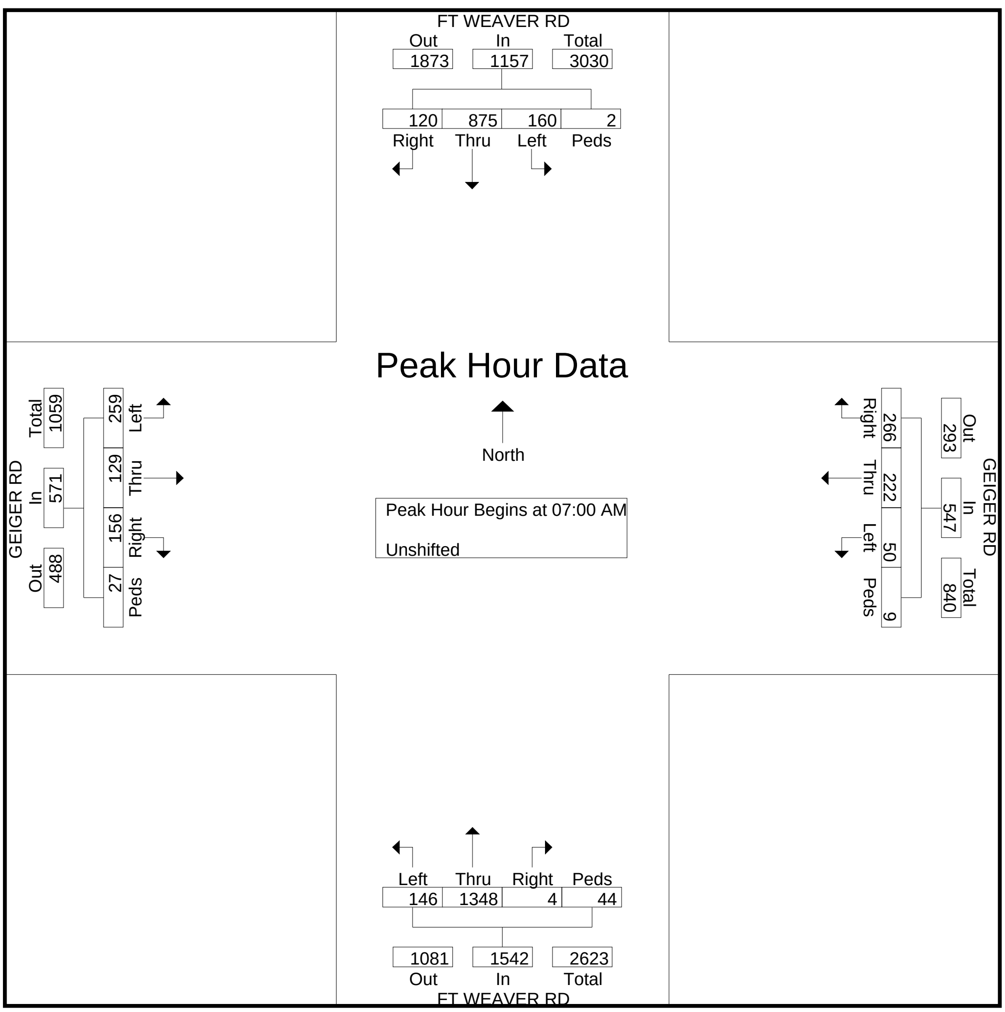
	FT WEAVER RD From North						GEIGER RD From East					FT WEAVER RD From South						GEIGER RD From West					
Start Time	Right	Thru	Left	U-Turns	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	U-Turns	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Int. Total
Peak Hour Analysis From 07:00 AM to 07:45 AM - Peak 1 of 1																							
Peak Hour for Entire Intersection Begins at 07:00 AM																							
07:00 AM	27	223	55	0	0	305	64	46	13	2	125	1	336	24	1	8	370	41	24	69	8	142	942
07:15 AM	26	219	43	1	0	289	74	68	22	1	165	3	276	30	1	18	328	49	42	59	7	157	939
07:30 AM	38	250	27	0	0	315	57	55	10	2	124	0	348	32	0	9	389	48	39	76	7	170	998
07:45 AM	29	183	35	1	0	248	71	53	5	4	133	0	388	60	1	6	455	18	24	55	5	102	938
Total Volume	120	875	160	2	0	1157	266	222	50	9	547	4	1348	146	3	41	1542	156	129	259	27	571	3817
% App. Total	10.4	75.6	13.8	0.2	0		48.6	40.6	9.1	1.6		0.3	87.4	9.5	0.2	2.7		27.3	22.6	45.4	4.7		
PHF	.789	.875	.727	.500	.000	.918	.899	.816	.568	.563	.829	.333	.869	.608	.750	.569	.847	.796	.768	.852	.844	.840	.956



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Site Code : 00000000
Start Date : 9/3/2014
Page No : 1

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	FT WEAVER RD From North					RENTON RD From East				FT WEAVER RD From South					RENTON RD From West				
Start Time	Right	Thru	Left	U-Turns	Peds	Right	Thru	Left	Peds	Right	Thru	Left	U-Turns	Peds	Right	Thru	Left	Peds	Int. Total
06:00 AM	24	154	1	17	0	3	11	7	4	11	493	8	0	0	11	4	85	0	833
06:15 AM	46	271	0	14	0	4	4	6	19	3	820	12	0	1	7	1	94	0	1302
06:30 AM	53	313	0	18	0	2	1	0	7	4	795	21	0	0	8	4	105	0	1331
06:45 AM	65	293	2	16	0	0	1	4	10	5	758	27	0	0	14	2	107	0	1304
Total	188	1031	3	65	0	9	17	17	40	23	2866	68	0	1	40	11	391	0	4770
07:00 AM	68	280	0	12	0	2	3	2	8	5	713	45	0	0	18	1	106	0	1263
07:15 AM	71	394	0	15	0	1	4	0	12	5	699	40	0	0	18	0	84	0	1343
07:30 AM	49	239	3	16	0	3	3	2	11	3	563	54	0	0	37	3	105	0	1091
07:45 AM	47	263	2	19	0	4	2	0	9	2	675	58	1	0	37	1	96	0	1216
Total	235	1176	5	62	0	10	12	4	40	15	2650	197	1	0	110	5	391	0	4913
Grand Total	423	2207	8	127	0	19	29	21	80	38	5516	265	1	1	150	16	782	0	9683
Apprch %	15.3	79.8	0.3	4.6	0	12.8	19.5	14.1	53.7	0.7	94.8	4.6	0	0	15.8	1.7	82.5	0	
Total %	4.4	22.8	0.1	1.3	0	0.2	0.3	0.2	0.8	0.4	57	2.7	0	0	1.5	0.2	8.1	0	

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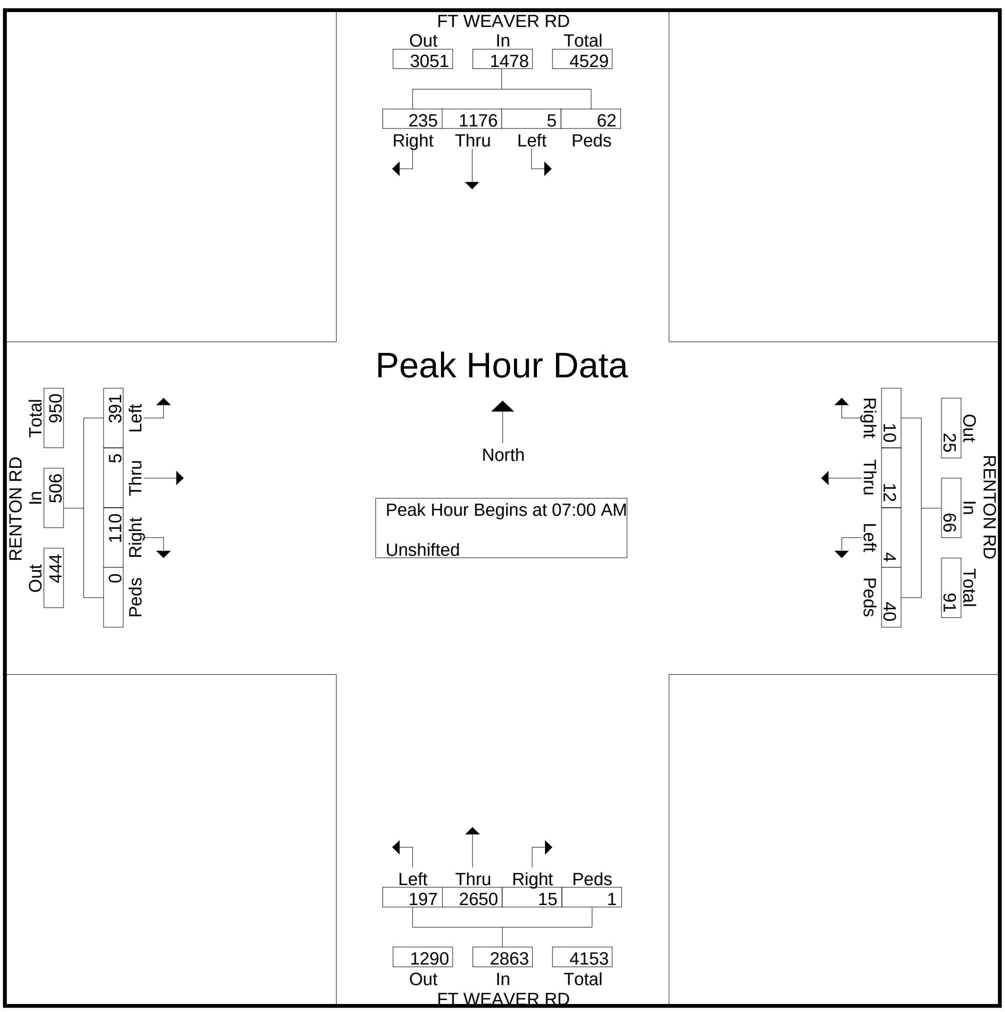
Site Code : 00000000
Start Date : 9/3/2014

	FT WEAVER RD From North						RENTON RD From East					FT WEAVER RD From South						RENTON RD From West					
Start Time	Right	Thru	Left	U-Turns	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	U-Turns	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Int. Total
Peak Hour Analysis From 07:00 AM to 07:45 AM - Peak 1 of 1																							
Peak Hour for Entire Intersection Begins at 07:00 AM																							
07:00 AM	68	280	0	12	0	360	2	3	2	8	15	5	713	45	0	0	763	18	1	106	0	125	1263
07:15 AM	71	394	0	15	0	480	1	4	0	12	17	5	699	40	0	0	744	18	0	84	0	102	1343
07:30 AM	49	239	3	16	0	307	3	3	2	11	19	3	563	54	0	0	620	37	3	105	0	145	1091
07:45 AM	47	263	2	19	0	331	4	2	0	9	15	2	675	58	1	0	736	37	1	96	0	134	1216
Total Volume	235	1176	5	62	0	1478	10	12	4	40	66	15	2650	197	1	0	2863	110	5	391	0	506	4913
% App. Total	15.9	79.6	0.3	4.2	0		15.2	18.2	6.1	60.6		0.5	92.6	6.9	0	0		21.7	1	77.3	0		
PHF	.827	.746	.417	.816	.000	.770	.625	.750	.500	.833	.868	.750	.929	.849	.250	.000	.938	.743	.417	.922	.000	.872	.915



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File Name : AM_Kapolei Pkwy - Geiger Rd
Site Code : 00000000
Start Date : 9/3/2014
Page No : 1

Groups Printed- Unshifted

	KAPOLEI PKWY From North				GEIGER RD From East				KAPOLEI PKWY From South				GEIGER RD From West				
Start Time	Right	Thru	Left	Peds	Right	Thru	Left	Peds	Right	Thru	Left	Peds	Right	Thru	Left	Peds	Int. Total
06:00 AM	5	29	14	0	21	47	9	1	18	101	54	1	17	19	1	0	337
06:15 AM	8	62	17	0	32	41	12	8	14	98	63	0	30	13	4	1	403
06:30 AM	7	58	28	2	27	61	11	3	16	97	78	0	40	19	3	0	450
06:45 AM	9	83	25	6	28	55	9	3	24	126	79	0	55	30	3	2	537
Total	29	232	84	8	108	204	41	15	72	422	274	1	142	81	11	3	1727
07:00 AM	10	119	29	1	38	46	20	13	20	130	70	0	46	22	3	4	571
07:15 AM	10	146	44	3	44	55	23	22	31	184	94	0	44	34	2	9	745
07:30 AM	4	138	36	2	53	61	28	8	47	230	90	0	46	33	3	0	779
07:45 AM	18	98	37	0	60	48	17	5	41	173	82	3	31	21	0	2	636
Total	42	501	146	6	195	210	88	48	139	717	336	3	167	110	8	15	2731
Grand Total	71	733	230	14	303	414	129	63	211	1139	610	4	309	191	19	18	4458
Apprch %	6.8	69.9	21.9	1.3	33.3	45.5	14.2	6.9	10.7	58	31.1	0.2	57.5	35.6	3.5	3.4	
Total %	1.6	16.4	5.2	0.3	6.8	9.3	2.9	1.4	4.7	25.5	13.7	0.1	6.9	4.3	0.4	0.4	

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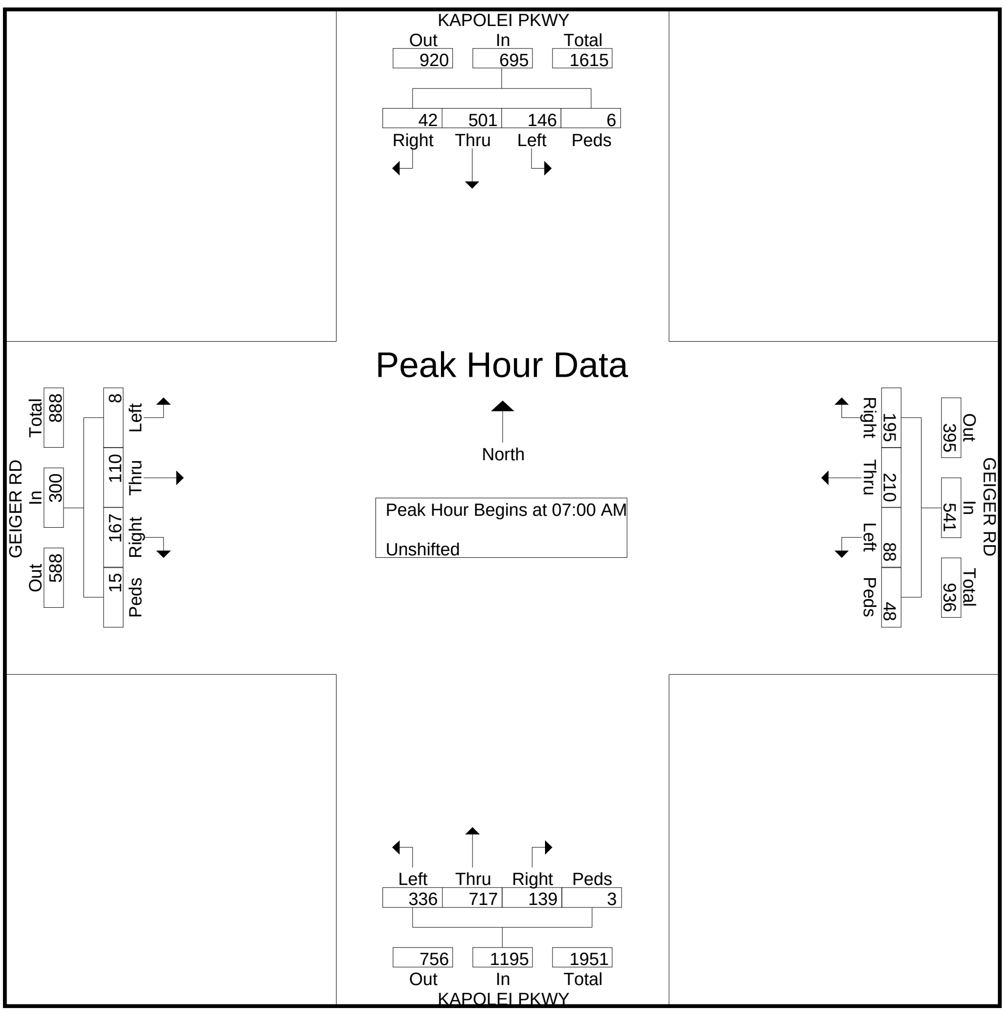
File Name : AM_Kapolei Pkwy - Geiger Rd
Site Code : 00000000
Start Date : 9/3/2014

	KAPOLEI PKWY From North					GEIGER RD From East					KAPOLEI PKWY From South					GEIGER RD From West					
Start Time	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Int. Total
Peak Hour Analysis From 07:00 AM to 07:45 AM - Peak 1 of 1																					
Peak Hour for Entire Intersection Begins at 07:00 AM																					
07:00 AM	10	119	29	1	159	38	46	20	13	117	20	130	70	0	220	46	22	3	4	75	571
07:15 AM	10	146	44	3	203	44	55	23	22	144	31	184	94	0	309	44	34	2	9	89	745
07:30 AM	4	138	36	2	180	53	61	28	8	150	47	230	90	0	367	46	33	3	0	82	779
07:45 AM	18	98	37	0	153	60	48	17	5	130	41	173	82	3	299	31	21	0	2	54	636
Total Volume	42	501	146	6	695	195	210	88	48	541	139	717	336	3	1195	167	110	8	15	300	2731
% App. Total	6	72.1	21	0.9		36	38.8	16.3	8.9		11.6	60	28.1	0.3		55.7	36.7	2.7	5		
PHF	.583	.858	.830	.500	.856	.813	.861	.786	.545	.902	.739	.779	.894	.250	.814	.908	.809	.667	.417	.843	.876



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File Name : AM_Kualakai Pkwy - Kapolei Pkwy
Site Code : 00000000
Start Date : 9/3/2014
Page No : 1

Groups Printed- Unshifted

	KUALAKAI PKWY From North				KAPOLEI PKWY From East				KUALAKAI PKWY From South				KAPOLEI PKWY From West				
Start Time	Right	Thru	Left	Peds	Right	Thru	Left	Peds	Right	Thru	Left	Peds	Right	Thru	Left	Peds	Int. Total
06:00 AM	16	0	17	0	58	46	0	0	0	0	0	0	0	43	97	0	277
06:15 AM	22	0	27	0	62	59	0	0	0	0	0	0	0	64	79	0	313
06:30 AM	28	0	37	2	72	61	0	0	0	0	0	0	0	69	96	0	365
06:45 AM	37	0	44	0	50	80	0	1	0	0	0	0	0	62	82	0	356
Total	103	0	125	2	242	246	0	1	0	0	0	0	0	238	354	0	1311
07:00 AM	42	0	33	2	58	107	0	0	0	0	0	0	0	76	94	0	412
07:15 AM	53	0	54	1	77	144	0	1	0	0	0	0	0	94	66	0	490
07:30 AM	65	0	46	1	96	195	0	3	0	0	0	0	0	90	83	0	579
07:45 AM	48	0	37	1	129	158	0	0	0	0	0	0	0	104	90	0	567
Total	208	0	170	5	360	604	0	4	0	0	0	0	0	364	333	0	2048
Grand Total	311	0	295	7	602	850	0	5	0	0	0	0	0	602	687	0	3359
Apprch %	50.7	0	48.1	1.1	41.3	58.3	0	0.3	0	0	0	0	0	46.7	53.3	0	
Total %	9.3	0	8.8	0.2	17.9	25.3	0	0.1	0	0	0	0	0	17.9	20.5	0	

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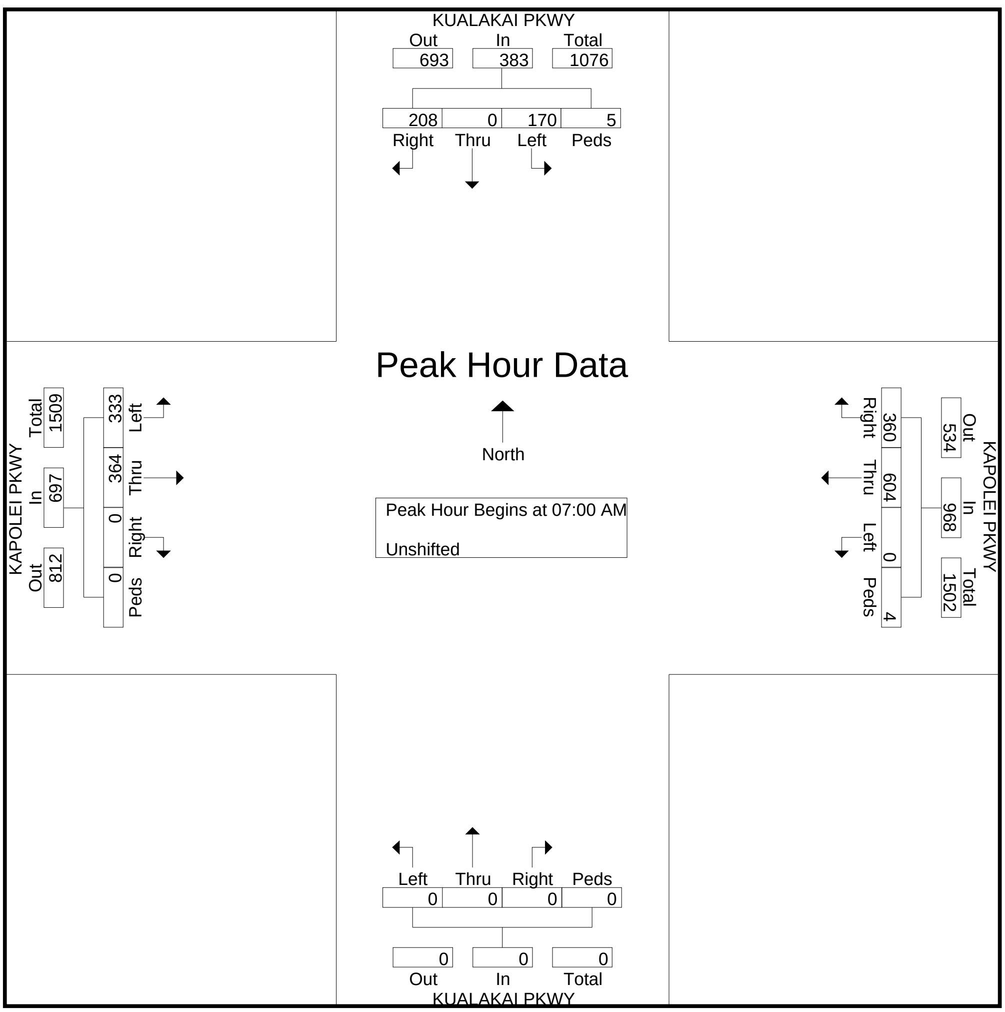
File Name : AM_Kualakai Pkwy - Kapolei Pkwy
Site Code : 00000000
Start Date : 9/3/2014

	KUALAKAI PKWY From North					KAPOLEI PKWY From East					KUALAKAI PKWY From South					KAPOLEI PKWY From West					
Start Time	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Int. Total
Peak Hour Analysis From 07:00 AM to 07:45 AM - Peak 1 of 1																					
Peak Hour for Entire Intersection Begins at 07:00 AM																					
07:00 AM	42	0	33	2	77	58	107	0	0	165	0	0	0	0	0	0	76	94	0	170	412
07:15 AM	53	0	54	1	108	77	144	0	1	222	0	0	0	0	0	0	94	66	0	160	490
07:30 AM	65	0	46	1	112	96	195	0	3	294	0	0	0	0	0	0	90	83	0	173	579
07:45 AM	48	0	37	1	86	129	158	0	0	287	0	0	0	0	0	0	104	90	0	194	567
Total Volume	208	0	170	5	383	360	604	0	4	968	0	0	0	0	0	0	364	333	0	697	2048
% App. Total	54.3	0	44.4	1.3		37.2	62.4	0	0.4		0	0	0	0		0	52.2	47.8	0		
PHF	.800	.000	.787	.625	.855	.698	.774	.000	.333	.823	.000	.000	.000	.000	.000	.000	.875	.886	.000	.898	.884



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File Name : AM_Phillipine Sea - Renton Rd
Site Code : 00000000
Start Date : 9/3/2014

Groups Printed- Class 1

	PHILLIPINE SEA From North				RENTON RD From East				PHILLIPINE SEA From South				RENTON RD From West				
Start Time	Rght	Thru	Left	Other	Rght	Thru	Left	Other	Rght	Thru	Left	Other	Rght	Thru	Left	Other	Int. Total
06:00 AM	0	0	0	0	0	1	44	0	20	0	0	0	0	0	0	0	65
06:15 AM	0	0	0	0	0	0	36	0	20	0	0	0	0	0	0	0	56
06:30 AM	0	0	0	0	0	0	44	0	20	0	0	0	1	0	0	0	65
06:45 AM	0	0	0	0	0	0	61	0	19	0	1	0	0	0	0	0	81
Total	0	0	0	0	0	1	185	0	79	0	1	0	1	0	0	0	267
07:00 AM	0	0	0	0	0	0	51	0	20	0	0	0	0	0	0	0	71
07:15 AM	0	0	0	0	0	0	42	0	21	0	1	0	0	0	0	0	64
07:30 AM	0	0	0	0	0	0	46	0	21	0	0	0	0	0	0	0	67
07:45 AM	0	0	0	0	0	1	42	0	18	0	1	0	0	0	0	0	62
Total	0	0	0	0	0	1	181	0	80	0	2	0	0	0	0	0	264
Grand Total	0	0	0	0	0	2	366	0	159	0	3	0	1	0	0	0	531
Apprch %	0	0	0	0	0	0.5	99.5	0	98.1	0	1.9	0	100	0	0	0	
Total %	0	0	0	0	0	0.4	68.9	0	29.9	0	0.6	0	0.2	0	0	0	

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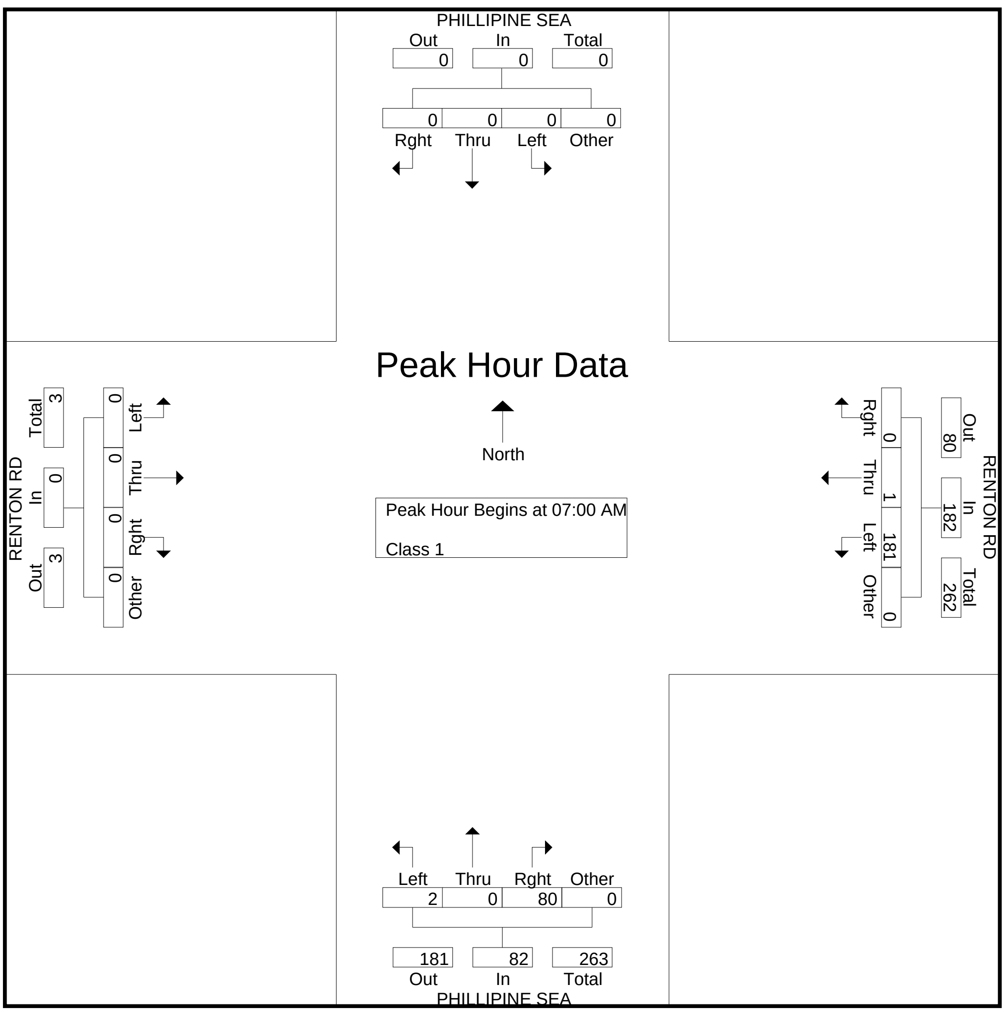
File Name : AM_Phillipine Sea - Renton Rd
Site Code : 00000000
Start Date : 9/3/2014

	PHILLIPINE SEA From North					RENTON RD From East					PHILLIPINE SEA From South					RENTON RD From West					
Start Time	Rght	Thru	Left	Other	App. Total	Rght	Thru	Left	Other	App. Total	Rght	Thru	Left	Other	App. Total	Rght	Thru	Left	Other	App. Total	Int. Total
Peak Hour Analysis From 07:00 AM to 07:45 AM - Peak 1 of 1																					
Peak Hour for Entire Intersection Begins at 07:00 AM																					
07:00 AM	0	0	0	0	0	0	0	51	0	51	20	0	0	0	20	0	0	0	0	0	71
07:15 AM	0	0	0	0	0	0	0	42	0	42	21	0	1	0	22	0	0	0	0	0	64
07:30 AM	0	0	0	0	0	0	0	46	0	46	21	0	0	0	21	0	0	0	0	0	67
07:45 AM	0	0	0	0	0	0	1	42	0	43	18	0	1	0	19	0	0	0	0	0	62
Total Volume	0	0	0	0	0	0	1	181	0	182	80	0	2	0	82	0	0	0	0	0	264
% App. Total	0	0	0	0		0	0.5	99.5	0		97.6	0	2.4	0		0	0	0	0		
PHF	.000	.000	.000	.000	.000	.000	.250	.887	.000	.892	.952	.000	.500	.000	.932	.000	.000	.000	.000	.000	.930



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File Name : AM_Phillipine Sea - Roosevelt Ave
Site Code : 00000000
Start Date : 9/3/2014

Groups Printed- Class 1

	PHILLIPINE SEA From North				ROOSEVELT AVE From East				PHILLIPINE SEA From South				ROOSEVELT AVE From West				
Start Time	Rght	Thru	Left	Other	Rght	Thru	Left	Other	Rght	Thru	Left	Other	Rght	Thru	Left	Other	Int. Total
06:00 AM	44	0	1	0	0	73	0	0	0	0	0	0	0	37	20	0	175
06:15 AM	30	0	4	0	0	78	0	0	0	0	0	0	0	49	15	0	176
06:30 AM	42	0	7	0	1	123	0	0	0	0	0	0	0	68	17	0	258
06:45 AM	55	0	3	0	2	108	0	0	0	0	0	0	0	67	18	0	253
Total	171	0	15	0	3	382	0	0	0	0	0	0	0	221	70	0	862
07:00 AM	48	0	2	0	2	100	0	0	0	0	0	0	0	55	16	0	223
07:15 AM	39	0	3	0	3	155	0	0	0	0	0	0	0	80	15	0	295
07:30 AM	40	0	4	0	4	141	0	0	0	0	0	0	0	65	17	0	271
07:45 AM	39	0	2	0	5	134	0	0	0	0	0	0	0	67	16	0	263
Total	166	0	11	0	14	530	0	0	0	0	0	0	0	267	64	0	1052
Grand Total	337	0	26	0	17	912	0	0	0	0	0	0	0	488	134	0	1914
Apprch %	92.8	0	7.2	0	1.8	98.2	0	0	0	0	0	0	0	78.5	21.5	0	
Total %	17.6	0	1.4	0	0.9	47.6	0	0	0	0	0	0	0	25.5	7	0	

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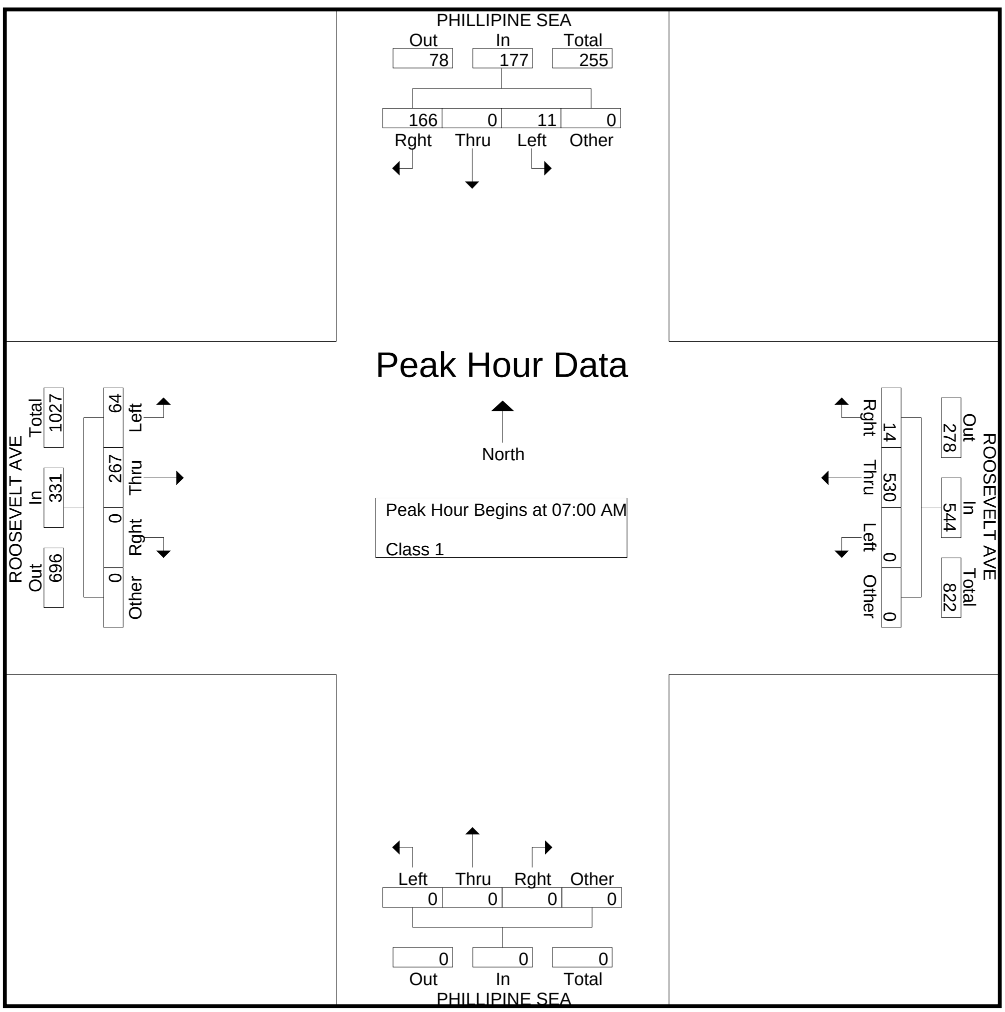
File Name : AM_Phillipine Sea - Roosevelt Ave
Site Code : 00000000
Start Date : 9/3/2014

	PHILLIPINE SEA From North					ROOSEVELT AVE From East					PHILLIPINE SEA From South					ROOSEVELT AVE From West					
Start Time	Rght	Thru	Left	Other	App. Total	Rght	Thru	Left	Other	App. Total	Rght	Thru	Left	Other	App. Total	Rght	Thru	Left	Other	App. Total	Int. Total
Peak Hour Analysis From 07:00 AM to 07:45 AM - Peak 1 of 1																					
Peak Hour for Entire Intersection Begins at 07:00 AM																					
07:00 AM	48	0	2	0	50	2	100	0	0	102	0	0	0	0	0	0	55	16	0	71	223
07:15 AM	39	0	3	0	42	3	155	0	0	158	0	0	0	0	0	0	80	15	0	95	295
07:30 AM	40	0	4	0	44	4	141	0	0	145	0	0	0	0	0	0	65	17	0	82	271
07:45 AM	39	0	2	0	41	5	134	0	0	139	0	0	0	0	0	0	67	16	0	83	263
Total Volume	166	0	11	0	177	14	530	0	0	544	0	0	0	0	0	0	267	64	0	331	1052
% App. Total	93.8	0	6.2	0		2.6	97.4	0	0		0	0	0	0		0	80.7	19.3	0		
PHF	.865	.000	.688	.000	.885	.700	.855	.000	.000	.861	.000	.000	.000	.000	.000	.000	.834	.941	.000	.871	.892



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File Name : AM_Renton Rd - Kapolei Pkwy
Site Code : 00000000
Start Date : 9/3/2014

Groups Printed- Unshifted

	RENTON RD From North				KAPOLEI PKWY From East				RENTON RD From South				KAPOLEI PKWY From West				
Start Time	Right	Thru	Left	Peds	Right	Thru	Left	Peds	Right	Thru	Left	Peds	Right	Thru	Left	Peds	Int. Total
06:00 AM	26	20	9	1	17	74	9	0	1	14	6	1	7	30	18	0	233
06:15 AM	22	20	19	2	35	103	8	1	5	12	3	0	11	56	29	0	326
06:30 AM	32	22	21	1	29	88	9	0	3	12	8	1	19	50	35	0	330
06:45 AM	33	29	36	4	51	95	7	0	5	18	3	0	22	50	29	0	382
Total	113	91	85	8	132	360	33	1	14	56	20	2	59	186	111	0	1271
07:00 AM	47	24	61	3	57	129	18	2	4	14	5	2	16	55	47	1	485
07:15 AM	57	22	85	1	109	168	9	1	3	17	9	0	10	76	55	1	623
07:30 AM	104	30	83	0	118	240	11	1	4	20	3	1	9	82	62	0	768
07:45 AM	82	32	59	2	66	168	5	0	5	10	7	0	7	76	49	0	568
Total	290	108	288	6	350	705	43	4	16	61	24	3	42	289	213	2	2444
Grand Total	403	199	373	14	482	1065	76	5	30	117	44	5	101	475	324	2	3715
Apprch %	40.7	20.1	37.7	1.4	29.6	65.4	4.7	0.3	15.3	59.7	22.4	2.6	11.2	52.7	35.9	0.2	
Total %	10.8	5.4	10	0.4	13	28.7	2	0.1	0.8	3.1	1.2	0.1	2.7	12.8	8.7	0.1	

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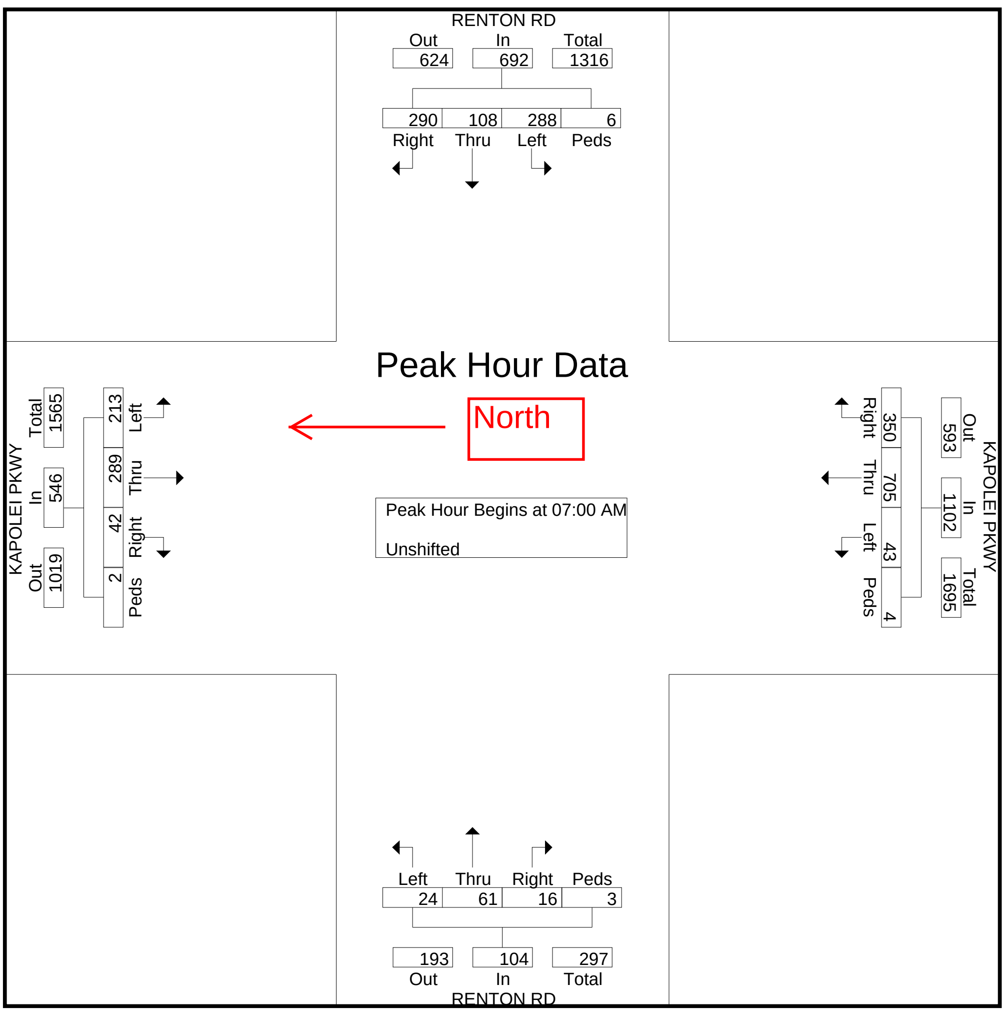
File Name : AM_Renton Rd - Kapolei Pkwy
Site Code : 00000000
Start Date : 9/3/2014

	RENTON RD From North					KAPOLEI PKWY From East					RENTON RD From South					KAPOLEI PKWY From West					
Start Time	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Int. Total
Peak Hour Analysis From 07:00 AM to 07:45 AM - Peak 1 of 1																					
Peak Hour for Entire Intersection Begins at 07:00 AM																					
07:00 AM	47	24	61	3	135	57	129	18	2	206	4	14	5	2	25	16	55	47	1	119	485
07:15 AM	57	22	85	1	165	109	168	9	1	287	3	17	9	0	29	10	76	55	1	142	623
07:30 AM	104	30	83	0	217	118	240	11	1	370	4	20	3	1	28	9	82	62	0	153	768
07:45 AM	82	32	59	2	175	66	168	5	0	239	5	10	7	0	22	7	76	49	0	132	568
Total Volume	290	108	288	6	692	350	705	43	4	1102	16	61	24	3	104	42	289	213	2	546	2444
% App. Total	41.9	15.6	41.6	0.9		31.8	64	3.9	0.4		15.4	58.7	23.1	2.9		7.7	52.9	39	0.4		
PHF	.697	.844	.847	.500	.797	.742	.734	.597	.500	.745	.800	.763	.667	.375	.897	.656	.881	.859	.500	.892	.796



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File Name : AM_WWTP Dwy #1 - Geiger Rd
Site Code : 00000000
Start Date : 9/3/2014
Page No : 1

Groups Printed- Class 1

	WWTP DWY #1 From North				GEIGER RD From East				From South				GEIGER RD From West				
Start Time	Rght	Thru	Left	Other	Rght	Thru	Left	Other	Rght	Thru	Left	Other	Rght	Thru	Left	Other	Int. Total
06:00 AM	0	0	0	0	0	79	10	0	0	0	1	0	0	35	0	0	125
06:15 AM	0	0	0	0	0	98	18	0	2	0	0	0	1	48	0	0	167
06:30 AM	0	0	0	0	0	142	5	0	8	0	1	0	3	52	0	0	211
06:45 AM	0	0	0	0	0	141	3	0	19	0	0	0	0	73	0	0	236
Total	0	0	0	0	0	460	36	0	29	0	2	0	4	208	0	0	739
07:00 AM	0	0	0	0	0	120	1	0	6	0	2	0	0	57	0	0	186
07:15 AM	0	0	0	0	0	160	4	0	3	0	1	0	1	77	0	0	246
07:30 AM	0	0	0	0	0	160	2	0	4	0	0	0	0	75	0	0	241
07:45 AM	0	0	0	0	0	152	1	0	2	0	0	0	0	62	0	0	217
Total	0	0	0	0	0	592	8	0	15	0	3	0	1	271	0	0	890
Grand Total	0	0	0	0	0	1052	44	0	44	0	5	0	5	479	0	0	1629
Apprch %	0	0	0	0	0	96	4	0	89.8	0	10.2	0	1	99	0	0	
Total %	0	0	0	0	0	64.6	2.7	0	2.7	0	0.3	0	0.3	29.4	0	0	

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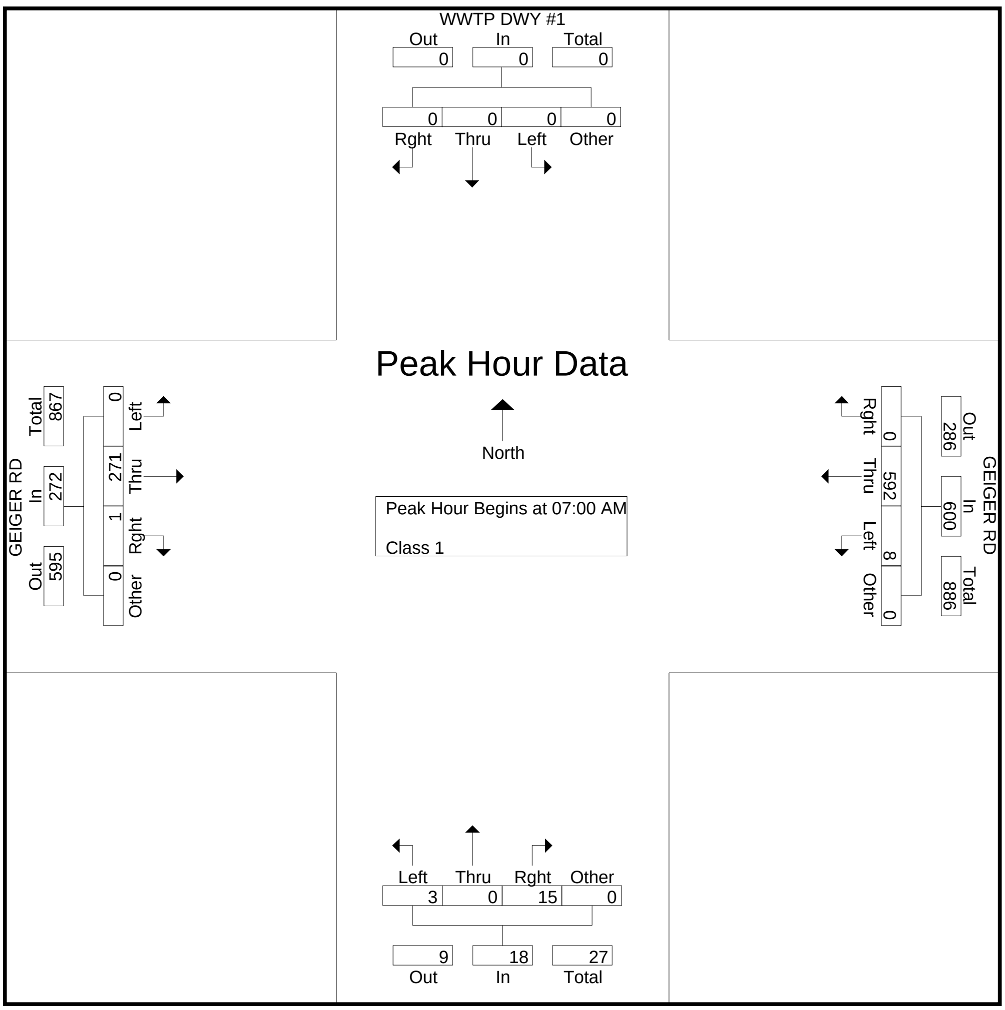
File Name : AM_WWTP Dwy #1 - Geiger Rd
Site Code : 00000000
Start Date : 9/3/2014

	WWTP DWY #1 From North					GEIGER RD From East					From South					GEIGER RD From West					
Start Time	Rght	Thru	Left	Other	App. Total	Rght	Thru	Left	Other	App. Total	Rght	Thru	Left	Other	App. Total	Rght	Thru	Left	Other	App. Total	Int. Total
Peak Hour Analysis From 07:00 AM to 07:45 AM - Peak 1 of 1																					
Peak Hour for Entire Intersection Begins at 07:00 AM																					
07:00 AM	0	0	0	0	0	0	120	1	0	121	6	0	2	0	8	0	57	0	0	57	186
07:15 AM	0	0	0	0	0	0	160	4	0	164	3	0	1	0	4	1	77	0	0	78	246
07:30 AM	0	0	0	0	0	0	160	2	0	162	4	0	0	0	4	0	75	0	0	75	241
07:45 AM	0	0	0	0	0	0	152	1	0	153	2	0	0	0	2	0	62	0	0	62	217
Total Volume	0	0	0	0	0	0	592	8	0	600	15	0	3	0	18	1	271	0	0	272	890
% App. Total	0	0	0	0		0	98.7	1.3	0		83.3	0	16.7	0		0.4	99.6	0	0		
PHF	.000	.000	.000	.000	.000	.000	.925	.500	.000	.915	.625	.000	.375	.000	.563	.250	.880	.000	.000	.872	.904



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File Name : AM_WWTP Dwy #2 - Geiger Rd
Site Code : 00000000
Start Date : 9/3/2014

Groups Printed- Class 1

	WWTP DWY #2 From North				GEIGER RD From East				From South				GEIGER RD From West				
Start Time	Rght	Thru	Left	Other	Rght	Thru	Left	Other	Rght	Thru	Left	Other	Rght	Thru	Left	Other	Int. Total
06:00 AM	0	0	1	0	1	69	0	0	0	0	0	0	0	35	1	0	107
06:15 AM	0	0	1	0	6	99	0	0	0	0	0	0	0	48	2	0	156
06:30 AM	1	0	0	0	15	124	0	0	0	0	0	0	0	53	3	0	196
06:45 AM	0	0	2	0	12	123	0	0	0	0	0	0	0	71	6	0	214
Total	1	0	4	0	34	415	0	0	0	0	0	0	0	207	12	0	673
07:00 AM	2	0	1	0	0	120	0	0	0	0	0	0	0	56	0	0	179
07:15 AM	3	0	2	0	0	155	0	0	0	0	0	0	0	77	0	0	237
07:30 AM	2	0	1	0	1	161	0	0	0	0	0	0	0	75	0	0	240
07:45 AM	3	0	2	0	3	143	0	0	0	0	0	0	0	60	0	0	211
Total	10	0	6	0	4	579	0	0	0	0	0	0	0	268	0	0	867
Grand Total	11	0	10	0	38	994	0	0	0	0	0	0	0	475	12	0	1540
Apprch %	52.4	0	47.6	0	3.7	96.3	0	0	0	0	0	0	0	97.5	2.5	0	
Total %	0.7	0	0.6	0	2.5	64.5	0	0	0	0	0	0	0	30.8	0.8	0	

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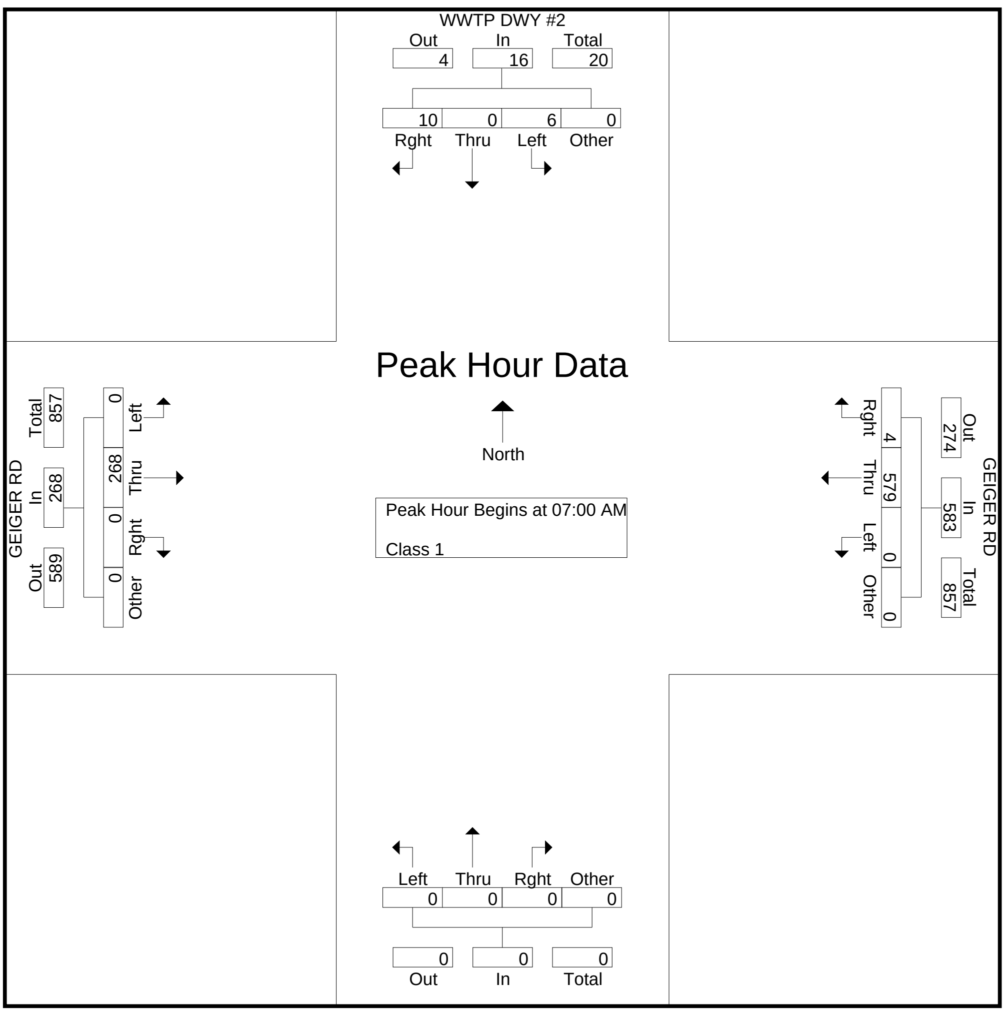
File Name : AM_WWTP Dwy #2 - Geiger Rd
Site Code : 00000000
Start Date : 9/3/2014

	WWTP DWY #2 From North					GEIGER RD From East					From South					GEIGER RD From West					
Start Time	Rght	Thru	Left	Other	App. Total	Rght	Thru	Left	Other	App. Total	Rght	Thru	Left	Other	App. Total	Rght	Thru	Left	Other	App. Total	Int. Total
Peak Hour Analysis From 07:00 AM to 07:45 AM - Peak 1 of 1																					
Peak Hour for Entire Intersection Begins at 07:00 AM																					
07:00 AM	2	0	1	0	3	0	120	0	0	120	0	0	0	0	0	0	56	0	0	56	179
07:15 AM	3	0	2	0	5	0	155	0	0	155	0	0	0	0	0	0	77	0	0	77	237
07:30 AM	2	0	1	0	3	1	161	0	0	162	0	0	0	0	0	0	75	0	0	75	240
07:45 AM	3	0	2	0	5	3	143	0	0	146	0	0	0	0	0	0	60	0	0	60	211
Total Volume	10	0	6	0	16	4	579	0	0	583	0	0	0	0	0	0	268	0	0	268	867
% App. Total	62.5	0	37.5	0		0.7	99.3	0	0		0	0	0	0		0	100	0	0		
PHF	.833	.000	.750	.000	.800	.333	.899	.000	.000	.900	.000	.000	.000	.000	.000	.000	.870	.000	.000	.870	.903



Austin Tsutsumi & Associates

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File Name : AM_WWTP Dwy #3 - Geiger Rd
Site Code : 00000000
Start Date : 9/3/2014
Page No : 1

Groups Printed- Class 1

	WWTP DWY #3 From North				GEIGER RD From East				From South				GEIGER RD From West				
Start Time	Rght	Thru	Left	Other	Rght	Thru	Left	Other	Rght	Thru	Left	Other	Rght	Thru	Left	Other	Int. Total
06:00 AM	0	0	0	0	0	70	0	0	0	0	0	0	0	36	0	0	106
06:15 AM	0	0	0	0	0	99	0	0	0	0	0	0	0	50	0	0	149
06:30 AM	0	0	0	0	0	126	0	0	0	0	0	0	0	61	0	0	187
06:45 AM	0	0	0	0	0	120	0	0	0	0	0	0	0	73	1	0	194
Total	0	0	0	0	0	415	0	0	0	0	0	0	0	220	1	0	636
07:00 AM	0	0	0	0	1	118	0	0	0	0	0	0	0	57	0	0	176
07:15 AM	2	0	1	0	2	159	0	0	0	0	0	0	0	75	0	0	239
07:30 AM	1	0	2	0	4	158	0	0	0	0	0	0	0	73	0	0	238
07:45 AM	4	0	2	0	6	140	0	0	0	0	0	0	0	56	3	0	211
Total	7	0	5	0	13	575	0	0	0	0	0	0	0	261	3	0	864
Grand Total	7	0	5	0	13	990	0	0	0	0	0	0	0	481	4	0	1500
Apprch %	58.3	0	41.7	0	1.3	98.7	0	0	0	0	0	0	0	99.2	0.8	0	
Total %	0.5	0	0.3	0	0.9	66	0	0	0	0	0	0	0	32.1	0.3	0	

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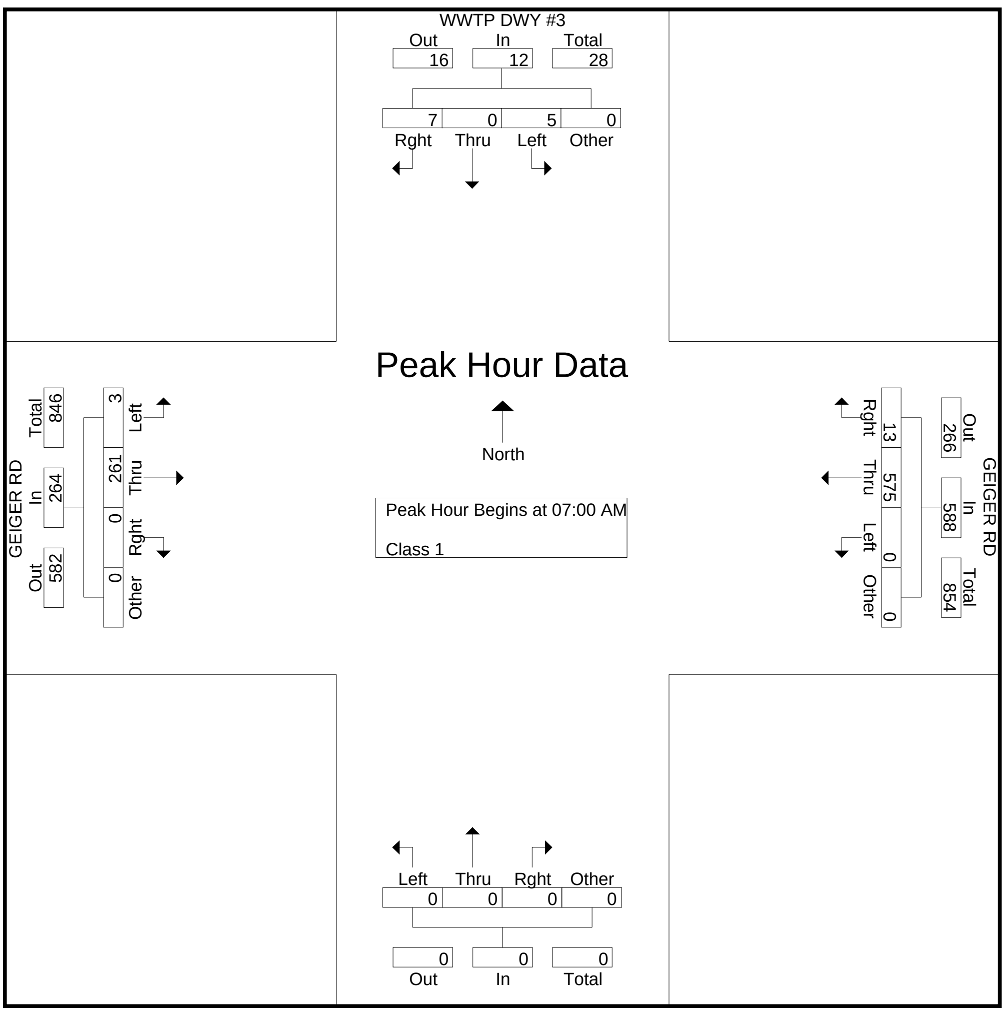
File Name : AM_WWTP Dwy #3 - Geiger Rd
Site Code : 00000000
Start Date : 9/3/2014
Page No : 2

	WWTP DWY #3 From North					GEIGER RD From East					From South					GEIGER RD From West					
Start Time	Rght	Thru	Left	Other	App. Total	Rght	Thru	Left	Other	App. Total	Rght	Thru	Left	Other	App. Total	Rght	Thru	Left	Other	App. Total	Int. Total
Peak Hour Analysis From 06:45 AM to 07:45 AM - Peak 1 of 1																					
Peak Hour for Entire Intersection Begins at 07:00 AM																					
07:00 AM	0	0	0	0	0	1	118	0	0	119	0	0	0	0	0	0	57	0	0	57	176
07:15 AM	2	0	1	0	3	2	159	0	0	161	0	0	0	0	0	0	75	0	0	75	239
07:30 AM	1	0	2	0	3	4	158	0	0	162	0	0	0	0	0	0	73	0	0	73	238
07:45 AM	4	0	2	0	6	6	140	0	0	146	0	0	0	0	0	0	56	3	0	59	211
Total Volume	7	0	5	0	12	13	575	0	0	588	0	0	0	0	0	0	261	3	0	264	864
% App. Total	58.3	0	41.7	0		2.2	97.8	0	0		0	0	0	0		0	98.9	1.1	0		
PHF	.438	.000	.625	.000	.500	.542	.904	.000	.000	.907	.000	.000	.000	.000	.000	.000	.870	.250	.000	.880	.904



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File Name : PM_Essex Rd - Geiger Rd
Site Code : 00000000
Start Date : 9/3/2014
Page No : 1

Groups Printed- Class 1

	From North				GEIGER RD From East				ESSEX RD From South				GEIGER RD From West				
Start Time	Rght	Thru	Left	Other	Rght	Thru	Left	Other	Rght	Thru	Left	Other	Rght	Thru	Left	Other	Int. Total
03:30 PM	0	0	0	0	0	98	2	0	0	0	2	0	2	133	0	0	237
03:45 PM	0	0	0	0	0	72	2	0	4	0	1	0	8	140	0	0	227
Total	0	0	0	0	0	170	4	0	4	0	3	0	10	273	0	0	464
04:00 PM	0	0	0	0	0	93	3	0	4	0	2	0	2	158	0	0	262
04:15 PM	0	0	0	0	0	89	3	0	3	0	2	0	4	153	0	0	254
04:30 PM	0	0	0	0	0	93	4	0	9	0	2	0	4	147	0	0	259
04:45 PM	0	0	0	0	0	70	1	0	3	0	3	0	3	166	0	0	246
Total	0	0	0	0	0	345	11	0	19	0	9	0	13	624	0	0	1021
05:00 PM	0	0	0	0	0	71	4	0	5	0	4	0	4	162	0	0	250
05:15 PM	0	0	0	0	0	67	6	0	7	0	3	0	5	136	0	0	224
Grand Total	0	0	0	0	0	653	25	0	35	0	19	0	32	1195	0	0	1959
Apprch %	0	0	0	0	0	96.3	3.7	0	64.8	0	35.2	0	2.6	97.4	0	0	
Total %	0	0	0	0	0	33.3	1.3	0	1.8	0	1	0	1.6	61	0	0	

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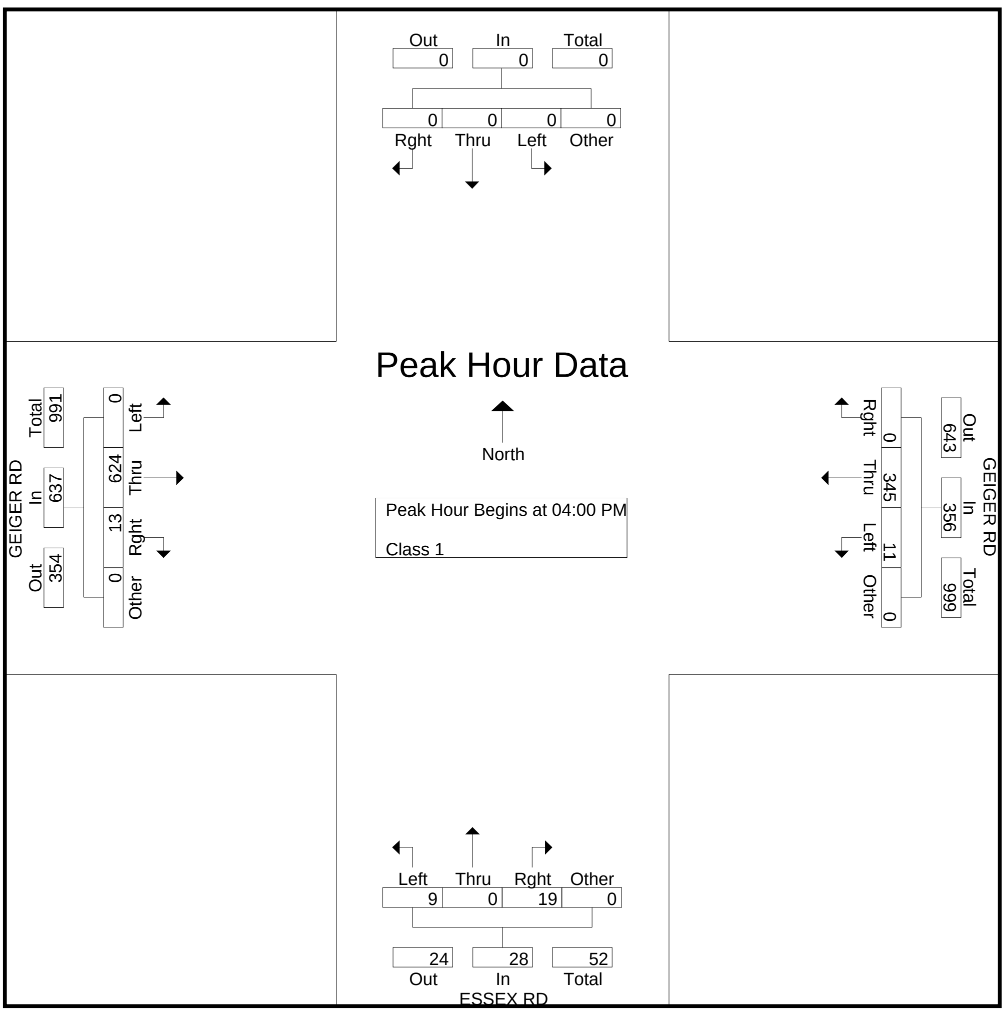
File Name : PM_Essex Rd - Geiger Rd
Site Code : 00000000
Start Date : 9/3/2014

	From North					GEIGER RD From East					ESSEX RD From South					GEIGER RD From West					
Start Time	Rght	Thru	Left	Other	App. Total	Rght	Thru	Left	Other	App. Total	Rght	Thru	Left	Other	App. Total	Rght	Thru	Left	Other	App. Total	Int. Total
Peak Hour Analysis From 04:00 PM to 04:45 PM - Peak 1 of 1																					
Peak Hour for Entire Intersection Begins at 04:00 PM																					
04:00 PM	0	0	0	0	0	0	93	3	0	96	4	0	2	0	6	2	158	0	0	160	262
04:15 PM	0	0	0	0	0	0	89	3	0	92	3	0	2	0	5	4	153	0	0	157	254
04:30 PM	0	0	0	0	0	0	93	4	0	97	9	0	2	0	11	4	147	0	0	151	259
04:45 PM	0	0	0	0	0	0	70	1	0	71	3	0	3	0	6	3	166	0	0	169	246
Total Volume	0	0	0	0	0	0	345	11	0	356	19	0	9	0	28	13	624	0	0	637	1021
% App. Total	0	0	0	0		0	96.9	3.1	0		67.9	0	32.1	0		2	98	0	0		
PHF	.000	.000	.000	.000	.000	.000	.927	.688	.000	.918	.528	.000	.750	.000	.636	.813	.940	.000	.000	.942	.974



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File Name : PM_Ft Weaver Rd - Geiger Rd
Site Code : 00000000
Start Date : 9/3/2014
Page No : 1

Groups Printed- Unshifted

	FT WEAVER RD From North					GEIGER RD From East				FT WEAVER RD From South				GEIGER RD From West				
Start Time	Right	Thru	Left	U-Turns	Peds	Right	Thru	Left	Peds	Right	Thru	Left	Peds	Right	Thru	Left	Peds	Int. Total
03:30 PM	68	399	89	1	0	33	34	2	0	1	266	48	5	34	30	40	7	1057
03:45 PM	53	314	84	0	0	27	33	6	0	3	266	30	20	35	59	52	11	993
Total	121	713	173	1	0	60	67	8	0	4	532	78	25	69	89	92	18	2050
04:00 PM	37	332	77	0	0	37	53	0	0	4	197	30	14	23	54	59	6	923
04:15 PM	43	345	59	0	0	28	38	1	0	1	222	34	15	44	44	50	15	939
04:30 PM	59	399	107	0	0	28	44	5	0	2	200	37	7	47	37	47	4	1023
04:45 PM	68	417	98	0	0	29	47	4	0	3	198	34	11	39	71	42	7	1068
Total	207	1493	341	0	0	122	182	10	0	10	817	135	47	153	206	198	32	3953
05:00 PM	53	356	109	0	0	28	41	6	0	1	181	39	14	48	83	53	2	1014
05:15 PM	79	376	83	0	0	27	31	6	0	2	222	25	12	32	43	46	11	995
Grand Total	460	2938	706	1	0	237	321	30	0	17	1752	277	98	302	421	389	63	8012
Apprch %	11.2	71.6	17.2	0	0	40.3	54.6	5.1	0	0.8	81.7	12.9	4.6	25.7	35.8	33.1	5.4	
Total %	5.7	36.7	8.8	0	0	3	4	0.4	0	0.2	21.9	3.5	1.2	3.8	5.3	4.9	0.8	

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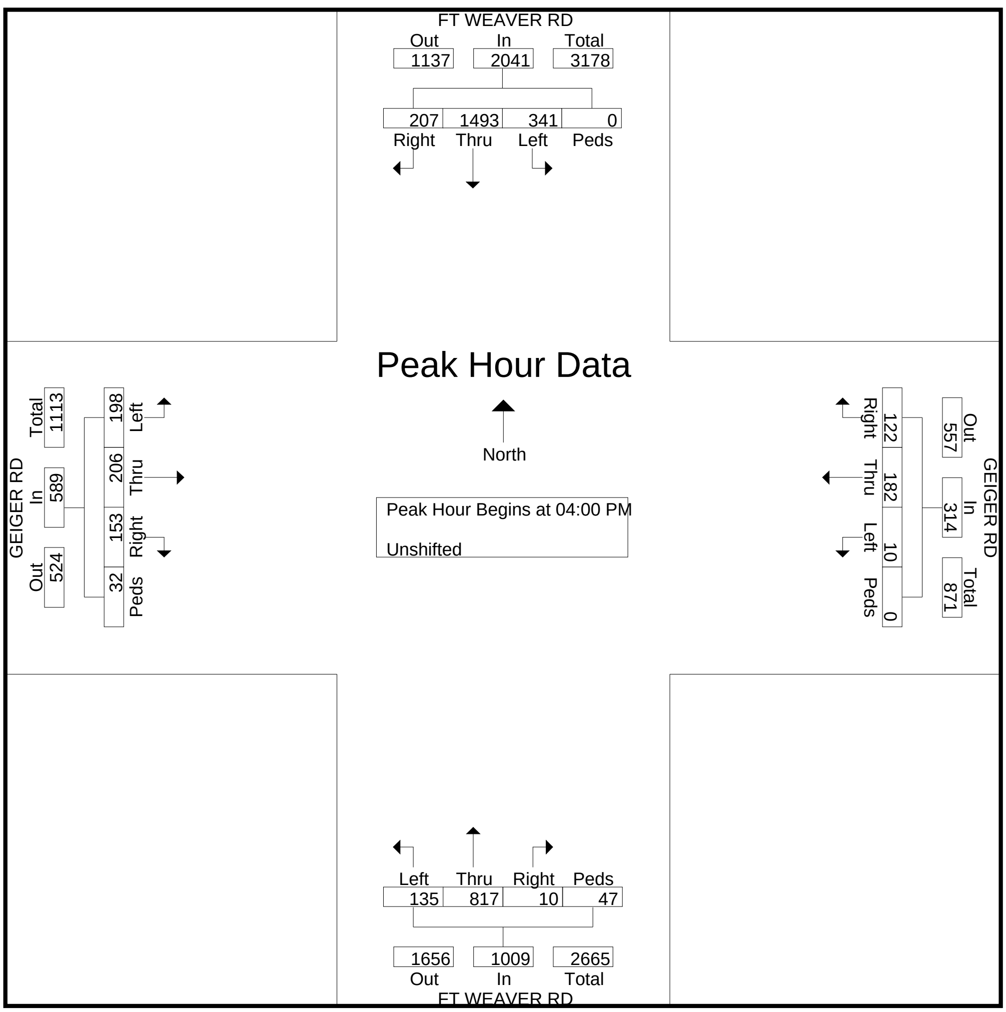
File Name : PM_Ft Weaver Rd - Geiger Rd
Site Code : 00000000
Start Date : 9/3/2014

	FT WEAVER RD From North						GEIGER RD From East					FT WEAVER RD From South					GEIGER RD From West					
Start Time	Right	Thru	Left	U-Turns	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Int. Total
Peak Hour Analysis From 04:00 PM to 04:45 PM - Peak 1 of 1																						
Peak Hour for Entire Intersection Begins at 04:00 PM																						
04:00 PM	37	332	77	0	0	446	37	53	0	0	90	4	197	30	14	245	23	54	59	6	142	923
04:15 PM	43	345	59	0	0	447	28	38	1	0	67	1	222	34	15	272	44	44	50	15	153	939
04:30 PM	59	399	107	0	0	565	28	44	5	0	77	2	200	37	7	246	47	37	47	4	135	1023
04:45 PM	68	417	98	0	0	583	29	47	4	0	80	3	198	34	11	246	39	71	42	7	159	1068
Total Volume	207	1493	341	0	0	2041	122	182	10	0	314	10	817	135	47	1009	153	206	198	32	589	3953
% App. Total	10.1	73.2	16.7				38.9							13.4					33.6			
PHF	.761	.895	.797	.000	.000	.875	.824	.858	.500	.000	.872	.625	.920	.912	.783	.927	.814	.725	.839	.533	.926	.925



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File Name : PM_Ft Weaver Rd - Renton Rd
Site Code : 00000000
Start Date : 9/3/2014
Page No : 1

Groups Printed- Unshifted

	FT WEAVER RD From North					RENTON RD From East				FT WEAVER RD From South					RENTON RD From West				
Start Time	Right	Thru	Left	U-Turns	Peds	Right	Thru	Left	Peds	Right	Thru	Left	U-Turns	Peds	Right	Thru	Left	Peds	Int. Total
03:30 PM	56	704	0	4	0	3	1	2	5	5	453	23	0	2	27	0	78	2	1365
03:45 PM	88	604	8	7	0	3	1	2	1	13	404	36	1	6	32	4	111	0	1321
Total	144	1308	8	11	0	6	2	4	6	18	857	59	1	8	59	4	189	2	2686
04:00 PM	83	565	11	9	0	4	7	9	19	21	398	33	1	14	23	12	99	1	1309
04:15 PM	71	582	10	4	0	8	10	13	5	18	330	31	1	6	24	11	100	0	1224
04:30 PM	68	733	8	11	0	8	8	8	4	10	380	25	0	7	24	7	75	3	1379
04:45 PM	76	748	8	7	0	2	3	4	3	5	302	24	0	5	26	6	81	1	1301
Total	298	2628	37	31	0	22	28	34	31	54	1410	113	2	32	97	36	355	5	5213
05:00 PM	57	660	4	8	0	8	3	2	13	14	359	32	0	1	27	5	65	0	1258
05:15 PM	70	674	10	6	0	3	3	2	12	9	320	18	2	9	18	5	79	5	1245
Grand Total	569	5270	59	56	0	39	36	42	62	95	2946	222	5	50	201	50	688	12	10402
Apprch %	9.6	88.5	1	0.9	0	21.8	20.1	23.5	34.6	2.9	88.8	6.7	0.2	1.5	21.1	5.3	72.3	1.3	
Total %	5.5	50.7	0.6	0.5	0	0.4	0.3	0.4	0.6	0.9	28.3	2.1	0	0.5	1.9	0.5	6.6	0.1	

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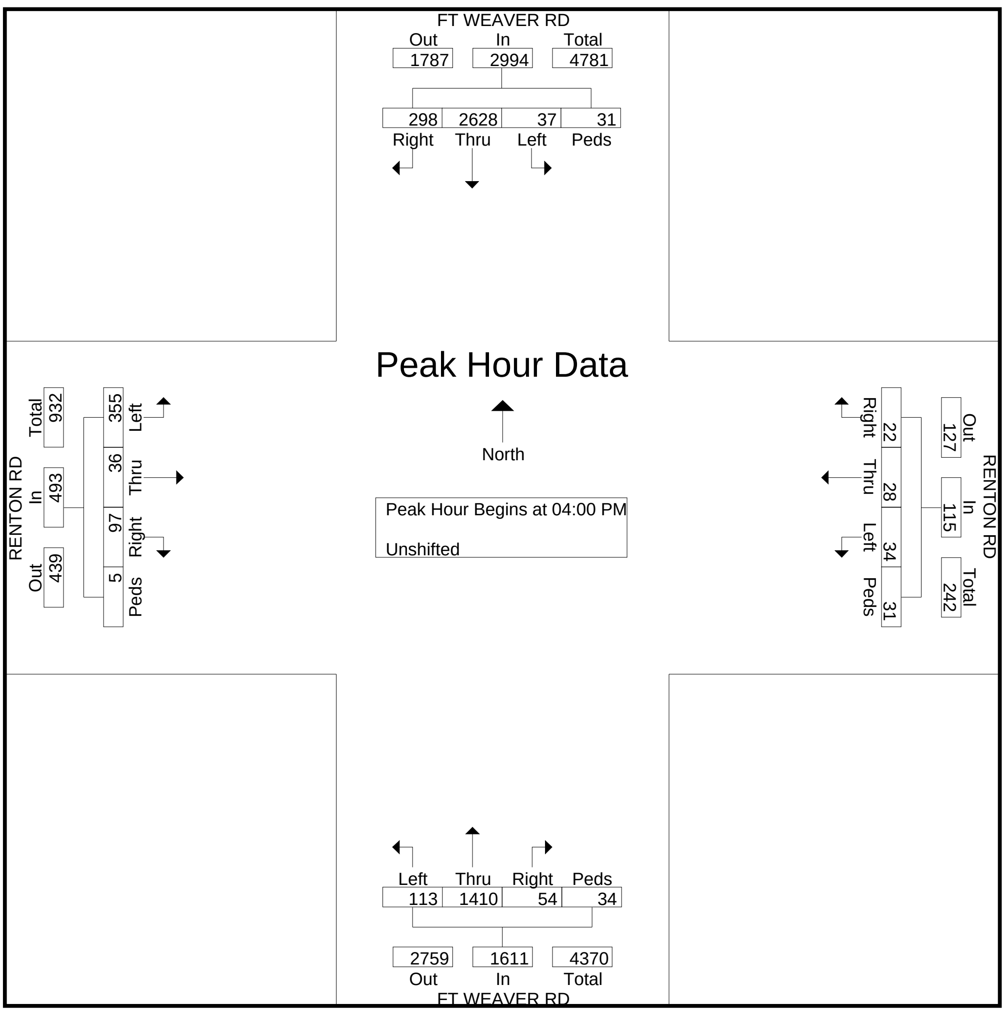
File Name : PM_Ft Weaver Rd - Renton Rd
Site Code : 00000000
Start Date : 9/3/2014

	FT WEAVER RD From North						RENTON RD From East					FT WEAVER RD From South						RENTON RD From West					
Start Time	Right	Thru	Left	U-Turns	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	U-Turns	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Int. Total
Peak Hour Analysis From 04:00 PM to 04:45 PM - Peak 1 of 1																							
Peak Hour for Entire Intersection Begins at 04:00 PM																							
04:00 PM	83	565	11	9	0	668	4	7	9	19	39	21	398	33	1	14	467	23	12	99	1	135	1309
04:15 PM	71	582	10	4	0	667	8	10	13	5	36	18	330	31	1	6	386	24	11	100	0	135	1224
04:30 PM	68	733	8	11	0	820	8	8	8	4	28	10	380	25	0	7	422	24	7	75	3	109	1379
04:45 PM	76	748	8	7	0	839	2	3	4	3	12	5	302	24	0	5	336	26	6	81	1	114	1301
Total Volume	298	2628	37	31	0	2994	22	28	34	31	115	54	1410	113	2	32	1611	97	36	355	5	493	5213
% App. Total	10	87.8	1.2	1	0		19.1	24.3	29.6	27		3.4	87.5	7	0.1	2		19.7	7.3	72	1		
PHF	.898	.878	.841	.705	.000	.892	.688	.700	.654	.408	.737	.643	.886	.856	.500	.571	.862	.933	.750	.888	.417	.913	.945



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File Name : PM_Kapolei Pkwy - Geiger Rd
Site Code : 00000000
Start Date : 9/3/2014
Page No : 1

Groups Printed- Unshifted

	KAPOLEI PKWY From North					GEIGER RD From East				KAPOLEI PKWY From South				GEIGER RD From West				
Start Time	Right	Thru	Left	U-Turns	Peds	Right	Thru	Left	Peds	Right	Thru	Left	Peds	Right	Thru	Left	Peds	Int. Total
03:30 PM	5	125	29	1	2	67	37	46	3	28	127	56	1	77	52	9	2	667
03:45 PM	8	108	24	0	1	60	24	26	7	13	111	42	0	97	64	10	4	599
Total	13	233	53	1	3	127	61	72	10	41	238	98	1	174	116	19	6	1266
04:00 PM	5	115	36	0	4	57	43	24	5	22	90	51	0	101	55	10	3	621
04:15 PM	9	122	38	0	0	59	26	24	4	26	121	57	1	91	45	11	5	639
04:30 PM	5	133	33	1	0	56	40	29	5	20	82	50	0	101	73	14	1	643
04:45 PM	6	122	45	0	2	60	33	44	4	24	76	38	0	102	55	10	2	623
Total	25	492	152	1	6	232	142	121	18	92	369	196	1	395	228	45	11	2526
05:00 PM	10	137	49	0	1	51	25	47	3	14	83	39	3	111	73	10	0	656
05:15 PM	3	137	35	0	0	57	26	36	5	22	90	45	4	81	50	10	3	604
Grand Total	51	999	289	2	10	467	254	276	36	169	780	378	9	761	467	84	20	5052
Apprch %	3.8	73.9	21.4	0.1	0.7	45.2	24.6	26.7	3.5	12.6	58.4	28.3	0.7	57.1	35.1	6.3	1.5	
Total %	1	19.8	5.7	0	0.2	9.2	5	5.5	0.7	3.3	15.4	7.5	0.2	15.1	9.2	1.7	0.4	

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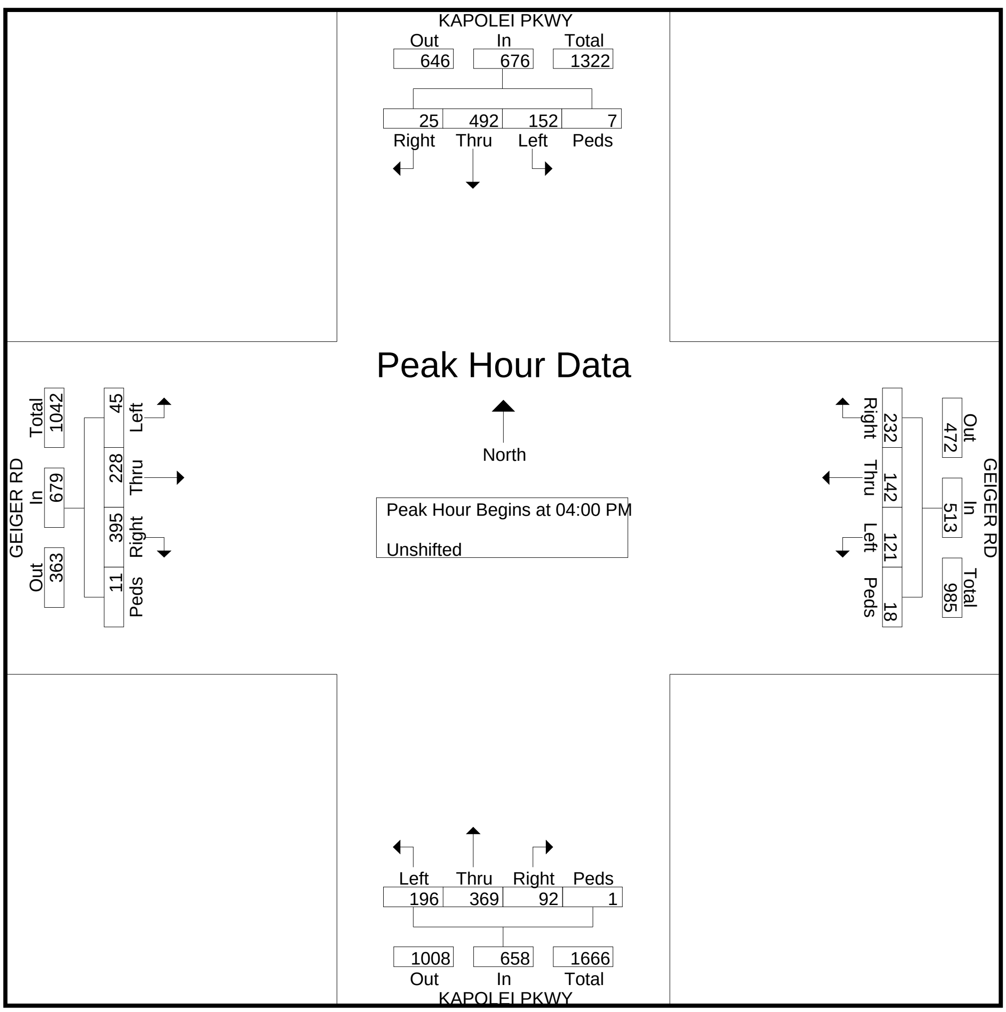
	KAPOLEI PKWY From North						GEIGER RD From East					KAPOLEI PKWY From South					GEIGER RD From West					
Start Time	Right	Thru	Left	U-Turns	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Int. Total
Peak Hour Analysis From 04:00 PM to 04:45 PM - Peak 1 of 1																						
Peak Hour for Entire Intersection Begins at 04:00 PM																						
04:00 PM	5	115	36	0	4	160	57	43	24	5	129	22	90	51	0	163	101	55	10	3	169	621
04:15 PM	9	122	38	0	0	169	59	26	24	4	113	26	121	57	1	205	91	45	11	5	152	639
04:30 PM	5	133	33	1	0	172	56	40	29	5	130	20	82	50	0	152	101	73	14	1	189	643
04:45 PM	6	122	45	0	2	175	60	33	44	4	141	24	76	38	0	138	102	55	10	2	169	623
Total Volume	25	492	152	1	6	676	232	142	121	18	513	92	369	196	1	658	395	228	45	11	679	2526
% App. Total	3.7	72.8	22.5	0.1	0.9		45.2	27.7	23.6	3.5		14	56.1	29.8	0.2		58.2	33.6	6.6	1.6		
PHF	.694	.925	.844	.250	.375	.966	.967	.826	.688	.900	.910	.885	.762	.860	.250	.802	.968	.781	.804	.550	.898	.982



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File Name : PM_Kualakai Pkwy - Kapolei Pkwy
Site Code : 00000000
Start Date : 9/3/2014

Groups Printed- Unshifted

	KUALAKAI PKWY From North				KAPOLEI PKWY From East				KUALAKAI PKWY From South				KAPOLEI PKWY From West				
Start Time	Right	Thru	Left	Peds	Right	Thru	Left	Peds	Right	Thru	Left	Peds	Right	Thru	Left	Peds	Int. Total
03:30 PM	69	0	83	0	51	91	0	0	0	0	0	0	0	114	59	0	467
03:45 PM	91	0	67	0	70	104	0	0	0	0	0	0	0	101	63	0	496
Total	160	0	150	0	121	195	0	0	0	0	0	0	0	215	122	0	963
04:00 PM	92	0	83	0	70	93	0	1	0	0	0	0	0	102	55	4	500
04:15 PM	67	0	108	1	58	84	0	1	0	0	0	0	0	86	38	0	443
04:30 PM	90	0	92	0	64	89	0	0	0	0	0	0	0	114	68	0	517
04:45 PM	85	0	94	0	61	90	0	2	0	0	0	0	0	140	57	0	529
Total	334	0	377	1	253	356	0	4	0	0	0	0	0	442	218	4	1989
05:00 PM	81	0	106	3	49	83	0	2	0	0	0	0	0	128	54	0	506
05:15 PM	83	0	105	1	56	64	0	0	0	0	0	0	0	77	41	0	427
Grand Total	658	0	738	5	479	698	0	6	0	0	0	0	0	862	435	4	3885
Apprch %	47	0	52.7	0.4	40.5	59	0	0.5	0	0	0	0	0	66.3	33.4	0.3	
Total %	16.9	0	19	0.1	12.3	18	0	0.2	0	0	0	0	0	22.2	11.2	0.1	

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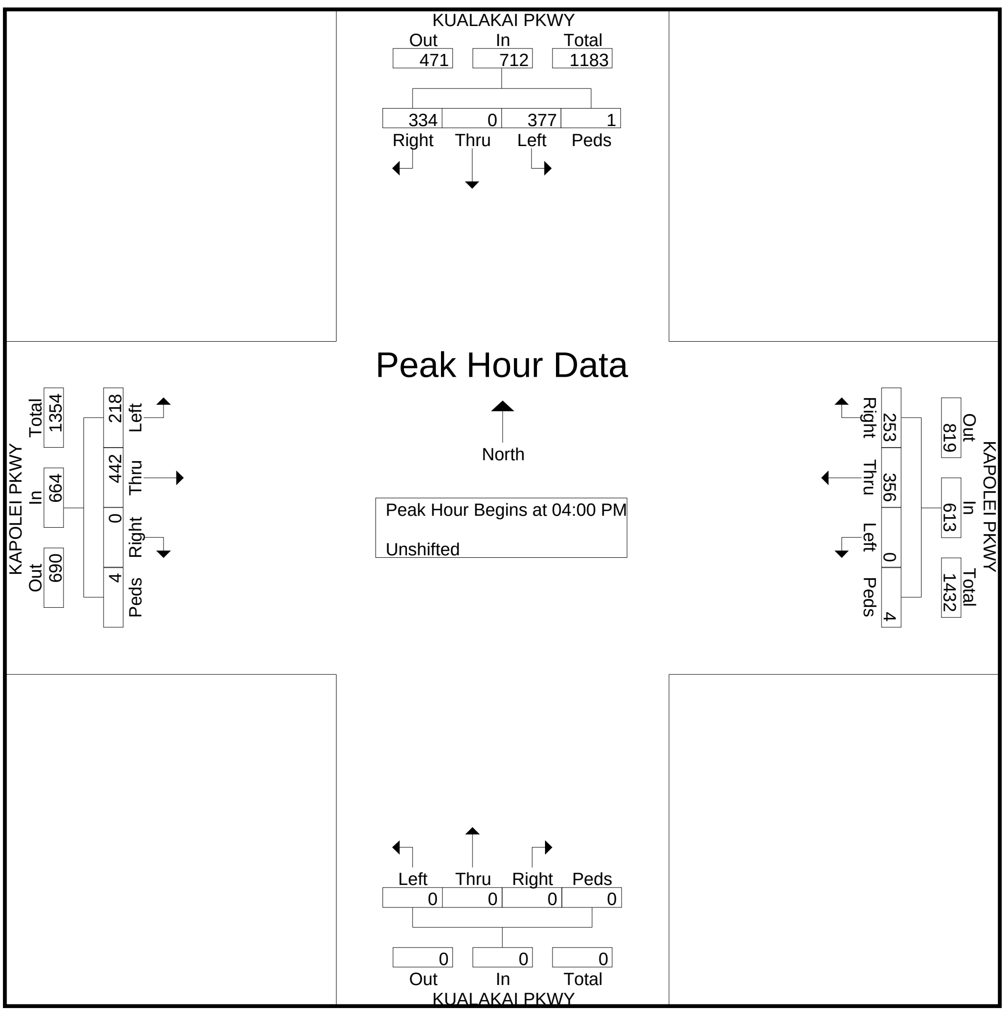
	KUALAKAI PKWY From North					KAPOLEI PKWY From East					KUALAKAI PKWY From South					KAPOLEI PKWY From West					
Start Time	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Int. Total
Peak Hour Analysis From 04:00 PM to 04:45 PM - Peak 1 of 1																					
Peak Hour for Entire Intersection Begins at 04:00 PM																					
04:00 PM	92	0	83	0	175	70	93	0	1	164	0	0	0	0	0	0	102	55	4	161	500
04:15 PM	67	0	108	1	176	58	84	0	1	143	0	0	0	0	0	0	86	38	0	124	443
04:30 PM	90	0	92	0	182	64	89	0	0	153	0	0	0	0	0	0	114	68	0	182	517
04:45 PM	85	0	94	0	179	61	90	0	2	153	0	0	0	0	0	0	140	57	0	197	529
Total Volume	334	0	377	1	712	253	356	0	4	613	0	0	0	0	0	0	442	218	4	664	1989
% App. Total	46.9	0	52.9	0.1		41.3	58.1	0	0.7		0	0	0	0		0	66.6	32.8	0.6		
PHF	.908	.000	.873	.250	.978	.904	.957	.000	.500	.934	.000	.000	.000	.000	.000	.000	.789	.801	.250	.843	.940



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File Name : PM_Phillipine Sea - Renton Rd
Site Code : 00000000
Start Date : 9/3/2014
Page No : 1

Groups Printed- Class 1

	PHILLIPINE SEA From North				RENTON RD From East				PHILLIPINE SEA From South				RENTON RD From West				
Start Time	Rght	Thru	Left	Other	Rght	Thru	Left	Other	Rght	Thru	Left	Other	Rght	Thru	Left	Other	Int. Total
03:30 PM	0	0	0	0	0	2	31	0	35	0	1	0	1	2	0	0	72
03:45 PM	0	0	0	0	0	0	30	0	50	0	1	0	0	1	0	0	82
Total	0	0	0	0	0	2	61	0	85	0	2	0	1	3	0	0	154
04:00 PM	0	0	0	0	0	2	29	0	53	0	1	0	0	1	0	0	86
04:15 PM	0	0	0	0	0	0	40	0	44	0	0	0	0	0	0	0	84
04:30 PM	0	0	0	0	0	0	42	0	47	0	3	0	3	1	0	0	96
04:45 PM	0	0	0	0	0	0	24	0	49	0	2	0	0	0	0	0	75
Total	0	0	0	0	0	2	135	0	193	0	6	0	3	2	0	0	341
05:00 PM	0	0	0	0	0	0	24	0	47	0	0	0	0	2	0	0	73
05:15 PM	0	0	0	0	0	1	34	0	48	0	0	0	2	0	0	0	85
Grand Total	0	0	0	0	0	5	254	0	373	0	8	0	6	7	0	0	653
Apprch %	0	0	0	0	0	1.9	98.1	0	97.9	0	2.1	0	46.2	53.8	0	0	
Total %	0	0	0	0	0	0.8	38.9	0	57.1	0	1.2	0	0.9	1.1	0	0	

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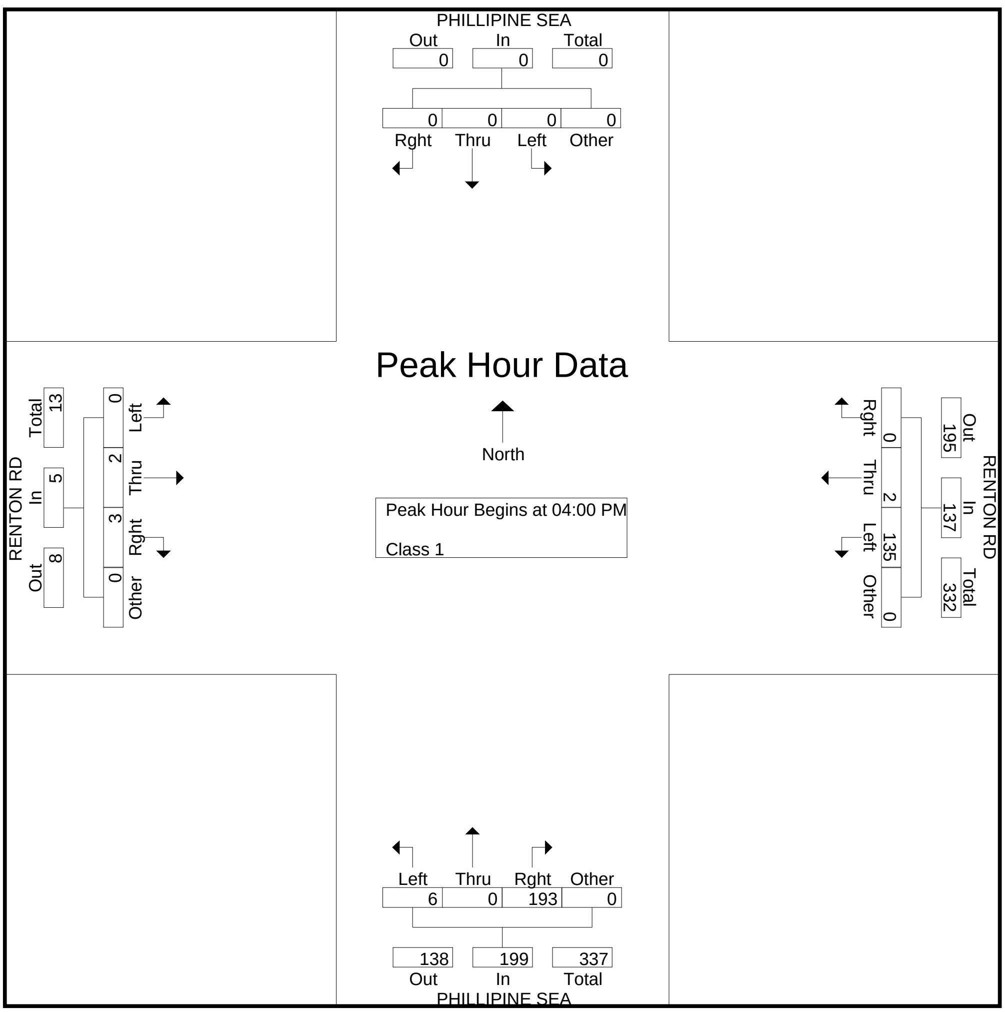
	PHILLIPINE SEA From North					RENTON RD From East					PHILLIPINE SEA From South					RENTON RD From West					
Start Time	Rght	Thru	Left	Other	App. Total	Rght	Thru	Left	Other	App. Total	Rght	Thru	Left	Other	App. Total	Rght	Thru	Left	Other	App. Total	Int. Total
Peak Hour Analysis From 04:00 PM to 04:45 PM - Peak 1 of 1																					
Peak Hour for Entire Intersection Begins at 04:00 PM																					
04:00 PM	0	0	0	0	0	0	2	29	0	31	53	0	1	0	54	0	1	0	0	1	86
04:15 PM	0	0	0	0	0	0	0	40	0	40	44	0	0	0	44	0	0	0	0	0	84
04:30 PM	0	0	0	0	0	0	0	42	0	42	47	0	3	0	50	3	1	0	0	4	96
04:45 PM	0	0	0	0	0	0	0	24	0	24	49	0	2	0	51	0	0	0	0	0	75
Total Volume	0	0	0	0	0	0	2	135	0	137	193	0	6	0	199	3	2	0	0	5	341
% App. Total	0	0	0	0		0	1.5	98.5	0		97	0	3	0		60	40	0	0		
PHF	.000	.000	.000	.000	.000	.000	.250	.804	.000	.815	.910	.000	.500	.000	.921	.250	.500	.000	.000	.313	.888



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File Name : PM_Phillipine Sea - Roosevelt Ave
Site Code : 00000000
Start Date : 9/3/2014
Page No : 1

Groups Printed- Class 1

	PHILLIPINE SEA From North				ROOSEVELT AVE From East				PHILLIPINE SEA From South				ROOSEVELT AVE From West				
Start Time	Rght	Thru	Left	Other	Rght	Thru	Left	Other	Rght	Thru	Left	Other	Rght	Thru	Left	Other	Int. Total
03:30 PM	27	1	8	0	3	91	0	0	0	0	0	0	0	134	36	0	300
03:45 PM	25	0	4	0	3	75	0	0	0	0	0	0	1	143	49	0	300
Total	52	1	12	0	6	166	0	0	0	0	0	0	1	277	85	0	600
04:00 PM	25	0	0	0	3	85	0	0	0	0	0	0	0	137	44	0	294
04:15 PM	37	0	5	0	6	86	0	0	0	0	0	0	0	149	43	0	326
04:30 PM	38	0	5	0	5	91	0	0	0	0	0	0	0	136	41	0	316
04:45 PM	23	0	4	0	3	69	0	0	0	0	0	0	0	161	44	0	304
Total	123	0	14	0	17	331	0	0	0	0	0	0	0	583	172	0	1240
05:00 PM	17	0	4	0	5	69	0	0	0	0	0	0	0	161	44	0	300
05:15 PM	33	0	5	0	2	72	0	0	0	0	0	0	0	132	45	0	289
Grand Total	225	1	35	0	30	638	0	0	0	0	0	0	1	1153	346	0	2429
Apprch %	86.2	0.4	13.4	0	4.5	95.5	0	0	0	0	0	0	0.1	76.9	23.1	0	
Total %	9.3	0	1.4	0	1.2	26.3	0	0	0	0	0	0	0	47.5	14.2	0	

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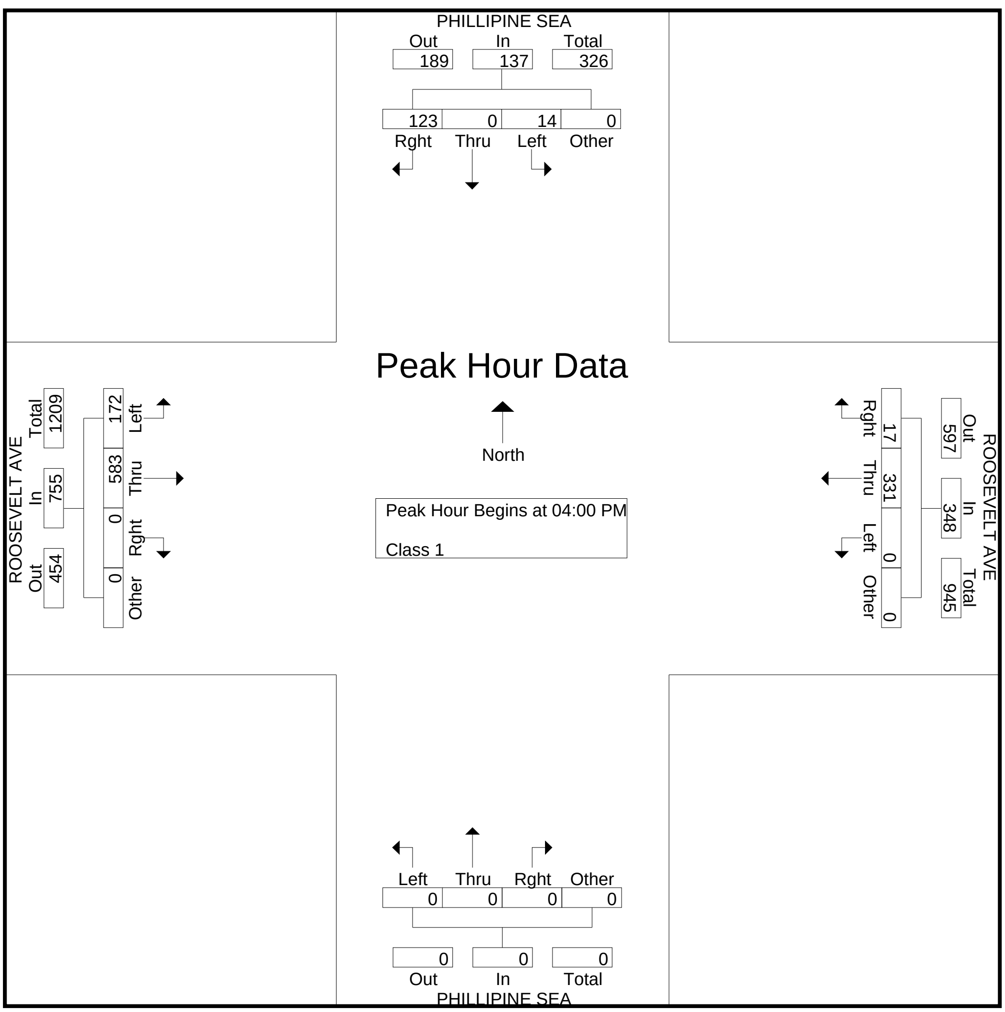
File Name : PM_Phillipine Sea - Roosevelt Ave
Site Code : 00000000
Start Date : 9/3/2014

	PHILLIPINE SEA From North					ROOSEVELT AVE From East					PHILLIPINE SEA From South					ROOSEVELT AVE From West					
Start Time	Rght	Thru	Left	Other	App. Total	Rght	Thru	Left	Other	App. Total	Rght	Thru	Left	Other	App. Total	Rght	Thru	Left	Other	App. Total	Int. Total
Peak Hour Analysis From 04:00 PM to 04:45 PM - Peak 1 of 1																					
Peak Hour for Entire Intersection Begins at 04:00 PM																					
04:00 PM	25	0	0	0	25	3	85	0	0	88	0	0	0	0	0	0	137	44	0	181	294
04:15 PM	37	0	5	0	42	6	86	0	0	92	0	0	0	0	0	0	149	43	0	192	326
04:30 PM	38	0	5	0	43	5	91	0	0	96	0	0	0	0	0	0	136	41	0	177	316
04:45 PM	23	0	4	0	27	3	69	0	0	72	0	0	0	0	0	0	161	44	0	205	304
Total Volume	123	0	14	0	137	17	331	0	0	348	0	0	0	0	0	0	583	172	0	755	1240
% App. Total	89.8	0	10.2	0		4.9	95.1	0	0		0	0	0	0		0	77.2	22.8	0		
PHF	.809	.000	.700	.000	.797	.708	.909	.000	.000	.906	.000	.000	.000	.000	.000	.000	.905	.977	.000	.921	.951



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File Name : PM_Renton Rd - Kapolei Pkwy
Site Code : 00000000
Start Date : 9/3/2014
Page No : 1

Groups Printed- Unshifted

	RENTON RD From North				KAPOLEI PKWY From East				RENTON RD From South				KAPOLEI PKWY From West					
Start Time	Right	Thru	Left	Peds	Right	Thru	Left	Peds	Right	Thru	Left	Peds	Right	Thru	Left	U-Turns	Peds	Int. Total
03:30 PM	35	16	43	1	41	121	4	0	10	19	11	1	12	141	34	0	0	489
03:45 PM	36	15	41	0	44	108	2	0	11	28	12	0	13	126	38	0	0	474
Total	71	31	84	1	85	229	6	0	21	47	23	1	25	267	72	0	0	963
04:00 PM	51	16	45	3	25	101	12	0	12	30	18	0	8	125	47	0	0	493
04:15 PM	36	20	37	2	28	98	9	0	13	22	14	0	13	136	38	0	0	466
04:30 PM	46	16	39	0	22	97	6	0	12	28	9	0	14	153	48	0	0	490
04:45 PM	33	10	37	5	35	86	5	1	19	19	16	4	13	171	51	1	0	506
Total	166	62	158	10	110	382	32	1	56	99	57	4	48	585	184	1	0	1955
05:00 PM	37	15	35	1	22	87	4	1	11	24	11	0	12	187	33	0	0	480
05:15 PM	41	24	36	1	30	91	9	0	10	35	10	0	12	136	29	1	0	465
Grand Total	315	132	313	13	247	789	51	2	98	205	101	5	97	1175	318	2	0	3863
Apprch %	40.8	17.1	40.5	1.7	22.7	72.5	4.7	0.2	24	50.1	24.7	1.2	6.1	73.8	20	0.1	0	
Total %	8.2	3.4	8.1	0.3	6.4	20.4	1.3	0.1	2.5	5.3	2.6	0.1	2.5	30.4	8.2	0.1	0	

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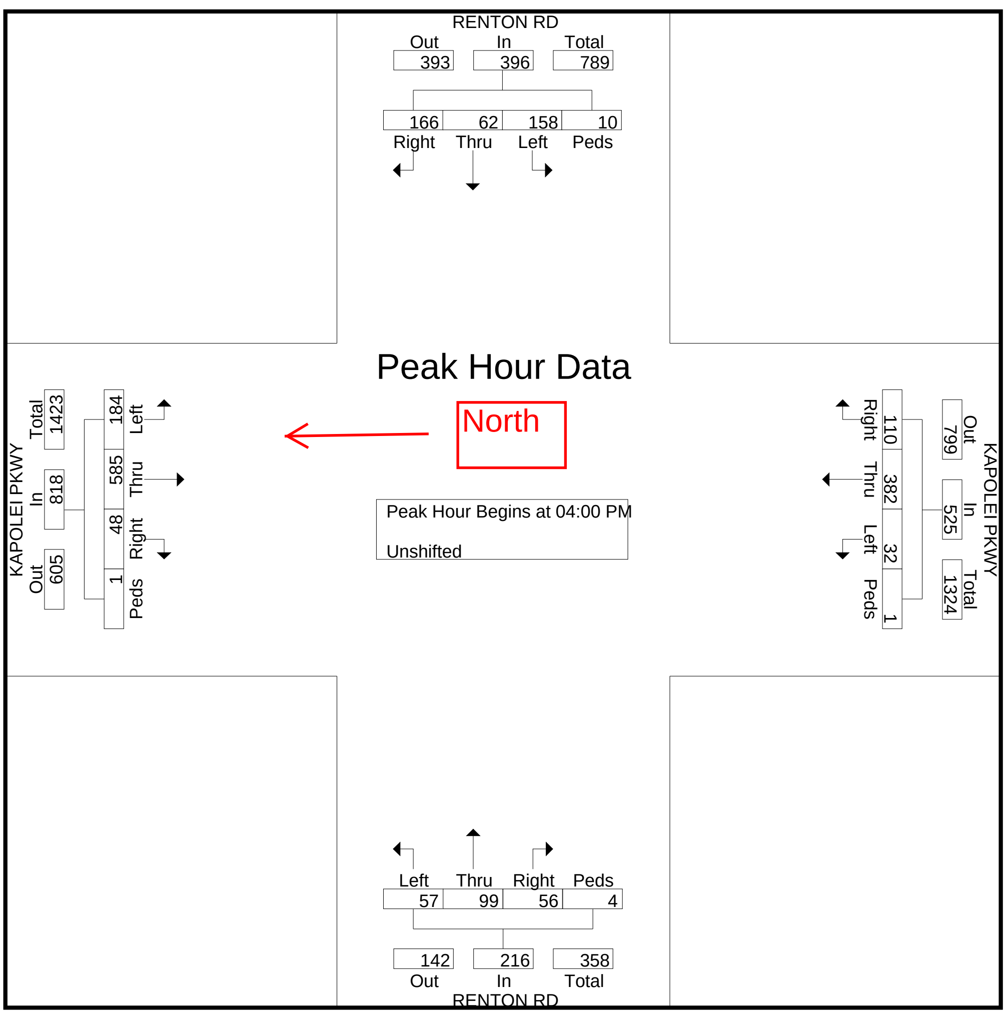
File Name : PM_Renton Rd - Kapolei Pkwy
Site Code : 00000000
Start Date : 9/3/2014

Peak Hour Analysis From 04:00 PM to 04:45 PM - Peak 1 of 1
Peak Hour for Entire Intersection Begins at 04:00 PM

	RENTON RD From North					KAPOLEI PKWY From East					RENTON RD From South					KAPOLEI PKWY From West						
Start Time	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	U-Turns	Peds	App. Total	Int. Total
04:00 PM	51	16	45	3	115	25	101	12	0	138	12	30	18	0	60	8	125	47	0	0	180	493
04:15 PM	36	20	37	2	95	28	98	9	0	135	13	22	14	0	49	13	136	38	0	0	187	466
04:30 PM	46	16	39	0	101	22	97	6	0	125	12	28	9	0	49	14	153	48	0	0	215	490
04:45 PM	33	10	37	5	85	35	86	5	1	127	19	19	16	4	58	13	171	51	1	0	236	506
Total Volume	166	62	158	10	396	110	382	32	1	525	56	99	57	4	216	48	585	184	1	0	818	1955
% App. Total	41.9	15.7	39.9	2.5		21	72.8	6.1	0.2		25.9	45.8	26.4	1.9		5.9	71.5	22.5	0.1	0		
PHF	.814	.775	.878	.500	.861	.786	.946	.667	.250	.951	.737	.825	.792	.250	.900	.857	.855	.902	.250	.000	.867	.966



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File Name : PM_WWTP Dwy #1 - Geiger Rd
Site Code : 00000000
Start Date : 9/3/2014

Groups Printed- Class 1

	WWTP DWY #1 From North				GEIGER RD From East				From South				GEIGER RD From West				
Start Time	Rght	Thru	Left	Other	Rght	Thru	Left	Other	Rght	Thru	Left	Other	Rght	Thru	Left	Other	Int. Total
03:30 PM	0	0	0	0	0	101	3	0	3	0	1	0	1	129	0	0	238
03:45 PM	1	0	0	0	0	96	5	0	5	0	0	0	0	137	0	0	244
Total	1	0	0	0	0	197	8	0	8	0	1	0	1	266	0	0	482
04:00 PM	0	0	0	0	0	71	1	0	2	0	0	0	0	138	0	0	212
04:15 PM	0	0	0	0	0	95	0	0	0	0	0	0	0	165	0	0	260
04:30 PM	0	0	0	0	0	93	0	0	0	0	0	0	0	156	0	0	249
04:45 PM	0	0	0	0	1	93	0	0	0	0	0	0	0	158	1	0	253
Total	0	0	0	0	1	352	1	0	2	0	0	0	0	617	1	0	974
05:00 PM	2	0	0	0	1	69	0	0	0	0	0	0	0	169	0	0	241
05:15 PM	1	0	0	0	0	75	0	0	1	0	0	0	0	167	0	0	244
Grand Total	4	0	0	0	2	693	9	0	11	0	1	0	1	1219	1	0	1941
Apprch %	100	0	0	0	0.3	98.4	1.3	0	91.7	0	8.3	0	0.1	99.8	0.1	0	
Total %	0.2	0	0	0	0.1	35.7	0.5	0	0.6	0	0.1	0	0.1	62.8	0.1	0	

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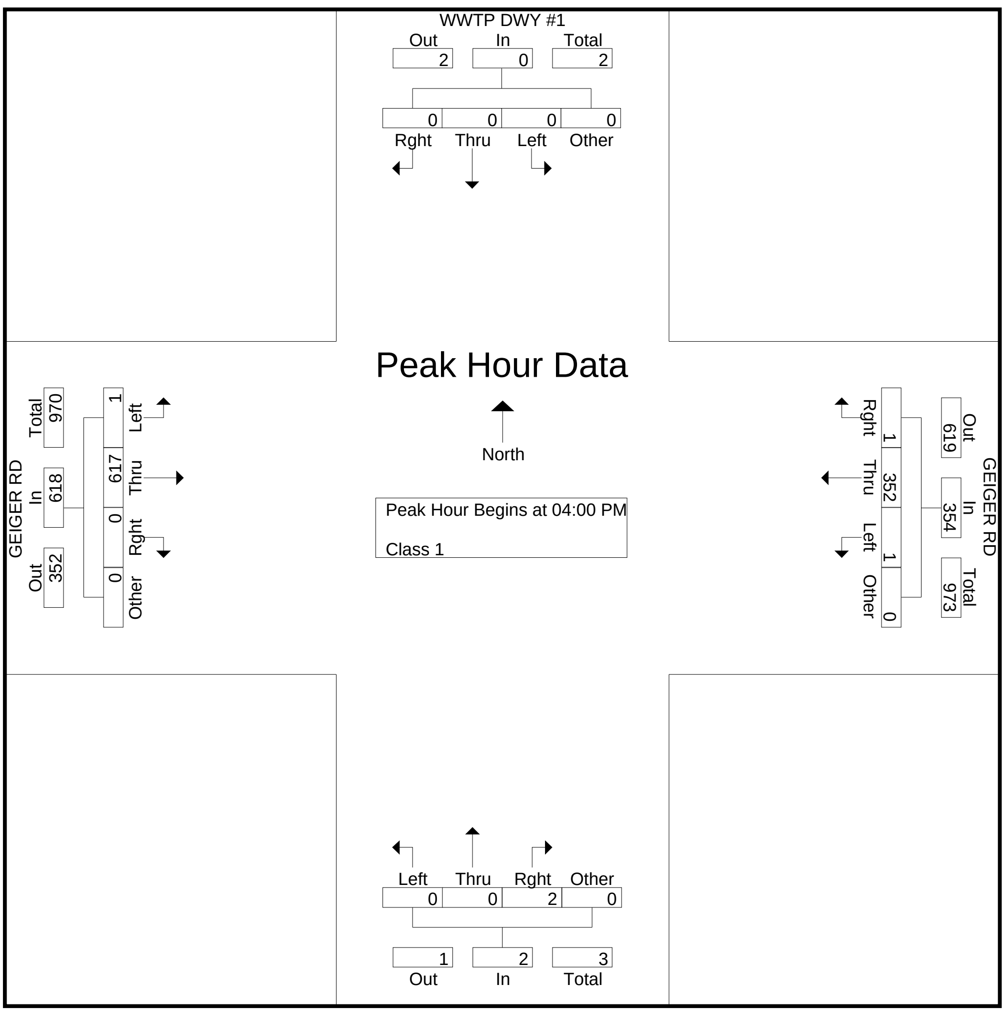
File Name : PM_WWTP Dwy #1 - Geiger Rd
Site Code : 00000000
Start Date : 9/3/2014
Page No : 2

	WWTP DWY #1 From North					GEIGER RD From East					From South					GEIGER RD From West					
Start Time	Rght	Thru	Left	Other	App. Total	Rght	Thru	Left	Other	App. Total	Rght	Thru	Left	Other	App. Total	Rght	Thru	Left	Other	App. Total	Int. Total
Peak Hour Analysis From 04:00 PM to 04:45 PM - Peak 1 of 1																					
Peak Hour for Entire Intersection Begins at 04:00 PM																					
04:00 PM	0	0	0	0	0	0	71	1	0	72	2	0	0	0	2	0	138	0	0	138	212
04:15 PM	0	0	0	0	0	0	95	0	0	95	0	0	0	0	0	0	165	0	0	165	260
04:30 PM	0	0	0	0	0	0	93	0	0	93	0	0	0	0	0	0	156	0	0	156	249
04:45 PM	0	0	0	0	0	1	93	0	0	94	0	0	0	0	0	0	158	1	0	159	253
Total Volume	0	0	0	0	0	1	352	1	0	354	2	0	0	0	2	0	617	1	0	618	974
% App. Total	0	0	0	0		0.3	99.4	0.3	0		100	0	0	0		0	99.8	0.2	0		
PHF	.000	.000	.000	.000	.000	.250	.926	.250	.000	.932	.250	.000	.000	.000	.250	.000	.935	.250	.000	.936	.937



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File Name : PM_WWTP Dwy #2 - Geiger Rd
Site Code : 00000000
Start Date : 9/3/2014
Page No : 1

Groups Printed- Class 1

	WWTP DWY #2 From North				GEIGER RD From East				From South				GEIGER RD From West				
Start Time	Rght	Thru	Left	Other	Rght	Thru	Left	Other	Rght	Thru	Left	Other	Rght	Thru	Left	Other	Int. Total
03:30 PM	0	0	6	0	0	94	0	0	0	0	0	0	0	132	0	0	232
03:45 PM	1	0	0	0	0	75	0	0	0	0	0	0	0	139	2	0	217
Total	1	0	6	0	0	169	0	0	0	0	0	0	0	271	2	0	449
04:00 PM	0	0	6	0	1	96	0	0	0	0	0	0	0	161	0	0	264
04:15 PM	1	0	2	0	1	94	0	0	0	0	0	0	0	157	0	0	255
04:30 PM	1	0	2	0	0	91	0	0	0	0	0	0	0	158	0	0	252
04:45 PM	0	0	0	0	0	73	0	0	0	0	0	0	0	168	0	0	241
Total	2	0	10	0	2	354	0	0	0	0	0	0	0	644	0	0	1012
05:00 PM	0	0	2	0	0	78	0	0	0	0	0	0	0	170	1	0	251
05:15 PM	2	0	0	0	0	71	0	0	0	0	0	0	0	145	1	0	219
Grand Total	5	0	18	0	2	672	0	0	0	0	0	0	0	1230	4	0	1931
Apprch %	21.7	0	78.3	0	0.3	99.7	0	0	0	0	0	0	0	99.7	0.3	0	
Total %	0.3	0	0.9	0	0.1	34.8	0	0	0	0	0	0	0	63.7	0.2	0	

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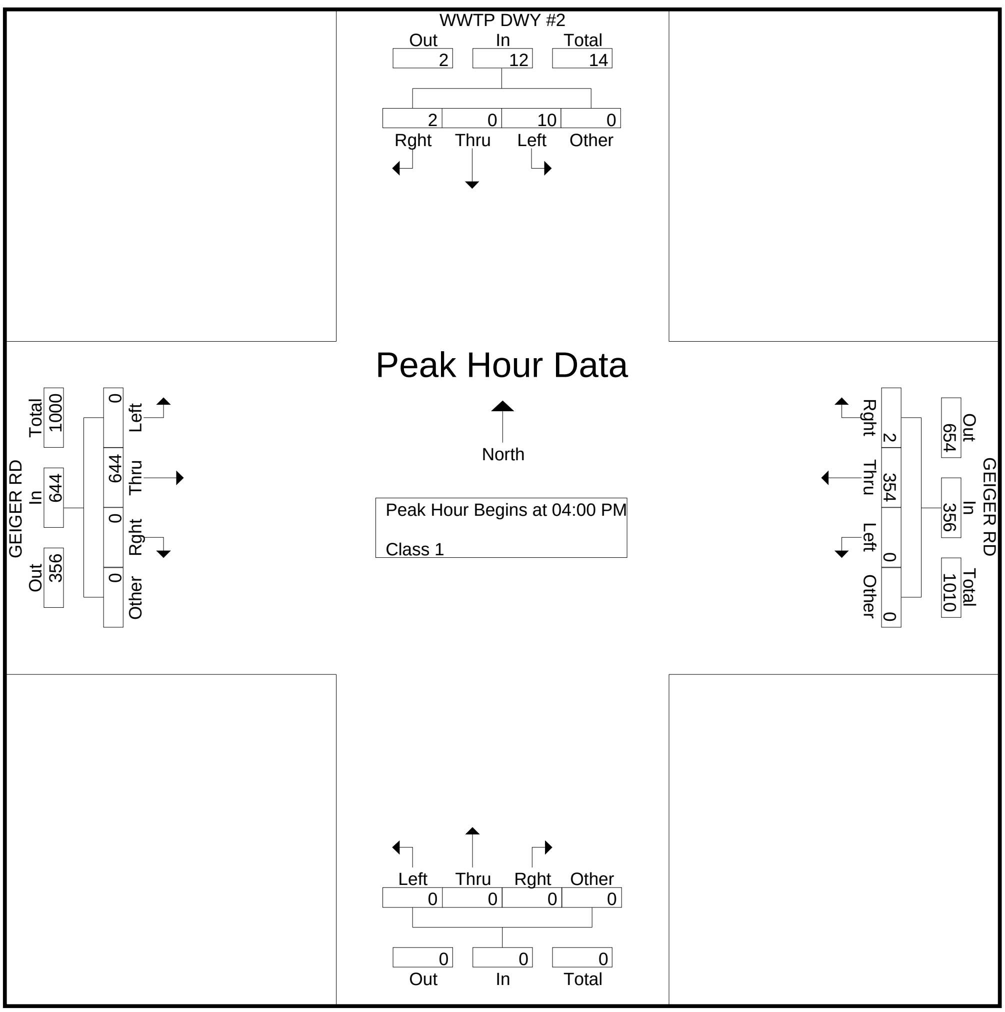
File Name : PM_WWTP Dwy #2 - Geiger Rd
Site Code : 00000000
Start Date : 9/3/2014

	WWTP DWY #2 From North					GEIGER RD From East					From South					GEIGER RD From West					
Start Time	Rght	Thru	Left	Other	App. Total	Rght	Thru	Left	Other	App. Total	Rght	Thru	Left	Other	App. Total	Rght	Thru	Left	Other	App. Total	Int. Total
Peak Hour Analysis From 04:00 PM to 04:45 PM - Peak 1 of 1																					
Peak Hour for Entire Intersection Begins at 04:00 PM																					
04:00 PM	0	0	6	0	6	1	96	0	0	97	0	0	0	0	0	0	161	0	0	161	264
04:15 PM	1	0	2	0	3	1	94	0	0	95	0	0	0	0	0	0	157	0	0	157	255
04:30 PM	1	0	2	0	3	0	91	0	0	91	0	0	0	0	0	0	158	0	0	158	252
04:45 PM	0	0	0	0	0	0	73	0	0	73	0	0	0	0	0	0	168	0	0	168	241
Total Volume	2	0	10	0	12	2	354	0	0	356	0	0	0	0	0	0	644	0	0	644	1012
% App. Total	16.7	0	83.3	0		0.6	99.4	0	0		0	0	0	0		0	100	0	0		
PHF	.500	.000	.417	.000	.500	.500	.922	.000	.000	.918	.000	.000	.000	.000	.000	.000	.958	.000	.000	.958	.958



Austin Tsutsumi & Associates

501 Sumner Street, Suite 521
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Phone: (808) 533-3646   Fax: (808) 526-1267

File Name : PM_WWTP Dwy #3 - Geiger Rd
Site Code : 00000000
Start Date : 9/3/2014

Groups Printed- Class 1

	WWTP DWY #3 From North				GEIGER RD From East				From South				GEIGER RD From West				
Start Time	Rght	Thru	Left	Other	Rght	Thru	Left	Other	Rght	Thru	Left	Other	Rght	Thru	Left	Other	Int. Total
03:30 PM	7	0	10	0	4	93	0	0	0	0	0	0	0	125	7	0	246
03:45 PM	6	0	1	0	5	70	0	0	0	0	0	0	0	137	3	0	222
Total	13	0	11	0	9	163	0	0	0	0	0	0	0	262	10	0	468
04:00 PM	3	0	3	0	5	91	0	0	0	0	0	0	0	159	1	0	262
04:15 PM	2	0	4	0	4	87	0	0	0	0	0	0	0	151	2	0	250
04:30 PM	5	0	6	0	5	89	0	0	0	0	0	0	0	154	4	0	263
04:45 PM	2	0	6	0	5	69	0	0	0	0	0	0	0	164	3	0	249
Total	12	0	19	0	19	336	0	0	0	0	0	0	0	628	10	0	1024
05:00 PM	4	0	3	0	4	71	0	0	0	0	0	0	0	168	1	0	251
05:15 PM	1	0	3	0	4	71	0	0	0	0	0	0	0	143	3	0	225
Grand Total	30	0	36	0	36	641	0	0	0	0	0	0	0	1201	24	0	1968
Apprch %	45.5	0	54.5	0	5.3	94.7	0	0	0	0	0	0	0	98	2	0	
Total %	1.5	0	1.8	0	1.8	32.6	0	0	0	0	0	0	0	61	1.2	0	

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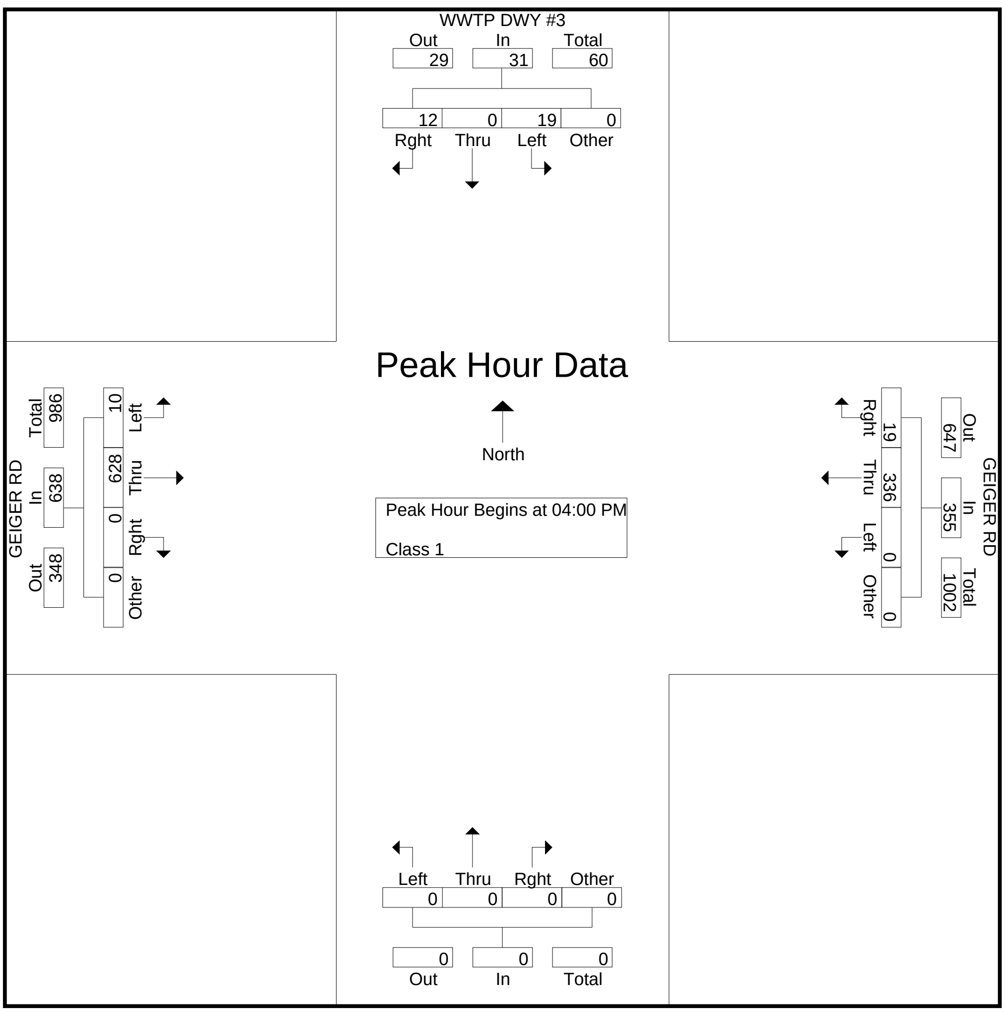
File Name : PM_WWTP Dwy #3 - Geiger Rd
Site Code : 00000000
Start Date : 9/3/2014

	WWTP DWY #3 From North					GEIGER RD From East					From South					GEIGER RD From West					
Start Time	Rght	Thru	Left	Other	App. Total	Rght	Thru	Left	Other	App. Total	Rght	Thru	Left	Other	App. Total	Rght	Thru	Left	Other	App. Total	Int. Total
Peak Hour Analysis From 04:00 PM to 04:45 PM - Peak 1 of 1																					
Peak Hour for Entire Intersection Begins at 04:00 PM																					
04:00 PM	3	0	3	0	6	5	91	0	0	96	0	0	0	0	0	0	159	1	0	160	262
04:15 PM	2	0	4	0	6	4	87	0	0	91	0	0	0	0	0	0	151	2	0	153	250
04:30 PM	5	0	6	0	11	5	89	0	0	94	0	0	0	0	0	0	154	4	0	158	263
04:45 PM	2	0	6	0	8	5	69	0	0	74	0	0	0	0	0	0	164	3	0	167	249
Total Volume	12	0	19	0	31	19	336	0	0	355	0	0	0	0	0	0	628	10	0	638	1024
% App. Total	38.7	0	61.3	0		5.4	94.6	0	0		0	0	0	0		0	98.4	1.6	0		
PHF	.600	.000	.792	.000	.705	.950	.923	.000	.000	.924	.000	.000	.000	.000	.000	.000	.957	.625	.000	.955	.973



APPENDIX B

Level of Service Criteria

APPENDIX B – LEVEL OF SERVICE (LOS) CRITERIA

VEHICULAR LEVEL OF SERVICE FOR SIGNALIZED INTERSECTIONS (HCM 2010)

Level of service for vehicles at signalized intersections is directly related to delay values and is assigned on that basis. Level of Service is a measure of the acceptability of delay values to motorists at a given intersection. The criteria are given in the table below.

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 is dependent 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 or approach in question.

VEHICULAR LEVEL OF SERVICE CRITERIA FOR UNSIGNALIZED INTERSECTIONS (HCM 2010)

The level of service criteria for vehicles at unsignalized intersections is defined as the average control delay, in seconds per vehicle.

LOS delay threshold values are lower for two-way stop-controlled (TWSC) and all-way stop-controlled (AWSC) intersections than those of signalized intersections. This is because more vehicles pass through signalized intersections, and therefore, drivers expect and tolerate greater delays. While the criteria for level of service for TWSC and AWSC intersections are the same, procedures to calculate the average total delay may differ.

Level of Service Criteria for Two-Way Stop-Controlled Intersections

Level of Service	Average Control Delay (sec/veh)
A	≤ 10
B	>10 and ≤15
C	>15 and ≤25
D	>25 and ≤35
E	>35 and ≤50
F	> 50

APPENDIX C

Full Level of Service Table

Table C1: Existing, Base Year 2021 (no mit), Future Year 2021 (no mit), Base Year 2030 (no mit), Base Year 2030 (with mit) and Future Year 2030 (no mit) Intersection Level of Service Summary

Intersection	Existing Conditions						BY 2021 (No Mit)						FY 2021 (No Mit)					
	AM			PM			AM			PM			AM			PM		
Intersection	HCM Delay	v/c Ratio	LOS	HCM Delay	v/c Ratio	LOS	HCM Delay	v/c Ratio	LOS	HCM Delay	v/c Ratio	LOS	HCM Delay	v/c Ratio	LOS	HCM Delay	v/c Ratio	LOS
1: Kapolei Pkwy & Kualakai Pkwy																		
EB LT	21.8	0.66	C	21.9	0.64	C	37.0	0.84	D	57.4	0.91	E	37.4	0.84	D	58.1	0.91	E
EB TH	3.7	0.12	A	5.8	0.18	A	16.7	0.24	B	31.4	0.38	C	17.1	0.25	B	31.3	0.38	C
EB RT	-	-	-	-	-	-	16.8	0.24	B	31.6	0.38	C	17.2	0.25	B	31.4	0.38	C
WB LT	-	-	-	-	-	-	46.1	0.61	D	62.6	0.78	E	46.6	0.61	D	63.1	0.78	E
WB TH	12.3	0.36	B	12.8	0.26	B	30.3	0.56	C	47.2	0.44	D	30.8	0.57	C	47.4	0.45	D
WB RT	7.9	0.28	A	6.3	0.19	A	19.8	0.44	B	28.3	0.45	C	19.7	0.44	B	28.4	0.46	C
NB LT	-	-	-	-	-	-	88.5	0.54	F	76.5	0.77	E	89.1	0.54	F	77.0	0.77	E
NB TH	-	-	-	-	-	-	41.3	0.29	D	56.2	0.71	E	41.7	0.29	D	57.0	0.72	E
NB TH/RT							41.2	0.29	D	56.2	0.71	E	41.7	0.29	D	57.0	0.72	E
SB LT	21.3	0.41	C	16.9	0.55	B	42.8	0.82	D	63.2	0.91	E	43.8	0.82	D	64.0	0.91	E
SB TH	-	-	-	-	-	-	28.7	0.15	C	33.4	0.33	C	28.5	0.15	C	33.9	0.33	C
SB RT	14.4	0.28	B	12.6	0.40	B	14.7	0.21	B	13.3	0.27	B	14.6	0.21	B	13.6	0.27	B
Overall	12.5	-	B	12.2	-	B	29.1	-	C	44.4	-	D	29.5	-	C	44.8	-	D
2: Kapolei Pkwy & Renton Rd																		
EB LT	26.5	0.07	C	17.5	0.14	B	34.8	0.10	C	26.8	0.19	C	36.7	0.10	D	27.8	0.26	C
EB TH/RT	23.9	0.14	C	17.1	0.31	B	30.1	0.16	C	26.1	0.37	C	30.2	0.16	C	26.9	0.42	C
WB LT	36.6	0.73	D	22.1	0.46	C	49.2	0.78	D	36.3	0.61	D	49.2	0.78	D	38.9	0.61	D
WB TH	24.4	0.21	C	16.0	0.13	B	31.2	0.25	C	24.0	0.14	C	32.1	0.33	C	23.9	0.14	C
WB RT	24.1	0.17	C	15.7	0.08	B	30.5	0.19	C	23.9	0.13	C	30.5	0.19	C	23.9	0.13	C
NB LT	62.9	0.77	E	40.7	0.66	D	73.2	0.77	E	67.6	0.79	E	73.4	0.77	E	72.2	0.79	E
NB TH	25.3	0.60	C	17.0	0.34	B	40.2	0.82	D	28.5	0.65	C	40.4	0.83	D	34.8	0.70	C
NB TH/RT	25.9	0.61	C	17.2	0.35	B	44.6	0.82	D	29.3	0.65	C	44.9	0.83	D	36.9	0.71	C
SB LT	45.2	0.85	D	28.5	0.77	C	60.7	0.90	E	51.9	0.90	D	61.0	0.90	E	44.8	0.89	D
SB TH	13.9	0.14	B	12.5	0.34	B	17.1	0.24	B	16.0	0.49	B	17.3	0.25	B	18.9	0.51	B
SB TH/RT	14.0	0.14	B	12.7	0.34	B	17.2	0.24	B	16.2	0.49	B	17.4	0.25	B	19.2	0.51	B
Overall	27.9	-	C	17.5	-	B	38.7	-	D	26.8	-	C	38.7	-	D	29.5	-	C
3: Phillipine Sea & Renton Rd																		
EB TH/RT	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
WB LT/TH	7.5	0.12	A	7.5	0.09	A	7.6	0.13	A	7.5	0.09	A	7.6	0.13	A	7.5	0.10	A
NB LT/RT	8.7	0.08	A	9.3	0.21	A	9.0	0.10	A	9.3	0.21	A	9.0	0.10	A	9.5	0.23	A
4: Phillipine Sea & Roosevelt Ave																		
EB LT/TH/RT	8.9	0.07	A	8.6	0.16	A	9.5	0.09	A	8.6	0.16	A	9.5	0.09	A	9.1	0.19	A
WB LT/TH/RT	0.0	-	A	0.0	-	A	0.0	-	A	0.0	-	A	0.0	-	A	0.0	-	A
NB LT/TH/RT	0.0	-	A	0.0	-	A	0.0	-	A	0.0	-	A	0.0	-	A	0.0	-	A
SB LT/TH/RT	18.0	0.41	C	18.0	0.35	C	26.6	0.57	D	18.0	0.35	C	26.7	0.57	D	34.4	0.59	D
5: Essex Rd & Roosevelt Ave/Geiger Rd																		
EB TH/RT	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
WB LT	7.9	0.02	A	9.0	0.01	A	8.0	0.02	A	9.0	0.01	A	8.0	0.02	A	9.5	0.02	A
WB TH	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
NB LT/RT	14.4	0.03	B	16.3	0.09	C	18.2	0.06	C	16.3	0.09	C	18.8	0.06	C	20.2	0.12	C
6: Geiger Rd & Ewa Refuse Convenience Center																		
EB LT/TH/RT	0.0	-	A	8.1	0.00	A	0.0	-	A	8.1	0.00	A	0.0	-	A	8.3	0.01	A
WB LT/TH/RT	7.9	0.01	A	8.9	0.00	A	0.0	-	A	8.9	0.00	A	0.0	-	A	0.0	-	A
NB LT/TH/RT	11.8	0.04	B	12.9	0.01	B	0.0	-	A	12.9	0.01	B	0.0	-	A	0.0	-	A
SB LT/TH/RT	0.0	-	A	0.0	-	A	0.0	-	A	0.0	-	A	0.0	-	A	0.0	-	A
7: Geiger Rd & Honouliuli Drwy 1																		
EB LT	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
EB LT/TH	0.0	-	A	0.0	-	A	0.0	-	A	0.0	-	A	9.5	0.01	A	0.0	-	A
WB TH/RT	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SB LT/RT	14.6	0.04	B	19.2	0.05	C	18.1	0.07	C	19.2	0.05	C	19.1	0.08	C	27.6	0.19	D
8: Geiger Rd & Honouliuli Drwy 2																		
EB LT	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
EB LT/TH/RT	8.8	0.00	A	8.1	0.01	A	9.3	0.01	A	8.1	0.01	A	9.7	0.01	A	8.3	0.01	A
WB LT/TH/RT	0.0	-	A	0.0	-	A	0.0	-	A	0.0	-	A	0.0	-	A	0.0	-	A
NB LT/TH/RT	0.0	-	A	0.0	-	A	0.0	-	A	0.0	-	A	0.0	-	A	0.0	-	A
SB LT/TH/RT	15.8	0.04	C	20.4	0.13	C	18.1	0.06	C	20.4	0.13	C	19.8	0.06	C	41.9	0.45	E
9: Kapolei Pkwy & Geiger Rd																		
EB LT	67.8	0.56	E	56.4	0.78	E	87.1	0.61	F	73.6	0.77	E	90.5	0.61	F	76.7	0.77	E
EB TH	35.2	0.35	D	30.5	0.63	C	47.1	0.31	D	46.5	0.75	D	44.9	0.25	D	50.2	0.81	D
EB TH/RT	35.2	0.36	D	31.1	0.66	C	47.2	0.32	D	47.5	0.77	D	45.0	0.26	D	53.8	0.85	D
EB RT	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
WB LT	46.9	0.77	D	42.2	0.78	D	67.9	0.80	E	71.9	0.86	E	67.8	0.80	E	77.3	0.86	E
WB TH	35.6	0.73	D	23.7	0.32	C	52.3	0.84	D	34.7	0.42	C	54.1	0.86	D	33.9	0.39	C
WB RT	29.4	0.15	C	22.4	0.14	C	39.5	0.13	D	31.3	0.13	C	38.5	0.21	D	30.9	0.14	C
NB LT	36.3	0.88	D	38.5	0.81	D	61.5	0.93	E	65.7	0.88	E	67.7	0.94	E	70.7	0.89	E
NB TH	18.2	0.53	B	23.3	0.41	C	24.5	0.66	C	35.0	0.64	C	29.2	0.70	C	38.5	0.67	D
NB RT	14.6	0.10	B	20.7	0.04	C	17.7	0.14	B	27.0	0.06	C	20.7	0.15	C	29.5	0.06	C
SB LT	42.2	0.79	D	40.1	0.79	D	66.6	0.86	E	62.0	0.86	E	67.8	0.86	E	66.1	0.86	E
SB TH	24.5	0.52	C	26.7	0.60	C	35.1	0.67	D	46.1	0.87	D	45.7	0.80	D	53.2	0.91	D
SB RT	20.5	0.01	C	22.1	0.01	C	26.8	0.02	C	28.3	0.02	C	32.8	0.03	C	30.9	0.02	C
Overall	27.9	-	C	30.3	-	C	39.5	-	D	46.3	-	D	45.2	-	D	51.0	-	D

Intersection	FY 2021 (WITH Mit)						BY 2030 (No Mit)					
	AM			PM			AM			PM		
Intersection	HCM Delay	v/c Ratio	LOS	HCM Delay	v/c Ratio	LOS	HCM Delay	v/c Ratio	LOS	HCM Delay	v/c Ratio	LOS
1: Kapolei Pkwy & Kualakai Pkwy												
EB LT							41.3	0.86	D	59.7	0.92	E
EB TH							18.1	0.32	B	31.5	0.40	C
EB RT							18.2	0.32	B	31.6	0.40	C
WB LT							50.5	0.63	D	70.7	0.80	E
WB TH							34.6	0.67	C	53.4	0.49	D
WB RT							22.0	0.48	C	34.1	0.50	C
NB LT							93.3	0.54	F	84.9	0.77	F
NB TH							44.8	0.33	D	65.3	0.77	E
NB TH/RT							44.7	0.34	D	65.3	0.78	E
SB LT							48.9	0.84	D	76.1	0.93	E
SB TH							30.6	0.17	C	40.6	0.37	D
SB RT							14.8	0.23	B	13.8	0.26	B
Overall							31.8	-	C	49.4	-	D
2: Kapolei Pkwy & Renton Rd												
EB LT							37.1	0.11	D	31.5	0.23	C
EB TH/RT							30.7	0.17	C	31.0	0.45	C
WB LT							53.9	0.81	D	56.0	0.77	E
WB TH							32.5	0.31	C	27.6	0.15	C
WB RT							33.1	0.35	C	27.7	0.16	C
NB LT							73.5	0.77	E	73.9	0.78	E
NB TH							59.5	0.97	E	34.3	0.67	C
NB TH/RT							71.3	0.97	E	35.7	0.68	C
SB LT							65.0	0.90	E	66.4	0.92	E
SB TH							19.2	0.27	B	19.1	0.52	B
SB TH/RT							19.3	0.27	B	19.3	0.52	B
Overall							50.1	-	D	33.1	-	C
3: Phillipine Sea & Renton Rd												
EB TH/RT							-	-	-	-	-	-
WB LT/TH							7.6	0.15	A	7.5	0.11	A
NB LT/RT							9.0	0.11	A	9.6	0.25	A
4: Phillipine Sea & Roosevelt Ave												
EB LT/TH/RT							10.2	0.11	B	9.2	0.21	A
WB LT/TH/RT							0.0	-	A	0.0	-	A
NB LT/TH/RT							0.0	-	A	0.0	-	A
SB LT/TH/RT							43.8	0.74	E	41.9	0.67	E
5: Essex Rd & Roosevelt Ave/Geiger Rd												
EB TH/RT							-	-	-	-	-	-
WB LT							8.0	0.02	A	9.6	0.02	A
WB TH							-	-	-	-	-	-
NB LT/RT							21.2	0.07	C	20.1	0.14	C
6: Geiger Rd & Ewa Refuse Convenience Center												
EB LT/TH/RT							0.0	-	A	8.4	0.01	A
WB LT/TH/RT							0.0	-	A	0.0	-	A
NB LT/TH/RT							0.0	-	A	0.0	-	A
SB LT/TH/RT							0.0	-	A	0.0	-	A
7: Geiger Rd & Honouliuli Drwy 1												
EB LT	10	0	A	0.0	-	A	-	-	-	-	-	-
EB LT/TH	-	-	-	-	-	-	0.0	-	A	0.0	-	A
WB TH/RT	-	-	-	-	-	-	-	-	-	-	-	-
SB LT/RT	19.0	0.1	C	27.6	0.2	D	21.7	0.09	C	22.4	0.07	C
8: Geiger Rd & Honouliuli Drwy 2												
EB LT	10	0	A	8	0	A	-	-	-	-	-	-
EB LT/TH/RT	-	-	-	-	-	-	9.9	0.01	A	8.4	0.01	A
WB LT/TH/RT	0.0	-	A	0.0	-	A	0.0	-	A	0.0	-	A
NB LT/TH/RT	0.0	-	A	0.0	-	A	0.0	-	A	0.0	-	A
SB LT/TH/RT	19.8	0.1	C	41.6	0.4	E	21.6	0.07	C	27.3	0.19	D
9: Kapolei Pkwy & Geiger Rd												
EB LT							99.4	0.62	F	77.6	0.77	E
EB TH							52.5	0.28	D	52.4	0.81	D
EB TH/RT							52.5	0.29	D	54.2	0.83	D
EB RT							-	-	-	-	-	-
WB LT							86.9	0.83	F	87.3	0.90	F
WB TH							68.2	0.89	E	35.4	0.41	D
WB RT							44.9	0.23	D	32.2	0.15	C
NB LT							97.9	1.03	F*	73.4	0.89	E
NB TH							34.4	0.81	C	41.7	0.74	D
NB RT							21.6	0.23	C	30.2	0.06	C
SB LT							86.3	0.89	F	70.9	0.88	E
SB TH							46.2	0.78	D	61.6	0.96	E
SB RT							32.8	0.03	C	30.9	0.02	C
Overall							53.3	-	D	55.9	-	E

Intersection	BY 2030 (WITH Mit)						FY 2030 (No Mit)					
	AM			PM			AM			PM		
Intersection	HCM Delay	v/c Ratio	LOS	HCM Delay	v/c Ratio	LOS	HCM Delay	v/c Ratio	LOS	HCM Delay	v/c Ratio	LOS
1: Kapolei Pkwy & Kualakai Pkwy												
EB LT							42.6	0.86	D	72.6	0.96	E
EB TH							18.4	0.32	B	33.5	0.43	C
EB RT							18.5	0.32	B	33.7	0.43	C
WB LT							51.7	0.63	D	72.7	0.81	E
WB TH							35.4	0.69	D	54.6	0.52	D
WB RT							22.1	0.49	C	33.7	0.51	C
NB LT							94.7	0.55	F	86.7	0.77	F
NB TH							45.9	0.34	D	65.7	0.74	E
NB TH/RT							45.9	0.34	D	65.5	0.74	E
SB LT							50.8	0.85	D	78.0	0.94	E
SB TH							31.0	0.17	C	40.1	0.36	D
SB RT							15.0	0.23	B	14.1	0.25	B
Overall							32.6	-	C	52.7	-	D
2: Kapolei Pkwy & Renton Rd												
EB LT	31.3	0.10	C	24.4	0.20	C	34.1	0.28	C	27.9	0.36	C
EB TH/RT	26.0	0.16	C	24.0	0.40	C	26.4	0.26	C	24.5	0.46	C
WB LT	42.8	0.77	D	36.1	0.64	D	51.5	0.81	D	40.1	0.66	D
WB TH	27.5	0.30	C	21.4	0.13	C	27.1	0.32	C	21.7	0.22	C
WB RT	26.9	0.24	C	21.6	0.16	C	26.2	0.24	C	21.3	0.17	C
NB LT	65.3	0.77	E	67.0	0.78	E	68.9	0.77	E	71.4	0.78	E
NB TH	36.3	0.86	D	28.6	0.64	C	44.1	0.90	D	33.9	0.68	C
NB TH/RT	42.0	0.86	D	29.8	0.65	C	52.3	0.91	D	35.7	0.69	C
SB LT	50.8	0.78	D	43.1	0.77	D	54.4	0.79	D	48.0	0.79	D
SB TH	18.7	0.28	B	21.4	0.60	C	21.7	0.31	C	26.5	0.67	C
SB TH/RT	18.8	0.29	B	21.7	0.60	C	21.9	0.31	C	27.2	0.67	C
Overall	35.1	-	D	27.6	-	C	40.3	-	D	31.6	-	C
3: Phillipine Sea & Renton Rd												
EB TH/RT							-	-	-	-	-	-
WB LT/TH							-	-	-	7.5	0.11	A
NB LT/RT							-	-	-	9.6	0.25	A
4: Phillipine Sea & Roosevelt Ave												
EB LT/TH/RT							10.3	0.11	B	9.3	0.21	A
WB LT/TH/RT							0.0	-	A	0.0	-	A
NB LT/TH/RT							0.0	-	A	0.0	-	A
SB LT/TH/RT							48.1	0.77	E	49.0	0.72	E
5: Essex Rd & Roosevelt Ave/Geiger Rd												
EB TH/RT							-	-	-	-	-	-
WB LT							8.1	0.02	A	9.8	0.02	A
WB TH							-	-	-	-	-	-
NB LT/RT							22.5	0.07	C	21.6	0.15	C
6: Geiger Rd & Ewa Refuse Convenience Center												
EB LT/TH/RT							0.0	-	A	8.5	0.01	A
WB LT/TH/RT							0.0	-	A	0.0	-	A
NB LT/TH/RT							0.0	-	A	0.0	-	A
SB LT/TH/RT							0.0	-	A	0.0	-	A
7: Geiger Rd & Honouliuli Drwy 1												
EB LT							10.1	0.01	B	8.5	0.01	A
EB LT/TH							-	-	-	-	-	-
WB TH/RT							-	-	-	-	-	-
SB LT/RT							25.7	0.18	D	36.1	0.34	E
8: Geiger Rd & Honouliuli Drwy 2												
EB LT							10.3	0.02	B	8.6	0.02	A
EB LT/TH/RT							-	-	-	-	-	-
WB LT/TH/RT							0.0	-	A	0.0	-	A
NB LT/TH/RT							0.0	-	A	0.0	-	A
SB LT/TH/RT							35.2	0.27	E	85.8	0.74	F
9: Kapolei Pkwy & Geiger Rd												
EB LT	83.7	0.60	F	74.6	0.77	E	86.5	0.60	F	78.4	0.77	E
EB TH	44.1	0.46	D	53.2	0.82	D	44.5	0.53	D	52.3	0.85	D
EB TH/RT	-	-	-	-	-	-	-	-	-	-	-	-
EB RT	40.5	0.09	D	48.3	0.70	D	39.9	0.10	D	54.6	0.86	D
WB LT	67.9	0.81	E	67.9	0.88	E	72.0	0.81	E	77.9	0.89	E
WB TH	50.0	0.85	D	34.7	0.42	C	54.1	0.87	D	32.7	0.43	C
WB RT	35.2	0.16	D	31.5	0.16	C	34.9	0.20	C	29.1	0.17	C
NB LT	53.2	0.86	D	59.4	0.77	E	49.7	0.85	D	66.2	0.82	E
NB TH	39.2	0.91	D	40.0	0.75	D	46.4	0.95	D	50.7	0.84	D
NB RT	21.1	0.24	C	28.9	0.05	C	23.1	0.24	C	34.1	0.05	C
SB LT	70.5	0.87	E	61.4	0.87	E	74.8	0.87	E	73.9	0.88	E
SB TH	30.5	0.66	C	37.9	0.80	D	35.7	0.72	D	54.4	0.92	D
SB RT	22.4	0.03	C	24.5	0.02	C	25.7	0.03	C	30.2	0.02	C
Overall	41.9	-	D	45.2	-	D	46.1	-	D	54.5	-	D

Note:
* = over-capacity, v/c > 1

Table C1: Existing, Base Year 2021 (no mit), Future Year 2021 (no mit), Base Year 2030 (no mit), Base Year 2030 (with mit) and Future Year 2030 (no mit) Intersection Level of Service Summary (continued)

Intersection	Existing Conditions						BY 2021 (No Mit)						FY 2021 (No Mit)					
	AM			PM			AM			PM			AM			PM		
	HCM Delay	v/c Ratio	LOS	HCM Delay	v/c Ratio	LOS	HCM Delay	v/c Ratio	LOS	HCM Delay	v/c Ratio	LOS	HCM Delay	v/c Ratio	LOS	HCM Delay	v/c Ratio	LOS
10: Ft Weaver Rd & Geiger Rd/Iroquois Rd																		
EB LT	107.0	0.65	F	106.7	0.65	F	107.2	0.68	F	104.6	0.65	F	107.4	0.68	F	99.7	0.62	F
EB LT/TH	101.9	0.63	F	102.5	0.65	F	101.8	0.66	F	100.0	0.65	F	101.4	0.66	F	96.7	0.62	F
EB RT	97.2	0.39	F	99.1	0.48	F	102.9	0.61	F	106.7	0.68	F	102.4	0.60	F	114.6	0.80	F
WB LT	85.3	0.18	F	90.3	0.05	F	85.0	0.19	F	86.7	0.06	F	85.3	0.19	F	87.6	0.06	F
WB TH	105.2	0.75	F	116.8	0.78	F	109.3	0.80	F	117.9	0.83	F	110.1	0.80	F	122.6	0.85	F
WB RT	85.2	0.19	F	90.4	0.06	F	85.4	0.23	F	87.5	0.12	F	85.6	0.23	F	88.5	0.12	F
NB LT	111.0	0.61	F	111.1	0.59	F	110.9	0.67	F	110.8	0.69	F	112.9	0.75	F	110.8	0.69	F
NB TH	35.9	0.53	D	33.2	0.33	C	39.0	0.56	D	38.6	0.38	D	39.1	0.56	D	39.9	0.39	D
NB RT	26.0	0.00	C	28.2	0.01	C	28.0	0.00	C	32.3	0.01	C	28.1	0.0	C	33.3	0.01	C
SB LT	77.0	0.63	E	119.0	0.80	F	82.7	0.67	F	123.1	0.80	F	82.7	0.67	F	123.7	0.80	F
SB TH	50.1	0.34	D	29.3	0.54	C	56.6	0.39	E	37.2	0.62	D	59.5	0.40	E	39.0	0.63	D
SB RT	141.5	0.08	F	32.3	0.17	C	215.0	0.10	F	36.0	0.20	D	236.8	0.10	F	37.9	0.20	D
Overall	65.2	0.60	E	57.8	0.64	E	72.6	0.63	E	64.4	0.70	E	75.2	0.65	E	66.3	0.73	E
11: Ft Weaver Rd & Renton Rd																		
EB LT	111.0	0.79	F	112.4	0.79	F	113.0	0.81	F	114.2	0.83	F	111.3	0.81	F	112.9	0.84	F
EB LT/TH	109.3	0.77	F	111.6	0.79	F	110.8	0.80	F	112.8	0.82	F	109.2	0.79	F	113.6	0.84	F
EB RT	86.5	0.16	F	86.3	0.09	F	87.6	0.27	F	87.2	0.26	F	86.9	0.26	F	84.5	0.25	F
WB LT/TH	118.6	0.34	F	121.2	0.63	F	118.9	0.39	F	122.3	0.66	F	118.9	0.39	F	122.3	0.66	F
WB RT	111.6	0.01	F	104.5	0.02	F	111.2	0.01	F	103.4	0.02	F	111.2	0.01	F	103.4	0.02	F
NB LT	120.7	0.81	F	100.3	0.70	F	124.9	0.85	F	100.3	0.74	F	125.7	0.85	F	100.5	0.74	F
NB TH	21.8	0.87	C	28.7	0.48	C	22.4	0.87	C	32.0	0.53	C	22.8	0.87	C	33.7	0.54	C
NB RT	14.9	0.01	B	40.0	0.05	D	15.4	0.02	B	41.3	0.05	D	15.6	0.02	B	44.2	0.05	D
SB LT	123.1	0.58	F	111.9	0.59	F	126.9	0.66	F	113.6	0.62	F	128.3	0.67	F	113.8	0.62	F
SB TH	31.3	0.44	C	54.6	0.95	D	37.2	0.51	D	64.5	0.99	E	37.8	0.52	D	73.1	**1.01**	E*
SB RT	45.8	0.17	D	34.6	0.21	C	56.2	0.23	E	40.3	0.27	D	58.3	0.26	E	42.4	0.27	D
Overall	39.8	0.84	D	53.9	0.88	D	44.3	0.85	D	60.5	0.90	E	44.8	0.86	D	65.5	0.92	E
12: Geiger Rd & Honouliuli Drwy 3																		
EB LT	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
EB LT/TH	-	-	-	-	-	-	-	-	-	-	-	-	9.8	0.01	A	0.0	-	A
WB TH/RT	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SB LT/RT	-	-	-	-	-	-	-	-	-	-	-	-	23.8	0.03	C	30.9	0.24	D
13: Roosevelt Ave & Honouliuli Drwy 4																		
EB LT	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
EB LT/TH	-	-	-	-	-	-	-	-	-	-	-	-	9.3	0.01	A	0.0	-	A
WB TH/RT	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SB LT/RT	-	-	-	-	-	-	-	-	-	-	-	-	0.0	-	A	21.3	0.13	C
14: Honouliuli Drwy 5 & Renton Rd																		
EB TH/RT	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
WB LT													7.5	0.06	A	7.7	0.00	A
WB TH	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
NB LT/RT	-	-	-	-	-	-	-	-	-	-	-	-	8.8	0.01	A	10.0	0.11	B

Intersection	FY 2021 (WITH Mit)						BY 2030 (No Mit)						BY 2030 (WITH Mit)						FY 2030 (No Mit)					
	AM			PM			AM			PM			AM			PM			AM			PM		
	HCM Delay	v/c Ratio	LOS	HCM Delay	v/c Ratio	LOS	HCM Delay	v/c Ratio	LOS	HCM Delay	v/c Ratio	LOS	HCM Delay	v/c Ratio	LOS	HCM Delay	v/c Ratio	LOS	HCM Delay	v/c Ratio	LOS	HCM Delay	v/c Ratio	LOS
10: Ft Weaver Rd & Geiger Rd/Iroquois Rd																								
EB LT							108.7	0.73	F	103.8	0.67	F							110.7	0.76	F	97.0	0.61	F
EB LT/TH							101.9	0.71	F	99.8	0.67	F							101.9	0.72	F	94.3	0.62	F
EB RT							106.8	0.70	F	107.7	0.72	F							112.5	0.77	F	122.9	0.88	F
WB LT							84.0	0.20	F	81.4	0.05	F							84.3	0.20	F	85.3	0.06	F
WB TH							112.4	0.83	F	121.1	0.89	F							113.7	0.84	F	150.4	0.99	F
WB RT							85.1	0.28	F	83.7	0.19	F							85.4	0.28	F	87.7	0.20	F
NB LT							110.8	0.68	F	110.4	0.72	F							112.3	0.74	F	111.2	0.75	F
NB TH							44.8	0.62	D	46.8	0.50	D							45.1	0.63	D	46.8	0.50	D
NB RT							31.1	0.01	C	36.8	0.01	D							31.3	0.01	C	36.8	0.01	D
SB LT							97.7	0.73	F	125.8	0.81	F							98.0	0.73	F	125.1	0.81	F
SB TH							63.7	0.52	E	47.4	0.78	D							65.2	0.53	E	50.0	0.79	D
SB RT							130.3	0.13	F	38.8	0.22	D							133.7	0.14	F	41.2	0.25	D
Overall							74.6	0.69	E	69.5	0.80	E							76.4	0.71	E	73.4	0.85	E
11: Ft Weaver Rd & Renton Rd																								
EB LT							113.1	0.81	F	113.6	0.81	F							107.9	0.81	F	113.6	0.85	F
EB LT/TH							111.5	0.79	F	113.3	0.81	F							110.0	0.82	F	114.3	0.85	F
EB RT							87.5	0.22	F	87.2	0.22	F							82.7	0.20	F	83.2	0.21	F
WB LT/TH							119.6	0.46	F	122.3	0.66	F							119.6	0.46	F	122.3	0.66	F
WB RT							110.5	0.01	F	103.5	0.02	F							110.5	0.01	F	103.5	0.02	F
NB LT							126.8	0.90	F	98.8	0.75	F							139.8	0.95	F	99.4	0.75	F
NB TH							23.0	0.88	C	34.6	0.61	C							27.0	0.91	C	37.7	0.64	D
NB RT							15.5	0.02	B	40.8	0.06	D							17.3	0.02	B	44.1	0.06	D
SB LT							127.5	0.68	F	115.2	0.64	F							131.7	0.71	F	115.1	0.64	F
SB TH							48.5	0.69	D	86.0	1.06	F*							51.1	0.71	D	105.5	**1.10**	F*
SB RT							63.5	0.29	E	38.6	0.27	D							68.7	0.31	E	44.0	0.32	D
Overall							49.1	0.87	D	70.4	0.95	E							53.3	0.90	D	80.9	0.98	F
12: Geiger Rd & Honouliuli Drwy 3																								
EB LT	10	0	A	0.0	-	A	-	-	-	-	-	-	-	-	-	-	-	-	10.3	0.0	B	8.6	0.0	A
EB LT/TH	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
WB TH/RT	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SB LT/RT	23.7	0.0	C	30.9	0.2	D	-	-	-	-	-	-	-	-	-	-	-	-	30.2	0.16	D	50.8	0.44	F
13: Roosevelt Ave & Honouliuli Drwy 4																								
EB LT	9	0	A	0.0	-	A	-	-	-	-	-	-	-	-	-	-	-	-	9.8	0.01	A	8.5	0.01	A
EB LT/TH	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
WB TH/RT	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SB LT/RT	0.0	-	A	21.3	0.1	C	-	-	-	-	-	-	-	-	-	-	-	-	22.7	0.12	C	27.3	0.25	D
14: Honouliuli Drwy 5 & Renton Rd																								
EB TH/RT	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
WB LT	7.5	0.1	A	7.7	0.0	A	-	-	-	-	-	-	-	-	-	-	-	-	7.5	0.04	A	8.1	0.12	A
WB TH	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
NB LT/RT	8.8	0.0	A	10.0	0.1	B	-	-	-	-	-	-	-	-	-	-	-	-	9.4	0.14	A	10.6	0.19	B

Note:
* = over-capacity, v/c > 1

APPENDIX D

Level of Service Calculations

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (veh/h)	333	364	604	360	170	208
Number	5	2	6	16	7	14
Initial Q (Qb), veh	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00			1.00	1.00	1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1863	1863	1863	1863	1863	1863
Adj Flow Rate, veh/h	362	396	657	391	185	226
Adj No. of Lanes	2	3	3	2	2	2
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Percent Heavy Veh, %	2	2	2	2	2	2
Cap, veh/h	550	3242	1842	1376	453	812
Arrive On Green	0.16	0.64	0.36	0.36	0.13	0.13
Sat Flow, veh/h	3442	5253	5253	2787	3442	2787
Grp Volume(v), veh/h	362	396	657	391	185	226
Grp Sat Flow(s),veh/h/ln	1721	1695	1695	1393	1721	1393
Q Serve(g_s), s	5.1	1.6	4.9	4.3	2.6	3.3
Cycle Q Clear(g_c), s	5.1	1.6	4.9	4.3	2.6	3.3
Prop In Lane	1.00			1.00	1.00	1.00
Lane Grp Cap(c), veh/h	550	3242	1842	1376	453	812
V/C Ratio(X)	0.66	0.12	0.36	0.28	0.41	0.28
Avail Cap(c_a), veh/h	1788	7925	4696	2940	2781	2697
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	20.5	3.7	12.1	7.7	20.7	14.2
Incr Delay (d2), s/veh	1.3	0.0	0.1	0.1	0.6	0.2
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	2.5	0.7	2.3	2.1	1.2	2.8
LnGrp Delay(d),s/veh	21.8	3.7	12.3	7.9	21.3	14.4
LnGrp LOS	C	A	B	A	C	B
Approach Vol, veh/h		758	1048		411	
Approach Delay, s/veh		12.4	10.6		17.5	
Approach LOS		B	B		B	

Timer	1	2	3	4	5	6	7	8
Assigned Phs		2		4	5	6		
Phs Duration (G+Y+Rc), s		39.1		12.8	14.3	24.8		
Change Period (Y+Rc), s		6.0		6.0	6.0	6.0		
Max Green Setting (Gmax), s		81.0		42.0	27.0	48.0		
Max Q Clear Time (g_c+I1), s		3.6		5.3	7.1	6.9		
Green Ext Time (p_c), s		12.8		1.6	1.2	11.9		

Intersection Summary		
HCM 2010 Ctrl Delay		12.5
HCM 2010 LOS		B

Notes

User approved changes to right turn type.

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	24	61	16	288	108	290	43	705	350	213	289	42
Number	3	8	18	7	4	14	5	2	12	1	6	16
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1863	1863	1900	1863	1863	1863	1863	1863	1900	1863	1863	1900
Adj Flow Rate, veh/h	26	66	12	313	117	82	47	766	300	232	314	32
Adj No. of Lanes	1	1	0	1	1	1	1	3	0	1	3	0
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Percent Heavy Veh, %	2	2	2	2	2	2	2	2	2	2	2	2
Cap, veh/h	376	460	84	431	559	475	61	1267	492	274	2216	222
Arrive On Green	0.30	0.30	0.30	0.30	0.30	0.30	0.03	0.35	0.35	0.15	0.47	0.47
Sat Flow, veh/h	1179	1535	279	1316	1863	1583	1774	3606	1400	1774	4700	470
Grp Volume(v), veh/h	26	0	78	313	117	82	47	720	346	232	225	121
Grp Sat Flow(s),veh/h/ln	1179	0	1814	1316	1863	1583	1774	1695	1616	1774	1695	1780
Q Serve(g_s), s	1.6	0.0	2.9	21.2	4.3	3.5	2.4	16.2	16.4	11.8	3.5	3.6
Cycle Q Clear(g_c), s	5.9	0.0	2.9	24.1	4.3	3.5	2.4	16.2	16.4	11.8	3.5	3.6
Prop In Lane	1.00		0.15	1.00		1.00	1.00		0.87	1.00		0.26
Lane Grp Cap(c), veh/h	376	0	544	431	559	475	61	1191	568	274	1599	839
V/C Ratio(X)	0.07	0.00	0.14	0.73	0.21	0.17	0.77	0.60	0.61	0.85	0.14	0.14
Avail Cap(c_a), veh/h	455	0	665	519	683	581	555	2889	1377	555	2889	1516
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	0.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	26.4	0.0	23.7	32.5	24.2	24.0	44.4	24.8	24.8	38.1	13.9	13.9
Incr Delay (d2), s/veh	0.1	0.0	0.1	4.1	0.2	0.2	18.5	0.5	1.1	7.1	0.0	0.1
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	0.5	0.0	1.5	8.1	2.3	1.6	1.5	7.7	7.5	6.3	1.6	1.8
LnGrp Delay(d),s/veh	26.5	0.0	23.9	36.6	24.4	24.1	62.9	25.3	25.9	45.2	13.9	14.0
LnGrp LOS	C		C	D	C	C	E	C	C	D	B	B
Approach Vol, veh/h		104			512			1113			578	
Approach Delay, s/veh		24.5			31.8			27.0			26.5	
Approach LOS		C			C			C			C	

Timer	1	2	3	4	5	6	7	8
Assigned Phs	1	2		4	5	6		8
Phs Duration (G+Y+Rc), s	20.3	38.6		33.8	9.2	49.7		33.8
Change Period (Y+Rc), s	6.0	6.0		6.0	6.0	6.0		6.0
Max Green Setting (Gmax), s	29.0	79.0		34.0	29.0	79.0		34.0
Max Q Clear Time (g_c+I1), s	13.8	18.4		26.1	4.4	5.6		7.9
Green Ext Time (p_c), s	0.6	14.2		1.7	0.1	14.4		2.7

Intersection Summary	
HCM 2010 Ctrl Delay	27.9
HCM 2010 LOS	C

Intersection	
Int Delay, s/veh	7.8

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Vol, veh/h	1	1	181	1	2	80
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	-	-	0	-
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	1	1	197	1	2	87

Major/Minor	Major1		Major2		Minor1	
Conflicting Flow All	0	0	2	0	397	2
Stage 1	-	-	-	-	2	-
Stage 2	-	-	-	-	395	-
Critical Hdwy	-	-	4.12	-	6.42	6.22
Critical Hdwy Stg 1	-	-	-	-	5.42	-
Critical Hdwy Stg 2	-	-	-	-	5.42	-
Follow-up Hdwy	-	-	2.218	-	3.518	3.318
Pot Cap-1 Maneuver	-	-	1620	-	608	1082
Stage 1	-	-	-	-	1021	-
Stage 2	-	-	-	-	681	-
Platoon blocked, %	-	-		-		
Mov Cap-1 Maneuver	-	-	1620	-	534	1082
Mov Cap-2 Maneuver	-	-	-	-	534	-
Stage 1	-	-	-	-	1021	-
Stage 2	-	-	-	-	598	-

Approach	EB	WB	NB
HCM Control Delay, s	0	7.5	8.7
HCM LOS			A

Minor Lane/Major Mvmt	NBLn1	EBT	EBR	WBL	WBT
Capacity (veh/h)	1056	-	-	1620	-
HCM Lane V/C Ratio	0.084	-	-	0.121	-
HCM Control Delay (s)	8.7	-	-	7.5	0
HCM Lane LOS	A	-	-	A	A
HCM 95th %tile Q(veh)	0.3	-	-	0.4	-

Intersection	
Int Delay, s/veh	3.6

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Vol, veh/h	64	267	0	0	530	14	0	0	0	11	0	166
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Free	Free	Stop	Stop	Stop	Stop	Stop	Stop
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	-	-	-	-	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	92	92	92	92	92	92	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2	2	2	2	2	2	2
Mvmt Flow	70	290	0	0	576	15	0	0	0	12	0	180

Major/Minor	Major1			Major2			Minor1			Minor2		
Conflicting Flow All	591	0	0	290	0	0	1103	1020	290	1013	1013	584
Stage 1	-	-	-	-	-	-	429	429	-	584	584	-
Stage 2	-	-	-	-	-	-	674	591	-	429	429	-
Critical Hdwy	4.12	-	-	4.12	-	-	7.12	6.52	6.22	7.12	6.52	6.22
Critical Hdwy Stg 1	-	-	-	-	-	-	6.12	5.52	-	6.12	5.52	-
Critical Hdwy Stg 2	-	-	-	-	-	-	6.12	5.52	-	6.12	5.52	-
Follow-up Hdwy	2.218	-	-	2.218	-	-	3.518	4.018	3.318	3.518	4.018	3.318
Pot Cap-1 Maneuver	985	-	-	1272	-	-	189	237	749	217	239	512
Stage 1	-	-	-	-	-	-	604	584	-	498	498	-
Stage 2	-	-	-	-	-	-	444	494	-	604	584	-
Platoon blocked, %		-	-		-	-						
Mov Cap-1 Maneuver	985	-	-	1272	-	-	114	217	749	203	219	512
Mov Cap-2 Maneuver	-	-	-	-	-	-	114	217	-	203	219	-
Stage 1	-	-	-	-	-	-	553	534	-	456	498	-
Stage 2	-	-	-	-	-	-	288	494	-	553	534	-

Approach	EB	WB	NB	SB
HCM Control Delay, s	1.7	0	0	18
HCM LOS			A	C

Minor Lane/Major Mvmt	NBLn1	EBL	EBT	EBR	WBL	WBT	WBR	SBLn1
Capacity (veh/h)	-	985	-	-	1272	-	-	468
HCM Lane V/C Ratio	-	0.071	-	-	-	-	-	0.411
HCM Control Delay (s)	0	8.9	0	-	0	-	-	18
HCM Lane LOS	A	A	A	-	A	-	-	C
HCM 95th %tile Q(veh)	-	0.2	-	-	0	-	-	2

Intersection	
Int Delay, s/veh	0.4

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Vol, veh/h	265	5	23	556	5	4
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	50	-	0	-
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	288	5	25	604	5	4

Major/Minor	Major1		Major2		Minor1	
Conflicting Flow All	0	0	293	0	945	291
Stage 1	-	-	-	-	291	-
Stage 2	-	-	-	-	654	-
Critical Hdwy	-	-	4.12	-	6.42	6.22
Critical Hdwy Stg 1	-	-	-	-	5.42	-
Critical Hdwy Stg 2	-	-	-	-	5.42	-
Follow-up Hdwy	-	-	2.218	-	3.518	3.318
Pot Cap-1 Maneuver	-	-	1269	-	291	748
Stage 1	-	-	-	-	759	-
Stage 2	-	-	-	-	517	-
Platoon blocked, %	-	-		-		
Mov Cap-1 Maneuver	-	-	1269	-	285	748
Mov Cap-2 Maneuver	-	-	-	-	285	-
Stage 1	-	-	-	-	759	-
Stage 2	-	-	-	-	507	-

Approach	EB	WB	NB
HCM Control Delay, s	0	0.3	14.4
HCM LOS			B

Minor Lane/Major Mvmt	NBLn1	EBT	EBR	WBL	WBT
Capacity (veh/h)	393	-	-	1269	-
HCM Lane V/C Ratio	0.025	-	-	0.02	-
HCM Control Delay (s)	14.4	-	-	7.9	-
HCM Lane LOS	B	-	-	A	-
HCM 95th %tile Q(veh)	0.1	-	-	0.1	-

Intersection	
Int Delay, s/veh	0.3

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Vol, veh/h	0	271	1	8	592	0	3	0	15	0	0	0
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Free	Free	Stop	Stop	Stop	Stop	Stop	Stop
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	-	-	-	-	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	92	92	92	92	92	92	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2	2	2	2	2	2	2
Mvmt Flow	0	295	1	9	643	0	3	0	16	0	0	0

Major/Minor	Major1			Major2			Minor1			Minor2		
Conflicting Flow All	643	0	0	296	0	0	956	956	295	964	957	643
Stage 1	-	-	-	-	-	-	295	295	-	661	661	-
Stage 2	-	-	-	-	-	-	661	661	-	303	296	-
Critical Hdwy	4.12	-	-	4.12	-	-	7.12	6.52	6.22	7.12	6.52	6.22
Critical Hdwy Stg 1	-	-	-	-	-	-	6.12	5.52	-	6.12	5.52	-
Critical Hdwy Stg 2	-	-	-	-	-	-	6.12	5.52	-	6.12	5.52	-
Follow-up Hdwy	2.218	-	-	2.218	-	-	3.518	4.018	3.318	3.518	4.018	3.318
Pot Cap-1 Maneuver	942	-	-	1265	-	-	238	258	744	235	258	473
Stage 1	-	-	-	-	-	-	713	669	-	452	460	-
Stage 2	-	-	-	-	-	-	452	460	-	706	668	-
Platoon blocked, %		-	-		-	-						
Mov Cap-1 Maneuver	942	-	-	1265	-	-	236	255	744	228	255	473
Mov Cap-2 Maneuver	-	-	-	-	-	-	236	255	-	228	255	-
Stage 1	-	-	-	-	-	-	713	669	-	452	455	-
Stage 2	-	-	-	-	-	-	447	455	-	691	668	-

Approach	EB	WB	NB	SB
HCM Control Delay, s	0	0.1	11.8	0
HCM LOS			B	A

Minor Lane/Major Mvmt	NBLn1	EBL	EBT	EBR	WBL	WBT	WBR	SBLn1
Capacity (veh/h)	548	942	-	-	1265	-	-	-
HCM Lane V/C Ratio	0.036	-	-	-	0.007	-	-	-
HCM Control Delay (s)	11.8	0	-	-	7.9	0	-	0
HCM Lane LOS	B	A	-	-	A	A	-	A
HCM 95th %tile Q(veh)	0.1	0	-	-	0	-	-	-

Intersection	
Int Delay, s/veh	0.3

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Vol, veh/h	0	268	579	4	6	10
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	-	-	0	-
Veh in Median Storage, #	-	0	0	-	0	-
Grade, %	-	0	0	-	0	-
Peak Hour Factor	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	0	291	629	4	7	11

Major/Minor	Major1		Major2		Minor2	
Conflicting Flow All	634	0	-	0	923	632
Stage 1	-	-	-	-	632	-
Stage 2	-	-	-	-	291	-
Critical Hdwy	4.12	-	-	-	6.42	6.22
Critical Hdwy Stg 1	-	-	-	-	5.42	-
Critical Hdwy Stg 2	-	-	-	-	5.42	-
Follow-up Hdwy	2.218	-	-	-	3.518	3.318
Pot Cap-1 Maneuver	949	-	-	-	299	480
Stage 1	-	-	-	-	530	-
Stage 2	-	-	-	-	759	-
Platoon blocked, %		-	-	-		
Mov Cap-1 Maneuver	949	-	-	-	299	480
Mov Cap-2 Maneuver	-	-	-	-	299	-
Stage 1	-	-	-	-	530	-
Stage 2	-	-	-	-	759	-

Approach	EB	WB	SB
HCM Control Delay, s	0	0	14.6
HCM LOS			B

Minor Lane/Major Mvmt	EBL	EBT	WBT	WBR	SBLn1
Capacity (veh/h)	949	-	-	-	391
HCM Lane V/C Ratio	-	-	-	-	0.044
HCM Control Delay (s)	0	-	-	-	14.6
HCM Lane LOS	A	-	-	-	B
HCM 95th %tile Q(veh)	0	-	-	-	0.1

Intersection	
Int Delay, s/veh	0.3

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Vol, veh/h	3	261	0	0	575	13	0	0	0	5	0	7
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Free	Free	Stop	Stop	Stop	Stop	Stop	Stop
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	-	-	-	-	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	92	92	92	92	92	92	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2	2	2	2	2	2	2
Mvmt Flow	3	284	0	0	625	14	0	0	0	5	0	8

Major/Minor	Major1			Major2			Minor1			Minor2		
Conflicting Flow All	639	0	0	284	0	0	926	929	284	922	922	632
Stage 1	-	-	-	-	-	-	290	290	-	632	632	-
Stage 2	-	-	-	-	-	-	636	639	-	290	290	-
Critical Hdwy	4.12	-	-	4.12	-	-	7.12	6.52	6.22	7.12	6.52	6.22
Critical Hdwy Stg 1	-	-	-	-	-	-	6.12	5.52	-	6.12	5.52	-
Critical Hdwy Stg 2	-	-	-	-	-	-	6.12	5.52	-	6.12	5.52	-
Follow-up Hdwy	2.218	-	-	2.218	-	-	3.518	4.018	3.318	3.518	4.018	3.318
Pot Cap-1 Maneuver	945	-	-	1278	-	-	249	268	755	251	270	480
Stage 1	-	-	-	-	-	-	718	672	-	468	474	-
Stage 2	-	-	-	-	-	-	466	470	-	718	672	-
Platoon blocked, %		-	-		-	-						
Mov Cap-1 Maneuver	945	-	-	1278	-	-	244	267	755	250	269	480
Mov Cap-2 Maneuver	-	-	-	-	-	-	244	267	-	250	269	-
Stage 1	-	-	-	-	-	-	715	669	-	466	474	-
Stage 2	-	-	-	-	-	-	459	470	-	715	669	-

Approach	EB	WB	NB	SB
HCM Control Delay, s	0.1	0	0	15.8
HCM LOS			A	C

Minor Lane/Major Mvmt	NBLn1	EBL	EBT	EBR	WBL	WBT	WBR	SBLn1
Capacity (veh/h)	-	945	-	-	1278	-	-	347
HCM Lane V/C Ratio	-	0.003	-	-	-	-	-	0.038
HCM Control Delay (s)	0	8.8	0	-	0	-	-	15.8
HCM Lane LOS	A	A	A	-	A	-	-	C
HCM 95th %tile Q(veh)	-	0	-	-	0	-	-	0.1

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	8	110	167	88	210	195	336	717	139	146	501	42
Number	7	4	14	3	8	18	5	2	12	1	6	16
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1863	1863	1900	1863	1863	1863	1863	1863	1863	1863	1863	1863
Adj Flow Rate, veh/h	9	120	14	96	228	39	365	779	64	159	545	7
Adj No. of Lanes	1	2	0	1	1	1	1	2	1	1	2	1
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Percent Heavy Veh, %	2	2	2	2	2	2	2	2	2	2	2	2
Cap, veh/h	16	342	39	125	314	267	416	1476	661	202	1048	469
Arrive On Green	0.01	0.11	0.11	0.07	0.17	0.17	0.23	0.42	0.42	0.11	0.30	0.30
Sat Flow, veh/h	1774	3199	368	1774	1863	1583	1774	3539	1583	1774	3539	1583
Grp Volume(v), veh/h	9	66	68	96	228	39	365	779	64	159	545	7
Grp Sat Flow(s),veh/h/ln	1774	1770	1798	1774	1863	1583	1774	1770	1583	1774	1770	1583
Q Serve(g_s), s	0.4	2.8	2.9	4.4	9.5	1.7	16.3	13.5	2.0	7.2	10.5	0.3
Cycle Q Clear(g_c), s	0.4	2.8	2.9	4.4	9.5	1.7	16.3	13.5	2.0	7.2	10.5	0.3
Prop In Lane	1.00		0.20	1.00		1.00	1.00		1.00	1.00		1.00
Lane Grp Cap(c), veh/h	16	189	192	125	314	267	416	1476	661	202	1048	469
V/C Ratio(X)	0.56	0.35	0.36	0.77	0.73	0.15	0.88	0.53	0.10	0.79	0.52	0.01
Avail Cap(c_a), veh/h	410	839	853	410	883	751	733	1894	847	733	1894	847
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	40.6	34.1	34.1	37.6	32.4	29.2	30.3	17.9	14.6	35.5	24.1	20.5
Incr Delay (d2), s/veh	27.3	1.1	1.1	9.4	3.2	0.2	6.0	0.3	0.1	6.7	0.4	0.0
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	0.3	1.4	1.5	2.5	5.2	0.8	8.7	6.7	0.9	3.9	5.2	0.1
LnGrp Delay(d),s/veh	67.8	35.2	35.2	46.9	35.6	29.4	36.3	18.2	14.6	42.2	24.5	20.5
LnGrp LOS	E	D	D	D	D	C	D	B	B	D	C	C
Approach Vol, veh/h		143			363			1208			711	
Approach Delay, s/veh		37.2			38.0			23.5			28.4	
Approach LOS		D			D			C			C	

Timer	1	2	3	4	5	6	7	8
Assigned Phs	1	2	3	4	5	6	7	8
Phs Duration (G+Y+Rc), s	15.3	40.3	11.8	14.8	25.3	30.3	6.7	19.8
Change Period (Y+Rc), s	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0
Max Green Setting (Gmax), s	34.0	44.0	19.0	39.0	34.0	44.0	19.0	39.0
Max Q Clear Time (g_c+I1), s	9.2	15.5	6.4	4.9	18.3	12.5	2.4	11.5
Green Ext Time (p_c), s	0.4	11.4	0.2	2.4	1.0	11.8	0.0	2.3

Intersection Summary		
HCM 2010 Ctrl Delay		27.9
HCM 2010 LOS		C

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	259	129	156	50	222	266	149	1348	4	162	875	120
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	6.0	4.0	4.0	6.0
Lane Util. Factor	0.91	0.91	1.00	1.00	1.00	0.88	0.97	0.91	1.00	0.97	0.91	1.00
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	0.98	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	1610	3307	1583	1770	1863	2787	3433	5085	1583	3433	5085	1583
Flt Permitted	0.95	0.98	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)	1610	3307	1583	1770	1863	2787	3433	5085	1583	3433	5085	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)	282	140	170	54	241	289	162	1465	4	176	951	130
RTOR Reduction (vph)	0	0	86	0	0	199	0	0	2	0	0	58
Lane Group Flow (vph)	141	281	84	54	241	91	162	1465	2	176	951	72
Turn Type	Split	NA	Perm	Split	NA	Perm	Prot	NA	Perm	Prot	NA	Perm
Protected Phases	3	3		4	4		5	2		1	6	
Permitted Phases			3			4			2			6
Actuated Green, G (s)	30.5	30.5	30.5	39.5	39.5	39.5	16.7	127.4	127.4	17.6	128.3	128.3
Effective Green, g (s)	32.5	32.5	32.5	41.5	41.5	41.5	18.7	130.4	128.4	19.6	131.3	129.3
Actuated g/C Ratio	0.14	0.14	0.14	0.17	0.17	0.17	0.08	0.54	0.54	0.08	0.55	0.54
Clearance Time (s)	6.0	6.0	6.0	6.0	6.0	6.0	6.0	7.0	7.0	6.0	7.0	7.0
Vehicle Extension (s)	5.0	5.0	5.0	5.0	5.0	5.0	3.0	5.0	5.0	3.0	5.0	5.0
Lane Grp Cap (vph)	218	447	214	306	322	481	267	2762	846	280	2781	852
v/s Ratio Prot	c0.09	0.08		0.03	c0.13		0.05	c0.29		c0.05	0.19	
v/s Ratio Perm			0.05			0.03			0.00			0.05
v/c Ratio	0.65	0.63	0.39	0.18	0.75	0.19	0.61	0.53	0.00	0.63	0.34	0.08
Uniform Delay, d1	98.3	98.0	94.7	84.7	94.3	84.8	107.1	35.2	26.0	106.7	30.3	26.8
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.68	1.65	5.28
Incremental Delay, d2	8.7	3.9	2.5	0.6	10.9	0.4	3.9	0.7	0.0	3.9	0.3	0.2
Delay (s)	107.0	101.9	97.2	85.3	105.2	85.2	111.0	35.9	26.0	77.0	50.1	141.5
Level of Service	F	F	F	F	F	F	F	D	C	E	D	F
Approach Delay (s)		101.8			93.5			43.3			63.3	
Approach LOS		F			F			D			E	

Intersection Summary			
HCM 2000 Control Delay	65.2	HCM 2000 Level of Service	E
HCM 2000 Volume to Capacity ratio	0.60		
Actuated Cycle Length (s)	240.0	Sum of lost time (s)	16.0
Intersection Capacity Utilization	64.0%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	391	5	110	4	12	10	198	2650	15	67	1176	235
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		6.0	4.0	6.0	5.0	6.0	4.0	5.0	7.0
Lane Util. Factor	0.95	0.95	1.00		1.00	1.00	1.00	0.91	1.00	1.00	0.91	1.00
Frpb, ped/bikes	1.00	1.00	0.91		1.00	1.00	1.00	1.00	0.83	1.00	1.00	0.97
Flpb, ped/bikes	1.00	1.00	1.00		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Frt	1.00	1.00	0.85		1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	0.95	1.00		0.99	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	1681	1687	1434		1841	1583	1770	5085	1311	1770	5085	1536
Flt Permitted	0.95	0.95	1.00		0.99	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)	1681	1687	1434		1841	1583	1770	5085	1311	1770	5085	1536
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	425	5	120	4	13	11	215	2880	16	73	1278	255
RTOR Reduction (vph)	0	0	84	0	0	11	0	0	6	0	0	113
Lane Group Flow (vph)	217	213	36	0	17	0	215	2880	10	73	1278	142
Confl. Peds. (#/hr)			43						31			2
Turn Type	Split	NA	Perm	Split	NA	Perm	Prot	NA	Perm	Prot	NA	Perm
Protected Phases	4	4		3	3		5	2		1	6	
Permitted Phases			4			3			2			6
Actuated Green, G (s)	39.3	39.3	39.3		6.6	6.6	36.2	154.9	154.9	15.2	133.9	133.9
Effective Green, g (s)	39.3	39.3	39.3		6.6	8.6	36.2	156.9	155.9	17.2	135.9	133.9
Actuated g/C Ratio	0.16	0.16	0.16		0.03	0.04	0.15	0.65	0.65	0.07	0.57	0.56
Clearance Time (s)	5.0	5.0	5.0		6.0	6.0	6.0	7.0	7.0	6.0	7.0	7.0
Vehicle Extension (s)	4.0	4.0	4.0		3.0	3.0	5.0	6.0	6.0	3.0	6.0	6.0
Lane Grp Cap (vph)	275	276	234		50	56	266	3324	851	126	2879	856
v/s Ratio Prot	c0.13	0.13			c0.01		c0.12	c0.57		0.04	0.25	
v/s Ratio Perm			0.03			0.00			0.01			0.09
v/c Ratio	0.79	0.77	0.16		0.34	0.01	0.81	0.87	0.01	0.58	0.44	0.17
Uniform Delay, d1	96.4	96.1	86.1		114.6	111.6	98.5	33.2	14.9	107.9	30.2	25.8
Progression Factor	1.00	1.00	1.00		1.00	1.00	1.14	0.61	1.00	1.09	1.02	1.76
Incremental Delay, d2	14.7	13.2	0.4		4.0	0.1	8.4	1.4	0.0	6.0	0.5	0.4
Delay (s)	111.0	109.3	86.5		118.6	111.6	120.7	21.8	14.9	123.1	31.3	45.8
Level of Service	F	F	F		F	F	F	C	B	F	C	D
Approach Delay (s)		105.0			115.9			28.6			37.7	
Approach LOS		F			F			C			D	

Intersection Summary			
HCM 2000 Control Delay	39.8	HCM 2000 Level of Service	D
HCM 2000 Volume to Capacity ratio	0.84		
Actuated Cycle Length (s)	240.0	Sum of lost time (s)	22.0
Intersection Capacity Utilization	94.7%	ICU Level of Service	F
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (veh/h)	218	442	356	253	377	334
Number	5	2	6	16	7	14
Initial Q (Qb), veh	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00			1.00	1.00	1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1863	1863	1863	1863	1863	1863
Adj Flow Rate, veh/h	237	480	387	275	410	363
Adj No. of Lanes	2	3	3	2	2	2
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Percent Heavy Veh, %	2	2	2	2	2	2
Cap, veh/h	368	2677	1480	1415	746	902
Arrive On Green	0.11	0.53	0.29	0.29	0.22	0.22
Sat Flow, veh/h	3442	5253	5253	2787	3442	2787
Grp Volume(v), veh/h	237	480	387	275	410	363
Grp Sat Flow(s),veh/h/ln	1721	1695	1695	1393	1721	1393
Q Serve(g_s), s	3.1	2.3	2.7	2.5	4.9	4.7
Cycle Q Clear(g_c), s	3.1	2.3	2.7	2.5	4.9	4.7
Prop In Lane	1.00			1.00	1.00	1.00
Lane Grp Cap(c), veh/h	368	2677	1480	1415	746	902
V/C Ratio(X)	0.64	0.18	0.26	0.19	0.55	0.40
Avail Cap(c_a), veh/h	516	6639	5224	3467	3094	2803
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	20.0	5.8	12.7	6.3	16.3	12.3
Incr Delay (d2), s/veh	1.9	0.0	0.1	0.1	0.6	0.3
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	1.5	1.1	1.3	1.4	2.4	3.9
LnGrp Delay(d),s/veh	21.9	5.8	12.8	6.3	16.9	12.6
LnGrp LOS	C	A	B	A	B	B
Approach Vol, veh/h		717	662		773	
Approach Delay, s/veh		11.1	10.1		14.9	
Approach LOS		B	B		B	

Timer	1	2	3	4	5	6	7	8
Assigned Phs		2		4	5	6		
Phs Duration (G+Y+Rc), s		30.6		16.1	11.0	19.6		
Change Period (Y+Rc), s		6.0		6.0	6.0	6.0		
Max Green Setting (Gmax), s		61.0		42.0	7.0	48.0		
Max Q Clear Time (g_c+I1), s		4.3		6.9	5.1	4.7		
Green Ext Time (p_c), s		9.1		3.2	0.2	8.9		

Intersection Summary		
HCM 2010 Ctrl Delay		12.2
HCM 2010 LOS		B

Notes
User approved changes to right turn type.

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	57	99	56	158	62	166	32	382	110	184	585	48
Number	3	8	18	7	4	14	5	2	12	1	6	16
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1863	1863	1900	1863	1863	1863	1863	1863	1900	1863	1863	1900
Adj Flow Rate, veh/h	62	108	40	172	67	32	35	415	66	200	636	44
Adj No. of Lanes	1	1	0	1	1	1	1	3	0	1	3	0
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Percent Heavy Veh, %	2	2	2	2	2	2	2	2	2	2	2	2
Cap, veh/h	437	348	129	375	500	425	53	1207	188	258	1883	129
Arrive On Green	0.27	0.27	0.27	0.27	0.27	0.27	0.03	0.27	0.27	0.15	0.39	0.39
Sat Flow, veh/h	1291	1297	481	1235	1863	1583	1774	4441	690	1774	4860	334
Grp Volume(v), veh/h	62	0	148	172	67	32	35	315	166	200	442	238
Grp Sat Flow(s),veh/h/ln	1291	0	1778	1235	1863	1583	1774	1695	1741	1774	1695	1804
Q Serve(g_s), s	2.2	0.0	3.8	7.4	1.6	0.9	1.1	4.3	4.4	6.2	5.3	5.3
Cycle Q Clear(g_c), s	3.8	0.0	3.8	11.2	1.6	0.9	1.1	4.3	4.4	6.2	5.3	5.3
Prop In Lane	1.00		0.27	1.00		1.00	1.00		0.40	1.00		0.19
Lane Grp Cap(c), veh/h	437	0	477	375	500	425	53	921	473	258	1314	699
V/C Ratio(X)	0.14	0.00	0.31	0.46	0.13	0.08	0.66	0.34	0.35	0.77	0.34	0.34
Avail Cap(c_a), veh/h	857	0	1055	777	1106	940	743	2308	1185	743	2308	1228
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	0.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	17.3	0.0	16.7	21.2	15.9	15.6	27.5	16.7	16.8	23.6	12.4	12.4
Incr Delay (d2), s/veh	0.1	0.0	0.4	0.9	0.1	0.1	13.2	0.2	0.4	4.9	0.2	0.3
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	0.8	0.0	1.9	2.6	0.8	0.4	0.7	2.0	2.2	3.4	2.5	2.7
LnGrp Delay(d),s/veh	17.5	0.0	17.1	22.1	16.0	15.7	40.7	17.0	17.2	28.5	12.5	12.7
LnGrp LOS	B		B	C	B	B	D	B	B	C	B	B
Approach Vol, veh/h		210			271			516			880	
Approach Delay, s/veh		17.2			19.8			18.7			16.2	
Approach LOS		B			B			B			B	

Timer	1	2	3	4	5	6	7	8
Assigned Phs	1	2		4	5	6		8
Phs Duration (G+Y+Rc), s	14.3	21.6		21.4	7.7	28.2		21.4
Change Period (Y+Rc), s	6.0	6.0		6.0	6.0	6.0		6.0
Max Green Setting (Gmax), s	24.0	39.0		34.0	24.0	39.0		34.0
Max Q Clear Time (g_c+I1), s	8.2	6.4		13.2	3.1	7.3		5.8
Green Ext Time (p_c), s	0.5	9.2		2.2	0.1	9.1		2.3

Intersection Summary	
HCM 2010 Ctrl Delay	17.5
HCM 2010 LOS	B

Intersection	
Int Delay, s/veh	8.4

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Vol, veh/h	2	3	135	2	6	193
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	-	-	0	-
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	2	3	147	2	7	210

Major/Minor	Major1		Major2		Minor1	
Conflicting Flow All	0	0	5	0	300	4
Stage 1	-	-	-	-	4	-
Stage 2	-	-	-	-	296	-
Critical Hdwy	-	-	4.12	-	6.42	6.22
Critical Hdwy Stg 1	-	-	-	-	5.42	-
Critical Hdwy Stg 2	-	-	-	-	5.42	-
Follow-up Hdwy	-	-	2.218	-	3.518	3.318
Pot Cap-1 Maneuver	-	-	1616	-	691	1080
Stage 1	-	-	-	-	1019	-
Stage 2	-	-	-	-	755	-
Platoon blocked, %	-	-		-		
Mov Cap-1 Maneuver	-	-	1616	-	628	1080
Mov Cap-2 Maneuver	-	-	-	-	628	-
Stage 1	-	-	-	-	1019	-
Stage 2	-	-	-	-	686	-

Approach	EB	WB	NB
HCM Control Delay, s	0	7.3	9.3
HCM LOS			A

Minor Lane/Major Mvmt	NBLn1	EBT	EBR	WBL	WBT
Capacity (veh/h)	1057	-	-	1616	-
HCM Lane V/C Ratio	0.205	-	-	0.091	-
HCM Control Delay (s)	9.3	-	-	7.5	0
HCM Lane LOS	A	-	-	A	A
HCM 95th %tile Q(veh)	0.8	-	-	0.3	-

Intersection	
Int Delay, s/veh	3.2

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Vol, veh/h	172	583	0	0	331	17	0	0	0	14	0	123
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Free	Free	Stop	Stop	Stop	Stop	Stop	Stop
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	-	-	-	-	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	92	92	92	92	92	92	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2	2	2	2	2	2	2
Mvmt Flow	187	634	0	0	360	18	0	0	0	15	0	134

Major/Minor	Major1			Major2			Minor1			Minor2		
Conflicting Flow All	378	0	0	634	0	0	1444	1386	634	1377	1377	369
Stage 1	-	-	-	-	-	-	1008	1008	-	369	369	-
Stage 2	-	-	-	-	-	-	436	378	-	1008	1008	-
Critical Hdwy	4.12	-	-	4.12	-	-	7.12	6.52	6.22	7.12	6.52	6.22
Critical Hdwy Stg 1	-	-	-	-	-	-	6.12	5.52	-	6.12	5.52	-
Critical Hdwy Stg 2	-	-	-	-	-	-	6.12	5.52	-	6.12	5.52	-
Follow-up Hdwy	2.218	-	-	2.218	-	-	3.518	4.018	3.318	3.518	4.018	3.318
Pot Cap-1 Maneuver	1180	-	-	949	-	-	110	143	479	122	145	677
Stage 1	-	-	-	-	-	-	290	318	-	651	621	-
Stage 2	-	-	-	-	-	-	599	615	-	290	318	-
Platoon blocked, %		-	-		-	-						
Mov Cap-1 Maneuver	1180	-	-	949	-	-	72	108	479	99	109	677
Mov Cap-2 Maneuver	-	-	-	-	-	-	72	108	-	99	109	-
Stage 1	-	-	-	-	-	-	219	240	-	492	621	-
Stage 2	-	-	-	-	-	-	481	615	-	219	240	-

Approach	EB	WB	NB	SB
HCM Control Delay, s	2	0	0	18
HCM LOS			A	C

Minor Lane/Major Mvmt	NBLn1	EBL	EBT	EBR	WBL	WBT	WBR	SBLn1
Capacity (veh/h)	-	1180	-	-	949	-	-	424
HCM Lane V/C Ratio	-	0.158	-	-	-	-	-	0.351
HCM Control Delay (s)	0	8.6	0	-	0	-	-	18
HCM Lane LOS	A	A	A	-	A	-	-	C
HCM 95th %tile Q(veh)	-	0.6	-	-	0	-	-	1.6

Intersection	
Int Delay, s/veh	0.6

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Vol, veh/h	624	13	11	345	9	19
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	50	-	0	-
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	678	14	12	375	10	21

Major/Minor	Major1		Major2		Minor1	
Conflicting Flow All	0	0	692	0	1084	685
Stage 1	-	-	-	-	685	-
Stage 2	-	-	-	-	399	-
Critical Hdwy	-	-	4.12	-	6.42	6.22
Critical Hdwy Stg 1	-	-	-	-	5.42	-
Critical Hdwy Stg 2	-	-	-	-	5.42	-
Follow-up Hdwy	-	-	2.218	-	3.518	3.318
Pot Cap-1 Maneuver	-	-	903	-	240	448
Stage 1	-	-	-	-	500	-
Stage 2	-	-	-	-	678	-
Platoon blocked, %	-	-		-		
Mov Cap-1 Maneuver	-	-	903	-	237	448
Mov Cap-2 Maneuver	-	-	-	-	237	-
Stage 1	-	-	-	-	500	-
Stage 2	-	-	-	-	669	-

Approach	EB	WB	NB
HCM Control Delay, s	0	0.3	16.3
HCM LOS			C

Minor Lane/Major Mvmt	NBLn1	EBT	EBR	WBL	WBT
Capacity (veh/h)	348	-	-	903	-
HCM Lane V/C Ratio	0.087	-	-	0.013	-
HCM Control Delay (s)	16.3	-	-	9	-
HCM Lane LOS	C	-	-	A	-
HCM 95th %tile Q(veh)	0.3	-	-	0	-

Intersection	
Int Delay, s/veh	0

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Vol, veh/h	1	617	0	1	352	1	0	0	2	0	0	0
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Free	Free	Stop	Stop	Stop	Stop	Stop	Stop
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	-	-	-	-	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	92	92	92	92	92	92	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2	2	2	2	2	2	2
Mvmt Flow	1	671	0	1	383	1	0	0	2	0	0	0

Major/Minor	Major1			Major2			Minor1			Minor2		
Conflicting Flow All	384	0	0	671	0	0	1058	1059	671	1059	1058	383
Stage 1	-	-	-	-	-	-	673	673	-	385	385	-
Stage 2	-	-	-	-	-	-	385	386	-	674	673	-
Critical Hdwy	4.12	-	-	4.12	-	-	7.12	6.52	6.22	7.12	6.52	6.22
Critical Hdwy Stg 1	-	-	-	-	-	-	6.12	5.52	-	6.12	5.52	-
Critical Hdwy Stg 2	-	-	-	-	-	-	6.12	5.52	-	6.12	5.52	-
Follow-up Hdwy	2.218	-	-	2.218	-	-	3.518	4.018	3.318	3.518	4.018	3.318
Pot Cap-1 Maneuver	1174	-	-	919	-	-	203	224	456	202	225	664
Stage 1	-	-	-	-	-	-	445	454	-	638	611	-
Stage 2	-	-	-	-	-	-	638	610	-	444	454	-
Platoon blocked, %		-	-		-	-						
Mov Cap-1 Maneuver	1174	-	-	919	-	-	203	224	456	201	225	664
Mov Cap-2 Maneuver	-	-	-	-	-	-	203	224	-	201	225	-
Stage 1	-	-	-	-	-	-	445	454	-	637	610	-
Stage 2	-	-	-	-	-	-	637	609	-	441	454	-

Approach	EB	WB	NB	SB
HCM Control Delay, s	0	0	12.9	0
HCM LOS			B	A

Minor Lane/Major Mvmt	NBLn1	EBL	EBT	EBR	WBL	WBT	WBR	SBLn1
Capacity (veh/h)	456	1174	-	-	919	-	-	-
HCM Lane V/C Ratio	0.005	0.001	-	-	0.001	-	-	-
HCM Control Delay (s)	12.9	8.1	0	-	8.9	0	-	0
HCM Lane LOS	B	A	A	-	A	A	-	A
HCM 95th %tile Q(veh)	0	0	-	-	0	-	-	-

Intersection	
Int Delay, s/veh	0.2

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Vol, veh/h	0	644	354	2	10	2
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	-	-	0	-
Veh in Median Storage, #	-	0	0	-	0	-
Grade, %	-	0	0	-	0	-
Peak Hour Factor	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	0	700	385	2	11	2

Major/Minor	Major1		Major2		Minor2	
Conflicting Flow All	387	0	-	0	1086	386
Stage 1	-	-	-	-	386	-
Stage 2	-	-	-	-	700	-
Critical Hdwy	4.12	-	-	-	6.42	6.22
Critical Hdwy Stg 1	-	-	-	-	5.42	-
Critical Hdwy Stg 2	-	-	-	-	5.42	-
Follow-up Hdwy	2.218	-	-	-	3.518	3.318
Pot Cap-1 Maneuver	1171	-	-	-	239	662
Stage 1	-	-	-	-	687	-
Stage 2	-	-	-	-	493	-
Platoon blocked, %		-	-	-		
Mov Cap-1 Maneuver	1171	-	-	-	239	662
Mov Cap-2 Maneuver	-	-	-	-	239	-
Stage 1	-	-	-	-	687	-
Stage 2	-	-	-	-	493	-

Approach	EB	WB	SB
HCM Control Delay, s	0	0	19.2
HCM LOS			C

Minor Lane/Major Mvmt	EBL	EBT	WBT	WBR	SBLn1
Capacity (veh/h)	1171	-	-	-	267
HCM Lane V/C Ratio	-	-	-	-	0.049
HCM Control Delay (s)	0	-	-	-	19.2
HCM Lane LOS	A	-	-	-	C
HCM 95th %tile Q(veh)	0	-	-	-	0.2

Intersection	
Int Delay, s/veh	0.7

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Vol, veh/h	10	628	0	0	336	19	0	0	0	19	0	12
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Free	Free	Stop	Stop	Stop	Stop	Stop	Stop
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	-	-	-	-	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	92	92	92	92	92	92	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2	2	2	2	2	2	2
Mvmt Flow	11	683	0	0	365	21	0	0	0	21	0	13

Major/Minor	Major1			Major2			Minor1			Minor2		
Conflicting Flow All	386	0	0	683	0	0	1086	1090	683	1080	1080	376
Stage 1	-	-	-	-	-	-	704	704	-	376	376	-
Stage 2	-	-	-	-	-	-	382	386	-	704	704	-
Critical Hdwy	4.12	-	-	4.12	-	-	7.12	6.52	6.22	7.12	6.52	6.22
Critical Hdwy Stg 1	-	-	-	-	-	-	6.12	5.52	-	6.12	5.52	-
Critical Hdwy Stg 2	-	-	-	-	-	-	6.12	5.52	-	6.12	5.52	-
Follow-up Hdwy	2.218	-	-	2.218	-	-	3.518	4.018	3.318	3.518	4.018	3.318
Pot Cap-1 Maneuver	1172	-	-	910	-	-	194	215	449	196	218	670
Stage 1	-	-	-	-	-	-	428	440	-	645	616	-
Stage 2	-	-	-	-	-	-	640	610	-	428	440	-
Platoon blocked, %		-	-		-	-						
Mov Cap-1 Maneuver	1172	-	-	910	-	-	188	212	449	194	215	670
Mov Cap-2 Maneuver	-	-	-	-	-	-	188	212	-	194	215	-
Stage 1	-	-	-	-	-	-	422	433	-	635	616	-
Stage 2	-	-	-	-	-	-	628	610	-	422	433	-

Approach	EB	WB	NB	SB
HCM Control Delay, s	0.1	0	0	20.4
HCM LOS			A	C

Minor Lane/Major Mvmt	NBLn1	EBL	EBT	EBR	WBL	WBT	WBR	SBLn1
Capacity (veh/h)	-	1172	-	-	910	-	-	268
HCM Lane V/C Ratio	-	0.009	-	-	-	-	-	0.126
HCM Control Delay (s)	0	8.1	0	-	0	-	-	20.4
HCM Lane LOS	A	A	A	-	A	-	-	C
HCM 95th %tile Q(veh)	-	0	-	-	0	-	-	0.4

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	45	228	395	121	142	232	196	369	92	153	492	25
Number	7	4	14	3	8	18	5	2	12	1	6	16
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1863	1863	1900	1863	1863	1863	1863	1863	1863	1863	1863	1863
Adj Flow Rate, veh/h	49	248	191	132	154	59	213	401	18	166	535	4
Adj No. of Lanes	1	2	0	1	1	1	1	2	1	1	2	1
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Percent Heavy Veh, %	2	2	2	2	2	2	2	2	2	2	2	2
Cap, veh/h	63	391	290	169	487	414	261	986	441	210	884	396
Arrive On Green	0.04	0.20	0.20	0.10	0.26	0.26	0.15	0.28	0.28	0.12	0.25	0.25
Sat Flow, veh/h	1774	1940	1438	1774	1863	1583	1774	3539	1583	1774	3539	1583
Grp Volume(v), veh/h	49	225	214	132	154	59	213	401	18	166	535	4
Grp Sat Flow(s),veh/h/ln	1774	1770	1609	1774	1863	1583	1774	1770	1583	1774	1770	1583
Q Serve(g_s), s	2.1	9.1	9.6	5.7	5.2	2.2	9.1	7.2	0.7	7.1	10.5	0.1
Cycle Q Clear(g_c), s	2.1	9.1	9.6	5.7	5.2	2.2	9.1	7.2	0.7	7.1	10.5	0.1
Prop In Lane	1.00		0.89	1.00		1.00	1.00		1.00	1.00		1.00
Lane Grp Cap(c), veh/h	63	356	324	169	487	414	261	986	441	210	884	396
V/C Ratio(X)	0.78	0.63	0.66	0.78	0.32	0.14	0.81	0.41	0.04	0.79	0.60	0.01
Avail Cap(c_a), veh/h	430	993	902	430	1045	888	656	1760	787	656	1760	787
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	37.5	28.7	28.8	34.7	23.3	22.2	32.4	23.0	20.6	33.6	26.0	22.1
Incr Delay (d2), s/veh	18.8	1.9	2.3	7.5	0.4	0.2	6.1	0.3	0.0	6.5	0.7	0.0
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	1.4	4.6	4.5	3.1	2.7	1.0	4.9	3.5	0.3	3.9	5.2	0.1
LnGrp Delay(d),s/veh	56.4	30.5	31.1	42.2	23.7	22.4	38.5	23.3	20.7	40.1	26.7	22.1
LnGrp LOS	E	C	C	D	C	C	D	C	C	D	C	C
Approach Vol, veh/h		488			345			632			705	
Approach Delay, s/veh		33.4			30.5			28.3			29.8	
Approach LOS		C			C			C			C	

Timer	1	2	3	4	5	6	7	8
Assigned Phs	1	2	3	4	5	6	7	8
Phs Duration (G+Y+Rc), s	15.3	27.9	13.5	21.8	17.6	25.6	8.8	26.5
Change Period (Y+Rc), s	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0
Max Green Setting (Gmax), s	29.0	39.0	19.0	44.0	29.0	39.0	19.0	44.0
Max Q Clear Time (g_c+I1), s	9.1	9.2	7.7	11.6	11.1	12.5	4.1	7.2
Green Ext Time (p_c), s	0.4	7.4	0.2	4.2	0.5	7.1	0.1	4.3

Intersection Summary			
HCM 2010 Ctrl Delay			30.3
HCM 2010 LOS			C

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	198	206	153	10	182	122	135	817	10	341	1493	207
Ideal Flow (vphpl)	1900	1900	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	6.0	4.0	4.0	6.0
Lane Util. Factor	0.91	0.91	1.00	1.00	1.00	0.88	0.97	0.91	1.00	0.97	0.91	1.00
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	0.99	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	1610	3349	1583	1770	1863	2787	3433	5085	1583	3433	5085	1583
Flt Permitted	0.95	0.99	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)	1610	3349	1583	1770	1863	2787	3433	5085	1583	3433	5085	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)	215	224	166	11	198	133	147	888	11	371	1623	225
RTOR Reduction (vph)	0	0	63	0	0	111	0	0	5	0	0	65
Lane Group Flow (vph)	142	297	103	11	198	22	147	888	6	371	1623	160
Turn Type	Split	NA	Perm	Split	NA	Perm	Prot	NA	Perm	Prot	NA	Perm
Protected Phases	3	3		4	4		5	2		1	6	
Permitted Phases			3			4			2			6
Actuated Green, G (s)	30.8	30.8	30.8	30.7	30.7	30.7	15.6	122.9	122.9	30.6	137.9	137.9
Effective Green, g (s)	32.8	32.8	32.8	32.7	32.7	32.7	17.6	125.9	123.9	32.6	140.9	138.9
Actuated g/C Ratio	0.14	0.14	0.14	0.14	0.14	0.14	0.07	0.52	0.52	0.14	0.59	0.58
Clearance Time (s)	6.0	6.0	6.0	6.0	6.0	6.0	6.0	7.0	7.0	6.0	7.0	7.0
Vehicle Extension (s)	5.0	5.0	5.0	5.0	5.0	5.0	3.0	5.0	5.0	3.0	5.0	5.0
Lane Grp Cap (vph)	220	457	216	241	253	379	251	2667	817	466	2985	916
v/s Ratio Prot	0.09	c0.09		0.01	c0.11		0.04	0.17		c0.11	c0.32	
v/s Ratio Perm			0.07			0.01			0.00			0.10
v/c Ratio	0.65	0.65	0.48	0.05	0.78	0.06	0.59	0.33	0.01	0.80	0.54	0.17
Uniform Delay, d1	98.1	98.2	95.7	90.1	100.2	90.2	107.7	32.9	28.2	100.5	30.1	23.7
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.10	0.95	1.35
Incremental Delay, d2	8.6	4.3	3.4	0.2	16.6	0.1	3.5	0.3	0.0	9.0	0.7	0.4
Delay (s)	106.7	102.5	99.1	90.3	116.8	90.4	111.1	33.2	28.2	119.0	29.3	32.3
Level of Service	F	F	F	F	F	F	F	C	C	F	C	C
Approach Delay (s)		102.5			105.7			44.1			44.6	
Approach LOS		F			F			D			D	

Intersection Summary			
HCM 2000 Control Delay	57.8	HCM 2000 Level of Service	E
HCM 2000 Volume to Capacity ratio	0.64		
Actuated Cycle Length (s)	240.0	Sum of lost time (s)	16.0
Intersection Capacity Utilization	66.0%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	355	36	97	34	28	22	115	1410	54	68	2628	298
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		6.0	4.0	6.0	5.0	6.0	4.0	5.0	7.0
Lane Util. Factor	0.95	0.95	1.00		1.00	1.00	1.00	0.91	1.00	1.00	0.91	1.00
Frpb, ped/bikes	1.00	1.00	0.91		1.00	1.00	1.00	1.00	0.83	1.00	1.00	0.97
Flpb, ped/bikes	1.00	1.00	1.00		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Frt	1.00	1.00	0.85		1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	0.96	1.00		0.97	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	1681	1700	1434		1813	1583	1770	5085	1311	1770	5085	1536
Flt Permitted	0.95	0.96	1.00		0.97	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)	1681	1700	1434		1813	1583	1770	5085	1311	1770	5085	1536
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	386	39	105	37	30	24	125	1533	59	74	2857	324
RTOR Reduction (vph)	0	0	84	0	0	22	0	0	22	0	0	136
Lane Group Flow (vph)	212	213	21	0	67	2	125	1533	37	74	2857	188
Confl. Peds. (#/hr)			43						31			2
Turn Type	Split	NA	Perm	Split	NA	Perm	Prot	NA	Perm	Prot	NA	Perm
Protected Phases	4	4		3	3		5	2		1	6	
Permitted Phases			4			3			2			6
Actuated Green, G (s)	38.3	38.3	38.3		14.2	14.2	24.2	148.4	148.4	15.1	139.3	139.3
Effective Green, g (s)	38.3	38.3	38.3		14.2	16.2	24.2	150.4	149.4	17.1	141.3	139.3
Actuated g/C Ratio	0.16	0.16	0.16		0.06	0.07	0.10	0.63	0.62	0.07	0.59	0.58
Clearance Time (s)	5.0	5.0	5.0		6.0	6.0	6.0	7.0	7.0	6.0	7.0	7.0
Vehicle Extension (s)	4.0	4.0	4.0		3.0	3.0	5.0	6.0	6.0	3.0	6.0	6.0
Lane Grp Cap (vph)	268	271	228		107	106	178	3186	816	126	2993	891
v/s Ratio Prot	c0.13	0.13			c0.04		c0.07	0.30		0.04	c0.56	
v/s Ratio Perm			0.01			0.00			0.03			0.12
v/c Ratio	0.79	0.79	0.09		0.63	0.02	0.70	0.48	0.05	0.59	0.95	0.21
Uniform Delay, d1	97.0	96.9	86.0		110.3	104.5	104.4	23.9	17.6	108.0	46.3	24.1
Progression Factor	1.00	1.00	1.00		1.00	1.00	0.90	1.19	2.27	0.97	0.99	1.41
Incremental Delay, d2	15.4	14.7	0.2		10.9	0.1	6.0	0.2	0.0	6.8	8.8	0.5
Delay (s)	112.4	111.6	86.3		121.2	104.5	100.3	28.7	40.0	111.9	54.6	34.6
Level of Service	F	F	F		F	F	F	C	D	F	D	C
Approach Delay (s)		106.9			116.8			34.3			53.9	
Approach LOS		F			F			C			D	

Intersection Summary			
HCM 2000 Control Delay	53.9	HCM 2000 Level of Service	D
HCM 2000 Volume to Capacity ratio	0.88		
Actuated Cycle Length (s)	240.0	Sum of lost time (s)	22.0
Intersection Capacity Utilization	98.1%	ICU Level of Service	F
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	625	515	5	120	705	475	5	85	15	395	120	430
Number	7	4	14	3	8	18	5	2	12	1	6	16
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		0.99
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1863	1863	1900	1863	1863	1863	1863	1863	1900	1863	1863	1863
Adj Flow Rate, veh/h	679	560	5	130	766	516	5	92	3	429	130	278
Adj No. of Lanes	2	3	0	2	3	2	1	2	0	2	2	2
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Percent Heavy Veh, %	2	2	2	2	2	2	2	2	2	2	2	2
Cap, veh/h	809	2293	20	215	1365	1174	9	317	10	526	844	1316
Arrive On Green	0.24	0.44	0.44	0.06	0.27	0.27	0.01	0.09	0.09	0.15	0.24	0.24
Sat Flow, veh/h	3442	5198	46	3442	5085	2787	1774	3499	114	3442	3539	2773
Grp Volume(v), veh/h	679	365	200	130	766	516	5	46	49	429	130	278
Grp Sat Flow(s),veh/h/ln	1721	1695	1855	1721	1695	1393	1774	1770	1843	1721	1770	1386
Q Serve(g_s), s	17.8	6.4	6.4	3.5	12.3	12.5	0.3	2.3	2.3	11.4	2.8	5.6
Cycle Q Clear(g_c), s	17.8	6.4	6.4	3.5	12.3	12.5	0.3	2.3	2.3	11.4	2.8	5.6
Prop In Lane	1.00		0.03	1.00		1.00	1.00		0.06	1.00		1.00
Lane Grp Cap(c), veh/h	809	1495	818	215	1365	1174	9	160	167	526	844	1316
V/C Ratio(X)	0.84	0.24	0.24	0.61	0.56	0.44	0.54	0.29	0.29	0.82	0.15	0.21
Avail Cap(c_a), veh/h	1378	1495	818	1378	2037	1542	224	709	738	798	1791	2058
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	34.6	16.6	16.6	43.3	29.9	19.5	47.1	40.3	40.3	38.9	28.6	14.6
Incr Delay (d2), s/veh	2.4	0.1	0.2	2.7	0.4	0.3	41.4	1.0	1.0	4.0	0.1	0.1
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	8.8	3.0	3.3	1.7	5.8	4.8	0.2	1.2	1.2	5.7	1.4	2.1
LnGrp Delay(d),s/veh	37.0	16.7	16.8	46.1	30.3	19.8	88.5	41.3	41.2	42.8	28.7	14.7
LnGrp LOS	D	B	B	D	C	B	F	D	D	D	C	B
Approach Vol, veh/h		1244			1412			100			837	
Approach Delay, s/veh		27.8			27.9			43.6			31.3	
Approach LOS		C			C			D			C	

Timer	1	2	3	4	5	6	7	8
Assigned Phs	1	2	3	4	5	6	7	8
Phs Duration (G+Y+Rc), s	20.5	14.6	11.9	47.8	6.5	28.6	28.3	31.5
Change Period (Y+Rc), s	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0
Max Green Setting (Gmax), s	22.0	38.0	38.0	38.0	12.0	48.0	38.0	38.0
Max Q Clear Time (g_c+I1), s	13.4	4.3	5.5	8.4	2.3	7.6	19.8	14.5
Green Ext Time (p_c), s	1.1	2.6	0.4	14.3	0.0	2.7	2.5	11.0

Intersection Summary	
HCM 2010 Ctrl Delay	29.1
HCM 2010 LOS	C

Notes
User approved changes to right turn type.

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	30	70	20	300	135	370	50	980	400	280	530	45
Number	3	8	18	7	4	14	5	2	12	1	6	16
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1863	1863	1900	1863	1863	1863	1863	1863	1900	1863	1863	1900
Adj Flow Rate, veh/h	33	76	13	326	147	93	54	1065	381	304	576	42
Adj No. of Lanes	1	1	0	1	1	1	1	3	0	1	3	0
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Percent Heavy Veh, %	2	2	2	2	2	2	2	2	2	2	2	2
Cap, veh/h	345	482	82	418	578	492	70	1291	462	338	2421	175
Arrive On Green	0.31	0.31	0.31	0.31	0.31	0.31	0.04	0.35	0.35	0.19	0.50	0.50
Sat Flow, veh/h	1135	1551	265	1303	1863	1583	1774	3697	1323	1774	4841	350
Grp Volume(v), veh/h	33	0	89	326	147	93	54	977	469	304	402	216
Grp Sat Flow(s),veh/h/ln	1135	0	1816	1303	1863	1583	1774	1695	1629	1774	1695	1801
Q Serve(g_s), s	2.7	0.0	4.3	29.1	7.1	5.2	3.6	31.6	31.6	20.1	8.1	8.2
Cycle Q Clear(g_c), s	9.8	0.0	4.3	33.3	7.1	5.2	3.6	31.6	31.6	20.1	8.1	8.2
Prop In Lane	1.00		0.15	1.00		1.00	1.00		0.81	1.00		0.19
Lane Grp Cap(c), veh/h	345	0	564	418	578	492	70	1184	569	338	1695	901
V/C Ratio(X)	0.10	0.00	0.16	0.78	0.25	0.19	0.77	0.82	0.82	0.90	0.24	0.24
Avail Cap(c_a), veh/h	399	0	650	480	667	567	251	1242	597	517	1750	930
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	0.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	34.7	0.0	30.0	42.1	31.0	30.3	57.1	35.7	35.7	47.5	17.0	17.1
Incr Delay (d2), s/veh	0.1	0.0	0.1	7.1	0.2	0.2	16.1	4.5	8.9	13.2	0.1	0.1
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	0.9	0.0	2.2	11.2	3.7	2.3	2.1	15.5	15.6	11.1	3.8	4.1
LnGrp Delay(d),s/veh	34.8	0.0	30.1	49.2	31.2	30.5	73.2	40.2	44.6	60.7	17.1	17.2
LnGrp LOS	C		C	D	C	C	E	D	D	E	B	B
Approach Vol, veh/h		122			566			1500			922	
Approach Delay, s/veh		31.4			41.4			42.8			31.5	
Approach LOS		C			D			D			C	

Timer	1	2	3	4	5	6	7	8
Assigned Phs	1	2		4	5	6		8
Phs Duration (G+Y+Rc), s	28.9	47.9		43.3	10.7	66.1		43.3
Change Period (Y+Rc), s	6.0	6.0		6.0	6.0	6.0		6.0
Max Green Setting (Gmax), s	35.0	44.0		43.0	17.0	62.0		43.0
Max Q Clear Time (g_c+I1), s	22.1	33.6		35.3	5.6	10.2		11.8
Green Ext Time (p_c), s	0.7	8.3		2.0	0.1	25.0		3.2

Intersection Summary	
HCM 2010 Ctrl Delay	38.7
HCM 2010 LOS	D

Intersection	
Int Delay, s/veh	7.7

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Vol, veh/h	5	5	195	5	5	90
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	-	-	0	-
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	5	5	212	5	5	98

Major/Minor	Major1		Major2		Minor1	
Conflicting Flow All	0	0	11	0	437	8
Stage 1	-	-	-	-	8	-
Stage 2	-	-	-	-	429	-
Critical Hdwy	-	-	4.12	-	6.42	6.22
Critical Hdwy Stg 1	-	-	-	-	5.42	-
Critical Hdwy Stg 2	-	-	-	-	5.42	-
Follow-up Hdwy	-	-	2.218	-	3.518	3.318
Pot Cap-1 Maneuver	-	-	1608	-	577	1074
Stage 1	-	-	-	-	1015	-
Stage 2	-	-	-	-	657	-
Platoon blocked, %	-	-		-		
Mov Cap-1 Maneuver	-	-	1608	-	501	1074
Mov Cap-2 Maneuver	-	-	-	-	501	-
Stage 1	-	-	-	-	1015	-
Stage 2	-	-	-	-	570	-

Approach	EB	WB	NB
HCM Control Delay, s	0	7.4	9
HCM LOS			A

Minor Lane/Major Mvmt	NBLn1	EBT	EBR	WBL	WBT
Capacity (veh/h)	1013	-	-	1608	-
HCM Lane V/C Ratio	0.102	-	-	0.132	-
HCM Control Delay (s)	9	-	-	7.6	0
HCM Lane LOS	A	-	-	A	A
HCM 95th %tile Q(veh)	0.3	-	-	0.5	-

Intersection												
Int Delay, s/veh	4.7											

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Vol, veh/h	70	295	0	0	655	20	0	0	0	15	0	180
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Free	Free	Stop	Stop	Stop	Stop	Stop	Stop
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	-	-	-	-	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	92	92	92	92	92	92	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2	2	2	2	2	2	2
Mvmt Flow	76	321	0	0	712	22	0	0	0	16	0	196

Major/Minor	Major1			Major2			Minor1			Minor2		
Conflicting Flow All	734	0	0	321	0	0	1294	1207	321	1196	1196	723
Stage 1	-	-	-	-	-	-	473	473	-	723	723	-
Stage 2	-	-	-	-	-	-	821	734	-	473	473	-
Critical Hdwy	4.12	-	-	4.12	-	-	7.12	6.52	6.22	7.12	6.52	6.22
Critical Hdwy Stg 1	-	-	-	-	-	-	6.12	5.52	-	6.12	5.52	-
Critical Hdwy Stg 2	-	-	-	-	-	-	6.12	5.52	-	6.12	5.52	-
Follow-up Hdwy	2.218	-	-	2.218	-	-	3.518	4.018	3.318	3.518	4.018	3.318
Pot Cap-1 Maneuver	871	-	-	1239	-	-	139	183	720	163	186	426
Stage 1	-	-	-	-	-	-	572	558	-	417	431	-
Stage 2	-	-	-	-	-	-	369	426	-	572	558	-
Platoon blocked, %		-	-		-	-						
Mov Cap-1 Maneuver	871	-	-	1239	-	-	69	164	720	150	166	426
Mov Cap-2 Maneuver	-	-	-	-	-	-	69	164	-	150	166	-
Stage 1	-	-	-	-	-	-	511	499	-	373	431	-
Stage 2	-	-	-	-	-	-	200	426	-	511	499	-

Approach	EB	WB	NB	SB
HCM Control Delay, s	1.8	0	0	26.6
HCM LOS			A	D

Minor Lane/Major Mvmt	NBLn1	EBL	EBT	EBR	WBL	WBT	WBR	SBLn1
Capacity (veh/h)	-	871	-	-	1239	-	-	373
HCM Lane V/C Ratio	-	0.087	-	-	-	-	-	0.568
HCM Control Delay (s)	0	9.5	0	-	0	-	-	26.6
HCM Lane LOS	A	A	A	-	A	-	-	D
HCM 95th %tile Q(veh)	-	0.3	-	-	0	-	-	3.4

Intersection	
Int Delay, s/veh	0.5

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Vol, veh/h	295	10	25	685	10	5
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	50	-	0	-
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	321	11	27	745	11	5

Major/Minor	Major1		Major2		Minor1	
Conflicting Flow All	0	0	332	0	1125	326
Stage 1	-	-	-	-	326	-
Stage 2	-	-	-	-	799	-
Critical Hdwy	-	-	4.12	-	6.42	6.22
Critical Hdwy Stg 1	-	-	-	-	5.42	-
Critical Hdwy Stg 2	-	-	-	-	5.42	-
Follow-up Hdwy	-	-	2.218	-	3.518	3.318
Pot Cap-1 Maneuver	-	-	1227	-	227	715
Stage 1	-	-	-	-	731	-
Stage 2	-	-	-	-	443	-
Platoon blocked, %	-	-		-		
Mov Cap-1 Maneuver	-	-	1227	-	222	715
Mov Cap-2 Maneuver	-	-	-	-	222	-
Stage 1	-	-	-	-	731	-
Stage 2	-	-	-	-	433	-

Approach	EB	WB	NB
HCM Control Delay, s	0	0.3	18.2
HCM LOS			C

Minor Lane/Major Mvmt	NBLn1	EBT	EBR	WBL	WBT
Capacity (veh/h)	288	-	-	1227	-
HCM Lane V/C Ratio	0.057	-	-	0.022	-
HCM Control Delay (s)	18.2	-	-	8	-
HCM Lane LOS	C	-	-	A	-
HCM 95th %tile Q(veh)	0.2	-	-	0.1	-

Intersection	
Int Delay, s/veh	0

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Vol, veh/h	0	300	0	0	725	0	0	0	0	0	0	0
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Free	Free	Stop	Stop	Stop	Stop	Stop	Stop
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	-	-	-	-	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	92	92	92	92	92	92	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2	2	2	2	2	2	2
Mvmt Flow	0	326	0	0	788	0	0	0	0	0	0	0

Major/Minor	Major1			Major2			Minor1			Minor2		
Conflicting Flow All	788	0	0	326	0	0	1114	1114	326	1114	1114	788
Stage 1	-	-	-	-	-	-	326	326	-	788	788	-
Stage 2	-	-	-	-	-	-	788	788	-	326	326	-
Critical Hdwy	4.12	-	-	4.12	-	-	7.12	6.52	6.22	7.12	6.52	6.22
Critical Hdwy Stg 1	-	-	-	-	-	-	6.12	5.52	-	6.12	5.52	-
Critical Hdwy Stg 2	-	-	-	-	-	-	6.12	5.52	-	6.12	5.52	-
Follow-up Hdwy	2.218	-	-	2.218	-	-	3.518	4.018	3.318	3.518	4.018	3.318
Pot Cap-1 Maneuver	831	-	-	1234	-	-	185	208	715	185	208	391
Stage 1	-	-	-	-	-	-	687	648	-	384	402	-
Stage 2	-	-	-	-	-	-	384	402	-	687	648	-
Platoon blocked, %		-	-		-	-						
Mov Cap-1 Maneuver	831	-	-	1234	-	-	185	208	715	185	208	391
Mov Cap-2 Maneuver	-	-	-	-	-	-	185	208	-	185	208	-
Stage 1	-	-	-	-	-	-	687	648	-	384	402	-
Stage 2	-	-	-	-	-	-	384	402	-	687	648	-

Approach	EB	WB	NB	SB
HCM Control Delay, s	0	0	0	0
HCM LOS			A	A

Minor Lane/Major Mvmt	NBLn1	EBL	EBT	EBR	WBL	WBT	WBR	SBLn1
Capacity (veh/h)	-	831	-	-	1234	-	-	-
HCM Lane V/C Ratio	-	-	-	-	-	-	-	-
HCM Control Delay (s)	0	0	-	-	0	-	-	0
HCM Lane LOS	A	A	-	-	A	-	-	A
HCM 95th %tile Q(veh)	-	0	-	-	0	-	-	-

Intersection	
Int Delay, s/veh	0.4

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Vol, veh/h	0	295	710	5	10	10
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	-	-	0	-
Veh in Median Storage, #	-	0	0	-	0	-
Grade, %	-	0	0	-	0	-
Peak Hour Factor	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	0	321	772	5	11	11

Major/Minor	Major1		Major2		Minor2	
Conflicting Flow All	777	0	-	0	1095	774
Stage 1	-	-	-	-	774	-
Stage 2	-	-	-	-	321	-
Critical Hdwy	4.12	-	-	-	6.42	6.22
Critical Hdwy Stg 1	-	-	-	-	5.42	-
Critical Hdwy Stg 2	-	-	-	-	5.42	-
Follow-up Hdwy	2.218	-	-	-	3.518	3.318
Pot Cap-1 Maneuver	839	-	-	-	236	398
Stage 1	-	-	-	-	455	-
Stage 2	-	-	-	-	735	-
Platoon blocked, %		-	-	-		
Mov Cap-1 Maneuver	839	-	-	-	236	398
Mov Cap-2 Maneuver	-	-	-	-	236	-
Stage 1	-	-	-	-	455	-
Stage 2	-	-	-	-	735	-

Approach	EB	WB	SB
HCM Control Delay, s	0	0	18.1
HCM LOS			C

Minor Lane/Major Mvmt	EBL	EBT	WBT	WBR	SBLn1
Capacity (veh/h)	839	-	-	-	296
HCM Lane V/C Ratio	-	-	-	-	0.073
HCM Control Delay (s)	0	-	-	-	18.1
HCM Lane LOS	A	-	-	-	C
HCM 95th %tile Q(veh)	0	-	-	-	0.2

Intersection	
Int Delay, s/veh	0.3

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Vol, veh/h	5	290	0	0	705	15	0	0	0	5	0	10
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Free	Free	Stop	Stop	Stop	Stop	Stop	Stop
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	-	-	-	-	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	92	92	92	92	92	92	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2	2	2	2	2	2	2
Mvmt Flow	5	315	0	0	766	16	0	0	0	5	0	11

Major/Minor	Major1			Major2			Minor1			Minor2		
Conflicting Flow All	783	0	0	315	0	0	1106	1109	315	1100	1100	774
Stage 1	-	-	-	-	-	-	326	326	-	774	774	-
Stage 2	-	-	-	-	-	-	780	783	-	326	326	-
Critical Hdwy	4.12	-	-	4.12	-	-	7.12	6.52	6.22	7.12	6.52	6.22
Critical Hdwy Stg 1	-	-	-	-	-	-	6.12	5.52	-	6.12	5.52	-
Critical Hdwy Stg 2	-	-	-	-	-	-	6.12	5.52	-	6.12	5.52	-
Follow-up Hdwy	2.218	-	-	2.218	-	-	3.518	4.018	3.318	3.518	4.018	3.318
Pot Cap-1 Maneuver	835	-	-	1245	-	-	188	210	725	190	212	398
Stage 1	-	-	-	-	-	-	687	648	-	391	408	-
Stage 2	-	-	-	-	-	-	388	404	-	687	648	-
Platoon blocked, %		-	-		-	-						
Mov Cap-1 Maneuver	835	-	-	1245	-	-	182	209	725	189	211	398
Mov Cap-2 Maneuver	-	-	-	-	-	-	182	209	-	189	211	-
Stage 1	-	-	-	-	-	-	682	643	-	388	408	-
Stage 2	-	-	-	-	-	-	377	404	-	682	643	-

Approach	EB	WB	NB	SB
HCM Control Delay, s	0.2	0	0	18.1
HCM LOS			A	C

Minor Lane/Major Mvmt	NBLn1	EBL	EBT	EBR	WBL	WBT	WBR	SBLn1
Capacity (veh/h)	-	835	-	-	1245	-	-	291
HCM Lane V/C Ratio	-	0.007	-	-	-	-	-	0.056
HCM Control Delay (s)	0	9.3	0	-	0	-	-	18.1
HCM Lane LOS	A	A	A	-	A	-	-	C
HCM 95th %tile Q(veh)	-	0	-	-	0	-	-	0.2

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	10	125	185	95	285	235	390	1015	180	160	720	50
Number	7	4	14	3	8	18	5	2	12	1	6	16
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1863	1863	1900	1863	1863	1863	1863	1863	1863	1863	1863	1863
Adj Flow Rate, veh/h	11	136	17	103	310	42	424	1103	109	174	783	12
Adj No. of Lanes	1	2	0	1	1	1	1	2	1	1	2	1
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Percent Heavy Veh, %	2	2	2	2	2	2	2	2	2	2	2	2
Cap, veh/h	18	434	53	128	370	314	458	1682	752	203	1175	525
Arrive On Green	0.01	0.14	0.14	0.07	0.20	0.20	0.26	0.48	0.48	0.11	0.33	0.33
Sat Flow, veh/h	1774	3173	391	1774	1863	1583	1774	3539	1583	1774	3539	1583
Grp Volume(v), veh/h	11	75	78	103	310	42	424	1103	109	174	783	12
Grp Sat Flow(s),veh/h/ln	1774	1770	1794	1774	1863	1583	1774	1770	1583	1774	1770	1583
Q Serve(g_s), s	0.7	4.6	4.7	6.8	19.1	2.6	27.8	28.3	4.6	11.5	22.6	0.6
Cycle Q Clear(g_c), s	0.7	4.6	4.7	6.8	19.1	2.6	27.8	28.3	4.6	11.5	22.6	0.6
Prop In Lane	1.00		0.22	1.00		1.00	1.00		1.00	1.00		1.00
Lane Grp Cap(c), veh/h	18	242	245	128	370	314	458	1682	752	203	1175	525
V/C Ratio(X)	0.61	0.31	0.32	0.80	0.84	0.13	0.93	0.66	0.14	0.86	0.67	0.02
Avail Cap(c_a), veh/h	193	549	557	193	578	491	580	1960	877	298	1395	624
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	58.8	46.4	46.4	54.5	45.9	39.3	43.1	23.8	17.6	51.8	34.2	26.8
Incr Delay (d2), s/veh	28.3	0.7	0.7	13.4	6.3	0.2	18.4	0.6	0.1	14.8	0.9	0.0
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	0.5	2.3	2.4	3.8	10.5	1.2	15.9	13.9	2.0	6.4	11.2	0.3
LnGrp Delay(d),s/veh	87.1	47.1	47.2	67.9	52.3	39.5	61.5	24.5	17.7	66.6	35.1	26.8
LnGrp LOS	F	D	D	E	D	D	E	C	B	E	D	C
Approach Vol, veh/h		164			455			1636			969	
Approach Delay, s/veh		49.8			54.6			33.6			40.7	
Approach LOS		D			D			C			D	

Timer	1	2	3	4	5	6	7	8
Assigned Phs	1	2	3	4	5	6	7	8
Phs Duration (G+Y+Rc), s	19.7	62.6	14.6	22.3	36.8	45.6	7.2	29.7
Change Period (Y+Rc), s	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0
Max Green Setting (Gmax), s	20.0	66.0	13.0	37.0	39.0	47.0	13.0	37.0
Max Q Clear Time (g_c+I1), s	13.5	30.3	8.8	6.7	29.8	24.6	2.7	21.1
Green Ext Time (p_c), s	0.2	20.0	0.1	3.1	1.0	14.9	0.0	2.6

Intersection Summary	
HCM 2010 Ctrl Delay	39.5
HCM 2010 LOS	D

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	290	145	185	55	240	285	195	1365	5	185	950	140
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	6.0	4.0	4.0	6.0
Lane Util. Factor	0.91	0.91	1.00	1.00	1.00	0.88	0.97	0.91	1.00	0.97	0.91	1.00
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	0.98	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	1610	3308	1583	1770	1863	2787	3433	5085	1583	3433	5085	1583
Flt Permitted	0.95	0.98	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)	1610	3308	1583	1770	1863	2787	3433	5085	1583	3433	5085	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)	315	158	201	60	261	310	212	1484	5	201	1033	152
RTOR Reduction (vph)	0	0	62	0	0	199	0	0	2	0	0	74
Lane Group Flow (vph)	157	316	139	60	261	111	212	1484	3	201	1033	78
Turn Type	Split	NA	Perm	Split	NA	Perm	Prot	NA	Perm	Prot	NA	Perm
Protected Phases	3	3		4	4		5	2		1	6	
Permitted Phases			3			4			2			6
Actuated Green, G (s)	32.6	32.6	32.6	40.2	40.2	40.2	20.1	123.1	123.1	19.1	122.1	122.1
Effective Green, g (s)	34.6	34.6	34.6	42.2	42.2	42.2	22.1	126.1	124.1	21.1	125.1	123.1
Actuated g/C Ratio	0.14	0.14	0.14	0.18	0.18	0.18	0.09	0.53	0.52	0.09	0.52	0.51
Clearance Time (s)	6.0	6.0	6.0	6.0	6.0	6.0	6.0	7.0	7.0	6.0	7.0	7.0
Vehicle Extension (s)	5.0	5.0	5.0	5.0	5.0	5.0	3.0	5.0	5.0	3.0	5.0	5.0
Lane Grp Cap (vph)	232	476	228	311	327	490	316	2671	818	301	2650	811
v/s Ratio Prot	c0.10	0.10		0.03	c0.14		c0.06	c0.29		0.06	0.20	
v/s Ratio Perm			0.09			0.04			0.00			0.05
v/c Ratio	0.68	0.66	0.61	0.19	0.80	0.23	0.67	0.56	0.00	0.67	0.39	0.10
Uniform Delay, d1	97.4	97.2	96.3	84.4	94.8	84.9	105.4	38.2	28.0	106.1	34.5	29.9
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.73	1.63	7.17
Incremental Delay, d2	9.8	4.6	6.6	0.6	14.5	0.5	5.5	0.8	0.0	5.0	0.4	0.2
Delay (s)	107.2	101.8	102.9	85.0	109.3	85.4	110.9	39.0	28.0	82.7	56.6	215.0
Level of Service	F	F	F	F	F	F	F	D	C	F	E	F
Approach Delay (s)		103.4			95.2			47.9			77.7	
Approach LOS		F			F			D			E	

Intersection Summary			
HCM 2000 Control Delay	72.6	HCM 2000 Level of Service	E
HCM 2000 Volume to Capacity ratio	0.63		
Actuated Cycle Length (s)	240.0	Sum of lost time (s)	16.0
Intersection Capacity Utilization	65.9%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	415	5	135	5	15	15	250	2625	20	75	1265	325
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		6.0	4.0	6.0	5.0	6.0	4.0	5.0	7.0
Lane Util. Factor	0.95	0.95	1.00		1.00	1.00	1.00	0.91	1.00	1.00	0.91	1.00
Frpb, ped/bikes	1.00	1.00	0.91		1.00	1.00	1.00	1.00	0.83	1.00	1.00	0.97
Flpb, ped/bikes	1.00	1.00	1.00		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Frt	1.00	1.00	0.85		1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	0.95	1.00		0.99	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	1681	1687	1434		1841	1583	1770	5085	1311	1770	5085	1536
Flt Permitted	0.95	0.95	1.00		0.99	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)	1681	1687	1434		1841	1583	1770	5085	1311	1770	5085	1536
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	451	5	147	5	16	16	272	2853	22	82	1375	353
RTOR Reduction (vph)	0	0	83	0	0	15	0	0	8	0	0	169
Lane Group Flow (vph)	230	226	64	0	21	1	272	2853	14	82	1375	184
Confl. Peds. (#/hr)			43						31			2
Turn Type	Split	NA	Perm	Split	NA	Perm	Prot	NA	Perm	Prot	NA	Perm
Protected Phases	4	4		3	3		5	2		1	6	
Permitted Phases			4			3			2			6
Actuated Green, G (s)	40.5	40.5	40.5		7.1	7.1	43.3	153.4	153.4	15.0	125.1	125.1
Effective Green, g (s)	40.5	40.5	40.5		7.1	9.1	43.3	155.4	154.4	17.0	127.1	125.1
Actuated g/C Ratio	0.17	0.17	0.17		0.03	0.04	0.18	0.65	0.64	0.07	0.53	0.52
Clearance Time (s)	5.0	5.0	5.0		6.0	6.0	6.0	7.0	7.0	6.0	7.0	7.0
Vehicle Extension (s)	4.0	4.0	4.0		3.0	3.0	5.0	6.0	6.0	3.0	6.0	6.0
Lane Grp Cap (vph)	283	284	241		54	60	319	3292	843	125	2692	800
v/s Ratio Prot	c0.14	0.13			c0.01		c0.15	c0.56		0.05	0.27	
v/s Ratio Perm			0.04			0.00			0.01			0.12
v/c Ratio	0.81	0.80	0.27		0.39	0.01	0.85	0.87	0.02	0.66	0.51	0.23
Uniform Delay, d1	96.1	95.8	86.8		114.3	111.1	95.3	34.0	15.4	108.7	36.4	31.3
Progression Factor	1.00	1.00	1.00		1.00	1.00	1.21	0.62	1.00	1.07	1.00	1.78
Incremental Delay, d2	16.9	15.0	0.8		4.6	0.1	9.9	1.4	0.0	11.2	0.7	0.6
Delay (s)	113.0	110.8	87.6		118.9	111.2	124.9	22.4	15.4	126.9	37.2	56.2
Level of Service	F	F	F		F	F	F	C	B	F	D	E
Approach Delay (s)		106.0			115.6			31.2			45.0	
Approach LOS		F			F			C			D	

Intersection Summary			
HCM 2000 Control Delay	44.3	HCM 2000 Level of Service	D
HCM 2000 Volume to Capacity ratio	0.85		
Actuated Cycle Length (s)	240.0	Sum of lost time (s)	22.0
Intersection Capacity Utilization	94.4%	ICU Level of Service	F
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	750	650	10	230	395	525	55	345	130	630	350	655
Number	7	4	14	3	8	18	5	2	12	1	6	16
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1863	1863	1900	1863	1863	1863	1863	1863	1900	1863	1863	1863
Adj Flow Rate, veh/h	815	707	11	250	429	517	60	375	18	685	380	447
Adj No. of Lanes	2	3	0	2	3	2	1	2	0	2	2	2
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Percent Heavy Veh, %	2	2	2	2	2	2	2	2	2	2	2	2
Cap, veh/h	898	1858	29	319	976	1144	78	528	25	752	1161	1638
Arrive On Green	0.26	0.36	0.36	0.09	0.19	0.19	0.04	0.15	0.15	0.22	0.33	0.33
Sat Flow, veh/h	3442	5159	80	3442	5085	2787	1774	3439	165	3442	3539	2776
Grp Volume(v), veh/h	815	464	254	250	429	517	60	192	201	685	380	447
Grp Sat Flow(s),veh/h/ln	1721	1695	1849	1721	1695	1393	1774	1770	1834	1721	1770	1388
Q Serve(g_s), s	30.1	13.3	13.4	9.3	9.8	17.7	4.4	13.6	13.7	25.5	10.6	10.4
Cycle Q Clear(g_c), s	30.1	13.3	13.4	9.3	9.8	17.7	4.4	13.6	13.7	25.5	10.6	10.4
Prop In Lane	1.00		0.04	1.00		1.00	1.00		0.09	1.00		1.00
Lane Grp Cap(c), veh/h	898	1221	666	319	976	1144	78	272	282	752	1161	1638
V/C Ratio(X)	0.91	0.38	0.38	0.78	0.44	0.45	0.77	0.71	0.71	0.91	0.33	0.27
Avail Cap(c_a), veh/h	1047	1221	666	942	1470	1415	513	633	656	838	1161	1638
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	47.1	31.2	31.2	58.4	46.9	28.0	62.2	52.8	52.9	50.1	33.2	13.2
Incr Delay (d2), s/veh	10.3	0.2	0.4	4.2	0.3	0.3	14.3	3.4	3.3	13.1	0.2	0.1
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	15.7	6.3	6.9	4.6	4.6	6.8	2.5	6.9	7.2	13.5	5.2	4.0
LnGrp Delay(d),s/veh	57.4	31.4	31.6	62.6	47.2	28.3	76.5	56.2	56.2	63.2	33.4	13.3
LnGrp LOS	E	C	C	E	D	C	E	E	E	E	C	B
Approach Vol, veh/h		1533			1196			453			1512	
Approach Delay, s/veh		45.2			42.3			58.9			41.0	
Approach LOS		D			D			E			D	

Timer	1	2	3	4	5	6	7	8
Assigned Phs	1	2	3	4	5	6	7	8
Phs Duration (G+Y+Rc), s	33.7	26.2	18.2	53.3	10.8	49.1	40.3	31.2
Change Period (Y+Rc), s	5.0	6.0	6.0	6.0	5.0	6.0	6.0	6.0
Max Green Setting (Gmax), s	32.0	47.0	36.0	42.0	38.0	41.0	40.0	38.0
Max Q Clear Time (g_c+I1), s	27.5	15.7	11.3	15.4	6.4	12.6	32.1	19.7
Green Ext Time (p_c), s	1.2	3.5	0.8	11.7	0.1	7.8	2.1	5.6

Intersection Summary	
HCM 2010 Ctrl Delay	44.4
HCM 2010 LOS	D

Notes

User approved changes to right turn type.

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	70	125	65	180	70	295	35	810	120	320	1100	55
Number	3	8	18	7	4	14	5	2	12	1	6	16
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1863	1863	1900	1863	1863	1863	1863	1863	1900	1863	1863	1900
Adj Flow Rate, veh/h	76	136	53	196	76	58	38	880	110	348	1196	57
Adj No. of Lanes	1	1	0	1	1	1	1	3	0	1	3	0
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Percent Heavy Veh, %	2	2	2	2	2	2	2	2	2	2	2	2
Cap, veh/h	402	368	143	321	536	456	48	1351	168	387	2417	115
Arrive On Green	0.29	0.29	0.29	0.29	0.29	0.29	0.03	0.29	0.29	0.22	0.49	0.49
Sat Flow, veh/h	1250	1277	498	1189	1863	1583	1774	4582	570	1774	4974	237
Grp Volume(v), veh/h	76	0	189	196	76	58	38	650	340	348	815	438
Grp Sat Flow(s),veh/h/ln	1250	0	1775	1189	1863	1583	1774	1695	1762	1774	1695	1821
Q Serve(g_s), s	4.3	0.0	7.7	14.2	2.7	2.4	1.9	15.1	15.2	17.2	14.7	14.7
Cycle Q Clear(g_c), s	7.1	0.0	7.7	21.9	2.7	2.4	1.9	15.1	15.2	17.2	14.7	14.7
Prop In Lane	1.00		0.28	1.00		1.00	1.00		0.32	1.00		0.13
Lane Grp Cap(c), veh/h	402	0	511	321	536	456	48	1000	520	387	1648	885
V/C Ratio(X)	0.19	0.00	0.37	0.61	0.14	0.13	0.79	0.65	0.65	0.90	0.49	0.49
Avail Cap(c_a), veh/h	512	0	667	426	700	595	471	1462	760	471	1648	885
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	0.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	26.5	0.0	25.7	34.4	23.9	23.8	43.7	27.8	27.8	34.4	15.7	15.7
Incr Delay (d2), s/veh	0.2	0.0	0.4	1.9	0.1	0.1	23.9	0.7	1.4	17.6	0.2	0.4
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	1.5	0.0	3.8	4.8	1.4	1.1	1.3	7.1	7.6	10.3	6.8	7.4
LnGrp Delay(d),s/veh	26.8	0.0	26.1	36.3	24.0	23.9	67.6	28.5	29.3	51.9	16.0	16.2
LnGrp LOS	C		C	D	C	C	E	C	C	D	B	B
Approach Vol, veh/h		265			330			1028			1601	
Approach Delay, s/veh		26.3			31.3			30.2			23.8	
Approach LOS		C			C			C			C	

Timer	1	2	3	4	5	6	7	8
Assigned Phs	1	2		4	5	6		8
Phs Duration (G+Y+Rc), s	25.7	32.7		32.0	8.5	49.9		32.0
Change Period (Y+Rc), s	6.0	6.0		6.0	6.0	6.0		6.0
Max Green Setting (Gmax), s	24.0	39.0		34.0	24.0	39.0		34.0
Max Q Clear Time (g_c+I1), s	19.2	17.2		23.9	3.9	16.7		9.7
Green Ext Time (p_c), s	0.5	9.4		2.1	0.1	16.1		2.9

Intersection Summary	
HCM 2010 Ctrl Delay	26.8
HCM 2010 LOS	C

Intersection	
Int Delay, s/veh	8.4

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Vol, veh/h	2	3	135	2	6	193
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	-	-	0	-
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	2	3	147	2	7	210

Major/Minor	Major1		Major2		Minor1	
Conflicting Flow All	0	0	5	0	300	4
Stage 1	-	-	-	-	4	-
Stage 2	-	-	-	-	296	-
Critical Hdwy	-	-	4.12	-	6.42	6.22
Critical Hdwy Stg 1	-	-	-	-	5.42	-
Critical Hdwy Stg 2	-	-	-	-	5.42	-
Follow-up Hdwy	-	-	2.218	-	3.518	3.318
Pot Cap-1 Maneuver	-	-	1616	-	691	1080
Stage 1	-	-	-	-	1019	-
Stage 2	-	-	-	-	755	-
Platoon blocked, %	-	-		-		
Mov Cap-1 Maneuver	-	-	1616	-	628	1080
Mov Cap-2 Maneuver	-	-	-	-	628	-
Stage 1	-	-	-	-	1019	-
Stage 2	-	-	-	-	686	-

Approach	EB	WB	NB
HCM Control Delay, s	0	7.3	9.3
HCM LOS			A

Minor Lane/Major Mvmt	NBLn1	EBT	EBR	WBL	WBT
Capacity (veh/h)	1057	-	-	1616	-
HCM Lane V/C Ratio	0.205	-	-	0.091	-
HCM Control Delay (s)	9.3	-	-	7.5	0
HCM Lane LOS	A	-	-	A	A
HCM 95th %tile Q(veh)	0.8	-	-	0.3	-

Intersection	
Int Delay, s/veh	3.2

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Vol, veh/h	172	583	0	0	331	17	0	0	0	14	0	123
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Free	Free	Stop	Stop	Stop	Stop	Stop	Stop
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	-	-	-	-	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	92	92	92	92	92	92	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2	2	2	2	2	2	2
Mvmt Flow	187	634	0	0	360	18	0	0	0	15	0	134

Major/Minor	Major1			Major2			Minor1			Minor2		
Conflicting Flow All	378	0	0	634	0	0	1444	1386	634	1377	1377	369
Stage 1	-	-	-	-	-	-	1008	1008	-	369	369	-
Stage 2	-	-	-	-	-	-	436	378	-	1008	1008	-
Critical Hdwy	4.12	-	-	4.12	-	-	7.12	6.52	6.22	7.12	6.52	6.22
Critical Hdwy Stg 1	-	-	-	-	-	-	6.12	5.52	-	6.12	5.52	-
Critical Hdwy Stg 2	-	-	-	-	-	-	6.12	5.52	-	6.12	5.52	-
Follow-up Hdwy	2.218	-	-	2.218	-	-	3.518	4.018	3.318	3.518	4.018	3.318
Pot Cap-1 Maneuver	1180	-	-	949	-	-	110	143	479	122	145	677
Stage 1	-	-	-	-	-	-	290	318	-	651	621	-
Stage 2	-	-	-	-	-	-	599	615	-	290	318	-
Platoon blocked, %		-	-		-	-						
Mov Cap-1 Maneuver	1180	-	-	949	-	-	72	108	479	99	109	677
Mov Cap-2 Maneuver	-	-	-	-	-	-	72	108	-	99	109	-
Stage 1	-	-	-	-	-	-	219	240	-	492	621	-
Stage 2	-	-	-	-	-	-	481	615	-	219	240	-

Approach	EB	WB	NB	SB
HCM Control Delay, s	2	0	0	18
HCM LOS			A	C

Minor Lane/Major Mvmt	NBLn1	EBL	EBT	EBR	WBL	WBT	WBR	SBLn1
Capacity (veh/h)	-	1180	-	-	949	-	-	424
HCM Lane V/C Ratio	-	0.158	-	-	-	-	-	0.351
HCM Control Delay (s)	0	8.6	0	-	0	-	-	18
HCM Lane LOS	A	A	A	-	A	-	-	C
HCM 95th %tile Q(veh)	-	0.6	-	-	0	-	-	1.6

Intersection	
Int Delay, s/veh	0.6

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Vol, veh/h	624	13	11	345	9	19
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	50	-	0	-
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	678	14	12	375	10	21

Major/Minor	Major1		Major2		Minor1	
Conflicting Flow All	0	0	692	0	1084	685
Stage 1	-	-	-	-	685	-
Stage 2	-	-	-	-	399	-
Critical Hdwy	-	-	4.12	-	6.42	6.22
Critical Hdwy Stg 1	-	-	-	-	5.42	-
Critical Hdwy Stg 2	-	-	-	-	5.42	-
Follow-up Hdwy	-	-	2.218	-	3.518	3.318
Pot Cap-1 Maneuver	-	-	903	-	240	448
Stage 1	-	-	-	-	500	-
Stage 2	-	-	-	-	678	-
Platoon blocked, %	-	-		-		
Mov Cap-1 Maneuver	-	-	903	-	237	448
Mov Cap-2 Maneuver	-	-	-	-	237	-
Stage 1	-	-	-	-	500	-
Stage 2	-	-	-	-	669	-

Approach	EB	WB	NB
HCM Control Delay, s	0	0.3	16.3
HCM LOS			C

Minor Lane/Major Mvmt	NBLn1	EBT	EBR	WBL	WBT
Capacity (veh/h)	348	-	-	903	-
HCM Lane V/C Ratio	0.087	-	-	0.013	-
HCM Control Delay (s)	16.3	-	-	9	-
HCM Lane LOS	C	-	-	A	-
HCM 95th %tile Q(veh)	0.3	-	-	0	-

Intersection	
Int Delay, s/veh	0

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Vol, veh/h	1	617	0	1	352	1	0	0	2	0	0	0
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Free	Free	Stop	Stop	Stop	Stop	Stop	Stop
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	-	-	-	-	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	92	92	92	92	92	92	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2	2	2	2	2	2	2
Mvmt Flow	1	671	0	1	383	1	0	0	2	0	0	0

Major/Minor	Major1			Major2			Minor1			Minor2		
Conflicting Flow All	384	0	0	671	0	0	1058	1059	671	1059	1058	383
Stage 1	-	-	-	-	-	-	673	673	-	385	385	-
Stage 2	-	-	-	-	-	-	385	386	-	674	673	-
Critical Hdwy	4.12	-	-	4.12	-	-	7.12	6.52	6.22	7.12	6.52	6.22
Critical Hdwy Stg 1	-	-	-	-	-	-	6.12	5.52	-	6.12	5.52	-
Critical Hdwy Stg 2	-	-	-	-	-	-	6.12	5.52	-	6.12	5.52	-
Follow-up Hdwy	2.218	-	-	2.218	-	-	3.518	4.018	3.318	3.518	4.018	3.318
Pot Cap-1 Maneuver	1174	-	-	919	-	-	203	224	456	202	225	664
Stage 1	-	-	-	-	-	-	445	454	-	638	611	-
Stage 2	-	-	-	-	-	-	638	610	-	444	454	-
Platoon blocked, %		-	-		-	-						
Mov Cap-1 Maneuver	1174	-	-	919	-	-	203	224	456	201	225	664
Mov Cap-2 Maneuver	-	-	-	-	-	-	203	224	-	201	225	-
Stage 1	-	-	-	-	-	-	445	454	-	637	610	-
Stage 2	-	-	-	-	-	-	637	609	-	441	454	-

Approach	EB	WB	NB	SB
HCM Control Delay, s	0	0	12.9	0
HCM LOS			B	A

Minor Lane/Major Mvmt	NBLn1	EBL	EBT	EBR	WBL	WBT	WBR	SBLn1
Capacity (veh/h)	456	1174	-	-	919	-	-	-
HCM Lane V/C Ratio	0.005	0.001	-	-	0.001	-	-	-
HCM Control Delay (s)	12.9	8.1	0	-	8.9	0	-	0
HCM Lane LOS	B	A	A	-	A	A	-	A
HCM 95th %tile Q(veh)	0	0	-	-	0	-	-	-

Intersection	
Int Delay, s/veh	0.2

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Vol, veh/h	0	644	354	2	10	2
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	-	-	0	-
Veh in Median Storage, #	-	0	0	-	0	-
Grade, %	-	0	0	-	0	-
Peak Hour Factor	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	0	700	385	2	11	2

Major/Minor	Major1		Major2		Minor2	
Conflicting Flow All	387	0	-	0	1086	386
Stage 1	-	-	-	-	386	-
Stage 2	-	-	-	-	700	-
Critical Hdwy	4.12	-	-	-	6.42	6.22
Critical Hdwy Stg 1	-	-	-	-	5.42	-
Critical Hdwy Stg 2	-	-	-	-	5.42	-
Follow-up Hdwy	2.218	-	-	-	3.518	3.318
Pot Cap-1 Maneuver	1171	-	-	-	239	662
Stage 1	-	-	-	-	687	-
Stage 2	-	-	-	-	493	-
Platoon blocked, %		-	-	-		
Mov Cap-1 Maneuver	1171	-	-	-	239	662
Mov Cap-2 Maneuver	-	-	-	-	239	-
Stage 1	-	-	-	-	687	-
Stage 2	-	-	-	-	493	-

Approach	EB	WB	SB
HCM Control Delay, s	0	0	19.2
HCM LOS			C

Minor Lane/Major Mvmt	EBL	EBT	WBT	WBR	SBLn1
Capacity (veh/h)	1171	-	-	-	267
HCM Lane V/C Ratio	-	-	-	-	0.049
HCM Control Delay (s)	0	-	-	-	19.2
HCM Lane LOS	A	-	-	-	C
HCM 95th %tile Q(veh)	0	-	-	-	0.2

Intersection	
Int Delay, s/veh	0.7

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Vol, veh/h	10	628	0	0	336	19	0	0	0	19	0	12
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Free	Free	Stop	Stop	Stop	Stop	Stop	Stop
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	-	-	-	-	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	92	92	92	92	92	92	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2	2	2	2	2	2	2
Mvmt Flow	11	683	0	0	365	21	0	0	0	21	0	13

Major/Minor	Major1			Major2			Minor1			Minor2		
Conflicting Flow All	386	0	0	683	0	0	1086	1090	683	1080	1080	376
Stage 1	-	-	-	-	-	-	704	704	-	376	376	-
Stage 2	-	-	-	-	-	-	382	386	-	704	704	-
Critical Hdwy	4.12	-	-	4.12	-	-	7.12	6.52	6.22	7.12	6.52	6.22
Critical Hdwy Stg 1	-	-	-	-	-	-	6.12	5.52	-	6.12	5.52	-
Critical Hdwy Stg 2	-	-	-	-	-	-	6.12	5.52	-	6.12	5.52	-
Follow-up Hdwy	2.218	-	-	2.218	-	-	3.518	4.018	3.318	3.518	4.018	3.318
Pot Cap-1 Maneuver	1172	-	-	910	-	-	194	215	449	196	218	670
Stage 1	-	-	-	-	-	-	428	440	-	645	616	-
Stage 2	-	-	-	-	-	-	640	610	-	428	440	-
Platoon blocked, %		-	-		-	-						
Mov Cap-1 Maneuver	1172	-	-	910	-	-	188	212	449	194	215	670
Mov Cap-2 Maneuver	-	-	-	-	-	-	188	212	-	194	215	-
Stage 1	-	-	-	-	-	-	422	433	-	635	616	-
Stage 2	-	-	-	-	-	-	628	610	-	422	433	-

Approach	EB	WB	NB	SB
HCM Control Delay, s	0.1	0	0	20.4
HCM LOS			A	C

Minor Lane/Major Mvmt	NBLn1	EBL	EBT	EBR	WBL	WBT	WBR	SBLn1
Capacity (veh/h)	-	1172	-	-	910	-	-	268
HCM Lane V/C Ratio	-	0.009	-	-	-	-	-	0.126
HCM Control Delay (s)	0	8.1	0	-	0	-	-	20.4
HCM Lane LOS	A	A	A	-	A	-	-	C
HCM 95th %tile Q(veh)	-	0	-	-	0	-	-	0.4

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	50	280	445	155	215	250	205	715	100	170	910	30
Number	7	4	14	3	8	18	5	2	12	1	6	16
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1863	1863	1900	1863	1863	1863	1863	1863	1863	1863	1863	1863
Adj Flow Rate, veh/h	54	304	280	168	234	64	223	777	33	185	989	9
Adj No. of Lanes	1	2	0	1	1	1	1	2	1	1	2	1
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Percent Heavy Veh, %	2	2	2	2	2	2	2	2	2	2	2	2
Cap, veh/h	71	405	363	196	558	475	254	1210	541	216	1134	508
Arrive On Green	0.04	0.23	0.23	0.11	0.30	0.30	0.14	0.34	0.34	0.12	0.32	0.32
Sat Flow, veh/h	1774	1770	1583	1774	1863	1583	1774	3539	1583	1774	3539	1583
Grp Volume(v), veh/h	54	304	280	168	234	64	223	777	33	185	989	9
Grp Sat Flow(s),veh/h/ln	1774	1770	1583	1774	1863	1583	1774	1770	1583	1774	1770	1583
Q Serve(g_s), s	3.7	19.5	20.2	11.3	12.3	3.6	15.0	22.5	1.7	12.5	32.1	0.5
Cycle Q Clear(g_c), s	3.7	19.5	20.2	11.3	12.3	3.6	15.0	22.5	1.7	12.5	32.1	0.5
Prop In Lane	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Lane Grp Cap(c), veh/h	71	405	363	196	558	475	254	1210	541	216	1134	508
V/C Ratio(X)	0.77	0.75	0.77	0.86	0.42	0.13	0.88	0.64	0.06	0.86	0.87	0.02
Avail Cap(c_a), veh/h	393	668	598	262	566	481	379	1210	541	379	1191	533
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	57.9	43.7	44.0	53.2	34.2	31.1	51.2	33.8	26.9	52.5	39.0	28.3
Incr Delay (d2), s/veh	15.7	2.8	3.5	18.6	0.5	0.1	14.5	1.2	0.0	9.5	7.1	0.0
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	2.1	9.9	9.1	6.6	6.4	1.6	8.4	11.2	0.8	6.7	16.8	0.2
LnGrp Delay(d),s/veh	73.6	46.5	47.5	71.9	34.7	31.3	65.7	35.0	27.0	62.0	46.1	28.3
LnGrp LOS	E	D	D	E	C	C	E	C	C	E	D	C
Approach Vol, veh/h		638			466			1033			1183	
Approach Delay, s/veh		49.3			47.6			41.3			48.4	
Approach LOS		D			D			D			D	

Timer	1	2	3	4	5	6	7	8
Assigned Phs	1	2	3	4	5	6	7	8
Phs Duration (G+Y+Rc), s	20.8	47.7	19.5	33.9	23.4	45.0	10.8	42.5
Change Period (Y+Rc), s	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0
Max Green Setting (Gmax), s	26.0	41.0	18.0	46.0	26.0	41.0	27.0	37.0
Max Q Clear Time (g_c+I1), s	14.5	24.5	13.3	22.2	17.0	34.1	5.7	14.3
Green Ext Time (p_c), s	0.4	11.1	0.2	5.7	0.4	4.9	0.1	5.6

Intersection Summary		
HCM 2010 Ctrl Delay		46.3
HCM 2010 LOS		D

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	215	225	205	15	220	150	215	870	15	350	1545	215
Ideal Flow (vphpl)	1900	1900	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	6.0	4.0	4.0	6.0
Lane Util. Factor	0.91	0.91	1.00	1.00	1.00	0.88	0.97	0.91	1.00	0.97	0.91	1.00
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	0.99	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	1610	3350	1583	1770	1863	2787	3433	5085	1583	3433	5085	1583
Flt Permitted	0.95	0.99	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)	1610	3350	1583	1770	1863	2787	3433	5085	1583	3433	5085	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)	234	245	223	16	239	163	234	946	16	380	1679	234
RTOR Reduction (vph)	0	0	62	0	0	112	0	0	8	0	0	71
Lane Group Flow (vph)	157	322	161	16	239	51	234	946	8	380	1679	163
Turn Type	Split	NA	Perm	Split	NA	Perm	Prot	NA	Perm	Prot	NA	Perm
Protected Phases	3	3		4	4		5	2		1	6	
Permitted Phases			3			4			2			6
Actuated Green, G (s)	33.8	33.8	33.8	35.2	35.2	35.2	21.6	114.9	114.9	31.1	124.4	124.4
Effective Green, g (s)	35.8	35.8	35.8	37.2	37.2	37.2	23.6	117.9	115.9	33.1	127.4	125.4
Actuated g/C Ratio	0.15	0.15	0.15	0.16	0.16	0.16	0.10	0.49	0.48	0.14	0.53	0.52
Clearance Time (s)	6.0	6.0	6.0	6.0	6.0	6.0	6.0	7.0	7.0	6.0	7.0	7.0
Vehicle Extension (s)	5.0	5.0	5.0	5.0	5.0	5.0	3.0	5.0	5.0	3.0	5.0	5.0
Lane Grp Cap (vph)	240	499	236	274	288	431	337	2498	764	473	2699	827
v/s Ratio Prot	0.10	0.10		0.01	c0.13		0.07	0.19		c0.11	c0.33	
v/s Ratio Perm			c0.10			0.02			0.00			0.10
v/c Ratio	0.65	0.65	0.68	0.06	0.83	0.12	0.69	0.38	0.01	0.80	0.62	0.20
Uniform Delay, d1	96.3	96.1	96.7	86.5	98.3	87.3	104.7	38.2	32.2	100.3	39.4	30.5
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.13	0.91	1.16
Incremental Delay, d2	8.3	3.9	10.0	0.2	19.5	0.3	6.1	0.4	0.0	9.4	1.1	0.5
Delay (s)	104.6	100.0	106.7	86.7	117.9	87.5	110.8	38.6	32.3	123.1	37.2	36.0
Level of Service	F	F	F	F	F	F	F	D	C	F	D	D
Approach Delay (s)		103.2			104.8			52.6			51.3	
Approach LOS		F			F			D			D	

Intersection Summary			
HCM 2000 Control Delay	64.4	HCM 2000 Level of Service	E
HCM 2000 Volume to Capacity ratio	0.70		
Actuated Cycle Length (s)	240.0	Sum of lost time (s)	16.0
Intersection Capacity Utilization	69.2%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	395	40	135	35	35	25	125	1495	60	75	2630	380
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		6.0	4.0	6.0	5.0	6.0	4.0	5.0	7.0
Lane Util. Factor	0.95	0.95	1.00		1.00	1.00	1.00	0.91	1.00	1.00	0.91	1.00
Frpb, ped/bikes	1.00	1.00	0.91		1.00	1.00	1.00	1.00	0.83	1.00	1.00	0.97
Flpb, ped/bikes	1.00	1.00	1.00		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Frt	1.00	1.00	0.85		1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	0.96	1.00		0.98	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	1681	1700	1434		1817	1583	1770	5085	1311	1770	5085	1536
Flt Permitted	0.95	0.96	1.00		0.98	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)	1681	1700	1434		1817	1583	1770	5085	1311	1770	5085	1536
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	429	43	147	38	38	27	136	1625	65	82	2859	413
RTOR Reduction (vph)	0	0	83	0	0	25	0	0	26	0	0	181
Lane Group Flow (vph)	236	236	64	0	76	2	136	1625	39	82	2859	232
Confl. Peds. (#/hr)			43						31			2
Turn Type	Split	NA	Perm	Split	NA	Perm	Prot	NA	Perm	Prot	NA	Perm
Protected Phases	4	4		3	3		5	2		1	6	
Permitted Phases			4			3			2			6
Actuated Green, G (s)	40.9	40.9	40.9		15.4	15.4	25.1	143.8	143.8	15.9	134.6	134.6
Effective Green, g (s)	40.9	40.9	40.9		15.4	17.4	25.1	145.8	144.8	17.9	136.6	134.6
Actuated g/C Ratio	0.17	0.17	0.17		0.06	0.07	0.10	0.61	0.60	0.07	0.57	0.56
Clearance Time (s)	5.0	5.0	5.0		6.0	6.0	6.0	7.0	7.0	6.0	7.0	7.0
Vehicle Extension (s)	4.0	4.0	4.0		3.0	3.0	5.0	6.0	6.0	3.0	6.0	6.0
Lane Grp Cap (vph)	286	289	244		116	114	185	3089	790	132	2894	861
v/s Ratio Prot	c0.14	0.14			c0.04		c0.08	0.32		0.05	c0.56	
v/s Ratio Perm			0.04			0.00			0.03			0.15
v/c Ratio	0.83	0.82	0.26		0.66	0.02	0.74	0.53	0.05	0.62	0.99	0.27
Uniform Delay, d1	96.1	95.9	86.5		109.7	103.4	104.2	27.2	19.5	107.8	50.9	27.3
Progression Factor	1.00	1.00	1.00		1.00	1.00	0.89	1.17	2.12	0.97	0.99	1.45
Incremental Delay, d2	18.1	16.9	0.8		12.5	0.1	7.1	0.3	0.0	8.7	14.0	0.8
Delay (s)	114.2	112.8	87.2		122.3	103.4	100.3	32.0	41.3	113.6	64.5	40.3
Level of Service	F	F	F		F	F	F	C	D	F	E	D
Approach Delay (s)		107.3			117.3			37.5			62.7	
Approach LOS		F			F			D			E	

Intersection Summary			
HCM 2000 Control Delay	60.5	HCM 2000 Level of Service	E
HCM 2000 Volume to Capacity ratio	0.90		
Actuated Cycle Length (s)	240.0	Sum of lost time (s)	22.0
Intersection Capacity Utilization	99.0%	ICU Level of Service	F
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	680	685	5	120	825	520	5	105	15	420	140	465
Number	7	4	14	3	8	18	5	2	12	1	6	16
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1863	1863	1900	1863	1863	1863	1863	1863	1900	1863	1863	1863
Adj Flow Rate, veh/h	739	745	5	130	897	565	5	114	3	457	152	318
Adj No. of Lanes	2	3	0	2	3	2	1	2	0	2	2	2
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Percent Heavy Veh, %	2	2	2	2	2	2	2	2	2	2	2	2
Cap, veh/h	859	2363	16	208	1343	1176	9	339	9	543	881	1386
Arrive On Green	0.25	0.45	0.45	0.06	0.26	0.26	0.01	0.10	0.10	0.16	0.25	0.25
Sat Flow, veh/h	3442	5212	35	3442	5085	2787	1774	3524	92	3442	3539	2773
Grp Volume(v), veh/h	739	484	266	130	897	565	5	57	60	457	152	318
Grp Sat Flow(s),veh/h/ln	1721	1695	1857	1721	1695	1393	1774	1770	1846	1721	1770	1387
Q Serve(g_s), s	21.2	9.4	9.4	3.8	16.3	15.2	0.3	3.1	3.1	13.3	3.5	6.7
Cycle Q Clear(g_c), s	21.2	9.4	9.4	3.8	16.3	15.2	0.3	3.1	3.1	13.3	3.5	6.7
Prop In Lane	1.00		0.02	1.00		1.00	1.00		0.05	1.00		1.00
Lane Grp Cap(c), veh/h	859	1537	842	208	1343	1176	9	170	178	543	881	1386
V/C Ratio(X)	0.86	0.32	0.32	0.63	0.67	0.48	0.54	0.33	0.34	0.84	0.17	0.23
Avail Cap(c_a), veh/h	1265	1537	842	1265	1869	1464	206	651	679	733	1643	1983
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	37.1	18.0	18.0	47.4	34.0	21.7	51.3	43.6	43.6	42.3	30.5	14.7
Incr Delay (d2), s/veh	4.2	0.1	0.2	3.1	0.6	0.3	42.0	1.1	1.1	6.6	0.1	0.1
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	10.6	4.4	4.8	1.9	7.7	5.8	0.2	1.6	1.7	6.8	1.7	2.6
LnGrp Delay(d),s/veh	41.3	18.1	18.2	50.5	34.6	22.0	93.3	44.8	44.7	48.9	30.6	14.8
LnGrp LOS	D	B	B	D	C	C	F	D	D	D	C	B
Approach Vol, veh/h		1489			1592			122			927	
Approach Delay, s/veh		29.6			31.4			46.7			34.2	
Approach LOS		C			C			D			C	

Timer	1	2	3	4	5	6	7	8
Assigned Phs	1	2	3	4	5	6	7	8
Phs Duration (G+Y+Rc), s	22.3	16.0	12.2	52.9	6.5	31.7	31.8	33.3
Change Period (Y+Rc), s	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0
Max Green Setting (Gmax), s	22.0	38.0	38.0	38.0	12.0	48.0	38.0	38.0
Max Q Clear Time (g_c+I1), s	15.3	5.1	5.8	11.4	2.3	8.7	23.2	18.3
Green Ext Time (p_c), s	1.0	3.1	0.4	16.6	0.0	3.2	2.6	9.0

Intersection Summary	
HCM 2010 Ctrl Delay	31.8
HCM 2010 LOS	C

Notes

User approved changes to right turn type.

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	30	75	20	315	170	410	60	1130	475	275	580	50
Number	3	8	18	7	4	14	5	2	12	1	6	16
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1863	1863	1900	1863	1863	1863	1863	1863	1900	1863	1863	1900
Adj Flow Rate, veh/h	33	82	15	342	185	180	65	1228	465	299	630	47
Adj No. of Lanes	1	1	0	1	1	1	1	3	0	1	3	0
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Percent Heavy Veh, %	2	2	2	2	2	2	2	2	2	2	2	2
Cap, veh/h	308	495	90	425	601	511	84	1267	478	331	2355	175
Arrive On Green	0.32	0.32	0.32	0.32	0.32	0.32	0.05	0.35	0.35	0.19	0.49	0.49
Sat Flow, veh/h	1013	1533	280	1293	1863	1583	1774	3638	1373	1774	4832	358
Grp Volume(v), veh/h	33	0	97	342	185	180	65	1144	549	299	441	236
Grp Sat Flow(s),veh/h/ln	1013	0	1813	1293	1863	1583	1774	1695	1620	1774	1695	1800
Q Serve(g_s), s	3.2	0.0	4.8	32.5	9.4	11.0	4.6	41.9	42.1	20.8	9.7	9.8
Cycle Q Clear(g_c), s	12.6	0.0	4.8	37.3	9.4	11.0	4.6	41.9	42.1	20.8	9.7	9.8
Prop In Lane	1.00		0.15	1.00		1.00	1.00		0.85	1.00		0.20
Lane Grp Cap(c), veh/h	308	0	585	425	601	511	84	1181	565	331	1653	877
V/C Ratio(X)	0.11	0.00	0.17	0.81	0.31	0.35	0.77	0.97	0.97	0.90	0.27	0.27
Avail Cap(c_a), veh/h	326	0	617	448	634	539	239	1181	565	492	1664	883
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	0.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	36.9	0.0	30.6	44.0	32.2	32.7	59.5	40.5	40.5	50.3	19.1	19.1
Incr Delay (d2), s/veh	0.2	0.0	0.1	9.9	0.3	0.4	14.0	19.1	30.8	14.8	0.1	0.2
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	0.9	0.0	2.4	12.8	4.9	4.8	2.6	22.7	23.6	11.6	4.5	4.9
LnGrp Delay(d),s/veh	37.1	0.0	30.7	53.9	32.5	33.1	73.5	59.5	71.3	65.0	19.2	19.3
LnGrp LOS	D		C	D	C	C	E	E	E	E	B	B
Approach Vol, veh/h		130			707			1758			976	
Approach Delay, s/veh		32.3			43.0			63.7			33.2	
Approach LOS		C			D			E			C	

Timer	1	2	3	4	5	6	7	8
Assigned Phs	1	2		4	5	6		8
Phs Duration (G+Y+Rc), s	29.5	50.0		46.8	12.0	67.6		46.8
Change Period (Y+Rc), s	6.0	6.0		6.0	6.0	6.0		6.0
Max Green Setting (Gmax), s	35.0	44.0		43.0	17.0	62.0		43.0
Max Q Clear Time (g_c+I1), s	22.8	44.1		39.3	6.6	11.8		14.6
Green Ext Time (p_c), s	0.7	0.0		1.4	0.1	30.4		4.0

Intersection Summary	
HCM 2010 Ctrl Delay	50.1
HCM 2010 LOS	D

Intersection	
Int Delay, s/veh	7.7

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Vol, veh/h	5	5	215	5	5	95
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	-	-	0	-
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	5	5	234	5	5	103

Major/Minor	Major1		Major2		Minor1	
Conflicting Flow All	0	0	11	0	481	8
Stage 1	-	-	-	-	8	-
Stage 2	-	-	-	-	473	-
Critical Hdwy	-	-	4.12	-	6.42	6.22
Critical Hdwy Stg 1	-	-	-	-	5.42	-
Critical Hdwy Stg 2	-	-	-	-	5.42	-
Follow-up Hdwy	-	-	2.218	-	3.518	3.318
Pot Cap-1 Maneuver	-	-	1608	-	544	1074
Stage 1	-	-	-	-	1015	-
Stage 2	-	-	-	-	627	-
Platoon blocked, %	-	-		-		
Mov Cap-1 Maneuver	-	-	1608	-	465	1074
Mov Cap-2 Maneuver	-	-	-	-	465	-
Stage 1	-	-	-	-	1015	-
Stage 2	-	-	-	-	535	-

Approach	EB	WB	NB
HCM Control Delay, s	0	7.4	9
HCM LOS			A

Minor Lane/Major Mvmt	NBLn1	EBT	EBR	WBL	WBT
Capacity (veh/h)	1008	-	-	1608	-
HCM Lane V/C Ratio	0.108	-	-	0.145	-
HCM Control Delay (s)	9	-	-	7.6	0
HCM Lane LOS	A	-	-	A	A
HCM 95th %tile Q(veh)	0.4	-	-	0.5	-

Intersection	
Int Delay, s/veh	7.2

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Vol, veh/h	80	310	0	0	780	20	0	0	0	15	0	195
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Free	Free	Stop	Stop	Stop	Stop	Stop	Stop
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	-	-	-	-	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	92	92	92	92	92	92	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2	2	2	2	2	2	2
Mvmt Flow	87	337	0	0	848	22	0	0	0	16	0	212

Major/Minor	Major1			Major2			Minor1			Minor2		
Conflicting Flow All	870	0	0	337	0	0	1476	1381	337	1370	1370	859
Stage 1	-	-	-	-	-	-	511	511	-	859	859	-
Stage 2	-	-	-	-	-	-	965	870	-	511	511	-
Critical Hdwy	4.12	-	-	4.12	-	-	7.12	6.52	6.22	7.12	6.52	6.22
Critical Hdwy Stg 1	-	-	-	-	-	-	6.12	5.52	-	6.12	5.52	-
Critical Hdwy Stg 2	-	-	-	-	-	-	6.12	5.52	-	6.12	5.52	-
Follow-up Hdwy	2.218	-	-	2.218	-	-	3.518	4.018	3.318	3.518	4.018	3.318
Pot Cap-1 Maneuver	775	-	-	1222	-	-	104	144	705	124	146	356
Stage 1	-	-	-	-	-	-	545	537	-	351	373	-
Stage 2	-	-	-	-	-	-	306	369	-	545	537	-
Platoon blocked, %		-	-		-	-						
Mov Cap-1 Maneuver	775	-	-	1222	-	-	38	124	705	111	126	356
Mov Cap-2 Maneuver	-	-	-	-	-	-	38	124	-	111	126	-
Stage 1	-	-	-	-	-	-	470	463	-	303	373	-
Stage 2	-	-	-	-	-	-	124	369	-	470	463	-

Approach	EB	WB	NB	SB
HCM Control Delay, s	2.1	0	0	43.8
HCM LOS			A	E

Minor Lane/Major Mvmt	NBLn1	EBL	EBT	EBR	WBL	WBT	WBR	SBLn1
Capacity (veh/h)	-	775	-	-	1222	-	-	308
HCM Lane V/C Ratio	-	0.112	-	-	-	-	-	0.741
HCM Control Delay (s)	0	10.2	0	-	0	-	-	43.8
HCM Lane LOS	A	B	A	-	A	-	-	E
HCM 95th %tile Q(veh)	-	0.4	-	-	0	-	-	5.5

Intersection	
Int Delay, s/veh	0.4

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Vol, veh/h	305	10	25	815	10	5
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	50	-	0	-
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	332	11	27	886	11	5

Major/Minor	Major1		Major2		Minor1	
Conflicting Flow All	0	0	342	0	1277	337
Stage 1	-	-	-	-	337	-
Stage 2	-	-	-	-	940	-
Critical Hdwy	-	-	4.12	-	6.42	6.22
Critical Hdwy Stg 1	-	-	-	-	5.42	-
Critical Hdwy Stg 2	-	-	-	-	5.42	-
Follow-up Hdwy	-	-	2.218	-	3.518	3.318
Pot Cap-1 Maneuver	-	-	1217	-	184	705
Stage 1	-	-	-	-	723	-
Stage 2	-	-	-	-	380	-
Platoon blocked, %	-	-		-		
Mov Cap-1 Maneuver	-	-	1217	-	180	705
Mov Cap-2 Maneuver	-	-	-	-	180	-
Stage 1	-	-	-	-	723	-
Stage 2	-	-	-	-	372	-

Approach	EB	WB	NB
HCM Control Delay, s	0	0.2	21.2
HCM LOS			C

Minor Lane/Major Mvmt	NBLn1	EBT	EBR	WBL	WBT
Capacity (veh/h)	239	-	-	1217	-
HCM Lane V/C Ratio	0.068	-	-	0.022	-
HCM Control Delay (s)	21.2	-	-	8	-
HCM Lane LOS	C	-	-	A	-
HCM 95th %tile Q(veh)	0.2	-	-	0.1	-

Intersection	
Int Delay, s/veh	0

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Vol, veh/h	0	315	0	0	865	0	0	0	0	0	0	0
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Free	Free	Stop	Stop	Stop	Stop	Stop	Stop
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	-	-	-	-	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	92	92	92	92	92	92	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2	2	2	2	2	2	2
Mvmt Flow	0	342	0	0	940	0	0	0	0	0	0	0

Major/Minor	Major1			Major2			Minor1			Minor2		
Conflicting Flow All	940	0	0	342	0	0	1282	1282	342	1282	1282	940
Stage 1	-	-	-	-	-	-	342	342	-	940	940	-
Stage 2	-	-	-	-	-	-	940	940	-	342	342	-
Critical Hdwy	4.12	-	-	4.12	-	-	7.12	6.52	6.22	7.12	6.52	6.22
Critical Hdwy Stg 1	-	-	-	-	-	-	6.12	5.52	-	6.12	5.52	-
Critical Hdwy Stg 2	-	-	-	-	-	-	6.12	5.52	-	6.12	5.52	-
Follow-up Hdwy	2.218	-	-	2.218	-	-	3.518	4.018	3.318	3.518	4.018	3.318
Pot Cap-1 Maneuver	729	-	-	1217	-	-	142	165	701	142	165	320
Stage 1	-	-	-	-	-	-	673	638	-	316	342	-
Stage 2	-	-	-	-	-	-	316	342	-	673	638	-
Platoon blocked, %		-	-		-	-						
Mov Cap-1 Maneuver	729	-	-	1217	-	-	142	165	701	142	165	320
Mov Cap-2 Maneuver	-	-	-	-	-	-	142	165	-	142	165	-
Stage 1	-	-	-	-	-	-	673	638	-	316	342	-
Stage 2	-	-	-	-	-	-	316	342	-	673	638	-

Approach	EB	WB	NB	SB
HCM Control Delay, s	0	0	0	0
HCM LOS			A	A

Minor Lane/Major Mvmt	NBLn1	EBL	EBT	EBR	WBL	WBT	WBR	SBLn1
Capacity (veh/h)	-	729	-	-	1217	-	-	-
HCM Lane V/C Ratio	-	-	-	-	-	-	-	-
HCM Control Delay (s)	0	0	-	-	0	-	-	0
HCM Lane LOS	A	A	-	-	A	-	-	A
HCM 95th %tile Q(veh)	-	0	-	-	0	-	-	-

Intersection	
Int Delay, s/veh	0.4

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Vol, veh/h	0	310	850	5	10	10
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	-	-	0	-
Veh in Median Storage, #	-	0	0	-	0	-
Grade, %	-	0	0	-	0	-
Peak Hour Factor	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	0	337	924	5	11	11

Major/Minor	Major1		Major2		Minor2	
Conflicting Flow All	929	0	-	0	1264	927
Stage 1	-	-	-	-	927	-
Stage 2	-	-	-	-	337	-
Critical Hdwy	4.12	-	-	-	6.42	6.22
Critical Hdwy Stg 1	-	-	-	-	5.42	-
Critical Hdwy Stg 2	-	-	-	-	5.42	-
Follow-up Hdwy	2.218	-	-	-	3.518	3.318
Pot Cap-1 Maneuver	736	-	-	-	187	325
Stage 1	-	-	-	-	385	-
Stage 2	-	-	-	-	723	-
Platoon blocked, %		-	-	-		
Mov Cap-1 Maneuver	736	-	-	-	187	325
Mov Cap-2 Maneuver	-	-	-	-	187	-
Stage 1	-	-	-	-	385	-
Stage 2	-	-	-	-	723	-

Approach	EB	WB	SB
HCM Control Delay, s	0	0	21.7
HCM LOS			C

Minor Lane/Major Mvmt	EBL	EBT	WBT	WBR	SBLn1
Capacity (veh/h)	736	-	-	-	237
HCM Lane V/C Ratio	-	-	-	-	0.092
HCM Control Delay (s)	0	-	-	-	21.7
HCM Lane LOS	A	-	-	-	C
HCM 95th %tile Q(veh)	0	-	-	-	0.3

Intersection	
Int Delay, s/veh	0.3

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Vol, veh/h	5	300	0	0	840	15	0	0	0	5	0	10
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Free	Free	Stop	Stop	Stop	Stop	Stop	Stop
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	-	-	-	-	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	92	92	92	92	92	92	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2	2	2	2	2	2	2
Mvmt Flow	5	326	0	0	913	16	0	0	0	5	0	11

Major/Minor	Major1			Major2			Minor1			Minor2		
Conflicting Flow All	929	0	0	326	0	0	1264	1266	326	1258	1258	921
Stage 1	-	-	-	-	-	-	337	337	-	921	921	-
Stage 2	-	-	-	-	-	-	927	929	-	337	337	-
Critical Hdwy	4.12	-	-	4.12	-	-	7.12	6.52	6.22	7.12	6.52	6.22
Critical Hdwy Stg 1	-	-	-	-	-	-	6.12	5.52	-	6.12	5.52	-
Critical Hdwy Stg 2	-	-	-	-	-	-	6.12	5.52	-	6.12	5.52	-
Follow-up Hdwy	2.218	-	-	2.218	-	-	3.518	4.018	3.318	3.518	4.018	3.318
Pot Cap-1 Maneuver	736	-	-	1234	-	-	146	169	715	148	171	328
Stage 1	-	-	-	-	-	-	677	641	-	324	349	-
Stage 2	-	-	-	-	-	-	322	346	-	677	641	-
Platoon blocked, %		-	-		-	-						
Mov Cap-1 Maneuver	736	-	-	1234	-	-	140	168	715	147	170	328
Mov Cap-2 Maneuver	-	-	-	-	-	-	140	168	-	147	170	-
Stage 1	-	-	-	-	-	-	672	636	-	321	349	-
Stage 2	-	-	-	-	-	-	311	346	-	672	636	-

Approach	EB	WB	NB	SB
HCM Control Delay, s	0.2	0	0	21.6
HCM LOS			A	C

Minor Lane/Major Mvmt	NBLn1	EBL	EBT	EBR	WBL	WBT	WBR	SBLn1
Capacity (veh/h)	-	736	-	-	1234	-	-	233
HCM Lane V/C Ratio	-	0.007	-	-	-	-	-	0.07
HCM Control Delay (s)	0	9.9	0	-	0	-	-	21.6
HCM Lane LOS	A	A	A	-	A	-	-	C
HCM 95th %tile Q(veh)	-	0	-	-	0	-	-	0.2

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	10	130	190	100	335	290	470	1265	245	175	805	60
Number	7	4	14	3	8	18	5	2	12	1	6	16
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1863	1863	1900	1863	1863	1863	1863	1863	1863	1863	1863	1863
Adj Flow Rate, veh/h	11	141	18	109	364	80	511	1375	174	190	875	16
Adj No. of Lanes	1	2	0	1	1	1	1	2	1	1	2	1
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Percent Heavy Veh, %	2	2	2	2	2	2	2	2	2	2	2	2
Cap, veh/h	18	493	62	132	410	348	497	1687	755	214	1124	503
Arrive On Green	0.01	0.16	0.16	0.07	0.22	0.22	0.28	0.48	0.48	0.12	0.32	0.32
Sat Flow, veh/h	1774	3164	398	1774	1863	1583	1774	3539	1583	1774	3539	1583
Grp Volume(v), veh/h	11	78	81	109	364	80	511	1375	174	190	875	16
Grp Sat Flow(s),veh/h/ln	1774	1770	1793	1774	1863	1583	1774	1770	1583	1774	1770	1583
Q Serve(g_s), s	0.9	5.4	5.6	8.4	26.4	5.8	39.0	46.3	9.0	14.7	31.2	1.0
Cycle Q Clear(g_c), s	0.9	5.4	5.6	8.4	26.4	5.8	39.0	46.3	9.0	14.7	31.2	1.0
Prop In Lane	1.00		0.22	1.00		1.00	1.00		1.00	1.00		1.00
Lane Grp Cap(c), veh/h	18	276	279	132	410	348	497	1687	755	214	1124	503
V/C Ratio(X)	0.62	0.28	0.29	0.83	0.89	0.23	1.03	0.81	0.23	0.89	0.78	0.03
Avail Cap(c_a), veh/h	166	470	476	166	495	421	497	1687	755	255	1195	534
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	68.7	51.9	52.0	63.6	52.6	44.6	50.1	31.2	21.4	60.3	43.1	32.8
Incr Delay (d2), s/veh	30.8	0.6	0.6	23.4	15.6	0.3	47.8	3.2	0.2	26.0	3.2	0.0
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	0.6	2.7	2.8	5.0	15.3	2.6	25.6	23.3	3.9	8.7	15.8	0.4
LnGrp Delay(d),s/veh	99.4	52.5	52.5	86.9	68.2	44.9	97.9	34.4	21.6	86.3	46.2	32.8
LnGrp LOS	F	D	D	F	E	D	F	C	C	F	D	C
Approach Vol, veh/h		170			553			2060			1081	
Approach Delay, s/veh		55.5			68.5			49.1			53.1	
Approach LOS		E			E			D			D	

Timer	1	2	3	4	5	6	7	8
Assigned Phs	1	2	3	4	5	6	7	8
Phs Duration (G+Y+Rc), s	22.8	72.4	16.3	27.7	45.0	50.2	7.4	36.6
Change Period (Y+Rc), s	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0
Max Green Setting (Gmax), s	20.0	66.0	13.0	37.0	39.0	47.0	13.0	37.0
Max Q Clear Time (g_c+I1), s	16.7	48.3	10.4	7.6	41.0	33.2	2.9	28.4
Green Ext Time (p_c), s	0.2	14.5	0.1	3.7	0.0	11.0	0.0	2.3

Intersection Summary		
HCM 2010 Ctrl Delay		53.3
HCM 2010 LOS		D

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	335	170	215	60	260	315	205	1460	10	220	1210	160
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	6.0	4.0	4.0	6.0
Lane Util. Factor	0.91	0.91	1.00	1.00	1.00	0.88	0.97	0.91	1.00	0.97	0.91	1.00
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	0.98	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	1610	3308	1583	1770	1863	2787	3433	5085	1583	3433	5085	1583
Flt Permitted	0.95	0.98	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)	1610	3308	1583	1770	1863	2787	3433	5085	1583	3433	5085	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)	364	185	234	65	283	342	223	1587	11	239	1315	174
RTOR Reduction (vph)	0	0	62	0	0	202	0	0	6	0	0	70
Lane Group Flow (vph)	182	367	172	65	283	140	223	1587	5	239	1315	104
Turn Type	Split	NA	Perm	Split	NA	Perm	Prot	NA	Perm	Prot	NA	Perm
Protected Phases	3	3		4	4		5	2		1	6	
Permitted Phases			3			4			2			6
Actuated Green, G (s)	35.4	35.4	35.4	41.7	41.7	41.7	20.9	117.0	117.0	20.9	117.0	117.0
Effective Green, g (s)	37.4	37.4	37.4	43.7	43.7	43.7	22.9	120.0	118.0	22.9	120.0	118.0
Actuated g/C Ratio	0.16	0.16	0.16	0.18	0.18	0.18	0.10	0.50	0.49	0.10	0.50	0.49
Clearance Time (s)	6.0	6.0	6.0	6.0	6.0	6.0	6.0	7.0	7.0	6.0	7.0	7.0
Vehicle Extension (s)	5.0	5.0	5.0	5.0	5.0	5.0	3.0	5.0	5.0	3.0	5.0	5.0
Lane Grp Cap (vph)	250	515	246	322	339	507	327	2542	778	327	2542	778
v/s Ratio Prot	c0.11	0.11		0.04	c0.15		0.06	c0.31		c0.07	0.26	
v/s Ratio Perm			0.11			0.05			0.00			0.07
v/c Ratio	0.73	0.71	0.70	0.20	0.83	0.28	0.68	0.62	0.01	0.73	0.52	0.13
Uniform Delay, d1	96.5	96.2	96.0	83.3	94.7	84.5	105.0	43.6	31.1	105.6	40.5	33.2
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.85	1.56	3.92
Incremental Delay, d2	12.3	5.7	10.8	0.6	17.7	0.6	5.8	1.2	0.0	7.7	0.7	0.3
Delay (s)	108.7	101.9	106.8	84.0	112.4	85.1	110.8	44.8	31.1	97.7	63.7	130.3
Level of Service	F	F	F	F	F	F	F	D	C	F	E	F
Approach Delay (s)		105.0			96.2			52.8			75.1	
Approach LOS		F			F			D			E	

Intersection Summary			
HCM 2000 Control Delay	74.6	HCM 2000 Level of Service	E
HCM 2000 Volume to Capacity ratio	0.69		
Actuated Cycle Length (s)	240.0	Sum of lost time (s)	16.0
Intersection Capacity Utilization	71.1%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	405	5	125	10	15	15	330	2660	20	80	1565	415
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		6.0	4.0	6.0	5.0	6.0	4.0	5.0	7.0
Lane Util. Factor	0.95	0.95	1.00		1.00	1.00	1.00	0.91	1.00	1.00	0.91	1.00
Frpb, ped/bikes	1.00	1.00	0.91		1.00	1.00	1.00	1.00	0.83	1.00	1.00	0.97
Flpb, ped/bikes	1.00	1.00	1.00		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Frt	1.00	1.00	0.85		1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	0.95	1.00		0.98	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	1681	1687	1434		1826	1583	1770	5085	1311	1770	5085	1536
Flt Permitted	0.95	0.95	1.00		0.98	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)	1681	1687	1434		1826	1583	1770	5085	1311	1770	5085	1536
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	440	5	136	11	16	16	359	2891	22	87	1701	451
RTOR Reduction (vph)	0	0	84	0	0	15	0	0	8	0	0	235
Lane Group Flow (vph)	224	221	53	0	27	1	359	2891	14	87	1701	216
Confl. Peds. (#/hr)			43						31			2
Turn Type	Split	NA	Perm	Split	NA	Perm	Prot	NA	Perm	Prot	NA	Perm
Protected Phases	4	4		3	3		5	2		1	6	
Permitted Phases			4			3			2			6
Actuated Green, G (s)	39.6	39.6	39.6		7.8	7.8	53.9	153.2	153.2	15.4	114.7	114.7
Effective Green, g (s)	39.6	39.6	39.6		7.8	9.8	53.9	155.2	154.2	17.4	116.7	114.7
Actuated g/C Ratio	0.17	0.17	0.17		0.03	0.04	0.22	0.65	0.64	0.07	0.49	0.48
Clearance Time (s)	5.0	5.0	5.0		6.0	6.0	6.0	7.0	7.0	6.0	7.0	7.0
Vehicle Extension (s)	4.0	4.0	4.0		3.0	3.0	5.0	6.0	6.0	3.0	6.0	6.0
Lane Grp Cap (vph)	277	278	236		59	64	397	3288	842	128	2472	734
v/s Ratio Prot	c0.13	0.13			c0.01		c0.20	c0.57		0.05	0.33	
v/s Ratio Perm			0.04			0.00			0.01			0.14
v/c Ratio	0.81	0.79	0.22		0.46	0.01	0.90	0.88	0.02	0.68	0.69	0.29
Uniform Delay, d1	96.5	96.3	86.9		114.0	110.4	90.5	34.7	15.5	108.6	47.6	38.0
Progression Factor	1.00	1.00	1.00		1.00	1.00	1.26	0.62	1.00	1.05	0.99	1.64
Incremental Delay, d2	16.6	15.2	0.7		5.5	0.1	12.4	1.6	0.0	13.1	1.5	1.0
Delay (s)	113.1	111.5	87.5		119.6	110.5	126.8	23.0	15.5	127.5	48.5	63.5
Level of Service	F	F	F		F	F	F	C	B	F	D	E
Approach Delay (s)		106.5			116.2			34.4			54.6	
Approach LOS		F			F			C			D	

Intersection Summary			
HCM 2000 Control Delay	49.1	HCM 2000 Level of Service	D
HCM 2000 Volume to Capacity ratio	0.87		
Actuated Cycle Length (s)	240.0	Sum of lost time (s)	22.0
Intersection Capacity Utilization	95.3%	ICU Level of Service	F
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	870	770	10	230	450	555	55	370	130	585	370	655
Number	7	4	14	3	8	18	5	2	12	1	6	16
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1863	1863	1900	1863	1863	1863	1863	1863	1900	1863	1863	1863
Adj Flow Rate, veh/h	946	837	11	250	489	549	60	402	17	636	402	441
Adj No. of Lanes	2	3	0	2	3	2	1	2	0	2	2	2
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Percent Heavy Veh, %	2	2	2	2	2	2	2	2	2	2	2	2
Cap, veh/h	1033	2095	28	313	996	1100	78	518	22	685	1080	1683
Arrive On Green	0.30	0.41	0.41	0.09	0.20	0.20	0.04	0.15	0.15	0.20	0.31	0.31
Sat Flow, veh/h	3442	5173	68	3442	5085	2787	1774	3461	146	3442	3539	2776
Grp Volume(v), veh/h	946	548	300	250	489	549	60	205	214	636	402	441
Grp Sat Flow(s),veh/h/ln	1721	1695	1851	1721	1695	1393	1774	1770	1837	1721	1770	1388
Q Serve(g_s), s	39.3	17.0	17.0	10.5	12.7	22.0	5.0	16.5	16.6	26.9	13.2	11.0
Cycle Q Clear(g_c), s	39.3	17.0	17.0	10.5	12.7	22.0	5.0	16.5	16.6	26.9	13.2	11.0
Prop In Lane	1.00		0.04	1.00		1.00	1.00		0.08	1.00		1.00
Lane Grp Cap(c), veh/h	1033	1373	750	313	996	1100	78	265	275	685	1080	1683
V/C Ratio(X)	0.92	0.40	0.40	0.80	0.49	0.50	0.77	0.77	0.78	0.93	0.37	0.26
Avail Cap(c_a), veh/h	1232	1373	750	1232	1305	1270	443	538	558	720	1080	1683
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	50.0	31.3	31.3	66.0	53.0	33.8	70.1	60.6	60.6	58.3	40.3	13.7
Incr Delay (d2), s/veh	9.7	0.2	0.3	4.7	0.4	0.4	14.8	4.8	4.7	17.8	0.2	0.1
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	20.0	8.0	8.8	5.2	6.0	8.5	2.8	8.4	8.8	14.5	6.5	4.2
LnGrp Delay(d),s/veh	59.7	31.5	31.6	70.7	53.4	34.1	84.9	65.3	65.3	76.1	40.6	13.8
LnGrp LOS	E	C	C	E	D	C	F	E	E	E	D	B
Approach Vol, veh/h		1794			1288			479			1479	
Approach Delay, s/veh		46.4			48.5			67.8			47.9	
Approach LOS		D			D			E			D	

Timer	1	2	3	4	5	6	7	8
Assigned Phs	1	2	3	4	5	6	7	8
Phs Duration (G+Y+Rc), s	34.5	28.2	19.4	66.0	11.5	51.2	50.4	35.0
Change Period (Y+Rc), s	5.0	6.0	6.0	6.0	5.0	6.0	6.0	6.0
Max Green Setting (Gmax), s	31.0	45.0	53.0	38.0	37.0	39.0	53.0	38.0
Max Q Clear Time (g_c+I1), s	28.9	18.6	12.5	19.0	7.0	15.2	41.3	24.0
Green Ext Time (p_c), s	0.6	2.7	0.9	11.3	0.1	7.7	3.1	5.0

Intersection Summary	
HCM 2010 Ctrl Delay	49.4
HCM 2010 LOS	D

Notes

User approved changes to right turn type.

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	85	165	75	205	80	325	40	890	130	320	1180	65
Number	3	8	18	7	4	14	5	2	12	1	6	16
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1863	1863	1900	1863	1863	1863	1863	1863	1900	1863	1863	1900
Adj Flow Rate, veh/h	92	179	67	223	87	79	43	967	123	348	1283	66
Adj No. of Lanes	1	1	0	1	1	1	1	3	0	1	3	0
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Percent Heavy Veh, %	2	2	2	2	2	2	2	2	2	2	2	2
Cap, veh/h	400	400	150	289	576	490	55	1434	182	378	2457	126
Arrive On Green	0.31	0.31	0.31	0.31	0.31	0.31	0.03	0.31	0.31	0.21	0.50	0.50
Sat Flow, veh/h	1215	1293	484	1129	1863	1583	1774	4571	580	1774	4953	255
Grp Volume(v), veh/h	92	0	246	223	87	79	43	717	373	348	878	471
Grp Sat Flow(s),veh/h/ln	1215	0	1777	1129	1863	1583	1774	1695	1760	1774	1695	1818
Q Serve(g_s), s	6.5	0.0	12.2	21.7	3.7	4.0	2.6	20.2	20.3	21.1	19.4	19.4
Cycle Q Clear(g_c), s	10.2	0.0	12.2	33.9	3.7	4.0	2.6	20.2	20.3	21.1	19.4	19.4
Prop In Lane	1.00		0.27	1.00		1.00	1.00		0.33	1.00		0.14
Lane Grp Cap(c), veh/h	400	0	550	289	576	490	55	1064	552	378	1681	902
V/C Ratio(X)	0.23	0.00	0.45	0.77	0.15	0.16	0.78	0.67	0.68	0.92	0.52	0.52
Avail Cap(c_a), veh/h	400	0	550	289	576	490	113	1141	593	420	1727	926
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	0.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	31.2	0.0	30.4	44.0	27.5	27.6	52.9	32.8	32.9	42.3	18.8	18.8
Incr Delay (d2), s/veh	0.3	0.0	0.6	12.0	0.1	0.2	21.0	1.4	2.8	24.0	0.3	0.5
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	2.2	0.0	6.1	7.7	1.9	1.8	1.6	9.7	10.3	12.9	9.1	9.8
LnGrp Delay(d),s/veh	31.5	0.0	31.0	56.0	27.6	27.7	73.9	34.3	35.7	66.4	19.1	19.3
LnGrp LOS	C		C	E	C	C	E	C	D	E	B	B
Approach Vol, veh/h		338			389			1133			1697	
Approach Delay, s/veh		31.1			43.9			36.2			28.9	
Approach LOS		C			D			D			C	

Timer	1	2	3	4	5	6	7	8
Assigned Phs	1	2		4	5	6		8
Phs Duration (G+Y+Rc), s	29.4	40.5		40.0	9.4	60.5		40.0
Change Period (Y+Rc), s	6.0	6.0		6.0	6.0	6.0		6.0
Max Green Setting (Gmax), s	26.0	37.0		34.0	7.0	56.0		34.0
Max Q Clear Time (g_c+I1), s	23.1	22.3		35.9	4.6	21.4		14.2
Green Ext Time (p_c), s	0.3	12.2		0.0	0.0	23.9		3.6

Intersection Summary	
HCM 2010 Ctrl Delay	33.1
HCM 2010 LOS	C

Intersection	
Int Delay, s/veh	8.5

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Vol, veh/h	5	5	160	5	10	230
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	-	-	0	-
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	5	5	174	5	11	250

Major/Minor	Major1		Major2		Minor1	
Conflicting Flow All	0	0	11	0	361	8
Stage 1	-	-	-	-	8	-
Stage 2	-	-	-	-	353	-
Critical Hdwy	-	-	4.12	-	6.42	6.22
Critical Hdwy Stg 1	-	-	-	-	5.42	-
Critical Hdwy Stg 2	-	-	-	-	5.42	-
Follow-up Hdwy	-	-	2.218	-	3.518	3.318
Pot Cap-1 Maneuver	-	-	1608	-	638	1074
Stage 1	-	-	-	-	1015	-
Stage 2	-	-	-	-	711	-
Platoon blocked, %	-	-		-		
Mov Cap-1 Maneuver	-	-	1608	-	568	1074
Mov Cap-2 Maneuver	-	-	-	-	568	-
Stage 1	-	-	-	-	1015	-
Stage 2	-	-	-	-	634	-

Approach	EB	WB	NB
HCM Control Delay, s	0	7.3	9.6
HCM LOS			A

Minor Lane/Major Mvmt	NBLn1	EBT	EBR	WBL	WBT
Capacity (veh/h)	1036	-	-	1608	-
HCM Lane V/C Ratio	0.252	-	-	0.108	-
HCM Control Delay (s)	9.6	-	-	7.5	0
HCM Lane LOS	A	-	-	A	A
HCM 95th %tile Q(veh)	1	-	-	0.4	-

Intersection	
Int Delay, s/veh	5.8

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Vol, veh/h	205	705	0	0	425	20	0	0	0	20	0	145
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Free	Free	Stop	Stop	Stop	Stop	Stop	Stop
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	-	-	-	-	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	92	92	92	92	92	92	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2	2	2	2	2	2	2
Mvmt Flow	223	766	0	0	462	22	0	0	0	22	0	158

Major/Minor	Major1			Major2			Minor1			Minor2		
Conflicting Flow All	484	0	0	766	0	0	1764	1696	766	1685	1685	473
Stage 1	-	-	-	-	-	-	1212	1212	-	473	473	-
Stage 2	-	-	-	-	-	-	552	484	-	1212	1212	-
Critical Hdwy	4.12	-	-	4.12	-	-	7.12	6.52	6.22	7.12	6.52	6.22
Critical Hdwy Stg 1	-	-	-	-	-	-	6.12	5.52	-	6.12	5.52	-
Critical Hdwy Stg 2	-	-	-	-	-	-	6.12	5.52	-	6.12	5.52	-
Follow-up Hdwy	2.218	-	-	2.218	-	-	3.518	4.018	3.318	3.518	4.018	3.318
Pot Cap-1 Maneuver	1079	-	-	847	-	-	66	93	403	75	94	591
Stage 1	-	-	-	-	-	-	222	255	-	572	558	-
Stage 2	-	-	-	-	-	-	518	552	-	222	255	-
Platoon blocked, %		-	-		-	-						
Mov Cap-1 Maneuver	1079	-	-	847	-	-	35	60	403	54	60	591
Mov Cap-2 Maneuver	-	-	-	-	-	-	35	60	-	54	60	-
Stage 1	-	-	-	-	-	-	142	163	-	366	558	-
Stage 2	-	-	-	-	-	-	380	552	-	142	163	-

Approach	EB	WB	NB	SB
HCM Control Delay, s	2.1	0	0	41.9
HCM LOS			A	E

Minor Lane/Major Mvmt	NBLn1	EBL	EBT	EBR	WBL	WBT	WBR	SBLn1
Capacity (veh/h)	-	1079	-	-	847	-	-	268
HCM Lane V/C Ratio	-	0.207	-	-	-	-	-	0.669
HCM Control Delay (s)	0	9.2	0	-	0	-	-	41.9
HCM Lane LOS	A	A	A	-	A	-	-	E
HCM 95th %tile Q(veh)	-	0.8	-	-	0	-	-	4.4

Intersection	
Int Delay, s/veh	0.7

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Vol, veh/h	750	15	15	440	10	25
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	50	-	0	-
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	815	16	16	478	11	27

Major/Minor	Major1		Major2		Minor1	
Conflicting Flow All	0	0	832	0	1334	823
Stage 1	-	-	-	-	823	-
Stage 2	-	-	-	-	511	-
Critical Hdwy	-	-	4.12	-	6.42	6.22
Critical Hdwy Stg 1	-	-	-	-	5.42	-
Critical Hdwy Stg 2	-	-	-	-	5.42	-
Follow-up Hdwy	-	-	2.218	-	3.518	3.318
Pot Cap-1 Maneuver	-	-	801	-	170	373
Stage 1	-	-	-	-	431	-
Stage 2	-	-	-	-	602	-
Platoon blocked, %	-	-		-		
Mov Cap-1 Maneuver	-	-	801	-	167	373
Mov Cap-2 Maneuver	-	-	-	-	167	-
Stage 1	-	-	-	-	431	-
Stage 2	-	-	-	-	590	-

Approach	EB	WB	NB
HCM Control Delay, s	0	0.3	20.1
HCM LOS			C

Minor Lane/Major Mvmt	NBLn1	EBT	EBR	WBL	WBT
Capacity (veh/h)	276	-	-	801	-
HCM Lane V/C Ratio	0.138	-	-	0.02	-
HCM Control Delay (s)	20.1	-	-	9.6	-
HCM Lane LOS	C	-	-	A	-
HCM 95th %tile Q(veh)	0.5	-	-	0.1	-

Intersection	
Int Delay, s/veh	0.1

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Vol, veh/h	5	745	0	0	445	5	0	0	0	0	0	0
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Free	Free	Stop	Stop	Stop	Stop	Stop	Stop
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	-	-	-	-	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	92	92	92	92	92	92	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2	2	2	2	2	2	2
Mvmt Flow	5	810	0	0	484	5	0	0	0	0	0	0

Major/Minor	Major1			Major2			Minor1			Minor2		
Conflicting Flow All	489	0	0	810	0	0	1307	1310	810	1307	1307	486
Stage 1	-	-	-	-	-	-	821	821	-	486	486	-
Stage 2	-	-	-	-	-	-	486	489	-	821	821	-
Critical Hdwy	4.12	-	-	4.12	-	-	7.12	6.52	6.22	7.12	6.52	6.22
Critical Hdwy Stg 1	-	-	-	-	-	-	6.12	5.52	-	6.12	5.52	-
Critical Hdwy Stg 2	-	-	-	-	-	-	6.12	5.52	-	6.12	5.52	-
Follow-up Hdwy	2.218	-	-	2.218	-	-	3.518	4.018	3.318	3.518	4.018	3.318
Pot Cap-1 Maneuver	1074	-	-	816	-	-	137	159	380	137	160	581
Stage 1	-	-	-	-	-	-	369	389	-	563	551	-
Stage 2	-	-	-	-	-	-	563	549	-	369	389	-
Platoon blocked, %		-	-		-	-						
Mov Cap-1 Maneuver	1074	-	-	816	-	-	136	158	380	136	159	581
Mov Cap-2 Maneuver	-	-	-	-	-	-	136	158	-	136	159	-
Stage 1	-	-	-	-	-	-	366	386	-	558	551	-
Stage 2	-	-	-	-	-	-	563	549	-	366	386	-

Approach	EB	WB	NB	SB
HCM Control Delay, s	0.1	0	0	0
HCM LOS			A	A

Minor Lane/Major Mvmt	NBLn1	EBL	EBT	EBR	WBL	WBT	WBR	SBLn1
Capacity (veh/h)	-	1074	-	-	816	-	-	-
HCM Lane V/C Ratio	-	0.005	-	-	-	-	-	-
HCM Control Delay (s)	0	8.4	0	-	0	-	-	0
HCM Lane LOS	A	A	A	-	A	-	-	A
HCM 95th %tile Q(veh)	-	0	-	-	0	-	-	-

Intersection	
Int Delay, s/veh	0.3

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Vol, veh/h	0	770	450	5	10	5
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	-	-	0	-
Veh in Median Storage, #	-	0	0	-	0	-
Grade, %	-	0	0	-	0	-
Peak Hour Factor	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	0	837	489	5	11	5

Major/Minor	Major1		Major2		Minor2	
Conflicting Flow All	495	0	-	0	1329	492
Stage 1	-	-	-	-	492	-
Stage 2	-	-	-	-	837	-
Critical Hdwy	4.12	-	-	-	6.42	6.22
Critical Hdwy Stg 1	-	-	-	-	5.42	-
Critical Hdwy Stg 2	-	-	-	-	5.42	-
Follow-up Hdwy	2.218	-	-	-	3.518	3.318
Pot Cap-1 Maneuver	1069	-	-	-	171	577
Stage 1	-	-	-	-	615	-
Stage 2	-	-	-	-	425	-
Platoon blocked, %		-	-	-		
Mov Cap-1 Maneuver	1069	-	-	-	171	577
Mov Cap-2 Maneuver	-	-	-	-	171	-
Stage 1	-	-	-	-	615	-
Stage 2	-	-	-	-	425	-

Approach	EB	WB	SB
HCM Control Delay, s	0	0	22.4
HCM LOS			C

Minor Lane/Major Mvmt	EBL	EBT	WBT	WBR	SBLn1
Capacity (veh/h)	1069	-	-	-	223
HCM Lane V/C Ratio	-	-	-	-	0.073
HCM Control Delay (s)	0	-	-	-	22.4
HCM Lane LOS	A	-	-	-	C
HCM 95th %tile Q(veh)	0	-	-	-	0.2

Intersection	
Int Delay, s/veh	0.8

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Vol, veh/h	10	755	0	0	430	20	0	0	0	20	0	15
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Free	Free	Stop	Stop	Stop	Stop	Stop	Stop
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	-	-	-	-	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	92	92	92	92	92	92	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2	2	2	2	2	2	2
Mvmt Flow	11	821	0	0	467	22	0	0	0	22	0	16

Major/Minor	Major1			Major2			Minor1			Minor2		
Conflicting Flow All	489	0	0	821	0	0	1328	1331	821	1320	1320	478
Stage 1	-	-	-	-	-	-	842	842	-	478	478	-
Stage 2	-	-	-	-	-	-	486	489	-	842	842	-
Critical Hdwy	4.12	-	-	4.12	-	-	7.12	6.52	6.22	7.12	6.52	6.22
Critical Hdwy Stg 1	-	-	-	-	-	-	6.12	5.52	-	6.12	5.52	-
Critical Hdwy Stg 2	-	-	-	-	-	-	6.12	5.52	-	6.12	5.52	-
Follow-up Hdwy	2.218	-	-	2.218	-	-	3.518	4.018	3.318	3.518	4.018	3.318
Pot Cap-1 Maneuver	1074	-	-	808	-	-	132	154	374	134	157	587
Stage 1	-	-	-	-	-	-	359	380	-	568	556	-
Stage 2	-	-	-	-	-	-	563	549	-	359	380	-
Platoon blocked, %		-	-		-	-						
Mov Cap-1 Maneuver	1074	-	-	808	-	-	126	151	374	132	154	587
Mov Cap-2 Maneuver	-	-	-	-	-	-	126	151	-	132	154	-
Stage 1	-	-	-	-	-	-	352	373	-	557	556	-
Stage 2	-	-	-	-	-	-	547	549	-	352	373	-

Approach	EB	WB	NB	SB
HCM Control Delay, s	0.1	0	0	27.5
HCM LOS			A	D

Minor Lane/Major Mvmt	NBLn1	EBL	EBT	EBR	WBL	WBT	WBR	SBLn1
Capacity (veh/h)	-	1074	-	-	808	-	-	198
HCM Lane V/C Ratio	-	0.01	-	-	-	-	-	0.192
HCM Control Delay (s)	0	8.4	0	-	0	-	-	27.5
HCM Lane LOS	A	A	A	-	A	-	-	D
HCM 95th %tile Q(veh)	-	0	-	-	0	-	-	0.7

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	50	290	465	200	220	275	215	785	110	195	975	30
Number	7	4	14	3	8	18	5	2	12	1	6	16
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1863	1863	1900	1863	1863	1863	1863	1863	1863	1863	1863	1863
Adj Flow Rate, veh/h	54	315	289	217	239	77	234	853	29	212	1060	8
Adj No. of Lanes	1	2	0	1	1	1	1	2	1	1	2	1
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Percent Heavy Veh, %	2	2	2	2	2	2	2	2	2	2	2	2
Cap, veh/h	70	388	347	241	587	499	262	1149	514	241	1106	495
Arrive On Green	0.04	0.22	0.22	0.14	0.32	0.32	0.15	0.32	0.32	0.14	0.31	0.31
Sat Flow, veh/h	1774	1770	1583	1774	1863	1583	1774	3539	1583	1774	3539	1583
Grp Volume(v), veh/h	54	315	289	217	239	77	234	853	29	212	1060	8
Grp Sat Flow(s),veh/h/ln	1774	1770	1583	1774	1863	1583	1774	1770	1583	1774	1770	1583
Q Serve(g_s), s	3.9	22.0	22.7	15.6	13.1	4.5	16.8	27.9	1.6	15.2	38.2	0.5
Cycle Q Clear(g_c), s	3.9	22.0	22.7	15.6	13.1	4.5	16.8	27.9	1.6	15.2	38.2	0.5
Prop In Lane	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Lane Grp Cap(c), veh/h	70	388	347	241	587	499	262	1149	514	241	1106	495
V/C Ratio(X)	0.77	0.81	0.83	0.90	0.41	0.15	0.89	0.74	0.06	0.88	0.96	0.02
Avail Cap(c_a), veh/h	369	627	561	246	587	499	355	1149	514	355	1117	500
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	61.8	48.2	48.5	55.3	34.9	32.0	54.4	39.0	30.2	55.1	43.8	30.9
Incr Delay (d2), s/veh	15.8	4.2	5.8	32.0	0.5	0.1	19.0	2.6	0.0	15.8	17.7	0.0
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	2.2	11.2	10.4	9.8	6.8	2.0	9.6	14.0	0.7	8.5	21.4	0.2
LnGrp Delay(d),s/veh	77.6	52.4	54.2	87.3	35.4	32.2	73.4	41.7	30.2	70.9	61.6	30.9
LnGrp LOS	E	D	D	F	D	C	E	D	C	E	E	C
Approach Vol, veh/h		658			533			1116			1280	
Approach Delay, s/veh		55.3			56.0			48.0			62.9	
Approach LOS		E			E			D			E	

Timer	1	2	3	4	5	6	7	8
Assigned Phs	1	2	3	4	5	6	7	8
Phs Duration (G+Y+Rc), s	23.6	48.2	23.7	34.5	25.2	46.6	11.2	47.0
Change Period (Y+Rc), s	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0
Max Green Setting (Gmax), s	26.0	41.0	18.0	46.0	26.0	41.0	27.0	37.0
Max Q Clear Time (g_c+I1), s	17.2	29.9	17.6	24.7	18.8	40.2	5.9	15.1
Green Ext Time (p_c), s	0.4	8.6	0.0	3.8	0.4	0.4	0.1	5.8

Intersection Summary	
HCM 2010 Ctrl Delay	55.9
HCM 2010 LOS	E

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	235	245	220	15	275	185	240	1065	15	360	1775	220
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	6.0	4.0	4.0	6.0
Lane Util. Factor	0.91	0.91	1.00	1.00	1.00	0.88	0.97	0.91	1.00	0.97	0.91	1.00
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	0.99	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	1610	3349	1583	1770	1863	2787	3433	5085	1583	3433	5085	1583
Flt Permitted	0.95	0.99	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)	1610	3349	1583	1770	1863	2787	3433	5085	1583	3433	5085	1583
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	255	266	239	16	299	201	261	1158	16	391	1929	239
RTOR Reduction (vph)	0	0	62	0	0	107	0	0	9	0	0	68
Lane Group Flow (vph)	168	353	177	16	299	94	261	1158	7	391	1929	171
Turn Type	Split	NA	Perm	Split	NA	Perm	Prot	NA	Perm	Prot	NA	Perm
Protected Phases	3	3		4	4		5	2		1	6	
Permitted Phases			3			4			2			6
Actuated Green, G (s)	35.6	35.6	35.6	41.4	41.4	41.4	23.5	106.4	106.4	31.6	114.5	114.5
Effective Green, g (s)	37.6	37.6	37.6	43.4	43.4	43.4	25.5	109.4	107.4	33.6	117.5	115.5
Actuated g/C Ratio	0.16	0.16	0.16	0.18	0.18	0.18	0.11	0.46	0.45	0.14	0.49	0.48
Clearance Time (s)	6.0	6.0	6.0	6.0	6.0	6.0	6.0	7.0	7.0	6.0	7.0	7.0
Vehicle Extension (s)	5.0	5.0	5.0	5.0	5.0	5.0	3.0	5.0	5.0	3.0	5.0	5.0
Lane Grp Cap (vph)	252	524	248	320	336	503	364	2317	708	480	2489	761
v/s Ratio Prot	0.10	0.11		0.01	c0.16		0.08	0.23		c0.11	c0.38	
v/s Ratio Perm			c0.11			0.03			0.00			0.11
v/c Ratio	0.67	0.67	0.72	0.05	0.89	0.19	0.72	0.50	0.01	0.81	0.78	0.22
Uniform Delay, d1	95.3	95.4	96.1	81.3	96.0	83.3	103.8	46.0	36.8	100.2	50.4	36.2
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.16	0.89	1.05
Incremental Delay, d2	8.5	4.4	11.6	0.1	25.2	0.4	6.6	0.8	0.0	10.1	2.4	0.7
Delay (s)	103.8	99.8	107.7	81.4	121.1	83.7	110.4	46.8	36.8	125.8	47.4	38.8
Level of Service	F	F	F	F	F	F	F	D	D	F	D	D
Approach Delay (s)		103.2			105.3			58.2			58.6	
Approach LOS		F			F			E			E	

Intersection Summary			
HCM 2000 Control Delay	69.5	HCM 2000 Level of Service	E
HCM 2000 Volume to Capacity ratio	0.80		
Actuated Cycle Length (s)	240.0	Sum of lost time (s)	16.0
Intersection Capacity Utilization	78.0%	ICU Level of Service	D
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	380	40	125	35	35	30	130	1740	65	80	2830	385
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		6.0	4.0	6.0	5.0	6.0	4.0	5.0	7.0
Lane Util. Factor	0.95	0.95	1.00		1.00	1.00	1.00	0.91	1.00	1.00	0.91	1.00
Frpb, ped/bikes	1.00	1.00	0.91		1.00	1.00	1.00	1.00	0.83	1.00	1.00	0.97
Flpb, ped/bikes	1.00	1.00	1.00		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Frt	1.00	1.00	0.85		1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	0.96	1.00		0.98	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	1681	1701	1434		1817	1583	1770	5085	1311	1770	5085	1536
Flt Permitted	0.95	0.96	1.00		0.98	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)	1681	1701	1434		1817	1583	1770	5085	1311	1770	5085	1536
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	413	43	136	38	38	33	141	1891	71	87	3076	418
RTOR Reduction (vph)	0	0	83	0	0	31	0	0	27	0	0	183
Lane Group Flow (vph)	227	229	53	0	76	2	141	1891	44	87	3076	235
Confl. Peds. (#/hr)			43						31			2
Turn Type	Split	NA	Perm	Split	NA	Perm	Prot	NA	Perm	Prot	NA	Perm
Protected Phases	4	4		3	3		5	2		1	6	
Permitted Phases			4			3			2			6
Actuated Green, G (s)	39.9	39.9	39.9		15.4	15.4	25.6	144.3	144.3	16.4	135.1	135.1
Effective Green, g (s)	39.9	39.9	39.9		15.4	17.4	25.6	146.3	145.3	18.4	137.1	135.1
Actuated g/C Ratio	0.17	0.17	0.17		0.06	0.07	0.11	0.61	0.61	0.08	0.57	0.56
Clearance Time (s)	5.0	5.0	5.0		6.0	6.0	6.0	7.0	7.0	6.0	7.0	7.0
Vehicle Extension (s)	4.0	4.0	4.0		3.0	3.0	5.0	6.0	6.0	3.0	6.0	6.0
Lane Grp Cap (vph)	279	282	238		116	114	188	3099	793	135	2904	864
v/s Ratio Prot	c0.14	0.13			c0.04		c0.08	0.37		0.05	c0.60	
v/s Ratio Perm			0.04			0.00			0.03			0.15
v/c Ratio	0.81	0.81	0.22		0.66	0.02	0.75	0.61	0.06	0.64	1.06	0.27
Uniform Delay, d1	96.5	96.4	86.6		109.7	103.4	104.1	29.1	19.3	107.6	51.5	27.1
Progression Factor	1.00	1.00	1.00		1.00	1.00	0.88	1.18	2.11	0.98	0.99	1.40
Incremental Delay, d2	17.2	16.9	0.6		12.5	0.1	7.6	0.4	0.1	10.0	35.0	0.8
Delay (s)	113.6	113.3	87.2		122.3	103.5	98.8	34.6	40.8	115.2	86.0	38.6
Level of Service	F	F	F		F	F	F	C	D	F	F	D
Approach Delay (s)		107.4			116.6			39.1			81.2	
Approach LOS		F			F			D			F	

Intersection Summary			
HCM 2000 Control Delay	70.4	HCM 2000 Level of Service	E
HCM 2000 Volume to Capacity ratio	0.95		
Actuated Cycle Length (s)	240.0	Sum of lost time (s)	22.0
Intersection Capacity Utilization	103.0%	ICU Level of Service	G
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	30	75	20	315	170	410	60	1130	475	275	580	50
Number	3	8	18	7	4	14	5	2	12	1	6	16
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1863	1863	1900	1863	1863	1863	1863	1863	1900	1863	1863	1900
Adj Flow Rate, veh/h	33	82	14	342	185	125	65	1228	464	299	630	46
Adj No. of Lanes	1	1	0	1	1	1	1	3	0	2	3	0
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Percent Heavy Veh, %	2	2	2	2	2	2	2	2	2	2	2	2
Cap, veh/h	340	515	88	447	618	525	84	1428	538	386	2211	160
Arrive On Green	0.33	0.33	0.33	0.33	0.33	0.33	0.05	0.39	0.39	0.11	0.46	0.46
Sat Flow, veh/h	1065	1551	265	1294	1863	1583	1774	3640	1371	3442	4840	351
Grp Volume(v), veh/h	33	0	96	342	185	125	65	1144	548	299	440	236
Grp Sat Flow(s),veh/h/ln	1065	0	1816	1294	1863	1583	1774	1695	1621	1721	1695	1801
Q Serve(g_s), s	2.6	0.0	4.1	27.8	8.1	6.3	4.0	34.0	34.1	9.3	8.9	9.0
Cycle Q Clear(g_c), s	10.7	0.0	4.1	31.9	8.1	6.3	4.0	34.0	34.1	9.3	8.9	9.0
Prop In Lane	1.00		0.15	1.00		1.00	1.00		0.85	1.00		0.19
Lane Grp Cap(c), veh/h	340	0	602	447	618	525	84	1330	636	386	1549	823
V/C Ratio(X)	0.10	0.00	0.16	0.77	0.30	0.24	0.77	0.86	0.86	0.78	0.28	0.29
Avail Cap(c_a), veh/h	404	0	711	524	729	620	275	1358	649	1097	1914	1017
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	0.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	31.2	0.0	25.9	37.2	27.2	26.6	51.7	30.6	30.6	47.4	18.6	18.6
Incr Delay (d2), s/veh	0.1	0.0	0.1	5.7	0.3	0.2	13.6	5.7	11.4	3.4	0.1	0.2
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	0.8	0.0	2.1	10.6	4.2	2.8	2.3	16.9	17.2	4.6	4.2	4.5
LnGrp Delay(d),s/veh	31.3	0.0	26.0	42.8	27.5	26.9	65.3	36.3	42.0	50.8	18.7	18.8
LnGrp LOS	C		C	D	C	C	E	D	D	D	B	B
Approach Vol, veh/h		129			652			1757			975	
Approach Delay, s/veh		27.4			35.4			39.2			28.6	
Approach LOS		C			D			D			C	

Timer	1	2	3	4	5	6	7	8
Assigned Phs	1	2		4	5	6		8
Phs Duration (G+Y+Rc), s	18.3	49.1		42.4	11.2	56.2		42.4
Change Period (Y+Rc), s	6.0	6.0		6.0	6.0	6.0		6.0
Max Green Setting (Gmax), s	35.0	44.0		43.0	17.0	62.0		43.0
Max Q Clear Time (g_c+I1), s	11.3	36.1		33.9	6.0	11.0		12.7
Green Ext Time (p_c), s	1.0	7.0		2.5	0.1	30.6		3.8

Intersection Summary	
HCM 2010 Ctrl Delay	35.1
HCM 2010 LOS	D

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	10	130	190	100	335	290	470	1265	245	175	805	60
Number	7	4	14	3	8	18	5	2	12	1	6	16
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1863	1863	1863	1863	1863	1863	1863	1863	1863	1863	1863	1863
Adj Flow Rate, veh/h	11	141	23	109	364	58	511	1375	162	190	875	19
Adj No. of Lanes	1	1	1	1	1	1	2	2	1	1	2	1
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Percent Heavy Veh, %	2	2	2	2	2	2	2	2	2	2	2	2
Cap, veh/h	18	305	259	135	428	363	594	1506	674	219	1332	596
Arrive On Green	0.01	0.16	0.16	0.08	0.23	0.23	0.17	0.43	0.43	0.12	0.38	0.38
Sat Flow, veh/h	1774	1863	1583	1774	1863	1583	3442	3539	1583	1774	3539	1583
Grp Volume(v), veh/h	11	141	23	109	364	58	511	1375	162	190	875	19
Grp Sat Flow(s),veh/h/ln	1774	1863	1583	1774	1863	1583	1721	1770	1583	1774	1770	1583
Q Serve(g_s), s	0.7	7.8	1.4	6.9	21.3	3.3	16.4	41.5	7.4	12.0	23.3	0.9
Cycle Q Clear(g_c), s	0.7	7.8	1.4	6.9	21.3	3.3	16.4	41.5	7.4	12.0	23.3	0.9
Prop In Lane	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Lane Grp Cap(c), veh/h	18	305	259	135	428	363	594	1506	674	219	1332	596
V/C Ratio(X)	0.60	0.46	0.09	0.81	0.85	0.16	0.86	0.91	0.24	0.87	0.66	0.03
Avail Cap(c_a), veh/h	187	606	515	187	606	515	787	1556	696	265	1332	596
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	56.0	43.0	40.3	51.7	41.9	35.0	45.7	30.7	20.9	48.9	29.4	22.4
Incr Delay (d2), s/veh	27.7	1.1	0.1	16.2	8.0	0.2	7.5	8.5	0.2	21.6	1.2	0.0
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	0.5	4.1	0.6	4.0	11.9	1.5	8.4	22.0	3.3	7.2	11.5	0.4
LnGrp Delay(d),s/veh	83.7	44.1	40.5	67.9	50.0	35.2	53.2	39.2	21.1	70.5	30.5	22.4
LnGrp LOS	F	D	D	E	D	D	D	D	C	E	C	C
Approach Vol, veh/h		175			531			2048			1084	
Approach Delay, s/veh		46.1			52.1			41.2			37.4	
Approach LOS		D			D			D			D	

Timer	1	2	3	4	5	6	7	8
Assigned Phs	1	2	3	4	5	6	7	8
Phs Duration (G+Y+Rc), s	20.1	54.4	14.7	24.6	25.6	48.8	7.2	32.1
Change Period (Y+Rc), s	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0
Max Green Setting (Gmax), s	17.0	50.0	12.0	37.0	26.0	41.0	12.0	37.0
Max Q Clear Time (g_c+I1), s	14.0	43.5	8.9	9.8	18.4	25.3	2.7	23.3
Green Ext Time (p_c), s	0.1	4.9	0.1	3.5	1.2	13.1	0.0	2.8

Intersection Summary		
HCM 2010 Ctrl Delay		41.9
HCM 2010 LOS		D

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	85	165	75	205	80	325	40	890	130	320	1180	65
Number	3	8	18	7	4	14	5	2	12	1	6	16
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1863	1863	1900	1863	1863	1863	1863	1863	1900	1863	1863	1900
Adj Flow Rate, veh/h	92	179	69	223	87	88	43	967	129	348	1283	67
Adj No. of Lanes	1	1	0	1	1	1	1	3	0	2	3	0
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Percent Heavy Veh, %	2	2	2	2	2	2	2	2	2	2	2	2
Cap, veh/h	458	449	173	351	652	555	55	1503	200	453	2136	112
Arrive On Green	0.35	0.35	0.35	0.35	0.35	0.35	0.03	0.33	0.33	0.13	0.43	0.43
Sat Flow, veh/h	1205	1282	494	1127	1863	1583	1774	4542	604	3442	4949	258
Grp Volume(v), veh/h	92	0	248	223	87	88	43	721	375	348	879	471
Grp Sat Flow(s),veh/h/ln	1205	0	1776	1127	1863	1583	1774	1695	1756	1721	1695	1817
Q Serve(g_s), s	5.4	0.0	10.1	17.9	3.1	3.7	2.3	17.4	17.5	9.4	19.1	19.1
Cycle Q Clear(g_c), s	8.5	0.0	10.1	28.1	3.1	3.7	2.3	17.4	17.5	9.4	19.1	19.1
Prop In Lane	1.00		0.28	1.00		1.00	1.00		0.34	1.00		0.14
Lane Grp Cap(c), veh/h	458	0	622	351	652	555	55	1122	581	453	1463	784
V/C Ratio(X)	0.20	0.00	0.40	0.64	0.13	0.16	0.78	0.64	0.65	0.77	0.60	0.60
Avail Cap(c_a), veh/h	651	0	905	530	949	807	369	1122	581	1575	1869	1002
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	0.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	24.2	0.0	23.6	34.2	21.3	21.5	46.3	27.3	27.4	40.3	21.0	21.0
Incr Delay (d2), s/veh	0.2	0.0	0.4	1.9	0.1	0.1	20.8	1.3	2.5	2.8	0.4	0.7
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	1.8	0.0	5.0	5.8	1.6	1.6	1.5	8.3	8.8	4.6	9.0	9.7
LnGrp Delay(d),s/veh	24.4	0.0	24.0	36.1	21.4	21.6	67.0	28.6	29.8	43.1	21.4	21.7
LnGrp LOS	C		C	D	C	C	E	C	C	D	C	C
Approach Vol, veh/h		340			398			1139			1698	
Approach Delay, s/veh		24.1			29.7			30.5			25.9	
Approach LOS		C			C			C			C	

Timer	1	2	3	4	5	6	7	8
Assigned Phs	1	2		4	5	6		8
Phs Duration (G+Y+Rc), s	18.7	37.8		39.7	9.0	47.5		39.7
Change Period (Y+Rc), s	6.0	6.0		6.0	6.0	6.0		6.0
Max Green Setting (Gmax), s	44.0	29.0		49.0	20.0	53.0		49.0
Max Q Clear Time (g_c+I1), s	11.4	19.5		30.1	4.3	21.1		12.1
Green Ext Time (p_c), s	1.3	8.3		3.6	0.1	20.4		4.1

Intersection Summary	
HCM 2010 Ctrl Delay	27.6
HCM 2010 LOS	C

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	50	290	465	200	220	275	215	785	110	195	975	30
Number	7	4	14	3	8	18	5	2	12	1	6	16
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1863	1863	1863	1863	1863	1863	1863	1863	1863	1863	1863	1863
Adj Flow Rate, veh/h	54	315	229	217	239	78	234	853	28	212	1060	9
Adj No. of Lanes	1	1	1	1	1	1	2	2	1	1	2	1
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Percent Heavy Veh, %	2	2	2	2	2	2	2	2	2	2	2	2
Cap, veh/h	70	384	326	247	569	484	302	1144	512	244	1319	590
Arrive On Green	0.04	0.21	0.21	0.14	0.31	0.31	0.09	0.32	0.32	0.14	0.37	0.37
Sat Flow, veh/h	1774	1863	1583	1774	1863	1583	3442	3539	1583	1774	3539	1583
Grp Volume(v), veh/h	54	315	229	217	239	78	234	853	28	212	1060	9
Grp Sat Flow(s),veh/h/ln	1774	1863	1583	1774	1863	1583	1721	1770	1583	1774	1770	1583
Q Serve(g_s), s	3.7	20.0	16.6	14.8	12.6	4.4	8.2	26.6	1.5	14.5	33.2	0.4
Cycle Q Clear(g_c), s	3.7	20.0	16.6	14.8	12.6	4.4	8.2	26.6	1.5	14.5	33.2	0.4
Prop In Lane	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Lane Grp Cap(c), veh/h	70	384	326	247	569	484	302	1144	512	244	1319	590
V/C Ratio(X)	0.77	0.82	0.70	0.88	0.42	0.16	0.77	0.75	0.05	0.87	0.80	0.02
Avail Cap(c_a), veh/h	359	557	474	359	569	484	668	1145	512	488	1431	640
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	58.8	46.9	45.5	52.2	34.2	31.4	55.2	37.3	28.8	52.2	34.7	24.5
Incr Delay (d2), s/veh	15.8	6.3	2.7	15.7	0.5	0.2	4.2	2.7	0.0	9.2	3.2	0.0
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	2.1	10.9	7.5	8.4	6.6	2.0	4.1	13.3	0.7	7.7	16.8	0.2
LnGrp Delay(d),s/veh	74.6	53.2	48.3	67.9	34.7	31.5	59.4	40.0	28.9	61.4	37.9	24.5
LnGrp LOS	E	D	D	E	C	C	E	D	C	E	D	C
Approach Vol, veh/h		598			534			1115			1281	
Approach Delay, s/veh		53.2			47.7			43.8			41.7	
Approach LOS		D			D			D			D	

Timer	1	2	3	4	5	6	7	8
Assigned Phs	1	2	3	4	5	6	7	8
Phs Duration (G+Y+Rc), s	23.0	45.9	23.2	31.5	16.9	52.1	10.9	43.8
Change Period (Y+Rc), s	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0
Max Green Setting (Gmax), s	34.0	40.0	25.0	37.0	24.0	50.0	25.0	37.0
Max Q Clear Time (g_c+I1), s	16.5	28.6	16.8	22.0	10.2	35.2	5.7	14.6
Green Ext Time (p_c), s	0.5	8.8	0.4	3.5	0.6	10.9	0.1	4.5

Intersection Summary	
HCM 2010 Ctrl Delay	45.2
HCM 2010 LOS	D

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	625	530	5	120	705	475	5	85	15	415	120	430
Number	7	4	14	3	8	18	5	2	12	1	6	16
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1863	1863	1900	1863	1863	1863	1863	1863	1900	1863	1863	1863
Adj Flow Rate, veh/h	679	576	5	130	766	516	5	92	3	451	130	278
Adj No. of Lanes	2	3	0	2	3	2	1	2	0	2	2	2
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Percent Heavy Veh, %	2	2	2	2	2	2	2	2	2	2	2	2
Cap, veh/h	808	2280	20	214	1352	1184	9	315	10	547	863	1330
Arrive On Green	0.23	0.44	0.44	0.06	0.27	0.27	0.01	0.09	0.09	0.16	0.24	0.24
Sat Flow, veh/h	3442	5200	45	3442	5085	2787	1774	3499	114	3442	3539	2773
Grp Volume(v), veh/h	679	375	206	130	766	516	5	46	49	451	130	278
Grp Sat Flow(s),veh/h/ln	1721	1695	1855	1721	1695	1393	1774	1770	1843	1721	1770	1386
Q Serve(g_s), s	18.0	6.7	6.7	3.5	12.5	12.5	0.3	2.3	2.4	12.2	2.8	5.6
Cycle Q Clear(g_c), s	18.0	6.7	6.7	3.5	12.5	12.5	0.3	2.3	2.4	12.2	2.8	5.6
Prop In Lane	1.00		0.02	1.00		1.00	1.00		0.06	1.00		1.00
Lane Grp Cap(c), veh/h	808	1486	813	214	1352	1184	9	160	166	547	863	1330
V/C Ratio(X)	0.84	0.25	0.25	0.61	0.57	0.44	0.54	0.29	0.29	0.82	0.15	0.21
Avail Cap(c_a), veh/h	1364	1486	813	1364	2016	1548	222	702	730	790	1772	2043
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	35.0	17.0	17.0	43.8	30.4	19.5	47.6	40.7	40.8	39.0	28.5	14.5
Incr Delay (d2), s/veh	2.5	0.1	0.2	2.8	0.4	0.3	41.5	1.0	1.0	4.8	0.1	0.1
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	8.9	3.1	3.5	1.8	5.9	4.9	0.2	1.2	1.2	6.1	1.4	2.1
LnGrp Delay(d),s/veh	37.4	17.1	17.2	46.6	30.8	19.7	89.1	41.7	41.7	43.8	28.5	14.6
LnGrp LOS	D	B	B	D	C	B	F	D	D	D	C	B
Approach Vol, veh/h		1260			1412			100			859	
Approach Delay, s/veh		28.1			28.2			44.1			32.0	
Approach LOS		C			C			D			C	

Timer	1	2	3	4	5	6	7	8
Assigned Phs	1	2	3	4	5	6	7	8
Phs Duration (G+Y+Rc), s	21.2	14.6	12.0	48.0	6.5	29.4	28.5	31.5
Change Period (Y+Rc), s	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0
Max Green Setting (Gmax), s	22.0	38.0	38.0	38.0	12.0	48.0	38.0	38.0
Max Q Clear Time (g_c+I1), s	14.2	4.4	5.5	8.7	2.3	7.6	20.0	14.5
Green Ext Time (p_c), s	1.1	2.6	0.4	14.4	0.0	2.7	2.5	11.0

Intersection Summary			
HCM 2010 Ctrl Delay			29.5
HCM 2010 LOS			C

Notes

User approved changes to right turn type.

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	30	70	20	300	175	370	50	980	400	280	530	80
Number	3	8	18	7	4	14	5	2	12	1	6	16
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1863	1863	1900	1863	1863	1863	1863	1863	1900	1863	1863	1900
Adj Flow Rate, veh/h	33	76	13	326	190	93	54	1065	381	304	576	73
Adj No. of Lanes	1	1	0	1	1	1	1	3	0	1	3	0
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Percent Heavy Veh, %	2	2	2	2	2	2	2	2	2	2	2	2
Cap, veh/h	314	483	83	419	580	493	70	1290	462	337	2288	286
Arrive On Green	0.31	0.31	0.31	0.31	0.31	0.31	0.04	0.35	0.35	0.19	0.50	0.50
Sat Flow, veh/h	1092	1551	265	1303	1863	1583	1774	3697	1323	1774	4579	573
Grp Volume(v), veh/h	33	0	89	326	190	93	54	977	469	304	425	224
Grp Sat Flow(s),veh/h/ln	1092	0	1816	1303	1863	1583	1774	1695	1629	1774	1695	1762
Q Serve(g_s), s	2.9	0.0	4.3	29.1	9.4	5.2	3.6	31.7	31.7	20.2	8.6	8.8
Cycle Q Clear(g_c), s	12.3	0.0	4.3	33.4	9.4	5.2	3.6	31.7	31.7	20.2	8.6	8.8
Prop In Lane	1.00		0.15	1.00		1.00	1.00		0.81	1.00		0.33
Lane Grp Cap(c), veh/h	314	0	565	419	580	493	70	1183	569	337	1694	880
V/C Ratio(X)	0.10	0.00	0.16	0.78	0.33	0.19	0.77	0.83	0.83	0.90	0.25	0.25
Avail Cap(c_a), veh/h	364	0	648	478	665	565	250	1238	595	515	1744	906
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	0.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	36.5	0.0	30.0	42.1	31.8	30.4	57.3	35.9	35.9	47.7	17.2	17.3
Incr Delay (d2), s/veh	0.1	0.0	0.1	7.0	0.3	0.2	16.1	4.5	9.0	13.3	0.1	0.2
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	0.9	0.0	2.2	11.3	4.9	2.3	2.1	15.5	15.6	11.1	4.0	4.3
LnGrp Delay(d),s/veh	36.7	0.0	30.2	49.2	32.1	30.5	73.4	40.4	44.9	61.0	17.3	17.4
LnGrp LOS	D		C	D	C	C	E	D	D	E	B	B
Approach Vol, veh/h		122			609			1500			953	
Approach Delay, s/veh		31.9			41.0			43.0			31.3	
Approach LOS		C			D			D			C	

Timer	1	2	3	4	5	6	7	8
Assigned Phs	1	2		4	5	6		8
Phs Duration (G+Y+Rc), s	28.9	48.1		43.5	10.8	66.2		43.5
Change Period (Y+Rc), s	6.0	6.0		6.0	6.0	6.0		6.0
Max Green Setting (Gmax), s	35.0	44.0		43.0	17.0	62.0		43.0
Max Q Clear Time (g_c+I1), s	22.2	33.7		35.4	5.6	10.8		14.3
Green Ext Time (p_c), s	0.7	8.3		2.1	0.1	25.4		3.5

Intersection Summary	
HCM 2010 Ctrl Delay	38.7
HCM 2010 LOS	D

Intersection	
Int Delay, s/veh	0

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Vol, veh/h	0	0	195	5	5	90
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	-	-	0	-
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	0	0	212	5	5	98

Major/Minor	Major1		Major2		Minor1	
Conflicting Flow All	0	0	0	0	429	0
Stage 1	-	-	-	-	0	-
Stage 2	-	-	-	-	429	-
Critical Hdwy	-	-	4.12	-	6.42	6.22
Critical Hdwy Stg 1	-	-	-	-	5.42	-
Critical Hdwy Stg 2	-	-	-	-	5.42	-
Follow-up Hdwy	-	-	2.218	-	3.518	3.318
Pot Cap-1 Maneuver	-	-	-	-	583	-
Stage 1	-	-	-	-	-	-
Stage 2	-	-	-	-	657	-
Platoon blocked, %	-	-		-		
Mov Cap-1 Maneuver	-	-	-	-	583	-
Mov Cap-2 Maneuver	-	-	-	-	583	-
Stage 1	-	-	-	-	-	-
Stage 2	-	-	-	-	657	-

Approach	EB	WB	NB
HCM Control Delay, s	0		
HCM LOS			-

Minor Lane/Major Mvmt	NBLn1	EBT	EBR	WBL	WBT
Capacity (veh/h)	-	-	-	-	-
HCM Lane V/C Ratio	-	-	-	-	-
HCM Control Delay (s)	-	-	-	-	-
HCM Lane LOS	-	-	-	-	-
HCM 95th %tile Q(veh)	-	-	-	-	-

Intersection	
Int Delay, s/veh	4.7

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Vol, veh/h	70	305	0	0	655	20	0	0	0	15	0	180
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Free	Free	Stop	Stop	Stop	Stop	Stop	Stop
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	-	-	-	-	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	92	92	92	92	92	92	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2	2	2	2	2	2	2
Mvmt Flow	76	332	0	0	712	22	0	0	0	16	0	196

Major/Minor	Major1			Major2			Minor1			Minor2		
Conflicting Flow All	734	0	0	332	0	0	1305	1218	332	1207	1207	723
Stage 1	-	-	-	-	-	-	484	484	-	723	723	-
Stage 2	-	-	-	-	-	-	821	734	-	484	484	-
Critical Hdwy	4.12	-	-	4.12	-	-	7.12	6.52	6.22	7.12	6.52	6.22
Critical Hdwy Stg 1	-	-	-	-	-	-	6.12	5.52	-	6.12	5.52	-
Critical Hdwy Stg 2	-	-	-	-	-	-	6.12	5.52	-	6.12	5.52	-
Follow-up Hdwy	2.218	-	-	2.218	-	-	3.518	4.018	3.318	3.518	4.018	3.318
Pot Cap-1 Maneuver	871	-	-	1227	-	-	137	181	710	160	183	426
Stage 1	-	-	-	-	-	-	564	552	-	417	431	-
Stage 2	-	-	-	-	-	-	369	426	-	564	552	-
Platoon blocked, %		-	-		-	-						
Mov Cap-1 Maneuver	871	-	-	1227	-	-	68	162	710	147	163	426
Mov Cap-2 Maneuver	-	-	-	-	-	-	68	162	-	147	163	-
Stage 1	-	-	-	-	-	-	504	493	-	372	431	-
Stage 2	-	-	-	-	-	-	200	426	-	504	493	-

Approach	EB	WB	NB	SB
HCM Control Delay, s	1.8	0	0	26.7
HCM LOS			A	D

Minor Lane/Major Mvmt	NBLn1	EBL	EBT	EBR	WBL	WBT	WBR	SBLn1
Capacity (veh/h)	-	871	-	-	1227	-	-	372
HCM Lane V/C Ratio	-	0.087	-	-	-	-	-	0.57
HCM Control Delay (s)	0	9.5	0	-	0	-	-	26.7
HCM Lane LOS	A	A	A	-	A	-	-	D
HCM 95th %tile Q(veh)	-	0.3	-	-	0	-	-	3.4

Intersection	
Int Delay, s/veh	0.5

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Vol, veh/h	300	10	25	705	10	5
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	50	-	0	-
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	326	11	27	766	11	5

Major/Minor	Major1		Major2		Minor1	
Conflicting Flow All	0	0	337	0	1153	332
Stage 1	-	-	-	-	332	-
Stage 2	-	-	-	-	821	-
Critical Hdwy	-	-	4.12	-	6.42	6.22
Critical Hdwy Stg 1	-	-	-	-	5.42	-
Critical Hdwy Stg 2	-	-	-	-	5.42	-
Follow-up Hdwy	-	-	2.218	-	3.518	3.318
Pot Cap-1 Maneuver	-	-	1222	-	218	710
Stage 1	-	-	-	-	727	-
Stage 2	-	-	-	-	432	-
Platoon blocked, %	-	-		-		
Mov Cap-1 Maneuver	-	-	1222	-	213	710
Mov Cap-2 Maneuver	-	-	-	-	213	-
Stage 1	-	-	-	-	727	-
Stage 2	-	-	-	-	422	-

Approach	EB	WB	NB
HCM Control Delay, s	0	0.3	18.8
HCM LOS			C

Minor Lane/Major Mvmt	NBLn1	EBT	EBR	WBL	WBT
Capacity (veh/h)	278	-	-	1222	-
HCM Lane V/C Ratio	0.059	-	-	0.022	-
HCM Control Delay (s)	18.8	-	-	8	-
HCM Lane LOS	C	-	-	A	-
HCM 95th %tile Q(veh)	0.2	-	-	0.1	-

Intersection	
Int Delay, s/veh	0

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Vol, veh/h	0	305	0	0	745	0	0	0	0	0	0	0
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Free	Free	Stop	Stop	Stop	Stop	Stop	Stop
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	-	-	-	-	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	92	92	92	92	92	92	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2	2	2	2	2	2	2
Mvmt Flow	0	332	0	0	810	0	0	0	0	0	0	0

Major/Minor	Major1			Major2			Minor1			Minor2		
Conflicting Flow All	810	0	0	332	0	0	1142	1142	332	1142	1142	810
Stage 1	-	-	-	-	-	-	332	332	-	810	810	-
Stage 2	-	-	-	-	-	-	810	810	-	332	332	-
Critical Hdwy	4.12	-	-	4.12	-	-	7.12	6.52	6.22	7.12	6.52	6.22
Critical Hdwy Stg 1	-	-	-	-	-	-	6.12	5.52	-	6.12	5.52	-
Critical Hdwy Stg 2	-	-	-	-	-	-	6.12	5.52	-	6.12	5.52	-
Follow-up Hdwy	2.218	-	-	2.218	-	-	3.518	4.018	3.318	3.518	4.018	3.318
Pot Cap-1 Maneuver	816	-	-	1227	-	-	177	200	710	177	200	380
Stage 1	-	-	-	-	-	-	681	644	-	374	393	-
Stage 2	-	-	-	-	-	-	374	393	-	681	644	-
Platoon blocked, %		-	-		-	-						
Mov Cap-1 Maneuver	816	-	-	1227	-	-	177	200	710	177	200	380
Mov Cap-2 Maneuver	-	-	-	-	-	-	177	200	-	177	200	-
Stage 1	-	-	-	-	-	-	681	644	-	374	393	-
Stage 2	-	-	-	-	-	-	374	393	-	681	644	-

Approach	EB	WB	NB	SB
HCM Control Delay, s	0	0	0	0
HCM LOS			A	A

Minor Lane/Major Mvmt	NBLn1	EBL	EBT	EBR	WBL	WBT	WBR	SBLn1
Capacity (veh/h)	-	816	-	-	1227	-	-	-
HCM Lane V/C Ratio	-	-	-	-	-	-	-	-
HCM Control Delay (s)	0	0	-	-	0	-	-	0
HCM Lane LOS	A	A	-	-	A	-	-	A
HCM 95th %tile Q(veh)	-	0	-	-	0	-	-	-

Intersection	
Int Delay, s/veh	0.4

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Vol, veh/h	5	300	730	30	10	10
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	100	-	-	-	0	-
Veh in Median Storage, #	-	0	0	-	0	-
Grade, %	-	0	0	-	0	-
Peak Hour Factor	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	5	326	793	33	11	11

Major/Minor	Major1		Major2		Minor2	
Conflicting Flow All	826	0	-	0	1147	810
Stage 1	-	-	-	-	810	-
Stage 2	-	-	-	-	337	-
Critical Hdwy	4.12	-	-	-	6.42	6.22
Critical Hdwy Stg 1	-	-	-	-	5.42	-
Critical Hdwy Stg 2	-	-	-	-	5.42	-
Follow-up Hdwy	2.218	-	-	-	3.518	3.318
Pot Cap-1 Maneuver	805	-	-	-	220	380
Stage 1	-	-	-	-	438	-
Stage 2	-	-	-	-	723	-
Platoon blocked, %		-	-	-		
Mov Cap-1 Maneuver	805	-	-	-	219	380
Mov Cap-2 Maneuver	-	-	-	-	219	-
Stage 1	-	-	-	-	438	-
Stage 2	-	-	-	-	719	-

Approach	EB	WB	SB
HCM Control Delay, s	0.2	0	19
HCM LOS			C

Minor Lane/Major Mvmt	EBL	EBT	WBT	WBR	SBLn1
Capacity (veh/h)	805	-	-	-	278
HCM Lane V/C Ratio	0.007	-	-	-	0.078
HCM Control Delay (s)	9.5	-	-	-	19
HCM Lane LOS	A	-	-	-	C
HCM 95th %tile Q(veh)	0	-	-	-	0.3

Intersection	
Int Delay, s/veh	0.3

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Vol, veh/h	10	290	0	0	750	50	0	0	0	5	0	10
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Free	Free	Stop	Stop	Stop	Stop	Stop	Stop
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	100	-	-	-	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	92	92	92	92	92	92	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2	2	2	2	2	2	2
Mvmt Flow	11	315	0	0	815	54	0	0	0	5	0	11

Major/Minor	Major1			Major2			Minor1			Minor2		
Conflicting Flow All	870	0	0	315	0	0	1185	1207	315	1179	1179	842
Stage 1	-	-	-	-	-	-	337	337	-	842	842	-
Stage 2	-	-	-	-	-	-	848	870	-	337	337	-
Critical Hdwy	4.12	-	-	4.12	-	-	7.12	6.52	6.22	7.12	6.52	6.22
Critical Hdwy Stg 1	-	-	-	-	-	-	6.12	5.52	-	6.12	5.52	-
Critical Hdwy Stg 2	-	-	-	-	-	-	6.12	5.52	-	6.12	5.52	-
Follow-up Hdwy	2.218	-	-	2.218	-	-	3.518	4.018	3.318	3.518	4.018	3.318
Pot Cap-1 Maneuver	775	-	-	1245	-	-	166	183	725	167	190	364
Stage 1	-	-	-	-	-	-	677	641	-	359	380	-
Stage 2	-	-	-	-	-	-	356	369	-	677	641	-
Platoon blocked, %		-	-		-	-						
Mov Cap-1 Maneuver	775	-	-	1245	-	-	159	180	725	165	187	364
Mov Cap-2 Maneuver	-	-	-	-	-	-	159	180	-	165	187	-
Stage 1	-	-	-	-	-	-	667	632	-	354	380	-
Stage 2	-	-	-	-	-	-	345	369	-	667	632	-

Approach	EB	WB	NB	SB
HCM Control Delay, s	0.3	0	0	19.8
HCM LOS			A	C

Minor Lane/Major Mvmt	NBLn1	EBL	EBT	EBR	WBL	WBT	WBR	SBLn1
Capacity (veh/h)	-	775	-	-	1245	-	-	260
HCM Lane V/C Ratio	-	0.014	-	-	-	-	-	0.063
HCM Control Delay (s)	0	9.7	-	-	0	-	-	19.8
HCM Lane LOS	A	A	-	-	A	-	-	C
HCM 95th %tile Q(veh)	-	0	-	-	0	-	-	0.2

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	10	130	185	95	350	235	435	1015	180	160	720	50
Number	7	4	14	3	8	18	5	2	12	1	6	16
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1863	1863	1900	1863	1863	1863	1863	1863	1863	1863	1863	1863
Adj Flow Rate, veh/h	11	141	19	103	380	77	473	1103	109	174	783	12
Adj No. of Lanes	1	2	0	1	1	1	1	2	1	1	2	1
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Percent Heavy Veh, %	2	2	2	2	2	2	2	2	2	2	2	2
Cap, veh/h	18	549	73	129	442	375	501	1580	707	203	984	440
Arrive On Green	0.01	0.17	0.17	0.07	0.24	0.24	0.28	0.45	0.45	0.11	0.28	0.28
Sat Flow, veh/h	1774	3142	417	1774	1863	1583	1774	3539	1583	1774	3539	1583
Grp Volume(v), veh/h	11	78	82	103	380	77	473	1103	109	174	783	12
Grp Sat Flow(s),veh/h/ln	1774	1770	1789	1774	1863	1583	1774	1770	1583	1774	1770	1583
Q Serve(g_s), s	0.8	4.8	4.9	7.1	24.4	4.9	32.6	31.3	5.1	12.0	25.6	0.7
Cycle Q Clear(g_c), s	0.8	4.8	4.9	7.1	24.4	4.9	32.6	31.3	5.1	12.0	25.6	0.7
Prop In Lane	1.00		0.23	1.00		1.00	1.00		1.00	1.00		1.00
Lane Grp Cap(c), veh/h	18	309	313	129	442	375	501	1580	707	203	984	440
V/C Ratio(X)	0.61	0.25	0.26	0.80	0.86	0.21	0.94	0.70	0.15	0.86	0.80	0.03
Avail Cap(c_a), veh/h	242	525	530	313	627	533	554	1580	707	313	1077	482
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	61.5	44.5	44.5	57.0	45.6	38.2	43.8	27.8	20.6	54.3	41.8	32.8
Incr Delay (d2), s/veh	29.0	0.4	0.4	10.8	8.5	0.3	23.9	1.4	0.1	13.5	3.9	0.0
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	0.5	2.4	2.5	3.9	13.6	2.2	19.2	15.6	2.3	6.7	13.0	0.3
LnGrp Delay(d),s/veh	90.5	44.9	45.0	67.8	54.1	38.5	67.7	29.2	20.7	67.8	45.7	32.8
LnGrp LOS	F	D	D	E	D	D	E	C	C	E	D	C
Approach Vol, veh/h		171			560			1685			969	
Approach Delay, s/veh		47.9			54.5			39.4			49.5	
Approach LOS		D			D			D			D	

Timer	1	2	3	4	5	6	7	8
Assigned Phs	1	2	3	4	5	6	7	8
Phs Duration (G+Y+Rc), s	20.3	61.7	15.1	27.8	41.3	40.7	7.3	35.6
Change Period (Y+Rc), s	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0
Max Green Setting (Gmax), s	22.0	55.0	22.0	37.0	39.0	38.0	17.0	42.0
Max Q Clear Time (g_c+I1), s	14.0	33.3	9.1	6.9	34.6	27.6	2.8	26.4
Green Ext Time (p_c), s	0.3	14.6	0.2	3.8	0.7	7.1	0.0	3.2

Intersection Summary	
HCM 2010 Ctrl Delay	45.2
HCM 2010 LOS	D

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	295	145	185	55	240	285	250	1365	5	185	950	150
Ideal Flow (vphpl)	1900	1900	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	6.0	4.0	4.0	6.0
Lane Util. Factor	0.91	0.91	1.00	1.00	1.00	0.88	0.97	0.91	1.00	0.97	0.91	1.00
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	0.98	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	1610	3307	1583	1770	1863	2787	3433	5085	1583	3433	5085	1583
Flt Permitted	0.95	0.98	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)	1610	3307	1583	1770	1863	2787	3433	5085	1583	3433	5085	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)	321	158	201	60	261	310	272	1484	5	201	1033	163
RTOR Reduction (vph)	0	0	62	0	0	200	0	0	2	0	0	82
Lane Group Flow (vph)	160	319	139	60	261	110	272	1484	3	201	1033	81
Turn Type	Split	NA	Perm	Split	NA	Perm	Prot	NA	Perm	Prot	NA	Perm
Protected Phases	3	3		4	4		5	2		1	6	
Permitted Phases			3			4			2			6
Actuated Green, G (s)	33.0	33.0	33.0	39.9	39.9	39.9	23.3	123.0	123.0	19.1	118.8	118.8
Effective Green, g (s)	35.0	35.0	35.0	41.9	41.9	41.9	25.3	126.0	124.0	21.1	121.8	119.8
Actuated g/C Ratio	0.15	0.15	0.15	0.17	0.17	0.17	0.11	0.52	0.52	0.09	0.51	0.50
Clearance Time (s)	6.0	6.0	6.0	6.0	6.0	6.0	6.0	7.0	7.0	6.0	7.0	7.0
Vehicle Extension (s)	5.0	5.0	5.0	5.0	5.0	5.0	3.0	5.0	5.0	3.0	5.0	5.0
Lane Grp Cap (vph)	234	482	230	309	325	486	361	2669	817	301	2580	790
v/s Ratio Prot	c0.10	0.10		0.03	c0.14		c0.08	c0.29		0.06	0.20	
v/s Ratio Perm			0.09			0.04			0.00			0.05
v/c Ratio	0.68	0.66	0.60	0.19	0.80	0.23	0.75	0.56	0.00	0.67	0.40	0.10
Uniform Delay, d1	97.2	96.9	96.0	84.6	95.1	85.1	104.3	38.2	28.1	106.1	36.5	31.7
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.73	1.62	7.45
Incremental Delay, d2	10.2	4.5	6.4	0.6	15.1	0.5	8.6	0.8	0.0	5.0	0.4	0.2
Delay (s)	107.4	101.4	102.4	85.3	110.1	85.6	112.9	39.1	28.1	82.7	59.5	236.8
Level of Service	F	F	F	F	F	F	F	D	C	F	E	F
Approach Delay (s)		103.1			95.7			50.5			83.5	
Approach LOS		F			F			D			F	

Intersection Summary			
HCM 2000 Control Delay	75.2	HCM 2000 Level of Service	E
HCM 2000 Volume to Capacity ratio	0.65		
Actuated Cycle Length (s)	240.0	Sum of lost time (s)	16.0
Intersection Capacity Utilization	66.5%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	420	5	135	5	15	15	250	2630	20	75	1275	365
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		6.0	4.0	6.0	5.0	6.0	4.0	5.0	7.0
Lane Util. Factor	0.95	0.95	1.00		1.00	1.00	1.00	0.91	1.00	1.00	0.91	1.00
Frpb, ped/bikes	1.00	1.00	0.91		1.00	1.00	1.00	1.00	0.83	1.00	1.00	0.97
Flpb, ped/bikes	1.00	1.00	1.00		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Frt	1.00	1.00	0.85		1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	0.95	1.00		0.99	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	1681	1687	1434		1841	1583	1770	5085	1311	1770	5085	1536
Flt Permitted	0.95	0.95	1.00		0.99	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)	1681	1687	1434		1841	1583	1770	5085	1311	1770	5085	1536
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	457	5	147	5	16	16	272	2859	22	82	1386	397
RTOR Reduction (vph)	0	0	83	0	0	15	0	0	8	0	0	191
Lane Group Flow (vph)	233	229	64	0	21	1	272	2859	14	82	1386	206
Confl. Peds. (#/hr)			43						31			2
Turn Type	Split	NA	Perm	Split	NA	Perm	Prot	NA	Perm	Prot	NA	Perm
Protected Phases	4	4		3	3		5	2		1	6	
Permitted Phases			4			3			2			6
Actuated Green, G (s)	41.3	41.3	41.3		7.1	7.1	43.3	152.9	152.9	14.7	124.3	124.3
Effective Green, g (s)	41.3	41.3	41.3		7.1	9.1	43.3	154.9	153.9	16.7	126.3	124.3
Actuated g/C Ratio	0.17	0.17	0.17		0.03	0.04	0.18	0.65	0.64	0.07	0.53	0.52
Clearance Time (s)	5.0	5.0	5.0		6.0	6.0	6.0	7.0	7.0	6.0	7.0	7.0
Vehicle Extension (s)	4.0	4.0	4.0		3.0	3.0	5.0	6.0	6.0	3.0	6.0	6.0
Lane Grp Cap (vph)	289	290	246		54	60	319	3281	840	123	2675	795
v/s Ratio Prot	c0.14	0.14			c0.01		c0.15	c0.56		0.05	0.27	
v/s Ratio Perm			0.04			0.00			0.01			0.13
v/c Ratio	0.81	0.79	0.26		0.39	0.01	0.85	0.87	0.02	0.67	0.52	0.26
Uniform Delay, d1	95.5	95.2	86.1		114.3	111.1	95.3	34.5	15.6	108.9	37.0	32.2
Progression Factor	1.00	1.00	1.00		1.00	1.00	1.22	0.62	1.00	1.06	1.00	1.79
Incremental Delay, d2	15.8	14.0	0.8		4.6	0.1	9.9	1.5	0.0	12.3	0.7	0.8
Delay (s)	111.3	109.2	86.9		118.9	111.2	125.7	22.8	15.6	128.3	37.8	58.3
Level of Service	F	F	F		F	F	F	C	B	F	D	E
Approach Delay (s)		104.6			115.6			31.6			46.1	
Approach LOS		F			F			C			D	

Intersection Summary			
HCM 2000 Control Delay	44.8	HCM 2000 Level of Service	D
HCM 2000 Volume to Capacity ratio	0.86		
Actuated Cycle Length (s)	240.0	Sum of lost time (s)	22.0
Intersection Capacity Utilization	94.5%	ICU Level of Service	F
Analysis Period (min)	15		

c Critical Lane Group

Intersection	
Int Delay, s/veh	0.2

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Vol, veh/h	5	295	795	40	5	0
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	100	-	-	-	0	-
Veh in Median Storage, #	-	0	0	-	0	-
Grade, %	-	0	0	-	0	-
Peak Hour Factor	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	5	321	864	43	5	0

Major/Minor	Major1		Major2		Minor2	
Conflicting Flow All	908	0	-	0	1218	886
Stage 1	-	-	-	-	886	-
Stage 2	-	-	-	-	332	-
Critical Hdwy	4.12	-	-	-	6.42	6.22
Critical Hdwy Stg 1	-	-	-	-	5.42	-
Critical Hdwy Stg 2	-	-	-	-	5.42	-
Follow-up Hdwy	2.218	-	-	-	3.518	3.318
Pot Cap-1 Maneuver	750	-	-	-	199	343
Stage 1	-	-	-	-	403	-
Stage 2	-	-	-	-	727	-
Platoon blocked, %		-	-	-		
Mov Cap-1 Maneuver	750	-	-	-	198	343
Mov Cap-2 Maneuver	-	-	-	-	198	-
Stage 1	-	-	-	-	403	-
Stage 2	-	-	-	-	722	-

Approach	EB	WB	SB
HCM Control Delay, s	0.2	0	23.7
HCM LOS			C

Minor Lane/Major Mvmt	EBL	EBT	WBT	WBR	SBLn1
Capacity (veh/h)	750	-	-	-	198
HCM Lane V/C Ratio	0.007	-	-	-	0.027
HCM Control Delay (s)	9.8	-	-	-	23.7
HCM Lane LOS	A	-	-	-	C
HCM 95th %tile Q(veh)	0	-	-	-	0.1

Intersection	
Int Delay, s/veh	0.1

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Vol, veh/h	10	315	670	25	0	0
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	100	-	-	-	0	-
Veh in Median Storage, #	-	0	0	-	0	-
Grade, %	-	0	0	-	0	-
Peak Hour Factor	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	11	342	728	27	0	0

Major/Minor	Major1		Major2		Minor2	
Conflicting Flow All	755	0	-	0	1106	742
Stage 1	-	-	-	-	742	-
Stage 2	-	-	-	-	364	-
Critical Hdwy	4.12	-	-	-	6.42	6.22
Critical Hdwy Stg 1	-	-	-	-	5.42	-
Critical Hdwy Stg 2	-	-	-	-	5.42	-
Follow-up Hdwy	2.218	-	-	-	3.518	3.318
Pot Cap-1 Maneuver	855	-	-	-	233	416
Stage 1	-	-	-	-	471	-
Stage 2	-	-	-	-	703	-
Platoon blocked, %		-	-	-		
Mov Cap-1 Maneuver	855	-	-	-	230	416
Mov Cap-2 Maneuver	-	-	-	-	230	-
Stage 1	-	-	-	-	471	-
Stage 2	-	-	-	-	694	-

Approach	EB	WB	SB
HCM Control Delay, s	0.3	0	0
HCM LOS			A

Minor Lane/Major Mvmt	EBL	EBT	WBT	WBR	SBLn1
Capacity (veh/h)	855	-	-	-	-
HCM Lane V/C Ratio	0.013	-	-	-	-
HCM Control Delay (s)	9.3	-	-	-	0
HCM Lane LOS	A	-	-	-	A
HCM 95th %tile Q(veh)	0	-	-	-	-

Intersection	
Int Delay, s/veh	1.7

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Vol, veh/h	90	0	75	200	0	5
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	100	-	0	-
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	98	0	82	217	0	5

Major/Minor	Major1		Major2		Minor1	
Conflicting Flow All	0	0	98	0	478	98
Stage 1	-	-	-	-	98	-
Stage 2	-	-	-	-	380	-
Critical Hdwy	-	-	4.12	-	6.42	6.22
Critical Hdwy Stg 1	-	-	-	-	5.42	-
Critical Hdwy Stg 2	-	-	-	-	5.42	-
Follow-up Hdwy	-	-	2.218	-	3.518	3.318
Pot Cap-1 Maneuver	-	-	1495	-	546	958
Stage 1	-	-	-	-	926	-
Stage 2	-	-	-	-	691	-
Platoon blocked, %	-	-		-		
Mov Cap-1 Maneuver	-	-	1495	-	516	958
Mov Cap-2 Maneuver	-	-	-	-	516	-
Stage 1	-	-	-	-	926	-
Stage 2	-	-	-	-	653	-

Approach	EB	WB	NB
HCM Control Delay, s	0	2.1	8.8
HCM LOS			A

Minor Lane/Major Mvmt	NBLn1	EBT	EBR	WBL	WBT
Capacity (veh/h)	958	-	-	1495	-
HCM Lane V/C Ratio	0.006	-	-	0.055	-
HCM Control Delay (s)	8.8	-	-	7.5	-
HCM Lane LOS	A	-	-	A	-
HCM 95th %tile Q(veh)	0	-	-	0.2	-

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	750	650	10	230	415	540	55	345	130	630	350	655
Number	7	4	14	3	8	18	5	2	12	1	6	16
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1863	1863	1900	1863	1863	1863	1863	1863	1900	1863	1863	1863
Adj Flow Rate, veh/h	815	707	11	250	451	533	60	375	18	685	380	447
Adj No. of Lanes	2	3	0	2	3	2	1	2	0	2	2	2
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Percent Heavy Veh, %	2	2	2	2	2	2	2	2	2	2	2	2
Cap, veh/h	896	1876	29	318	995	1153	78	523	25	751	1154	1631
Arrive On Green	0.26	0.36	0.36	0.09	0.20	0.20	0.04	0.15	0.15	0.22	0.33	0.33
Sat Flow, veh/h	3442	5159	80	3442	5085	2787	1774	3439	165	3442	3539	2776
Grp Volume(v), veh/h	815	464	254	250	451	533	60	192	201	685	380	447
Grp Sat Flow(s),veh/h/ln	1721	1695	1849	1721	1695	1393	1774	1770	1834	1721	1770	1388
Q Serve(g_s), s	30.4	13.4	13.4	9.4	10.4	18.4	4.4	13.7	13.8	25.7	10.7	10.5
Cycle Q Clear(g_c), s	30.4	13.4	13.4	9.4	10.4	18.4	4.4	13.7	13.8	25.7	10.7	10.5
Prop In Lane	1.00		0.04	1.00		1.00	1.00		0.09	1.00		1.00
Lane Grp Cap(c), veh/h	896	1233	672	318	995	1153	78	269	279	751	1154	1631
V/C Ratio(X)	0.91	0.38	0.38	0.78	0.45	0.46	0.77	0.72	0.72	0.91	0.33	0.27
Avail Cap(c_a), veh/h	1039	1233	672	935	1458	1407	509	628	650	831	1154	1631
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	47.5	31.1	31.1	58.8	47.0	28.1	62.7	53.4	53.5	50.6	33.7	13.5
Incr Delay (d2), s/veh	10.6	0.2	0.4	4.3	0.3	0.3	14.3	3.5	3.5	13.5	0.2	0.1
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	15.8	6.3	6.9	4.7	4.9	7.1	2.5	6.9	7.3	13.7	5.3	4.0
LnGrp Delay(d),s/veh	58.1	31.3	31.4	63.1	47.4	28.4	77.0	57.0	57.0	64.0	33.9	13.6
LnGrp LOS	E	C	C	E	D	C	E	E	E	E	C	B
Approach Vol, veh/h		1533			1234			453			1512	
Approach Delay, s/veh		45.5			42.4			59.6			41.5	
Approach LOS		D			D			E			D	

Timer	1	2	3	4	5	6	7	8
Assigned Phs	1	2	3	4	5	6	7	8
Phs Duration (G+Y+Rc), s	33.9	26.2	18.3	54.2	10.8	49.2	40.5	31.9
Change Period (Y+Rc), s	5.0	6.0	6.0	6.0	5.0	6.0	6.0	6.0
Max Green Setting (Gmax), s	32.0	47.0	36.0	42.0	38.0	41.0	40.0	38.0
Max Q Clear Time (g_c+I1), s	27.7	15.8	11.4	15.4	6.4	12.7	32.4	20.4
Green Ext Time (p_c), s	1.2	3.3	0.8	12.0	0.1	7.8	2.1	5.6

Intersection Summary			
HCM 2010 Ctrl Delay			44.8
HCM 2010 LOS			D

Notes

User approved changes to right turn type.

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	105	170	65	180	75	295	35	810	120	320	1100	55
Number	3	8	18	7	4	14	5	2	12	1	6	16
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1863	1863	1900	1863	1863	1863	1863	1863	1900	1863	1863	1900
Adj Flow Rate, veh/h	114	185	59	196	82	69	38	880	116	348	1196	57
Adj No. of Lanes	1	1	0	1	1	1	1	3	0	1	3	0
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Percent Heavy Veh, %	2	2	2	2	2	2	2	2	2	2	2	2
Cap, veh/h	434	440	140	319	606	515	48	1249	164	391	2327	111
Arrive On Green	0.33	0.33	0.33	0.33	0.33	0.33	0.03	0.27	0.27	0.22	0.47	0.47
Sat Flow, veh/h	1231	1355	432	1131	1863	1583	1774	4550	597	1774	4974	237
Grp Volume(v), veh/h	114	0	244	196	82	69	38	655	341	348	815	438
Grp Sat Flow(s),veh/h/ln	1231	0	1787	1131	1863	1583	1774	1695	1757	1774	1695	1821
Q Serve(g_s), s	7.2	0.0	10.7	16.4	3.1	3.1	2.1	17.4	17.5	19.0	16.9	16.9
Cycle Q Clear(g_c), s	10.3	0.0	10.7	27.1	3.1	3.1	2.1	17.4	17.5	19.0	16.9	16.9
Prop In Lane	1.00		0.24	1.00		1.00	1.00		0.34	1.00		0.13
Lane Grp Cap(c), veh/h	434	0	581	319	606	515	48	930	482	391	1586	852
V/C Ratio(X)	0.26	0.00	0.42	0.61	0.14	0.13	0.79	0.70	0.71	0.89	0.51	0.51
Avail Cap(c_a), veh/h	636	0	874	505	912	775	354	982	509	780	1795	964
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	0.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	27.5	0.0	26.4	37.0	23.8	23.8	48.4	32.7	32.7	37.8	18.7	18.7
Incr Delay (d2), s/veh	0.3	0.0	0.5	1.9	0.1	0.1	23.8	2.2	4.2	7.0	0.3	0.5
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	2.5	0.0	5.4	5.3	1.6	1.4	1.4	8.4	9.0	10.0	7.9	8.5
LnGrp Delay(d),s/veh	27.8	0.0	26.9	38.9	23.9	23.9	72.2	34.8	36.9	44.8	18.9	19.2
LnGrp LOS	C		C	D	C	C	E	C	D	D	B	B
Approach Vol, veh/h		358			347			1034			1601	
Approach Delay, s/veh		27.2			32.4			36.9			24.6	
Approach LOS		C			C			D			C	

Timer	1	2	3	4	5	6	7	8
Assigned Phs	1	2		4	5	6		8
Phs Duration (G+Y+Rc), s	28.1	33.5		38.6	8.7	52.8		38.6
Change Period (Y+Rc), s	6.0	6.0		6.0	6.0	6.0		6.0
Max Green Setting (Gmax), s	44.0	29.0		49.0	20.0	53.0		49.0
Max Q Clear Time (g_c+I1), s	21.0	19.5		29.1	4.1	18.9		12.7
Green Ext Time (p_c), s	1.0	8.0		3.5	0.0	21.7		3.8

Intersection Summary	
HCM 2010 Ctrl Delay	29.5
HCM 2010 LOS	C

Intersection	
Int Delay, s/veh	8.3

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Vol, veh/h	5	5	145	5	10	210
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	-	-	0	-
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	5	5	158	5	11	228

Major/Minor	Major1		Major2		Minor1	
Conflicting Flow All	0	0	11	0	329	8
Stage 1	-	-	-	-	8	-
Stage 2	-	-	-	-	321	-
Critical Hdwy	-	-	4.12	-	6.42	6.22
Critical Hdwy Stg 1	-	-	-	-	5.42	-
Critical Hdwy Stg 2	-	-	-	-	5.42	-
Follow-up Hdwy	-	-	2.218	-	3.518	3.318
Pot Cap-1 Maneuver	-	-	1608	-	665	1074
Stage 1	-	-	-	-	1015	-
Stage 2	-	-	-	-	735	-
Platoon blocked, %	-	-		-		
Mov Cap-1 Maneuver	-	-	1608	-	599	1074
Mov Cap-2 Maneuver	-	-	-	-	599	-
Stage 1	-	-	-	-	1015	-
Stage 2	-	-	-	-	662	-

Approach	EB	WB	NB
HCM Control Delay, s	0	7.2	9.5
HCM LOS			A

Minor Lane/Major Mvmt	NBLn1	EBT	EBR	WBL	WBT
Capacity (veh/h)	1037	-	-	1608	-
HCM Lane V/C Ratio	0.231	-	-	0.098	-
HCM Control Delay (s)	9.5	-	-	7.5	0
HCM Lane LOS	A	-	-	A	A
HCM 95th %tile Q(veh)	0.9	-	-	0.3	-

Intersection	
Int Delay, s/veh	4.8

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Vol, veh/h	185	680	0	0	420	20	0	0	0	20	0	135
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Free	Free	Stop	Stop	Stop	Stop	Stop	Stop
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	-	-	-	-	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	92	92	92	92	92	92	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2	2	2	2	2	2	2
Mvmt Flow	201	739	0	0	457	22	0	0	0	22	0	147

Major/Minor	Major1			Major2			Minor1			Minor2		
Conflicting Flow All	478	0	0	739	0	0	1682	1619	739	1608	1608	467
Stage 1	-	-	-	-	-	-	1141	1141	-	467	467	-
Stage 2	-	-	-	-	-	-	541	478	-	1141	1141	-
Critical Hdwy	4.12	-	-	4.12	-	-	7.12	6.52	6.22	7.12	6.52	6.22
Critical Hdwy Stg 1	-	-	-	-	-	-	6.12	5.52	-	6.12	5.52	-
Critical Hdwy Stg 2	-	-	-	-	-	-	6.12	5.52	-	6.12	5.52	-
Follow-up Hdwy	2.218	-	-	2.218	-	-	3.518	4.018	3.318	3.518	4.018	3.318
Pot Cap-1 Maneuver	1084	-	-	867	-	-	75	103	417	84	105	596
Stage 1	-	-	-	-	-	-	244	275	-	576	562	-
Stage 2	-	-	-	-	-	-	525	556	-	244	275	-
Platoon blocked, %		-	-		-	-						
Mov Cap-1 Maneuver	1084	-	-	867	-	-	43	71	417	63	72	596
Mov Cap-2 Maneuver	-	-	-	-	-	-	43	71	-	63	72	-
Stage 1	-	-	-	-	-	-	167	188	-	395	562	-
Stage 2	-	-	-	-	-	-	396	556	-	167	188	-

Approach	EB	WB	NB	SB
HCM Control Delay, s	1.9	0	0	34.4
HCM LOS			A	D

Minor Lane/Major Mvmt	NBLn1	EBL	EBT	EBR	WBL	WBT	WBR	SBLn1
Capacity (veh/h)	-	1084	-	-	867	-	-	285
HCM Lane V/C Ratio	-	0.186	-	-	-	-	-	0.591
HCM Control Delay (s)	0	9.1	0	-	0	-	-	34.4
HCM Lane LOS	A	A	A	-	A	-	-	D
HCM 95th %tile Q(veh)	-	0.7	-	-	0	-	-	3.5

Intersection	
Int Delay, s/veh	0.6

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Vol, veh/h	740	15	15	430	10	20
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	50	-	0	-
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	804	16	16	467	11	22

Major/Minor	Major1		Major2		Minor1	
Conflicting Flow All	0	0	821	0	1313	813
Stage 1	-	-	-	-	813	-
Stage 2	-	-	-	-	500	-
Critical Hdwy	-	-	4.12	-	6.42	6.22
Critical Hdwy Stg 1	-	-	-	-	5.42	-
Critical Hdwy Stg 2	-	-	-	-	5.42	-
Follow-up Hdwy	-	-	2.218	-	3.518	3.318
Pot Cap-1 Maneuver	-	-	808	-	175	378
Stage 1	-	-	-	-	436	-
Stage 2	-	-	-	-	609	-
Platoon blocked, %	-	-		-		
Mov Cap-1 Maneuver	-	-	808	-	172	378
Mov Cap-2 Maneuver	-	-	-	-	172	-
Stage 1	-	-	-	-	436	-
Stage 2	-	-	-	-	597	-

Approach	EB	WB	NB
HCM Control Delay, s	0	0.3	20.2
HCM LOS			C

Minor Lane/Major Mvmt	NBLn1	EBT	EBR	WBL	WBT
Capacity (veh/h)	270	-	-	808	-
HCM Lane V/C Ratio	0.121	-	-	0.02	-
HCM Control Delay (s)	20.2	-	-	9.5	-
HCM Lane LOS	C	-	-	A	-
HCM 95th %tile Q(veh)	0.4	-	-	0.1	-

Intersection	
Int Delay, s/veh	0.1

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Vol, veh/h	5	730	0	0	435	5	0	0	0	0	0	0
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Free	Free	Stop	Stop	Stop	Stop	Stop	Stop
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	-	-	-	-	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	92	92	92	92	92	92	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2	2	2	2	2	2	2
Mvmt Flow	5	793	0	0	473	5	0	0	0	0	0	0

Major/Minor	Major1			Major2			Minor1			Minor2		
Conflicting Flow All	478	0	0	793	0	0	1280	1282	793	1280	1280	476
Stage 1	-	-	-	-	-	-	804	804	-	476	476	-
Stage 2	-	-	-	-	-	-	476	478	-	804	804	-
Critical Hdwy	4.12	-	-	4.12	-	-	7.12	6.52	6.22	7.12	6.52	6.22
Critical Hdwy Stg 1	-	-	-	-	-	-	6.12	5.52	-	6.12	5.52	-
Critical Hdwy Stg 2	-	-	-	-	-	-	6.12	5.52	-	6.12	5.52	-
Follow-up Hdwy	2.218	-	-	2.218	-	-	3.518	4.018	3.318	3.518	4.018	3.318
Pot Cap-1 Maneuver	1084	-	-	828	-	-	143	165	389	143	166	589
Stage 1	-	-	-	-	-	-	377	396	-	570	557	-
Stage 2	-	-	-	-	-	-	570	556	-	377	396	-
Platoon blocked, %		-	-		-	-						
Mov Cap-1 Maneuver	1084	-	-	828	-	-	142	164	389	142	165	589
Mov Cap-2 Maneuver	-	-	-	-	-	-	142	164	-	142	165	-
Stage 1	-	-	-	-	-	-	374	393	-	565	557	-
Stage 2	-	-	-	-	-	-	570	556	-	374	393	-

Approach	EB	WB	NB	SB
HCM Control Delay, s	0.1	0	0	0
HCM LOS			A	A

Minor Lane/Major Mvmt	NBLn1	EBL	EBT	EBR	WBL	WBT	WBR	SBLn1
Capacity (veh/h)	-	1084	-	-	828	-	-	-
HCM Lane V/C Ratio	-	0.005	-	-	-	-	-	-
HCM Control Delay (s)	0	8.3	0	-	0	-	-	0
HCM Lane LOS	A	A	A	-	A	-	-	A
HCM 95th %tile Q(veh)	-	0	-	-	0	-	-	-

Intersection	
Int Delay, s/veh	0.8

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Vol, veh/h	0	760	435	5	30	5
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	100	-	-	-	0	-
Veh in Median Storage, #	-	0	0	-	0	-
Grade, %	-	0	0	-	0	-
Peak Hour Factor	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	0	826	473	5	33	5

Major/Minor	Major1		Major2		Minor2	
Conflicting Flow All	478	0	-	0	1302	476
Stage 1	-	-	-	-	476	-
Stage 2	-	-	-	-	826	-
Critical Hdwy	4.12	-	-	-	6.42	6.22
Critical Hdwy Stg 1	-	-	-	-	5.42	-
Critical Hdwy Stg 2	-	-	-	-	5.42	-
Follow-up Hdwy	2.218	-	-	-	3.518	3.318
Pot Cap-1 Maneuver	1084	-	-	-	177	589
Stage 1	-	-	-	-	625	-
Stage 2	-	-	-	-	430	-
Platoon blocked, %		-	-	-		
Mov Cap-1 Maneuver	1084	-	-	-	177	589
Mov Cap-2 Maneuver	-	-	-	-	177	-
Stage 1	-	-	-	-	625	-
Stage 2	-	-	-	-	430	-

Approach	EB	WB	SB
HCM Control Delay, s	0	0	27.6
HCM LOS			D

Minor Lane/Major Mvmt	EBL	EBT	WBT	WBR	SBLn1
Capacity (veh/h)	1084	-	-	-	197
HCM Lane V/C Ratio	-	-	-	-	0.193
HCM Control Delay (s)	0	-	-	-	27.6
HCM Lane LOS	A	-	-	-	D
HCM 95th %tile Q(veh)	0	-	-	-	0.7

Intersection	
Int Delay, s/veh	2.3

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Vol, veh/h	10	765	0	0	415	20	0	0	0	50	0	20
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Free	Free	Stop	Stop	Stop	Stop	Stop	Stop
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	100	-	-	-	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	92	92	92	92	92	92	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2	2	2	2	2	2	2
Mvmt Flow	11	832	0	0	451	22	0	0	0	54	0	22

Major/Minor	Major1			Major2			Minor1			Minor2		
Conflicting Flow All	473	0	0	832	0	0	1326	1326	832	1315	1315	462
Stage 1	-	-	-	-	-	-	853	853	-	462	462	-
Stage 2	-	-	-	-	-	-	473	473	-	853	853	-
Critical Hdwy	4.12	-	-	4.12	-	-	7.12	6.52	6.22	7.12	6.52	6.22
Critical Hdwy Stg 1	-	-	-	-	-	-	6.12	5.52	-	6.12	5.52	-
Critical Hdwy Stg 2	-	-	-	-	-	-	6.12	5.52	-	6.12	5.52	-
Follow-up Hdwy	2.218	-	-	2.218	-	-	3.518	4.018	3.318	3.518	4.018	3.318
Pot Cap-1 Maneuver	1089	-	-	801	-	-	133	156	369	135	158	600
Stage 1	-	-	-	-	-	-	354	376	-	580	565	-
Stage 2	-	-	-	-	-	-	572	558	-	354	376	-
Platoon blocked, %		-	-		-	-						
Mov Cap-1 Maneuver	1089	-	-	801	-	-	127	154	369	134	156	600
Mov Cap-2 Maneuver	-	-	-	-	-	-	127	154	-	134	156	-
Stage 1	-	-	-	-	-	-	350	372	-	574	565	-
Stage 2	-	-	-	-	-	-	551	558	-	350	372	-

Approach	EB	WB	NB	SB
HCM Control Delay, s	0.1	0	0	41.6
HCM LOS			A	E

Minor Lane/Major Mvmt	NBLn1	EBL	EBT	EBR	WBL	WBT	WBR	SBLn1
Capacity (veh/h)	-	1089	-	-	801	-	-	172
HCM Lane V/C Ratio	-	0.01	-	-	-	-	-	0.442
HCM Control Delay (s)	0	8.3	-	-	0	-	-	41.6
HCM Lane LOS	A	A	-	-	A	-	-	E
HCM 95th %tile Q(veh)	-	0	-	-	0	-	-	2

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	50	335	485	155	215	250	205	715	100	170	910	30
Number	7	4	14	3	8	18	5	2	12	1	6	16
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1863	1863	1900	1863	1863	1863	1863	1863	1863	1863	1863	1863
Adj Flow Rate, veh/h	54	364	341	168	234	74	223	777	30	185	989	8
Adj No. of Lanes	1	2	0	1	1	1	1	2	1	1	2	1
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Percent Heavy Veh, %	2	2	2	2	2	2	2	2	2	2	2	2
Cap, veh/h	70	449	402	195	603	513	252	1163	520	214	1087	486
Arrive On Green	0.04	0.25	0.25	0.11	0.32	0.32	0.14	0.33	0.33	0.12	0.31	0.31
Sat Flow, veh/h	1774	1770	1583	1774	1863	1583	1774	3539	1583	1774	3539	1583
Grp Volume(v), veh/h	54	364	341	168	234	74	223	777	30	185	989	8
Grp Sat Flow(s),veh/h/ln	1774	1770	1583	1774	1863	1583	1774	1770	1583	1774	1770	1583
Q Serve(g_s), s	3.9	24.7	26.2	11.9	12.4	4.2	15.8	24.2	1.7	13.1	34.4	0.5
Cycle Q Clear(g_c), s	3.9	24.7	26.2	11.9	12.4	4.2	15.8	24.2	1.7	13.1	34.4	0.5
Prop In Lane	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Lane Grp Cap(c), veh/h	70	449	402	195	603	513	252	1163	520	214	1087	486
V/C Ratio(X)	0.77	0.81	0.85	0.86	0.39	0.14	0.89	0.67	0.06	0.86	0.91	0.02
Avail Cap(c_a), veh/h	374	636	569	249	603	513	360	1163	520	360	1133	507
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	60.9	44.9	45.5	56.1	33.5	30.7	53.9	37.0	29.4	55.3	42.7	30.9
Incr Delay (d2), s/veh	15.8	5.3	8.3	21.2	0.4	0.1	16.8	1.5	0.0	10.8	10.6	0.0
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	2.2	12.8	12.4	7.0	6.5	1.9	8.9	12.0	0.7	7.1	18.4	0.2
LnGrp Delay(d),s/veh	76.7	50.2	53.8	77.3	33.9	30.9	70.7	38.5	29.5	66.1	53.2	30.9
LnGrp LOS	E	D	D	E	C	C	E	D	C	E	D	C
Approach Vol, veh/h		759			476			1030			1182	
Approach Delay, s/veh		53.7			48.7			45.2			55.1	
Approach LOS		D			D			D			E	

Timer	1	2	3	4	5	6	7	8
Assigned Phs	1	2	3	4	5	6	7	8
Phs Duration (G+Y+Rc), s	21.4	48.1	20.0	38.5	24.2	45.3	11.1	47.5
Change Period (Y+Rc), s	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0
Max Green Setting (Gmax), s	26.0	41.0	18.0	46.0	26.0	41.0	27.0	37.0
Max Q Clear Time (g_c+I1), s	15.1	26.2	13.9	28.2	17.8	36.4	5.9	14.4
Green Ext Time (p_c), s	0.4	10.3	0.2	4.3	0.4	2.9	0.1	6.7

Intersection Summary	
HCM 2010 Ctrl Delay	51.0
HCM 2010 LOS	D

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	230	225	250	15	220	150	215	870	15	350	1545	220
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	6.0	4.0	4.0	6.0
Lane Util. Factor	0.91	0.91	1.00	1.00	1.00	0.88	0.97	0.91	1.00	0.97	0.91	1.00
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	0.99	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	1610	3345	1583	1770	1863	2787	3433	5085	1583	3433	5085	1583
Flt Permitted	0.95	0.99	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)	1610	3345	1583	1770	1863	2787	3433	5085	1583	3433	5085	1583
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	250	245	272	16	239	163	234	946	16	380	1679	239
RTOR Reduction (vph)	0	0	68	0	0	113	0	0	8	0	0	73
Lane Group Flow (vph)	160	335	204	16	239	50	234	946	8	380	1679	166
Turn Type	Split	NA	Perm	Split	NA	Perm	Prot	NA	Perm	Prot	NA	Perm
Protected Phases	3	3		4	4		5	2		1	6	
Permitted Phases			3			4			2			6
Actuated Green, G (s)	36.9	36.9	36.9	34.1	34.1	34.1	21.6	112.9	112.9	31.1	122.4	122.4
Effective Green, g (s)	38.9	38.9	38.9	36.1	36.1	36.1	23.6	115.9	113.9	33.1	125.4	123.4
Actuated g/C Ratio	0.16	0.16	0.16	0.15	0.15	0.15	0.10	0.48	0.47	0.14	0.52	0.51
Clearance Time (s)	6.0	6.0	6.0	6.0	6.0	6.0	6.0	7.0	7.0	6.0	7.0	7.0
Vehicle Extension (s)	5.0	5.0	5.0	5.0	5.0	5.0	3.0	5.0	5.0	3.0	5.0	5.0
Lane Grp Cap (vph)	260	542	256	266	280	419	337	2455	751	473	2656	813
v/s Ratio Prot	0.10	0.10		0.01	c0.13		0.07	0.19		c0.11	c0.33	
v/s Ratio Perm			c0.13			0.02			0.00			0.10
v/c Ratio	0.62	0.62	0.80	0.06	0.85	0.12	0.69	0.39	0.01	0.80	0.63	0.20
Uniform Delay, d1	93.6	93.6	96.8	87.4	99.4	88.2	104.7	39.4	33.3	100.3	40.9	31.6
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.14	0.93	1.18
Incremental Delay, d2	6.1	3.0	17.8	0.2	23.3	0.3	6.1	0.5	0.0	9.4	1.1	0.6
Delay (s)	99.7	96.7	114.6	87.6	122.6	88.5	110.8	39.9	33.3	123.7	39.0	37.9
Level of Service	F	F	F	F	F	F	F	D	C	F	D	D
Approach Delay (s)		103.6			108.0			53.7			52.9	
Approach LOS		F			F			D			D	

Intersection Summary			
HCM 2000 Control Delay	66.3	HCM 2000 Level of Service	E
HCM 2000 Volume to Capacity ratio	0.73		
Actuated Cycle Length (s)	240.0	Sum of lost time (s)	16.0
Intersection Capacity Utilization	69.5%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	440	40	135	35	35	25	125	1510	60	75	2635	385
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		6.0	4.0	6.0	5.0	6.0	4.0	5.0	7.0
Lane Util. Factor	0.95	0.95	1.00		1.00	1.00	1.00	0.91	1.00	1.00	0.91	1.00
Frpb, ped/bikes	1.00	1.00	0.91		1.00	1.00	1.00	1.00	0.83	1.00	1.00	0.97
Flpb, ped/bikes	1.00	1.00	1.00		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Frt	1.00	1.00	0.85		1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	0.96	1.00		0.98	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	1681	1699	1434		1817	1583	1770	5085	1311	1770	5085	1536
Flt Permitted	0.95	0.96	1.00		0.98	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)	1681	1699	1434		1817	1583	1770	5085	1311	1770	5085	1536
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	478	43	147	38	38	27	136	1641	65	82	2864	418
RTOR Reduction (vph)	0	0	82	0	0	25	0	0	27	0	0	189
Lane Group Flow (vph)	258	263	65	0	76	2	136	1641	38	82	2864	229
Confl. Peds. (#/hr)			43						31			2
Turn Type	Split	NA	Perm	Split	NA	Perm	Prot	NA	Perm	Prot	NA	Perm
Protected Phases	4	4		3	3		5	2		1	6	
Permitted Phases			4			3			2			6
Actuated Green, G (s)	44.1	44.1	44.1		15.4	15.4	25.1	140.6	140.6	15.9	131.4	131.4
Effective Green, g (s)	44.1	44.1	44.1		15.4	17.4	25.1	142.6	141.6	17.9	133.4	131.4
Actuated g/C Ratio	0.18	0.18	0.18		0.06	0.07	0.10	0.59	0.59	0.07	0.56	0.55
Clearance Time (s)	5.0	5.0	5.0		6.0	6.0	6.0	7.0	7.0	6.0	7.0	7.0
Vehicle Extension (s)	4.0	4.0	4.0		3.0	3.0	5.0	6.0	6.0	3.0	6.0	6.0
Lane Grp Cap (vph)	308	312	263		116	114	185	3021	773	132	2826	840
v/s Ratio Prot	0.15	c0.15			c0.04		c0.08	0.32		0.05	c0.56	
v/s Ratio Perm			0.05			0.00			0.03			0.15
v/c Ratio	0.84	0.84	0.25		0.66	0.02	0.74	0.54	0.05	0.62	1.01	0.27
Uniform Delay, d1	94.5	94.6	83.8		109.7	103.4	104.2	29.2	20.8	107.8	53.3	28.9
Progression Factor	1.00	1.00	1.00		1.00	1.00	0.90	1.15	2.12	0.98	0.99	1.44
Incremental Delay, d2	18.4	18.9	0.7		12.5	0.1	7.1	0.3	0.0	8.7	20.3	0.8
Delay (s)	112.9	113.6	84.5		122.3	103.4	100.5	33.7	44.2	113.8	73.1	42.4
Level of Service	F	F	F		F	F	F	C	D	F	E	D
Approach Delay (s)		106.9			117.3			39.0			70.2	
Approach LOS		F			F			D			E	

Intersection Summary			
HCM 2000 Control Delay	65.5	HCM 2000 Level of Service	E
HCM 2000 Volume to Capacity ratio	0.92		
Actuated Cycle Length (s)	240.0	Sum of lost time (s)	22.0
Intersection Capacity Utilization	99.4%	ICU Level of Service	F
Analysis Period (min)	15		

c Critical Lane Group

Intersection	
Int Delay, s/veh	1

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Vol, veh/h	0	810	430	5	35	5
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	100	-	-	-	0	-
Veh in Median Storage, #	-	0	0	-	0	-
Grade, %	-	0	0	-	0	-
Peak Hour Factor	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	0	880	467	5	38	5

Major/Minor	Major1		Major2		Minor2	
Conflicting Flow All	473	0	-	0	1350	470
Stage 1	-	-	-	-	470	-
Stage 2	-	-	-	-	880	-
Critical Hdwy	4.12	-	-	-	6.42	6.22
Critical Hdwy Stg 1	-	-	-	-	5.42	-
Critical Hdwy Stg 2	-	-	-	-	5.42	-
Follow-up Hdwy	2.218	-	-	-	3.518	3.318
Pot Cap-1 Maneuver	1089	-	-	-	166	594
Stage 1	-	-	-	-	629	-
Stage 2	-	-	-	-	406	-
Platoon blocked, %		-	-	-		
Mov Cap-1 Maneuver	1089	-	-	-	166	594
Mov Cap-2 Maneuver	-	-	-	-	166	-
Stage 1	-	-	-	-	629	-
Stage 2	-	-	-	-	406	-

Approach	EB	WB	SB
HCM Control Delay, s	0	0	30.9
HCM LOS			D

Minor Lane/Major Mvmt	EBL	EBT	WBT	WBR	SBLn1
Capacity (veh/h)	1089	-	-	-	182
HCM Lane V/C Ratio	-	-	-	-	0.239
HCM Control Delay (s)	0	-	-	-	30.9
HCM Lane LOS	A	-	-	-	D
HCM 95th %tile Q(veh)	0	-	-	-	0.9

Intersection	
Int Delay, s/veh	0.6

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Vol, veh/h	0	695	435	0	20	10
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	100	-	-	-	0	-
Veh in Median Storage, #	-	0	0	-	0	-
Grade, %	-	0	0	-	0	-
Peak Hour Factor	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	0	755	473	0	22	11

Major/Minor	Major1		Major2		Minor2	
Conflicting Flow All	473	0	-	0	1228	473
Stage 1	-	-	-	-	473	-
Stage 2	-	-	-	-	755	-
Critical Hdwy	4.12	-	-	-	6.42	6.22
Critical Hdwy Stg 1	-	-	-	-	5.42	-
Critical Hdwy Stg 2	-	-	-	-	5.42	-
Follow-up Hdwy	2.218	-	-	-	3.518	3.318
Pot Cap-1 Maneuver	1089	-	-	-	197	591
Stage 1	-	-	-	-	627	-
Stage 2	-	-	-	-	464	-
Platoon blocked, %		-	-	-		
Mov Cap-1 Maneuver	1089	-	-	-	197	591
Mov Cap-2 Maneuver	-	-	-	-	197	-
Stage 1	-	-	-	-	627	-
Stage 2	-	-	-	-	464	-

Approach	EB	WB	SB
HCM Control Delay, s	0	0	21.3
HCM LOS			C

Minor Lane/Major Mvmt	EBL	EBT	WBT	WBR	SBLn1
Capacity (veh/h)	1089	-	-	-	253
HCM Lane V/C Ratio	-	-	-	-	0.129
HCM Control Delay (s)	0	-	-	-	21.3
HCM Lane LOS	A	-	-	-	C
HCM 95th %tile Q(veh)	0	-	-	-	0.4

Intersection	
Int Delay, s/veh	2

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Vol, veh/h	210	0	5	150	0	85
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	100	-	0	-
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	228	0	5	163	0	92

Major/Minor	Major1		Major2		Minor1	
Conflicting Flow All	0	0	228	0	402	228
Stage 1	-	-	-	-	228	-
Stage 2	-	-	-	-	174	-
Critical Hdwy	-	-	4.12	-	6.42	6.22
Critical Hdwy Stg 1	-	-	-	-	5.42	-
Critical Hdwy Stg 2	-	-	-	-	5.42	-
Follow-up Hdwy	-	-	2.218	-	3.518	3.318
Pot Cap-1 Maneuver	-	-	1340	-	604	811
Stage 1	-	-	-	-	810	-
Stage 2	-	-	-	-	856	-
Platoon blocked, %	-	-		-		
Mov Cap-1 Maneuver	-	-	1340	-	602	811
Mov Cap-2 Maneuver	-	-	-	-	602	-
Stage 1	-	-	-	-	810	-
Stage 2	-	-	-	-	853	-

Approach	EB	WB	NB
HCM Control Delay, s	0	0.2	10
HCM LOS			B

Minor Lane/Major Mvmt	NBLn1	EBT	EBR	WBL	WBT
Capacity (veh/h)	811	-	-	1340	-
HCM Lane V/C Ratio	0.114	-	-	0.004	-
HCM Control Delay (s)	10	-	-	7.7	-
HCM Lane LOS	B	-	-	A	-
HCM 95th %tile Q(veh)	0.4	-	-	0	-

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	870	805	10	230	485	585	55	370	130	625	370	655
Number	7	4	14	3	8	18	5	2	12	1	6	16
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1863	1863	1900	1863	1863	1863	1863	1863	1900	1863	1863	1863
Adj Flow Rate, veh/h	946	875	11	250	527	582	60	402	5	679	402	423
Adj No. of Lanes	2	3	0	2	3	2	1	2	0	2	2	2
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Percent Heavy Veh, %	2	2	2	2	2	2	2	2	2	2	2	2
Cap, veh/h	986	2054	26	310	1019	1145	78	541	7	724	1125	1681
Arrive On Green	0.29	0.40	0.40	0.09	0.20	0.20	0.04	0.15	0.15	0.21	0.32	0.32
Sat Flow, veh/h	3442	5176	65	3442	5085	2787	1774	3580	44	3442	3539	2776
Grp Volume(v), veh/h	946	573	313	250	527	582	60	199	208	679	402	423
Grp Sat Flow(s),veh/h/ln	1721	1695	1851	1721	1695	1393	1774	1770	1855	1721	1770	1388
Q Serve(g_s), s	41.1	18.6	18.7	10.8	14.0	23.6	5.1	16.3	16.3	29.5	13.3	10.8
Cycle Q Clear(g_c), s	41.1	18.6	18.7	10.8	14.0	23.6	5.1	16.3	16.3	29.5	13.3	10.8
Prop In Lane	1.00		0.04	1.00		1.00	1.00		0.02	1.00		1.00
Lane Grp Cap(c), veh/h	986	1345	734	310	1019	1145	78	268	280	724	1125	1681
V/C Ratio(X)	0.96	0.43	0.43	0.81	0.52	0.51	0.77	0.74	0.74	0.94	0.36	0.25
Avail Cap(c_a), veh/h	997	1345	734	997	1272	1284	456	606	635	748	1125	1681
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	53.3	33.3	33.3	67.8	54.2	33.3	71.9	61.6	61.6	59.0	39.9	14.0
Incr Delay (d2), s/veh	19.3	0.2	0.4	4.9	0.4	0.4	14.9	4.0	3.9	19.0	0.2	0.1
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	22.2	8.8	9.6	5.4	6.6	9.1	2.8	8.3	8.7	16.0	6.5	4.1
LnGrp Delay(d),s/veh	72.6	33.5	33.7	72.7	54.6	33.7	86.7	65.7	65.5	78.0	40.1	14.1
LnGrp LOS	E	C	C	E	D	C	F	E	E	E	D	B
Approach Vol, veh/h		1832			1359			467			1504	
Approach Delay, s/veh		53.7			48.9			68.3			49.9	
Approach LOS		D			D			E			D	

Timer	1	2	3	4	5	6	7	8
Assigned Phs	1	2	3	4	5	6	7	8
Phs Duration (G+Y+Rc), s	37.0	29.0	19.7	66.2	11.6	54.3	49.5	36.4
Change Period (Y+Rc), s	5.0	6.0	6.0	6.0	5.0	6.0	6.0	6.0
Max Green Setting (Gmax), s	33.0	52.0	44.0	38.0	39.0	46.0	44.0	38.0
Max Q Clear Time (g_c+I1), s	31.5	18.3	12.8	20.7	7.1	15.3	43.1	25.6
Green Ext Time (p_c), s	0.5	3.7	0.9	11.2	0.1	8.1	0.4	4.8

Intersection Summary	
HCM 2010 Ctrl Delay	52.7
HCM 2010 LOS	D

Notes

User approved changes to right turn type.

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	145	230	75	205	145	325	40	890	130	320	1180	135
Number	3	8	18	7	4	14	5	2	12	1	6	16
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1863	1863	1900	1863	1863	1863	1863	1863	1900	1863	1863	1900
Adj Flow Rate, veh/h	158	250	73	223	158	106	43	967	129	348	1283	137
Adj No. of Lanes	1	1	0	1	1	1	1	3	0	2	3	0
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Percent Heavy Veh, %	2	2	2	2	2	2	2	2	2	2	2	2
Cap, veh/h	440	542	158	338	729	619	55	1412	188	443	1906	203
Arrive On Green	0.39	0.39	0.39	0.39	0.39	0.39	0.03	0.31	0.31	0.13	0.41	0.41
Sat Flow, veh/h	1111	1386	405	1052	1863	1583	1774	4542	604	3442	4667	498
Grp Volume(v), veh/h	158	0	323	223	158	106	43	721	375	348	932	488
Grp Sat Flow(s),veh/h/ln	1111	0	1791	1052	1863	1583	1774	1695	1756	1721	1695	1775
Q Serve(g_s), s	11.7	0.0	14.2	21.2	6.0	4.6	2.6	19.8	19.9	10.4	23.9	23.9
Cycle Q Clear(g_c), s	17.7	0.0	14.2	35.5	6.0	4.6	2.6	19.8	19.9	10.4	23.9	23.9
Prop In Lane	1.00		0.23	1.00		1.00	1.00		0.34	1.00		0.28
Lane Grp Cap(c), veh/h	440	0	701	338	729	619	55	1054	546	443	1384	725
V/C Ratio(X)	0.36	0.00	0.46	0.66	0.22	0.17	0.78	0.68	0.69	0.79	0.67	0.67
Avail Cap(c_a), veh/h	517	0	825	412	858	730	334	1054	546	1424	1690	885
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	0.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	27.4	0.0	24.0	37.2	21.5	21.1	51.1	32.1	32.1	44.9	25.7	25.7
Incr Delay (d2), s/veh	0.5	0.0	0.5	2.8	0.1	0.1	20.3	1.8	3.6	3.1	0.8	1.5
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	3.7	0.0	7.1	6.4	3.1	2.0	1.6	9.5	10.1	5.2	11.3	12.0
LnGrp Delay(d),s/veh	27.9	0.0	24.5	40.1	21.7	21.3	71.4	33.9	35.7	48.0	26.5	27.2
LnGrp LOS	C		C	D	C	C	E	C	D	D	C	C
Approach Vol, veh/h		481			487			1139			1768	
Approach Delay, s/veh		25.6			30.0			35.9			30.9	
Approach LOS		C			C			D			C	

Timer	1	2	3	4	5	6	7	8
Assigned Phs	1	2		4	5	6		8
Phs Duration (G+Y+Rc), s	19.7	39.1		47.6	9.3	49.4		47.6
Change Period (Y+Rc), s	6.0	6.0		6.0	6.0	6.0		6.0
Max Green Setting (Gmax), s	44.0	29.0		49.0	20.0	53.0		49.0
Max Q Clear Time (g_c+I1), s	12.4	21.9		37.5	4.6	25.9		19.7
Green Ext Time (p_c), s	1.3	6.4		4.1	0.1	17.6		5.8

Intersection Summary			
HCM 2010 Ctrl Delay			31.6
HCM 2010 LOS			C

Intersection	
Int Delay, s/veh	0

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Vol, veh/h	0	0	215	5	5	95
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	-	-	0	-
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	0	0	234	5	5	103

Major/Minor	Major1		Major2		Minor1	
Conflicting Flow All	0	0	0	0	473	0
Stage 1	-	-	-	-	0	-
Stage 2	-	-	-	-	473	-
Critical Hdwy	-	-	4.12	-	6.42	6.22
Critical Hdwy Stg 1	-	-	-	-	5.42	-
Critical Hdwy Stg 2	-	-	-	-	5.42	-
Follow-up Hdwy	-	-	2.218	-	3.518	3.318
Pot Cap-1 Maneuver	-	-	-	-	550	-
Stage 1	-	-	-	-	-	-
Stage 2	-	-	-	-	627	-
Platoon blocked, %	-	-		-		
Mov Cap-1 Maneuver	-	-	-	-	550	-
Mov Cap-2 Maneuver	-	-	-	-	550	-
Stage 1	-	-	-	-	-	-
Stage 2	-	-	-	-	627	-

Approach	EB	WB	NB
HCM Control Delay, s	0		
HCM LOS			-

Minor Lane/Major Mvmt	NBLn1	EBT	EBR	WBL	WBT
Capacity (veh/h)	-	-	-	-	-
HCM Lane V/C Ratio	-	-	-	-	-
HCM Control Delay (s)	-	-	-	-	-
HCM Lane LOS	-	-	-	-	-
HCM 95th %tile Q(veh)	-	-	-	-	-

Intersection	
Int Delay, s/veh	7.7

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Vol, veh/h	80	320	0	0	800	20	0	0	0	15	0	195
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Free	Free	Stop	Stop	Stop	Stop	Stop	Stop
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	-	-	-	-	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	92	92	92	92	92	92	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2	2	2	2	2	2	2
Mvmt Flow	87	348	0	0	870	22	0	0	0	16	0	212

Major/Minor	Major1			Major2			Minor1			Minor2		
Conflicting Flow All	891	0	0	348	0	0	1508	1413	348	1402	1402	880
Stage 1	-	-	-	-	-	-	522	522	-	880	880	-
Stage 2	-	-	-	-	-	-	986	891	-	522	522	-
Critical Hdwy	4.12	-	-	4.12	-	-	7.12	6.52	6.22	7.12	6.52	6.22
Critical Hdwy Stg 1	-	-	-	-	-	-	6.12	5.52	-	6.12	5.52	-
Critical Hdwy Stg 2	-	-	-	-	-	-	6.12	5.52	-	6.12	5.52	-
Follow-up Hdwy	2.218	-	-	2.218	-	-	3.518	4.018	3.318	3.518	4.018	3.318
Pot Cap-1 Maneuver	761	-	-	1211	-	-	99	138	695	117	140	346
Stage 1	-	-	-	-	-	-	538	531	-	342	365	-
Stage 2	-	-	-	-	-	-	298	361	-	538	531	-
Platoon blocked, %		-	-		-	-						
Mov Cap-1 Maneuver	761	-	-	1211	-	-	34	118	695	104	120	346
Mov Cap-2 Maneuver	-	-	-	-	-	-	34	118	-	104	120	-
Stage 1	-	-	-	-	-	-	462	456	-	293	365	-
Stage 2	-	-	-	-	-	-	115	361	-	462	456	-

Approach	EB	WB	NB	SB
HCM Control Delay, s	2.1	0	0	48.1
HCM LOS			A	E

Minor Lane/Major Mvmt	NBLn1	EBL	EBT	EBR	WBL	WBT	WBR	SBLn1
Capacity (veh/h)	-	761	-	-	1211	-	-	297
HCM Lane V/C Ratio	-	0.114	-	-	-	-	-	0.769
HCM Control Delay (s)	0	10.3	0	-	0	-	-	48.1
HCM Lane LOS	A	B	A	-	A	-	-	E
HCM 95th %tile Q(veh)	-	0.4	-	-	0	-	-	5.9

Intersection	
Int Delay, s/veh	0.4

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Vol, veh/h	325	10	25	845	10	5
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	50	-	0	-
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	353	11	27	918	11	5

Major/Minor	Major1		Major2		Minor1	
Conflicting Flow All	0	0	364	0	1332	359
Stage 1	-	-	-	-	359	-
Stage 2	-	-	-	-	973	-
Critical Hdwy	-	-	4.12	-	6.42	6.22
Critical Hdwy Stg 1	-	-	-	-	5.42	-
Critical Hdwy Stg 2	-	-	-	-	5.42	-
Follow-up Hdwy	-	-	2.218	-	3.518	3.318
Pot Cap-1 Maneuver	-	-	1195	-	170	685
Stage 1	-	-	-	-	707	-
Stage 2	-	-	-	-	366	-
Platoon blocked, %	-	-		-		
Mov Cap-1 Maneuver	-	-	1195	-	166	685
Mov Cap-2 Maneuver	-	-	-	-	166	-
Stage 1	-	-	-	-	707	-
Stage 2	-	-	-	-	358	-

Approach	EB	WB	NB
HCM Control Delay, s	0	0.2	22.5
HCM LOS			C

Minor Lane/Major Mvmt	NBLn1	EBT	EBR	WBL	WBT
Capacity (veh/h)	222	-	-	1195	-
HCM Lane V/C Ratio	0.073	-	-	0.023	-
HCM Control Delay (s)	22.5	-	-	8.1	-
HCM Lane LOS	C	-	-	A	-
HCM 95th %tile Q(veh)	0.2	-	-	0.1	-

Intersection	
Int Delay, s/veh	0

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Vol, veh/h	0	330	0	0	895	0	0	0	0	0	0	0
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Free	Free	Stop	Stop	Stop	Stop	Stop	Stop
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	-	-	-	-	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	92	92	92	92	92	92	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2	2	2	2	2	2	2
Mvmt Flow	0	359	0	0	973	0	0	0	0	0	0	0

Major/Minor	Major1			Major2			Minor1			Minor2		
Conflicting Flow All	973	0	0	359	0	0	1332	1332	359	1332	1332	973
Stage 1	-	-	-	-	-	-	359	359	-	973	973	-
Stage 2	-	-	-	-	-	-	973	973	-	359	359	-
Critical Hdwy	4.12	-	-	4.12	-	-	7.12	6.52	6.22	7.12	6.52	6.22
Critical Hdwy Stg 1	-	-	-	-	-	-	6.12	5.52	-	6.12	5.52	-
Critical Hdwy Stg 2	-	-	-	-	-	-	6.12	5.52	-	6.12	5.52	-
Follow-up Hdwy	2.218	-	-	2.218	-	-	3.518	4.018	3.318	3.518	4.018	3.318
Pot Cap-1 Maneuver	709	-	-	1200	-	-	131	154	685	131	154	306
Stage 1	-	-	-	-	-	-	659	627	-	303	330	-
Stage 2	-	-	-	-	-	-	303	330	-	659	627	-
Platoon blocked, %		-	-		-	-						
Mov Cap-1 Maneuver	709	-	-	1200	-	-	131	154	685	131	154	306
Mov Cap-2 Maneuver	-	-	-	-	-	-	131	154	-	131	154	-
Stage 1	-	-	-	-	-	-	659	627	-	303	330	-
Stage 2	-	-	-	-	-	-	303	330	-	659	627	-

Approach	EB	WB	NB	SB
HCM Control Delay, s	0	0	0	0
HCM LOS			A	A

Minor Lane/Major Mvmt	NBLn1	EBL	EBT	EBR	WBL	WBT	WBR	SBLn1
Capacity (veh/h)	-	709	-	-	1200	-	-	-
HCM Lane V/C Ratio	-	-	-	-	-	-	-	-
HCM Control Delay (s)	0	0	-	-	0	-	-	0
HCM Lane LOS	A	A	-	-	A	-	-	A
HCM 95th %tile Q(veh)	-	0	-	-	0	-	-	-

Intersection	
Int Delay, s/veh	0.8

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Vol, veh/h	5	325	870	25	20	15
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	100	-	-	-	0	-
Veh in Median Storage, #	-	0	0	-	0	-
Grade, %	-	0	0	-	0	-
Peak Hour Factor	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	5	353	946	27	22	16

Major/Minor	Major1		Major2		Minor2	
Conflicting Flow All	973	0	-	0	1323	959
Stage 1	-	-	-	-	959	-
Stage 2	-	-	-	-	364	-
Critical Hdwy	4.12	-	-	-	6.42	6.22
Critical Hdwy Stg 1	-	-	-	-	5.42	-
Critical Hdwy Stg 2	-	-	-	-	5.42	-
Follow-up Hdwy	2.218	-	-	-	3.518	3.318
Pot Cap-1 Maneuver	709	-	-	-	172	312
Stage 1	-	-	-	-	372	-
Stage 2	-	-	-	-	703	-
Platoon blocked, %		-	-	-		
Mov Cap-1 Maneuver	709	-	-	-	171	312
Mov Cap-2 Maneuver	-	-	-	-	171	-
Stage 1	-	-	-	-	372	-
Stage 2	-	-	-	-	698	-

Approach	EB	WB	SB
HCM Control Delay, s	0.2	0	25.7
HCM LOS			D

Minor Lane/Major Mvmt	EBL	EBT	WBT	WBR	SBLn1
Capacity (veh/h)	709	-	-	-	212
HCM Lane V/C Ratio	0.008	-	-	-	0.179
HCM Control Delay (s)	10.1	-	-	-	25.7
HCM Lane LOS	B	-	-	-	D
HCM 95th %tile Q(veh)	0	-	-	-	0.6

Intersection	
Int Delay, s/veh	1.2

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Vol, veh/h	10	325	0	0	875	40	0	0	0	25	0	15
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Free	Free	Stop	Stop	Stop	Stop	Stop	Stop
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	100	-	-	-	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	92	92	92	92	92	92	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2	2	2	2	2	2	2
Mvmt Flow	11	353	0	0	951	43	0	0	0	27	0	16

Major/Minor	Major1			Major2			Minor1			Minor2		
Conflicting Flow All	995	0	0	353	0	0	1356	1370	353	1348	1348	973
Stage 1	-	-	-	-	-	-	375	375	-	973	973	-
Stage 2	-	-	-	-	-	-	981	995	-	375	375	-
Critical Hdwy	4.12	-	-	4.12	-	-	7.12	6.52	6.22	7.12	6.52	6.22
Critical Hdwy Stg 1	-	-	-	-	-	-	6.12	5.52	-	6.12	5.52	-
Critical Hdwy Stg 2	-	-	-	-	-	-	6.12	5.52	-	6.12	5.52	-
Follow-up Hdwy	2.218	-	-	2.218	-	-	3.518	4.018	3.318	3.518	4.018	3.318
Pot Cap-1 Maneuver	695	-	-	1206	-	-	126	146	691	128	151	306
Stage 1	-	-	-	-	-	-	646	617	-	303	330	-
Stage 2	-	-	-	-	-	-	300	323	-	646	617	-
Platoon blocked, %		-	-		-	-						
Mov Cap-1 Maneuver	695	-	-	1206	-	-	118	144	691	126	149	306
Mov Cap-2 Maneuver	-	-	-	-	-	-	118	144	-	126	149	-
Stage 1	-	-	-	-	-	-	636	607	-	298	330	-
Stage 2	-	-	-	-	-	-	284	323	-	636	607	-

Approach	EB	WB	NB	SB
HCM Control Delay, s	0.3	0	0	35.2
HCM LOS			A	E

Minor Lane/Major Mvmt	NBLn1	EBL	EBT	EBR	WBL	WBT	WBR	SBLn1
Capacity (veh/h)	-	695	-	-	1206	-	-	162
HCM Lane V/C Ratio	-	0.016	-	-	-	-	-	0.268
HCM Control Delay (s)	0	10.3	-	-	0	-	-	35.2
HCM Lane LOS	A	B	-	-	A	-	-	E
HCM 95th %tile Q(veh)	-	0	-	-	0	-	-	1

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	50	375	535	200	265	275	250	785	110	195	975	30
Number	7	4	14	3	8	18	5	2	12	1	6	16
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1863	1863	1863	1863	1863	1863	1863	1863	1863	1863	1863	1863
Adj Flow Rate, veh/h	54	408	353	217	288	94	272	853	24	212	1060	8
Adj No. of Lanes	1	1	1	1	1	1	2	2	1	1	2	1
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Percent Heavy Veh, %	2	2	2	2	2	2	2	2	2	2	2	2
Cap, veh/h	71	483	410	244	665	565	331	1013	453	240	1151	515
Arrive On Green	0.04	0.26	0.26	0.14	0.36	0.36	0.10	0.29	0.29	0.14	0.33	0.33
Sat Flow, veh/h	1774	1863	1583	1774	1863	1583	3442	3539	1583	1774	3539	1583
Grp Volume(v), veh/h	54	408	353	217	288	94	272	853	24	212	1060	8
Grp Sat Flow(s),veh/h/ln	1774	1863	1583	1774	1863	1583	1721	1770	1583	1774	1770	1583
Q Serve(g_s), s	4.0	27.4	28.0	15.8	15.5	5.4	10.2	29.9	1.4	15.5	38.0	0.5
Cycle Q Clear(g_c), s	4.0	27.4	28.0	15.8	15.5	5.4	10.2	29.9	1.4	15.5	38.0	0.5
Prop In Lane	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Lane Grp Cap(c), veh/h	71	483	410	244	665	565	331	1013	453	240	1151	515
V/C Ratio(X)	0.77	0.85	0.86	0.89	0.43	0.17	0.82	0.84	0.05	0.88	0.92	0.02
Avail Cap(c_a), veh/h	431	721	613	310	665	565	470	1013	453	336	1181	529
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	62.7	46.3	46.6	55.9	32.3	29.0	58.5	44.2	34.1	56.0	42.8	30.2
Incr Delay (d2), s/veh	15.7	6.0	8.0	22.0	0.4	0.1	7.7	6.5	0.0	17.9	11.6	0.0
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	2.3	14.9	13.1	9.3	8.1	2.4	5.2	15.5	0.6	8.8	20.4	0.2
LnGrp Delay(d),s/veh	78.4	52.3	54.6	77.9	32.7	29.1	66.2	50.7	34.1	73.9	54.4	30.2
LnGrp LOS	E	D	D	E	C	C	E	D	C	E	D	C

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Approach Vol, veh/h		815			599			1149			1280	
Approach Delay, s/veh		55.0			48.5			54.1			57.5	
Approach LOS		E			D			D			E	

Timer	1	2	3	4	5	6	7	8
Assigned Phs	1	2	3	4	5	6	7	8
Phs Duration (G+Y+Rc), s	23.8	43.7	24.1	40.2	18.7	48.9	11.2	53.0
Change Period (Y+Rc), s	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0
Max Green Setting (Gmax), s	25.0	37.0	23.0	51.0	18.0	44.0	32.0	42.0
Max Q Clear Time (g_c+I1), s	17.5	31.9	17.8	30.0	12.2	40.0	6.0	17.5
Green Ext Time (p_c), s	0.3	4.3	0.3	4.1	0.5	2.8	0.1	6.4

Intersection Summary			
HCM 2010 Ctrl Delay			54.5
HCM 2010 LOS			D

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	250	245	290	15	275	185	270	1065	15	360	1775	240
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	6.0	4.0	4.0	6.0
Lane Util. Factor	0.91	0.91	1.00	1.00	1.00	0.88	0.97	0.91	1.00	0.97	0.91	1.00
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	0.99	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	1610	3345	1583	1770	1863	2787	3433	5085	1583	3433	5085	1583
Flt Permitted	0.95	0.99	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)	1610	3345	1583	1770	1863	2787	3433	5085	1583	3433	5085	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)	272	266	315	16	299	201	293	1158	16	391	1929	261
RTOR Reduction (vph)	0	0	72	0	0	110	0	0	9	0	0	75
Lane Group Flow (vph)	174	364	243	16	299	91	293	1158	7	391	1929	186
Turn Type	Split	NA	Perm	Split	NA	Perm	Prot	NA	Perm	Prot	NA	Perm
Protected Phases	3	3		4	4		5	2		1	6	
Permitted Phases			3			4			2			6
Actuated Green, G (s)	40.2	40.2	40.2	36.8	36.8	36.8	25.2	106.4	106.4	31.6	112.8	112.8
Effective Green, g (s)	42.2	42.2	42.2	38.8	38.8	38.8	27.2	109.4	107.4	33.6	115.8	113.8
Actuated g/C Ratio	0.18	0.18	0.18	0.16	0.16	0.16	0.11	0.46	0.45	0.14	0.48	0.47
Clearance Time (s)	6.0	6.0	6.0	6.0	6.0	6.0	6.0	7.0	7.0	6.0	7.0	7.0
Vehicle Extension (s)	5.0	5.0	5.0	5.0	5.0	5.0	3.0	5.0	5.0	3.0	5.0	5.0
Lane Grp Cap (vph)	283	588	278	286	301	450	389	2317	708	480	2453	750
v/s Ratio Prot	0.11	0.11		0.01	c0.16		0.09	0.23		c0.11	c0.38	
v/s Ratio Perm			c0.15			0.03			0.00			0.12
v/c Ratio	0.61	0.62	0.88	0.06	0.99	0.20	0.75	0.50	0.01	0.81	0.79	0.25
Uniform Delay, d1	91.4	91.5	96.3	85.1	100.5	87.2	103.1	46.0	36.8	100.2	51.8	37.6
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.15	0.92	1.07
Incremental Delay, d2	5.6	2.8	26.6	0.2	50.0	0.5	8.0	0.8	0.0	10.1	2.6	0.8
Delay (s)	97.0	94.3	122.9	85.3	150.4	87.7	111.2	46.8	36.8	125.1	50.0	41.2
Level of Service	F	F	F	F	F	F	F	D	D	F	D	D
Approach Delay (s)		105.4			124.0			59.5			60.5	
Approach LOS		F			F			E			E	

Intersection Summary			
HCM 2000 Control Delay	73.4	HCM 2000 Level of Service	E
HCM 2000 Volume to Capacity ratio	0.85		
Actuated Cycle Length (s)	240.0	Sum of lost time (s)	16.0
Intersection Capacity Utilization	79.2%	ICU Level of Service	D
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	450	40	125	35	35	30	130	1760	65	80	2845	450
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		6.0	4.0	6.0	5.0	6.0	4.0	5.0	7.0
Lane Util. Factor	0.95	0.95	1.00		1.00	1.00	1.00	0.91	1.00	1.00	0.91	1.00
Frpb, ped/bikes	1.00	1.00	0.91		1.00	1.00	1.00	1.00	0.83	1.00	1.00	0.97
Flpb, ped/bikes	1.00	1.00	1.00		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Frt	1.00	1.00	0.85		1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	0.96	1.00		0.98	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	1681	1698	1434		1817	1583	1770	5085	1311	1770	5085	1536
Flt Permitted	0.95	0.96	1.00		0.98	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)	1681	1698	1434		1817	1583	1770	5085	1311	1770	5085	1536
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	489	43	136	38	38	33	141	1913	71	87	3092	489
RTOR Reduction (vph)	0	0	81	0	0	31	0	0	28	0	0	223
Lane Group Flow (vph)	264	268	55	0	76	2	141	1913	43	87	3092	266
Confl. Peds. (#/hr)			43						31			2
Turn Type	Split	NA	Perm	Split	NA	Perm	Prot	NA	Perm	Prot	NA	Perm
Protected Phases	4	4		3	3		5	2		1	6	
Permitted Phases			4			3			2			6
Actuated Green, G (s)	44.6	44.6	44.6		15.4	15.4	25.6	139.6	139.6	16.4	130.4	130.4
Effective Green, g (s)	44.6	44.6	44.6		15.4	17.4	25.6	141.6	140.6	18.4	132.4	130.4
Actuated g/C Ratio	0.19	0.19	0.19		0.06	0.07	0.11	0.59	0.59	0.08	0.55	0.54
Clearance Time (s)	5.0	5.0	5.0		6.0	6.0	6.0	7.0	7.0	6.0	7.0	7.0
Vehicle Extension (s)	4.0	4.0	4.0		3.0	3.0	5.0	6.0	6.0	3.0	6.0	6.0
Lane Grp Cap (vph)	312	315	266		116	114	188	3000	768	135	2805	834
v/s Ratio Prot	0.16	c0.16			c0.04		c0.08	c0.38		0.05	c0.61	
v/s Ratio Perm			0.04			0.00			0.03			0.17
v/c Ratio	0.85	0.85	0.21		0.66	0.02	0.75	0.64	0.06	0.64	1.10	0.32
Uniform Delay, d1	94.4	94.5	82.7		109.7	103.4	104.1	32.3	21.3	107.6	53.8	30.3
Progression Factor	1.00	1.00	1.00		1.00	1.00	0.88	1.15	2.07	0.98	0.99	1.42
Incremental Delay, d2	19.3	19.9	0.5		12.5	0.1	7.6	0.4	0.1	10.0	52.1	1.0
Delay (s)	113.6	114.3	83.2		122.3	103.5	99.4	37.7	44.1	115.1	105.5	44.0
Level of Service	F	F	F		F	F	F	D	D	F	F	D
Approach Delay (s)		107.7			116.6			42.0			97.5	
Approach LOS		F			F			D			F	

Intersection Summary			
HCM 2000 Control Delay	80.9	HCM 2000 Level of Service	F
HCM 2000 Volume to Capacity ratio	0.98		
Actuated Cycle Length (s)	240.0	Sum of lost time (s)	22.0
Intersection Capacity Utilization	103.8%	ICU Level of Service	G
Analysis Period (min)	15		

c Critical Lane Group

Intersection	
Int Delay, s/veh	0.6

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Vol, veh/h	5	350	915	25	20	5
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	100	-	-	-	0	-
Veh in Median Storage, #	-	0	0	-	0	-
Grade, %	-	0	0	-	0	-
Peak Hour Factor	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	5	380	995	27	22	5

Major/Minor	Major1		Major2		Minor2	
Conflicting Flow All	1022	0	-	0	1399	1008
Stage 1	-	-	-	-	1008	-
Stage 2	-	-	-	-	391	-
Critical Hdwy	4.12	-	-	-	6.42	6.22
Critical Hdwy Stg 1	-	-	-	-	5.42	-
Critical Hdwy Stg 2	-	-	-	-	5.42	-
Follow-up Hdwy	2.218	-	-	-	3.518	3.318
Pot Cap-1 Maneuver	679	-	-	-	155	292
Stage 1	-	-	-	-	353	-
Stage 2	-	-	-	-	683	-
Platoon blocked, %		-	-	-		
Mov Cap-1 Maneuver	679	-	-	-	154	292
Mov Cap-2 Maneuver	-	-	-	-	154	-
Stage 1	-	-	-	-	353	-
Stage 2	-	-	-	-	678	-

Approach	EB	WB	SB
HCM Control Delay, s	0.1	0	30.2
HCM LOS			D

Minor Lane/Major Mvmt	EBL	EBT	WBT	WBR	SBLn1
Capacity (veh/h)	679	-	-	-	170
HCM Lane V/C Ratio	0.008	-	-	-	0.16
HCM Control Delay (s)	10.3	-	-	-	30.2
HCM Lane LOS	B	-	-	-	D
HCM 95th %tile Q(veh)	0	-	-	-	0.6

Intersection	
Int Delay, s/veh	0.5

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Vol, veh/h	5	325	805	20	15	10
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	100	-	-	-	0	-
Veh in Median Storage, #	-	0	0	-	0	-
Grade, %	-	0	0	-	0	-
Peak Hour Factor	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	5	353	875	22	16	11

Major/Minor	Major1		Major2		Minor2	
Conflicting Flow All	897	0	-	0	1250	886
Stage 1	-	-	-	-	886	-
Stage 2	-	-	-	-	364	-
Critical Hdwy	4.12	-	-	-	6.42	6.22
Critical Hdwy Stg 1	-	-	-	-	5.42	-
Critical Hdwy Stg 2	-	-	-	-	5.42	-
Follow-up Hdwy	2.218	-	-	-	3.518	3.318
Pot Cap-1 Maneuver	757	-	-	-	191	343
Stage 1	-	-	-	-	403	-
Stage 2	-	-	-	-	703	-
Platoon blocked, %		-	-	-		
Mov Cap-1 Maneuver	757	-	-	-	190	343
Mov Cap-2 Maneuver	-	-	-	-	190	-
Stage 1	-	-	-	-	403	-
Stage 2	-	-	-	-	698	-

Approach	EB	WB	SB
HCM Control Delay, s	0.1	0	22.7
HCM LOS			C

Minor Lane/Major Mvmt	EBL	EBT	WBT	WBR	SBLn1
Capacity (veh/h)	757	-	-	-	231
HCM Lane V/C Ratio	0.007	-	-	-	0.118
HCM Control Delay (s)	9.8	-	-	-	22.7
HCM Lane LOS	A	-	-	-	C
HCM 95th %tile Q(veh)	0	-	-	-	0.4

Intersection	
Int Delay, s/veh	3.2

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Vol, veh/h	95	0	55	215	0	125
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	100	-	0	-
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	103	0	60	234	0	136

Major/Minor	Major1		Major2		Minor1	
Conflicting Flow All	0	0	103	0	456	103
Stage 1	-	-	-	-	103	-
Stage 2	-	-	-	-	353	-
Critical Hdwy	-	-	4.12	-	6.42	6.22
Critical Hdwy Stg 1	-	-	-	-	5.42	-
Critical Hdwy Stg 2	-	-	-	-	5.42	-
Follow-up Hdwy	-	-	2.218	-	3.518	3.318
Pot Cap-1 Maneuver	-	-	1489	-	562	952
Stage 1	-	-	-	-	921	-
Stage 2	-	-	-	-	711	-
Platoon blocked, %	-	-		-		
Mov Cap-1 Maneuver	-	-	1489	-	539	952
Mov Cap-2 Maneuver	-	-	-	-	539	-
Stage 1	-	-	-	-	921	-
Stage 2	-	-	-	-	682	-

Approach	EB	WB	NB
HCM Control Delay, s	0	1.5	9.4
HCM LOS			A

Minor Lane/Major Mvmt	NBLn1	EBT	EBR	WBL	WBT
Capacity (veh/h)	952	-	-	1489	-
HCM Lane V/C Ratio	0.143	-	-	0.04	-
HCM Control Delay (s)	9.4	-	-	7.5	-
HCM Lane LOS	A	-	-	A	-
HCM 95th %tile Q(veh)	0.5	-	-	0.1	-

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	680	700	5	120	860	540	5	105	15	435	140	465
Number	7	4	14	3	8	18	5	2	12	1	6	16
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1863	1863	1900	1863	1863	1863	1863	1863	1900	1863	1863	1863
Adj Flow Rate, veh/h	739	761	5	130	935	587	5	114	3	473	152	318
Adj No. of Lanes	2	3	0	2	3	2	1	2	0	2	2	2
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Percent Heavy Veh, %	2	2	2	2	2	2	2	2	2	2	2	2
Cap, veh/h	855	2379	16	206	1362	1196	9	335	9	556	890	1390
Arrive On Green	0.25	0.46	0.46	0.06	0.27	0.27	0.01	0.10	0.10	0.16	0.25	0.25
Sat Flow, veh/h	3442	5213	34	3442	5085	2787	1774	3524	92	3442	3539	2773
Grp Volume(v), veh/h	739	495	271	130	935	587	5	57	60	473	152	318
Grp Sat Flow(s),veh/h/ln	1721	1695	1857	1721	1695	1393	1774	1770	1846	1721	1770	1387
Q Serve(g_s), s	21.7	9.8	9.8	3.9	17.4	16.1	0.3	3.2	3.2	14.1	3.6	6.8
Cycle Q Clear(g_c), s	21.7	9.8	9.8	3.9	17.4	16.1	0.3	3.2	3.2	14.1	3.6	6.8
Prop In Lane	1.00		0.02	1.00		1.00	1.00		0.05	1.00		1.00
Lane Grp Cap(c), veh/h	855	1548	848	206	1362	1196	9	168	176	556	890	1390
V/C Ratio(X)	0.86	0.32	0.32	0.63	0.69	0.49	0.55	0.34	0.34	0.85	0.17	0.23
Avail Cap(c_a), veh/h	1237	1548	848	1237	1828	1452	201	636	664	716	1607	1952
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	38.0	18.3	18.3	48.6	34.7	21.8	52.5	44.7	44.7	43.1	30.9	14.9
Incr Delay (d2), s/veh	4.6	0.1	0.2	3.2	0.7	0.3	42.2	1.2	1.1	7.8	0.1	0.1
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	10.8	4.6	5.1	2.0	8.2	6.2	0.3	1.6	1.7	7.3	1.7	2.6
LnGrp Delay(d),s/veh	42.6	18.4	18.5	51.7	35.4	22.1	94.7	45.9	45.9	50.8	31.0	15.0
LnGrp LOS	D	B	B	D	D	C	F	D	D	D	C	B
Approach Vol, veh/h		1505			1652			122			943	
Approach Delay, s/veh		30.3			32.0			47.9			35.6	
Approach LOS		C			C			D			D	

Timer	1	2	3	4	5	6	7	8
Assigned Phs	1	2	3	4	5	6	7	8
Phs Duration (G+Y+Rc), s	23.1	16.1	12.3	54.3	6.5	32.6	32.3	34.3
Change Period (Y+Rc), s	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0
Max Green Setting (Gmax), s	22.0	38.0	38.0	38.0	12.0	48.0	38.0	38.0
Max Q Clear Time (g_c+I1), s	16.1	5.2	5.9	11.8	2.3	8.8	23.7	19.4
Green Ext Time (p_c), s	0.9	3.1	0.4	17.1	0.0	3.2	2.5	8.9

Intersection Summary	
HCM 2010 Ctrl Delay	32.6
HCM 2010 LOS	C

Notes

User approved changes to right turn type.

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	90	140	20	315	200	410	60	1130	475	275	580	75
Number	3	8	18	7	4	14	5	2	12	1	6	16
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1863	1863	1900	1863	1863	1863	1863	1863	1900	1863	1863	1900
Adj Flow Rate, veh/h	98	152	19	342	217	139	65	1228	462	299	630	69
Adj No. of Lanes	1	1	0	1	1	1	1	3	0	2	3	0
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Percent Heavy Veh, %	2	2	2	2	2	2	2	2	2	2	2	2
Cap, veh/h	347	590	74	422	677	576	84	1357	509	380	2028	220
Arrive On Green	0.36	0.36	0.36	0.36	0.36	0.36	0.05	0.37	0.37	0.11	0.44	0.44
Sat Flow, veh/h	1021	1624	203	1209	1863	1583	1774	3645	1367	3442	4658	505
Grp Volume(v), veh/h	98	0	171	342	217	139	65	1142	548	299	457	242
Grp Sat Flow(s),veh/h/ln	1021	0	1827	1209	1863	1583	1774	1695	1621	1721	1695	1774
Q Serve(g_s), s	9.0	0.0	7.7	32.4	9.8	7.2	4.2	37.4	37.5	9.9	10.3	10.5
Cycle Q Clear(g_c), s	18.8	0.0	7.7	40.1	9.8	7.2	4.2	37.4	37.5	9.9	10.3	10.5
Prop In Lane	1.00		0.11	1.00		1.00	1.00		0.84	1.00		0.28
Lane Grp Cap(c), veh/h	347	0	664	422	677	576	84	1262	604	380	1476	772
V/C Ratio(X)	0.28	0.00	0.26	0.81	0.32	0.24	0.77	0.90	0.91	0.79	0.31	0.31
Avail Cap(c_a), veh/h	351	0	670	426	684	581	257	1273	609	1028	1794	938
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	0.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	33.6	0.0	26.2	40.3	26.9	26.0	55.2	34.8	34.9	50.8	21.6	21.6
Incr Delay (d2), s/veh	0.4	0.0	0.2	11.2	0.3	0.2	13.8	9.3	17.4	3.6	0.1	0.2
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	2.6	0.0	3.9	12.1	5.1	3.2	2.4	19.1	19.7	4.9	4.8	5.2
LnGrp Delay(d),s/veh	34.1	0.0	26.4	51.5	27.1	26.2	68.9	44.1	52.3	54.4	21.7	21.9
LnGrp LOS	C		C	D	C	C	E	D	D	D	C	C
Approach Vol, veh/h		269			698			1755			998	
Approach Delay, s/veh		29.2			38.9			47.6			31.5	
Approach LOS		C			D			D			C	

Timer	1	2	3	4	5	6	7	8
Assigned Phs	1	2		4	5	6		8
Phs Duration (G+Y+Rc), s	18.9	49.6		48.6	11.6	57.0		48.6
Change Period (Y+Rc), s	6.0	6.0		6.0	6.0	6.0		6.0
Max Green Setting (Gmax), s	35.0	44.0		43.0	17.0	62.0		43.0
Max Q Clear Time (g_c+I1), s	11.9	39.5		42.1	6.2	12.5		20.8
Green Ext Time (p_c), s	1.0	4.1		0.5	0.1	30.4		4.9

Intersection Summary	
HCM 2010 Ctrl Delay	40.3
HCM 2010 LOS	D

Intersection	
Int Delay, s/veh	8.5

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Vol, veh/h	5	5	160	5	10	230
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	-	-	0	-
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	5	5	174	5	11	250

Major/Minor	Major1		Major2		Minor1	
Conflicting Flow All	0	0	11	0	361	8
Stage 1	-	-	-	-	8	-
Stage 2	-	-	-	-	353	-
Critical Hdwy	-	-	4.12	-	6.42	6.22
Critical Hdwy Stg 1	-	-	-	-	5.42	-
Critical Hdwy Stg 2	-	-	-	-	5.42	-
Follow-up Hdwy	-	-	2.218	-	3.518	3.318
Pot Cap-1 Maneuver	-	-	1608	-	638	1074
Stage 1	-	-	-	-	1015	-
Stage 2	-	-	-	-	711	-
Platoon blocked, %	-	-		-		
Mov Cap-1 Maneuver	-	-	1608	-	568	1074
Mov Cap-2 Maneuver	-	-	-	-	568	-
Stage 1	-	-	-	-	1015	-
Stage 2	-	-	-	-	634	-

Approach	EB	WB	NB
HCM Control Delay, s	0	7.3	9.6
HCM LOS			A

Minor Lane/Major Mvmt	NBLn1	EBT	EBR	WBL	WBT
Capacity (veh/h)	1036	-	-	1608	-
HCM Lane V/C Ratio	0.252	-	-	0.108	-
HCM Control Delay (s)	9.6	-	-	7.5	0
HCM Lane LOS	A	-	-	A	A
HCM 95th %tile Q(veh)	1	-	-	0.4	-

Intersection	
Int Delay, s/veh	6.4

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Vol, veh/h	205	725	0	0	445	20	0	0	0	20	0	145
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Free	Free	Stop	Stop	Stop	Stop	Stop	Stop
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	-	-	-	-	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	92	92	92	92	92	92	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2	2	2	2	2	2	2
Mvmt Flow	223	788	0	0	484	22	0	0	0	22	0	158

Major/Minor	Major1			Major2			Minor1			Minor2		
Conflicting Flow All	505	0	0	788	0	0	1807	1739	788	1729	1729	495
Stage 1	-	-	-	-	-	-	1234	1234	-	495	495	-
Stage 2	-	-	-	-	-	-	573	505	-	1234	1234	-
Critical Hdwy	4.12	-	-	4.12	-	-	7.12	6.52	6.22	7.12	6.52	6.22
Critical Hdwy Stg 1	-	-	-	-	-	-	6.12	5.52	-	6.12	5.52	-
Critical Hdwy Stg 2	-	-	-	-	-	-	6.12	5.52	-	6.12	5.52	-
Follow-up Hdwy	2.218	-	-	2.218	-	-	3.518	4.018	3.318	3.518	4.018	3.318
Pot Cap-1 Maneuver	1060	-	-	831	-	-	61	87	391	69	88	575
Stage 1	-	-	-	-	-	-	216	249	-	556	546	-
Stage 2	-	-	-	-	-	-	505	540	-	216	249	-
Platoon blocked, %		-	-		-	-						
Mov Cap-1 Maneuver	1060	-	-	831	-	-	31	54	391	49	55	575
Mov Cap-2 Maneuver	-	-	-	-	-	-	31	54	-	49	55	-
Stage 1	-	-	-	-	-	-	135	156	-	348	546	-
Stage 2	-	-	-	-	-	-	367	540	-	135	156	-

Approach	EB	WB	NB	SB
HCM Control Delay, s	2	0	0	49
HCM LOS			A	E

Minor Lane/Major Mvmt	NBLn1	EBL	EBT	EBR	WBL	WBT	WBR	SBLn1
Capacity (veh/h)	-	1060	-	-	831	-	-	250
HCM Lane V/C Ratio	-	0.21	-	-	-	-	-	0.717
HCM Control Delay (s)	0	9.3	0	-	0	-	-	49
HCM Lane LOS	A	A	A	-	A	-	-	E
HCM 95th %tile Q(veh)	-	0.8	-	-	0	-	-	4.9

Intersection	
Int Delay, s/veh	0.7

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Vol, veh/h	790	15	15	465	10	25
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	50	-	0	-
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	859	16	16	505	11	27

Major/Minor	Major1		Major2		Minor1	
Conflicting Flow All	0	0	875	0	1405	867
Stage 1	-	-	-	-	867	-
Stage 2	-	-	-	-	538	-
Critical Hdwy	-	-	4.12	-	6.42	6.22
Critical Hdwy Stg 1	-	-	-	-	5.42	-
Critical Hdwy Stg 2	-	-	-	-	5.42	-
Follow-up Hdwy	-	-	2.218	-	3.518	3.318
Pot Cap-1 Maneuver	-	-	771	-	154	352
Stage 1	-	-	-	-	411	-
Stage 2	-	-	-	-	585	-
Platoon blocked, %	-	-		-		
Mov Cap-1 Maneuver	-	-	771	-	151	352
Mov Cap-2 Maneuver	-	-	-	-	151	-
Stage 1	-	-	-	-	411	-
Stage 2	-	-	-	-	573	-

Approach	EB	WB	NB
HCM Control Delay, s	0	0.3	21.6
HCM LOS			C

Minor Lane/Major Mvmt	NBLn1	EBT	EBR	WBL	WBT
Capacity (veh/h)	255	-	-	771	-
HCM Lane V/C Ratio	0.149	-	-	0.021	-
HCM Control Delay (s)	21.6	-	-	9.8	-
HCM Lane LOS	C	-	-	A	-
HCM 95th %tile Q(veh)	0.5	-	-	0.1	-

Intersection	
Int Delay, s/veh	0.1

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Vol, veh/h	5	785	0	0	475	5	0	0	0	0	0	0
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Free	Free	Stop	Stop	Stop	Stop	Stop	Stop
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	-	-	-	-	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	92	92	92	92	92	92	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2	2	2	2	2	2	2
Mvmt Flow	5	853	0	0	516	5	0	0	0	0	0	0

Major/Minor	Major1			Major2			Minor1			Minor2		
Conflicting Flow All	522	0	0	853	0	0	1383	1386	853	1383	1383	519
Stage 1	-	-	-	-	-	-	864	864	-	519	519	-
Stage 2	-	-	-	-	-	-	519	522	-	864	864	-
Critical Hdwy	4.12	-	-	4.12	-	-	7.12	6.52	6.22	7.12	6.52	6.22
Critical Hdwy Stg 1	-	-	-	-	-	-	6.12	5.52	-	6.12	5.52	-
Critical Hdwy Stg 2	-	-	-	-	-	-	6.12	5.52	-	6.12	5.52	-
Follow-up Hdwy	2.218	-	-	2.218	-	-	3.518	4.018	3.318	3.518	4.018	3.318
Pot Cap-1 Maneuver	1044	-	-	786	-	-	121	143	359	121	144	557
Stage 1	-	-	-	-	-	-	349	371	-	540	533	-
Stage 2	-	-	-	-	-	-	540	531	-	349	371	-
Platoon blocked, %		-	-		-	-						
Mov Cap-1 Maneuver	1044	-	-	786	-	-	120	142	359	120	143	557
Mov Cap-2 Maneuver	-	-	-	-	-	-	120	142	-	120	143	-
Stage 1	-	-	-	-	-	-	346	368	-	535	533	-
Stage 2	-	-	-	-	-	-	540	531	-	346	368	-

Approach	EB	WB	NB	SB
HCM Control Delay, s	0.1	0	0	0
HCM LOS			A	A

Minor Lane/Major Mvmt	NBLn1	EBL	EBT	EBR	WBL	WBT	WBR	SBLn1
Capacity (veh/h)	-	1044	-	-	786	-	-	-
HCM Lane V/C Ratio	-	0.005	-	-	-	-	-	-
HCM Control Delay (s)	0	8.5	0	-	0	-	-	0
HCM Lane LOS	A	A	A	-	A	-	-	A
HCM 95th %tile Q(veh)	-	0	-	-	0	-	-	-

Intersection	
Int Delay, s/veh	1.5

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Vol, veh/h	5	810	470	20	45	10
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	100	-	-	-	0	-
Veh in Median Storage, #	-	0	0	-	0	-
Grade, %	-	0	0	-	0	-
Peak Hour Factor	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	5	880	511	22	49	11

Major/Minor	Major1		Major2		Minor2	
Conflicting Flow All	533	0	-	0	1413	522
Stage 1	-	-	-	-	522	-
Stage 2	-	-	-	-	891	-
Critical Hdwy	4.12	-	-	-	6.42	6.22
Critical Hdwy Stg 1	-	-	-	-	5.42	-
Critical Hdwy Stg 2	-	-	-	-	5.42	-
Follow-up Hdwy	2.218	-	-	-	3.518	3.318
Pot Cap-1 Maneuver	1035	-	-	-	152	555
Stage 1	-	-	-	-	595	-
Stage 2	-	-	-	-	401	-
Platoon blocked, %		-	-	-		
Mov Cap-1 Maneuver	1035	-	-	-	151	555
Mov Cap-2 Maneuver	-	-	-	-	151	-
Stage 1	-	-	-	-	595	-
Stage 2	-	-	-	-	399	-

Approach	EB	WB	SB
HCM Control Delay, s	0.1	0	36.1
HCM LOS			E

Minor Lane/Major Mvmt	EBL	EBT	WBT	WBR	SBLn1
Capacity (veh/h)	1035	-	-	-	174
HCM Lane V/C Ratio	0.005	-	-	-	0.344
HCM Control Delay (s)	8.5	-	-	-	36.1
HCM Lane LOS	A	-	-	-	E
HCM 95th %tile Q(veh)	0	-	-	-	1.4

Intersection	
Int Delay, s/veh	5.5

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Vol, veh/h	15	820	0	0	460	45	0	0	0	70	0	20
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Free	Free	Stop	Stop	Stop	Stop	Stop	Stop
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	100	-	-	-	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	92	92	92	92	92	92	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2	2	2	2	2	2	2
Mvmt Flow	16	891	0	0	500	49	0	0	0	76	0	22

Major/Minor	Major1			Major2			Minor1			Minor2		
Conflicting Flow All	549	0	0	891	0	0	1459	1473	891	1448	1448	524
Stage 1	-	-	-	-	-	-	924	924	-	524	524	-
Stage 2	-	-	-	-	-	-	535	549	-	924	924	-
Critical Hdwy	4.12	-	-	4.12	-	-	7.12	6.52	6.22	7.12	6.52	6.22
Critical Hdwy Stg 1	-	-	-	-	-	-	6.12	5.52	-	6.12	5.52	-
Critical Hdwy Stg 2	-	-	-	-	-	-	6.12	5.52	-	6.12	5.52	-
Follow-up Hdwy	2.218	-	-	2.218	-	-	3.518	4.018	3.318	3.518	4.018	3.318
Pot Cap-1 Maneuver	1021	-	-	761	-	-	107	127	341	109	131	553
Stage 1	-	-	-	-	-	-	323	348	-	537	530	-
Stage 2	-	-	-	-	-	-	529	516	-	323	348	-
Platoon blocked, %		-	-		-	-						
Mov Cap-1 Maneuver	1021	-	-	761	-	-	102	125	341	108	129	553
Mov Cap-2 Maneuver	-	-	-	-	-	-	102	125	-	108	129	-
Stage 1	-	-	-	-	-	-	318	343	-	529	530	-
Stage 2	-	-	-	-	-	-	508	516	-	318	343	-

Approach	EB	WB	NB	SB
HCM Control Delay, s	0.2	0	0	85.8
HCM LOS			A	F

Minor Lane/Major Mvmt	NBLn1	EBL	EBT	EBR	WBL	WBT	WBR	SBLn1
Capacity (veh/h)	-	1021	-	-	761	-	-	132
HCM Lane V/C Ratio	-	0.016	-	-	-	-	-	0.741
HCM Control Delay (s)	0	8.6	-	-	0	-	-	85.8
HCM Lane LOS	A	A	-	-	A	-	-	F
HCM 95th %tile Q(veh)	-	0	-	-	0	-	-	4.3

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	10	170	215	100	380	290	505	1265	245	175	805	60
Number	7	4	14	3	8	18	5	2	12	1	6	16
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1863	1863	1863	1863	1863	1863	1863	1863	1863	1863	1863	1863
Adj Flow Rate, veh/h	11	185	30	109	413	80	549	1375	159	190	875	17
Adj No. of Lanes	1	1	1	1	1	1	2	2	1	1	2	1
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Percent Heavy Veh, %	2	2	2	2	2	2	2	2	2	2	2	2
Cap, veh/h	18	351	298	134	473	402	646	1451	649	218	1222	547
Arrive On Green	0.01	0.19	0.19	0.08	0.25	0.25	0.19	0.41	0.41	0.12	0.35	0.35
Sat Flow, veh/h	1774	1863	1583	1774	1863	1583	3442	3539	1583	1774	3539	1583
Grp Volume(v), veh/h	11	185	30	109	413	80	549	1375	159	190	875	17
Grp Sat Flow(s),veh/h/ln	1774	1863	1583	1774	1863	1583	1721	1770	1583	1774	1770	1583
Q Serve(g_s), s	0.7	10.6	1.9	7.2	25.1	4.7	18.2	44.4	7.8	12.4	25.4	0.8
Cycle Q Clear(g_c), s	0.7	10.6	1.9	7.2	25.1	4.7	18.2	44.4	7.8	12.4	25.4	0.8
Prop In Lane	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Lane Grp Cap(c), veh/h	18	351	298	134	473	402	646	1451	649	218	1222	547
V/C Ratio(X)	0.60	0.53	0.10	0.81	0.87	0.20	0.85	0.95	0.24	0.87	0.72	0.03
Avail Cap(c_a), veh/h	180	582	495	180	582	495	1163	1495	669	255	1222	547
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	58.3	43.3	39.7	53.9	42.3	34.7	46.4	33.7	22.9	51.0	33.7	25.6
Incr Delay (d2), s/veh	28.2	1.2	0.1	18.1	11.8	0.2	3.2	12.7	0.2	23.8	2.0	0.0
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	0.5	5.6	0.8	4.2	14.5	2.1	9.0	24.1	3.4	7.6	12.7	0.4
LnGrp Delay(d),s/veh	86.5	44.5	39.9	72.0	54.1	34.9	49.7	46.4	23.1	74.8	35.7	25.7
LnGrp LOS	F	D	D	E	D	C	D	D	C	E	D	C
Approach Vol, veh/h		226			602			2083			1082	
Approach Delay, s/veh		45.9			54.8			45.5			42.4	
Approach LOS		D			D			D			D	

Timer	1	2	3	4	5	6	7	8
Assigned Phs	1	2	3	4	5	6	7	8
Phs Duration (G+Y+Rc), s	20.5	54.5	15.0	28.3	28.2	46.9	7.2	36.1
Change Period (Y+Rc), s	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0
Max Green Setting (Gmax), s	17.0	50.0	12.0	37.0	40.0	27.0	12.0	37.0
Max Q Clear Time (g_c+I1), s	14.4	46.4	9.2	12.6	20.2	27.4	2.7	27.1
Green Ext Time (p_c), s	0.1	2.2	0.1	4.2	2.0	0.0	0.0	2.9

Intersection Summary			
HCM 2010 Ctrl Delay			46.1
HCM 2010 LOS			D

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	355	170	235	60	260	315	245	1460	10	220	1210	170
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	6.0	4.0	4.0	6.0
Lane Util. Factor	0.91	0.91	1.00	1.00	1.00	0.88	0.97	0.91	1.00	0.97	0.91	1.00
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	0.98	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	1610	3306	1583	1770	1863	2787	3433	5085	1583	3433	5085	1583
Flt Permitted	0.95	0.98	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)	1610	3306	1583	1770	1863	2787	3433	5085	1583	3433	5085	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)	386	185	255	65	283	342	266	1587	11	239	1315	185
RTOR Reduction (vph)	0	0	61	0	0	202	0	0	6	0	0	75
Lane Group Flow (vph)	193	378	194	65	283	140	266	1587	5	239	1315	110
Turn Type	Split	NA	Perm	Split	NA	Perm	Prot	NA	Perm	Prot	NA	Perm
Protected Phases	3	3		4	4		5	2		1	6	
Permitted Phases			3			4			2			6
Actuated Green, G (s)	36.1	36.1	36.1	41.4	41.4	41.4	23.1	116.6	116.6	20.9	114.4	114.4
Effective Green, g (s)	38.1	38.1	38.1	43.4	43.4	43.4	25.1	119.6	117.6	22.9	117.4	115.4
Actuated g/C Ratio	0.16	0.16	0.16	0.18	0.18	0.18	0.10	0.50	0.49	0.10	0.49	0.48
Clearance Time (s)	6.0	6.0	6.0	6.0	6.0	6.0	6.0	7.0	7.0	6.0	7.0	7.0
Vehicle Extension (s)	5.0	5.0	5.0	5.0	5.0	5.0	3.0	5.0	5.0	3.0	5.0	5.0
Lane Grp Cap (vph)	255	524	251	320	336	503	359	2534	775	327	2487	761
v/s Ratio Prot	0.12	0.11		0.04	c0.15		c0.08	c0.31		0.07	0.26	
v/s Ratio Perm			c0.12			0.05			0.00			0.07
v/c Ratio	0.76	0.72	0.77	0.20	0.84	0.28	0.74	0.63	0.01	0.73	0.53	0.14
Uniform Delay, d1	96.5	95.9	96.8	83.6	95.0	84.8	104.3	43.9	31.3	105.6	42.2	34.8
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.85	1.53	3.84
Incremental Delay, d2	14.2	5.9	15.7	0.7	18.7	0.6	8.0	1.2	0.0	7.7	0.8	0.4
Delay (s)	110.7	101.9	112.5	84.3	113.7	85.4	112.3	45.1	31.3	98.0	65.2	133.7
Level of Service	F	F	F	F	F	F	F	D	C	F	E	F
Approach Delay (s)		107.2			96.9			54.6			77.0	
Approach LOS		F			F			D			E	

Intersection Summary			
HCM 2000 Control Delay	76.4	HCM 2000 Level of Service	E
HCM 2000 Volume to Capacity ratio	0.71		
Actuated Cycle Length (s)	240.0	Sum of lost time (s)	16.0
Intersection Capacity Utilization	71.5%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	470	5	125	10	15	15	330	2675	20	80	1570	440
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		6.0	4.0	6.0	5.0	6.0	4.0	5.0	7.0
Lane Util. Factor	0.95	0.95	1.00		1.00	1.00	1.00	0.91	1.00	1.00	0.91	1.00
Frpb, ped/bikes	1.00	1.00	0.91		1.00	1.00	1.00	1.00	0.83	1.00	1.00	0.97
Flpb, ped/bikes	1.00	1.00	1.00		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Frt	1.00	1.00	0.85		1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	0.95	1.00		0.98	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	1681	1687	1434		1826	1583	1770	5085	1311	1770	5085	1536
Flt Permitted	0.95	0.95	1.00		0.98	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)	1681	1687	1434		1826	1583	1770	5085	1311	1770	5085	1536
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	511	5	136	11	16	16	359	2908	22	87	1707	478
RTOR Reduction (vph)	0	0	81	0	0	15	0	0	8	0	0	256
Lane Group Flow (vph)	255	261	55	0	27	1	359	2908	14	87	1707	222
Confl. Peds. (#/hr)			43						31			2
Turn Type	Split	NA	Perm	Split	NA	Perm	Prot	NA	Perm	Prot	NA	Perm
Protected Phases	4	4		3	3		5	2		1	6	
Permitted Phases			4			3			2			6
Actuated Green, G (s)	45.2	45.2	45.2		7.8	7.8	51.4	148.3	148.3	14.7	111.6	111.6
Effective Green, g (s)	45.2	45.2	45.2		7.8	9.8	51.4	150.3	149.3	16.7	113.6	111.6
Actuated g/C Ratio	0.19	0.19	0.19		0.03	0.04	0.21	0.63	0.62	0.07	0.47	0.46
Clearance Time (s)	5.0	5.0	5.0		6.0	6.0	6.0	7.0	7.0	6.0	7.0	7.0
Vehicle Extension (s)	4.0	4.0	4.0		3.0	3.0	5.0	6.0	6.0	3.0	6.0	6.0
Lane Grp Cap (vph)	316	317	270		59	64	379	3184	815	123	2406	714
v/s Ratio Prot	0.15	c0.15			c0.01		c0.20	c0.57		0.05	0.34	
v/s Ratio Perm			0.04			0.00			0.01			0.14
v/c Ratio	0.81	0.82	0.20		0.46	0.01	0.95	0.91	0.02	0.71	0.71	0.31
Uniform Delay, d1	93.2	93.6	82.2		114.0	110.4	93.0	39.2	17.3	109.3	50.1	40.2
Progression Factor	1.00	1.00	1.00		1.00	1.00	1.30	0.63	1.00	1.05	0.98	1.68
Incremental Delay, d2	14.7	16.4	0.5		5.5	0.1	18.6	2.3	0.0	16.5	1.8	1.1
Delay (s)	107.9	110.0	82.7		119.6	110.5	139.8	27.0	17.3	131.7	51.1	68.7
Level of Service	F	F	F		F	F	F	C	B	F	D	E
Approach Delay (s)		103.5			116.2			39.3			57.9	
Approach LOS		F			F			D			E	

Intersection Summary			
HCM 2000 Control Delay	53.3	HCM 2000 Level of Service	D
HCM 2000 Volume to Capacity ratio	0.90		
Actuated Cycle Length (s)	240.0	Sum of lost time (s)	22.0
Intersection Capacity Utilization	96.0%	ICU Level of Service	F
Analysis Period (min)	15		

c Critical Lane Group

Intersection	
Int Delay, s/veh	1.9

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Vol, veh/h	5	885	505	25	50	5
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	100	-	-	-	0	-
Veh in Median Storage, #	-	0	0	-	0	-
Grade, %	-	0	0	-	0	-
Peak Hour Factor	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	5	962	549	27	54	5

Major/Minor	Major1		Major2		Minor2	
Conflicting Flow All	576	0	-	0	1536	563
Stage 1	-	-	-	-	563	-
Stage 2	-	-	-	-	973	-
Critical Hdwy	4.12	-	-	-	6.42	6.22
Critical Hdwy Stg 1	-	-	-	-	5.42	-
Critical Hdwy Stg 2	-	-	-	-	5.42	-
Follow-up Hdwy	2.218	-	-	-	3.518	3.318
Pot Cap-1 Maneuver	997	-	-	-	128	526
Stage 1	-	-	-	-	570	-
Stage 2	-	-	-	-	366	-
Platoon blocked, %		-	-	-		
Mov Cap-1 Maneuver	997	-	-	-	127	526
Mov Cap-2 Maneuver	-	-	-	-	127	-
Stage 1	-	-	-	-	570	-
Stage 2	-	-	-	-	364	-

Approach	EB	WB	SB
HCM Control Delay, s	0	0	50.8
HCM LOS			F

Minor Lane/Major Mvmt	EBL	EBT	WBT	WBR	SBLn1
Capacity (veh/h)	997	-	-	-	136
HCM Lane V/C Ratio	0.005	-	-	-	0.44
HCM Control Delay (s)	8.6	-	-	-	50.8
HCM Lane LOS	A	-	-	-	F
HCM 95th %tile Q(veh)	0	-	-	-	2

Intersection	
Int Delay, s/veh	1.1

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Vol, veh/h	10	735	455	20	35	15
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	100	-	-	-	0	-
Veh in Median Storage, #	-	0	0	-	0	-
Grade, %	-	0	0	-	0	-
Peak Hour Factor	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	11	799	495	22	38	16

Major/Minor	Major1		Major2		Minor2	
Conflicting Flow All	516	0	-	0	1326	505
Stage 1	-	-	-	-	505	-
Stage 2	-	-	-	-	821	-
Critical Hdwy	4.12	-	-	-	6.42	6.22
Critical Hdwy Stg 1	-	-	-	-	5.42	-
Critical Hdwy Stg 2	-	-	-	-	5.42	-
Follow-up Hdwy	2.218	-	-	-	3.518	3.318
Pot Cap-1 Maneuver	1050	-	-	-	172	567
Stage 1	-	-	-	-	606	-
Stage 2	-	-	-	-	432	-
Platoon blocked, %		-	-	-		
Mov Cap-1 Maneuver	1050	-	-	-	170	567
Mov Cap-2 Maneuver	-	-	-	-	170	-
Stage 1	-	-	-	-	606	-
Stage 2	-	-	-	-	427	-

Approach	EB	WB	SB
HCM Control Delay, s	0.1	0	27.3
HCM LOS			D

Minor Lane/Major Mvmt	EBL	EBT	WBT	WBR	SBLn1
Capacity (veh/h)	1050	-	-	-	215
HCM Lane V/C Ratio	0.01	-	-	-	0.253
HCM Control Delay (s)	8.5	-	-	-	27.3
HCM Lane LOS	A	-	-	-	D
HCM 95th %tile Q(veh)	0	-	-	-	1

Intersection	
Int Delay, s/veh	3.8

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Vol, veh/h	230	0	140	165	0	135
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	100	-	0	-
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	250	0	152	179	0	147

Major/Minor	Major1		Major2		Minor1	
Conflicting Flow All	0	0	250	0	734	250
Stage 1	-	-	-	-	250	-
Stage 2	-	-	-	-	484	-
Critical Hdwy	-	-	4.12	-	6.42	6.22
Critical Hdwy Stg 1	-	-	-	-	5.42	-
Critical Hdwy Stg 2	-	-	-	-	5.42	-
Follow-up Hdwy	-	-	2.218	-	3.518	3.318
Pot Cap-1 Maneuver	-	-	1316	-	387	789
Stage 1	-	-	-	-	792	-
Stage 2	-	-	-	-	620	-
Platoon blocked, %	-	-		-		
Mov Cap-1 Maneuver	-	-	1316	-	342	789
Mov Cap-2 Maneuver	-	-	-	-	342	-
Stage 1	-	-	-	-	792	-
Stage 2	-	-	-	-	548	-

Approach	EB	WB	NB
HCM Control Delay, s	0	3.7	10.6
HCM LOS			B

Minor Lane/Major Mvmt	NBLn1	EBT	EBR	WBL	WBT
Capacity (veh/h)	789	-	-	1316	-
HCM Lane V/C Ratio	0.186	-	-	0.116	-
HCM Control Delay (s)	10.6	-	-	8.1	-
HCM Lane LOS	B	-	-	A	-
HCM 95th %tile Q(veh)	0.7	-	-	0.4	-

APPENDIX E

A Technical Memorandum for Honouliuli WWTP Facilities Plan

TECHNICAL MEMORANDUM

Estimates of Parameters for Use in Traffic Impact Analysis Report

Background

A Facilities Plan for the Honouliuli Wastewater Treatment Plant (WWTP) is being developed. As part of the Facilities Plan development, an environmental impact statement (EIS) is being prepared. One component of the EIS is a traffic impact analysis report (TIAR).

The TIAR require certain data inputs including the level and timing of projected activities for the site.

This technical memorandum provides the following data items for use by the TIAR:

- Number of WWTP employees for the existing and potential ultimate operational scenarios;
- Estimated years of peak construction and ultimate operation;
- Estimated construction activity for peak year of construction during the AM and PM peak hour traffic time periods. The construction activity information provided includes truck trips and construction worker count.

The sources of information used to provide these data items come from the Honouliuli WWTP Facilities Plan. Data sources referenced in this technical memorandum are:

- Evaluation of Services Technical Memorandum – Item 12.1- August 2012
- Honouliuli WWTP Site Layout Phase 1 Plan
- Figure 5-3: Anticipated Schedule for Two Construction Packages
- Biosolids Processing and Phase 2 Capacity expansion are additional separate packages that will also be executed during the planning period.
- Construction man-hour estimate from Task 12.N cost estimate

Number of Honouliuli WWTP Employees

Existing WWTP Employees

Table 3-1. Honouliuli WWP Current Staffing Levels from the Evaluation of Services Technical Memorandum – Item 12.1 – August 2012 documents the current staffing level at the Honouliuli WWTP at 39 full time equivalent (FTE) positions.

Potential Future WWTP Employees

There are several potential future scenarios of future employment at the Honouliuli WWTP. For the purposes of the EIS, the potential future scenario which involves relocation major components of the City and County of Honolulu wastewater staff to Honouliuli will be used. Based on Table 4-1 Functional Areas Estimated Staffing and Estimated Footprint the projected future WWTP employees are estimated at 320 FTE positions.

Table 1 summarizes the existing and projected future employment at the Honouliuli WWTP.

Table 1

Number of Honouliuli WWTP Employees

Scenario	Number of Employees (FTE)
Existing	39
Projected Ultimate	320
Notes: FTE = full-time equivalents	

Benchmark Years

The benchmark years that will be used for the TIAR are:

- Peak year of construction
- Year of operation

Peak Year of Construction

There are, potentially, four construction packages:

- Phase 1 – Package 1
- Phase 1 – Package 2
- Biosolids Processing
- Phase 2

Based on the Construction man-hour estimate from Task 12.N cost estimate, Phase 1-Package 1 will involve the largest man-hour effort of the four construction packages. Assuming that the peak year of construction would occur at the midpoint of the Package 1 construction, the man-hour estimate documents this as the year 2021.

Year of Operation

For the purposes of the EIS, the year of operation will be assumed to be the year when the non-process staff relocation to Honouliuli WWTP is complete. Based on the schedule indicated by the Construction man-hour estimate from Task 12.N cost estimate, Package 2, the non-process facilities, will be complete by 2027.

Assuming that Package 2 occurs according to this schedule and assuming it takes about 2 to 3 years to fully relocate and assimilate non-process staff to Honouliuli WWTP, a reasonable year of operation to be analyzed would be 2030.

Table 2 summarizes the Benchmark Years for use by the TIAR.

Table 2

Benchmark Years for TIAR

Scenario	Benchmark Year
Peak Year of Construction	2021
Year of Operation	2030
Notes: Based on Construction Man-Hour Estimate from Task 12-N Cost Estimate	

Intensity of Construction Activity

Two items related to construction activity are estimated:

- Construction worker count
- Number of truck trips

For the purposes of the TIAR, the time periods of interest are the AM and PM peak traffic hours of adjacent street traffic. These time periods are used because they represent the time periods when the greatest amounts of the surrounding community traffic are traveling. Therefore any traffic generated by the project, in this case the construction associated with the project, would impact the greatest amount of community traffic during these periods.

<u>Construction Worker Count</u>

The peak year of construction has been identified as the year 2021 assuming that mid-point of Phase 1 – Package 1 construction represents that maximum construction activity for the Honouliuli WWTP expansion. The estimated peak construction staffing for Package 1 is 185 construction workers. Typically, not all employees arrive and leave during the same hour. However to make the analysis conservative, all employees are assumed to arrive and leave within the same hours. The other three packages have much less earthwork and reinforced concrete construction so the peak conditions from Phase 1 – Package 1 will govern. All the other projects will have a lower construction worker count.

State of Hawaiʻi Department of Transportation (HDOT) traffic counts at Station B72007600297-Fort Weaver Road between Geiger Road and Kolowaka Road were reviewed to determine peaking characteristics of traffic in the ʻEwa area. This data was dated August 15, 2011. The bi-directional AM peak hour occurred from 6:30 AM to 7:30 AM with the makai-bound AM peak hour occurring from 6:45 AM to 7:45 AM. The makai-bound direction would be the direction impacted by construction workers driving to the Honouliuli WWTP site. Given that construction often begins very early in the day, it is likely that most construction workers inbound to Honouliuli WWTP would miss the AM peak hour associated with the commuter peak. However, to be conservative, the inbound construction workers are assumed to arrive during the AM peak hour.

The bi-directional PM peak commuter hour at the same count station occurred between 5:00 PM and 6:00 PM. Construction workers leaving the Honouliuli WWTP would leave much earlier than this peak hour. However, the mauka-bound directional peak hour occurred between 3:00 PM and 4:00 PM. Although the traffic volume involved in this directional peak hour is about half the amount of the directional peak during PM peak commuter hour, it is possible that the 3:00 PM to 4:00 PM peak could experience some impact from the departing construction workers. Therefore, for construction impacts, this 3:00 PM to 4:00 PM time period should be the PM peak hour analyzed. The later commuter peak is not likely to be affected by the construction traffic, and if the TIAR elects to evaluate the commuter PM peak hour, then the construction worker impact should be assumed to be zero.

Table 3 summarizes these estimates.

Number of Truck Trips

The number of truck trips generated during the AM and PM peak hours would vary greatly from day to day, depending on the type of construction activity occurring. The maximum truck trip activity would occur during either a concrete pour or during export of excess soil from the site. Although there is a large amount of construction in Package 1, concrete pours are likely to be divided into segments. It is estimated that a typical segment could handle 4 cement trucks per hour generating 8 truck trips per hour (4 in each direction). The other three packages have much less earthwork and reinforced concrete construction so the peak conditions from Phase 1 – Package 1 will govern. All the other projects will have a lower construction vehicle count than the values listed below. .

In either case, it would be very common for the contractor to avoid the peak hours or the specs could mandate that the contractor avoid the peak hours. Even in the unlikely scenario that concrete trucks or dump trucks do not avoid the peak hours, it is likely that these activities would probably generate only 4 truck trips each way (8 truck trips total) during the peak hour.

Table 3

Construction Activity

Item	AM Peak Hour (6:30 – 7:30 AM)	PM Peak Hour (3:00 – 4:00 PM)
Construction Worker Count	185[a]	185/0[a]
Truck Trips (two-way volume)*	8 vph	8 vph[b]

Notes: Based on Construction Man-Hour Estimate from Task 12-N Cost Estimate

*Truck trips are two-way trips. There are 4 vph into the site and 4 vph out of the site. vph=vehicles per hour.

[a] Construction workers would be inbound during the AM peak hour and outbound during the PM peak hour. This analysis assumes 1 vehicle trip per construction worker. Construction workers might overlap with the commuter AM peak hour, but would be in the opposite direction from the peak commuter direction. To be conservative, the construction worker arrivals are shown as occurring during the AM peak hour of adjacent street traffic. Construction workers leaving the site would miss the PM peak commuter hour. The could coincide with the directional PM peak hour in the mauka-bound direction which occurs between 3 PM and 4 PM. This peak is half the traffic volume of the commuter peak. If the TIAR evaluates this mid-afternoon peak, then the outbound construction workers would be 185. If the PM peak commuter hour is evaluated, the outbound construction workers would be 0.

[b] It is not likely that these truck trips would occur during the commuter peak hours, but if they did, this would be the estimated volumes.

APPENDICES

APPENDIX A

Traffic Count Data

Austin Tsutsumi & Associates

501 Sumner Street, Suite 521
Honolulu, HI 96817-5031
Phone: (808) 533-3646   Fax: (808) 526-1267

File Name : AM_Essex Rd - Geiger Rd
Site Code : 00000000
Start Date : 9/3/2014
Page No : 1

Groups Printed- Class 1

	From North				GEIGER RD From East				ESSEX RD From South				GEIGER RD From West				
Start Time	Rght	Thru	Left	Other	Rght	Thru	Left	Other	Rght	Thru	Left	Other	Rght	Thru	Left	Other	Int. Total
06:00 AM	0	0	0	0	0	67	1	0	0	0	0	0	1	37	0	0	106
06:15 AM	0	0	0	0	0	97	3	0	0	0	0	0	4	48	0	0	152
06:30 AM	0	0	0	0	0	120	5	0	2	0	0	0	6	62	0	0	195
06:45 AM	0	0	0	0	0	112	7	0	3	0	0	0	2	68	0	0	192
Total	0	0	0	0	0	396	16	0	5	0	0	0	13	215	0	0	645
07:00 AM	0	0	0	0	0	112	5	0	0	0	2	0	0	57	0	0	176
07:15 AM	0	0	0	0	0	155	6	0	2	0	1	0	2	74	0	0	240
07:30 AM	0	0	0	0	0	153	5	0	2	0	2	0	1	71	0	0	234
07:45 AM	0	0	0	0	0	136	7	0	0	0	0	0	2	63	0	0	208
Total	0	0	0	0	0	556	23	0	4	0	5	0	5	265	0	0	858
Grand Total	0	0	0	0	0	952	39	0	9	0	5	0	18	480	0	0	1503
Apprch %	0	0	0	0	0	96.1	3.9	0	64.3	0	35.7	0	3.6	96.4	0	0	
Total %	0	0	0	0	0	63.3	2.6	0	0.6	0	0.3	0	1.2	31.9	0	0	

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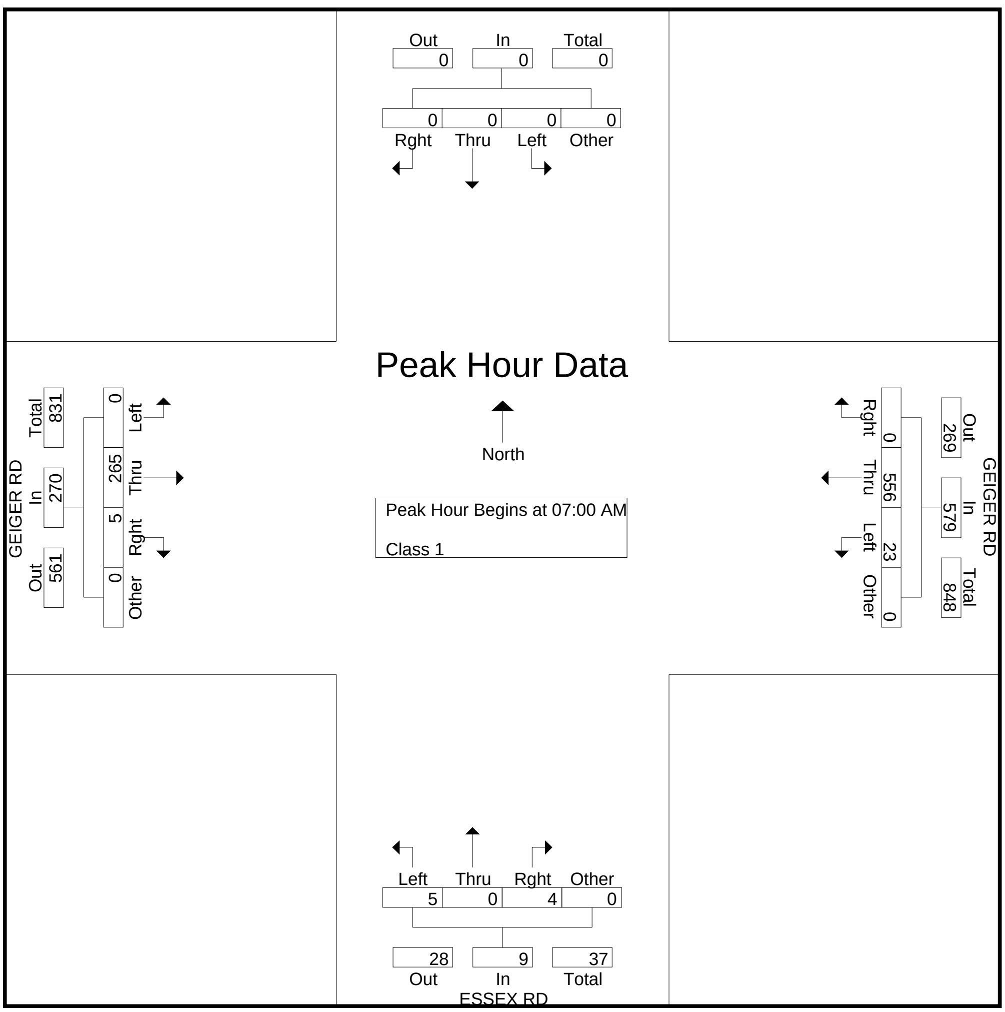
File Name : AM_Essex Rd - Geiger Rd
Site Code : 00000000
Start Date : 9/3/2014

	From North					GEIGER RD From East					ESSEX RD From South					GEIGER RD From West					
Start Time	Rght	Thru	Left	Other	App. Total	Rght	Thru	Left	Other	App. Total	Rght	Thru	Left	Other	App. Total	Rght	Thru	Left	Other	App. Total	Int. Total
Peak Hour Analysis From 07:00 AM to 07:45 AM - Peak 1 of 1																					
Peak Hour for Entire Intersection Begins at 07:00 AM																					
07:00 AM	0	0	0	0	0	0	112	5	0	117	0	0	2	0	2	0	57	0	0	57	176
07:15 AM	0	0	0	0	0	0	155	6	0	161	2	0	1	0	3	2	74	0	0	76	240
07:30 AM	0	0	0	0	0	0	153	5	0	158	2	0	2	0	4	1	71	0	0	72	234
07:45 AM	0	0	0	0	0	0	136	7	0	143	0	0	0	0	0	2	63	0	0	65	208
Total Volume	0	0	0	0	0	0	556	23	0	579	4	0	5	0	9	5	265	0	0	270	858
% App. Total	0	0	0	0		0	96	4	0		44.4	0	55.6	0		1.9	98.1	0	0		
PHF	.000	.000	.000	.000	.000	.000	.897	.821	.000	.899	.500	.000	.625	.000	.563	.625	.895	.000	.000	.888	.894



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Phone: (808) 533-3646   Fax: (808) 526-1267

File Name : AM_Ft Weaver Rd - Geiger Rd
Site Code : 00000000
Start Date : 9/3/2014
Page No : 1

Groups Printed- Unshifted

	FT WEAVER RD From North					GEIGER RD From East				FT WEAVER RD From South					GEIGER RD From West				
Start Time	Right	Thru	Left	U-Turns	Peds	Right	Thru	Left	Peds	Right	Thru	Left	U-Turns	Peds	Right	Thru	Left	Peds	Int. Total
06:00 AM	28	97	31	0	0	63	43	2	1	1	364	11	2	5	11	12	62	2	735
06:15 AM	28	153	51	0	0	77	31	3	0	3	275	25	2	4	12	16	49	2	731
06:30 AM	38	196	39	0	0	65	36	5	1	0	343	9	0	9	13	29	58	3	844
06:45 AM	29	217	36	0	0	87	37	5	3	1	356	20	0	8	30	17	56	2	904
Total	123	663	157	0	0	292	147	15	5	5	1338	65	4	26	66	74	225	9	3214
07:00 AM	27	223	55	0	0	64	46	13	2	1	336	24	1	8	41	24	69	8	942
07:15 AM	26	219	43	1	0	74	68	22	1	3	276	30	1	18	49	42	59	7	939
07:30 AM	38	250	27	0	0	57	55	10	2	0	348	32	0	9	48	39	76	7	998
07:45 AM	29	183	35	1	0	71	53	5	4	0	388	60	1	6	18	24	55	5	938
Total	120	875	160	2	0	266	222	50	9	4	1348	146	3	41	156	129	259	27	3817
Grand Total	243	1538	317	2	0	558	369	65	14	9	2686	211	7	67	222	203	484	36	7031
Apprch %	11.6	73.2	15.1	0.1	0	55.5	36.7	6.5	1.4	0.3	90.1	7.1	0.2	2.2	23.5	21.5	51.2	3.8	
Total %	3.5	21.9	4.5	0	0	7.9	5.2	0.9	0.2	0.1	38.2	3	0.1	1	3.2	2.9	6.9	0.5	

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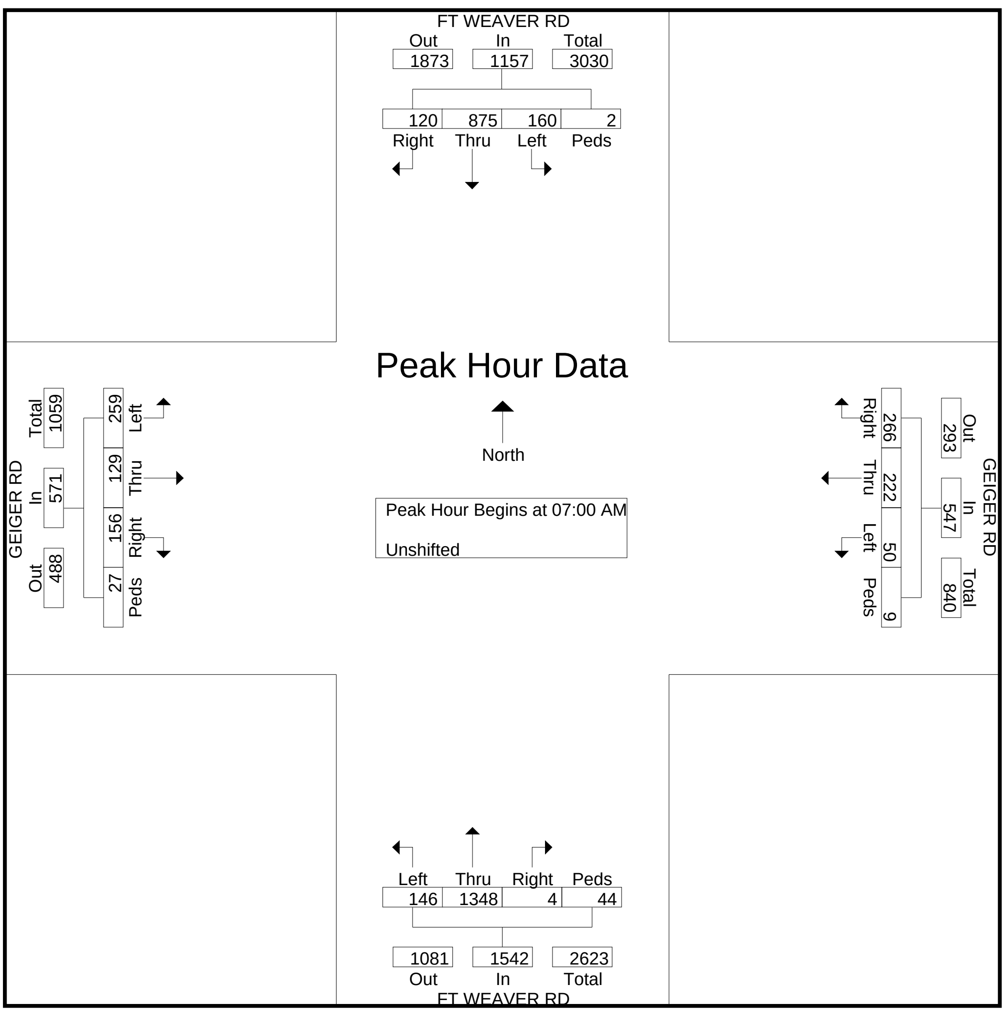
Site Code : 00000000
Start Date : 9/3/2014

	FT WEAVER RD From North						GEIGER RD From East					FT WEAVER RD From South						GEIGER RD From West					
Start Time	Right	Thru	Left	U-Turns	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	U-Turns	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Int. Total
Peak Hour Analysis From 07:00 AM to 07:45 AM - Peak 1 of 1																							
Peak Hour for Entire Intersection Begins at 07:00 AM																							
07:00 AM	27	223	55	0	0	305	64	46	13	2	125	1	336	24	1	8	370	41	24	69	8	142	942
07:15 AM	26	219	43	1	0	289	74	68	22	1	165	3	276	30	1	18	328	49	42	59	7	157	939
07:30 AM	38	250	27	0	0	315	57	55	10	2	124	0	348	32	0	9	389	48	39	76	7	170	998
07:45 AM	29	183	35	1	0	248	71	53	5	4	133	0	388	60	1	6	455	18	24	55	5	102	938
Total Volume	120	875	160	2	0	1157	266	222	50	9	547	4	1348	146	3	41	1542	156	129	259	27	571	3817
% App. Total	10.4	75.6	13.8	0.2	0		48.6	40.6	9.1	1.6		0.3	87.4	9.5	0.2	2.7		27.3	22.6	45.4	4.7		
PHF	.789	.875	.727	.500	.000	.918	.899	.816	.568	.563	.829	.333	.869	.608	.750	.569	.847	.796	.768	.852	.844	.840	.956



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File Name : AM_Ft Weaver Rd - Renton Rd
Site Code : 00000000
Start Date : 9/3/2014

Groups Printed- Unshifted

	FT WEAVER RD From North					RENTON RD From East				FT WEAVER RD From South					RENTON RD From West				
Start Time	Right	Thru	Left	U-Turns	Peds	Right	Thru	Left	Peds	Right	Thru	Left	U-Turns	Peds	Right	Thru	Left	Peds	Int. Total
06:00 AM	24	154	1	17	0	3	11	7	4	11	493	8	0	0	11	4	85	0	833
06:15 AM	46	271	0	14	0	4	4	6	19	3	820	12	0	1	7	1	94	0	1302
06:30 AM	53	313	0	18	0	2	1	0	7	4	795	21	0	0	8	4	105	0	1331
06:45 AM	65	293	2	16	0	0	1	4	10	5	758	27	0	0	14	2	107	0	1304
Total	188	1031	3	65	0	9	17	17	40	23	2866	68	0	1	40	11	391	0	4770
07:00 AM	68	280	0	12	0	2	3	2	8	5	713	45	0	0	18	1	106	0	1263
07:15 AM	71	394	0	15	0	1	4	0	12	5	699	40	0	0	18	0	84	0	1343
07:30 AM	49	239	3	16	0	3	3	2	11	3	563	54	0	0	37	3	105	0	1091
07:45 AM	47	263	2	19	0	4	2	0	9	2	675	58	1	0	37	1	96	0	1216
Total	235	1176	5	62	0	10	12	4	40	15	2650	197	1	0	110	5	391	0	4913
Grand Total	423	2207	8	127	0	19	29	21	80	38	5516	265	1	1	150	16	782	0	9683
Apprch %	15.3	79.8	0.3	4.6	0	12.8	19.5	14.1	53.7	0.7	94.8	4.6	0	0	15.8	1.7	82.5	0	
Total %	4.4	22.8	0.1	1.3	0	0.2	0.3	0.2	0.8	0.4	57	2.7	0	0	1.5	0.2	8.1	0	

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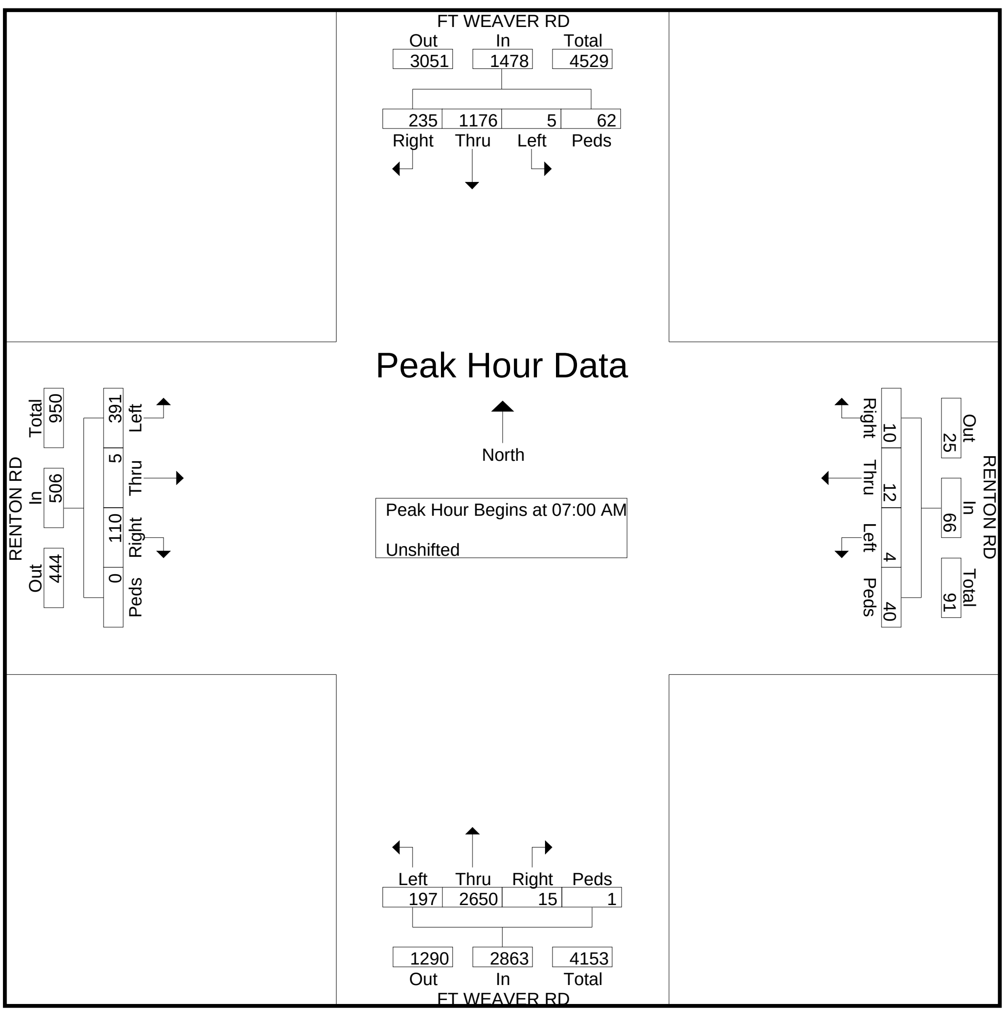
File Name : AM_Ft Weaver Rd - Renton Rd
Site Code : 00000000
Start Date : 9/3/2014
Page No : 2

	FT WEAVER RD From North						RENTON RD From East					FT WEAVER RD From South						RENTON RD From West					
Start Time	Right	Thru	Left	U-Turns	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	U-Turns	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Int. Total
Peak Hour Analysis From 07:00 AM to 07:45 AM - Peak 1 of 1																							
Peak Hour for Entire Intersection Begins at 07:00 AM																							
07:00 AM	68	280	0	12	0	360	2	3	2	8	15	5	713	45	0	0	763	18	1	106	0	125	1263
07:15 AM	71	394	0	15	0	480	1	4	0	12	17	5	699	40	0	0	744	18	0	84	0	102	1343
07:30 AM	49	239	3	16	0	307	3	3	2	11	19	3	563	54	0	0	620	37	3	105	0	145	1091
07:45 AM	47	263	2	19	0	331	4	2	0	9	15	2	675	58	1	0	736	37	1	96	0	134	1216
Total Volume	235	1176	5	62	0	1478	10	12	4	40	66	15	2650	197	1	0	2863	110	5	391	0	506	4913
% App. Total	15.9	79.6	0.3	4.2	0		15.2	18.2	6.1	60.6		0.5	92.6	6.9	0	0		21.7	1	77.3	0		
PHF	.827	.746	.417	.816	.000	.770	.625	.750	.500	.833	.868	.750	.929	.849	.250	.000	.938	.743	.417	.922	.000	.872	.915



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Phone: (808) 533-3646 Fax: (808) 526-1267

File Name : AM_Kapolei Pkwy - Geiger Rd
Site Code : 00000000
Start Date : 9/3/2014
Page No : 1

Groups Printed- Unshifted

	KAPOLEI PKWY From North				GEIGER RD From East				KAPOLEI PKWY From South				GEIGER RD From West				
Start Time	Right	Thru	Left	Peds	Right	Thru	Left	Peds	Right	Thru	Left	Peds	Right	Thru	Left	Peds	Int. Total
06:00 AM	5	29	14	0	21	47	9	1	18	101	54	1	17	19	1	0	337
06:15 AM	8	62	17	0	32	41	12	8	14	98	63	0	30	13	4	1	403
06:30 AM	7	58	28	2	27	61	11	3	16	97	78	0	40	19	3	0	450
06:45 AM	9	83	25	6	28	55	9	3	24	126	79	0	55	30	3	2	537
Total	29	232	84	8	108	204	41	15	72	422	274	1	142	81	11	3	1727
07:00 AM	10	119	29	1	38	46	20	13	20	130	70	0	46	22	3	4	571
07:15 AM	10	146	44	3	44	55	23	22	31	184	94	0	44	34	2	9	745
07:30 AM	4	138	36	2	53	61	28	8	47	230	90	0	46	33	3	0	779
07:45 AM	18	98	37	0	60	48	17	5	41	173	82	3	31	21	0	2	636
Total	42	501	146	6	195	210	88	48	139	717	336	3	167	110	8	15	2731
Grand Total	71	733	230	14	303	414	129	63	211	1139	610	4	309	191	19	18	4458
Apprch %	6.8	69.9	21.9	1.3	33.3	45.5	14.2	6.9	10.7	58	31.1	0.2	57.5	35.6	3.5	3.4	
Total %	1.6	16.4	5.2	0.3	6.8	9.3	2.9	1.4	4.7	25.5	13.7	0.1	6.9	4.3	0.4	0.4	

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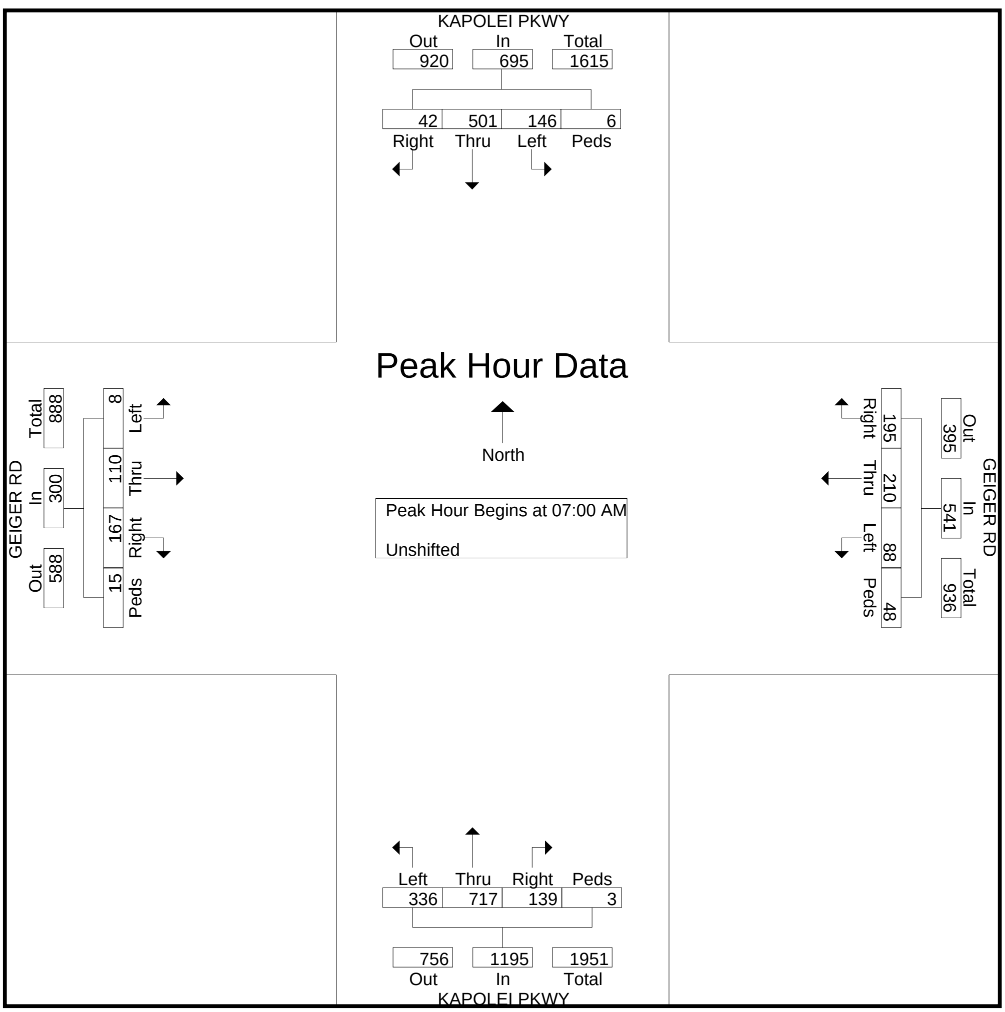
File Name : AM_Kapolei Pkwy - Geiger Rd
Site Code : 00000000
Start Date : 9/3/2014

	KAPOLEI PKWY From North					GEIGER RD From East					KAPOLEI PKWY From South					GEIGER RD From West					
Start Time	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Int. Total
Peak Hour Analysis From 07:00 AM to 07:45 AM - Peak 1 of 1																					
Peak Hour for Entire Intersection Begins at 07:00 AM																					
07:00 AM	10	119	29	1	159	38	46	20	13	117	20	130	70	0	220	46	22	3	4	75	571
07:15 AM	10	146	44	3	203	44	55	23	22	144	31	184	94	0	309	44	34	2	9	89	745
07:30 AM	4	138	36	2	180	53	61	28	8	150	47	230	90	0	367	46	33	3	0	82	779
07:45 AM	18	98	37	0	153	60	48	17	5	130	41	173	82	3	299	31	21	0	2	54	636
Total Volume	42	501	146	6	695	195	210	88	48	541	139	717	336	3	1195	167	110	8	15	300	2731
% App. Total	6	72.1	21	0.9		36	38.8	16.3	8.9		11.6	60	28.1	0.3		55.7	36.7	2.7	5		
PHF	.583	.858	.830	.500	.856	.813	.861	.786	.545	.902	.739	.779	.894	.250	.814	.908	.809	.667	.417	.843	.876



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File Name : AM_Kualakai Pkwy - Kapolei Pkwy
Site Code : 00000000
Start Date : 9/3/2014

Groups Printed- Unshifted

	KUALAKAI PKWY From North				KAPOLEI PKWY From East				KUALAKAI PKWY From South				KAPOLEI PKWY From West				
Start Time	Right	Thru	Left	Peds	Right	Thru	Left	Peds	Right	Thru	Left	Peds	Right	Thru	Left	Peds	Int. Total
06:00 AM	16	0	17	0	58	46	0	0	0	0	0	0	0	43	97	0	277
06:15 AM	22	0	27	0	62	59	0	0	0	0	0	0	0	64	79	0	313
06:30 AM	28	0	37	2	72	61	0	0	0	0	0	0	0	69	96	0	365
06:45 AM	37	0	44	0	50	80	0	1	0	0	0	0	0	62	82	0	356
Total	103	0	125	2	242	246	0	1	0	0	0	0	0	238	354	0	1311
07:00 AM	42	0	33	2	58	107	0	0	0	0	0	0	0	76	94	0	412
07:15 AM	53	0	54	1	77	144	0	1	0	0	0	0	0	94	66	0	490
07:30 AM	65	0	46	1	96	195	0	3	0	0	0	0	0	90	83	0	579
07:45 AM	48	0	37	1	129	158	0	0	0	0	0	0	0	104	90	0	567
Total	208	0	170	5	360	604	0	4	0	0	0	0	0	364	333	0	2048
Grand Total	311	0	295	7	602	850	0	5	0	0	0	0	0	602	687	0	3359
Apprch %	50.7	0	48.1	1.1	41.3	58.3	0	0.3	0	0	0	0	0	46.7	53.3	0	
Total %	9.3	0	8.8	0.2	17.9	25.3	0	0.1	0	0	0	0	0	17.9	20.5	0	

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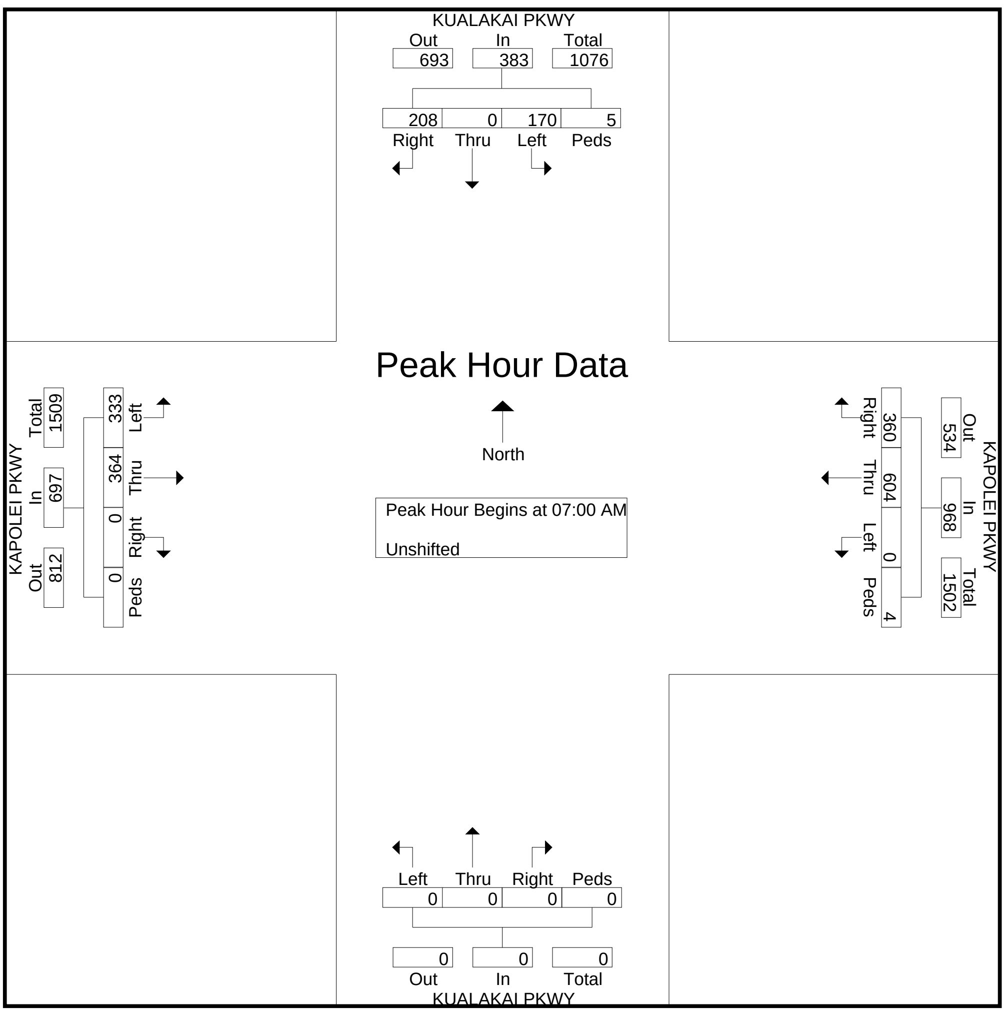
File Name : AM_Kualakai Pkwy - Kapolei Pkwy
Site Code : 00000000
Start Date : 9/3/2014
Page No : 2

	KUALAKAI PKWY From North					KAPOLEI PKWY From East					KUALAKAI PKWY From South					KAPOLEI PKWY From West					
Start Time	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Int. Total
Peak Hour Analysis From 07:00 AM to 07:45 AM - Peak 1 of 1																					
Peak Hour for Entire Intersection Begins at 07:00 AM																					
07:00 AM	42	0	33	2	77	58	107	0	0	165	0	0	0	0	0	0	76	94	0	170	412
07:15 AM	53	0	54	1	108	77	144	0	1	222	0	0	0	0	0	0	94	66	0	160	490
07:30 AM	65	0	46	1	112	96	195	0	3	294	0	0	0	0	0	0	90	83	0	173	579
07:45 AM	48	0	37	1	86	129	158	0	0	287	0	0	0	0	0	0	104	90	0	194	567
Total Volume	208	0	170	5	383	360	604	0	4	968	0	0	0	0	0	0	364	333	0	697	2048
% App. Total	54.3	0	44.4	1.3		37.2	62.4	0	0.4		0	0	0	0		0	52.2	47.8	0		
PHF	.800	.000	.787	.625	.855	.698	.774	.000	.333	.823	.000	.000	.000	.000	.000	.000	.875	.886	.000	.898	.884



Austin Tsutsumi & Associates

501 Sumner Street, Suite 521
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Phone: (808) 533-3646   Fax: (808) 526-1267

File Name : AM_Phillipine Sea - Renton Rd
Site Code : 00000000
Start Date : 9/3/2014

Groups Printed- Class 1

	PHILLIPINE SEA From North				RENTON RD From East				PHILLIPINE SEA From South				RENTON RD From West				
Start Time	Rght	Thru	Left	Other	Rght	Thru	Left	Other	Rght	Thru	Left	Other	Rght	Thru	Left	Other	Int. Total
06:00 AM	0	0	0	0	0	1	44	0	20	0	0	0	0	0	0	0	65
06:15 AM	0	0	0	0	0	0	36	0	20	0	0	0	0	0	0	0	56
06:30 AM	0	0	0	0	0	0	44	0	20	0	0	0	1	0	0	0	65
06:45 AM	0	0	0	0	0	0	61	0	19	0	1	0	0	0	0	0	81
Total	0	0	0	0	0	1	185	0	79	0	1	0	1	0	0	0	267
07:00 AM	0	0	0	0	0	0	51	0	20	0	0	0	0	0	0	0	71
07:15 AM	0	0	0	0	0	0	42	0	21	0	1	0	0	0	0	0	64
07:30 AM	0	0	0	0	0	0	46	0	21	0	0	0	0	0	0	0	67
07:45 AM	0	0	0	0	0	1	42	0	18	0	1	0	0	0	0	0	62
Total	0	0	0	0	0	1	181	0	80	0	2	0	0	0	0	0	264
Grand Total	0	0	0	0	0	2	366	0	159	0	3	0	1	0	0	0	531
Apprch %	0	0	0	0	0	0.5	99.5	0	98.1	0	1.9	0	100	0	0	0	
Total %	0	0	0	0	0	0.4	68.9	0	29.9	0	0.6	0	0.2	0	0	0	

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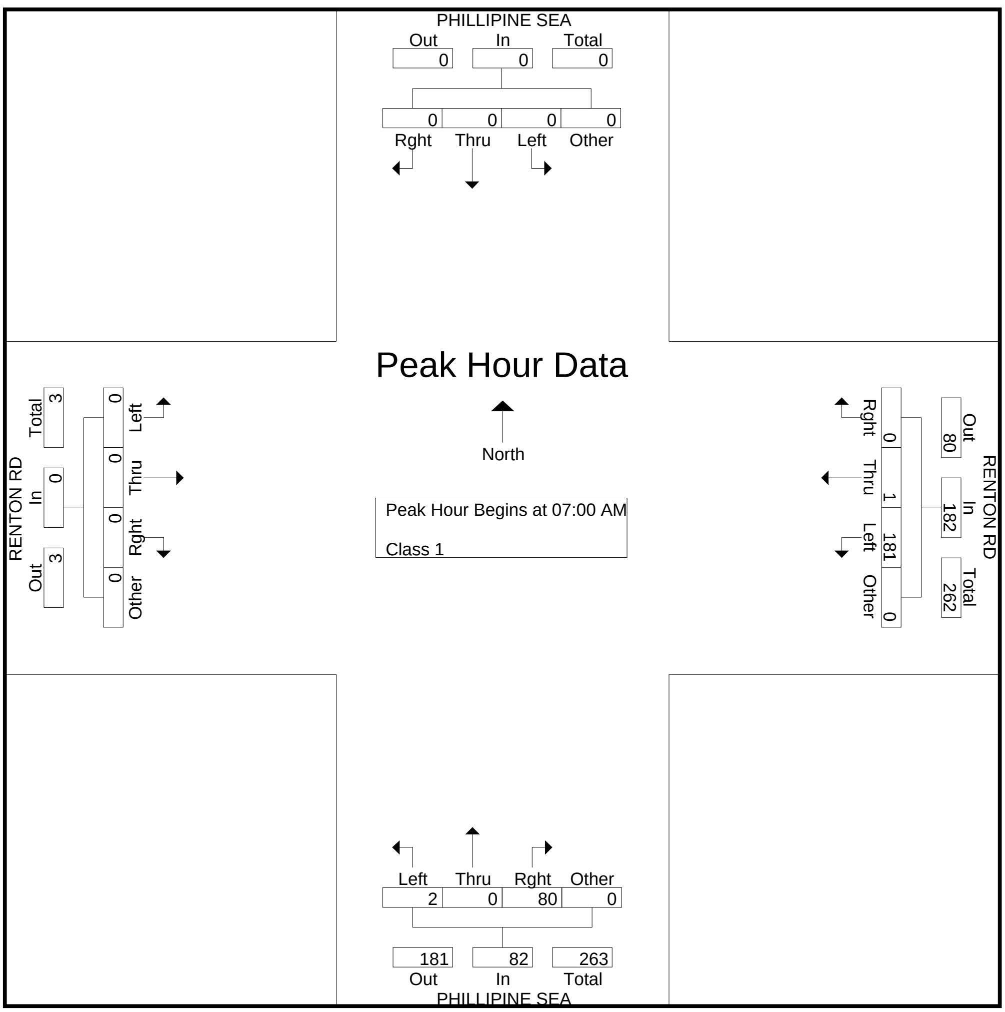
File Name : AM_Phillipine Sea - Renton Rd
Site Code : 00000000
Start Date : 9/3/2014

	PHILLIPINE SEA From North					RENTON RD From East					PHILLIPINE SEA From South					RENTON RD From West					
Start Time	Rght	Thru	Left	Other	App. Total	Rght	Thru	Left	Other	App. Total	Rght	Thru	Left	Other	App. Total	Rght	Thru	Left	Other	App. Total	Int. Total
Peak Hour Analysis From 07:00 AM to 07:45 AM - Peak 1 of 1																					
Peak Hour for Entire Intersection Begins at 07:00 AM																					
07:00 AM	0	0	0	0	0	0	0	51	0	51	20	0	0	0	20	0	0	0	0	0	71
07:15 AM	0	0	0	0	0	0	0	42	0	42	21	0	1	0	22	0	0	0	0	0	64
07:30 AM	0	0	0	0	0	0	0	46	0	46	21	0	0	0	21	0	0	0	0	0	67
07:45 AM	0	0	0	0	0	0	1	42	0	43	18	0	1	0	19	0	0	0	0	0	62
Total Volume	0	0	0	0	0	0	1	181	0	182	80	0	2	0	82	0	0	0	0	0	264
% App. Total	0	0	0	0		0	0.5	99.5	0		97.6	0	2.4	0		0	0	0	0		
PHF	.000	.000	.000	.000	.000	.000	.250	.887	.000	.892	.952	.000	.500	.000	.932	.000	.000	.000	.000	.000	.930



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File Name : AM_Phillipine Sea - Roosevelt Ave
Site Code : 00000000
Start Date : 9/3/2014

Groups Printed- Class 1

	PHILLIPINE SEA From North				ROOSEVELT AVE From East				PHILLIPINE SEA From South				ROOSEVELT AVE From West				
Start Time	Rght	Thru	Left	Other	Rght	Thru	Left	Other	Rght	Thru	Left	Other	Rght	Thru	Left	Other	Int. Total
06:00 AM	44	0	1	0	0	73	0	0	0	0	0	0	0	37	20	0	175
06:15 AM	30	0	4	0	0	78	0	0	0	0	0	0	0	49	15	0	176
06:30 AM	42	0	7	0	1	123	0	0	0	0	0	0	0	68	17	0	258
06:45 AM	55	0	3	0	2	108	0	0	0	0	0	0	0	67	18	0	253
Total	171	0	15	0	3	382	0	0	0	0	0	0	0	221	70	0	862
07:00 AM	48	0	2	0	2	100	0	0	0	0	0	0	0	55	16	0	223
07:15 AM	39	0	3	0	3	155	0	0	0	0	0	0	0	80	15	0	295
07:30 AM	40	0	4	0	4	141	0	0	0	0	0	0	0	65	17	0	271
07:45 AM	39	0	2	0	5	134	0	0	0	0	0	0	0	67	16	0	263
Total	166	0	11	0	14	530	0	0	0	0	0	0	0	267	64	0	1052
Grand Total	337	0	26	0	17	912	0	0	0	0	0	0	0	488	134	0	1914
Apprch %	92.8	0	7.2	0	1.8	98.2	0	0	0	0	0	0	0	78.5	21.5	0	
Total %	17.6	0	1.4	0	0.9	47.6	0	0	0	0	0	0	0	25.5	7	0	

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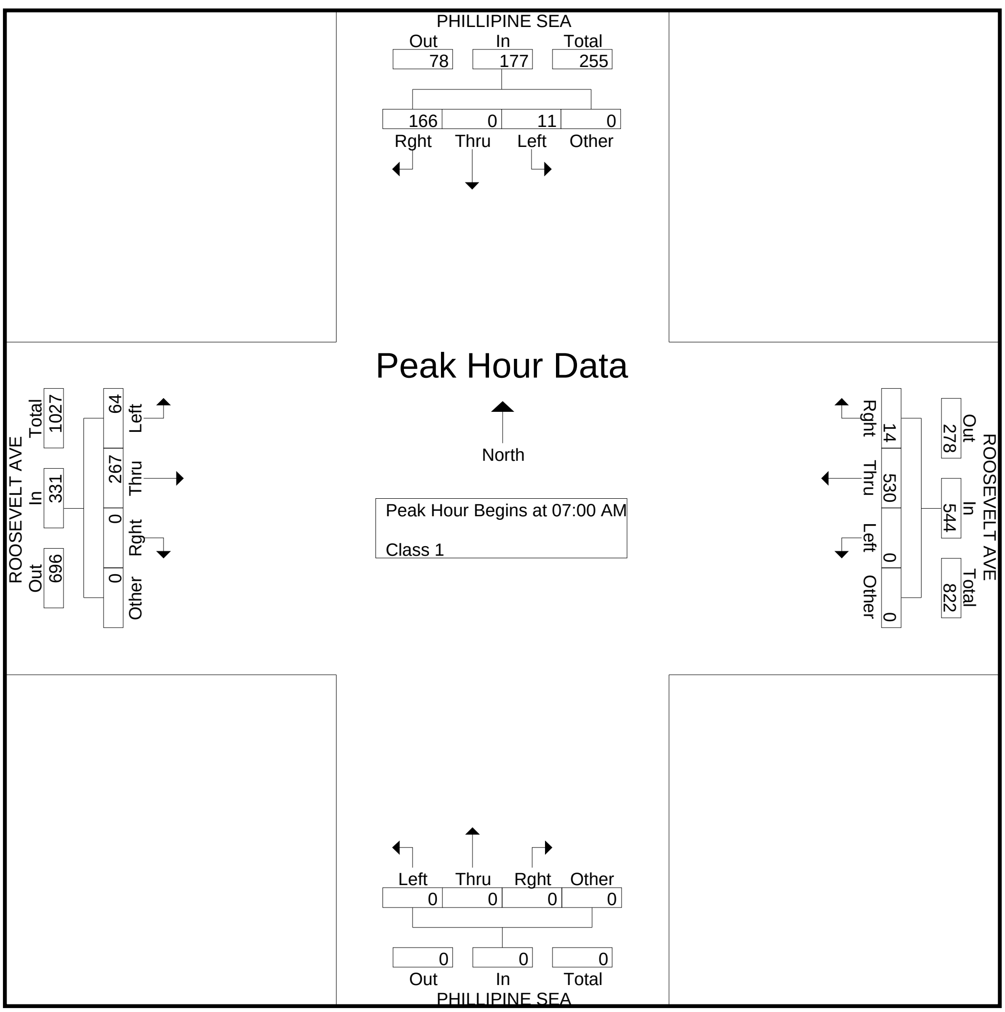
File Name : AM_Phillipine Sea - Roosevelt Ave
Site Code : 00000000
Start Date : 9/3/2014

	PHILLIPINE SEA From North					ROOSEVELT AVE From East					PHILLIPINE SEA From South					ROOSEVELT AVE From West					
Start Time	Rght	Thru	Left	Other	App. Total	Rght	Thru	Left	Other	App. Total	Rght	Thru	Left	Other	App. Total	Rght	Thru	Left	Other	App. Total	Int. Total
Peak Hour Analysis From 07:00 AM to 07:45 AM - Peak 1 of 1																					
Peak Hour for Entire Intersection Begins at 07:00 AM																					
07:00 AM	48	0	2	0	50	2	100	0	0	102	0	0	0	0	0	0	55	16	0	71	223
07:15 AM	39	0	3	0	42	3	155	0	0	158	0	0	0	0	0	0	80	15	0	95	295
07:30 AM	40	0	4	0	44	4	141	0	0	145	0	0	0	0	0	0	65	17	0	82	271
07:45 AM	39	0	2	0	41	5	134	0	0	139	0	0	0	0	0	0	67	16	0	83	263
Total Volume	166	0	11	0	177	14	530	0	0	544	0	0	0	0	0	0	267	64	0	331	1052
% App. Total	93.8	0	6.2	0		2.6	97.4	0	0		0	0	0	0		0	80.7	19.3	0		
PHF	.865	.000	.688	.000	.885	.700	.855	.000	.000	.861	.000	.000	.000	.000	.000	.000	.834	.941	.000	.871	.892



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File Name : AM_Renton Rd - Kapolei Pkwy
Site Code : 00000000
Start Date : 9/3/2014
Page No : 1

Groups Printed- Unshifted

	RENTON RD From North				KAPOLEI PKWY From East				RENTON RD From South				KAPOLEI PKWY From West				
Start Time	Right	Thru	Left	Peds	Right	Thru	Left	Peds	Right	Thru	Left	Peds	Right	Thru	Left	Peds	Int. Total
06:00 AM	26	20	9	1	17	74	9	0	1	14	6	1	7	30	18	0	233
06:15 AM	22	20	19	2	35	103	8	1	5	12	3	0	11	56	29	0	326
06:30 AM	32	22	21	1	29	88	9	0	3	12	8	1	19	50	35	0	330
06:45 AM	33	29	36	4	51	95	7	0	5	18	3	0	22	50	29	0	382
Total	113	91	85	8	132	360	33	1	14	56	20	2	59	186	111	0	1271
07:00 AM	47	24	61	3	57	129	18	2	4	14	5	2	16	55	47	1	485
07:15 AM	57	22	85	1	109	168	9	1	3	17	9	0	10	76	55	1	623
07:30 AM	104	30	83	0	118	240	11	1	4	20	3	1	9	82	62	0	768
07:45 AM	82	32	59	2	66	168	5	0	5	10	7	0	7	76	49	0	568
Total	290	108	288	6	350	705	43	4	16	61	24	3	42	289	213	2	2444
Grand Total	403	199	373	14	482	1065	76	5	30	117	44	5	101	475	324	2	3715
Apprch %	40.7	20.1	37.7	1.4	29.6	65.4	4.7	0.3	15.3	59.7	22.4	2.6	11.2	52.7	35.9	0.2	
Total %	10.8	5.4	10	0.4	13	28.7	2	0.1	0.8	3.1	1.2	0.1	2.7	12.8	8.7	0.1	

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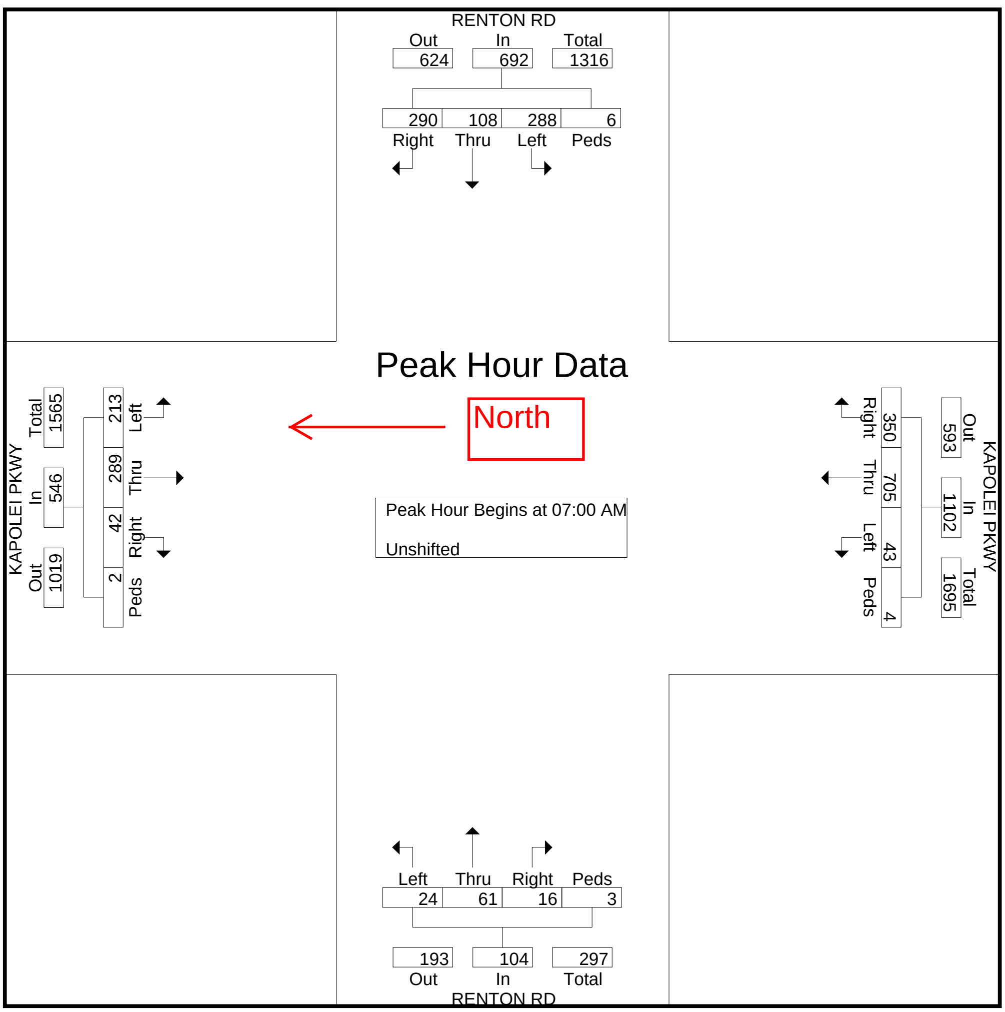
	RENTON RD From North					KAPOLEI PKWY From East					RENTON RD From South					KAPOLEI PKWY From West					
Start Time	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Int. Total
Peak Hour Analysis From 07:00 AM to 07:45 AM - Peak 1 of 1																					
Peak Hour for Entire Intersection Begins at 07:00 AM																					
07:00 AM	47	24	61	3	135	57	129	18	2	206	4	14	5	2	25	16	55	47	1	119	485
07:15 AM	57	22	85	1	165	109	168	9	1	287	3	17	9	0	29	10	76	55	1	142	623
07:30 AM	104	30	83	0	217	118	240	11	1	370	4	20	3	1	28	9	82	62	0	153	768
07:45 AM	82	32	59	2	175	66	168	5	0	239	5	10	7	0	22	7	76	49	0	132	568
Total Volume	290	108	288	6	692	350	705	43	4	1102	16	61	24	3	104	42	289	213	2	546	2444
% App. Total	41.9	15.6	41.6	0.9		31.8	64	3.9	0.4		15.4	58.7	23.1	2.9		7.7	52.9	39	0.4		
PHF	.697	.844	.847	.500	.797	.742	.734	.597	.500	.745	.800	.763	.667	.375	.897	.656	.881	.859	.500	.892	.796



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File Name : AM_WWTP Dwy #1 - Geiger Rd
Site Code : 00000000
Start Date : 9/3/2014
Page No : 1

Groups Printed- Class 1

	WWTP DWY #1 From North				GEIGER RD From East				From South				GEIGER RD From West				
Start Time	Rght	Thru	Left	Other	Rght	Thru	Left	Other	Rght	Thru	Left	Other	Rght	Thru	Left	Other	Int. Total
06:00 AM	0	0	0	0	0	79	10	0	0	0	1	0	0	35	0	0	125
06:15 AM	0	0	0	0	0	98	18	0	2	0	0	0	1	48	0	0	167
06:30 AM	0	0	0	0	0	142	5	0	8	0	1	0	3	52	0	0	211
06:45 AM	0	0	0	0	0	141	3	0	19	0	0	0	0	73	0	0	236
Total	0	0	0	0	0	460	36	0	29	0	2	0	4	208	0	0	739
07:00 AM	0	0	0	0	0	120	1	0	6	0	2	0	0	57	0	0	186
07:15 AM	0	0	0	0	0	160	4	0	3	0	1	0	1	77	0	0	246
07:30 AM	0	0	0	0	0	160	2	0	4	0	0	0	0	75	0	0	241
07:45 AM	0	0	0	0	0	152	1	0	2	0	0	0	0	62	0	0	217
Total	0	0	0	0	0	592	8	0	15	0	3	0	1	271	0	0	890
Grand Total	0	0	0	0	0	1052	44	0	44	0	5	0	5	479	0	0	1629
Apprch %	0	0	0	0	0	96	4	0	89.8	0	10.2	0	1	99	0	0	
Total %	0	0	0	0	0	64.6	2.7	0	2.7	0	0.3	0	0.3	29.4	0	0	

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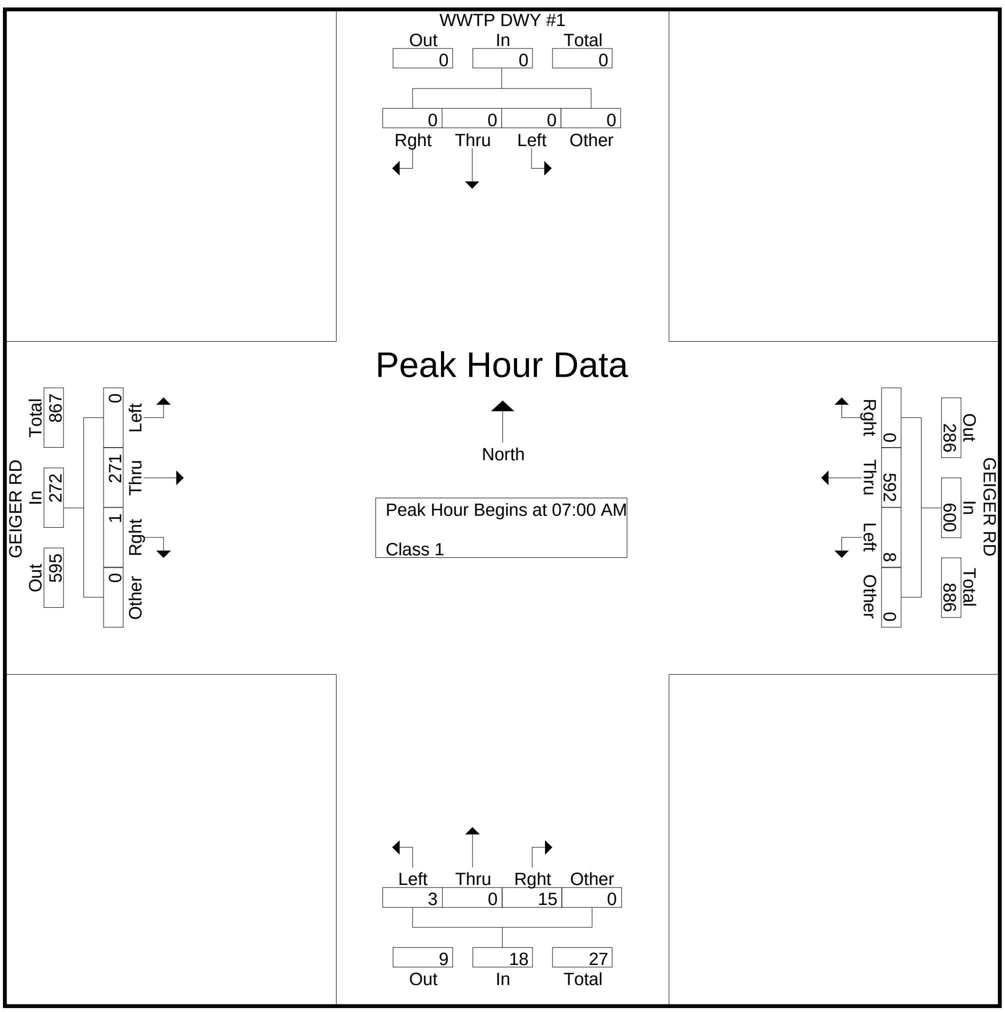
File Name : AM_WWTP Dwy #1 - Geiger Rd
Site Code : 00000000
Start Date : 9/3/2014

	WWTP DWY #1 From North					GEIGER RD From East					From South					GEIGER RD From West					
Start Time	Rght	Thru	Left	Other	App. Total	Rght	Thru	Left	Other	App. Total	Rght	Thru	Left	Other	App. Total	Rght	Thru	Left	Other	App. Total	Int. Total
Peak Hour Analysis From 07:00 AM to 07:45 AM - Peak 1 of 1																					
Peak Hour for Entire Intersection Begins at 07:00 AM																					
07:00 AM	0	0	0	0	0	0	120	1	0	121	6	0	2	0	8	0	57	0	0	57	186
07:15 AM	0	0	0	0	0	0	160	4	0	164	3	0	1	0	4	1	77	0	0	78	246
07:30 AM	0	0	0	0	0	0	160	2	0	162	4	0	0	0	4	0	75	0	0	75	241
07:45 AM	0	0	0	0	0	0	152	1	0	153	2	0	0	0	2	0	62	0	0	62	217
Total Volume	0	0	0	0	0	0	592	8	0	600	15	0	3	0	18	1	271	0	0	272	890
% App. Total	0	0	0	0		0	98.7	1.3	0		83.3	0	16.7	0		0.4	99.6	0	0		
PHF	.000	.000	.000	.000	.000	.000	.925	.500	.000	.915	.625	.000	.375	.000	.563	.250	.880	.000	.000	.872	.904



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File Name : AM_WWTP Dwy #2 - Geiger Rd
Site Code : 00000000
Start Date : 9/3/2014
Page No : 1

Groups Printed- Class 1

	WWTP DWY #2 From North				GEIGER RD From East				From South				GEIGER RD From West				
Start Time	Rght	Thru	Left	Other	Rght	Thru	Left	Other	Rght	Thru	Left	Other	Rght	Thru	Left	Other	Int. Total
06:00 AM	0	0	1	0	1	69	0	0	0	0	0	0	0	35	1	0	107
06:15 AM	0	0	1	0	6	99	0	0	0	0	0	0	0	48	2	0	156
06:30 AM	1	0	0	0	15	124	0	0	0	0	0	0	0	53	3	0	196
06:45 AM	0	0	2	0	12	123	0	0	0	0	0	0	0	71	6	0	214
Total	1	0	4	0	34	415	0	0	0	0	0	0	0	207	12	0	673
07:00 AM	2	0	1	0	0	120	0	0	0	0	0	0	0	56	0	0	179
07:15 AM	3	0	2	0	0	155	0	0	0	0	0	0	0	77	0	0	237
07:30 AM	2	0	1	0	1	161	0	0	0	0	0	0	0	75	0	0	240
07:45 AM	3	0	2	0	3	143	0	0	0	0	0	0	0	60	0	0	211
Total	10	0	6	0	4	579	0	0	0	0	0	0	0	268	0	0	867
Grand Total	11	0	10	0	38	994	0	0	0	0	0	0	0	475	12	0	1540
Apprch %	52.4	0	47.6	0	3.7	96.3	0	0	0	0	0	0	0	97.5	2.5	0	
Total %	0.7	0	0.6	0	2.5	64.5	0	0	0	0	0	0	0	30.8	0.8	0	

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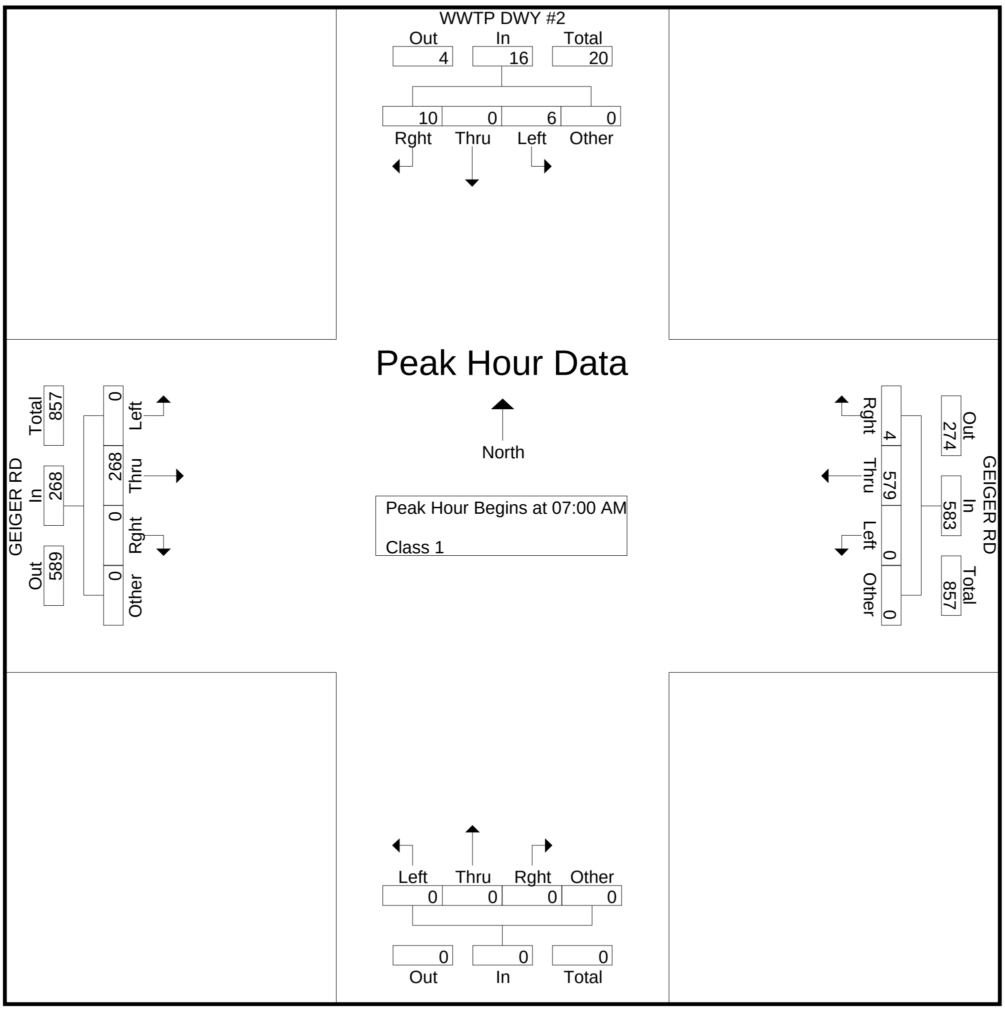
File Name : AM_WWTP Dwy #2 - Geiger Rd
Site Code : 00000000
Start Date : 9/3/2014
Page No : 2

	WWTP DWY #2 From North					GEIGER RD From East					From South					GEIGER RD From West					
Start Time	Rght	Thru	Left	Other	App. Total	Rght	Thru	Left	Other	App. Total	Rght	Thru	Left	Other	App. Total	Rght	Thru	Left	Other	App. Total	Int. Total
Peak Hour Analysis From 07:00 AM to 07:45 AM - Peak 1 of 1																					
Peak Hour for Entire Intersection Begins at 07:00 AM																					
07:00 AM	2	0	1	0	3	0	120	0	0	120	0	0	0	0	0	0	56	0	0	56	179
07:15 AM	3	0	2	0	5	0	155	0	0	155	0	0	0	0	0	0	77	0	0	77	237
07:30 AM	2	0	1	0	3	1	161	0	0	162	0	0	0	0	0	0	75	0	0	75	240
07:45 AM	3	0	2	0	5	3	143	0	0	146	0	0	0	0	0	0	60	0	0	60	211
Total Volume	10	0	6	0	16	4	579	0	0	583	0	0	0	0	0	0	268	0	0	268	867
% App. Total	62.5	0	37.5	0		0.7	99.3	0	0		0	0	0	0		0	100	0	0		
PHF	.833	.000	.750	.000	.800	.333	.899	.000	.000	.900	.000	.000	.000	.000	.000	.000	.870	.000	.000	.870	.903



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File Name : AM_WWTP Dwy #3 - Geiger Rd
Site Code : 00000000
Start Date : 9/3/2014

Groups Printed- Class 1

	WWTP DWY #3 From North				GEIGER RD From East				From South				GEIGER RD From West				
Start Time	Rght	Thru	Left	Other	Rght	Thru	Left	Other	Rght	Thru	Left	Other	Rght	Thru	Left	Other	Int. Total
06:00 AM	0	0	0	0	0	70	0	0	0	0	0	0	0	36	0	0	106
06:15 AM	0	0	0	0	0	99	0	0	0	0	0	0	0	50	0	0	149
06:30 AM	0	0	0	0	0	126	0	0	0	0	0	0	0	61	0	0	187
06:45 AM	0	0	0	0	0	120	0	0	0	0	0	0	0	73	1	0	194
Total	0	0	0	0	0	415	0	0	0	0	0	0	0	220	1	0	636
07:00 AM	0	0	0	0	1	118	0	0	0	0	0	0	0	57	0	0	176
07:15 AM	2	0	1	0	2	159	0	0	0	0	0	0	0	75	0	0	239
07:30 AM	1	0	2	0	4	158	0	0	0	0	0	0	0	73	0	0	238
07:45 AM	4	0	2	0	6	140	0	0	0	0	0	0	0	56	3	0	211
Total	7	0	5	0	13	575	0	0	0	0	0	0	0	261	3	0	864
Grand Total	7	0	5	0	13	990	0	0	0	0	0	0	0	481	4	0	1500
Apprch %	58.3	0	41.7	0	1.3	98.7	0	0	0	0	0	0	0	99.2	0.8	0	
Total %	0.5	0	0.3	0	0.9	66	0	0	0	0	0	0	0	32.1	0.3	0	

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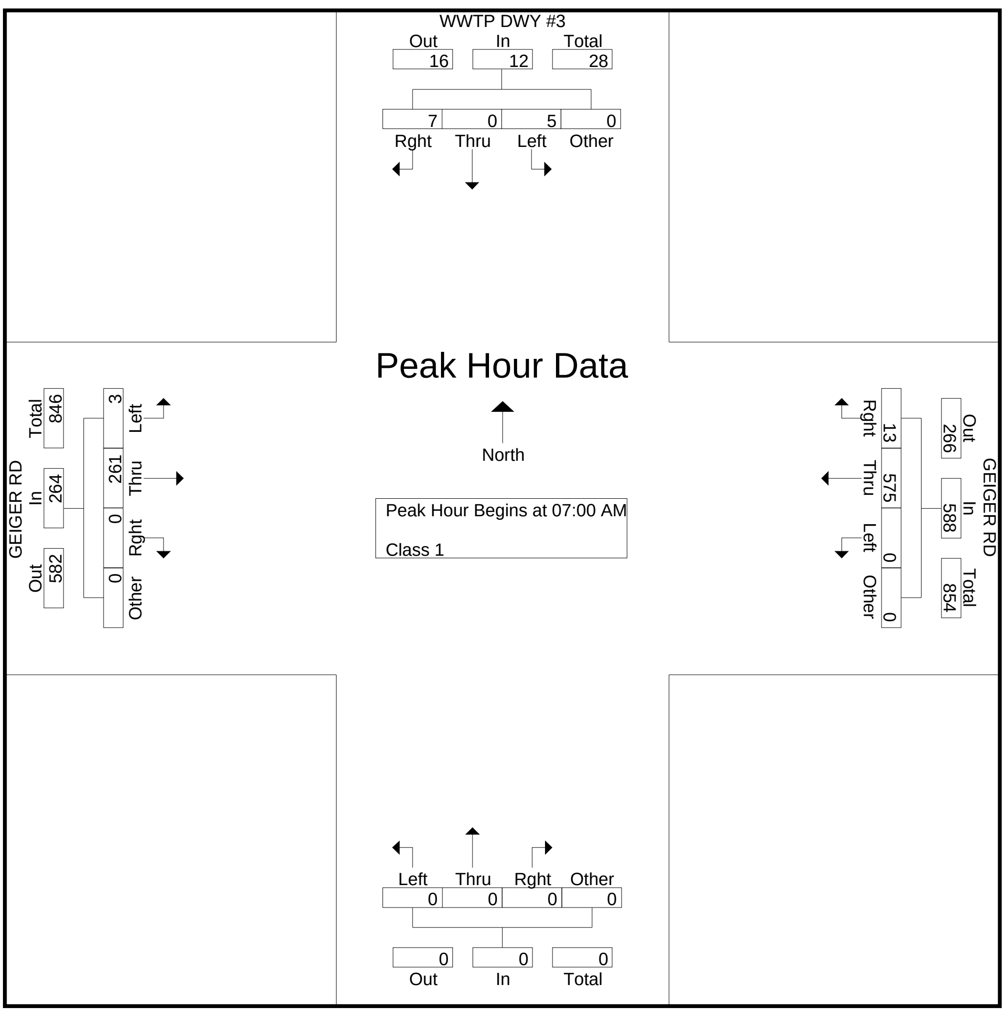
File Name : AM_WWTP Dwy #3 - Geiger Rd
Site Code : 00000000
Start Date : 9/3/2014

	WWTP DWY #3 From North					GEIGER RD From East					From South					GEIGER RD From West					
Start Time	Rght	Thru	Left	Other	App. Total	Rght	Thru	Left	Other	App. Total	Rght	Thru	Left	Other	App. Total	Rght	Thru	Left	Other	App. Total	Int. Total
Peak Hour Analysis From 06:45 AM to 07:45 AM - Peak 1 of 1																					
Peak Hour for Entire Intersection Begins at 07:00 AM																					
07:00 AM	0	0	0	0	0	1	118	0	0	119	0	0	0	0	0	0	57	0	0	57	176
07:15 AM	2	0	1	0	3	2	159	0	0	161	0	0	0	0	0	0	75	0	0	75	239
07:30 AM	1	0	2	0	3	4	158	0	0	162	0	0	0	0	0	0	73	0	0	73	238
07:45 AM	4	0	2	0	6	6	140	0	0	146	0	0	0	0	0	0	56	3	0	59	211
Total Volume	7	0	5	0	12	13	575	0	0	588	0	0	0	0	0	0	261	3	0	264	864
% App. Total	58.3	0	41.7	0		2.2	97.8	0	0		0	0	0	0		0	98.9	1.1	0		
PHF	.438	.000	.625	.000	.500	.542	.904	.000	.000	.907	.000	.000	.000	.000	.000	.000	.870	.250	.000	.880	.904



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File Name : PM_Essex Rd - Geiger Rd
Site Code : 00000000
Start Date : 9/3/2014

Groups Printed- Class 1

	From North				GEIGER RD From East				ESSEX RD From South				GEIGER RD From West				
Start Time	Rght	Thru	Left	Other	Rght	Thru	Left	Other	Rght	Thru	Left	Other	Rght	Thru	Left	Other	Int. Total
03:30 PM	0	0	0	0	0	98	2	0	0	0	2	0	2	133	0	0	237
03:45 PM	0	0	0	0	0	72	2	0	4	0	1	0	8	140	0	0	227
Total	0	0	0	0	0	170	4	0	4	0	3	0	10	273	0	0	464
04:00 PM	0	0	0	0	0	93	3	0	4	0	2	0	2	158	0	0	262
04:15 PM	0	0	0	0	0	89	3	0	3	0	2	0	4	153	0	0	254
04:30 PM	0	0	0	0	0	93	4	0	9	0	2	0	4	147	0	0	259
04:45 PM	0	0	0	0	0	70	1	0	3	0	3	0	3	166	0	0	246
Total	0	0	0	0	0	345	11	0	19	0	9	0	13	624	0	0	1021
05:00 PM	0	0	0	0	0	71	4	0	5	0	4	0	4	162	0	0	250
05:15 PM	0	0	0	0	0	67	6	0	7	0	3	0	5	136	0	0	224
Grand Total	0	0	0	0	0	653	25	0	35	0	19	0	32	1195	0	0	1959
Apprch %	0	0	0	0	0	96.3	3.7	0	64.8	0	35.2	0	2.6	97.4	0	0	
Total %	0	0	0	0	0	33.3	1.3	0	1.8	0	1	0	1.6	61	0	0	

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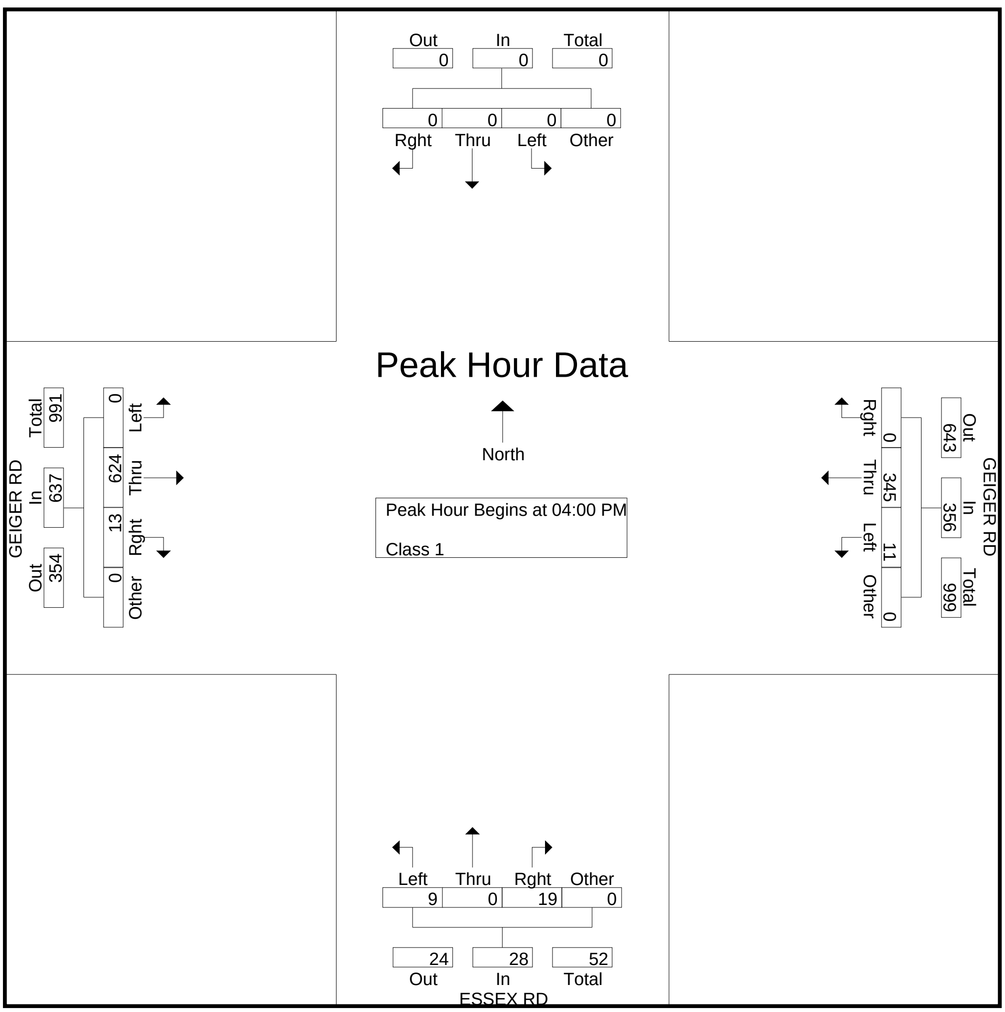
	From North					GEIGER RD From East					ESSEX RD From South					GEIGER RD From West					
Start Time	Rght	Thru	Left	Other	App. Total	Rght	Thru	Left	Other	App. Total	Rght	Thru	Left	Other	App. Total	Rght	Thru	Left	Other	App. Total	Int. Total
Peak Hour Analysis From 04:00 PM to 04:45 PM - Peak 1 of 1																					
Peak Hour for Entire Intersection Begins at 04:00 PM																					
04:00 PM	0	0	0	0	0	0	93	3	0	96	4	0	2	0	6	2	158	0	0	160	262
04:15 PM	0	0	0	0	0	0	89	3	0	92	3	0	2	0	5	4	153	0	0	157	254
04:30 PM	0	0	0	0	0	0	93	4	0	97	9	0	2	0	11	4	147	0	0	151	259
04:45 PM	0	0	0	0	0	0	70	1	0	71	3	0	3	0	6	3	166	0	0	169	246
Total Volume	0	0	0	0	0	0	345	11	0	356	19	0	9	0	28	13	624	0	0	637	1021
% App. Total	0	0	0	0		0	96.9	3.1	0		67.9	0	32.1	0		2	98	0	0		
PHF	.000	.000	.000	.000	.000	.000	.927	.688	.000	.918	.528	.000	.750	.000	.636	.813	.940	.000	.000	.942	.974



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Phone: (808) 533-3646 Fax: (808) 526-1267

File Name : PM_Ft Weaver Rd - Geiger Rd
Site Code : 00000000
Start Date : 9/3/2014

Groups Printed- Unshifted

	FT WEAVER RD From North					GEIGER RD From East				FT WEAVER RD From South				GEIGER RD From West				
Start Time	Right	Thru	Left	U-Turns	Peds	Right	Thru	Left	Peds	Right	Thru	Left	Peds	Right	Thru	Left	Peds	Int. Total
03:30 PM	68	399	89	1	0	33	34	2	0	1	266	48	5	34	30	40	7	1057
03:45 PM	53	314	84	0	0	27	33	6	0	3	266	30	20	35	59	52	11	993
Total	121	713	173	1	0	60	67	8	0	4	532	78	25	69	89	92	18	2050
04:00 PM	37	332	77	0	0	37	53	0	0	4	197	30	14	23	54	59	6	923
04:15 PM	43	345	59	0	0	28	38	1	0	1	222	34	15	44	44	50	15	939
04:30 PM	59	399	107	0	0	28	44	5	0	2	200	37	7	47	37	47	4	1023
04:45 PM	68	417	98	0	0	29	47	4	0	3	198	34	11	39	71	42	7	1068
Total	207	1493	341	0	0	122	182	10	0	10	817	135	47	153	206	198	32	3953
05:00 PM	53	356	109	0	0	28	41	6	0	1	181	39	14	48	83	53	2	1014
05:15 PM	79	376	83	0	0	27	31	6	0	2	222	25	12	32	43	46	11	995
Grand Total	460	2938	706	1	0	237	321	30	0	17	1752	277	98	302	421	389	63	8012
Apprch %	11.2	71.6	17.2	0	0	40.3	54.6	5.1	0	0.8	81.7	12.9	4.6	25.7	35.8	33.1	5.4	
Total %	5.7	36.7	8.8	0	0	3	4	0.4	0	0.2	21.9	3.5	1.2	3.8	5.3	4.9	0.8	

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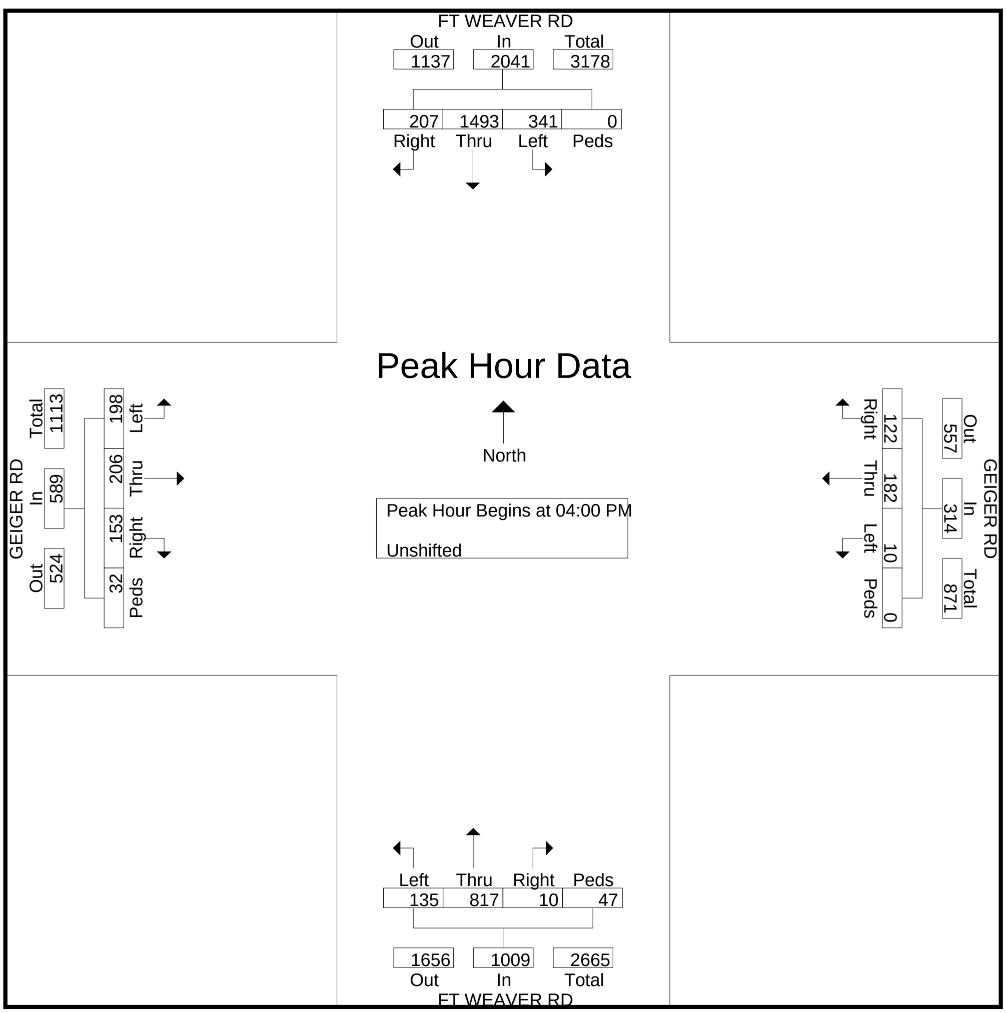
File Name : PM_Ft Weaver Rd - Geiger Rd
Site Code : 00000000
Start Date : 9/3/2014

	FT WEAVER RD From North						GEIGER RD From East					FT WEAVER RD From South					GEIGER RD From West					
Start Time	Right	Thru	Left	U-Turns	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Int. Total
Peak Hour Analysis From 04:00 PM to 04:45 PM - Peak 1 of 1																						
Peak Hour for Entire Intersection Begins at 04:00 PM																						
04:00 PM	37	332	77	0	0	446	37	53	0	0	90	4	197	30	14	245	23	54	59	6	142	923
04:15 PM	43	345	59	0	0	447	28	38	1	0	67	1	222	34	15	272	44	44	50	15	153	939
04:30 PM	59	399	107	0	0	565	28	44	5	0	77	2	200	37	7	246	47	37	47	4	135	1023
04:45 PM	68	417	98	0	0	583	29	47	4	0	80	3	198	34	11	246	39	71	42	7	159	1068
Total Volume	207	1493	341	0	0	2041	122	182	10	0	314	10	817	135	47	1009	153	206	198	32	589	3953
% App. Total	10.1	73.2	16.7				38.9							13.4					33.6			
PHF	.761	.895	.797	.000	.000	.875	.824	.858	.500	.000	.872	.625	.920	.912	.783	.927	.814	.725	.839	.533	.926	.925



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File Name : PM_Ft Weaver Rd - Renton Rd
Site Code : 00000000
Start Date : 9/3/2014

Groups Printed- Unshifted

	FT WEAVER RD From North					RENTON RD From East				FT WEAVER RD From South					RENTON RD From West				
Start Time	Right	Thru	Left	U-Turns	Peds	Right	Thru	Left	Peds	Right	Thru	Left	U-Turns	Peds	Right	Thru	Left	Peds	Int. Total
03:30 PM	56	704	0	4	0	3	1	2	5	5	453	23	0	2	27	0	78	2	1365
03:45 PM	88	604	8	7	0	3	1	2	1	13	404	36	1	6	32	4	111	0	1321
Total	144	1308	8	11	0	6	2	4	6	18	857	59	1	8	59	4	189	2	2686
04:00 PM	83	565	11	9	0	4	7	9	19	21	398	33	1	14	23	12	99	1	1309
04:15 PM	71	582	10	4	0	8	10	13	5	18	330	31	1	6	24	11	100	0	1224
04:30 PM	68	733	8	11	0	8	8	8	4	10	380	25	0	7	24	7	75	3	1379
04:45 PM	76	748	8	7	0	2	3	4	3	5	302	24	0	5	26	6	81	1	1301
Total	298	2628	37	31	0	22	28	34	31	54	1410	113	2	32	97	36	355	5	5213
05:00 PM	57	660	4	8	0	8	3	2	13	14	359	32	0	1	27	5	65	0	1258
05:15 PM	70	674	10	6	0	3	3	2	12	9	320	18	2	9	18	5	79	5	1245
Grand Total	569	5270	59	56	0	39	36	42	62	95	2946	222	5	50	201	50	688	12	10402
Apprch %	9.6	88.5	1	0.9	0	21.8	20.1	23.5	34.6	2.9	88.8	6.7	0.2	1.5	21.1	5.3	72.3	1.3	
Total %	5.5	50.7	0.6	0.5	0	0.4	0.3	0.4	0.6	0.9	28.3	2.1	0	0.5	1.9	0.5	6.6	0.1	

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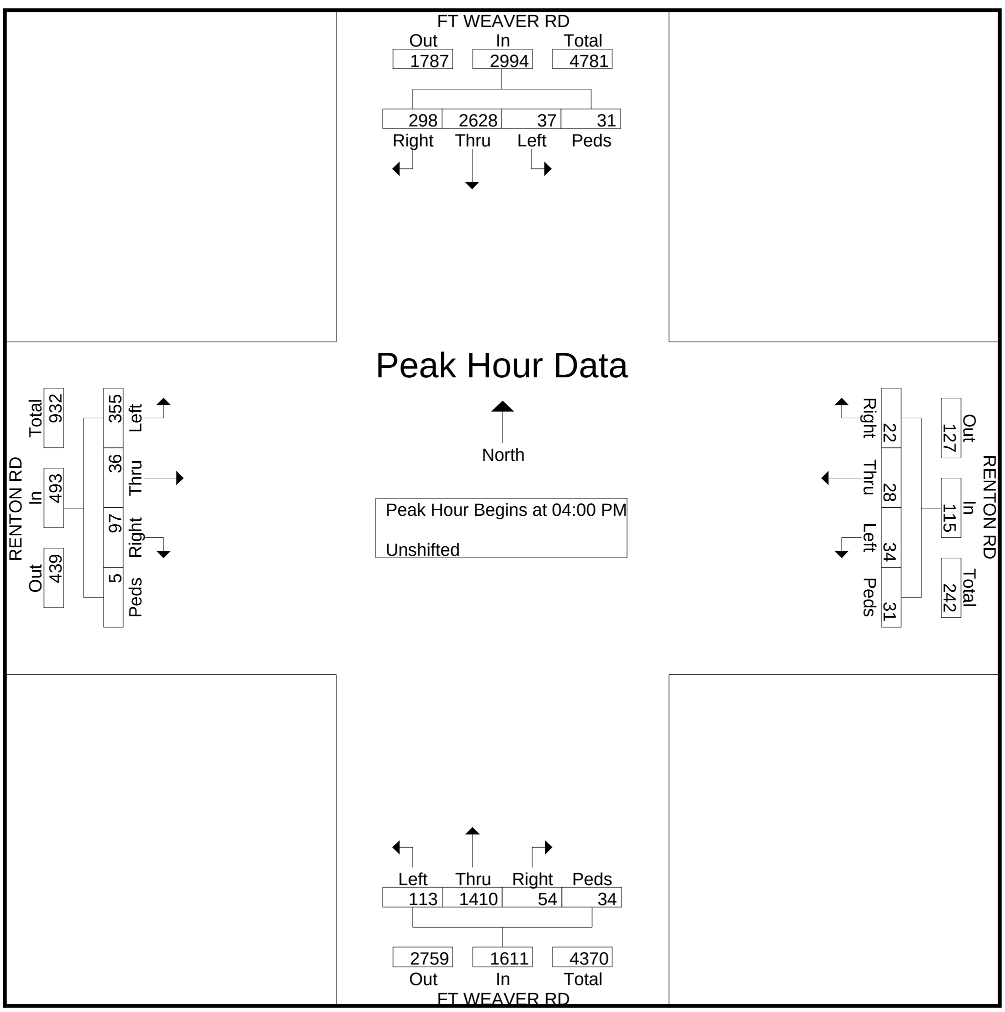
File Name : PM_Ft Weaver Rd - Renton Rd
Site Code : 00000000
Start Date : 9/3/2014

	FT WEAVER RD From North						RENTON RD From East					FT WEAVER RD From South						RENTON RD From West					
Start Time	Right	Thru	Left	U-Turns	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	U-Turns	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Int. Total
Peak Hour Analysis From 04:00 PM to 04:45 PM - Peak 1 of 1																							
Peak Hour for Entire Intersection Begins at 04:00 PM																							
04:00 PM	83	565	11	9	0	668	4	7	9	19	39	21	398	33	1	14	467	23	12	99	1	135	1309
04:15 PM	71	582	10	4	0	667	8	10	13	5	36	18	330	31	1	6	386	24	11	100	0	135	1224
04:30 PM	68	733	8	11	0	820	8	8	8	4	28	10	380	25	0	7	422	24	7	75	3	109	1379
04:45 PM	76	748	8	7	0	839	2	3	4	3	12	5	302	24	0	5	336	26	6	81	1	114	1301
Total Volume	298	2628	37	31	0	2994	22	28	34	31	115	54	1410	113	2	32	1611	97	36	355	5	493	5213
% App. Total	10	87.8	1.2	1	0		19.1	24.3	29.6	27		3.4	87.5	7	0.1	2		19.7	7.3	72	1		
PHF	.898	.878	.841	.705	.000	.892	.688	.700	.654	.408	.737	.643	.886	.856	.500	.571	.862	.933	.750	.888	.417	.913	.945



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File Name : PM_Kapolei Pkwy - Geiger Rd
Site Code : 00000000
Start Date : 9/3/2014
Page No : 1

Groups Printed- Unshifted

	KAPOLEI PKWY From North					GEIGER RD From East				KAPOLEI PKWY From South				GEIGER RD From West				
Start Time	Right	Thru	Left	U-Turns	Peds	Right	Thru	Left	Peds	Right	Thru	Left	Peds	Right	Thru	Left	Peds	Int. Total
03:30 PM	5	125	29	1	2	67	37	46	3	28	127	56	1	77	52	9	2	667
03:45 PM	8	108	24	0	1	60	24	26	7	13	111	42	0	97	64	10	4	599
Total	13	233	53	1	3	127	61	72	10	41	238	98	1	174	116	19	6	1266
04:00 PM	5	115	36	0	4	57	43	24	5	22	90	51	0	101	55	10	3	621
04:15 PM	9	122	38	0	0	59	26	24	4	26	121	57	1	91	45	11	5	639
04:30 PM	5	133	33	1	0	56	40	29	5	20	82	50	0	101	73	14	1	643
04:45 PM	6	122	45	0	2	60	33	44	4	24	76	38	0	102	55	10	2	623
Total	25	492	152	1	6	232	142	121	18	92	369	196	1	395	228	45	11	2526
05:00 PM	10	137	49	0	1	51	25	47	3	14	83	39	3	111	73	10	0	656
05:15 PM	3	137	35	0	0	57	26	36	5	22	90	45	4	81	50	10	3	604
Grand Total	51	999	289	2	10	467	254	276	36	169	780	378	9	761	467	84	20	5052
Apprch %	3.8	73.9	21.4	0.1	0.7	45.2	24.6	26.7	3.5	12.6	58.4	28.3	0.7	57.1	35.1	6.3	1.5	
Total %	1	19.8	5.7	0	0.2	9.2	5	5.5	0.7	3.3	15.4	7.5	0.2	15.1	9.2	1.7	0.4	

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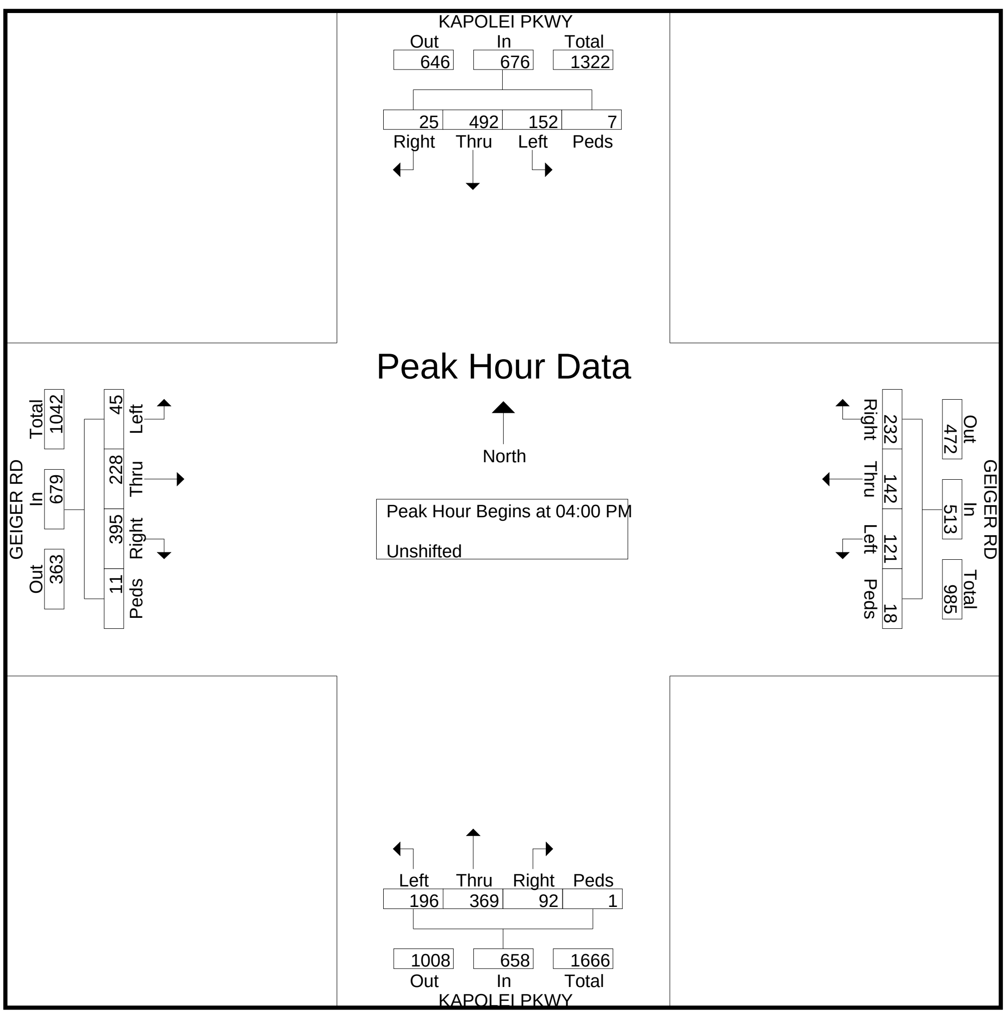
File Name : PM_Kapolei Pkwy - Geiger Rd
Site Code : 00000000
Start Date : 9/3/2014

	KAPOLEI PKWY From North						GEIGER RD From East					KAPOLEI PKWY From South					GEIGER RD From West					
Start Time	Right	Thru	Left	U-Turns	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Int. Total
Peak Hour Analysis From 04:00 PM to 04:45 PM - Peak 1 of 1																						
Peak Hour for Entire Intersection Begins at 04:00 PM																						
04:00 PM	5	115	36	0	4	160	57	43	24	5	129	22	90	51	0	163	101	55	10	3	169	621
04:15 PM	9	122	38	0	0	169	59	26	24	4	113	26	121	57	1	205	91	45	11	5	152	639
04:30 PM	5	133	33	1	0	172	56	40	29	5	130	20	82	50	0	152	101	73	14	1	189	643
04:45 PM	6	122	45	0	2	175	60	33	44	4	141	24	76	38	0	138	102	55	10	2	169	623
Total Volume	25	492	152	1	6	676	232	142	121	18	513	92	369	196	1	658	395	228	45	11	679	2526
% App. Total	3.7	72.8	22.5	0.1	0.9		45.2	27.7	23.6	3.5		14	56.1	29.8	0.2		58.2	33.6	6.6	1.6		
PHF	.694	.925	.844	.250	.375	.966	.967	.826	.688	.900	.910	.885	.762	.860	.250	.802	.968	.781	.804	.550	.898	.982



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File Name : PM_Kualakai Pkwy - Kapolei Pkwy
Site Code : 00000000
Start Date : 9/3/2014

Groups Printed- Unshifted

	KUALAKAI PKWY From North				KAPOLEI PKWY From East				KUALAKAI PKWY From South				KAPOLEI PKWY From West				
Start Time	Right	Thru	Left	Peds	Right	Thru	Left	Peds	Right	Thru	Left	Peds	Right	Thru	Left	Peds	Int. Total
03:30 PM	69	0	83	0	51	91	0	0	0	0	0	0	0	114	59	0	467
03:45 PM	91	0	67	0	70	104	0	0	0	0	0	0	0	101	63	0	496
Total	160	0	150	0	121	195	0	0	0	0	0	0	0	215	122	0	963
04:00 PM	92	0	83	0	70	93	0	1	0	0	0	0	0	102	55	4	500
04:15 PM	67	0	108	1	58	84	0	1	0	0	0	0	0	86	38	0	443
04:30 PM	90	0	92	0	64	89	0	0	0	0	0	0	0	114	68	0	517
04:45 PM	85	0	94	0	61	90	0	2	0	0	0	0	0	140	57	0	529
Total	334	0	377	1	253	356	0	4	0	0	0	0	0	442	218	4	1989
05:00 PM	81	0	106	3	49	83	0	2	0	0	0	0	0	128	54	0	506
05:15 PM	83	0	105	1	56	64	0	0	0	0	0	0	0	77	41	0	427
Grand Total	658	0	738	5	479	698	0	6	0	0	0	0	0	862	435	4	3885
Apprch %	47	0	52.7	0.4	40.5	59	0	0.5	0	0	0	0	0	66.3	33.4	0.3	
Total %	16.9	0	19	0.1	12.3	18	0	0.2	0	0	0	0	0	22.2	11.2	0.1	

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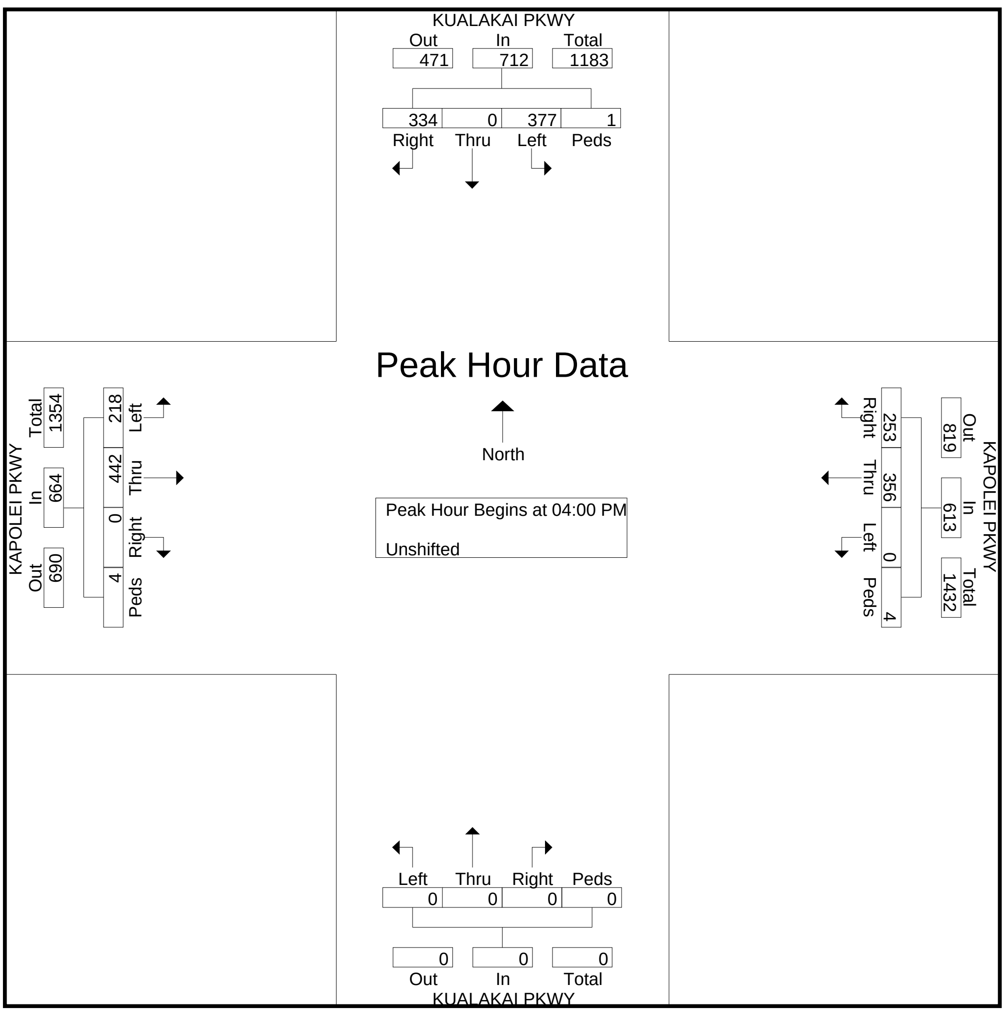
File Name : PM_Kualakai Pkwy - Kapolei Pkwy
Site Code : 00000000
Start Date : 9/3/2014

	KUALAKAI PKWY From North					KAPOLEI PKWY From East					KUALAKAI PKWY From South					KAPOLEI PKWY From West					
Start Time	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Int. Total
Peak Hour Analysis From 04:00 PM to 04:45 PM - Peak 1 of 1																					
Peak Hour for Entire Intersection Begins at 04:00 PM																					
04:00 PM	92	0	83	0	175	70	93	0	1	164	0	0	0	0	0	0	102	55	4	161	500
04:15 PM	67	0	108	1	176	58	84	0	1	143	0	0	0	0	0	0	86	38	0	124	443
04:30 PM	90	0	92	0	182	64	89	0	0	153	0	0	0	0	0	0	114	68	0	182	517
04:45 PM	85	0	94	0	179	61	90	0	2	153	0	0	0	0	0	0	140	57	0	197	529
Total Volume	334	0	377	1	712	253	356	0	4	613	0	0	0	0	0	0	442	218	4	664	1989
% App. Total	46.9	0	52.9	0.1		41.3	58.1	0	0.7		0	0	0	0		0	66.6	32.8	0.6		
PHF	.908	.000	.873	.250	.978	.904	.957	.000	.500	.934	.000	.000	.000	.000	.000	.000	.789	.801	.250	.843	.940



Austin Tsutsumi & Associates

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File Name : PM_Phillipine Sea - Renton Rd
Site Code : 00000000
Start Date : 9/3/2014
Page No : 1

Groups Printed- Class 1

	PHILLIPINE SEA From North				RENTON RD From East				PHILLIPINE SEA From South				RENTON RD From West				
Start Time	Rght	Thru	Left	Other	Rght	Thru	Left	Other	Rght	Thru	Left	Other	Rght	Thru	Left	Other	Int. Total
03:30 PM	0	0	0	0	0	2	31	0	35	0	1	0	1	2	0	0	72
03:45 PM	0	0	0	0	0	0	30	0	50	0	1	0	0	1	0	0	82
Total	0	0	0	0	0	2	61	0	85	0	2	0	1	3	0	0	154
04:00 PM	0	0	0	0	0	2	29	0	53	0	1	0	0	1	0	0	86
04:15 PM	0	0	0	0	0	0	40	0	44	0	0	0	0	0	0	0	84
04:30 PM	0	0	0	0	0	0	42	0	47	0	3	0	3	1	0	0	96
04:45 PM	0	0	0	0	0	0	24	0	49	0	2	0	0	0	0	0	75
Total	0	0	0	0	0	2	135	0	193	0	6	0	3	2	0	0	341
05:00 PM	0	0	0	0	0	0	24	0	47	0	0	0	0	2	0	0	73
05:15 PM	0	0	0	0	0	1	34	0	48	0	0	0	2	0	0	0	85
Grand Total	0	0	0	0	0	5	254	0	373	0	8	0	6	7	0	0	653
Apprch %	0	0	0	0	0	1.9	98.1	0	97.9	0	2.1	0	46.2	53.8	0	0	
Total %	0	0	0	0	0	0.8	38.9	0	57.1	0	1.2	0	0.9	1.1	0	0	

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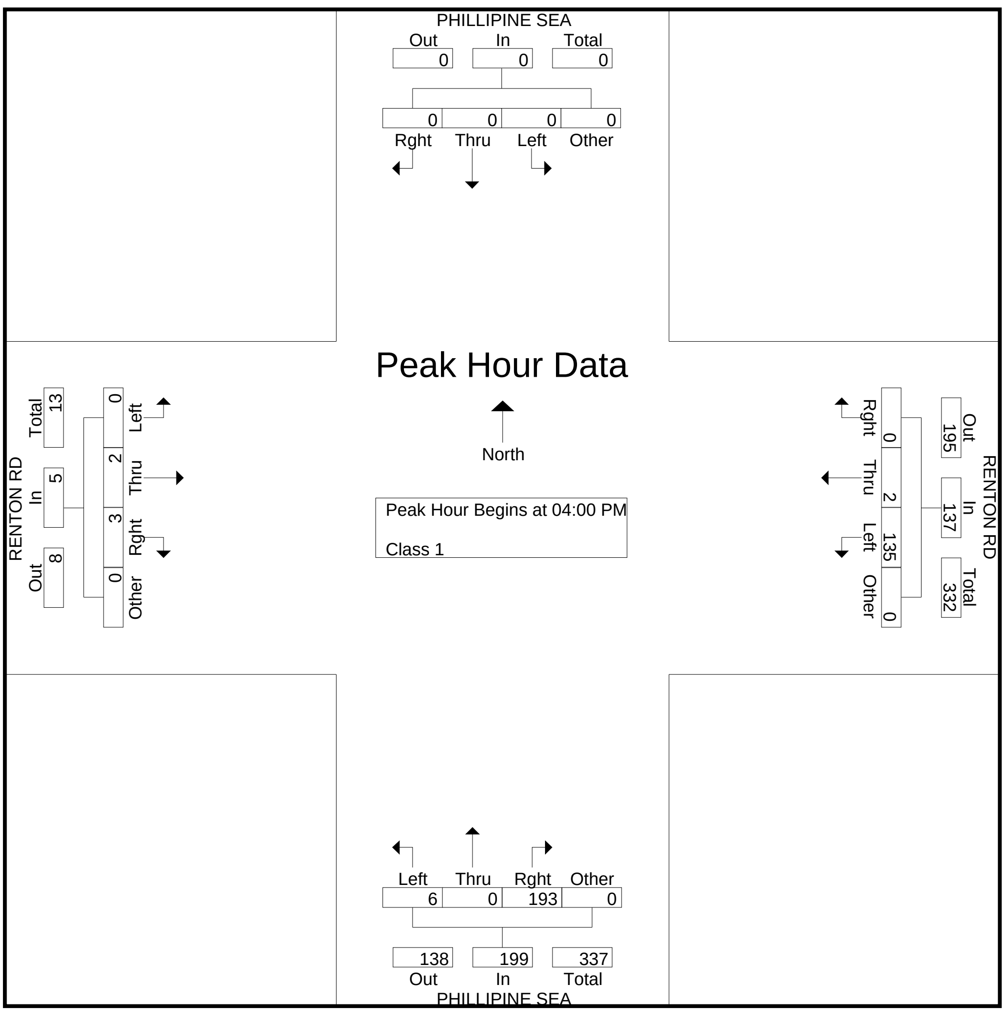
File Name : PM_Phillipine Sea - Renton Rd
Site Code : 00000000
Start Date : 9/3/2014

	PHILLIPINE SEA From North					RENTON RD From East					PHILLIPINE SEA From South					RENTON RD From West					
Start Time	Rght	Thru	Left	Other	App. Total	Rght	Thru	Left	Other	App. Total	Rght	Thru	Left	Other	App. Total	Rght	Thru	Left	Other	App. Total	Int. Total
Peak Hour Analysis From 04:00 PM to 04:45 PM - Peak 1 of 1																					
Peak Hour for Entire Intersection Begins at 04:00 PM																					
04:00 PM	0	0	0	0	0	0	2	29	0	31	53	0	1	0	54	0	1	0	0	1	86
04:15 PM	0	0	0	0	0	0	0	40	0	40	44	0	0	0	44	0	0	0	0	0	84
04:30 PM	0	0	0	0	0	0	0	42	0	42	47	0	3	0	50	3	1	0	0	4	96
04:45 PM	0	0	0	0	0	0	0	24	0	24	49	0	2	0	51	0	0	0	0	0	75
Total Volume	0	0	0	0	0	0	2	135	0	137	193	0	6	0	199	3	2	0	0	5	341
% App. Total	0	0	0	0		0	1.5	98.5	0		97	0	3	0		60	40	0	0		
PHF	.000	.000	.000	.000	.000	.000	.250	.804	.000	.815	.910	.000	.500	.000	.921	.250	.500	.000	.000	.313	.888



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File Name : PM_Phillipine Sea - Roosevelt Ave
Site Code : 00000000
Start Date : 9/3/2014

Groups Printed- Class 1

	PHILLIPINE SEA From North				ROOSEVELT AVE From East				PHILLIPINE SEA From South				ROOSEVELT AVE From West				
Start Time	Rght	Thru	Left	Other	Rght	Thru	Left	Other	Rght	Thru	Left	Other	Rght	Thru	Left	Other	Int. Total
03:30 PM	27	1	8	0	3	91	0	0	0	0	0	0	0	134	36	0	300
03:45 PM	25	0	4	0	3	75	0	0	0	0	0	0	1	143	49	0	300
Total	52	1	12	0	6	166	0	0	0	0	0	0	1	277	85	0	600
04:00 PM	25	0	0	0	3	85	0	0	0	0	0	0	0	137	44	0	294
04:15 PM	37	0	5	0	6	86	0	0	0	0	0	0	0	149	43	0	326
04:30 PM	38	0	5	0	5	91	0	0	0	0	0	0	0	136	41	0	316
04:45 PM	23	0	4	0	3	69	0	0	0	0	0	0	0	161	44	0	304
Total	123	0	14	0	17	331	0	0	0	0	0	0	0	583	172	0	1240
05:00 PM	17	0	4	0	5	69	0	0	0	0	0	0	0	161	44	0	300
05:15 PM	33	0	5	0	2	72	0	0	0	0	0	0	0	132	45	0	289
Grand Total	225	1	35	0	30	638	0	0	0	0	0	0	1	1153	346	0	2429
Apprch %	86.2	0.4	13.4	0	4.5	95.5	0	0	0	0	0	0	0.1	76.9	23.1	0	
Total %	9.3	0	1.4	0	1.2	26.3	0	0	0	0	0	0	0	47.5	14.2	0	

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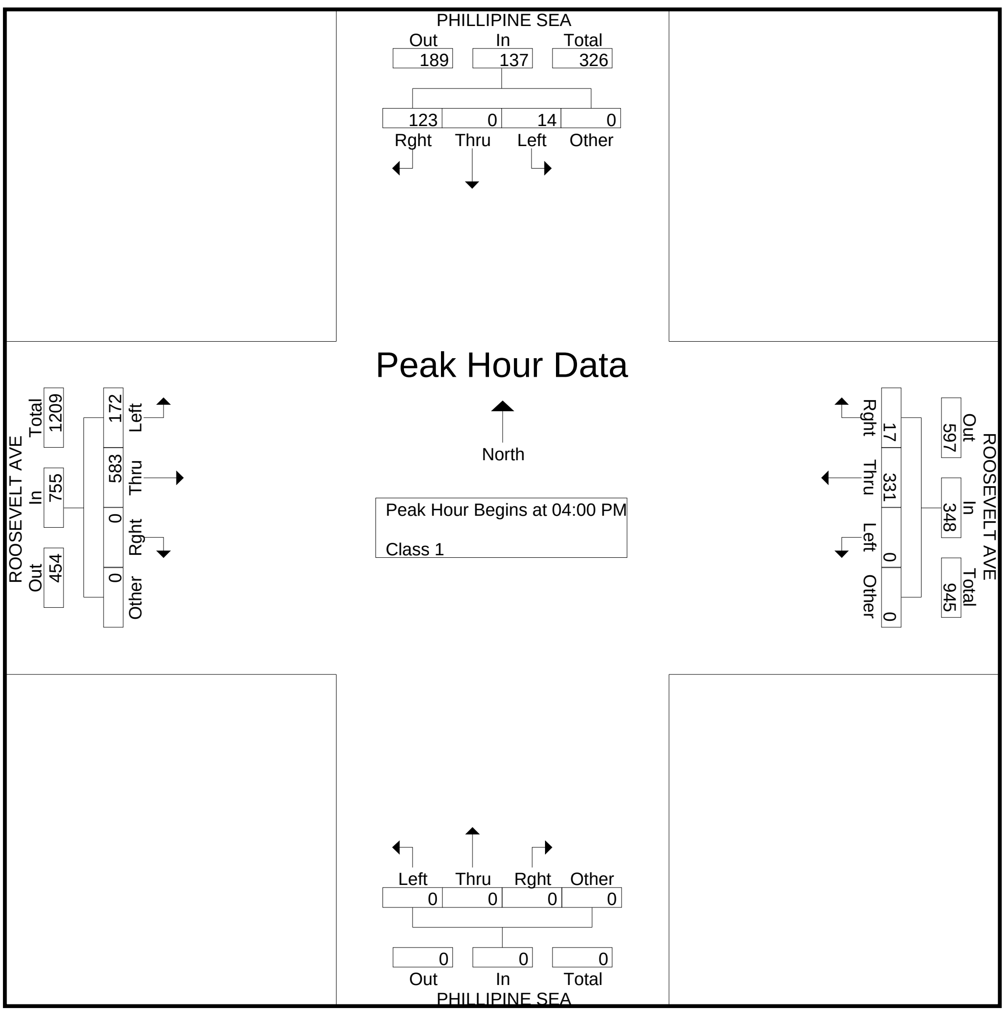
File Name : PM_Phillipine Sea - Roosevelt Ave
Site Code : 00000000
Start Date : 9/3/2014

	PHILLIPINE SEA From North					ROOSEVELT AVE From East					PHILLIPINE SEA From South					ROOSEVELT AVE From West					
Start Time	Rght	Thru	Left	Other	App. Total	Rght	Thru	Left	Other	App. Total	Rght	Thru	Left	Other	App. Total	Rght	Thru	Left	Other	App. Total	Int. Total
Peak Hour Analysis From 04:00 PM to 04:45 PM - Peak 1 of 1																					
Peak Hour for Entire Intersection Begins at 04:00 PM																					
04:00 PM	25	0	0	0	25	3	85	0	0	88	0	0	0	0	0	0	137	44	0	181	294
04:15 PM	37	0	5	0	42	6	86	0	0	92	0	0	0	0	0	0	149	43	0	192	326
04:30 PM	38	0	5	0	43	5	91	0	0	96	0	0	0	0	0	0	136	41	0	177	316
04:45 PM	23	0	4	0	27	3	69	0	0	72	0	0	0	0	0	0	161	44	0	205	304
Total Volume	123	0	14	0	137	17	331	0	0	348	0	0	0	0	0	0	583	172	0	755	1240
% App. Total	89.8	0	10.2	0		4.9	95.1	0	0		0	0	0	0		0	77.2	22.8	0		
PHF	.809	.000	.700	.000	.797	.708	.909	.000	.000	.906	.000	.000	.000	.000	.000	.000	.905	.977	.000	.921	.951



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File Name : PM_Renton Rd - Kapolei Pkwy
Site Code : 00000000
Start Date : 9/3/2014

Groups Printed- Unshifted

	RENTON RD From North				KAPOLEI PKWY From East				RENTON RD From South				KAPOLEI PKWY From West					
Start Time	Right	Thru	Left	Peds	Right	Thru	Left	Peds	Right	Thru	Left	Peds	Right	Thru	Left	U-Turns	Peds	Int. Total
03:30 PM	35	16	43	1	41	121	4	0	10	19	11	1	12	141	34	0	0	489
03:45 PM	36	15	41	0	44	108	2	0	11	28	12	0	13	126	38	0	0	474
Total	71	31	84	1	85	229	6	0	21	47	23	1	25	267	72	0	0	963
04:00 PM	51	16	45	3	25	101	12	0	12	30	18	0	8	125	47	0	0	493
04:15 PM	36	20	37	2	28	98	9	0	13	22	14	0	13	136	38	0	0	466
04:30 PM	46	16	39	0	22	97	6	0	12	28	9	0	14	153	48	0	0	490
04:45 PM	33	10	37	5	35	86	5	1	19	19	16	4	13	171	51	1	0	506
Total	166	62	158	10	110	382	32	1	56	99	57	4	48	585	184	1	0	1955
05:00 PM	37	15	35	1	22	87	4	1	11	24	11	0	12	187	33	0	0	480
05:15 PM	41	24	36	1	30	91	9	0	10	35	10	0	12	136	29	1	0	465
Grand Total	315	132	313	13	247	789	51	2	98	205	101	5	97	1175	318	2	0	3863
Apprch %	40.8	17.1	40.5	1.7	22.7	72.5	4.7	0.2	24	50.1	24.7	1.2	6.1	73.8	20	0.1	0	
Total %	8.2	3.4	8.1	0.3	6.4	20.4	1.3	0.1	2.5	5.3	2.6	0.1	2.5	30.4	8.2	0.1	0	

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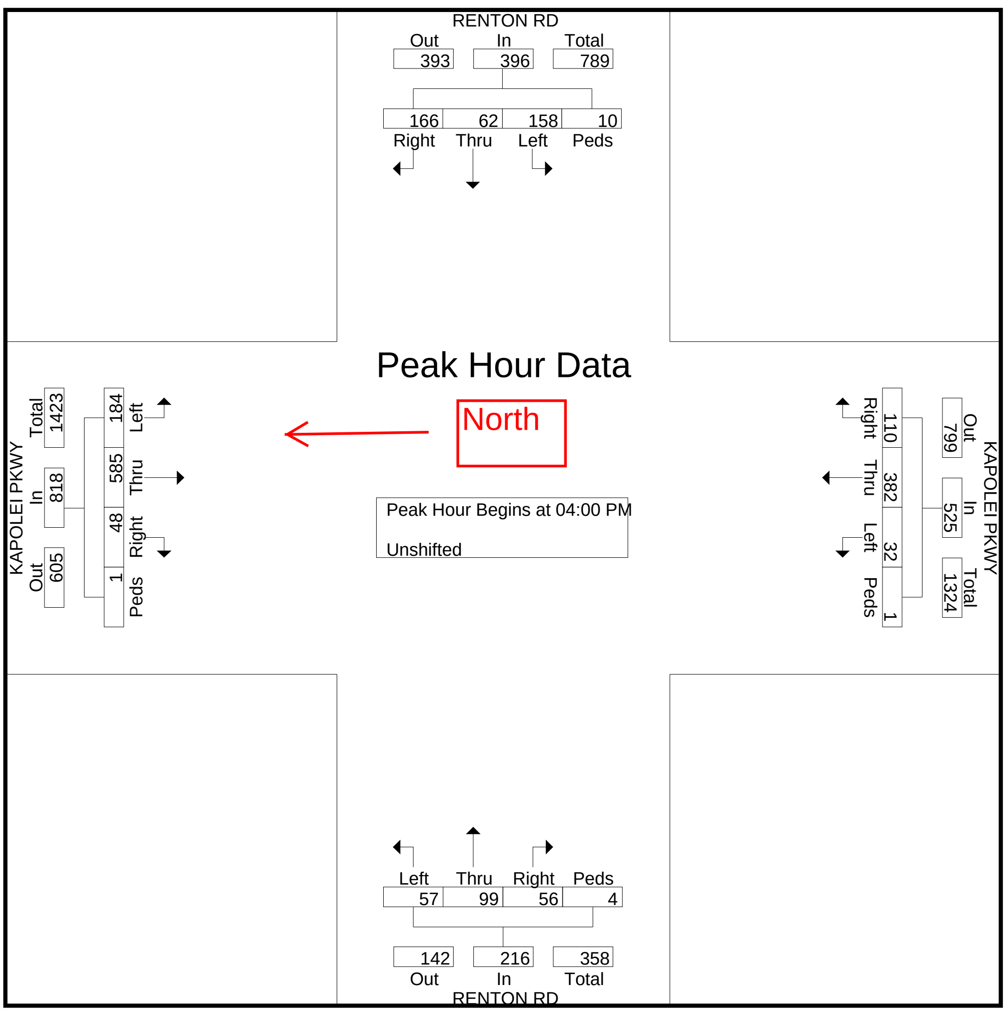
File Name : PM_Renton Rd - Kapolei Pkwy
Site Code : 00000000
Start Date : 9/3/2014
Page No : 2

	RENTON RD From North					KAPOLEI PKWY From East					RENTON RD From South					KAPOLEI PKWY From West						
Start Time	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	U-Turns	Peds	App. Total	Int. Total
Peak Hour Analysis From 04:00 PM to 04:45 PM - Peak 1 of 1																						
Peak Hour for Entire Intersection Begins at 04:00 PM																						
04:00 PM	51	16	45	3	115	25	101	12	0	138	12	30	18	0	60	8	125	47	0	0	180	493
04:15 PM	36	20	37	2	95	28	98	9	0	135	13	22	14	0	49	13	136	38	0	0	187	466
04:30 PM	46	16	39	0	101	22	97	6	0	125	12	28	9	0	49	14	153	48	0	0	215	490
04:45 PM	33	10	37	5	85	35	86	5	1	127	19	19	16	4	58	13	171	51	1	0	236	506
Total Volume	166	62	158	10	396	110	382	32	1	525	56	99	57	4	216	48	585	184	1	0	818	1955
% App. Total	41.9	15.7	39.9	2.5		21	72.8	6.1	0.2		25.9	45.8	26.4	1.9		5.9	71.5	22.5	0.1	0		
PHF	.814	.775	.878	.500	.861	.786	.946	.667	.250	.951	.737	.825	.792	.250	.900	.857	.855	.902	.250	.000	.867	.966



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File Name : PM_WWTP Dwy #1 - Geiger Rd
Site Code : 00000000
Start Date : 9/3/2014

Groups Printed- Class 1

	WWTP DWY #1 From North				GEIGER RD From East				From South				GEIGER RD From West				
Start Time	Rght	Thru	Left	Other	Rght	Thru	Left	Other	Rght	Thru	Left	Other	Rght	Thru	Left	Other	Int. Total
03:30 PM	0	0	0	0	0	101	3	0	3	0	1	0	1	129	0	0	238
03:45 PM	1	0	0	0	0	96	5	0	5	0	0	0	0	137	0	0	244
Total	1	0	0	0	0	197	8	0	8	0	1	0	1	266	0	0	482
04:00 PM	0	0	0	0	0	71	1	0	2	0	0	0	0	138	0	0	212
04:15 PM	0	0	0	0	0	95	0	0	0	0	0	0	0	165	0	0	260
04:30 PM	0	0	0	0	0	93	0	0	0	0	0	0	0	156	0	0	249
04:45 PM	0	0	0	0	1	93	0	0	0	0	0	0	0	158	1	0	253
Total	0	0	0	0	1	352	1	0	2	0	0	0	0	617	1	0	974
05:00 PM	2	0	0	0	1	69	0	0	0	0	0	0	0	169	0	0	241
05:15 PM	1	0	0	0	0	75	0	0	1	0	0	0	0	167	0	0	244
Grand Total	4	0	0	0	2	693	9	0	11	0	1	0	1	1219	1	0	1941
Apprch %	100	0	0	0	0.3	98.4	1.3	0	91.7	0	8.3	0	0.1	99.8	0.1	0	
Total %	0.2	0	0	0	0.1	35.7	0.5	0	0.6	0	0.1	0	0.1	62.8	0.1	0	

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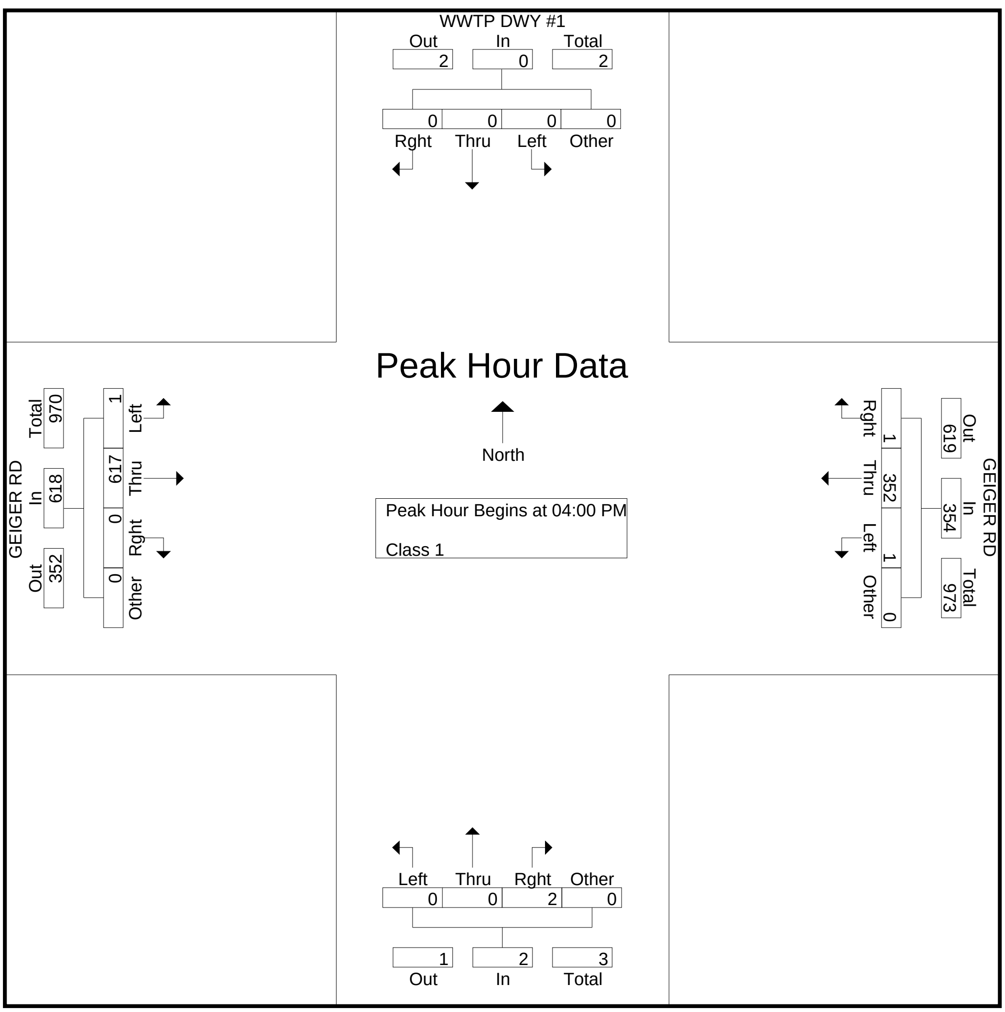
File Name : PM_WWTP Dwy #1 - Geiger Rd
Site Code : 00000000
Start Date : 9/3/2014

	WWTP DWY #1 From North					GEIGER RD From East					From South					GEIGER RD From West					
Start Time	Rght	Thru	Left	Other	App. Total	Rght	Thru	Left	Other	App. Total	Rght	Thru	Left	Other	App. Total	Rght	Thru	Left	Other	App. Total	Int. Total
Peak Hour Analysis From 04:00 PM to 04:45 PM - Peak 1 of 1																					
Peak Hour for Entire Intersection Begins at 04:00 PM																					
04:00 PM	0	0	0	0	0	0	71	1	0	72	2	0	0	0	2	0	138	0	0	138	212
04:15 PM	0	0	0	0	0	0	95	0	0	95	0	0	0	0	0	0	165	0	0	165	260
04:30 PM	0	0	0	0	0	0	93	0	0	93	0	0	0	0	0	0	156	0	0	156	249
04:45 PM	0	0	0	0	0	1	93	0	0	94	0	0	0	0	0	0	158	1	0	159	253
Total Volume	0	0	0	0	0	1	352	1	0	354	2	0	0	0	2	0	617	1	0	618	974
% App. Total	0	0	0	0		0.3	99.4	0.3	0		100	0	0	0		0	99.8	0.2	0		
PHF	.000	.000	.000	.000	.000	.250	.926	.250	.000	.932	.250	.000	.000	.000	.250	.000	.935	.250	.000	.936	.937



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File Name : PM_WWTP Dwy #2 - Geiger Rd
Site Code : 00000000
Start Date : 9/3/2014

Groups Printed- Class 1

	WWTP DWY #2 From North				GEIGER RD From East				From South				GEIGER RD From West				
Start Time	Rght	Thru	Left	Other	Rght	Thru	Left	Other	Rght	Thru	Left	Other	Rght	Thru	Left	Other	Int. Total
03:30 PM	0	0	6	0	0	94	0	0	0	0	0	0	0	132	0	0	232
03:45 PM	1	0	0	0	0	75	0	0	0	0	0	0	0	139	2	0	217
Total	1	0	6	0	0	169	0	0	0	0	0	0	0	271	2	0	449
04:00 PM	0	0	6	0	1	96	0	0	0	0	0	0	0	161	0	0	264
04:15 PM	1	0	2	0	1	94	0	0	0	0	0	0	0	157	0	0	255
04:30 PM	1	0	2	0	0	91	0	0	0	0	0	0	0	158	0	0	252
04:45 PM	0	0	0	0	0	73	0	0	0	0	0	0	0	168	0	0	241
Total	2	0	10	0	2	354	0	0	0	0	0	0	0	644	0	0	1012
05:00 PM	0	0	2	0	0	78	0	0	0	0	0	0	0	170	1	0	251
05:15 PM	2	0	0	0	0	71	0	0	0	0	0	0	0	145	1	0	219
Grand Total	5	0	18	0	2	672	0	0	0	0	0	0	0	1230	4	0	1931
Apprch %	21.7	0	78.3	0	0.3	99.7	0	0	0	0	0	0	0	99.7	0.3	0	
Total %	0.3	0	0.9	0	0.1	34.8	0	0	0	0	0	0	0	63.7	0.2	0	

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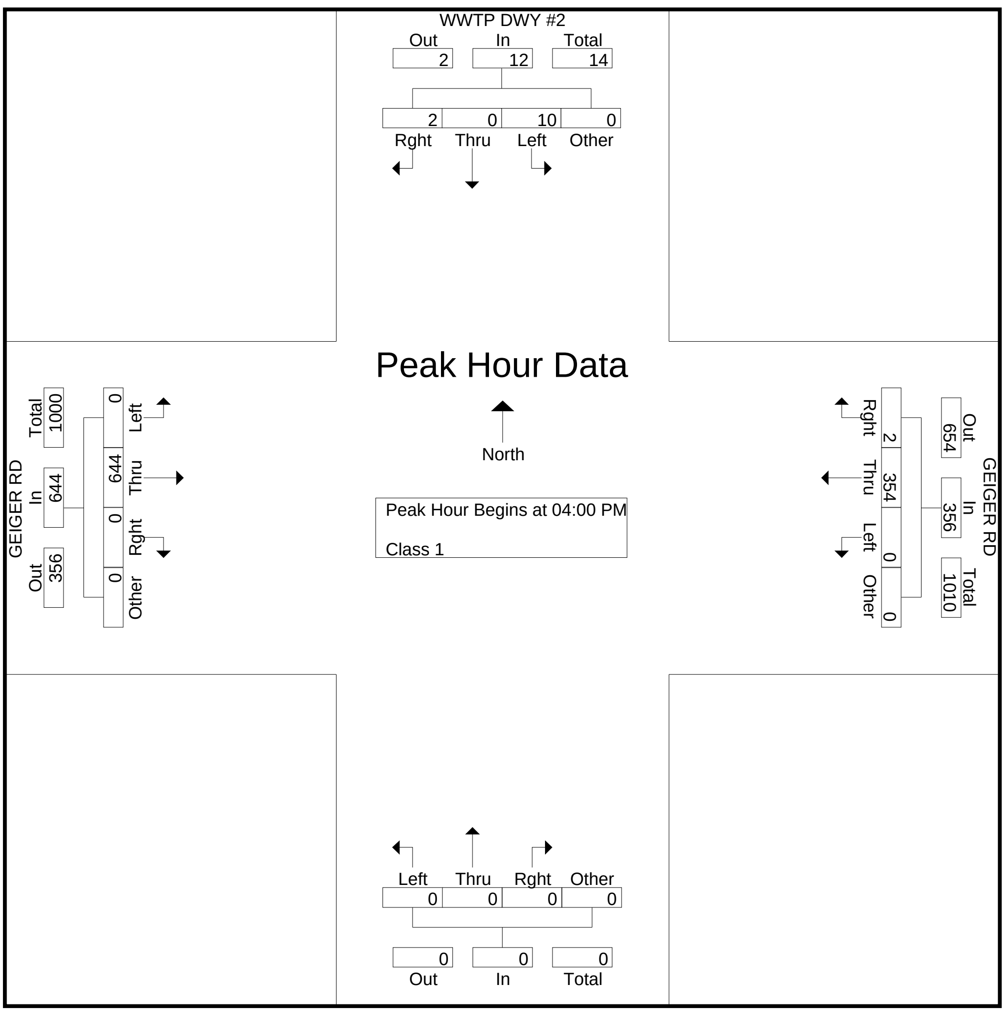
File Name : PM_WWTP Dwy #2 - Geiger Rd
Site Code : 00000000
Start Date : 9/3/2014

	WWTP DWY #2 From North					GEIGER RD From East					From South					GEIGER RD From West					
Start Time	Rght	Thru	Left	Other	App. Total	Rght	Thru	Left	Other	App. Total	Rght	Thru	Left	Other	App. Total	Rght	Thru	Left	Other	App. Total	Int. Total
Peak Hour Analysis From 04:00 PM to 04:45 PM - Peak 1 of 1																					
Peak Hour for Entire Intersection Begins at 04:00 PM																					
04:00 PM	0	0	6	0	6	1	96	0	0	97	0	0	0	0	0	0	161	0	0	161	264
04:15 PM	1	0	2	0	3	1	94	0	0	95	0	0	0	0	0	0	157	0	0	157	255
04:30 PM	1	0	2	0	3	0	91	0	0	91	0	0	0	0	0	0	158	0	0	158	252
04:45 PM	0	0	0	0	0	0	73	0	0	73	0	0	0	0	0	0	168	0	0	168	241
Total Volume	2	0	10	0	12	2	354	0	0	356	0	0	0	0	0	0	644	0	0	644	1012
% App. Total	16.7	0	83.3	0		0.6	99.4	0	0		0	0	0	0		0	100	0	0		
PHF	.500	.000	.417	.000	.500	.500	.922	.000	.000	.918	.000	.000	.000	.000	.000	.000	.958	.000	.000	.958	.958



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File Name : PM_WWTP Dwy #3 - Geiger Rd
Site Code : 00000000
Start Date : 9/3/2014
Page No : 1

Groups Printed- Class 1

	WWTP DWY #3 From North				GEIGER RD From East				From South				GEIGER RD From West				
Start Time	Rght	Thru	Left	Other	Rght	Thru	Left	Other	Rght	Thru	Left	Other	Rght	Thru	Left	Other	Int. Total
03:30 PM	7	0	10	0	4	93	0	0	0	0	0	0	0	125	7	0	246
03:45 PM	6	0	1	0	5	70	0	0	0	0	0	0	0	137	3	0	222
Total	13	0	11	0	9	163	0	0	0	0	0	0	0	262	10	0	468
04:00 PM	3	0	3	0	5	91	0	0	0	0	0	0	0	159	1	0	262
04:15 PM	2	0	4	0	4	87	0	0	0	0	0	0	0	151	2	0	250
04:30 PM	5	0	6	0	5	89	0	0	0	0	0	0	0	154	4	0	263
04:45 PM	2	0	6	0	5	69	0	0	0	0	0	0	0	164	3	0	249
Total	12	0	19	0	19	336	0	0	0	0	0	0	0	628	10	0	1024
05:00 PM	4	0	3	0	4	71	0	0	0	0	0	0	0	168	1	0	251
05:15 PM	1	0	3	0	4	71	0	0	0	0	0	0	0	143	3	0	225
Grand Total	30	0	36	0	36	641	0	0	0	0	0	0	0	1201	24	0	1968
Apprch %	45.5	0	54.5	0	5.3	94.7	0	0	0	0	0	0	0	98	2	0	
Total %	1.5	0	1.8	0	1.8	32.6	0	0	0	0	0	0	0	61	1.2	0	

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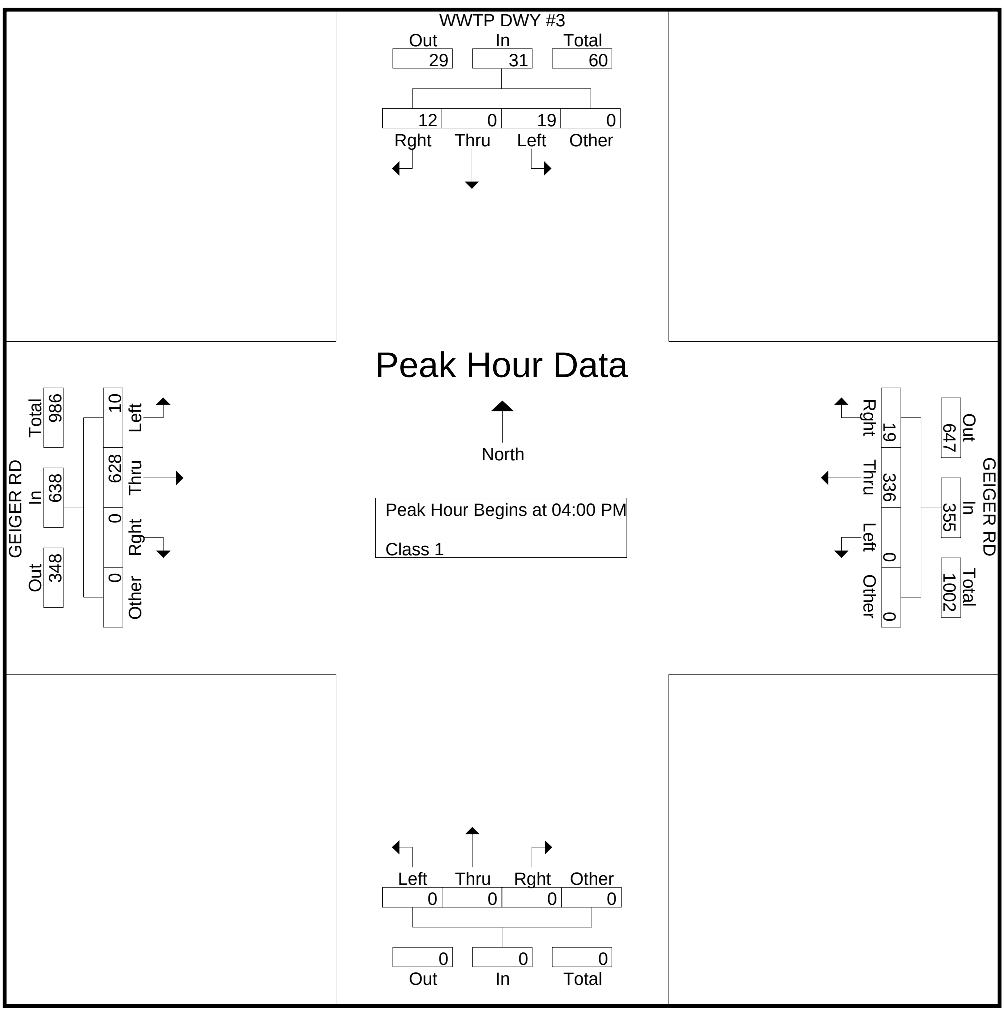
File Name : PM_WWTP Dwy #3 - Geiger Rd
Site Code : 00000000
Start Date : 9/3/2014

	WWTP DWY #3 From North					GEIGER RD From East					From South					GEIGER RD From West					
Start Time	Rght	Thru	Left	Other	App. Total	Rght	Thru	Left	Other	App. Total	Rght	Thru	Left	Other	App. Total	Rght	Thru	Left	Other	App. Total	Int. Total
Peak Hour Analysis From 04:00 PM to 04:45 PM - Peak 1 of 1																					
Peak Hour for Entire Intersection Begins at 04:00 PM																					
04:00 PM	3	0	3	0	6	5	91	0	0	96	0	0	0	0	0	0	159	1	0	160	262
04:15 PM	2	0	4	0	6	4	87	0	0	91	0	0	0	0	0	0	151	2	0	153	250
04:30 PM	5	0	6	0	11	5	89	0	0	94	0	0	0	0	0	0	154	4	0	158	263
04:45 PM	2	0	6	0	8	5	69	0	0	74	0	0	0	0	0	0	164	3	0	167	249
Total Volume	12	0	19	0	31	19	336	0	0	355	0	0	0	0	0	0	628	10	0	638	1024
% App. Total	38.7	0	61.3	0		5.4	94.6	0	0		0	0	0	0		0	98.4	1.6	0		
PHF	.600	.000	.792	.000	.705	.950	.923	.000	.000	.924	.000	.000	.000	.000	.000	.000	.957	.625	.000	.955	.973



APPENDIX B

Level of Service Criteria

APPENDIX B – LEVEL OF SERVICE (LOS) CRITERIA

VEHICULAR LEVEL OF SERVICE FOR SIGNALIZED INTERSECTIONS (HCM 2010)

Level of service for vehicles at signalized intersections is directly related to delay values and is assigned on that basis. Level of Service is a measure of the acceptability of delay values to motorists at a given intersection. The criteria are given in the table below.

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 is dependent 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 or approach in question.

VEHICULAR LEVEL OF SERVICE CRITERIA FOR UNSIGNALIZED INTERSECTIONS (HCM 2010)

The level of service criteria for vehicles at unsignalized intersections is defined as the average control delay, in seconds per vehicle.

LOS delay threshold values are lower for two-way stop-controlled (TWSC) and all-way stop-controlled (AWSC) intersections than those of signalized intersections. This is because more vehicles pass through signalized intersections, and therefore, drivers expect and tolerate greater delays. While the criteria for level of service for TWSC and AWSC intersections are the same, procedures to calculate the average total delay may differ.

Level of Service Criteria for Two-Way Stop-Controlled Intersections

Level of Service	Average Control Delay (sec/veh)
A	≤ 10
B	>10 and ≤15
C	>15 and ≤25
D	>25 and ≤35
E	>35 and ≤50
F	> 50

APPENDIX C

Full Level of Service Table

Table C1: Existing, Base Year 2021 (no mit), Future Year 2021 (no mit), Base Year 2030 (no mit), Base Year 2030 (with mit) and Future Year 2030 (no mit) Intersection Level of Service Summary

Intersection	Existing Conditions						BY 2021 (No Mit)						FY 2021 (No Mit)					
	AM			PM			AM			PM			AM			PM		
	HCM Delay	v/c Ratio	LOS	HCM Delay	v/c Ratio	LOS	HCM Delay	v/c Ratio	LOS	HCM Delay	v/c Ratio	LOS	HCM Delay	v/c Ratio	LOS	HCM Delay	v/c Ratio	LOS
1: Kapolei Pkwy & Kualakai Pkwy																		
EB LT	21.8	0.66	C	21.9	0.64	C	37.0	0.84	D	57.4	0.91	E	37.4	0.84	D	58.1	0.91	E
EB TH	3.7	0.12	A	5.8	0.18	A	16.7	0.24	B	31.4	0.38	C	17.1	0.25	B	31.3	0.38	C
EB RT	-	-	-	-	-	-	16.8	0.24	B	31.6	0.38	C	17.2	0.25	B	31.4	0.38	C
WB LT	-	-	-	-	-	-	46.1	0.61	D	62.6	0.78	E	46.6	0.61	D	63.1	0.78	E
WB TH	12.3	0.36	B	12.8	0.26	B	30.3	0.56	C	47.2	0.44	D	30.8	0.57	C	47.4	0.45	D
WB RT	7.9	0.28	A	6.3	0.19	A	19.8	0.44	B	28.3	0.45	C	19.7	0.44	B	28.4	0.46	C
NB LT	-	-	-	-	-	-	88.5	0.54	F	76.5	0.77	E	89.1	0.54	F	77.0	0.77	E
NB TH	-	-	-	-	-	-	41.3	0.29	D	56.2	0.71	E	41.7	0.29	D	57.0	0.72	E
NB TH/RT							41.2	0.29	D	56.2	0.71	E	41.7	0.29	D	57.0	0.72	E
SB LT	21.3	0.41	C	16.9	0.55	B	42.8	0.82	D	63.2	0.91	E	43.8	0.82	D	64.0	0.91	E
SB TH	-	-	-	-	-	-	28.7	0.15	C	33.4	0.33	C	28.5	0.15	C	33.9	0.33	C
SB RT	14.4	0.28	B	12.6	0.40	B	14.7	0.21	B	13.3	0.27	B	14.6	0.21	B	13.6	0.27	B
Overall	12.5	-	B	12.2	-	B	29.1	-	C	44.4	-	D	29.5	-	C	44.8	-	D
2: Kapolei Pkwy & Renton Rd																		
EB LT	26.5	0.07	C	17.5	0.14	B	34.8	0.10	C	26.8	0.19	C	36.7	0.10	D	27.8	0.26	C
EB TH/RT	23.9	0.14	C	17.1	0.31	B	30.1	0.16	C	26.1	0.37	C	30.2	0.16	C	26.9	0.42	C
WB LT	36.6	0.73	D	22.1	0.46	C	49.2	0.78	D	36.3	0.61	D	49.2	0.78	D	38.9	0.61	D
WB TH	24.4	0.21	C	16.0	0.13	B	31.2	0.25	C	24.0	0.14	C	32.1	0.33	C	23.9	0.14	C
WB RT	24.1	0.17	C	15.7	0.08	B	30.5	0.19	C	23.9	0.13	C	30.5	0.19	C	23.9	0.13	C
NB LT	62.9	0.77	E	40.7	0.66	D	73.2	0.77	E	67.6	0.79	E	73.4	0.77	E	72.2	0.79	E
NB TH	25.3	0.60	C	17.0	0.34	B	40.2	0.82	D	28.5	0.65	C	40.4	0.83	D	34.8	0.70	C
NB TH/RT	25.9	0.61	C	17.2	0.35	B	44.6	0.82	D	29.3	0.65	C	44.9	0.83	D	36.9	0.71	C
SB LT	45.2	0.85	D	28.5	0.77	C	60.7	0.90	E	51.9	0.90	D	61.0	0.90	E	44.8	0.89	D
SB TH	13.9	0.14	B	12.5	0.34	B	17.1	0.24	B	16.0	0.49	B	17.3	0.25	B	18.9	0.51	B
SB TH/RT	14.0	0.14	B	12.7	0.34	B	17.2	0.24	B	16.2	0.49	B	17.4	0.25	B	19.2	0.51	B
Overall	27.9	-	C	17.5	-	B	38.7	-	D	26.8	-	C	38.7	-	D	29.5	-	C
3: Phillipine Sea & Renton Rd																		
EB TH/RT	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
WB LT/TH	7.5	0.12	A	7.5	0.09	A	7.6	0.13	A	7.5	0.09	A	7.6	0.13	A	7.5	0.10	A
NB LT/RT	8.7	0.08	A	9.3	0.21	A	9.0	0.10	A	9.3	0.21	A	9.0	0.10	A	9.5	0.23	A
4: Phillipine Sea & Roosevelt Ave																		
EB LT/TH/RT	8.9	0.07	A	8.6	0.16	A	9.5	0.09	A	8.6	0.16	A	9.5	0.09	A	9.1	0.19	A
WB LT/TH/RT	0.0	-	A	0.0	-	A	0.0	-	A	0.0	-	A	0.0	-	A	0.0	-	A
NB LT/TH/RT	0.0	-	A	0.0	-	A	0.0	-	A	0.0	-	A	0.0	-	A	0.0	-	A
SB LT/TH/RT	18.0	0.41	C	18.0	0.35	C	26.6	0.57	D	18.0	0.35	C	26.7	0.57	D	34.4	0.59	D
5: Essex Rd & Roosevelt Ave/Geiger Rd																		
EB TH/RT	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
WB LT	7.9	0.02	A	9.0	0.01	A	8.0	0.02	A	9.0	0.01	A	8.0	0.02	A	9.5	0.02	A
WB TH	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
NB LT/RT	14.4	0.03	B	16.3	0.09	C	18.2	0.06	C	16.3	0.09	C	18.8	0.06	C	20.2	0.12	C
6: Geiger Rd & Ewa Refuse Convenience Center																		
EB LT/TH/RT	0.0	-	A	8.1	0.00	A	0.0	-	A	8.1	0.00	A	0.0	-	A	8.3	0.01	A
WB LT/TH/RT	7.9	0.01	A	8.9	0.00	A	0.0	-	A	8.9	0.00	A	0.0	-	A	0.0	-	A
NB LT/TH/RT	11.8	0.04	B	12.9	0.01	B	0.0	-	A	12.9	0.01	B	0.0	-	A	0.0	-	A
SB LT/TH/RT	0.0	-	A	0.0	-	A	0.0	-	A	0.0	-	A	0.0	-	A	0.0	-	A
7: Geiger Rd & Honouliuli Drwy 1																		
EB LT/TH	0.0	-	A	0.0	-	A	0.0	-	A	0.0	-	A	9.5	0.01	A	0.0	-	A
WB TH/RT	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SB LT/RT	14.6	0.04	B	19.2	0.05	C	18.1	0.07	C	19.2	0.05	C	19.1	0.08	C	27.6	0.19	D
8: Geiger Rd & Honouliuli Drwy 2																		
EB LT/TH/RT	8.8	0.00	A	8.1	0.01	A	9.3	0.01	A	8.1	0.01	A	9.7	0.01	A	8.3	0.01	A
WB LT/TH/RT	0.0	-	A	0.0	-	A	0.0	-	A	0.0	-	A	0.0	-	A	0.0	-	A
NB LT/TH/RT	0.0	-	A	0.0	-	A	0.0	-	A	0.0	-	A	0.0	-	A	0.0	-	A
SB LT/TH/RT	15.8	0.04	C	20.4	0.13	C	18.1	0.06	C	20.4	0.13	C	19.8	0.06	C	41.9	0.45	E
9: Kapolei Pkwy & Geiger Rd																		
EB LT	67.8	0.56	E	56.4	0.78	E	87.1	0.61	F	73.6	0.77	E	90.5	0.61	F	76.7	0.77	E
EB TH	35.2	0.35	D	30.5	0.63	C	47.1	0.31	D	46.5	0.75	D	44.9	0.25	D	50.2	0.81	D
EB TH/RT	35.2	0.36	D	31.1	0.66	C	47.2	0.32	D	47.5	0.77	D	45.0	0.26	D	53.8	0.85	D
EB RT	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
WB LT	46.9	0.77	D	42.2	0.78	D	67.9	0.80	E	71.9	0.86	E	67.8	0.80	E	77.3	0.86	E
WB TH	35.6	0.73	D	23.7	0.32	C	52.3	0.84	D	34.7	0.42	C	54.1	0.86	D	33.9	0.39	C
WB RT	29.4	0.15	C	22.4	0.14	C	39.5	0.13	D	31.3	0.13	C	38.5	0.21	D	30.9	0.14	C
NB LT	36.3	0.88	D	38.5	0.81	D	61.5	0.93	E	65.7	0.88	E	67.7	0.94	E	70.7	0.89	E
NB TH	18.2	0.53	B	23.3	0.41	C	24.5	0.66	C	35.0	0.64	C	29.2	0.70	C	38.5	0.67	D
NB RT	14.6	0.10	B	20.7	0.04	C	17.7	0.14	B	27.0	0.06	C	20.7	0.15	C	29.5	0.06	C
SB LT	42.2	0.79	D	40.1	0.79	D	66.6	0.86	E	62.0	0.86	E	67.8	0.86	E	66.1	0.86	E
SB TH	24.5	0.52	C	26.7	0.60	C	35.1	0.67	D	46.1	0.87	D	45.7	0.80	D	53.2	0.91	D
SB RT	20.5	0.01	C	22.1	0.01	C	26.8	0.02	C	28.3	0.02	C	32.8	0.03	C	30.9	0.02	C
Overall	27.9	-	C	30.3	-	C	39.5	-	D	46.3	-	D	45.2	-	D	51.0	-	D

Intersection	BY 2030 (No Mit)						BY 2030 WITH MITIGATION						FY 2030 (No Mit)					
	AM			PM			AM			PM			AM			PM		
	HCM Delay	v/c Ratio	LOS	HCM Delay	v/c Ratio	LOS	HCM Delay	v/c Ratio	LOS	HCM Delay	v/c Ratio	LOS	HCM Delay	v/c Ratio	LOS	HCM Delay	v/c Ratio	LOS
1: Kapolei Pkwy & Kualakai Pkwy																		
EB LT	41.3	0.86	D	59.7	0.92	E							42.6	0.86	D	72.6	0.96	E
EB TH	18.1	0.32	B	31.5	0.40	C							18.4	0.32	B	33.5	0.43	C
EB RT	18.2	0.32	B	31.6	0.40	C							18.5	0.32	B	33.7	0.43	C
WB LT	50.5	0.63	D	70.7	0.80	E							51.7	0.63	D	72.7	0.81	E
WB TH	34.6	0.67	C	53.4	0.49	D							35.4	0.69	D	54.6	0.52	D
WB RT	22.0	0.48	C	34.1	0.50	C							22.1	0.49	C	33.7	0.51	C
NB LT	93.3	0.54	F	84.9	0.77	F							94.7	0.55	F	86.7	0.77	F
NB TH	44.8	0.33	D	65.3	0.77	E							45.9	0.34	D	65.7	0.74	E
NB TH/RT	44.7	0.34	D	65.3	0.78	E							45.9	0.34	D	65.5	0.74	E
SB LT	48.9	0.84	D	76.1	0.93	E							50.8	0.85	D	78.0	0.94	E
SB TH	30.6	0.17	C	40.6	0.37	D							31.0	0.17	C	40.1	0.36	D
SB RT	14.8	0.23	B	13.8	0.26	B							15.0	0.23	B	14.1	0.25	B
Overall	31.8	-	C	49.4	-	D							32.6	-	C	52.7	-	D
2: Kapolei Pkwy & Renton Rd																		
EB LT	37.1	0.11	D	31.5	0.23	C	31.3	0.10	C	24.4	0.20	C	34.1	0.28	C	27.9	0.36	C
EB TH/RT	30.7	0.17	C	31.0	0.45	C	26.0	0.16	C	24.0	0.40	C	26.4	0.26	C	24.5	0.46	C
WB LT	53.9	0.81	D	56.0	0.77	E	42.8	0.77	D	36.1	0.64	D	51.5	0.81	D	40.1	0.66	D
WB TH	32.5	0.31	C	27.6	0.15	C	27.5	0.30	C	21.4	0.13	C	27.1	0.32	C	21.7	0.22	C
WB RT	33.1	0.35	C	27.7	0.16	C	26.9	0.24	C	21.6	0.16	C	26.2	0.24	C	21.3	0.17	C
NB LT	73.5	0.77	E	73.9	0.78	E	65.3	0.77	E	67.0	0.78	E	68.9	0.77	E	71.4	0.78	E
NB TH	59.5	0.97	E	34.3	0.67	C	36.3	0.86	D	28.6	0.64	C	44.1	0.90	D	33.9	0.68	C
NB TH/RT	71.3	0.97	E	35.7	0.68	C	42.0	0.86	D	29.8	0.65	C	52.3	0.91	D	35.7	0.69	C
SB LT	65.0	0.90	E	66.4	0.92	E	50.8	0.78	D	43.1	0.77	D	54.4	0.79	D	48.0	0.79	D
SB TH	19.2	0.27	B	19.1	0.52	B	18.7	0.28	B	21.4	0.60	C	21.7	0.31	C	26.5	0.67	C
SB TH/RT	19.3	0.27	B	19.3	0.52	B	18.8	0.29	B	21.7	0.60	C	21.9	0.31	C	27.2	0.67	C
Overall	50.1	-	D	33.1	-	C	35.1	-	D	27.6	-	C	40.3	-	D	31.6	-	C
3: Phillipine Sea & Renton Rd																		
EB TH/RT	-	-	-	-	-	-							-	-	-	-	-	-
WB LT/TH	7.6	0.15	A	7.5	0.11	A							-	-	-	7.5	0.11	A
NB LT/RT	9.0	0.11	A	9.6	0.25	A							-	-	-	9.6	0.25	A
4: Phillipine Sea & Roosevelt Ave																		
EB LT/TH/RT	10.2	0.11	B	9.2	0.21	A							10.3	0.11	B	9.3	0.21	A
WB LT/TH/RT	0.0	-	A	0.0	-	A							0.0	-	A	0.0	-	A
NB LT/TH/RT	0.0	-	A	0.0	-	A							0.0	-	A	0.0	-	A
SB LT/TH/RT	43.8	0.74	E	41.9	0.67	E							48.1	0.77	E	49.0	0.72	E
5: Essex Rd & Roosevelt Ave/Geiger Rd																		
EB TH/RT	-	-	-	-	-	-							-	-	-	-	-	-
WB LT	8.0	0.02	A	9.6	0.02	A							8.1	0.02	A	9.8	0.02	A
WB TH	-	-	-	-	-	-							-	-	-	-	-	-
NB LT/RT	21.2	0.07	C	20.1	0.14	C							22.5	0.07	C	21.6	0.15	C
6: Geiger Rd & Ewa Refuse Convenience Center																		
EB LT/TH/RT	0.0	-	A	8.4	0.01	A							0.0	-	A	8.5	0.01	A
WB LT/TH/RT	0.0	-	A	0.0	-	A							0.0	-	A	0.0	-	A
NB LT/TH/RT	0.0	-	A	0.0	-	A							0.0	-	A	0.0	-	A
SB LT/TH/RT	0.0	-	A	0.0	-	A							0.0	-	A	0.0	-	A
7: Geiger Rd & Honouliuli Drwy 1																		
EB LT/TH	0.0	-	A	0.0	-	A							10.1	0.01	B	8.5	0.01	A
WB TH/RT	-	-	-	-	-	-							-	-	-	-	-	-
SB LT/RT	21.7	0.09	C	22.4	0.07	C							25.8	0.18	D	36.1	0.34	E
8: Geiger Rd & Honouliuli Drwy 2																		
EB LT/TH/RT	9.9	0.01	A	8.4	0.01	A							10.3	0.02	B	8.6	0.02	A
WB LT/TH/RT	0.0	-	A	0.0	-	A							0.0	-	A	0.0	-	A
NB LT/TH/RT	0.0	-	A	0.0	-	A							0.0	-	A	0.0	-	A
SB LT/TH/RT	21.6	0.07	C	27.5	0.19	D							35.2	0.27	E	90.2	0.76	F
9: Kapolei Pkwy & Geiger Rd																		
EB LT	99.4	0.62	F	77.6	0.77	E	83.7	0.60	F	74.6	0.77	E	86.5	0.60	F	78.4	0.77	E
EB TH	52.5	0.28	D	52.4	0.81	D	44.1	0.46	D	53.2	0.82	D	44.5	0.53	D	52.3	0.85	D
EB TH/RT	52.5	0.29	D	54.2	0.83	D	-	-	-	-	-	-	-	-	-	-	-	-
EB RT	-	-	-	-	-	-	40.5	0.09	D	48.3	0.70	D	39.9	0.10	D	54.6	0.86	D
WB LT	86.9	0.83	F	87.3	0.90	F	67.9	0.81	E	67.9	0.88	E	72.0	0.81	E	77.9	0.89	E
WB TH	68.2	0.89	E	35.4	0.41	D	50.0	0.85	D	34.7	0.42	C	54.1	0.87	D	32.7	0.43	C
WB RT	44.9	0.23	D	32.2	0.15	C	35.2	0.16	D	31.5	0.16	C	34.9	0.20	C	29.1	0.17	C
NB LT	97.9	1.03	F*	73.4	0.89	E	53.2	0.86	D	59.4	0.77	E	49.7	0.85	D	66.2	0.82	E
NB TH	34.4	0.81	C	41.7	0.74	D	39.2	0.91	D	40.0	0.75	D	46.4	0.95	D	50.7	0.84	D
NB RT	21.6	0.23	C	30.2	0.06	C	21.1	0.24	C	28.9	0.05	C	23.1	0.24	C	34.1	0.05	C
SB LT	86.3	0.89	F	70.9	0.88	E	70.5	0.87	E	61.4	0.87	E	74.8	0.87	E	73.9	0.88	E
SB TH	46.2	0.78	D	61.6	0.96	E	30.5	0.66	C	37.9	0.80	D	35.7	0.72	D	54.4	0.92	D
SB RT	32.8	0.03	C	30.9	0.02	C	22.4	0.03	C	24.5	0.02	C	25.7	0.03	C	30.2	0.02	C
Overall	53.3	-	D	55.9	-	E	41.9	-	D	45.2	-	D	46.1	-	D	54.5	-	D

Note:
* = over-capacity, v/c > 1

Table C1: Existing, Base Year 2021 (no mit), Future Year 2021 (no mit), Base Year 2030 (no mit), Base Year 2030 (with mit) and Future Year 2030 (no mit) Intersection Level of Service Summary (continued)

	Existing Conditions						BY 2021 (No Mit)						FY 2021 (No Mit)						BY 2030 (No Mit)						BY 2030 WITH MITIGATION						FY 2030 (No Mit)					
	AM			PM			AM			PM			AM			PM			AM			PM			AM			PM			AM			PM		
Intersection	HCM Delay	v/c Ratio	LOS	HCM Delay	v/c Ratio	LOS	HCM Delay	v/c Ratio	LOS	HCM Delay	v/c Ratio	LOS	HCM Delay	v/c Ratio	LOS	HCM Delay	v/c Ratio	LOS	HCM Delay	v/c Ratio	LOS	HCM Delay	v/c Ratio	LOS	HCM Delay	v/c Ratio	LOS	HCM Delay	v/c Ratio	LOS	HCM Delay	v/c Ratio	LOS	HCM Delay	v/c Ratio	LOS
10: Ft Weaver Rd & Geiger Rd/Iroquois Rd																																				
EB LT	107.0	0.65	F	106.7	0.65	F	107.2	0.68	F	104.6	0.65	F	107.4	0.68	F	99.7	0.62	F	108.7	0.73	F	103.8	0.67	F							110.7	0.76	F	97.0	0.61	F
EB LT/TH	101.9	0.63	F	102.5	0.65	F	101.8	0.66	F	100.0	0.65	F	101.4	0.66	F	96.7	0.62	F	101.9	0.71	F	99.8	0.67	F							101.9	0.72	F	94.3	0.62	F
EB RT	97.2	0.39	F	99.1	0.48	F	102.9	0.61	F	106.7	0.68	F	102.4	0.60	F	114.6	0.80	F	106.8	0.70	F	107.7	0.72	F							112.5	0.77	F	122.9	0.88	F
WB LT	85.3	0.18	F	90.3	0.05	F	85.0	0.19	F	86.7	0.06	F	85.3	0.19	F	87.6	0.06	F	84.0	0.20	F	81.4	0.05	F							84.3	0.20	F	85.3	0.06	F
WB TH	105.2	0.75	F	116.8	0.78	F	109.3	0.80	F	117.9	0.83	F	110.1	0.80	F	122.6	0.85	F	112.4	0.83	F	121.1	0.89	F							113.7	0.84	F	150.4	0.99	F
WB RT	85.2	0.19	F	90.4	0.06	F	85.4	0.23	F	87.5	0.12	F	85.6	0.23	F	88.5	0.12	F	85.1	0.28	F	83.7	0.19	F							85.4	0.28	F	87.7	0.20	F
NB LT	111.0	0.61	F	111.1	0.59	F	110.9	0.67	F	110.8	0.69	F	112.9	0.75	F	110.8	0.69	F	110.8	0.68	F	110.4	0.72	F							112.3	0.74	F	111.2	0.75	F
NB TH	35.9	0.53	D	33.2	0.33	C	39.0	0.56	D	38.6	0.38	D	39.1	0.56	D	39.9	0.39	D	44.8	0.62	D	46.8	0.50	D							45.1	0.63	D	46.8	0.50	D
NB RT	26.0	0.00	C	28.2	0.01	C	28.0	0.00	C	32.3	0.01	C	28.1	0.0	C	33.3	0.01	C	31.1	0.01	C	36.8	0.01	D							31.3	0.01	C	36.8	0.01	D
SB LT	77.0	0.63	E	119.0	0.80	F	82.7	0.67	F	123.1	0.80	F	82.7	0.67	F	123.7	0.80	F	97.7	0.73	F	125.8	0.81	F							98.0	0.73	F	125.1	0.81	F
SB TH	50.1	0.34	D	29.3	0.54	C	56.6	0.39	E	37.2	0.62	D	59.5	0.40	E	39.0	0.63	D	63.7	0.52	E	47.4	0.78	D							65.2	0.53	E	50.0	0.79	D
SB RT	141.5	0.08	F	32.3	0.17	C	215.0	0.10	F	36.0	0.20	D	236.8	0.10	F	37.9	0.20	D	130.3	0.13	F	38.8	0.22	D							133.7	0.14	F	41.2	0.25	D
Overall	65.2	0.60	E	57.8	0.64	E	72.6	0.63	E	64.4	0.70	E	75.2	0.65	E	66.3	0.73	E	74.6	0.69	E	69.5	0.80	E							76.4	0.71	E	73.4	0.85	E
11: Ft Weaver Rd & Renton Rd																																				
EB LT	111.0	0.79	F	112.4	0.79	F	113.0	0.81	F	114.2	0.83	F	111.3	0.81	F	112.9	0.84	F	113.1	0.81	F	113.6	0.81	F							107.9	0.81	F	113.6	0.85	F
EB LT/TH	109.3	0.77	F	111.6	0.79	F	110.8	0.80	F	112.8	0.82	F	109.2	0.79	F	113.6	0.84	F	111.5	0.79	F	113.3	0.81	F							110.0	0.82	F	114.3	0.85	F
EB RT	86.5	0.16	F	86.3	0.09	F	87.6	0.27	F	87.2	0.26	F	86.9	0.26	F	84.5	0.25	F	87.5	0.22	F	87.2	0.22	F							82.7	0.20	F	83.2	0.21	F
WB LT/TH	118.6	0.34	F	121.2	0.63	F	118.9	0.39	F	122.3	0.66	F	118.9	0.39	F	122.3	0.66	F	119.6	0.46	F	122.3	0.66	F							119.6	0.46	F	122.3	0.66	F
WB RT	111.6	0.01	F	104.5	0.02	F	111.2	0.01	F	103.4	0.02	F	111.2	0.01	F	103.4	0.02	F	110.5	0.01	F	103.5	0.02	F							110.5	0.01	F	103.5	0.02	F
NB LT	120.7	0.81	F	100.3	0.70	F	124.9	0.85	F	100.3	0.74	F	125.7	0.85	F	100.5	0.74	F	126.8	0.90	F	98.8	0.75	F							139.8	0.95	F	99.4	0.75	F
NB TH	21.8	0.87	C	28.7	0.48	C	22.4	0.87	C	32.0	0.53	C	22.8	0.87	C	33.7	0.54	C	23.0	0.88	C	34.6	0.61	C							27.0	0.91	C	37.7	0.64	D
NB RT	14.9	0.01	B	40.0	0.05	D	15.4	0.02	B	41.3	0.05	D	15.6	0.02	B	44.2	0.05	D	15.5	0.02	B	40.8	0.06	D							17.3	0.02	B	44.1	0.06	D
SB LT	123.1	0.58	F	111.9	0.59	F	126.9	0.66	F	113.6	0.62	F	128.3	0.67	F	113.8	0.62	F	127.5	0.68	F	115.2	0.64	F							131.7	0.71	F	115.1	0.64	F
SB TH	31.3	0.44	C	54.6	0.95	D	37.2	0.51	D	64.5	0.99	E	37.8	0.52	D	73.1	**1.01**	E*	48.5	0.69	D	86.0	1.06	**F***							51.1	0.71	D	105.5	**1.10**	**F***
SB RT	45.8	0.17	D	34.6	0.21	C	56.2	0.23	E	40.3	0.27	D	58.3	0.26	E	42.4	0.27	D	63.5	0.29	E	38.6	0.27	D							68.7	0.31	E	44.0	0.32	D
Overall	39.8	0.84	D	53.9	0.88	D	44.3	0.85	D	60.5	0.90	E	44.8	0.86	D	65.5	0.92	E	49.1	0.87	D	70.4	0.95	E							53.3	0.90	D	80.9	0.98	F
12: Geiger Rd & Honouliuli Drwy 3																																				
EB LT/TH													9.8	0.01	A	0.0	-	A													10.3	0.01	B	8.6	0.01	A
WB TH/RT													-	-	-	-	-	-													-	-	-	-	-	-
SB LT/RT													23.8	0.03	C	30.9	0.24	D													30.2	0.16	D	50.8	0.44	F
13: Roosevelt Ave & Honouliuli Drwy 4																																				
EB LT/TH													9.3	0.01	A	0.0	-	A													9.8	0.01	A	8.5	0.01	A
WB TH/RT													-	-	-	-	-	-													-	-	-	-	-	-
SB LT/RT													0.0	-	A	21.3	0.13	C													22.7	0.12	C	27.5	0.25	D
14: Honouliuli Drwy 5 & Renton Rd																																				
EB TH/RT													-	-	-	-	-	-													-	-	-	-	-	-
WB LT													7.5	0.06	A	7.7	0.00	A													7.5	0.04	A	8.1	0.12	A
WB TH													-	-	-	-	-	-													-	-	-	-	-	-
NB LT/RT													8.8	0.01	A	10.0	0.11	B													9.4	0.14	A	10.6	0.19	B

Note:
* = over-capacity, v/c > 1

APPENDIX D

Level of Service Calculations

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (veh/h)	333	364	604	360	170	208
Number	5	2	6	16	7	14
Initial Q (Qb), veh	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00			1.00	1.00	1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1863	1863	1863	1863	1863	1863
Adj Flow Rate, veh/h	362	396	657	391	185	226
Adj No. of Lanes	2	3	3	2	2	2
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Percent Heavy Veh, %	2	2	2	2	2	2
Cap, veh/h	550	3242	1842	1376	453	812
Arrive On Green	0.16	0.64	0.36	0.36	0.13	0.13
Sat Flow, veh/h	3442	5253	5253	2787	3442	2787
Grp Volume(v), veh/h	362	396	657	391	185	226
Grp Sat Flow(s),veh/h/ln	1721	1695	1695	1393	1721	1393
Q Serve(g_s), s	5.1	1.6	4.9	4.3	2.6	3.3
Cycle Q Clear(g_c), s	5.1	1.6	4.9	4.3	2.6	3.3
Prop In Lane	1.00			1.00	1.00	1.00
Lane Grp Cap(c), veh/h	550	3242	1842	1376	453	812
V/C Ratio(X)	0.66	0.12	0.36	0.28	0.41	0.28
Avail Cap(c_a), veh/h	1788	7925	4696	2940	2781	2697
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	20.5	3.7	12.1	7.7	20.7	14.2
Incr Delay (d2), s/veh	1.3	0.0	0.1	0.1	0.6	0.2
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	2.5	0.7	2.3	2.1	1.2	2.8
LnGrp Delay(d),s/veh	21.8	3.7	12.3	7.9	21.3	14.4
LnGrp LOS	C	A	B	A	C	B
Approach Vol, veh/h		758	1048		411	
Approach Delay, s/veh		12.4	10.6		17.5	
Approach LOS		B	B		B	

Timer	1	2	3	4	5	6	7	8
Assigned Phs		2		4	5	6		
Phs Duration (G+Y+Rc), s		39.1		12.8	14.3	24.8		
Change Period (Y+Rc), s		6.0		6.0	6.0	6.0		
Max Green Setting (Gmax), s		81.0		42.0	27.0	48.0		
Max Q Clear Time (g_c+I1), s		3.6		5.3	7.1	6.9		
Green Ext Time (p_c), s		12.8		1.6	1.2	11.9		

Intersection Summary	
HCM 2010 Ctrl Delay	12.5
HCM 2010 LOS	B

Notes

User approved changes to right turn type.

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	24	61	16	288	108	290	43	705	350	213	289	42
Number	3	8	18	7	4	14	5	2	12	1	6	16
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1863	1863	1900	1863	1863	1863	1863	1863	1900	1863	1863	1900
Adj Flow Rate, veh/h	26	66	12	313	117	82	47	766	300	232	314	32
Adj No. of Lanes	1	1	0	1	1	1	1	3	0	1	3	0
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Percent Heavy Veh, %	2	2	2	2	2	2	2	2	2	2	2	2
Cap, veh/h	376	460	84	431	559	475	61	1267	492	274	2216	222
Arrive On Green	0.30	0.30	0.30	0.30	0.30	0.30	0.03	0.35	0.35	0.15	0.47	0.47
Sat Flow, veh/h	1179	1535	279	1316	1863	1583	1774	3606	1400	1774	4700	470
Grp Volume(v), veh/h	26	0	78	313	117	82	47	720	346	232	225	121
Grp Sat Flow(s),veh/h/ln	1179	0	1814	1316	1863	1583	1774	1695	1616	1774	1695	1780
Q Serve(g_s), s	1.6	0.0	2.9	21.2	4.3	3.5	2.4	16.2	16.4	11.8	3.5	3.6
Cycle Q Clear(g_c), s	5.9	0.0	2.9	24.1	4.3	3.5	2.4	16.2	16.4	11.8	3.5	3.6
Prop In Lane	1.00		0.15	1.00		1.00	1.00		0.87	1.00		0.26
Lane Grp Cap(c), veh/h	376	0	544	431	559	475	61	1191	568	274	1599	839
V/C Ratio(X)	0.07	0.00	0.14	0.73	0.21	0.17	0.77	0.60	0.61	0.85	0.14	0.14
Avail Cap(c_a), veh/h	455	0	665	519	683	581	555	2889	1377	555	2889	1516
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	0.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	26.4	0.0	23.7	32.5	24.2	24.0	44.4	24.8	24.8	38.1	13.9	13.9
Incr Delay (d2), s/veh	0.1	0.0	0.1	4.1	0.2	0.2	18.5	0.5	1.1	7.1	0.0	0.1
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	0.5	0.0	1.5	8.1	2.3	1.6	1.5	7.7	7.5	6.3	1.6	1.8
LnGrp Delay(d),s/veh	26.5	0.0	23.9	36.6	24.4	24.1	62.9	25.3	25.9	45.2	13.9	14.0
LnGrp LOS	C		C	D	C	C	E	C	C	D	B	B
Approach Vol, veh/h		104			512			1113			578	
Approach Delay, s/veh		24.5			31.8			27.0			26.5	
Approach LOS		C			C			C			C	

Timer	1	2	3	4	5	6	7	8
Assigned Phs	1	2		4	5	6		8
Phs Duration (G+Y+Rc), s	20.3	38.6		33.8	9.2	49.7		33.8
Change Period (Y+Rc), s	6.0	6.0		6.0	6.0	6.0		6.0
Max Green Setting (Gmax), s	29.0	79.0		34.0	29.0	79.0		34.0
Max Q Clear Time (g_c+I1), s	13.8	18.4		26.1	4.4	5.6		7.9
Green Ext Time (p_c), s	0.6	14.2		1.7	0.1	14.4		2.7

Intersection Summary	
HCM 2010 Ctrl Delay	27.9
HCM 2010 LOS	C

Intersection	
Int Delay, s/veh	7.8

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Vol, veh/h	1	1	181	1	2	80
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	-	-	0	-
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	1	1	197	1	2	87

Major/Minor	Major1		Major2		Minor1	
Conflicting Flow All	0	0	2	0	397	2
Stage 1	-	-	-	-	2	-
Stage 2	-	-	-	-	395	-
Critical Hdwy	-	-	4.12	-	6.42	6.22
Critical Hdwy Stg 1	-	-	-	-	5.42	-
Critical Hdwy Stg 2	-	-	-	-	5.42	-
Follow-up Hdwy	-	-	2.218	-	3.518	3.318
Pot Cap-1 Maneuver	-	-	1620	-	608	1082
Stage 1	-	-	-	-	1021	-
Stage 2	-	-	-	-	681	-
Platoon blocked, %	-	-		-		
Mov Cap-1 Maneuver	-	-	1620	-	534	1082
Mov Cap-2 Maneuver	-	-	-	-	534	-
Stage 1	-	-	-	-	1021	-
Stage 2	-	-	-	-	598	-

Approach	EB	WB	NB
HCM Control Delay, s	0	7.5	8.7
HCM LOS			A

Minor Lane/Major Mvmt	NBLn1	EBT	EBR	WBL	WBT
Capacity (veh/h)	1056	-	-	1620	-
HCM Lane V/C Ratio	0.084	-	-	0.121	-
HCM Control Delay (s)	8.7	-	-	7.5	0
HCM Lane LOS	A	-	-	A	A
HCM 95th %tile Q(veh)	0.3	-	-	0.4	-

Intersection	
Int Delay, s/veh	3.6

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Vol, veh/h	64	267	0	0	530	14	0	0	0	11	0	166
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Free	Free	Stop	Stop	Stop	Stop	Stop	Stop
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	-	-	-	-	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	92	92	92	92	92	92	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2	2	2	2	2	2	2
Mvmt Flow	70	290	0	0	576	15	0	0	0	12	0	180

Major/Minor	Major1			Major2			Minor1			Minor2		
Conflicting Flow All	591	0	0	290	0	0	1103	1020	290	1013	1013	584
Stage 1	-	-	-	-	-	-	429	429	-	584	584	-
Stage 2	-	-	-	-	-	-	674	591	-	429	429	-
Critical Hdwy	4.12	-	-	4.12	-	-	7.12	6.52	6.22	7.12	6.52	6.22
Critical Hdwy Stg 1	-	-	-	-	-	-	6.12	5.52	-	6.12	5.52	-
Critical Hdwy Stg 2	-	-	-	-	-	-	6.12	5.52	-	6.12	5.52	-
Follow-up Hdwy	2.218	-	-	2.218	-	-	3.518	4.018	3.318	3.518	4.018	3.318
Pot Cap-1 Maneuver	985	-	-	1272	-	-	189	237	749	217	239	512
Stage 1	-	-	-	-	-	-	604	584	-	498	498	-
Stage 2	-	-	-	-	-	-	444	494	-	604	584	-
Platoon blocked, %		-	-		-	-						
Mov Cap-1 Maneuver	985	-	-	1272	-	-	114	217	749	203	219	512
Mov Cap-2 Maneuver	-	-	-	-	-	-	114	217	-	203	219	-
Stage 1	-	-	-	-	-	-	553	534	-	456	498	-
Stage 2	-	-	-	-	-	-	288	494	-	553	534	-

Approach	EB	WB	NB	SB
HCM Control Delay, s	1.7	0	0	18
HCM LOS			A	C

Minor Lane/Major Mvmt	NBLn1	EBL	EBT	EBR	WBL	WBT	WBR	SBLn1
Capacity (veh/h)	-	985	-	-	1272	-	-	468
HCM Lane V/C Ratio	-	0.071	-	-	-	-	-	0.411
HCM Control Delay (s)	0	8.9	0	-	0	-	-	18
HCM Lane LOS	A	A	A	-	A	-	-	C
HCM 95th %tile Q(veh)	-	0.2	-	-	0	-	-	2

Intersection	
Int Delay, s/veh	0.4

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Vol, veh/h	265	5	23	556	5	4
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	50	-	0	-
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	288	5	25	604	5	4

Major/Minor	Major1		Major2		Minor1	
Conflicting Flow All	0	0	293	0	945	291
Stage 1	-	-	-	-	291	-
Stage 2	-	-	-	-	654	-
Critical Hdwy	-	-	4.12	-	6.42	6.22
Critical Hdwy Stg 1	-	-	-	-	5.42	-
Critical Hdwy Stg 2	-	-	-	-	5.42	-
Follow-up Hdwy	-	-	2.218	-	3.518	3.318
Pot Cap-1 Maneuver	-	-	1269	-	291	748
Stage 1	-	-	-	-	759	-
Stage 2	-	-	-	-	517	-
Platoon blocked, %	-	-		-		
Mov Cap-1 Maneuver	-	-	1269	-	285	748
Mov Cap-2 Maneuver	-	-	-	-	285	-
Stage 1	-	-	-	-	759	-
Stage 2	-	-	-	-	507	-

Approach	EB	WB	NB
HCM Control Delay, s	0	0.3	14.4
HCM LOS			B

Minor Lane/Major Mvmt	NBLn1	EBT	EBR	WBL	WBT
Capacity (veh/h)	393	-	-	1269	-
HCM Lane V/C Ratio	0.025	-	-	0.02	-
HCM Control Delay (s)	14.4	-	-	7.9	-
HCM Lane LOS	B	-	-	A	-
HCM 95th %tile Q(veh)	0.1	-	-	0.1	-

Intersection												
Int Delay, s/veh	0.3											

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Vol, veh/h	0	271	1	8	592	0	3	0	15	0	0	0
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Free	Free	Stop	Stop	Stop	Stop	Stop	Stop
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	-	-	-	-	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	92	92	92	92	92	92	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2	2	2	2	2	2	2
Mvmt Flow	0	295	1	9	643	0	3	0	16	0	0	0

Major/Minor	Major1			Major2			Minor1			Minor2		
Conflicting Flow All	643	0	0	296	0	0	956	956	295	964	957	643
Stage 1	-	-	-	-	-	-	295	295	-	661	661	-
Stage 2	-	-	-	-	-	-	661	661	-	303	296	-
Critical Hdwy	4.12	-	-	4.12	-	-	7.12	6.52	6.22	7.12	6.52	6.22
Critical Hdwy Stg 1	-	-	-	-	-	-	6.12	5.52	-	6.12	5.52	-
Critical Hdwy Stg 2	-	-	-	-	-	-	6.12	5.52	-	6.12	5.52	-
Follow-up Hdwy	2.218	-	-	2.218	-	-	3.518	4.018	3.318	3.518	4.018	3.318
Pot Cap-1 Maneuver	942	-	-	1265	-	-	238	258	744	235	258	473
Stage 1	-	-	-	-	-	-	713	669	-	452	460	-
Stage 2	-	-	-	-	-	-	452	460	-	706	668	-
Platoon blocked, %		-	-		-	-						
Mov Cap-1 Maneuver	942	-	-	1265	-	-	236	255	744	228	255	473
Mov Cap-2 Maneuver	-	-	-	-	-	-	236	255	-	228	255	-
Stage 1	-	-	-	-	-	-	713	669	-	452	455	-
Stage 2	-	-	-	-	-	-	447	455	-	691	668	-

Approach	EB	WB	NB	SB
HCM Control Delay, s	0	0.1	11.8	0
HCM LOS			B	A

Minor Lane/Major Mvmt	NBLn1	EBL	EBT	EBR	WBL	WBT	WBR	SBLn1
Capacity (veh/h)	548	942	-	-	1265	-	-	-
HCM Lane V/C Ratio	0.036	-	-	-	0.007	-	-	-
HCM Control Delay (s)	11.8	0	-	-	7.9	0	-	0
HCM Lane LOS	B	A	-	-	A	A	-	A
HCM 95th %tile Q(veh)	0.1	0	-	-	0	-	-	-

Intersection	
Int Delay, s/veh	0.3

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Vol, veh/h	0	268	579	4	6	10
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	-	-	0	-
Veh in Median Storage, #	-	0	0	-	0	-
Grade, %	-	0	0	-	0	-
Peak Hour Factor	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	0	291	629	4	7	11

Major/Minor	Major1		Major2		Minor2	
Conflicting Flow All	634	0	-	0	923	632
Stage 1	-	-	-	-	632	-
Stage 2	-	-	-	-	291	-
Critical Hdwy	4.12	-	-	-	6.42	6.22
Critical Hdwy Stg 1	-	-	-	-	5.42	-
Critical Hdwy Stg 2	-	-	-	-	5.42	-
Follow-up Hdwy	2.218	-	-	-	3.518	3.318
Pot Cap-1 Maneuver	949	-	-	-	299	480
Stage 1	-	-	-	-	530	-
Stage 2	-	-	-	-	759	-
Platoon blocked, %		-	-	-		
Mov Cap-1 Maneuver	949	-	-	-	299	480
Mov Cap-2 Maneuver	-	-	-	-	299	-
Stage 1	-	-	-	-	530	-
Stage 2	-	-	-	-	759	-

Approach	EB	WB	SB
HCM Control Delay, s	0	0	14.6
HCM LOS			B

Minor Lane/Major Mvmt	EBL	EBT	WBT	WBR	SBLn1
Capacity (veh/h)	949	-	-	-	391
HCM Lane V/C Ratio	-	-	-	-	0.044
HCM Control Delay (s)	0	-	-	-	14.6
HCM Lane LOS	A	-	-	-	B
HCM 95th %tile Q(veh)	0	-	-	-	0.1

Intersection	
Int Delay, s/veh	0.3

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Vol, veh/h	3	261	0	0	575	13	0	0	0	5	0	7
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Free	Free	Stop	Stop	Stop	Stop	Stop	Stop
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	-	-	-	-	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	92	92	92	92	92	92	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2	2	2	2	2	2	2
Mvmt Flow	3	284	0	0	625	14	0	0	0	5	0	8

Major/Minor	Major1			Major2			Minor1			Minor2		
Conflicting Flow All	639	0	0	284	0	0	926	929	284	922	922	632
Stage 1	-	-	-	-	-	-	290	290	-	632	632	-
Stage 2	-	-	-	-	-	-	636	639	-	290	290	-
Critical Hdwy	4.12	-	-	4.12	-	-	7.12	6.52	6.22	7.12	6.52	6.22
Critical Hdwy Stg 1	-	-	-	-	-	-	6.12	5.52	-	6.12	5.52	-
Critical Hdwy Stg 2	-	-	-	-	-	-	6.12	5.52	-	6.12	5.52	-
Follow-up Hdwy	2.218	-	-	2.218	-	-	3.518	4.018	3.318	3.518	4.018	3.318
Pot Cap-1 Maneuver	945	-	-	1278	-	-	249	268	755	251	270	480
Stage 1	-	-	-	-	-	-	718	672	-	468	474	-
Stage 2	-	-	-	-	-	-	466	470	-	718	672	-
Platoon blocked, %		-	-		-	-						
Mov Cap-1 Maneuver	945	-	-	1278	-	-	244	267	755	250	269	480
Mov Cap-2 Maneuver	-	-	-	-	-	-	244	267	-	250	269	-
Stage 1	-	-	-	-	-	-	715	669	-	466	474	-
Stage 2	-	-	-	-	-	-	459	470	-	715	669	-

Approach	EB	WB	NB	SB
HCM Control Delay, s	0.1	0	0	15.8
HCM LOS			A	C

Minor Lane/Major Mvmt	NBLn1	EBL	EBT	EBR	WBL	WBT	WBR	SBLn1
Capacity (veh/h)	-	945	-	-	1278	-	-	347
HCM Lane V/C Ratio	-	0.003	-	-	-	-	-	0.038
HCM Control Delay (s)	0	8.8	0	-	0	-	-	15.8
HCM Lane LOS	A	A	A	-	A	-	-	C
HCM 95th %tile Q(veh)	-	0	-	-	0	-	-	0.1

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	8	110	167	88	210	195	336	717	139	146	501	42
Number	7	4	14	3	8	18	5	2	12	1	6	16
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1863	1863	1900	1863	1863	1863	1863	1863	1863	1863	1863	1863
Adj Flow Rate, veh/h	9	120	14	96	228	39	365	779	64	159	545	7
Adj No. of Lanes	1	2	0	1	1	1	1	2	1	1	2	1
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Percent Heavy Veh, %	2	2	2	2	2	2	2	2	2	2	2	2
Cap, veh/h	16	342	39	125	314	267	416	1476	661	202	1048	469
Arrive On Green	0.01	0.11	0.11	0.07	0.17	0.17	0.23	0.42	0.42	0.11	0.30	0.30
Sat Flow, veh/h	1774	3199	368	1774	1863	1583	1774	3539	1583	1774	3539	1583
Grp Volume(v), veh/h	9	66	68	96	228	39	365	779	64	159	545	7
Grp Sat Flow(s),veh/h/ln	1774	1770	1798	1774	1863	1583	1774	1770	1583	1774	1770	1583
Q Serve(g_s), s	0.4	2.8	2.9	4.4	9.5	1.7	16.3	13.5	2.0	7.2	10.5	0.3
Cycle Q Clear(g_c), s	0.4	2.8	2.9	4.4	9.5	1.7	16.3	13.5	2.0	7.2	10.5	0.3
Prop In Lane	1.00		0.20	1.00		1.00	1.00		1.00	1.00		1.00
Lane Grp Cap(c), veh/h	16	189	192	125	314	267	416	1476	661	202	1048	469
V/C Ratio(X)	0.56	0.35	0.36	0.77	0.73	0.15	0.88	0.53	0.10	0.79	0.52	0.01
Avail Cap(c_a), veh/h	410	839	853	410	883	751	733	1894	847	733	1894	847
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	40.6	34.1	34.1	37.6	32.4	29.2	30.3	17.9	14.6	35.5	24.1	20.5
Incr Delay (d2), s/veh	27.3	1.1	1.1	9.4	3.2	0.2	6.0	0.3	0.1	6.7	0.4	0.0
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	0.3	1.4	1.5	2.5	5.2	0.8	8.7	6.7	0.9	3.9	5.2	0.1
LnGrp Delay(d),s/veh	67.8	35.2	35.2	46.9	35.6	29.4	36.3	18.2	14.6	42.2	24.5	20.5
LnGrp LOS	E	D	D	D	D	C	D	B	B	D	C	C
Approach Vol, veh/h		143			363			1208			711	
Approach Delay, s/veh		37.2			38.0			23.5			28.4	
Approach LOS		D			D			C			C	

Timer	1	2	3	4	5	6	7	8
Assigned Phs	1	2	3	4	5	6	7	8
Phs Duration (G+Y+Rc), s	15.3	40.3	11.8	14.8	25.3	30.3	6.7	19.8
Change Period (Y+Rc), s	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0
Max Green Setting (Gmax), s	34.0	44.0	19.0	39.0	34.0	44.0	19.0	39.0
Max Q Clear Time (g_c+I1), s	9.2	15.5	6.4	4.9	18.3	12.5	2.4	11.5
Green Ext Time (p_c), s	0.4	11.4	0.2	2.4	1.0	11.8	0.0	2.3

Intersection Summary	
HCM 2010 Ctrl Delay	27.9
HCM 2010 LOS	C

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	259	129	156	50	222	266	149	1348	4	162	875	120
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	6.0	4.0	4.0	6.0
Lane Util. Factor	0.91	0.91	1.00	1.00	1.00	0.88	0.97	0.91	1.00	0.97	0.91	1.00
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	0.98	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	1610	3307	1583	1770	1863	2787	3433	5085	1583	3433	5085	1583
Flt Permitted	0.95	0.98	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)	1610	3307	1583	1770	1863	2787	3433	5085	1583	3433	5085	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)	282	140	170	54	241	289	162	1465	4	176	951	130
RTOR Reduction (vph)	0	0	86	0	0	199	0	0	2	0	0	58
Lane Group Flow (vph)	141	281	84	54	241	91	162	1465	2	176	951	72
Turn Type	Split	NA	Perm	Split	NA	Perm	Prot	NA	Perm	Prot	NA	Perm
Protected Phases	3	3		4	4		5	2		1	6	
Permitted Phases			3			4			2			6
Actuated Green, G (s)	30.5	30.5	30.5	39.5	39.5	39.5	16.7	127.4	127.4	17.6	128.3	128.3
Effective Green, g (s)	32.5	32.5	32.5	41.5	41.5	41.5	18.7	130.4	128.4	19.6	131.3	129.3
Actuated g/C Ratio	0.14	0.14	0.14	0.17	0.17	0.17	0.08	0.54	0.54	0.08	0.55	0.54
Clearance Time (s)	6.0	6.0	6.0	6.0	6.0	6.0	6.0	7.0	7.0	6.0	7.0	7.0
Vehicle Extension (s)	5.0	5.0	5.0	5.0	5.0	5.0	3.0	5.0	5.0	3.0	5.0	5.0
Lane Grp Cap (vph)	218	447	214	306	322	481	267	2762	846	280	2781	852
v/s Ratio Prot	c0.09	0.08		0.03	c0.13		0.05	c0.29		c0.05	0.19	
v/s Ratio Perm			0.05			0.03			0.00			0.05
v/c Ratio	0.65	0.63	0.39	0.18	0.75	0.19	0.61	0.53	0.00	0.63	0.34	0.08
Uniform Delay, d1	98.3	98.0	94.7	84.7	94.3	84.8	107.1	35.2	26.0	106.7	30.3	26.8
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.68	1.65	5.28
Incremental Delay, d2	8.7	3.9	2.5	0.6	10.9	0.4	3.9	0.7	0.0	3.9	0.3	0.2
Delay (s)	107.0	101.9	97.2	85.3	105.2	85.2	111.0	35.9	26.0	77.0	50.1	141.5
Level of Service	F	F	F	F	F	F	F	D	C	E	D	F
Approach Delay (s)		101.8			93.5			43.3			63.3	
Approach LOS		F			F			D			E	

Intersection Summary			
HCM 2000 Control Delay	65.2	HCM 2000 Level of Service	E
HCM 2000 Volume to Capacity ratio	0.60		
Actuated Cycle Length (s)	240.0	Sum of lost time (s)	16.0
Intersection Capacity Utilization	64.0%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	391	5	110	4	12	10	198	2650	15	67	1176	235
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		6.0	4.0	6.0	5.0	6.0	4.0	5.0	7.0
Lane Util. Factor	0.95	0.95	1.00		1.00	1.00	1.00	0.91	1.00	1.00	0.91	1.00
Frpb, ped/bikes	1.00	1.00	0.91		1.00	1.00	1.00	1.00	0.83	1.00	1.00	0.97
Flpb, ped/bikes	1.00	1.00	1.00		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Frt	1.00	1.00	0.85		1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	0.95	1.00		0.99	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	1681	1687	1434		1841	1583	1770	5085	1311	1770	5085	1536
Flt Permitted	0.95	0.95	1.00		0.99	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)	1681	1687	1434		1841	1583	1770	5085	1311	1770	5085	1536
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	425	5	120	4	13	11	215	2880	16	73	1278	255
RTOR Reduction (vph)	0	0	84	0	0	11	0	0	6	0	0	113
Lane Group Flow (vph)	217	213	36	0	17	0	215	2880	10	73	1278	142
Confl. Peds. (#/hr)			43						31			2
Turn Type	Split	NA	Perm	Split	NA	Perm	Prot	NA	Perm	Prot	NA	Perm
Protected Phases	4	4		3	3		5	2		1	6	
Permitted Phases			4			3			2			6
Actuated Green, G (s)	39.3	39.3	39.3		6.6	6.6	36.2	154.9	154.9	15.2	133.9	133.9
Effective Green, g (s)	39.3	39.3	39.3		6.6	8.6	36.2	156.9	155.9	17.2	135.9	133.9
Actuated g/C Ratio	0.16	0.16	0.16		0.03	0.04	0.15	0.65	0.65	0.07	0.57	0.56
Clearance Time (s)	5.0	5.0	5.0		6.0	6.0	6.0	7.0	7.0	6.0	7.0	7.0
Vehicle Extension (s)	4.0	4.0	4.0		3.0	3.0	5.0	6.0	6.0	3.0	6.0	6.0
Lane Grp Cap (vph)	275	276	234		50	56	266	3324	851	126	2879	856
v/s Ratio Prot	c0.13	0.13			c0.01		c0.12	c0.57		0.04	0.25	
v/s Ratio Perm			0.03			0.00			0.01			0.09
v/c Ratio	0.79	0.77	0.16		0.34	0.01	0.81	0.87	0.01	0.58	0.44	0.17
Uniform Delay, d1	96.4	96.1	86.1		114.6	111.6	98.5	33.2	14.9	107.9	30.2	25.8
Progression Factor	1.00	1.00	1.00		1.00	1.00	1.14	0.61	1.00	1.09	1.02	1.76
Incremental Delay, d2	14.7	13.2	0.4		4.0	0.1	8.4	1.4	0.0	6.0	0.5	0.4
Delay (s)	111.0	109.3	86.5		118.6	111.6	120.7	21.8	14.9	123.1	31.3	45.8
Level of Service	F	F	F		F	F	F	C	B	F	C	D
Approach Delay (s)		105.0			115.9			28.6			37.7	
Approach LOS		F			F			C			D	

Intersection Summary			
HCM 2000 Control Delay	39.8	HCM 2000 Level of Service	D
HCM 2000 Volume to Capacity ratio	0.84		
Actuated Cycle Length (s)	240.0	Sum of lost time (s)	22.0
Intersection Capacity Utilization	94.7%	ICU Level of Service	F
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (veh/h)	218	442	356	253	377	334
Number	5	2	6	16	7	14
Initial Q (Qb), veh	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00			1.00	1.00	1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1863	1863	1863	1863	1863	1863
Adj Flow Rate, veh/h	237	480	387	275	410	363
Adj No. of Lanes	2	3	3	2	2	2
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Percent Heavy Veh, %	2	2	2	2	2	2
Cap, veh/h	368	2677	1480	1415	746	902
Arrive On Green	0.11	0.53	0.29	0.29	0.22	0.22
Sat Flow, veh/h	3442	5253	5253	2787	3442	2787
Grp Volume(v), veh/h	237	480	387	275	410	363
Grp Sat Flow(s),veh/h/ln	1721	1695	1695	1393	1721	1393
Q Serve(g_s), s	3.1	2.3	2.7	2.5	4.9	4.7
Cycle Q Clear(g_c), s	3.1	2.3	2.7	2.5	4.9	4.7
Prop In Lane	1.00			1.00	1.00	1.00
Lane Grp Cap(c), veh/h	368	2677	1480	1415	746	902
V/C Ratio(X)	0.64	0.18	0.26	0.19	0.55	0.40
Avail Cap(c_a), veh/h	516	6639	5224	3467	3094	2803
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	20.0	5.8	12.7	6.3	16.3	12.3
Incr Delay (d2), s/veh	1.9	0.0	0.1	0.1	0.6	0.3
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	1.5	1.1	1.3	1.4	2.4	3.9
LnGrp Delay(d),s/veh	21.9	5.8	12.8	6.3	16.9	12.6
LnGrp LOS	C	A	B	A	B	B
Approach Vol, veh/h		717	662		773	
Approach Delay, s/veh		11.1	10.1		14.9	
Approach LOS		B	B		B	

Timer	1	2	3	4	5	6	7	8
Assigned Phs		2		4	5	6		
Phs Duration (G+Y+Rc), s		30.6		16.1	11.0	19.6		
Change Period (Y+Rc), s		6.0		6.0	6.0	6.0		
Max Green Setting (Gmax), s		61.0		42.0	7.0	48.0		
Max Q Clear Time (g_c+I1), s		4.3		6.9	5.1	4.7		
Green Ext Time (p_c), s		9.1		3.2	0.2	8.9		

Intersection Summary	
HCM 2010 Ctrl Delay	12.2
HCM 2010 LOS	B

Notes

User approved changes to right turn type.

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	57	99	56	158	62	166	32	382	110	184	585	48
Number	3	8	18	7	4	14	5	2	12	1	6	16
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1863	1863	1900	1863	1863	1863	1863	1863	1900	1863	1863	1900
Adj Flow Rate, veh/h	62	108	40	172	67	32	35	415	66	200	636	44
Adj No. of Lanes	1	1	0	1	1	1	1	3	0	1	3	0
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Percent Heavy Veh, %	2	2	2	2	2	2	2	2	2	2	2	2
Cap, veh/h	437	348	129	375	500	425	53	1207	188	258	1883	129
Arrive On Green	0.27	0.27	0.27	0.27	0.27	0.27	0.03	0.27	0.27	0.15	0.39	0.39
Sat Flow, veh/h	1291	1297	481	1235	1863	1583	1774	4441	690	1774	4860	334
Grp Volume(v), veh/h	62	0	148	172	67	32	35	315	166	200	442	238
Grp Sat Flow(s),veh/h/ln	1291	0	1778	1235	1863	1583	1774	1695	1741	1774	1695	1804
Q Serve(g_s), s	2.2	0.0	3.8	7.4	1.6	0.9	1.1	4.3	4.4	6.2	5.3	5.3
Cycle Q Clear(g_c), s	3.8	0.0	3.8	11.2	1.6	0.9	1.1	4.3	4.4	6.2	5.3	5.3
Prop In Lane	1.00		0.27	1.00		1.00	1.00		0.40	1.00		0.19
Lane Grp Cap(c), veh/h	437	0	477	375	500	425	53	921	473	258	1314	699
V/C Ratio(X)	0.14	0.00	0.31	0.46	0.13	0.08	0.66	0.34	0.35	0.77	0.34	0.34
Avail Cap(c_a), veh/h	857	0	1055	777	1106	940	743	2308	1185	743	2308	1228
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	0.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	17.3	0.0	16.7	21.2	15.9	15.6	27.5	16.7	16.8	23.6	12.4	12.4
Incr Delay (d2), s/veh	0.1	0.0	0.4	0.9	0.1	0.1	13.2	0.2	0.4	4.9	0.2	0.3
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	0.8	0.0	1.9	2.6	0.8	0.4	0.7	2.0	2.2	3.4	2.5	2.7
LnGrp Delay(d),s/veh	17.5	0.0	17.1	22.1	16.0	15.7	40.7	17.0	17.2	28.5	12.5	12.7
LnGrp LOS	B		B	C	B	B	D	B	B	C	B	B
Approach Vol, veh/h		210			271			516			880	
Approach Delay, s/veh		17.2			19.8			18.7			16.2	
Approach LOS		B			B			B			B	

Timer	1	2	3	4	5	6	7	8
Assigned Phs	1	2		4	5	6		8
Phs Duration (G+Y+Rc), s	14.3	21.6		21.4	7.7	28.2		21.4
Change Period (Y+Rc), s	6.0	6.0		6.0	6.0	6.0		6.0
Max Green Setting (Gmax), s	24.0	39.0		34.0	24.0	39.0		34.0
Max Q Clear Time (g_c+I1), s	8.2	6.4		13.2	3.1	7.3		5.8
Green Ext Time (p_c), s	0.5	9.2		2.2	0.1	9.1		2.3

Intersection Summary		
HCM 2010 Ctrl Delay		17.5
HCM 2010 LOS		B

Intersection	
Int Delay, s/veh	8.4

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Vol, veh/h	2	3	135	2	6	193
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	-	-	0	-
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	2	3	147	2	7	210

Major/Minor	Major1		Major2		Minor1	
Conflicting Flow All	0	0	5	0	300	4
Stage 1	-	-	-	-	4	-
Stage 2	-	-	-	-	296	-
Critical Hdwy	-	-	4.12	-	6.42	6.22
Critical Hdwy Stg 1	-	-	-	-	5.42	-
Critical Hdwy Stg 2	-	-	-	-	5.42	-
Follow-up Hdwy	-	-	2.218	-	3.518	3.318
Pot Cap-1 Maneuver	-	-	1616	-	691	1080
Stage 1	-	-	-	-	1019	-
Stage 2	-	-	-	-	755	-
Platoon blocked, %	-	-		-		
Mov Cap-1 Maneuver	-	-	1616	-	628	1080
Mov Cap-2 Maneuver	-	-	-	-	628	-
Stage 1	-	-	-	-	1019	-
Stage 2	-	-	-	-	686	-

Approach	EB	WB	NB
HCM Control Delay, s	0	7.3	9.3
HCM LOS			A

Minor Lane/Major Mvmt	NBLn1	EBT	EBR	WBL	WBT
Capacity (veh/h)	1057	-	-	1616	-
HCM Lane V/C Ratio	0.205	-	-	0.091	-
HCM Control Delay (s)	9.3	-	-	7.5	0
HCM Lane LOS	A	-	-	A	A
HCM 95th %tile Q(veh)	0.8	-	-	0.3	-

Intersection	
Int Delay, s/veh	3.2

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Vol, veh/h	172	583	0	0	331	17	0	0	0	14	0	123
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Free	Free	Stop	Stop	Stop	Stop	Stop	Stop
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	-	-	-	-	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	92	92	92	92	92	92	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2	2	2	2	2	2	2
Mvmt Flow	187	634	0	0	360	18	0	0	0	15	0	134

Major/Minor	Major1			Major2			Minor1			Minor2		
Conflicting Flow All	378	0	0	634	0	0	1444	1386	634	1377	1377	369
Stage 1	-	-	-	-	-	-	1008	1008	-	369	369	-
Stage 2	-	-	-	-	-	-	436	378	-	1008	1008	-
Critical Hdwy	4.12	-	-	4.12	-	-	7.12	6.52	6.22	7.12	6.52	6.22
Critical Hdwy Stg 1	-	-	-	-	-	-	6.12	5.52	-	6.12	5.52	-
Critical Hdwy Stg 2	-	-	-	-	-	-	6.12	5.52	-	6.12	5.52	-
Follow-up Hdwy	2.218	-	-	2.218	-	-	3.518	4.018	3.318	3.518	4.018	3.318
Pot Cap-1 Maneuver	1180	-	-	949	-	-	110	143	479	122	145	677
Stage 1	-	-	-	-	-	-	290	318	-	651	621	-
Stage 2	-	-	-	-	-	-	599	615	-	290	318	-
Platoon blocked, %		-	-		-	-						
Mov Cap-1 Maneuver	1180	-	-	949	-	-	72	108	479	99	109	677
Mov Cap-2 Maneuver	-	-	-	-	-	-	72	108	-	99	109	-
Stage 1	-	-	-	-	-	-	219	240	-	492	621	-
Stage 2	-	-	-	-	-	-	481	615	-	219	240	-

Approach	EB	WB	NB	SB
HCM Control Delay, s	2	0	0	18
HCM LOS			A	C

Minor Lane/Major Mvmt	NBLn1	EBL	EBT	EBR	WBL	WBT	WBR	SBLn1
Capacity (veh/h)	-	1180	-	-	949	-	-	424
HCM Lane V/C Ratio	-	0.158	-	-	-	-	-	0.351
HCM Control Delay (s)	0	8.6	0	-	0	-	-	18
HCM Lane LOS	A	A	A	-	A	-	-	C
HCM 95th %tile Q(veh)	-	0.6	-	-	0	-	-	1.6

Intersection	
Int Delay, s/veh	0.6

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Vol, veh/h	624	13	11	345	9	19
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	50	-	0	-
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	678	14	12	375	10	21

Major/Minor	Major1		Major2		Minor1	
Conflicting Flow All	0	0	692	0	1084	685
Stage 1	-	-	-	-	685	-
Stage 2	-	-	-	-	399	-
Critical Hdwy	-	-	4.12	-	6.42	6.22
Critical Hdwy Stg 1	-	-	-	-	5.42	-
Critical Hdwy Stg 2	-	-	-	-	5.42	-
Follow-up Hdwy	-	-	2.218	-	3.518	3.318
Pot Cap-1 Maneuver	-	-	903	-	240	448
Stage 1	-	-	-	-	500	-
Stage 2	-	-	-	-	678	-
Platoon blocked, %	-	-		-		
Mov Cap-1 Maneuver	-	-	903	-	237	448
Mov Cap-2 Maneuver	-	-	-	-	237	-
Stage 1	-	-	-	-	500	-
Stage 2	-	-	-	-	669	-

Approach	EB	WB	NB
HCM Control Delay, s	0	0.3	16.3
HCM LOS			C

Minor Lane/Major Mvmt	NBLn1	EBT	EBR	WBL	WBT
Capacity (veh/h)	348	-	-	903	-
HCM Lane V/C Ratio	0.087	-	-	0.013	-
HCM Control Delay (s)	16.3	-	-	9	-
HCM Lane LOS	C	-	-	A	-
HCM 95th %tile Q(veh)	0.3	-	-	0	-

Intersection	
Int Delay, s/veh	0

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Vol, veh/h	1	617	0	1	352	1	0	0	2	0	0	0
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Free	Free	Stop	Stop	Stop	Stop	Stop	Stop
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	-	-	-	-	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	92	92	92	92	92	92	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2	2	2	2	2	2	2
Mvmt Flow	1	671	0	1	383	1	0	0	2	0	0	0

Major/Minor	Major1			Major2			Minor1			Minor2		
Conflicting Flow All	384	0	0	671	0	0	1058	1059	671	1059	1058	383
Stage 1	-	-	-	-	-	-	673	673	-	385	385	-
Stage 2	-	-	-	-	-	-	385	386	-	674	673	-
Critical Hdwy	4.12	-	-	4.12	-	-	7.12	6.52	6.22	7.12	6.52	6.22
Critical Hdwy Stg 1	-	-	-	-	-	-	6.12	5.52	-	6.12	5.52	-
Critical Hdwy Stg 2	-	-	-	-	-	-	6.12	5.52	-	6.12	5.52	-
Follow-up Hdwy	2.218	-	-	2.218	-	-	3.518	4.018	3.318	3.518	4.018	3.318
Pot Cap-1 Maneuver	1174	-	-	919	-	-	203	224	456	202	225	664
Stage 1	-	-	-	-	-	-	445	454	-	638	611	-
Stage 2	-	-	-	-	-	-	638	610	-	444	454	-
Platoon blocked, %		-	-		-	-						
Mov Cap-1 Maneuver	1174	-	-	919	-	-	203	224	456	201	225	664
Mov Cap-2 Maneuver	-	-	-	-	-	-	203	224	-	201	225	-
Stage 1	-	-	-	-	-	-	445	454	-	637	610	-
Stage 2	-	-	-	-	-	-	637	609	-	441	454	-

Approach	EB	WB	NB	SB
HCM Control Delay, s	0	0	12.9	0
HCM LOS			B	A

Minor Lane/Major Mvmt	NBLn1	EBL	EBT	EBR	WBL	WBT	WBR	SBLn1
Capacity (veh/h)	456	1174	-	-	919	-	-	-
HCM Lane V/C Ratio	0.005	0.001	-	-	0.001	-	-	-
HCM Control Delay (s)	12.9	8.1	0	-	8.9	0	-	0
HCM Lane LOS	B	A	A	-	A	A	-	A
HCM 95th %tile Q(veh)	0	0	-	-	0	-	-	-

Intersection	
Int Delay, s/veh	0.2

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Vol, veh/h	0	644	354	2	10	2
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	-	-	0	-
Veh in Median Storage, #	-	0	0	-	0	-
Grade, %	-	0	0	-	0	-
Peak Hour Factor	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	0	700	385	2	11	2

Major/Minor	Major1		Major2		Minor2	
Conflicting Flow All	387	0	-	0	1086	386
Stage 1	-	-	-	-	386	-
Stage 2	-	-	-	-	700	-
Critical Hdwy	4.12	-	-	-	6.42	6.22
Critical Hdwy Stg 1	-	-	-	-	5.42	-
Critical Hdwy Stg 2	-	-	-	-	5.42	-
Follow-up Hdwy	2.218	-	-	-	3.518	3.318
Pot Cap-1 Maneuver	1171	-	-	-	239	662
Stage 1	-	-	-	-	687	-
Stage 2	-	-	-	-	493	-
Platoon blocked, %		-	-	-		
Mov Cap-1 Maneuver	1171	-	-	-	239	662
Mov Cap-2 Maneuver	-	-	-	-	239	-
Stage 1	-	-	-	-	687	-
Stage 2	-	-	-	-	493	-

Approach	EB	WB	SB
HCM Control Delay, s	0	0	19.2
HCM LOS			C

Minor Lane/Major Mvmt	EBL	EBT	WBT	WBR	SBLn1
Capacity (veh/h)	1171	-	-	-	267
HCM Lane V/C Ratio	-	-	-	-	0.049
HCM Control Delay (s)	0	-	-	-	19.2
HCM Lane LOS	A	-	-	-	C
HCM 95th %tile Q(veh)	0	-	-	-	0.2

Intersection	
Int Delay, s/veh	0.7

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Vol, veh/h	10	628	0	0	336	19	0	0	0	19	0	12
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Free	Free	Stop	Stop	Stop	Stop	Stop	Stop
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	-	-	-	-	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	92	92	92	92	92	92	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2	2	2	2	2	2	2
Mvmt Flow	11	683	0	0	365	21	0	0	0	21	0	13

Major/Minor	Major1			Major2			Minor1			Minor2		
Conflicting Flow All	386	0	0	683	0	0	1086	1090	683	1080	1080	376
Stage 1	-	-	-	-	-	-	704	704	-	376	376	-
Stage 2	-	-	-	-	-	-	382	386	-	704	704	-
Critical Hdwy	4.12	-	-	4.12	-	-	7.12	6.52	6.22	7.12	6.52	6.22
Critical Hdwy Stg 1	-	-	-	-	-	-	6.12	5.52	-	6.12	5.52	-
Critical Hdwy Stg 2	-	-	-	-	-	-	6.12	5.52	-	6.12	5.52	-
Follow-up Hdwy	2.218	-	-	2.218	-	-	3.518	4.018	3.318	3.518	4.018	3.318
Pot Cap-1 Maneuver	1172	-	-	910	-	-	194	215	449	196	218	670
Stage 1	-	-	-	-	-	-	428	440	-	645	616	-
Stage 2	-	-	-	-	-	-	640	610	-	428	440	-
Platoon blocked, %		-	-		-	-						
Mov Cap-1 Maneuver	1172	-	-	910	-	-	188	212	449	194	215	670
Mov Cap-2 Maneuver	-	-	-	-	-	-	188	212	-	194	215	-
Stage 1	-	-	-	-	-	-	422	433	-	635	616	-
Stage 2	-	-	-	-	-	-	628	610	-	422	433	-

Approach	EB	WB	NB	SB
HCM Control Delay, s	0.1	0	0	20.4
HCM LOS			A	C

Minor Lane/Major Mvmt	NBLn1	EBL	EBT	EBR	WBL	WBT	WBR	SBLn1
Capacity (veh/h)	-	1172	-	-	910	-	-	268
HCM Lane V/C Ratio	-	0.009	-	-	-	-	-	0.126
HCM Control Delay (s)	0	8.1	0	-	0	-	-	20.4
HCM Lane LOS	A	A	A	-	A	-	-	C
HCM 95th %tile Q(veh)	-	0	-	-	0	-	-	0.4

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	45	228	395	121	142	232	196	369	92	153	492	25
Number	7	4	14	3	8	18	5	2	12	1	6	16
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1863	1863	1900	1863	1863	1863	1863	1863	1863	1863	1863	1863
Adj Flow Rate, veh/h	49	248	191	132	154	59	213	401	18	166	535	4
Adj No. of Lanes	1	2	0	1	1	1	1	2	1	1	2	1
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Percent Heavy Veh, %	2	2	2	2	2	2	2	2	2	2	2	2
Cap, veh/h	63	391	290	169	487	414	261	986	441	210	884	396
Arrive On Green	0.04	0.20	0.20	0.10	0.26	0.26	0.15	0.28	0.28	0.12	0.25	0.25
Sat Flow, veh/h	1774	1940	1438	1774	1863	1583	1774	3539	1583	1774	3539	1583
Grp Volume(v), veh/h	49	225	214	132	154	59	213	401	18	166	535	4
Grp Sat Flow(s),veh/h/ln	1774	1770	1609	1774	1863	1583	1774	1770	1583	1774	1770	1583
Q Serve(g_s), s	2.1	9.1	9.6	5.7	5.2	2.2	9.1	7.2	0.7	7.1	10.5	0.1
Cycle Q Clear(g_c), s	2.1	9.1	9.6	5.7	5.2	2.2	9.1	7.2	0.7	7.1	10.5	0.1
Prop In Lane	1.00		0.89	1.00		1.00	1.00		1.00	1.00		1.00
Lane Grp Cap(c), veh/h	63	356	324	169	487	414	261	986	441	210	884	396
V/C Ratio(X)	0.78	0.63	0.66	0.78	0.32	0.14	0.81	0.41	0.04	0.79	0.60	0.01
Avail Cap(c_a), veh/h	430	993	902	430	1045	888	656	1760	787	656	1760	787
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	37.5	28.7	28.8	34.7	23.3	22.2	32.4	23.0	20.6	33.6	26.0	22.1
Incr Delay (d2), s/veh	18.8	1.9	2.3	7.5	0.4	0.2	6.1	0.3	0.0	6.5	0.7	0.0
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	1.4	4.6	4.5	3.1	2.7	1.0	4.9	3.5	0.3	3.9	5.2	0.1
LnGrp Delay(d),s/veh	56.4	30.5	31.1	42.2	23.7	22.4	38.5	23.3	20.7	40.1	26.7	22.1
LnGrp LOS	E	C	C	D	C	C	D	C	C	D	C	C
Approach Vol, veh/h		488			345			632			705	
Approach Delay, s/veh		33.4			30.5			28.3			29.8	
Approach LOS		C			C			C			C	

Timer	1	2	3	4	5	6	7	8
Assigned Phs	1	2	3	4	5	6	7	8
Phs Duration (G+Y+Rc), s	15.3	27.9	13.5	21.8	17.6	25.6	8.8	26.5
Change Period (Y+Rc), s	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0
Max Green Setting (Gmax), s	29.0	39.0	19.0	44.0	29.0	39.0	19.0	44.0
Max Q Clear Time (g_c+I1), s	9.1	9.2	7.7	11.6	11.1	12.5	4.1	7.2
Green Ext Time (p_c), s	0.4	7.4	0.2	4.2	0.5	7.1	0.1	4.3

Intersection Summary			
HCM 2010 Ctrl Delay			30.3
HCM 2010 LOS			C

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	198	206	153	10	182	122	135	817	10	341	1493	207
Ideal Flow (vphpl)	1900	1900	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	6.0	4.0	4.0	6.0
Lane Util. Factor	0.91	0.91	1.00	1.00	1.00	0.88	0.97	0.91	1.00	0.97	0.91	1.00
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	0.99	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	1610	3349	1583	1770	1863	2787	3433	5085	1583	3433	5085	1583
Flt Permitted	0.95	0.99	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)	1610	3349	1583	1770	1863	2787	3433	5085	1583	3433	5085	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)	215	224	166	11	198	133	147	888	11	371	1623	225
RTOR Reduction (vph)	0	0	63	0	0	111	0	0	5	0	0	65
Lane Group Flow (vph)	142	297	103	11	198	22	147	888	6	371	1623	160
Turn Type	Split	NA	Perm	Split	NA	Perm	Prot	NA	Perm	Prot	NA	Perm
Protected Phases	3	3		4	4		5	2		1	6	
Permitted Phases			3			4			2			6
Actuated Green, G (s)	30.8	30.8	30.8	30.7	30.7	30.7	15.6	122.9	122.9	30.6	137.9	137.9
Effective Green, g (s)	32.8	32.8	32.8	32.7	32.7	32.7	17.6	125.9	123.9	32.6	140.9	138.9
Actuated g/C Ratio	0.14	0.14	0.14	0.14	0.14	0.14	0.07	0.52	0.52	0.14	0.59	0.58
Clearance Time (s)	6.0	6.0	6.0	6.0	6.0	6.0	6.0	7.0	7.0	6.0	7.0	7.0
Vehicle Extension (s)	5.0	5.0	5.0	5.0	5.0	5.0	3.0	5.0	5.0	3.0	5.0	5.0
Lane Grp Cap (vph)	220	457	216	241	253	379	251	2667	817	466	2985	916
v/s Ratio Prot	0.09	c0.09		0.01	c0.11		0.04	0.17		c0.11	c0.32	
v/s Ratio Perm			0.07			0.01			0.00			0.10
v/c Ratio	0.65	0.65	0.48	0.05	0.78	0.06	0.59	0.33	0.01	0.80	0.54	0.17
Uniform Delay, d1	98.1	98.2	95.7	90.1	100.2	90.2	107.7	32.9	28.2	100.5	30.1	23.7
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.10	0.95	1.35
Incremental Delay, d2	8.6	4.3	3.4	0.2	16.6	0.1	3.5	0.3	0.0	9.0	0.7	0.4
Delay (s)	106.7	102.5	99.1	90.3	116.8	90.4	111.1	33.2	28.2	119.0	29.3	32.3
Level of Service	F	F	F	F	F	F	F	C	C	F	C	C
Approach Delay (s)		102.5			105.7			44.1			44.6	
Approach LOS		F			F			D			D	

Intersection Summary			
HCM 2000 Control Delay	57.8	HCM 2000 Level of Service	E
HCM 2000 Volume to Capacity ratio	0.64		
Actuated Cycle Length (s)	240.0	Sum of lost time (s)	16.0
Intersection Capacity Utilization	66.0%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	355	36	97	34	28	22	115	1410	54	68	2628	298
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		6.0	4.0	6.0	5.0	6.0	4.0	5.0	7.0
Lane Util. Factor	0.95	0.95	1.00		1.00	1.00	1.00	0.91	1.00	1.00	0.91	1.00
Frpb, ped/bikes	1.00	1.00	0.91		1.00	1.00	1.00	1.00	0.83	1.00	1.00	0.97
Flpb, ped/bikes	1.00	1.00	1.00		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Frt	1.00	1.00	0.85		1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	0.96	1.00		0.97	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	1681	1700	1434		1813	1583	1770	5085	1311	1770	5085	1536
Flt Permitted	0.95	0.96	1.00		0.97	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)	1681	1700	1434		1813	1583	1770	5085	1311	1770	5085	1536
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	386	39	105	37	30	24	125	1533	59	74	2857	324
RTOR Reduction (vph)	0	0	84	0	0	22	0	0	22	0	0	136
Lane Group Flow (vph)	212	213	21	0	67	2	125	1533	37	74	2857	188
Confl. Peds. (#/hr)			43						31			2
Turn Type	Split	NA	Perm	Split	NA	Perm	Prot	NA	Perm	Prot	NA	Perm
Protected Phases	4	4		3	3		5	2		1	6	
Permitted Phases			4			3			2			6
Actuated Green, G (s)	38.3	38.3	38.3		14.2	14.2	24.2	148.4	148.4	15.1	139.3	139.3
Effective Green, g (s)	38.3	38.3	38.3		14.2	16.2	24.2	150.4	149.4	17.1	141.3	139.3
Actuated g/C Ratio	0.16	0.16	0.16		0.06	0.07	0.10	0.63	0.62	0.07	0.59	0.58
Clearance Time (s)	5.0	5.0	5.0		6.0	6.0	6.0	7.0	7.0	6.0	7.0	7.0
Vehicle Extension (s)	4.0	4.0	4.0		3.0	3.0	5.0	6.0	6.0	3.0	6.0	6.0
Lane Grp Cap (vph)	268	271	228		107	106	178	3186	816	126	2993	891
v/s Ratio Prot	c0.13	0.13			c0.04		c0.07	0.30		0.04	c0.56	
v/s Ratio Perm			0.01			0.00			0.03			0.12
v/c Ratio	0.79	0.79	0.09		0.63	0.02	0.70	0.48	0.05	0.59	0.95	0.21
Uniform Delay, d1	97.0	96.9	86.0		110.3	104.5	104.4	23.9	17.6	108.0	46.3	24.1
Progression Factor	1.00	1.00	1.00		1.00	1.00	0.90	1.19	2.27	0.97	0.99	1.41
Incremental Delay, d2	15.4	14.7	0.2		10.9	0.1	6.0	0.2	0.0	6.8	8.8	0.5
Delay (s)	112.4	111.6	86.3		121.2	104.5	100.3	28.7	40.0	111.9	54.6	34.6
Level of Service	F	F	F		F	F	F	C	D	F	D	C
Approach Delay (s)		106.9			116.8			34.3			53.9	
Approach LOS		F			F			C			D	

Intersection Summary			
HCM 2000 Control Delay	53.9	HCM 2000 Level of Service	D
HCM 2000 Volume to Capacity ratio	0.88		
Actuated Cycle Length (s)	240.0	Sum of lost time (s)	22.0
Intersection Capacity Utilization	98.1%	ICU Level of Service	F
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	625	515	5	120	705	475	5	85	15	395	120	430
Number	7	4	14	3	8	18	5	2	12	1	6	16
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		0.99
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1863	1863	1900	1863	1863	1863	1863	1863	1900	1863	1863	1863
Adj Flow Rate, veh/h	679	560	5	130	766	516	5	92	3	429	130	278
Adj No. of Lanes	2	3	0	2	3	2	1	2	0	2	2	2
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Percent Heavy Veh, %	2	2	2	2	2	2	2	2	2	2	2	2
Cap, veh/h	809	2293	20	215	1365	1174	9	317	10	526	844	1316
Arrive On Green	0.24	0.44	0.44	0.06	0.27	0.27	0.01	0.09	0.09	0.15	0.24	0.24
Sat Flow, veh/h	3442	5198	46	3442	5085	2787	1774	3499	114	3442	3539	2773
Grp Volume(v), veh/h	679	365	200	130	766	516	5	46	49	429	130	278
Grp Sat Flow(s),veh/h/ln	1721	1695	1855	1721	1695	1393	1774	1770	1843	1721	1770	1386
Q Serve(g_s), s	17.8	6.4	6.4	3.5	12.3	12.5	0.3	2.3	2.3	11.4	2.8	5.6
Cycle Q Clear(g_c), s	17.8	6.4	6.4	3.5	12.3	12.5	0.3	2.3	2.3	11.4	2.8	5.6
Prop In Lane	1.00		0.03	1.00		1.00	1.00		0.06	1.00		1.00
Lane Grp Cap(c), veh/h	809	1495	818	215	1365	1174	9	160	167	526	844	1316
V/C Ratio(X)	0.84	0.24	0.24	0.61	0.56	0.44	0.54	0.29	0.29	0.82	0.15	0.21
Avail Cap(c_a), veh/h	1378	1495	818	1378	2037	1542	224	709	738	798	1791	2058
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	34.6	16.6	16.6	43.3	29.9	19.5	47.1	40.3	40.3	38.9	28.6	14.6
Incr Delay (d2), s/veh	2.4	0.1	0.2	2.7	0.4	0.3	41.4	1.0	1.0	4.0	0.1	0.1
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	8.8	3.0	3.3	1.7	5.8	4.8	0.2	1.2	1.2	5.7	1.4	2.1
LnGrp Delay(d),s/veh	37.0	16.7	16.8	46.1	30.3	19.8	88.5	41.3	41.2	42.8	28.7	14.7
LnGrp LOS	D	B	B	D	C	B	F	D	D	D	C	B
Approach Vol, veh/h		1244			1412			100			837	
Approach Delay, s/veh		27.8			27.9			43.6			31.3	
Approach LOS		C			C			D			C	

Timer	1	2	3	4	5	6	7	8
Assigned Phs	1	2	3	4	5	6	7	8
Phs Duration (G+Y+Rc), s	20.5	14.6	11.9	47.8	6.5	28.6	28.3	31.5
Change Period (Y+Rc), s	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0
Max Green Setting (Gmax), s	22.0	38.0	38.0	38.0	12.0	48.0	38.0	38.0
Max Q Clear Time (g_c+I1), s	13.4	4.3	5.5	8.4	2.3	7.6	19.8	14.5
Green Ext Time (p_c), s	1.1	2.6	0.4	14.3	0.0	2.7	2.5	11.0

Intersection Summary	
HCM 2010 Ctrl Delay	29.1
HCM 2010 LOS	C

Notes

User approved changes to right turn type.

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	30	70	20	300	135	370	50	980	400	280	530	45
Number	3	8	18	7	4	14	5	2	12	1	6	16
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1863	1863	1900	1863	1863	1863	1863	1863	1900	1863	1863	1900
Adj Flow Rate, veh/h	33	76	13	326	147	93	54	1065	381	304	576	42
Adj No. of Lanes	1	1	0	1	1	1	1	3	0	1	3	0
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Percent Heavy Veh, %	2	2	2	2	2	2	2	2	2	2	2	2
Cap, veh/h	345	482	82	418	578	492	70	1291	462	338	2421	175
Arrive On Green	0.31	0.31	0.31	0.31	0.31	0.31	0.04	0.35	0.35	0.19	0.50	0.50
Sat Flow, veh/h	1135	1551	265	1303	1863	1583	1774	3697	1323	1774	4841	350
Grp Volume(v), veh/h	33	0	89	326	147	93	54	977	469	304	402	216
Grp Sat Flow(s),veh/h/ln	1135	0	1816	1303	1863	1583	1774	1695	1629	1774	1695	1801
Q Serve(g_s), s	2.7	0.0	4.3	29.1	7.1	5.2	3.6	31.6	31.6	20.1	8.1	8.2
Cycle Q Clear(g_c), s	9.8	0.0	4.3	33.3	7.1	5.2	3.6	31.6	31.6	20.1	8.1	8.2
Prop In Lane	1.00		0.15	1.00		1.00	1.00		0.81	1.00		0.19
Lane Grp Cap(c), veh/h	345	0	564	418	578	492	70	1184	569	338	1695	901
V/C Ratio(X)	0.10	0.00	0.16	0.78	0.25	0.19	0.77	0.82	0.82	0.90	0.24	0.24
Avail Cap(c_a), veh/h	399	0	650	480	667	567	251	1242	597	517	1750	930
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	0.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	34.7	0.0	30.0	42.1	31.0	30.3	57.1	35.7	35.7	47.5	17.0	17.1
Incr Delay (d2), s/veh	0.1	0.0	0.1	7.1	0.2	0.2	16.1	4.5	8.9	13.2	0.1	0.1
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	0.9	0.0	2.2	11.2	3.7	2.3	2.1	15.5	15.6	11.1	3.8	4.1
LnGrp Delay(d),s/veh	34.8	0.0	30.1	49.2	31.2	30.5	73.2	40.2	44.6	60.7	17.1	17.2
LnGrp LOS	C		C	D	C	C	E	D	D	E	B	B
Approach Vol, veh/h		122			566			1500			922	
Approach Delay, s/veh		31.4			41.4			42.8			31.5	
Approach LOS		C			D			D			C	

Timer	1	2	3	4	5	6	7	8
Assigned Phs	1	2		4	5	6		8
Phs Duration (G+Y+Rc), s	28.9	47.9		43.3	10.7	66.1		43.3
Change Period (Y+Rc), s	6.0	6.0		6.0	6.0	6.0		6.0
Max Green Setting (Gmax), s	35.0	44.0		43.0	17.0	62.0		43.0
Max Q Clear Time (g_c+I1), s	22.1	33.6		35.3	5.6	10.2		11.8
Green Ext Time (p_c), s	0.7	8.3		2.0	0.1	25.0		3.2

Intersection Summary	
HCM 2010 Ctrl Delay	38.7
HCM 2010 LOS	D

Intersection	
Int Delay, s/veh	7.7

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Vol, veh/h	5	5	195	5	5	90
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	-	-	0	-
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	5	5	212	5	5	98

Major/Minor	Major1		Major2		Minor1	
Conflicting Flow All	0	0	11	0	437	8
Stage 1	-	-	-	-	8	-
Stage 2	-	-	-	-	429	-
Critical Hdwy	-	-	4.12	-	6.42	6.22
Critical Hdwy Stg 1	-	-	-	-	5.42	-
Critical Hdwy Stg 2	-	-	-	-	5.42	-
Follow-up Hdwy	-	-	2.218	-	3.518	3.318
Pot Cap-1 Maneuver	-	-	1608	-	577	1074
Stage 1	-	-	-	-	1015	-
Stage 2	-	-	-	-	657	-
Platoon blocked, %	-	-		-		
Mov Cap-1 Maneuver	-	-	1608	-	501	1074
Mov Cap-2 Maneuver	-	-	-	-	501	-
Stage 1	-	-	-	-	1015	-
Stage 2	-	-	-	-	570	-

Approach	EB	WB	NB
HCM Control Delay, s	0	7.4	9
HCM LOS			A

Minor Lane/Major Mvmt	NBLn1	EBT	EBR	WBL	WBT
Capacity (veh/h)	1013	-	-	1608	-
HCM Lane V/C Ratio	0.102	-	-	0.132	-
HCM Control Delay (s)	9	-	-	7.6	0
HCM Lane LOS	A	-	-	A	A
HCM 95th %tile Q(veh)	0.3	-	-	0.5	-

Intersection	
Int Delay, s/veh	4.7

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Vol, veh/h	70	295	0	0	655	20	0	0	0	15	0	180
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Free	Free	Stop	Stop	Stop	Stop	Stop	Stop
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	-	-	-	-	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	92	92	92	92	92	92	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2	2	2	2	2	2	2
Mvmt Flow	76	321	0	0	712	22	0	0	0	16	0	196

Major/Minor	Major1			Major2			Minor1			Minor2		
Conflicting Flow All	734	0	0	321	0	0	1294	1207	321	1196	1196	723
Stage 1	-	-	-	-	-	-	473	473	-	723	723	-
Stage 2	-	-	-	-	-	-	821	734	-	473	473	-
Critical Hdwy	4.12	-	-	4.12	-	-	7.12	6.52	6.22	7.12	6.52	6.22
Critical Hdwy Stg 1	-	-	-	-	-	-	6.12	5.52	-	6.12	5.52	-
Critical Hdwy Stg 2	-	-	-	-	-	-	6.12	5.52	-	6.12	5.52	-
Follow-up Hdwy	2.218	-	-	2.218	-	-	3.518	4.018	3.318	3.518	4.018	3.318
Pot Cap-1 Maneuver	871	-	-	1239	-	-	139	183	720	163	186	426
Stage 1	-	-	-	-	-	-	572	558	-	417	431	-
Stage 2	-	-	-	-	-	-	369	426	-	572	558	-
Platoon blocked, %		-	-		-	-						
Mov Cap-1 Maneuver	871	-	-	1239	-	-	69	164	720	150	166	426
Mov Cap-2 Maneuver	-	-	-	-	-	-	69	164	-	150	166	-
Stage 1	-	-	-	-	-	-	511	499	-	373	431	-
Stage 2	-	-	-	-	-	-	200	426	-	511	499	-

Approach	EB	WB	NB	SB
HCM Control Delay, s	1.8	0	0	26.6
HCM LOS			A	D

Minor Lane/Major Mvmt	NBLn1	EBL	EBT	EBR	WBL	WBT	WBR	SBLn1
Capacity (veh/h)	-	871	-	-	1239	-	-	373
HCM Lane V/C Ratio	-	0.087	-	-	-	-	-	0.568
HCM Control Delay (s)	0	9.5	0	-	0	-	-	26.6
HCM Lane LOS	A	A	A	-	A	-	-	D
HCM 95th %tile Q(veh)	-	0.3	-	-	0	-	-	3.4

Intersection	
Int Delay, s/veh	0.5

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Vol, veh/h	295	10	25	685	10	5
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	50	-	0	-
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	321	11	27	745	11	5

Major/Minor	Major1		Major2		Minor1	
Conflicting Flow All	0	0	332	0	1125	326
Stage 1	-	-	-	-	326	-
Stage 2	-	-	-	-	799	-
Critical Hdwy	-	-	4.12	-	6.42	6.22
Critical Hdwy Stg 1	-	-	-	-	5.42	-
Critical Hdwy Stg 2	-	-	-	-	5.42	-
Follow-up Hdwy	-	-	2.218	-	3.518	3.318
Pot Cap-1 Maneuver	-	-	1227	-	227	715
Stage 1	-	-	-	-	731	-
Stage 2	-	-	-	-	443	-
Platoon blocked, %	-	-		-		
Mov Cap-1 Maneuver	-	-	1227	-	222	715
Mov Cap-2 Maneuver	-	-	-	-	222	-
Stage 1	-	-	-	-	731	-
Stage 2	-	-	-	-	433	-

Approach	EB	WB	NB
HCM Control Delay, s	0	0.3	18.2
HCM LOS			C

Minor Lane/Major Mvmt	NBLn1	EBT	EBR	WBL	WBT
Capacity (veh/h)	288	-	-	1227	-
HCM Lane V/C Ratio	0.057	-	-	0.022	-
HCM Control Delay (s)	18.2	-	-	8	-
HCM Lane LOS	C	-	-	A	-
HCM 95th %tile Q(veh)	0.2	-	-	0.1	-

Intersection	
Int Delay, s/veh	0

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Vol, veh/h	0	300	0	0	725	0	0	0	0	0	0	0
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Free	Free	Stop	Stop	Stop	Stop	Stop	Stop
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	-	-	-	-	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	92	92	92	92	92	92	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2	2	2	2	2	2	2
Mvmt Flow	0	326	0	0	788	0	0	0	0	0	0	0

Major/Minor	Major1			Major2			Minor1			Minor2		
Conflicting Flow All	788	0	0	326	0	0	1114	1114	326	1114	1114	788
Stage 1	-	-	-	-	-	-	326	326	-	788	788	-
Stage 2	-	-	-	-	-	-	788	788	-	326	326	-
Critical Hdwy	4.12	-	-	4.12	-	-	7.12	6.52	6.22	7.12	6.52	6.22
Critical Hdwy Stg 1	-	-	-	-	-	-	6.12	5.52	-	6.12	5.52	-
Critical Hdwy Stg 2	-	-	-	-	-	-	6.12	5.52	-	6.12	5.52	-
Follow-up Hdwy	2.218	-	-	2.218	-	-	3.518	4.018	3.318	3.518	4.018	3.318
Pot Cap-1 Maneuver	831	-	-	1234	-	-	185	208	715	185	208	391
Stage 1	-	-	-	-	-	-	687	648	-	384	402	-
Stage 2	-	-	-	-	-	-	384	402	-	687	648	-
Platoon blocked, %		-	-		-	-						
Mov Cap-1 Maneuver	831	-	-	1234	-	-	185	208	715	185	208	391
Mov Cap-2 Maneuver	-	-	-	-	-	-	185	208	-	185	208	-
Stage 1	-	-	-	-	-	-	687	648	-	384	402	-
Stage 2	-	-	-	-	-	-	384	402	-	687	648	-

Approach	EB	WB	NB	SB
HCM Control Delay, s	0	0	0	0
HCM LOS			A	A

Minor Lane/Major Mvmt	NBLn1	EBL	EBT	EBR	WBL	WBT	WBR	SBLn1
Capacity (veh/h)	-	831	-	-	1234	-	-	-
HCM Lane V/C Ratio	-	-	-	-	-	-	-	-
HCM Control Delay (s)	0	0	-	-	0	-	-	0
HCM Lane LOS	A	A	-	-	A	-	-	A
HCM 95th %tile Q(veh)	-	0	-	-	0	-	-	-

Intersection	
Int Delay, s/veh	0.4

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Vol, veh/h	0	295	710	5	10	10
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	-	-	0	-
Veh in Median Storage, #	-	0	0	-	0	-
Grade, %	-	0	0	-	0	-
Peak Hour Factor	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	0	321	772	5	11	11

Major/Minor	Major1		Major2		Minor2	
Conflicting Flow All	777	0	-	0	1095	774
Stage 1	-	-	-	-	774	-
Stage 2	-	-	-	-	321	-
Critical Hdwy	4.12	-	-	-	6.42	6.22
Critical Hdwy Stg 1	-	-	-	-	5.42	-
Critical Hdwy Stg 2	-	-	-	-	5.42	-
Follow-up Hdwy	2.218	-	-	-	3.518	3.318
Pot Cap-1 Maneuver	839	-	-	-	236	398
Stage 1	-	-	-	-	455	-
Stage 2	-	-	-	-	735	-
Platoon blocked, %		-	-	-		
Mov Cap-1 Maneuver	839	-	-	-	236	398
Mov Cap-2 Maneuver	-	-	-	-	236	-
Stage 1	-	-	-	-	455	-
Stage 2	-	-	-	-	735	-

Approach	EB	WB	SB
HCM Control Delay, s	0	0	18.1
HCM LOS			C

Minor Lane/Major Mvmt	EBL	EBT	WBT	WBR	SBLn1
Capacity (veh/h)	839	-	-	-	296
HCM Lane V/C Ratio	-	-	-	-	0.073
HCM Control Delay (s)	0	-	-	-	18.1
HCM Lane LOS	A	-	-	-	C
HCM 95th %tile Q(veh)	0	-	-	-	0.2

Intersection	
Int Delay, s/veh	0.3

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Vol, veh/h	5	290	0	0	705	15	0	0	0	5	0	10
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Free	Free	Stop	Stop	Stop	Stop	Stop	Stop
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	-	-	-	-	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	92	92	92	92	92	92	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2	2	2	2	2	2	2
Mvmt Flow	5	315	0	0	766	16	0	0	0	5	0	11

Major/Minor	Major1			Major2			Minor1			Minor2		
Conflicting Flow All	783	0	0	315	0	0	1106	1109	315	1100	1100	774
Stage 1	-	-	-	-	-	-	326	326	-	774	774	-
Stage 2	-	-	-	-	-	-	780	783	-	326	326	-
Critical Hdwy	4.12	-	-	4.12	-	-	7.12	6.52	6.22	7.12	6.52	6.22
Critical Hdwy Stg 1	-	-	-	-	-	-	6.12	5.52	-	6.12	5.52	-
Critical Hdwy Stg 2	-	-	-	-	-	-	6.12	5.52	-	6.12	5.52	-
Follow-up Hdwy	2.218	-	-	2.218	-	-	3.518	4.018	3.318	3.518	4.018	3.318
Pot Cap-1 Maneuver	835	-	-	1245	-	-	188	210	725	190	212	398
Stage 1	-	-	-	-	-	-	687	648	-	391	408	-
Stage 2	-	-	-	-	-	-	388	404	-	687	648	-
Platoon blocked, %		-	-		-	-						
Mov Cap-1 Maneuver	835	-	-	1245	-	-	182	209	725	189	211	398
Mov Cap-2 Maneuver	-	-	-	-	-	-	182	209	-	189	211	-
Stage 1	-	-	-	-	-	-	682	643	-	388	408	-
Stage 2	-	-	-	-	-	-	377	404	-	682	643	-

Approach	EB	WB	NB	SB
HCM Control Delay, s	0.2	0	0	18.1
HCM LOS			A	C

Minor Lane/Major Mvmt	NBLn1	EBL	EBT	EBR	WBL	WBT	WBR	SBLn1
Capacity (veh/h)	-	835	-	-	1245	-	-	291
HCM Lane V/C Ratio	-	0.007	-	-	-	-	-	0.056
HCM Control Delay (s)	0	9.3	0	-	0	-	-	18.1
HCM Lane LOS	A	A	A	-	A	-	-	C
HCM 95th %tile Q(veh)	-	0	-	-	0	-	-	0.2

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	10	125	185	95	285	235	390	1015	180	160	720	50
Number	7	4	14	3	8	18	5	2	12	1	6	16
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1863	1863	1900	1863	1863	1863	1863	1863	1863	1863	1863	1863
Adj Flow Rate, veh/h	11	136	17	103	310	42	424	1103	109	174	783	12
Adj No. of Lanes	1	2	0	1	1	1	1	2	1	1	2	1
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Percent Heavy Veh, %	2	2	2	2	2	2	2	2	2	2	2	2
Cap, veh/h	18	434	53	128	370	314	458	1682	752	203	1175	525
Arrive On Green	0.01	0.14	0.14	0.07	0.20	0.20	0.26	0.48	0.48	0.11	0.33	0.33
Sat Flow, veh/h	1774	3173	391	1774	1863	1583	1774	3539	1583	1774	3539	1583
Grp Volume(v), veh/h	11	75	78	103	310	42	424	1103	109	174	783	12
Grp Sat Flow(s),veh/h/ln	1774	1770	1794	1774	1863	1583	1774	1770	1583	1774	1770	1583
Q Serve(g_s), s	0.7	4.6	4.7	6.8	19.1	2.6	27.8	28.3	4.6	11.5	22.6	0.6
Cycle Q Clear(g_c), s	0.7	4.6	4.7	6.8	19.1	2.6	27.8	28.3	4.6	11.5	22.6	0.6
Prop In Lane	1.00		0.22	1.00		1.00	1.00		1.00	1.00		1.00
Lane Grp Cap(c), veh/h	18	242	245	128	370	314	458	1682	752	203	1175	525
V/C Ratio(X)	0.61	0.31	0.32	0.80	0.84	0.13	0.93	0.66	0.14	0.86	0.67	0.02
Avail Cap(c_a), veh/h	193	549	557	193	578	491	580	1960	877	298	1395	624
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	58.8	46.4	46.4	54.5	45.9	39.3	43.1	23.8	17.6	51.8	34.2	26.8
Incr Delay (d2), s/veh	28.3	0.7	0.7	13.4	6.3	0.2	18.4	0.6	0.1	14.8	0.9	0.0
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	0.5	2.3	2.4	3.8	10.5	1.2	15.9	13.9	2.0	6.4	11.2	0.3
LnGrp Delay(d),s/veh	87.1	47.1	47.2	67.9	52.3	39.5	61.5	24.5	17.7	66.6	35.1	26.8
LnGrp LOS	F	D	D	E	D	D	E	C	B	E	D	C
Approach Vol, veh/h		164			455			1636			969	
Approach Delay, s/veh		49.8			54.6			33.6			40.7	
Approach LOS		D			D			C			D	

Timer	1	2	3	4	5	6	7	8
Assigned Phs	1	2	3	4	5	6	7	8
Phs Duration (G+Y+Rc), s	19.7	62.6	14.6	22.3	36.8	45.6	7.2	29.7
Change Period (Y+Rc), s	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0
Max Green Setting (Gmax), s	20.0	66.0	13.0	37.0	39.0	47.0	13.0	37.0
Max Q Clear Time (g_c+I1), s	13.5	30.3	8.8	6.7	29.8	24.6	2.7	21.1
Green Ext Time (p_c), s	0.2	20.0	0.1	3.1	1.0	14.9	0.0	2.6

Intersection Summary	
HCM 2010 Ctrl Delay	39.5
HCM 2010 LOS	D

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	290	145	185	55	240	285	195	1365	5	185	950	140
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	6.0	4.0	4.0	6.0
Lane Util. Factor	0.91	0.91	1.00	1.00	1.00	0.88	0.97	0.91	1.00	0.97	0.91	1.00
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	0.98	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	1610	3308	1583	1770	1863	2787	3433	5085	1583	3433	5085	1583
Flt Permitted	0.95	0.98	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)	1610	3308	1583	1770	1863	2787	3433	5085	1583	3433	5085	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)	315	158	201	60	261	310	212	1484	5	201	1033	152
RTOR Reduction (vph)	0	0	62	0	0	199	0	0	2	0	0	74
Lane Group Flow (vph)	157	316	139	60	261	111	212	1484	3	201	1033	78
Turn Type	Split	NA	Perm	Split	NA	Perm	Prot	NA	Perm	Prot	NA	Perm
Protected Phases	3	3		4	4		5	2		1	6	
Permitted Phases			3			4			2			6
Actuated Green, G (s)	32.6	32.6	32.6	40.2	40.2	40.2	20.1	123.1	123.1	19.1	122.1	122.1
Effective Green, g (s)	34.6	34.6	34.6	42.2	42.2	42.2	22.1	126.1	124.1	21.1	125.1	123.1
Actuated g/C Ratio	0.14	0.14	0.14	0.18	0.18	0.18	0.09	0.53	0.52	0.09	0.52	0.51
Clearance Time (s)	6.0	6.0	6.0	6.0	6.0	6.0	6.0	7.0	7.0	6.0	7.0	7.0
Vehicle Extension (s)	5.0	5.0	5.0	5.0	5.0	5.0	3.0	5.0	5.0	3.0	5.0	5.0
Lane Grp Cap (vph)	232	476	228	311	327	490	316	2671	818	301	2650	811
v/s Ratio Prot	c0.10	0.10		0.03	c0.14		c0.06	c0.29		0.06	0.20	
v/s Ratio Perm			0.09			0.04			0.00			0.05
v/c Ratio	0.68	0.66	0.61	0.19	0.80	0.23	0.67	0.56	0.00	0.67	0.39	0.10
Uniform Delay, d1	97.4	97.2	96.3	84.4	94.8	84.9	105.4	38.2	28.0	106.1	34.5	29.9
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.73	1.63	7.17
Incremental Delay, d2	9.8	4.6	6.6	0.6	14.5	0.5	5.5	0.8	0.0	5.0	0.4	0.2
Delay (s)	107.2	101.8	102.9	85.0	109.3	85.4	110.9	39.0	28.0	82.7	56.6	215.0
Level of Service	F	F	F	F	F	F	F	D	C	F	E	F
Approach Delay (s)		103.4			95.2			47.9			77.7	
Approach LOS		F			F			D			E	

Intersection Summary			
HCM 2000 Control Delay	72.6	HCM 2000 Level of Service	E
HCM 2000 Volume to Capacity ratio	0.63		
Actuated Cycle Length (s)	240.0	Sum of lost time (s)	16.0
Intersection Capacity Utilization	65.9%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	415	5	135	5	15	15	250	2625	20	75	1265	325
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		6.0	4.0	6.0	5.0	6.0	4.0	5.0	7.0
Lane Util. Factor	0.95	0.95	1.00		1.00	1.00	1.00	0.91	1.00	1.00	0.91	1.00
Frpb, ped/bikes	1.00	1.00	0.91		1.00	1.00	1.00	1.00	0.83	1.00	1.00	0.97
Flpb, ped/bikes	1.00	1.00	1.00		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Frt	1.00	1.00	0.85		1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	0.95	1.00		0.99	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	1681	1687	1434		1841	1583	1770	5085	1311	1770	5085	1536
Flt Permitted	0.95	0.95	1.00		0.99	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)	1681	1687	1434		1841	1583	1770	5085	1311	1770	5085	1536
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	451	5	147	5	16	16	272	2853	22	82	1375	353
RTOR Reduction (vph)	0	0	83	0	0	15	0	0	8	0	0	169
Lane Group Flow (vph)	230	226	64	0	21	1	272	2853	14	82	1375	184
Confl. Peds. (#/hr)			43						31			2
Turn Type	Split	NA	Perm	Split	NA	Perm	Prot	NA	Perm	Prot	NA	Perm
Protected Phases	4	4		3	3		5	2		1	6	
Permitted Phases			4			3			2			6
Actuated Green, G (s)	40.5	40.5	40.5		7.1	7.1	43.3	153.4	153.4	15.0	125.1	125.1
Effective Green, g (s)	40.5	40.5	40.5		7.1	9.1	43.3	155.4	154.4	17.0	127.1	125.1
Actuated g/C Ratio	0.17	0.17	0.17		0.03	0.04	0.18	0.65	0.64	0.07	0.53	0.52
Clearance Time (s)	5.0	5.0	5.0		6.0	6.0	6.0	7.0	7.0	6.0	7.0	7.0
Vehicle Extension (s)	4.0	4.0	4.0		3.0	3.0	5.0	6.0	6.0	3.0	6.0	6.0
Lane Grp Cap (vph)	283	284	241		54	60	319	3292	843	125	2692	800
v/s Ratio Prot	c0.14	0.13			c0.01		c0.15	c0.56		0.05	0.27	
v/s Ratio Perm			0.04			0.00			0.01			0.12
v/c Ratio	0.81	0.80	0.27		0.39	0.01	0.85	0.87	0.02	0.66	0.51	0.23
Uniform Delay, d1	96.1	95.8	86.8		114.3	111.1	95.3	34.0	15.4	108.7	36.4	31.3
Progression Factor	1.00	1.00	1.00		1.00	1.00	1.21	0.62	1.00	1.07	1.00	1.78
Incremental Delay, d2	16.9	15.0	0.8		4.6	0.1	9.9	1.4	0.0	11.2	0.7	0.6
Delay (s)	113.0	110.8	87.6		118.9	111.2	124.9	22.4	15.4	126.9	37.2	56.2
Level of Service	F	F	F		F	F	F	C	B	F	D	E
Approach Delay (s)		106.0			115.6			31.2			45.0	
Approach LOS		F			F			C			D	

Intersection Summary			
HCM 2000 Control Delay	44.3	HCM 2000 Level of Service	D
HCM 2000 Volume to Capacity ratio	0.85		
Actuated Cycle Length (s)	240.0	Sum of lost time (s)	22.0
Intersection Capacity Utilization	94.4%	ICU Level of Service	F
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	750	650	10	230	395	525	55	345	130	630	350	655
Number	7	4	14	3	8	18	5	2	12	1	6	16
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1863	1863	1900	1863	1863	1863	1863	1863	1900	1863	1863	1863
Adj Flow Rate, veh/h	815	707	11	250	429	517	60	375	18	685	380	447
Adj No. of Lanes	2	3	0	2	3	2	1	2	0	2	2	2
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Percent Heavy Veh, %	2	2	2	2	2	2	2	2	2	2	2	2
Cap, veh/h	898	1858	29	319	976	1144	78	528	25	752	1161	1638
Arrive On Green	0.26	0.36	0.36	0.09	0.19	0.19	0.04	0.15	0.15	0.22	0.33	0.33
Sat Flow, veh/h	3442	5159	80	3442	5085	2787	1774	3439	165	3442	3539	2776
Grp Volume(v), veh/h	815	464	254	250	429	517	60	192	201	685	380	447
Grp Sat Flow(s),veh/h/ln	1721	1695	1849	1721	1695	1393	1774	1770	1834	1721	1770	1388
Q Serve(g_s), s	30.1	13.3	13.4	9.3	9.8	17.7	4.4	13.6	13.7	25.5	10.6	10.4
Cycle Q Clear(g_c), s	30.1	13.3	13.4	9.3	9.8	17.7	4.4	13.6	13.7	25.5	10.6	10.4
Prop In Lane	1.00		0.04	1.00		1.00	1.00		0.09	1.00		1.00
Lane Grp Cap(c), veh/h	898	1221	666	319	976	1144	78	272	282	752	1161	1638
V/C Ratio(X)	0.91	0.38	0.38	0.78	0.44	0.45	0.77	0.71	0.71	0.91	0.33	0.27
Avail Cap(c_a), veh/h	1047	1221	666	942	1470	1415	513	633	656	838	1161	1638
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	47.1	31.2	31.2	58.4	46.9	28.0	62.2	52.8	52.9	50.1	33.2	13.2
Incr Delay (d2), s/veh	10.3	0.2	0.4	4.2	0.3	0.3	14.3	3.4	3.3	13.1	0.2	0.1
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	15.7	6.3	6.9	4.6	4.6	6.8	2.5	6.9	7.2	13.5	5.2	4.0
LnGrp Delay(d),s/veh	57.4	31.4	31.6	62.6	47.2	28.3	76.5	56.2	56.2	63.2	33.4	13.3
LnGrp LOS	E	C	C	E	D	C	E	E	E	E	C	B
Approach Vol, veh/h		1533			1196			453			1512	
Approach Delay, s/veh		45.2			42.3			58.9			41.0	
Approach LOS		D			D			E			D	

Timer	1	2	3	4	5	6	7	8
Assigned Phs	1	2	3	4	5	6	7	8
Phs Duration (G+Y+Rc), s	33.7	26.2	18.2	53.3	10.8	49.1	40.3	31.2
Change Period (Y+Rc), s	5.0	6.0	6.0	6.0	5.0	6.0	6.0	6.0
Max Green Setting (Gmax), s	32.0	47.0	36.0	42.0	38.0	41.0	40.0	38.0
Max Q Clear Time (g_c+I1), s	27.5	15.7	11.3	15.4	6.4	12.6	32.1	19.7
Green Ext Time (p_c), s	1.2	3.5	0.8	11.7	0.1	7.8	2.1	5.6

Intersection Summary	
HCM 2010 Ctrl Delay	44.4
HCM 2010 LOS	D

Notes

User approved changes to right turn type.

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	70	125	65	180	70	295	35	810	120	320	1100	55
Number	3	8	18	7	4	14	5	2	12	1	6	16
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1863	1863	1900	1863	1863	1863	1863	1863	1900	1863	1863	1900
Adj Flow Rate, veh/h	76	136	53	196	76	58	38	880	110	348	1196	57
Adj No. of Lanes	1	1	0	1	1	1	1	3	0	1	3	0
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Percent Heavy Veh, %	2	2	2	2	2	2	2	2	2	2	2	2
Cap, veh/h	402	368	143	321	536	456	48	1351	168	387	2417	115
Arrive On Green	0.29	0.29	0.29	0.29	0.29	0.29	0.03	0.29	0.29	0.22	0.49	0.49
Sat Flow, veh/h	1250	1277	498	1189	1863	1583	1774	4582	570	1774	4974	237
Grp Volume(v), veh/h	76	0	189	196	76	58	38	650	340	348	815	438
Grp Sat Flow(s),veh/h/ln	1250	0	1775	1189	1863	1583	1774	1695	1762	1774	1695	1821
Q Serve(g_s), s	4.3	0.0	7.7	14.2	2.7	2.4	1.9	15.1	15.2	17.2	14.7	14.7
Cycle Q Clear(g_c), s	7.1	0.0	7.7	21.9	2.7	2.4	1.9	15.1	15.2	17.2	14.7	14.7
Prop In Lane	1.00		0.28	1.00		1.00	1.00		0.32	1.00		0.13
Lane Grp Cap(c), veh/h	402	0	511	321	536	456	48	1000	520	387	1648	885
V/C Ratio(X)	0.19	0.00	0.37	0.61	0.14	0.13	0.79	0.65	0.65	0.90	0.49	0.49
Avail Cap(c_a), veh/h	512	0	667	426	700	595	471	1462	760	471	1648	885
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	0.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	26.5	0.0	25.7	34.4	23.9	23.8	43.7	27.8	27.8	34.4	15.7	15.7
Incr Delay (d2), s/veh	0.2	0.0	0.4	1.9	0.1	0.1	23.9	0.7	1.4	17.6	0.2	0.4
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	1.5	0.0	3.8	4.8	1.4	1.1	1.3	7.1	7.6	10.3	6.8	7.4
LnGrp Delay(d),s/veh	26.8	0.0	26.1	36.3	24.0	23.9	67.6	28.5	29.3	51.9	16.0	16.2
LnGrp LOS	C		C	D	C	C	E	C	C	D	B	B
Approach Vol, veh/h		265			330			1028			1601	
Approach Delay, s/veh		26.3			31.3			30.2			23.8	
Approach LOS		C			C			C			C	

Timer	1	2	3	4	5	6	7	8
Assigned Phs	1	2		4	5	6		8
Phs Duration (G+Y+Rc), s	25.7	32.7		32.0	8.5	49.9		32.0
Change Period (Y+Rc), s	6.0	6.0		6.0	6.0	6.0		6.0
Max Green Setting (Gmax), s	24.0	39.0		34.0	24.0	39.0		34.0
Max Q Clear Time (g_c+I1), s	19.2	17.2		23.9	3.9	16.7		9.7
Green Ext Time (p_c), s	0.5	9.4		2.1	0.1	16.1		2.9

Intersection Summary			
HCM 2010 Ctrl Delay			26.8
HCM 2010 LOS			C

Intersection	
Int Delay, s/veh	8.4

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Vol, veh/h	2	3	135	2	6	193
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	-	-	0	-
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	2	3	147	2	7	210

Major/Minor	Major1		Major2		Minor1	
Conflicting Flow All	0	0	5	0	300	4
Stage 1	-	-	-	-	4	-
Stage 2	-	-	-	-	296	-
Critical Hdwy	-	-	4.12	-	6.42	6.22
Critical Hdwy Stg 1	-	-	-	-	5.42	-
Critical Hdwy Stg 2	-	-	-	-	5.42	-
Follow-up Hdwy	-	-	2.218	-	3.518	3.318
Pot Cap-1 Maneuver	-	-	1616	-	691	1080
Stage 1	-	-	-	-	1019	-
Stage 2	-	-	-	-	755	-
Platoon blocked, %	-	-		-		
Mov Cap-1 Maneuver	-	-	1616	-	628	1080
Mov Cap-2 Maneuver	-	-	-	-	628	-
Stage 1	-	-	-	-	1019	-
Stage 2	-	-	-	-	686	-

Approach	EB	WB	NB
HCM Control Delay, s	0	7.3	9.3
HCM LOS			A

Minor Lane/Major Mvmt	NBLn1	EBT	EBR	WBL	WBT
Capacity (veh/h)	1057	-	-	1616	-
HCM Lane V/C Ratio	0.205	-	-	0.091	-
HCM Control Delay (s)	9.3	-	-	7.5	0
HCM Lane LOS	A	-	-	A	A
HCM 95th %tile Q(veh)	0.8	-	-	0.3	-

Intersection	
Int Delay, s/veh	3.2

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Vol, veh/h	172	583	0	0	331	17	0	0	0	14	0	123
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Free	Free	Stop	Stop	Stop	Stop	Stop	Stop
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	-	-	-	-	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	92	92	92	92	92	92	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2	2	2	2	2	2	2
Mvmt Flow	187	634	0	0	360	18	0	0	0	15	0	134

Major/Minor	Major1			Major2			Minor1			Minor2		
Conflicting Flow All	378	0	0	634	0	0	1444	1386	634	1377	1377	369
Stage 1	-	-	-	-	-	-	1008	1008	-	369	369	-
Stage 2	-	-	-	-	-	-	436	378	-	1008	1008	-
Critical Hdwy	4.12	-	-	4.12	-	-	7.12	6.52	6.22	7.12	6.52	6.22
Critical Hdwy Stg 1	-	-	-	-	-	-	6.12	5.52	-	6.12	5.52	-
Critical Hdwy Stg 2	-	-	-	-	-	-	6.12	5.52	-	6.12	5.52	-
Follow-up Hdwy	2.218	-	-	2.218	-	-	3.518	4.018	3.318	3.518	4.018	3.318
Pot Cap-1 Maneuver	1180	-	-	949	-	-	110	143	479	122	145	677
Stage 1	-	-	-	-	-	-	290	318	-	651	621	-
Stage 2	-	-	-	-	-	-	599	615	-	290	318	-
Platoon blocked, %		-	-		-	-						
Mov Cap-1 Maneuver	1180	-	-	949	-	-	72	108	479	99	109	677
Mov Cap-2 Maneuver	-	-	-	-	-	-	72	108	-	99	109	-
Stage 1	-	-	-	-	-	-	219	240	-	492	621	-
Stage 2	-	-	-	-	-	-	481	615	-	219	240	-

Approach	EB	WB	NB	SB
HCM Control Delay, s	2	0	0	18
HCM LOS			A	C

Minor Lane/Major Mvmt	NBLn1	EBL	EBT	EBR	WBL	WBT	WBR	SBLn1
Capacity (veh/h)	-	1180	-	-	949	-	-	424
HCM Lane V/C Ratio	-	0.158	-	-	-	-	-	0.351
HCM Control Delay (s)	0	8.6	0	-	0	-	-	18
HCM Lane LOS	A	A	A	-	A	-	-	C
HCM 95th %tile Q(veh)	-	0.6	-	-	0	-	-	1.6

Intersection	
Int Delay, s/veh	0.6

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Vol, veh/h	624	13	11	345	9	19
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	50	-	0	-
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	678	14	12	375	10	21

Major/Minor	Major1		Major2		Minor1	
Conflicting Flow All	0	0	692	0	1084	685
Stage 1	-	-	-	-	685	-
Stage 2	-	-	-	-	399	-
Critical Hdwy	-	-	4.12	-	6.42	6.22
Critical Hdwy Stg 1	-	-	-	-	5.42	-
Critical Hdwy Stg 2	-	-	-	-	5.42	-
Follow-up Hdwy	-	-	2.218	-	3.518	3.318
Pot Cap-1 Maneuver	-	-	903	-	240	448
Stage 1	-	-	-	-	500	-
Stage 2	-	-	-	-	678	-
Platoon blocked, %	-	-		-		
Mov Cap-1 Maneuver	-	-	903	-	237	448
Mov Cap-2 Maneuver	-	-	-	-	237	-
Stage 1	-	-	-	-	500	-
Stage 2	-	-	-	-	669	-

Approach	EB	WB	NB
HCM Control Delay, s	0	0.3	16.3
HCM LOS			C

Minor Lane/Major Mvmt	NBLn1	EBT	EBR	WBL	WBT
Capacity (veh/h)	348	-	-	903	-
HCM Lane V/C Ratio	0.087	-	-	0.013	-
HCM Control Delay (s)	16.3	-	-	9	-
HCM Lane LOS	C	-	-	A	-
HCM 95th %tile Q(veh)	0.3	-	-	0	-

Intersection	
Int Delay, s/veh	0

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Vol, veh/h	1	617	0	1	352	1	0	0	2	0	0	0
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Free	Free	Stop	Stop	Stop	Stop	Stop	Stop
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	-	-	-	-	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	92	92	92	92	92	92	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2	2	2	2	2	2	2
Mvmt Flow	1	671	0	1	383	1	0	0	2	0	0	0

Major/Minor	Major1			Major2			Minor1			Minor2		
Conflicting Flow All	384	0	0	671	0	0	1058	1059	671	1059	1058	383
Stage 1	-	-	-	-	-	-	673	673	-	385	385	-
Stage 2	-	-	-	-	-	-	385	386	-	674	673	-
Critical Hdwy	4.12	-	-	4.12	-	-	7.12	6.52	6.22	7.12	6.52	6.22
Critical Hdwy Stg 1	-	-	-	-	-	-	6.12	5.52	-	6.12	5.52	-
Critical Hdwy Stg 2	-	-	-	-	-	-	6.12	5.52	-	6.12	5.52	-
Follow-up Hdwy	2.218	-	-	2.218	-	-	3.518	4.018	3.318	3.518	4.018	3.318
Pot Cap-1 Maneuver	1174	-	-	919	-	-	203	224	456	202	225	664
Stage 1	-	-	-	-	-	-	445	454	-	638	611	-
Stage 2	-	-	-	-	-	-	638	610	-	444	454	-
Platoon blocked, %		-	-		-	-						
Mov Cap-1 Maneuver	1174	-	-	919	-	-	203	224	456	201	225	664
Mov Cap-2 Maneuver	-	-	-	-	-	-	203	224	-	201	225	-
Stage 1	-	-	-	-	-	-	445	454	-	637	610	-
Stage 2	-	-	-	-	-	-	637	609	-	441	454	-

Approach	EB	WB	NB	SB
HCM Control Delay, s	0	0	12.9	0
HCM LOS			B	A

Minor Lane/Major Mvmt	NBLn1	EBL	EBT	EBR	WBL	WBT	WBR	SBLn1
Capacity (veh/h)	456	1174	-	-	919	-	-	-
HCM Lane V/C Ratio	0.005	0.001	-	-	0.001	-	-	-
HCM Control Delay (s)	12.9	8.1	0	-	8.9	0	-	0
HCM Lane LOS	B	A	A	-	A	A	-	A
HCM 95th %tile Q(veh)	0	0	-	-	0	-	-	-

Intersection	
Int Delay, s/veh	0.2

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Vol, veh/h	0	644	354	2	10	2
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	-	-	0	-
Veh in Median Storage, #	-	0	0	-	0	-
Grade, %	-	0	0	-	0	-
Peak Hour Factor	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	0	700	385	2	11	2

Major/Minor	Major1		Major2		Minor2	
Conflicting Flow All	387	0	-	0	1086	386
Stage 1	-	-	-	-	386	-
Stage 2	-	-	-	-	700	-
Critical Hdwy	4.12	-	-	-	6.42	6.22
Critical Hdwy Stg 1	-	-	-	-	5.42	-
Critical Hdwy Stg 2	-	-	-	-	5.42	-
Follow-up Hdwy	2.218	-	-	-	3.518	3.318
Pot Cap-1 Maneuver	1171	-	-	-	239	662
Stage 1	-	-	-	-	687	-
Stage 2	-	-	-	-	493	-
Platoon blocked, %		-	-	-		
Mov Cap-1 Maneuver	1171	-	-	-	239	662
Mov Cap-2 Maneuver	-	-	-	-	239	-
Stage 1	-	-	-	-	687	-
Stage 2	-	-	-	-	493	-

Approach	EB	WB	SB
HCM Control Delay, s	0	0	19.2
HCM LOS			C

Minor Lane/Major Mvmt	EBL	EBT	WBT	WBR	SBLn1
Capacity (veh/h)	1171	-	-	-	267
HCM Lane V/C Ratio	-	-	-	-	0.049
HCM Control Delay (s)	0	-	-	-	19.2
HCM Lane LOS	A	-	-	-	C
HCM 95th %tile Q(veh)	0	-	-	-	0.2

Intersection	
Int Delay, s/veh	0.7

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Vol, veh/h	10	628	0	0	336	19	0	0	0	19	0	12
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Free	Free	Stop	Stop	Stop	Stop	Stop	Stop
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	-	-	-	-	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	92	92	92	92	92	92	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2	2	2	2	2	2	2
Mvmt Flow	11	683	0	0	365	21	0	0	0	21	0	13

Major/Minor	Major1			Major2			Minor1			Minor2		
Conflicting Flow All	386	0	0	683	0	0	1086	1090	683	1080	1080	376
Stage 1	-	-	-	-	-	-	704	704	-	376	376	-
Stage 2	-	-	-	-	-	-	382	386	-	704	704	-
Critical Hdwy	4.12	-	-	4.12	-	-	7.12	6.52	6.22	7.12	6.52	6.22
Critical Hdwy Stg 1	-	-	-	-	-	-	6.12	5.52	-	6.12	5.52	-
Critical Hdwy Stg 2	-	-	-	-	-	-	6.12	5.52	-	6.12	5.52	-
Follow-up Hdwy	2.218	-	-	2.218	-	-	3.518	4.018	3.318	3.518	4.018	3.318
Pot Cap-1 Maneuver	1172	-	-	910	-	-	194	215	449	196	218	670
Stage 1	-	-	-	-	-	-	428	440	-	645	616	-
Stage 2	-	-	-	-	-	-	640	610	-	428	440	-
Platoon blocked, %		-	-		-	-						
Mov Cap-1 Maneuver	1172	-	-	910	-	-	188	212	449	194	215	670
Mov Cap-2 Maneuver	-	-	-	-	-	-	188	212	-	194	215	-
Stage 1	-	-	-	-	-	-	422	433	-	635	616	-
Stage 2	-	-	-	-	-	-	628	610	-	422	433	-

Approach	EB	WB	NB	SB
HCM Control Delay, s	0.1	0	0	20.4
HCM LOS			A	C

Minor Lane/Major Mvmt	NBLn1	EBL	EBT	EBR	WBL	WBT	WBR	SBLn1
Capacity (veh/h)	-	1172	-	-	910	-	-	268
HCM Lane V/C Ratio	-	0.009	-	-	-	-	-	0.126
HCM Control Delay (s)	0	8.1	0	-	0	-	-	20.4
HCM Lane LOS	A	A	A	-	A	-	-	C
HCM 95th %tile Q(veh)	-	0	-	-	0	-	-	0.4

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	50	280	445	155	215	250	205	715	100	170	910	30
Number	7	4	14	3	8	18	5	2	12	1	6	16
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1863	1863	1900	1863	1863	1863	1863	1863	1863	1863	1863	1863
Adj Flow Rate, veh/h	54	304	280	168	234	64	223	777	33	185	989	9
Adj No. of Lanes	1	2	0	1	1	1	1	2	1	1	2	1
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Percent Heavy Veh, %	2	2	2	2	2	2	2	2	2	2	2	2
Cap, veh/h	71	405	363	196	558	475	254	1210	541	216	1134	508
Arrive On Green	0.04	0.23	0.23	0.11	0.30	0.30	0.14	0.34	0.34	0.12	0.32	0.32
Sat Flow, veh/h	1774	1770	1583	1774	1863	1583	1774	3539	1583	1774	3539	1583
Grp Volume(v), veh/h	54	304	280	168	234	64	223	777	33	185	989	9
Grp Sat Flow(s),veh/h/ln	1774	1770	1583	1774	1863	1583	1774	1770	1583	1774	1770	1583
Q Serve(g_s), s	3.7	19.5	20.2	11.3	12.3	3.6	15.0	22.5	1.7	12.5	32.1	0.5
Cycle Q Clear(g_c), s	3.7	19.5	20.2	11.3	12.3	3.6	15.0	22.5	1.7	12.5	32.1	0.5
Prop In Lane	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Lane Grp Cap(c), veh/h	71	405	363	196	558	475	254	1210	541	216	1134	508
V/C Ratio(X)	0.77	0.75	0.77	0.86	0.42	0.13	0.88	0.64	0.06	0.86	0.87	0.02
Avail Cap(c_a), veh/h	393	668	598	262	566	481	379	1210	541	379	1191	533
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	57.9	43.7	44.0	53.2	34.2	31.1	51.2	33.8	26.9	52.5	39.0	28.3
Incr Delay (d2), s/veh	15.7	2.8	3.5	18.6	0.5	0.1	14.5	1.2	0.0	9.5	7.1	0.0
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	2.1	9.9	9.1	6.6	6.4	1.6	8.4	11.2	0.8	6.7	16.8	0.2
LnGrp Delay(d),s/veh	73.6	46.5	47.5	71.9	34.7	31.3	65.7	35.0	27.0	62.0	46.1	28.3
LnGrp LOS	E	D	D	E	C	C	E	C	C	E	D	C
Approach Vol, veh/h		638			466			1033			1183	
Approach Delay, s/veh		49.3			47.6			41.3			48.4	
Approach LOS		D			D			D			D	

Timer	1	2	3	4	5	6	7	8
Assigned Phs	1	2	3	4	5	6	7	8
Phs Duration (G+Y+Rc), s	20.8	47.7	19.5	33.9	23.4	45.0	10.8	42.5
Change Period (Y+Rc), s	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0
Max Green Setting (Gmax), s	26.0	41.0	18.0	46.0	26.0	41.0	27.0	37.0
Max Q Clear Time (g_c+I1), s	14.5	24.5	13.3	22.2	17.0	34.1	5.7	14.3
Green Ext Time (p_c), s	0.4	11.1	0.2	5.7	0.4	4.9	0.1	5.6

Intersection Summary		
HCM 2010 Ctrl Delay		46.3
HCM 2010 LOS		D

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	215	225	205	15	220	150	215	870	15	350	1545	215
Ideal Flow (vphpl)	1900	1900	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	6.0	4.0	4.0	6.0
Lane Util. Factor	0.91	0.91	1.00	1.00	1.00	0.88	0.97	0.91	1.00	0.97	0.91	1.00
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	0.99	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	1610	3350	1583	1770	1863	2787	3433	5085	1583	3433	5085	1583
Flt Permitted	0.95	0.99	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)	1610	3350	1583	1770	1863	2787	3433	5085	1583	3433	5085	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)	234	245	223	16	239	163	234	946	16	380	1679	234
RTOR Reduction (vph)	0	0	62	0	0	112	0	0	8	0	0	71
Lane Group Flow (vph)	157	322	161	16	239	51	234	946	8	380	1679	163
Turn Type	Split	NA	Perm	Split	NA	Perm	Prot	NA	Perm	Prot	NA	Perm
Protected Phases	3	3		4	4		5	2		1	6	
Permitted Phases			3			4			2			6
Actuated Green, G (s)	33.8	33.8	33.8	35.2	35.2	35.2	21.6	114.9	114.9	31.1	124.4	124.4
Effective Green, g (s)	35.8	35.8	35.8	37.2	37.2	37.2	23.6	117.9	115.9	33.1	127.4	125.4
Actuated g/C Ratio	0.15	0.15	0.15	0.16	0.16	0.16	0.10	0.49	0.48	0.14	0.53	0.52
Clearance Time (s)	6.0	6.0	6.0	6.0	6.0	6.0	6.0	7.0	7.0	6.0	7.0	7.0
Vehicle Extension (s)	5.0	5.0	5.0	5.0	5.0	5.0	3.0	5.0	5.0	3.0	5.0	5.0
Lane Grp Cap (vph)	240	499	236	274	288	431	337	2498	764	473	2699	827
v/s Ratio Prot	0.10	0.10		0.01	c0.13		0.07	0.19		c0.11	c0.33	
v/s Ratio Perm			c0.10			0.02			0.00			0.10
v/c Ratio	0.65	0.65	0.68	0.06	0.83	0.12	0.69	0.38	0.01	0.80	0.62	0.20
Uniform Delay, d1	96.3	96.1	96.7	86.5	98.3	87.3	104.7	38.2	32.2	100.3	39.4	30.5
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.13	0.91	1.16
Incremental Delay, d2	8.3	3.9	10.0	0.2	19.5	0.3	6.1	0.4	0.0	9.4	1.1	0.5
Delay (s)	104.6	100.0	106.7	86.7	117.9	87.5	110.8	38.6	32.3	123.1	37.2	36.0
Level of Service	F	F	F	F	F	F	F	D	C	F	D	D
Approach Delay (s)		103.2			104.8			52.6			51.3	
Approach LOS		F			F			D			D	

Intersection Summary			
HCM 2000 Control Delay	64.4	HCM 2000 Level of Service	E
HCM 2000 Volume to Capacity ratio	0.70		
Actuated Cycle Length (s)	240.0	Sum of lost time (s)	16.0
Intersection Capacity Utilization	69.2%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	395	40	135	35	35	25	125	1495	60	75	2630	380
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		6.0	4.0	6.0	5.0	6.0	4.0	5.0	7.0
Lane Util. Factor	0.95	0.95	1.00		1.00	1.00	1.00	0.91	1.00	1.00	0.91	1.00
Frpb, ped/bikes	1.00	1.00	0.91		1.00	1.00	1.00	1.00	0.83	1.00	1.00	0.97
Flpb, ped/bikes	1.00	1.00	1.00		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Frt	1.00	1.00	0.85		1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	0.96	1.00		0.98	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	1681	1700	1434		1817	1583	1770	5085	1311	1770	5085	1536
Flt Permitted	0.95	0.96	1.00		0.98	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)	1681	1700	1434		1817	1583	1770	5085	1311	1770	5085	1536
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	429	43	147	38	38	27	136	1625	65	82	2859	413
RTOR Reduction (vph)	0	0	83	0	0	25	0	0	26	0	0	181
Lane Group Flow (vph)	236	236	64	0	76	2	136	1625	39	82	2859	232
Confl. Peds. (#/hr)			43						31			2
Turn Type	Split	NA	Perm	Split	NA	Perm	Prot	NA	Perm	Prot	NA	Perm
Protected Phases	4	4		3	3		5	2		1	6	
Permitted Phases			4			3			2			6
Actuated Green, G (s)	40.9	40.9	40.9		15.4	15.4	25.1	143.8	143.8	15.9	134.6	134.6
Effective Green, g (s)	40.9	40.9	40.9		15.4	17.4	25.1	145.8	144.8	17.9	136.6	134.6
Actuated g/C Ratio	0.17	0.17	0.17		0.06	0.07	0.10	0.61	0.60	0.07	0.57	0.56
Clearance Time (s)	5.0	5.0	5.0		6.0	6.0	6.0	7.0	7.0	6.0	7.0	7.0
Vehicle Extension (s)	4.0	4.0	4.0		3.0	3.0	5.0	6.0	6.0	3.0	6.0	6.0
Lane Grp Cap (vph)	286	289	244		116	114	185	3089	790	132	2894	861
v/s Ratio Prot	c0.14	0.14			c0.04		c0.08	0.32		0.05	c0.56	
v/s Ratio Perm			0.04			0.00			0.03			0.15
v/c Ratio	0.83	0.82	0.26		0.66	0.02	0.74	0.53	0.05	0.62	0.99	0.27
Uniform Delay, d1	96.1	95.9	86.5		109.7	103.4	104.2	27.2	19.5	107.8	50.9	27.3
Progression Factor	1.00	1.00	1.00		1.00	1.00	0.89	1.17	2.12	0.97	0.99	1.45
Incremental Delay, d2	18.1	16.9	0.8		12.5	0.1	7.1	0.3	0.0	8.7	14.0	0.8
Delay (s)	114.2	112.8	87.2		122.3	103.4	100.3	32.0	41.3	113.6	64.5	40.3
Level of Service	F	F	F		F	F	F	C	D	F	E	D
Approach Delay (s)		107.3			117.3			37.5			62.7	
Approach LOS		F			F			D			E	

Intersection Summary			
HCM 2000 Control Delay	60.5	HCM 2000 Level of Service	E
HCM 2000 Volume to Capacity ratio	0.90		
Actuated Cycle Length (s)	240.0	Sum of lost time (s)	22.0
Intersection Capacity Utilization	99.0%	ICU Level of Service	F
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	680	685	5	120	825	520	5	105	15	420	140	465
Number	7	4	14	3	8	18	5	2	12	1	6	16
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1863	1863	1900	1863	1863	1863	1863	1863	1900	1863	1863	1863
Adj Flow Rate, veh/h	739	745	5	130	897	565	5	114	3	457	152	318
Adj No. of Lanes	2	3	0	2	3	2	1	2	0	2	2	2
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Percent Heavy Veh, %	2	2	2	2	2	2	2	2	2	2	2	2
Cap, veh/h	859	2363	16	208	1343	1176	9	339	9	543	881	1386
Arrive On Green	0.25	0.45	0.45	0.06	0.26	0.26	0.01	0.10	0.10	0.16	0.25	0.25
Sat Flow, veh/h	3442	5212	35	3442	5085	2787	1774	3524	92	3442	3539	2773
Grp Volume(v), veh/h	739	484	266	130	897	565	5	57	60	457	152	318
Grp Sat Flow(s),veh/h/ln	1721	1695	1857	1721	1695	1393	1774	1770	1846	1721	1770	1387
Q Serve(g_s), s	21.2	9.4	9.4	3.8	16.3	15.2	0.3	3.1	3.1	13.3	3.5	6.7
Cycle Q Clear(g_c), s	21.2	9.4	9.4	3.8	16.3	15.2	0.3	3.1	3.1	13.3	3.5	6.7
Prop In Lane	1.00		0.02	1.00		1.00	1.00		0.05	1.00		1.00
Lane Grp Cap(c), veh/h	859	1537	842	208	1343	1176	9	170	178	543	881	1386
V/C Ratio(X)	0.86	0.32	0.32	0.63	0.67	0.48	0.54	0.33	0.34	0.84	0.17	0.23
Avail Cap(c_a), veh/h	1265	1537	842	1265	1869	1464	206	651	679	733	1643	1983
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	37.1	18.0	18.0	47.4	34.0	21.7	51.3	43.6	43.6	42.3	30.5	14.7
Incr Delay (d2), s/veh	4.2	0.1	0.2	3.1	0.6	0.3	42.0	1.1	1.1	6.6	0.1	0.1
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	10.6	4.4	4.8	1.9	7.7	5.8	0.2	1.6	1.7	6.8	1.7	2.6
LnGrp Delay(d),s/veh	41.3	18.1	18.2	50.5	34.6	22.0	93.3	44.8	44.7	48.9	30.6	14.8
LnGrp LOS	D	B	B	D	C	C	F	D	D	D	C	B
Approach Vol, veh/h		1489			1592			122			927	
Approach Delay, s/veh		29.6			31.4			46.7			34.2	
Approach LOS		C			C			D			C	

Timer	1	2	3	4	5	6	7	8
Assigned Phs	1	2	3	4	5	6	7	8
Phs Duration (G+Y+Rc), s	22.3	16.0	12.2	52.9	6.5	31.7	31.8	33.3
Change Period (Y+Rc), s	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0
Max Green Setting (Gmax), s	22.0	38.0	38.0	38.0	12.0	48.0	38.0	38.0
Max Q Clear Time (g_c+I1), s	15.3	5.1	5.8	11.4	2.3	8.7	23.2	18.3
Green Ext Time (p_c), s	1.0	3.1	0.4	16.6	0.0	3.2	2.6	9.0

Intersection Summary			
HCM 2010 Ctrl Delay			31.8
HCM 2010 LOS			C

Notes

User approved changes to right turn type.

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	30	75	20	315	170	410	60	1130	475	275	580	50
Number	3	8	18	7	4	14	5	2	12	1	6	16
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1863	1863	1900	1863	1863	1863	1863	1863	1900	1863	1863	1900
Adj Flow Rate, veh/h	33	82	15	342	185	180	65	1228	465	299	630	47
Adj No. of Lanes	1	1	0	1	1	1	1	3	0	1	3	0
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Percent Heavy Veh, %	2	2	2	2	2	2	2	2	2	2	2	2
Cap, veh/h	308	495	90	425	601	511	84	1267	478	331	2355	175
Arrive On Green	0.32	0.32	0.32	0.32	0.32	0.32	0.05	0.35	0.35	0.19	0.49	0.49
Sat Flow, veh/h	1013	1533	280	1293	1863	1583	1774	3638	1373	1774	4832	358
Grp Volume(v), veh/h	33	0	97	342	185	180	65	1144	549	299	441	236
Grp Sat Flow(s),veh/h/ln	1013	0	1813	1293	1863	1583	1774	1695	1620	1774	1695	1800
Q Serve(g_s), s	3.2	0.0	4.8	32.5	9.4	11.0	4.6	41.9	42.1	20.8	9.7	9.8
Cycle Q Clear(g_c), s	12.6	0.0	4.8	37.3	9.4	11.0	4.6	41.9	42.1	20.8	9.7	9.8
Prop In Lane	1.00		0.15	1.00		1.00	1.00		0.85	1.00		0.20
Lane Grp Cap(c), veh/h	308	0	585	425	601	511	84	1181	565	331	1653	877
V/C Ratio(X)	0.11	0.00	0.17	0.81	0.31	0.35	0.77	0.97	0.97	0.90	0.27	0.27
Avail Cap(c_a), veh/h	326	0	617	448	634	539	239	1181	565	492	1664	883
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	0.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	36.9	0.0	30.6	44.0	32.2	32.7	59.5	40.5	40.5	50.3	19.1	19.1
Incr Delay (d2), s/veh	0.2	0.0	0.1	9.9	0.3	0.4	14.0	19.1	30.8	14.8	0.1	0.2
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	0.9	0.0	2.4	12.8	4.9	4.8	2.6	22.7	23.6	11.6	4.5	4.9
LnGrp Delay(d),s/veh	37.1	0.0	30.7	53.9	32.5	33.1	73.5	59.5	71.3	65.0	19.2	19.3
LnGrp LOS	D		C	D	C	C	E	E	E	E	B	B
Approach Vol, veh/h		130			707			1758			976	
Approach Delay, s/veh		32.3			43.0			63.7			33.2	
Approach LOS		C			D			E			C	

Timer	1	2	3	4	5	6	7	8
Assigned Phs	1	2		4	5	6		8
Phs Duration (G+Y+Rc), s	29.5	50.0		46.8	12.0	67.6		46.8
Change Period (Y+Rc), s	6.0	6.0		6.0	6.0	6.0		6.0
Max Green Setting (Gmax), s	35.0	44.0		43.0	17.0	62.0		43.0
Max Q Clear Time (g_c+I1), s	22.8	44.1		39.3	6.6	11.8		14.6
Green Ext Time (p_c), s	0.7	0.0		1.4	0.1	30.4		4.0

Intersection Summary	
HCM 2010 Ctrl Delay	50.1
HCM 2010 LOS	D

Intersection	
Int Delay, s/veh	7.7

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Vol, veh/h	5	5	215	5	5	95
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	-	-	0	-
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	5	5	234	5	5	103

Major/Minor	Major1		Major2		Minor1	
Conflicting Flow All	0	0	11	0	481	8
Stage 1	-	-	-	-	8	-
Stage 2	-	-	-	-	473	-
Critical Hdwy	-	-	4.12	-	6.42	6.22
Critical Hdwy Stg 1	-	-	-	-	5.42	-
Critical Hdwy Stg 2	-	-	-	-	5.42	-
Follow-up Hdwy	-	-	2.218	-	3.518	3.318
Pot Cap-1 Maneuver	-	-	1608	-	544	1074
Stage 1	-	-	-	-	1015	-
Stage 2	-	-	-	-	627	-
Platoon blocked, %	-	-		-		
Mov Cap-1 Maneuver	-	-	1608	-	465	1074
Mov Cap-2 Maneuver	-	-	-	-	465	-
Stage 1	-	-	-	-	1015	-
Stage 2	-	-	-	-	535	-

Approach	EB	WB	NB
HCM Control Delay, s	0	7.4	9
HCM LOS			A

Minor Lane/Major Mvmt	NBLn1	EBT	EBR	WBL	WBT
Capacity (veh/h)	1008	-	-	1608	-
HCM Lane V/C Ratio	0.108	-	-	0.145	-
HCM Control Delay (s)	9	-	-	7.6	0
HCM Lane LOS	A	-	-	A	A
HCM 95th %tile Q(veh)	0.4	-	-	0.5	-

Intersection	
Int Delay, s/veh	7.2

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Vol, veh/h	80	310	0	0	780	20	0	0	0	15	0	195
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Free	Free	Stop	Stop	Stop	Stop	Stop	Stop
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	-	-	-	-	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	92	92	92	92	92	92	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2	2	2	2	2	2	2
Mvmt Flow	87	337	0	0	848	22	0	0	0	16	0	212

Major/Minor	Major1			Major2			Minor1			Minor2		
Conflicting Flow All	870	0	0	337	0	0	1476	1381	337	1370	1370	859
Stage 1	-	-	-	-	-	-	511	511	-	859	859	-
Stage 2	-	-	-	-	-	-	965	870	-	511	511	-
Critical Hdwy	4.12	-	-	4.12	-	-	7.12	6.52	6.22	7.12	6.52	6.22
Critical Hdwy Stg 1	-	-	-	-	-	-	6.12	5.52	-	6.12	5.52	-
Critical Hdwy Stg 2	-	-	-	-	-	-	6.12	5.52	-	6.12	5.52	-
Follow-up Hdwy	2.218	-	-	2.218	-	-	3.518	4.018	3.318	3.518	4.018	3.318
Pot Cap-1 Maneuver	775	-	-	1222	-	-	104	144	705	124	146	356
Stage 1	-	-	-	-	-	-	545	537	-	351	373	-
Stage 2	-	-	-	-	-	-	306	369	-	545	537	-
Platoon blocked, %		-	-		-	-						
Mov Cap-1 Maneuver	775	-	-	1222	-	-	38	124	705	111	126	356
Mov Cap-2 Maneuver	-	-	-	-	-	-	38	124	-	111	126	-
Stage 1	-	-	-	-	-	-	470	463	-	303	373	-
Stage 2	-	-	-	-	-	-	124	369	-	470	463	-

Approach	EB	WB	NB	SB
HCM Control Delay, s	2.1	0	0	43.8
HCM LOS			A	E

Minor Lane/Major Mvmt	NBLn1	EBL	EBT	EBR	WBL	WBT	WBR	SBLn1
Capacity (veh/h)	-	775	-	-	1222	-	-	308
HCM Lane V/C Ratio	-	0.112	-	-	-	-	-	0.741
HCM Control Delay (s)	0	10.2	0	-	0	-	-	43.8
HCM Lane LOS	A	B	A	-	A	-	-	E
HCM 95th %tile Q(veh)	-	0.4	-	-	0	-	-	5.5

Intersection	
Int Delay, s/veh	0.4

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Vol, veh/h	305	10	25	815	10	5
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	50	-	0	-
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	332	11	27	886	11	5

Major/Minor	Major1		Major2		Minor1	
Conflicting Flow All	0	0	342	0	1277	337
Stage 1	-	-	-	-	337	-
Stage 2	-	-	-	-	940	-
Critical Hdwy	-	-	4.12	-	6.42	6.22
Critical Hdwy Stg 1	-	-	-	-	5.42	-
Critical Hdwy Stg 2	-	-	-	-	5.42	-
Follow-up Hdwy	-	-	2.218	-	3.518	3.318
Pot Cap-1 Maneuver	-	-	1217	-	184	705
Stage 1	-	-	-	-	723	-
Stage 2	-	-	-	-	380	-
Platoon blocked, %	-	-		-		
Mov Cap-1 Maneuver	-	-	1217	-	180	705
Mov Cap-2 Maneuver	-	-	-	-	180	-
Stage 1	-	-	-	-	723	-
Stage 2	-	-	-	-	372	-

Approach	EB	WB	NB
HCM Control Delay, s	0	0.2	21.2
HCM LOS			C

Minor Lane/Major Mvmt	NBLn1	EBT	EBR	WBL	WBT
Capacity (veh/h)	239	-	-	1217	-
HCM Lane V/C Ratio	0.068	-	-	0.022	-
HCM Control Delay (s)	21.2	-	-	8	-
HCM Lane LOS	C	-	-	A	-
HCM 95th %tile Q(veh)	0.2	-	-	0.1	-

Intersection	
Int Delay, s/veh	0

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Vol, veh/h	0	315	0	0	865	0	0	0	0	0	0	0
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Free	Free	Stop	Stop	Stop	Stop	Stop	Stop
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	-	-	-	-	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	92	92	92	92	92	92	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2	2	2	2	2	2	2
Mvmt Flow	0	342	0	0	940	0	0	0	0	0	0	0

Major/Minor	Major1			Major2			Minor1			Minor2		
Conflicting Flow All	940	0	0	342	0	0	1282	1282	342	1282	1282	940
Stage 1	-	-	-	-	-	-	342	342	-	940	940	-
Stage 2	-	-	-	-	-	-	940	940	-	342	342	-
Critical Hdwy	4.12	-	-	4.12	-	-	7.12	6.52	6.22	7.12	6.52	6.22
Critical Hdwy Stg 1	-	-	-	-	-	-	6.12	5.52	-	6.12	5.52	-
Critical Hdwy Stg 2	-	-	-	-	-	-	6.12	5.52	-	6.12	5.52	-
Follow-up Hdwy	2.218	-	-	2.218	-	-	3.518	4.018	3.318	3.518	4.018	3.318
Pot Cap-1 Maneuver	729	-	-	1217	-	-	142	165	701	142	165	320
Stage 1	-	-	-	-	-	-	673	638	-	316	342	-
Stage 2	-	-	-	-	-	-	316	342	-	673	638	-
Platoon blocked, %		-	-		-	-						
Mov Cap-1 Maneuver	729	-	-	1217	-	-	142	165	701	142	165	320
Mov Cap-2 Maneuver	-	-	-	-	-	-	142	165	-	142	165	-
Stage 1	-	-	-	-	-	-	673	638	-	316	342	-
Stage 2	-	-	-	-	-	-	316	342	-	673	638	-

Approach	EB	WB	NB	SB
HCM Control Delay, s	0	0	0	0
HCM LOS			A	A

Minor Lane/Major Mvmt	NBLn1	EBL	EBT	EBR	WBL	WBT	WBR	SBLn1
Capacity (veh/h)	-	729	-	-	1217	-	-	-
HCM Lane V/C Ratio	-	-	-	-	-	-	-	-
HCM Control Delay (s)	0	0	-	-	0	-	-	0
HCM Lane LOS	A	A	-	-	A	-	-	A
HCM 95th %tile Q(veh)	-	0	-	-	0	-	-	-

Intersection	
Int Delay, s/veh	0.4

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Vol, veh/h	0	310	850	5	10	10
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	-	-	0	-
Veh in Median Storage, #	-	0	0	-	0	-
Grade, %	-	0	0	-	0	-
Peak Hour Factor	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	0	337	924	5	11	11

Major/Minor	Major1		Major2		Minor2	
Conflicting Flow All	929	0	-	0	1264	927
Stage 1	-	-	-	-	927	-
Stage 2	-	-	-	-	337	-
Critical Hdwy	4.12	-	-	-	6.42	6.22
Critical Hdwy Stg 1	-	-	-	-	5.42	-
Critical Hdwy Stg 2	-	-	-	-	5.42	-
Follow-up Hdwy	2.218	-	-	-	3.518	3.318
Pot Cap-1 Maneuver	736	-	-	-	187	325
Stage 1	-	-	-	-	385	-
Stage 2	-	-	-	-	723	-
Platoon blocked, %		-	-	-		
Mov Cap-1 Maneuver	736	-	-	-	187	325
Mov Cap-2 Maneuver	-	-	-	-	187	-
Stage 1	-	-	-	-	385	-
Stage 2	-	-	-	-	723	-

Approach	EB	WB	SB
HCM Control Delay, s	0	0	21.7
HCM LOS			C

Minor Lane/Major Mvmt	EBL	EBT	WBT	WBR	SBLn1
Capacity (veh/h)	736	-	-	-	237
HCM Lane V/C Ratio	-	-	-	-	0.092
HCM Control Delay (s)	0	-	-	-	21.7
HCM Lane LOS	A	-	-	-	C
HCM 95th %tile Q(veh)	0	-	-	-	0.3

Intersection	
Int Delay, s/veh	0.3

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Vol, veh/h	5	300	0	0	840	15	0	0	0	5	0	10
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Free	Free	Stop	Stop	Stop	Stop	Stop	Stop
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	-	-	-	-	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	92	92	92	92	92	92	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2	2	2	2	2	2	2
Mvmt Flow	5	326	0	0	913	16	0	0	0	5	0	11

Major/Minor	Major1			Major2			Minor1			Minor2		
Conflicting Flow All	929	0	0	326	0	0	1264	1266	326	1258	1258	921
Stage 1	-	-	-	-	-	-	337	337	-	921	921	-
Stage 2	-	-	-	-	-	-	927	929	-	337	337	-
Critical Hdwy	4.12	-	-	4.12	-	-	7.12	6.52	6.22	7.12	6.52	6.22
Critical Hdwy Stg 1	-	-	-	-	-	-	6.12	5.52	-	6.12	5.52	-
Critical Hdwy Stg 2	-	-	-	-	-	-	6.12	5.52	-	6.12	5.52	-
Follow-up Hdwy	2.218	-	-	2.218	-	-	3.518	4.018	3.318	3.518	4.018	3.318
Pot Cap-1 Maneuver	736	-	-	1234	-	-	146	169	715	148	171	328
Stage 1	-	-	-	-	-	-	677	641	-	324	349	-
Stage 2	-	-	-	-	-	-	322	346	-	677	641	-
Platoon blocked, %		-	-		-	-						
Mov Cap-1 Maneuver	736	-	-	1234	-	-	140	168	715	147	170	328
Mov Cap-2 Maneuver	-	-	-	-	-	-	140	168	-	147	170	-
Stage 1	-	-	-	-	-	-	672	636	-	321	349	-
Stage 2	-	-	-	-	-	-	311	346	-	672	636	-

Approach	EB	WB	NB	SB
HCM Control Delay, s	0.2	0	0	21.6
HCM LOS			A	C

Minor Lane/Major Mvmt	NBLn1	EBL	EBT	EBR	WBL	WBT	WBR	SBLn1
Capacity (veh/h)	-	736	-	-	1234	-	-	233
HCM Lane V/C Ratio	-	0.007	-	-	-	-	-	0.07
HCM Control Delay (s)	0	9.9	0	-	0	-	-	21.6
HCM Lane LOS	A	A	A	-	A	-	-	C
HCM 95th %tile Q(veh)	-	0	-	-	0	-	-	0.2

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	10	130	190	100	335	290	470	1265	245	175	805	60
Number	7	4	14	3	8	18	5	2	12	1	6	16
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1863	1863	1900	1863	1863	1863	1863	1863	1863	1863	1863	1863
Adj Flow Rate, veh/h	11	141	18	109	364	80	511	1375	174	190	875	16
Adj No. of Lanes	1	2	0	1	1	1	1	2	1	1	2	1
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Percent Heavy Veh, %	2	2	2	2	2	2	2	2	2	2	2	2
Cap, veh/h	18	493	62	132	410	348	497	1687	755	214	1124	503
Arrive On Green	0.01	0.16	0.16	0.07	0.22	0.22	0.28	0.48	0.48	0.12	0.32	0.32
Sat Flow, veh/h	1774	3164	398	1774	1863	1583	1774	3539	1583	1774	3539	1583
Grp Volume(v), veh/h	11	78	81	109	364	80	511	1375	174	190	875	16
Grp Sat Flow(s),veh/h/ln	1774	1770	1793	1774	1863	1583	1774	1770	1583	1774	1770	1583
Q Serve(g_s), s	0.9	5.4	5.6	8.4	26.4	5.8	39.0	46.3	9.0	14.7	31.2	1.0
Cycle Q Clear(g_c), s	0.9	5.4	5.6	8.4	26.4	5.8	39.0	46.3	9.0	14.7	31.2	1.0
Prop In Lane	1.00		0.22	1.00		1.00	1.00		1.00	1.00		1.00
Lane Grp Cap(c), veh/h	18	276	279	132	410	348	497	1687	755	214	1124	503
V/C Ratio(X)	0.62	0.28	0.29	0.83	0.89	0.23	1.03	0.81	0.23	0.89	0.78	0.03
Avail Cap(c_a), veh/h	166	470	476	166	495	421	497	1687	755	255	1195	534
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	68.7	51.9	52.0	63.6	52.6	44.6	50.1	31.2	21.4	60.3	43.1	32.8
Incr Delay (d2), s/veh	30.8	0.6	0.6	23.4	15.6	0.3	47.8	3.2	0.2	26.0	3.2	0.0
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	0.6	2.7	2.8	5.0	15.3	2.6	25.6	23.3	3.9	8.7	15.8	0.4
LnGrp Delay(d),s/veh	99.4	52.5	52.5	86.9	68.2	44.9	97.9	34.4	21.6	86.3	46.2	32.8
LnGrp LOS	F	D	D	F	E	D	F	C	C	F	D	C
Approach Vol, veh/h		170			553			2060			1081	
Approach Delay, s/veh		55.5			68.5			49.1			53.1	
Approach LOS		E			E			D			D	

Timer	1	2	3	4	5	6	7	8
Assigned Phs	1	2	3	4	5	6	7	8
Phs Duration (G+Y+Rc), s	22.8	72.4	16.3	27.7	45.0	50.2	7.4	36.6
Change Period (Y+Rc), s	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0
Max Green Setting (Gmax), s	20.0	66.0	13.0	37.0	39.0	47.0	13.0	37.0
Max Q Clear Time (g_c+I1), s	16.7	48.3	10.4	7.6	41.0	33.2	2.9	28.4
Green Ext Time (p_c), s	0.2	14.5	0.1	3.7	0.0	11.0	0.0	2.3

Intersection Summary		
HCM 2010 Ctrl Delay		53.3
HCM 2010 LOS		D

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	335	170	215	60	260	315	205	1460	10	220	1210	160
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	6.0	4.0	4.0	6.0
Lane Util. Factor	0.91	0.91	1.00	1.00	1.00	0.88	0.97	0.91	1.00	0.97	0.91	1.00
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	0.98	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	1610	3308	1583	1770	1863	2787	3433	5085	1583	3433	5085	1583
Flt Permitted	0.95	0.98	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)	1610	3308	1583	1770	1863	2787	3433	5085	1583	3433	5085	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)	364	185	234	65	283	342	223	1587	11	239	1315	174
RTOR Reduction (vph)	0	0	62	0	0	202	0	0	6	0	0	70
Lane Group Flow (vph)	182	367	172	65	283	140	223	1587	5	239	1315	104
Turn Type	Split	NA	Perm	Split	NA	Perm	Prot	NA	Perm	Prot	NA	Perm
Protected Phases	3	3		4	4		5	2		1	6	
Permitted Phases			3			4			2			6
Actuated Green, G (s)	35.4	35.4	35.4	41.7	41.7	41.7	20.9	117.0	117.0	20.9	117.0	117.0
Effective Green, g (s)	37.4	37.4	37.4	43.7	43.7	43.7	22.9	120.0	118.0	22.9	120.0	118.0
Actuated g/C Ratio	0.16	0.16	0.16	0.18	0.18	0.18	0.10	0.50	0.49	0.10	0.50	0.49
Clearance Time (s)	6.0	6.0	6.0	6.0	6.0	6.0	6.0	7.0	7.0	6.0	7.0	7.0
Vehicle Extension (s)	5.0	5.0	5.0	5.0	5.0	5.0	3.0	5.0	5.0	3.0	5.0	5.0
Lane Grp Cap (vph)	250	515	246	322	339	507	327	2542	778	327	2542	778
v/s Ratio Prot	c0.11	0.11		0.04	c0.15		0.06	c0.31		c0.07	0.26	
v/s Ratio Perm			0.11			0.05			0.00			0.07
v/c Ratio	0.73	0.71	0.70	0.20	0.83	0.28	0.68	0.62	0.01	0.73	0.52	0.13
Uniform Delay, d1	96.5	96.2	96.0	83.3	94.7	84.5	105.0	43.6	31.1	105.6	40.5	33.2
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.85	1.56	3.92
Incremental Delay, d2	12.3	5.7	10.8	0.6	17.7	0.6	5.8	1.2	0.0	7.7	0.7	0.3
Delay (s)	108.7	101.9	106.8	84.0	112.4	85.1	110.8	44.8	31.1	97.7	63.7	130.3
Level of Service	F	F	F	F	F	F	F	D	C	F	E	F
Approach Delay (s)		105.0			96.2			52.8			75.1	
Approach LOS		F			F			D			E	

Intersection Summary			
HCM 2000 Control Delay	74.6	HCM 2000 Level of Service	E
HCM 2000 Volume to Capacity ratio	0.69		
Actuated Cycle Length (s)	240.0	Sum of lost time (s)	16.0
Intersection Capacity Utilization	71.1%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	405	5	125	10	15	15	330	2660	20	80	1565	415
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		6.0	4.0	6.0	5.0	6.0	4.0	5.0	7.0
Lane Util. Factor	0.95	0.95	1.00		1.00	1.00	1.00	0.91	1.00	1.00	0.91	1.00
Frpb, ped/bikes	1.00	1.00	0.91		1.00	1.00	1.00	1.00	0.83	1.00	1.00	0.97
Flpb, ped/bikes	1.00	1.00	1.00		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Frt	1.00	1.00	0.85		1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	0.95	1.00		0.98	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	1681	1687	1434		1826	1583	1770	5085	1311	1770	5085	1536
Flt Permitted	0.95	0.95	1.00		0.98	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)	1681	1687	1434		1826	1583	1770	5085	1311	1770	5085	1536
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	440	5	136	11	16	16	359	2891	22	87	1701	451
RTOR Reduction (vph)	0	0	84	0	0	15	0	0	8	0	0	235
Lane Group Flow (vph)	224	221	53	0	27	1	359	2891	14	87	1701	216
Confl. Peds. (#/hr)			43						31			2
Turn Type	Split	NA	Perm	Split	NA	Perm	Prot	NA	Perm	Prot	NA	Perm
Protected Phases	4	4		3	3		5	2		1	6	
Permitted Phases			4			3			2			6
Actuated Green, G (s)	39.6	39.6	39.6		7.8	7.8	53.9	153.2	153.2	15.4	114.7	114.7
Effective Green, g (s)	39.6	39.6	39.6		7.8	9.8	53.9	155.2	154.2	17.4	116.7	114.7
Actuated g/C Ratio	0.17	0.17	0.17		0.03	0.04	0.22	0.65	0.64	0.07	0.49	0.48
Clearance Time (s)	5.0	5.0	5.0		6.0	6.0	6.0	7.0	7.0	6.0	7.0	7.0
Vehicle Extension (s)	4.0	4.0	4.0		3.0	3.0	5.0	6.0	6.0	3.0	6.0	6.0
Lane Grp Cap (vph)	277	278	236		59	64	397	3288	842	128	2472	734
v/s Ratio Prot	c0.13	0.13			c0.01		c0.20	c0.57		0.05	0.33	
v/s Ratio Perm			0.04			0.00			0.01			0.14
v/c Ratio	0.81	0.79	0.22		0.46	0.01	0.90	0.88	0.02	0.68	0.69	0.29
Uniform Delay, d1	96.5	96.3	86.9		114.0	110.4	90.5	34.7	15.5	108.6	47.6	38.0
Progression Factor	1.00	1.00	1.00		1.00	1.00	1.26	0.62	1.00	1.05	0.99	1.64
Incremental Delay, d2	16.6	15.2	0.7		5.5	0.1	12.4	1.6	0.0	13.1	1.5	1.0
Delay (s)	113.1	111.5	87.5		119.6	110.5	126.8	23.0	15.5	127.5	48.5	63.5
Level of Service	F	F	F		F	F	F	C	B	F	D	E
Approach Delay (s)		106.5			116.2			34.4			54.6	
Approach LOS		F			F			C			D	

Intersection Summary			
HCM 2000 Control Delay	49.1	HCM 2000 Level of Service	D
HCM 2000 Volume to Capacity ratio	0.87		
Actuated Cycle Length (s)	240.0	Sum of lost time (s)	22.0
Intersection Capacity Utilization	95.3%	ICU Level of Service	F
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	870	770	10	230	450	555	55	370	130	585	370	655
Number	7	4	14	3	8	18	5	2	12	1	6	16
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1863	1863	1900	1863	1863	1863	1863	1863	1900	1863	1863	1863
Adj Flow Rate, veh/h	946	837	11	250	489	549	60	402	17	636	402	441
Adj No. of Lanes	2	3	0	2	3	2	1	2	0	2	2	2
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Percent Heavy Veh, %	2	2	2	2	2	2	2	2	2	2	2	2
Cap, veh/h	1033	2095	28	313	996	1100	78	518	22	685	1080	1683
Arrive On Green	0.30	0.41	0.41	0.09	0.20	0.20	0.04	0.15	0.15	0.20	0.31	0.31
Sat Flow, veh/h	3442	5173	68	3442	5085	2787	1774	3461	146	3442	3539	2776
Grp Volume(v), veh/h	946	548	300	250	489	549	60	205	214	636	402	441
Grp Sat Flow(s),veh/h/ln	1721	1695	1851	1721	1695	1393	1774	1770	1837	1721	1770	1388
Q Serve(g_s), s	39.3	17.0	17.0	10.5	12.7	22.0	5.0	16.5	16.6	26.9	13.2	11.0
Cycle Q Clear(g_c), s	39.3	17.0	17.0	10.5	12.7	22.0	5.0	16.5	16.6	26.9	13.2	11.0
Prop In Lane	1.00		0.04	1.00		1.00	1.00		0.08	1.00		1.00
Lane Grp Cap(c), veh/h	1033	1373	750	313	996	1100	78	265	275	685	1080	1683
V/C Ratio(X)	0.92	0.40	0.40	0.80	0.49	0.50	0.77	0.77	0.78	0.93	0.37	0.26
Avail Cap(c_a), veh/h	1232	1373	750	1232	1305	1270	443	538	558	720	1080	1683
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	50.0	31.3	31.3	66.0	53.0	33.8	70.1	60.6	60.6	58.3	40.3	13.7
Incr Delay (d2), s/veh	9.7	0.2	0.3	4.7	0.4	0.4	14.8	4.8	4.7	17.8	0.2	0.1
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	20.0	8.0	8.8	5.2	6.0	8.5	2.8	8.4	8.8	14.5	6.5	4.2
LnGrp Delay(d),s/veh	59.7	31.5	31.6	70.7	53.4	34.1	84.9	65.3	65.3	76.1	40.6	13.8
LnGrp LOS	E	C	C	E	D	C	F	E	E	E	D	B
Approach Vol, veh/h		1794			1288			479			1479	
Approach Delay, s/veh		46.4			48.5			67.8			47.9	
Approach LOS		D			D			E			D	

Timer	1	2	3	4	5	6	7	8
Assigned Phs	1	2	3	4	5	6	7	8
Phs Duration (G+Y+Rc), s	34.5	28.2	19.4	66.0	11.5	51.2	50.4	35.0
Change Period (Y+Rc), s	5.0	6.0	6.0	6.0	5.0	6.0	6.0	6.0
Max Green Setting (Gmax), s	31.0	45.0	53.0	38.0	37.0	39.0	53.0	38.0
Max Q Clear Time (g_c+I1), s	28.9	18.6	12.5	19.0	7.0	15.2	41.3	24.0
Green Ext Time (p_c), s	0.6	2.7	0.9	11.3	0.1	7.7	3.1	5.0

Intersection Summary	
HCM 2010 Ctrl Delay	49.4
HCM 2010 LOS	D

Notes

User approved changes to right turn type.

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	85	165	75	205	80	325	40	890	130	320	1180	65
Number	3	8	18	7	4	14	5	2	12	1	6	16
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1863	1863	1900	1863	1863	1863	1863	1863	1900	1863	1863	1900
Adj Flow Rate, veh/h	92	179	67	223	87	79	43	967	123	348	1283	66
Adj No. of Lanes	1	1	0	1	1	1	1	3	0	1	3	0
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Percent Heavy Veh, %	2	2	2	2	2	2	2	2	2	2	2	2
Cap, veh/h	400	400	150	289	576	490	55	1434	182	378	2457	126
Arrive On Green	0.31	0.31	0.31	0.31	0.31	0.31	0.03	0.31	0.31	0.21	0.50	0.50
Sat Flow, veh/h	1215	1293	484	1129	1863	1583	1774	4571	580	1774	4953	255
Grp Volume(v), veh/h	92	0	246	223	87	79	43	717	373	348	878	471
Grp Sat Flow(s),veh/h/ln	1215	0	1777	1129	1863	1583	1774	1695	1760	1774	1695	1818
Q Serve(g_s), s	6.5	0.0	12.2	21.7	3.7	4.0	2.6	20.2	20.3	21.1	19.4	19.4
Cycle Q Clear(g_c), s	10.2	0.0	12.2	33.9	3.7	4.0	2.6	20.2	20.3	21.1	19.4	19.4
Prop In Lane	1.00		0.27	1.00		1.00	1.00		0.33	1.00		0.14
Lane Grp Cap(c), veh/h	400	0	550	289	576	490	55	1064	552	378	1681	902
V/C Ratio(X)	0.23	0.00	0.45	0.77	0.15	0.16	0.78	0.67	0.68	0.92	0.52	0.52
Avail Cap(c_a), veh/h	400	0	550	289	576	490	113	1141	593	420	1727	926
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	0.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	31.2	0.0	30.4	44.0	27.5	27.6	52.9	32.8	32.9	42.3	18.8	18.8
Incr Delay (d2), s/veh	0.3	0.0	0.6	12.0	0.1	0.2	21.0	1.4	2.8	24.0	0.3	0.5
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	2.2	0.0	6.1	7.7	1.9	1.8	1.6	9.7	10.3	12.9	9.1	9.8
LnGrp Delay(d),s/veh	31.5	0.0	31.0	56.0	27.6	27.7	73.9	34.3	35.7	66.4	19.1	19.3
LnGrp LOS	C		C	E	C	C	E	C	D	E	B	B
Approach Vol, veh/h		338			389			1133			1697	
Approach Delay, s/veh		31.1			43.9			36.2			28.9	
Approach LOS		C			D			D			C	

Timer	1	2	3	4	5	6	7	8
Assigned Phs	1	2		4	5	6		8
Phs Duration (G+Y+Rc), s	29.4	40.5		40.0	9.4	60.5		40.0
Change Period (Y+Rc), s	6.0	6.0		6.0	6.0	6.0		6.0
Max Green Setting (Gmax), s	26.0	37.0		34.0	7.0	56.0		34.0
Max Q Clear Time (g_c+I1), s	23.1	22.3		35.9	4.6	21.4		14.2
Green Ext Time (p_c), s	0.3	12.2		0.0	0.0	23.9		3.6

Intersection Summary	
HCM 2010 Ctrl Delay	33.1
HCM 2010 LOS	C

Intersection	
Int Delay, s/veh	8.5

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Vol, veh/h	5	5	160	5	10	230
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	-	-	0	-
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	5	5	174	5	11	250

Major/Minor	Major1		Major2		Minor1	
Conflicting Flow All	0	0	11	0	361	8
Stage 1	-	-	-	-	8	-
Stage 2	-	-	-	-	353	-
Critical Hdwy	-	-	4.12	-	6.42	6.22
Critical Hdwy Stg 1	-	-	-	-	5.42	-
Critical Hdwy Stg 2	-	-	-	-	5.42	-
Follow-up Hdwy	-	-	2.218	-	3.518	3.318
Pot Cap-1 Maneuver	-	-	1608	-	638	1074
Stage 1	-	-	-	-	1015	-
Stage 2	-	-	-	-	711	-
Platoon blocked, %	-	-		-		
Mov Cap-1 Maneuver	-	-	1608	-	568	1074
Mov Cap-2 Maneuver	-	-	-	-	568	-
Stage 1	-	-	-	-	1015	-
Stage 2	-	-	-	-	634	-

Approach	EB	WB	NB
HCM Control Delay, s	0	7.3	9.6
HCM LOS			A

Minor Lane/Major Mvmt	NBLn1	EBT	EBR	WBL	WBT
Capacity (veh/h)	1036	-	-	1608	-
HCM Lane V/C Ratio	0.252	-	-	0.108	-
HCM Control Delay (s)	9.6	-	-	7.5	0
HCM Lane LOS	A	-	-	A	A
HCM 95th %tile Q(veh)	1	-	-	0.4	-

Intersection	
Int Delay, s/veh	5.8

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Vol, veh/h	205	705	0	0	425	20	0	0	0	20	0	145
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Free	Free	Stop	Stop	Stop	Stop	Stop	Stop
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	-	-	-	-	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	92	92	92	92	92	92	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2	2	2	2	2	2	2
Mvmt Flow	223	766	0	0	462	22	0	0	0	22	0	158

Major/Minor	Major1			Major2			Minor1			Minor2		
Conflicting Flow All	484	0	0	766	0	0	1764	1696	766	1685	1685	473
Stage 1	-	-	-	-	-	-	1212	1212	-	473	473	-
Stage 2	-	-	-	-	-	-	552	484	-	1212	1212	-
Critical Hdwy	4.12	-	-	4.12	-	-	7.12	6.52	6.22	7.12	6.52	6.22
Critical Hdwy Stg 1	-	-	-	-	-	-	6.12	5.52	-	6.12	5.52	-
Critical Hdwy Stg 2	-	-	-	-	-	-	6.12	5.52	-	6.12	5.52	-
Follow-up Hdwy	2.218	-	-	2.218	-	-	3.518	4.018	3.318	3.518	4.018	3.318
Pot Cap-1 Maneuver	1079	-	-	847	-	-	66	93	403	75	94	591
Stage 1	-	-	-	-	-	-	222	255	-	572	558	-
Stage 2	-	-	-	-	-	-	518	552	-	222	255	-
Platoon blocked, %		-	-		-	-						
Mov Cap-1 Maneuver	1079	-	-	847	-	-	35	60	403	54	60	591
Mov Cap-2 Maneuver	-	-	-	-	-	-	35	60	-	54	60	-
Stage 1	-	-	-	-	-	-	142	163	-	366	558	-
Stage 2	-	-	-	-	-	-	380	552	-	142	163	-

Approach	EB	WB	NB	SB
HCM Control Delay, s	2.1	0	0	41.9
HCM LOS			A	E

Minor Lane/Major Mvmt	NBLn1	EBL	EBT	EBR	WBL	WBT	WBR	SBLn1
Capacity (veh/h)	-	1079	-	-	847	-	-	268
HCM Lane V/C Ratio	-	0.207	-	-	-	-	-	0.669
HCM Control Delay (s)	0	9.2	0	-	0	-	-	41.9
HCM Lane LOS	A	A	A	-	A	-	-	E
HCM 95th %tile Q(veh)	-	0.8	-	-	0	-	-	4.4

Intersection	
Int Delay, s/veh	0.7

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Vol, veh/h	750	15	15	440	10	25
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	50	-	0	-
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	815	16	16	478	11	27

Major/Minor	Major1		Major2		Minor1	
Conflicting Flow All	0	0	832	0	1334	823
Stage 1	-	-	-	-	823	-
Stage 2	-	-	-	-	511	-
Critical Hdwy	-	-	4.12	-	6.42	6.22
Critical Hdwy Stg 1	-	-	-	-	5.42	-
Critical Hdwy Stg 2	-	-	-	-	5.42	-
Follow-up Hdwy	-	-	2.218	-	3.518	3.318
Pot Cap-1 Maneuver	-	-	801	-	170	373
Stage 1	-	-	-	-	431	-
Stage 2	-	-	-	-	602	-
Platoon blocked, %	-	-		-		
Mov Cap-1 Maneuver	-	-	801	-	167	373
Mov Cap-2 Maneuver	-	-	-	-	167	-
Stage 1	-	-	-	-	431	-
Stage 2	-	-	-	-	590	-

Approach	EB	WB	NB
HCM Control Delay, s	0	0.3	20.1
HCM LOS			C

Minor Lane/Major Mvmt	NBLn1	EBT	EBR	WBL	WBT
Capacity (veh/h)	276	-	-	801	-
HCM Lane V/C Ratio	0.138	-	-	0.02	-
HCM Control Delay (s)	20.1	-	-	9.6	-
HCM Lane LOS	C	-	-	A	-
HCM 95th %tile Q(veh)	0.5	-	-	0.1	-

Intersection	
Int Delay, s/veh	0.1

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Vol, veh/h	5	745	0	0	445	5	0	0	0	0	0	0
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Free	Free	Stop	Stop	Stop	Stop	Stop	Stop
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	-	-	-	-	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	92	92	92	92	92	92	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2	2	2	2	2	2	2
Mvmt Flow	5	810	0	0	484	5	0	0	0	0	0	0

Major/Minor	Major1			Major2			Minor1			Minor2		
Conflicting Flow All	489	0	0	810	0	0	1307	1310	810	1307	1307	486
Stage 1	-	-	-	-	-	-	821	821	-	486	486	-
Stage 2	-	-	-	-	-	-	486	489	-	821	821	-
Critical Hdwy	4.12	-	-	4.12	-	-	7.12	6.52	6.22	7.12	6.52	6.22
Critical Hdwy Stg 1	-	-	-	-	-	-	6.12	5.52	-	6.12	5.52	-
Critical Hdwy Stg 2	-	-	-	-	-	-	6.12	5.52	-	6.12	5.52	-
Follow-up Hdwy	2.218	-	-	2.218	-	-	3.518	4.018	3.318	3.518	4.018	3.318
Pot Cap-1 Maneuver	1074	-	-	816	-	-	137	159	380	137	160	581
Stage 1	-	-	-	-	-	-	369	389	-	563	551	-
Stage 2	-	-	-	-	-	-	563	549	-	369	389	-
Platoon blocked, %		-	-		-	-						
Mov Cap-1 Maneuver	1074	-	-	816	-	-	136	158	380	136	159	581
Mov Cap-2 Maneuver	-	-	-	-	-	-	136	158	-	136	159	-
Stage 1	-	-	-	-	-	-	366	386	-	558	551	-
Stage 2	-	-	-	-	-	-	563	549	-	366	386	-

Approach	EB	WB	NB	SB
HCM Control Delay, s	0.1	0	0	0
HCM LOS			A	A

Minor Lane/Major Mvmt	NBLn1	EBL	EBT	EBR	WBL	WBT	WBR	SBLn1
Capacity (veh/h)	-	1074	-	-	816	-	-	-
HCM Lane V/C Ratio	-	0.005	-	-	-	-	-	-
HCM Control Delay (s)	0	8.4	0	-	0	-	-	0
HCM Lane LOS	A	A	A	-	A	-	-	A
HCM 95th %tile Q(veh)	-	0	-	-	0	-	-	-

Intersection	
Int Delay, s/veh	0.3

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Vol, veh/h	0	770	450	5	10	5
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	-	-	0	-
Veh in Median Storage, #	-	0	0	-	0	-
Grade, %	-	0	0	-	0	-
Peak Hour Factor	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	0	837	489	5	11	5

Major/Minor	Major1		Major2		Minor2	
Conflicting Flow All	495	0	-	0	1329	492
Stage 1	-	-	-	-	492	-
Stage 2	-	-	-	-	837	-
Critical Hdwy	4.12	-	-	-	6.42	6.22
Critical Hdwy Stg 1	-	-	-	-	5.42	-
Critical Hdwy Stg 2	-	-	-	-	5.42	-
Follow-up Hdwy	2.218	-	-	-	3.518	3.318
Pot Cap-1 Maneuver	1069	-	-	-	171	577
Stage 1	-	-	-	-	615	-
Stage 2	-	-	-	-	425	-
Platoon blocked, %		-	-	-		
Mov Cap-1 Maneuver	1069	-	-	-	171	577
Mov Cap-2 Maneuver	-	-	-	-	171	-
Stage 1	-	-	-	-	615	-
Stage 2	-	-	-	-	425	-

Approach	EB	WB	SB
HCM Control Delay, s	0	0	22.4
HCM LOS			C

Minor Lane/Major Mvmt	EBL	EBT	WBT	WBR	SBLn1
Capacity (veh/h)	1069	-	-	-	223
HCM Lane V/C Ratio	-	-	-	-	0.073
HCM Control Delay (s)	0	-	-	-	22.4
HCM Lane LOS	A	-	-	-	C
HCM 95th %tile Q(veh)	0	-	-	-	0.2

Intersection	
Int Delay, s/veh	0.8

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Vol, veh/h	10	755	0	0	430	20	0	0	0	20	0	15
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Free	Free	Stop	Stop	Stop	Stop	Stop	Stop
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	-	-	-	-	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	92	92	92	92	92	92	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2	2	2	2	2	2	2
Mvmt Flow	11	821	0	0	467	22	0	0	0	22	0	16

Major/Minor	Major1			Major2			Minor1			Minor2		
Conflicting Flow All	489	0	0	821	0	0	1328	1331	821	1320	1320	478
Stage 1	-	-	-	-	-	-	842	842	-	478	478	-
Stage 2	-	-	-	-	-	-	486	489	-	842	842	-
Critical Hdwy	4.12	-	-	4.12	-	-	7.12	6.52	6.22	7.12	6.52	6.22
Critical Hdwy Stg 1	-	-	-	-	-	-	6.12	5.52	-	6.12	5.52	-
Critical Hdwy Stg 2	-	-	-	-	-	-	6.12	5.52	-	6.12	5.52	-
Follow-up Hdwy	2.218	-	-	2.218	-	-	3.518	4.018	3.318	3.518	4.018	3.318
Pot Cap-1 Maneuver	1074	-	-	808	-	-	132	154	374	134	157	587
Stage 1	-	-	-	-	-	-	359	380	-	568	556	-
Stage 2	-	-	-	-	-	-	563	549	-	359	380	-
Platoon blocked, %		-	-		-	-						
Mov Cap-1 Maneuver	1074	-	-	808	-	-	126	151	374	132	154	587
Mov Cap-2 Maneuver	-	-	-	-	-	-	126	151	-	132	154	-
Stage 1	-	-	-	-	-	-	352	373	-	557	556	-
Stage 2	-	-	-	-	-	-	547	549	-	352	373	-

Approach	EB	WB	NB	SB
HCM Control Delay, s	0.1	0	0	27.5
HCM LOS			A	D

Minor Lane/Major Mvmt	NBLn1	EBL	EBT	EBR	WBL	WBT	WBR	SBLn1
Capacity (veh/h)	-	1074	-	-	808	-	-	198
HCM Lane V/C Ratio	-	0.01	-	-	-	-	-	0.192
HCM Control Delay (s)	0	8.4	0	-	0	-	-	27.5
HCM Lane LOS	A	A	A	-	A	-	-	D
HCM 95th %tile Q(veh)	-	0	-	-	0	-	-	0.7

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	50	290	465	200	220	275	215	785	110	195	975	30
Number	7	4	14	3	8	18	5	2	12	1	6	16
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1863	1863	1900	1863	1863	1863	1863	1863	1863	1863	1863	1863
Adj Flow Rate, veh/h	54	315	289	217	239	77	234	853	29	212	1060	8
Adj No. of Lanes	1	2	0	1	1	1	1	2	1	1	2	1
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Percent Heavy Veh, %	2	2	2	2	2	2	2	2	2	2	2	2
Cap, veh/h	70	388	347	241	587	499	262	1149	514	241	1106	495
Arrive On Green	0.04	0.22	0.22	0.14	0.32	0.32	0.15	0.32	0.32	0.14	0.31	0.31
Sat Flow, veh/h	1774	1770	1583	1774	1863	1583	1774	3539	1583	1774	3539	1583
Grp Volume(v), veh/h	54	315	289	217	239	77	234	853	29	212	1060	8
Grp Sat Flow(s),veh/h/ln	1774	1770	1583	1774	1863	1583	1774	1770	1583	1774	1770	1583
Q Serve(g_s), s	3.9	22.0	22.7	15.6	13.1	4.5	16.8	27.9	1.6	15.2	38.2	0.5
Cycle Q Clear(g_c), s	3.9	22.0	22.7	15.6	13.1	4.5	16.8	27.9	1.6	15.2	38.2	0.5
Prop In Lane	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Lane Grp Cap(c), veh/h	70	388	347	241	587	499	262	1149	514	241	1106	495
V/C Ratio(X)	0.77	0.81	0.83	0.90	0.41	0.15	0.89	0.74	0.06	0.88	0.96	0.02
Avail Cap(c_a), veh/h	369	627	561	246	587	499	355	1149	514	355	1117	500
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	61.8	48.2	48.5	55.3	34.9	32.0	54.4	39.0	30.2	55.1	43.8	30.9
Incr Delay (d2), s/veh	15.8	4.2	5.8	32.0	0.5	0.1	19.0	2.6	0.0	15.8	17.7	0.0
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	2.2	11.2	10.4	9.8	6.8	2.0	9.6	14.0	0.7	8.5	21.4	0.2
LnGrp Delay(d),s/veh	77.6	52.4	54.2	87.3	35.4	32.2	73.4	41.7	30.2	70.9	61.6	30.9
LnGrp LOS	E	D	D	F	D	C	E	D	C	E	E	C
Approach Vol, veh/h		658			533			1116			1280	
Approach Delay, s/veh		55.3			56.0			48.0			62.9	
Approach LOS		E			E			D			E	

Timer	1	2	3	4	5	6	7	8
Assigned Phs	1	2	3	4	5	6	7	8
Phs Duration (G+Y+Rc), s	23.6	48.2	23.7	34.5	25.2	46.6	11.2	47.0
Change Period (Y+Rc), s	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0
Max Green Setting (Gmax), s	26.0	41.0	18.0	46.0	26.0	41.0	27.0	37.0
Max Q Clear Time (g_c+I1), s	17.2	29.9	17.6	24.7	18.8	40.2	5.9	15.1
Green Ext Time (p_c), s	0.4	8.6	0.0	3.8	0.4	0.4	0.1	5.8

Intersection Summary	
HCM 2010 Ctrl Delay	55.9
HCM 2010 LOS	E

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	235	245	220	15	275	185	240	1065	15	360	1775	220
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	6.0	4.0	4.0	6.0
Lane Util. Factor	0.91	0.91	1.00	1.00	1.00	0.88	0.97	0.91	1.00	0.97	0.91	1.00
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	0.99	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	1610	3349	1583	1770	1863	2787	3433	5085	1583	3433	5085	1583
Flt Permitted	0.95	0.99	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)	1610	3349	1583	1770	1863	2787	3433	5085	1583	3433	5085	1583
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	255	266	239	16	299	201	261	1158	16	391	1929	239
RTOR Reduction (vph)	0	0	62	0	0	107	0	0	9	0	0	68
Lane Group Flow (vph)	168	353	177	16	299	94	261	1158	7	391	1929	171
Turn Type	Split	NA	Perm	Split	NA	Perm	Prot	NA	Perm	Prot	NA	Perm
Protected Phases	3	3		4	4		5	2		1	6	
Permitted Phases			3			4			2			6
Actuated Green, G (s)	35.6	35.6	35.6	41.4	41.4	41.4	23.5	106.4	106.4	31.6	114.5	114.5
Effective Green, g (s)	37.6	37.6	37.6	43.4	43.4	43.4	25.5	109.4	107.4	33.6	117.5	115.5
Actuated g/C Ratio	0.16	0.16	0.16	0.18	0.18	0.18	0.11	0.46	0.45	0.14	0.49	0.48
Clearance Time (s)	6.0	6.0	6.0	6.0	6.0	6.0	6.0	7.0	7.0	6.0	7.0	7.0
Vehicle Extension (s)	5.0	5.0	5.0	5.0	5.0	5.0	3.0	5.0	5.0	3.0	5.0	5.0
Lane Grp Cap (vph)	252	524	248	320	336	503	364	2317	708	480	2489	761
v/s Ratio Prot	0.10	0.11		0.01	c0.16		0.08	0.23		c0.11	c0.38	
v/s Ratio Perm			c0.11			0.03			0.00			0.11
v/c Ratio	0.67	0.67	0.72	0.05	0.89	0.19	0.72	0.50	0.01	0.81	0.78	0.22
Uniform Delay, d1	95.3	95.4	96.1	81.3	96.0	83.3	103.8	46.0	36.8	100.2	50.4	36.2
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.16	0.89	1.05
Incremental Delay, d2	8.5	4.4	11.6	0.1	25.2	0.4	6.6	0.8	0.0	10.1	2.4	0.7
Delay (s)	103.8	99.8	107.7	81.4	121.1	83.7	110.4	46.8	36.8	125.8	47.4	38.8
Level of Service	F	F	F	F	F	F	F	D	D	F	D	D
Approach Delay (s)		103.2			105.3			58.2			58.6	
Approach LOS		F			F			E			E	

Intersection Summary			
HCM 2000 Control Delay	69.5	HCM 2000 Level of Service	E
HCM 2000 Volume to Capacity ratio	0.80		
Actuated Cycle Length (s)	240.0	Sum of lost time (s)	16.0
Intersection Capacity Utilization	78.0%	ICU Level of Service	D
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	380	40	125	35	35	30	130	1740	65	80	2830	385
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		6.0	4.0	6.0	5.0	6.0	4.0	5.0	7.0
Lane Util. Factor	0.95	0.95	1.00		1.00	1.00	1.00	0.91	1.00	1.00	0.91	1.00
Frpb, ped/bikes	1.00	1.00	0.91		1.00	1.00	1.00	1.00	0.83	1.00	1.00	0.97
Flpb, ped/bikes	1.00	1.00	1.00		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Frt	1.00	1.00	0.85		1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	0.96	1.00		0.98	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	1681	1701	1434		1817	1583	1770	5085	1311	1770	5085	1536
Flt Permitted	0.95	0.96	1.00		0.98	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)	1681	1701	1434		1817	1583	1770	5085	1311	1770	5085	1536
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	413	43	136	38	38	33	141	1891	71	87	3076	418
RTOR Reduction (vph)	0	0	83	0	0	31	0	0	27	0	0	183
Lane Group Flow (vph)	227	229	53	0	76	2	141	1891	44	87	3076	235
Confl. Peds. (#/hr)			43						31			2
Turn Type	Split	NA	Perm	Split	NA	Perm	Prot	NA	Perm	Prot	NA	Perm
Protected Phases	4	4		3	3		5	2		1	6	
Permitted Phases			4			3			2			6
Actuated Green, G (s)	39.9	39.9	39.9		15.4	15.4	25.6	144.3	144.3	16.4	135.1	135.1
Effective Green, g (s)	39.9	39.9	39.9		15.4	17.4	25.6	146.3	145.3	18.4	137.1	135.1
Actuated g/C Ratio	0.17	0.17	0.17		0.06	0.07	0.11	0.61	0.61	0.08	0.57	0.56
Clearance Time (s)	5.0	5.0	5.0		6.0	6.0	6.0	7.0	7.0	6.0	7.0	7.0
Vehicle Extension (s)	4.0	4.0	4.0		3.0	3.0	5.0	6.0	6.0	3.0	6.0	6.0
Lane Grp Cap (vph)	279	282	238		116	114	188	3099	793	135	2904	864
v/s Ratio Prot	c0.14	0.13			c0.04		c0.08	0.37		0.05	c0.60	
v/s Ratio Perm			0.04			0.00			0.03			0.15
v/c Ratio	0.81	0.81	0.22		0.66	0.02	0.75	0.61	0.06	0.64	1.06	0.27
Uniform Delay, d1	96.5	96.4	86.6		109.7	103.4	104.1	29.1	19.3	107.6	51.5	27.1
Progression Factor	1.00	1.00	1.00		1.00	1.00	0.88	1.18	2.11	0.98	0.99	1.40
Incremental Delay, d2	17.2	16.9	0.6		12.5	0.1	7.6	0.4	0.1	10.0	35.0	0.8
Delay (s)	113.6	113.3	87.2		122.3	103.5	98.8	34.6	40.8	115.2	86.0	38.6
Level of Service	F	F	F		F	F	F	C	D	F	F	D
Approach Delay (s)		107.4			116.6			39.1			81.2	
Approach LOS		F			F			D			F	

Intersection Summary			
HCM 2000 Control Delay	70.4	HCM 2000 Level of Service	E
HCM 2000 Volume to Capacity ratio	0.95		
Actuated Cycle Length (s)	240.0	Sum of lost time (s)	22.0
Intersection Capacity Utilization	103.0%	ICU Level of Service	G
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	30	75	20	315	170	410	60	1130	475	275	580	50
Number	3	8	18	7	4	14	5	2	12	1	6	16
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1863	1863	1900	1863	1863	1863	1863	1863	1900	1863	1863	1900
Adj Flow Rate, veh/h	33	82	14	342	185	125	65	1228	464	299	630	46
Adj No. of Lanes	1	1	0	1	1	1	1	3	0	2	3	0
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Percent Heavy Veh, %	2	2	2	2	2	2	2	2	2	2	2	2
Cap, veh/h	340	515	88	447	618	525	84	1428	538	386	2211	160
Arrive On Green	0.33	0.33	0.33	0.33	0.33	0.33	0.05	0.39	0.39	0.11	0.46	0.46
Sat Flow, veh/h	1065	1551	265	1294	1863	1583	1774	3640	1371	3442	4840	351
Grp Volume(v), veh/h	33	0	96	342	185	125	65	1144	548	299	440	236
Grp Sat Flow(s),veh/h/ln	1065	0	1816	1294	1863	1583	1774	1695	1621	1721	1695	1801
Q Serve(g_s), s	2.6	0.0	4.1	27.8	8.1	6.3	4.0	34.0	34.1	9.3	8.9	9.0
Cycle Q Clear(g_c), s	10.7	0.0	4.1	31.9	8.1	6.3	4.0	34.0	34.1	9.3	8.9	9.0
Prop In Lane	1.00		0.15	1.00		1.00	1.00		0.85	1.00		0.19
Lane Grp Cap(c), veh/h	340	0	602	447	618	525	84	1330	636	386	1549	823
V/C Ratio(X)	0.10	0.00	0.16	0.77	0.30	0.24	0.77	0.86	0.86	0.78	0.28	0.29
Avail Cap(c_a), veh/h	404	0	711	524	729	620	275	1358	649	1097	1914	1017
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	0.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	31.2	0.0	25.9	37.2	27.2	26.6	51.7	30.6	30.6	47.4	18.6	18.6
Incr Delay (d2), s/veh	0.1	0.0	0.1	5.7	0.3	0.2	13.6	5.7	11.4	3.4	0.1	0.2
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	0.8	0.0	2.1	10.6	4.2	2.8	2.3	16.9	17.2	4.6	4.2	4.5
LnGrp Delay(d),s/veh	31.3	0.0	26.0	42.8	27.5	26.9	65.3	36.3	42.0	50.8	18.7	18.8
LnGrp LOS	C		C	D	C	C	E	D	D	D	B	B
Approach Vol, veh/h		129			652			1757			975	
Approach Delay, s/veh		27.4			35.4			39.2			28.6	
Approach LOS		C			D			D			C	

Timer	1	2	3	4	5	6	7	8
Assigned Phs	1	2		4	5	6		8
Phs Duration (G+Y+Rc), s	18.3	49.1		42.4	11.2	56.2		42.4
Change Period (Y+Rc), s	6.0	6.0		6.0	6.0	6.0		6.0
Max Green Setting (Gmax), s	35.0	44.0		43.0	17.0	62.0		43.0
Max Q Clear Time (g_c+I1), s	11.3	36.1		33.9	6.0	11.0		12.7
Green Ext Time (p_c), s	1.0	7.0		2.5	0.1	30.6		3.8

Intersection Summary	
HCM 2010 Ctrl Delay	35.1
HCM 2010 LOS	D

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	10	130	190	100	335	290	470	1265	245	175	805	60
Number	7	4	14	3	8	18	5	2	12	1	6	16
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1863	1863	1863	1863	1863	1863	1863	1863	1863	1863	1863	1863
Adj Flow Rate, veh/h	11	141	23	109	364	58	511	1375	162	190	875	19
Adj No. of Lanes	1	1	1	1	1	1	2	2	1	1	2	1
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Percent Heavy Veh, %	2	2	2	2	2	2	2	2	2	2	2	2
Cap, veh/h	18	305	259	135	428	363	594	1506	674	219	1332	596
Arrive On Green	0.01	0.16	0.16	0.08	0.23	0.23	0.17	0.43	0.43	0.12	0.38	0.38
Sat Flow, veh/h	1774	1863	1583	1774	1863	1583	3442	3539	1583	1774	3539	1583
Grp Volume(v), veh/h	11	141	23	109	364	58	511	1375	162	190	875	19
Grp Sat Flow(s),veh/h/ln	1774	1863	1583	1774	1863	1583	1721	1770	1583	1774	1770	1583
Q Serve(g_s), s	0.7	7.8	1.4	6.9	21.3	3.3	16.4	41.5	7.4	12.0	23.3	0.9
Cycle Q Clear(g_c), s	0.7	7.8	1.4	6.9	21.3	3.3	16.4	41.5	7.4	12.0	23.3	0.9
Prop In Lane	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Lane Grp Cap(c), veh/h	18	305	259	135	428	363	594	1506	674	219	1332	596
V/C Ratio(X)	0.60	0.46	0.09	0.81	0.85	0.16	0.86	0.91	0.24	0.87	0.66	0.03
Avail Cap(c_a), veh/h	187	606	515	187	606	515	787	1556	696	265	1332	596
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	56.0	43.0	40.3	51.7	41.9	35.0	45.7	30.7	20.9	48.9	29.4	22.4
Incr Delay (d2), s/veh	27.7	1.1	0.1	16.2	8.0	0.2	7.5	8.5	0.2	21.6	1.2	0.0
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	0.5	4.1	0.6	4.0	11.9	1.5	8.4	22.0	3.3	7.2	11.5	0.4
LnGrp Delay(d),s/veh	83.7	44.1	40.5	67.9	50.0	35.2	53.2	39.2	21.1	70.5	30.5	22.4
LnGrp LOS	F	D	D	E	D	D	D	D	C	E	C	C
Approach Vol, veh/h		175			531			2048			1084	
Approach Delay, s/veh		46.1			52.1			41.2			37.4	
Approach LOS		D			D			D			D	

Timer	1	2	3	4	5	6	7	8
Assigned Phs	1	2	3	4	5	6	7	8
Phs Duration (G+Y+Rc), s	20.1	54.4	14.7	24.6	25.6	48.8	7.2	32.1
Change Period (Y+Rc), s	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0
Max Green Setting (Gmax), s	17.0	50.0	12.0	37.0	26.0	41.0	12.0	37.0
Max Q Clear Time (g_c+I1), s	14.0	43.5	8.9	9.8	18.4	25.3	2.7	23.3
Green Ext Time (p_c), s	0.1	4.9	0.1	3.5	1.2	13.1	0.0	2.8

Intersection Summary	
HCM 2010 Ctrl Delay	41.9
HCM 2010 LOS	D

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	85	165	75	205	80	325	40	890	130	320	1180	65
Number	3	8	18	7	4	14	5	2	12	1	6	16
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1863	1863	1900	1863	1863	1863	1863	1863	1900	1863	1863	1900
Adj Flow Rate, veh/h	92	179	69	223	87	88	43	967	129	348	1283	67
Adj No. of Lanes	1	1	0	1	1	1	1	3	0	2	3	0
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Percent Heavy Veh, %	2	2	2	2	2	2	2	2	2	2	2	2
Cap, veh/h	458	449	173	351	652	555	55	1503	200	453	2136	112
Arrive On Green	0.35	0.35	0.35	0.35	0.35	0.35	0.03	0.33	0.33	0.13	0.43	0.43
Sat Flow, veh/h	1205	1282	494	1127	1863	1583	1774	4542	604	3442	4949	258
Grp Volume(v), veh/h	92	0	248	223	87	88	43	721	375	348	879	471
Grp Sat Flow(s),veh/h/ln	1205	0	1776	1127	1863	1583	1774	1695	1756	1721	1695	1817
Q Serve(g_s), s	5.4	0.0	10.1	17.9	3.1	3.7	2.3	17.4	17.5	9.4	19.1	19.1
Cycle Q Clear(g_c), s	8.5	0.0	10.1	28.1	3.1	3.7	2.3	17.4	17.5	9.4	19.1	19.1
Prop In Lane	1.00		0.28	1.00		1.00	1.00		0.34	1.00		0.14
Lane Grp Cap(c), veh/h	458	0	622	351	652	555	55	1122	581	453	1463	784
V/C Ratio(X)	0.20	0.00	0.40	0.64	0.13	0.16	0.78	0.64	0.65	0.77	0.60	0.60
Avail Cap(c_a), veh/h	651	0	905	530	949	807	369	1122	581	1575	1869	1002
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	0.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	24.2	0.0	23.6	34.2	21.3	21.5	46.3	27.3	27.4	40.3	21.0	21.0
Incr Delay (d2), s/veh	0.2	0.0	0.4	1.9	0.1	0.1	20.8	1.3	2.5	2.8	0.4	0.7
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	1.8	0.0	5.0	5.8	1.6	1.6	1.5	8.3	8.8	4.6	9.0	9.7
LnGrp Delay(d),s/veh	24.4	0.0	24.0	36.1	21.4	21.6	67.0	28.6	29.8	43.1	21.4	21.7
LnGrp LOS	C		C	D	C	C	E	C	C	D	C	C
Approach Vol, veh/h		340			398			1139			1698	
Approach Delay, s/veh		24.1			29.7			30.5			25.9	
Approach LOS		C			C			C			C	

Timer	1	2	3	4	5	6	7	8
Assigned Phs	1	2		4	5	6		8
Phs Duration (G+Y+Rc), s	18.7	37.8		39.7	9.0	47.5		39.7
Change Period (Y+Rc), s	6.0	6.0		6.0	6.0	6.0		6.0
Max Green Setting (Gmax), s	44.0	29.0		49.0	20.0	53.0		49.0
Max Q Clear Time (g_c+I1), s	11.4	19.5		30.1	4.3	21.1		12.1
Green Ext Time (p_c), s	1.3	8.3		3.6	0.1	20.4		4.1

Intersection Summary	
HCM 2010 Ctrl Delay	27.6
HCM 2010 LOS	C

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	50	290	465	200	220	275	215	785	110	195	975	30
Number	7	4	14	3	8	18	5	2	12	1	6	16
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1863	1863	1863	1863	1863	1863	1863	1863	1863	1863	1863	1863
Adj Flow Rate, veh/h	54	315	229	217	239	78	234	853	28	212	1060	9
Adj No. of Lanes	1	1	1	1	1	1	2	2	1	1	2	1
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Percent Heavy Veh, %	2	2	2	2	2	2	2	2	2	2	2	2
Cap, veh/h	70	384	326	247	569	484	302	1144	512	244	1319	590
Arrive On Green	0.04	0.21	0.21	0.14	0.31	0.31	0.09	0.32	0.32	0.14	0.37	0.37
Sat Flow, veh/h	1774	1863	1583	1774	1863	1583	3442	3539	1583	1774	3539	1583
Grp Volume(v), veh/h	54	315	229	217	239	78	234	853	28	212	1060	9
Grp Sat Flow(s),veh/h/ln	1774	1863	1583	1774	1863	1583	1721	1770	1583	1774	1770	1583
Q Serve(g_s), s	3.7	20.0	16.6	14.8	12.6	4.4	8.2	26.6	1.5	14.5	33.2	0.4
Cycle Q Clear(g_c), s	3.7	20.0	16.6	14.8	12.6	4.4	8.2	26.6	1.5	14.5	33.2	0.4
Prop In Lane	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Lane Grp Cap(c), veh/h	70	384	326	247	569	484	302	1144	512	244	1319	590
V/C Ratio(X)	0.77	0.82	0.70	0.88	0.42	0.16	0.77	0.75	0.05	0.87	0.80	0.02
Avail Cap(c_a), veh/h	359	557	474	359	569	484	668	1145	512	488	1431	640
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	58.8	46.9	45.5	52.2	34.2	31.4	55.2	37.3	28.8	52.2	34.7	24.5
Incr Delay (d2), s/veh	15.8	6.3	2.7	15.7	0.5	0.2	4.2	2.7	0.0	9.2	3.2	0.0
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	2.1	10.9	7.5	8.4	6.6	2.0	4.1	13.3	0.7	7.7	16.8	0.2
LnGrp Delay(d),s/veh	74.6	53.2	48.3	67.9	34.7	31.5	59.4	40.0	28.9	61.4	37.9	24.5
LnGrp LOS	E	D	D	E	C	C	E	D	C	E	D	C
Approach Vol, veh/h		598			534			1115			1281	
Approach Delay, s/veh		53.2			47.7			43.8			41.7	
Approach LOS		D			D			D			D	

Timer	1	2	3	4	5	6	7	8
Assigned Phs	1	2	3	4	5	6	7	8
Phs Duration (G+Y+Rc), s	23.0	45.9	23.2	31.5	16.9	52.1	10.9	43.8
Change Period (Y+Rc), s	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0
Max Green Setting (Gmax), s	34.0	40.0	25.0	37.0	24.0	50.0	25.0	37.0
Max Q Clear Time (g_c+I1), s	16.5	28.6	16.8	22.0	10.2	35.2	5.7	14.6
Green Ext Time (p_c), s	0.5	8.8	0.4	3.5	0.6	10.9	0.1	4.5

Intersection Summary	
HCM 2010 Ctrl Delay	45.2
HCM 2010 LOS	D

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	625	530	5	120	705	475	5	85	15	415	120	430
Number	7	4	14	3	8	18	5	2	12	1	6	16
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1863	1863	1900	1863	1863	1863	1863	1863	1900	1863	1863	1863
Adj Flow Rate, veh/h	679	576	5	130	766	516	5	92	3	451	130	278
Adj No. of Lanes	2	3	0	2	3	2	1	2	0	2	2	2
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Percent Heavy Veh, %	2	2	2	2	2	2	2	2	2	2	2	2
Cap, veh/h	808	2280	20	214	1352	1184	9	315	10	547	863	1330
Arrive On Green	0.23	0.44	0.44	0.06	0.27	0.27	0.01	0.09	0.09	0.16	0.24	0.24
Sat Flow, veh/h	3442	5200	45	3442	5085	2787	1774	3499	114	3442	3539	2773
Grp Volume(v), veh/h	679	375	206	130	766	516	5	46	49	451	130	278
Grp Sat Flow(s),veh/h/ln	1721	1695	1855	1721	1695	1393	1774	1770	1843	1721	1770	1386
Q Serve(g_s), s	18.0	6.7	6.7	3.5	12.5	12.5	0.3	2.3	2.4	12.2	2.8	5.6
Cycle Q Clear(g_c), s	18.0	6.7	6.7	3.5	12.5	12.5	0.3	2.3	2.4	12.2	2.8	5.6
Prop In Lane	1.00		0.02	1.00		1.00	1.00		0.06	1.00		1.00
Lane Grp Cap(c), veh/h	808	1486	813	214	1352	1184	9	160	166	547	863	1330
V/C Ratio(X)	0.84	0.25	0.25	0.61	0.57	0.44	0.54	0.29	0.29	0.82	0.15	0.21
Avail Cap(c_a), veh/h	1364	1486	813	1364	2016	1548	222	702	730	790	1772	2043
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	35.0	17.0	17.0	43.8	30.4	19.5	47.6	40.7	40.8	39.0	28.5	14.5
Incr Delay (d2), s/veh	2.5	0.1	0.2	2.8	0.4	0.3	41.5	1.0	1.0	4.8	0.1	0.1
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	8.9	3.1	3.5	1.8	5.9	4.9	0.2	1.2	1.2	6.1	1.4	2.1
LnGrp Delay(d),s/veh	37.4	17.1	17.2	46.6	30.8	19.7	89.1	41.7	41.7	43.8	28.5	14.6
LnGrp LOS	D	B	B	D	C	B	F	D	D	D	C	B
Approach Vol, veh/h		1260			1412			100			859	
Approach Delay, s/veh		28.1			28.2			44.1			32.0	
Approach LOS		C			C			D			C	

Timer	1	2	3	4	5	6	7	8
Assigned Phs	1	2	3	4	5	6	7	8
Phs Duration (G+Y+Rc), s	21.2	14.6	12.0	48.0	6.5	29.4	28.5	31.5
Change Period (Y+Rc), s	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0
Max Green Setting (Gmax), s	22.0	38.0	38.0	38.0	12.0	48.0	38.0	38.0
Max Q Clear Time (g_c+I1), s	14.2	4.4	5.5	8.7	2.3	7.6	20.0	14.5
Green Ext Time (p_c), s	1.1	2.6	0.4	14.4	0.0	2.7	2.5	11.0

Intersection Summary	
HCM 2010 Ctrl Delay	29.5
HCM 2010 LOS	C

Notes

User approved changes to right turn type.

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	30	70	20	300	175	370	50	980	400	280	530	80
Number	3	8	18	7	4	14	5	2	12	1	6	16
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1863	1863	1900	1863	1863	1863	1863	1863	1900	1863	1863	1900
Adj Flow Rate, veh/h	33	76	13	326	190	93	54	1065	381	304	576	73
Adj No. of Lanes	1	1	0	1	1	1	1	3	0	1	3	0
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Percent Heavy Veh, %	2	2	2	2	2	2	2	2	2	2	2	2
Cap, veh/h	314	483	83	419	580	493	70	1290	462	337	2288	286
Arrive On Green	0.31	0.31	0.31	0.31	0.31	0.31	0.04	0.35	0.35	0.19	0.50	0.50
Sat Flow, veh/h	1092	1551	265	1303	1863	1583	1774	3697	1323	1774	4579	573
Grp Volume(v), veh/h	33	0	89	326	190	93	54	977	469	304	425	224
Grp Sat Flow(s),veh/h/ln	1092	0	1816	1303	1863	1583	1774	1695	1629	1774	1695	1762
Q Serve(g_s), s	2.9	0.0	4.3	29.1	9.4	5.2	3.6	31.7	31.7	20.2	8.6	8.8
Cycle Q Clear(g_c), s	12.3	0.0	4.3	33.4	9.4	5.2	3.6	31.7	31.7	20.2	8.6	8.8
Prop In Lane	1.00		0.15	1.00		1.00	1.00		0.81	1.00		0.33
Lane Grp Cap(c), veh/h	314	0	565	419	580	493	70	1183	569	337	1694	880
V/C Ratio(X)	0.10	0.00	0.16	0.78	0.33	0.19	0.77	0.83	0.83	0.90	0.25	0.25
Avail Cap(c_a), veh/h	364	0	648	478	665	565	250	1238	595	515	1744	906
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	0.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	36.5	0.0	30.0	42.1	31.8	30.4	57.3	35.9	35.9	47.7	17.2	17.3
Incr Delay (d2), s/veh	0.1	0.0	0.1	7.0	0.3	0.2	16.1	4.5	9.0	13.3	0.1	0.2
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	0.9	0.0	2.2	11.3	4.9	2.3	2.1	15.5	15.6	11.1	4.0	4.3
LnGrp Delay(d),s/veh	36.7	0.0	30.2	49.2	32.1	30.5	73.4	40.4	44.9	61.0	17.3	17.4
LnGrp LOS	D		C	D	C	C	E	D	D	E	B	B
Approach Vol, veh/h		122			609			1500			953	
Approach Delay, s/veh		31.9			41.0			43.0			31.3	
Approach LOS		C			D			D			C	

Timer	1	2	3	4	5	6	7	8
Assigned Phs	1	2		4	5	6		8
Phs Duration (G+Y+Rc), s	28.9	48.1		43.5	10.8	66.2		43.5
Change Period (Y+Rc), s	6.0	6.0		6.0	6.0	6.0		6.0
Max Green Setting (Gmax), s	35.0	44.0		43.0	17.0	62.0		43.0
Max Q Clear Time (g_c+I1), s	22.2	33.7		35.4	5.6	10.8		14.3
Green Ext Time (p_c), s	0.7	8.3		2.1	0.1	25.4		3.5

Intersection Summary	
HCM 2010 Ctrl Delay	38.7
HCM 2010 LOS	D

Intersection	
Int Delay, s/veh	7.7

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Vol, veh/h	5	5	195	5	5	90
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	-	-	0	-
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	5	5	212	5	5	98

Major/Minor	Major1		Major2		Minor1	
Conflicting Flow All	0	0	11	0	437	8
Stage 1	-	-	-	-	8	-
Stage 2	-	-	-	-	429	-
Critical Hdwy	-	-	4.12	-	6.42	6.22
Critical Hdwy Stg 1	-	-	-	-	5.42	-
Critical Hdwy Stg 2	-	-	-	-	5.42	-
Follow-up Hdwy	-	-	2.218	-	3.518	3.318
Pot Cap-1 Maneuver	-	-	1608	-	577	1074
Stage 1	-	-	-	-	1015	-
Stage 2	-	-	-	-	657	-
Platoon blocked, %	-	-		-		
Mov Cap-1 Maneuver	-	-	1608	-	501	1074
Mov Cap-2 Maneuver	-	-	-	-	501	-
Stage 1	-	-	-	-	1015	-
Stage 2	-	-	-	-	570	-

Approach	EB	WB	NB
HCM Control Delay, s	0	7.4	9
HCM LOS			A

Minor Lane/Major Mvmt	NBLn1	EBT	EBR	WBL	WBT
Capacity (veh/h)	1013	-	-	1608	-
HCM Lane V/C Ratio	0.102	-	-	0.132	-
HCM Control Delay (s)	9	-	-	7.6	0
HCM Lane LOS	A	-	-	A	A
HCM 95th %tile Q(veh)	0.3	-	-	0.5	-

Intersection	
Int Delay, s/veh	4.7

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Vol, veh/h	70	305	0	0	655	20	0	0	0	15	0	180
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Free	Free	Stop	Stop	Stop	Stop	Stop	Stop
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	-	-	-	-	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	92	92	92	92	92	92	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2	2	2	2	2	2	2
Mvmt Flow	76	332	0	0	712	22	0	0	0	16	0	196

Major/Minor	Major1			Major2			Minor1			Minor2		
Conflicting Flow All	734	0	0	332	0	0	1305	1218	332	1207	1207	723
Stage 1	-	-	-	-	-	-	484	484	-	723	723	-
Stage 2	-	-	-	-	-	-	821	734	-	484	484	-
Critical Hdwy	4.12	-	-	4.12	-	-	7.12	6.52	6.22	7.12	6.52	6.22
Critical Hdwy Stg 1	-	-	-	-	-	-	6.12	5.52	-	6.12	5.52	-
Critical Hdwy Stg 2	-	-	-	-	-	-	6.12	5.52	-	6.12	5.52	-
Follow-up Hdwy	2.218	-	-	2.218	-	-	3.518	4.018	3.318	3.518	4.018	3.318
Pot Cap-1 Maneuver	871	-	-	1227	-	-	137	181	710	160	183	426
Stage 1	-	-	-	-	-	-	564	552	-	417	431	-
Stage 2	-	-	-	-	-	-	369	426	-	564	552	-
Platoon blocked, %		-	-		-	-						
Mov Cap-1 Maneuver	871	-	-	1227	-	-	68	162	710	147	163	426
Mov Cap-2 Maneuver	-	-	-	-	-	-	68	162	-	147	163	-
Stage 1	-	-	-	-	-	-	504	493	-	372	431	-
Stage 2	-	-	-	-	-	-	200	426	-	504	493	-

Approach	EB	WB	NB	SB
HCM Control Delay, s	1.8	0	0	26.7
HCM LOS			A	D

Minor Lane/Major Mvmt	NBLn1	EBL	EBT	EBR	WBL	WBT	WBR	SBLn1
Capacity (veh/h)	-	871	-	-	1227	-	-	372
HCM Lane V/C Ratio	-	0.087	-	-	-	-	-	0.57
HCM Control Delay (s)	0	9.5	0	-	0	-	-	26.7
HCM Lane LOS	A	A	A	-	A	-	-	D
HCM 95th %tile Q(veh)	-	0.3	-	-	0	-	-	3.4

Intersection	
Int Delay, s/veh	0.5

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Vol, veh/h	300	10	25	705	10	5
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	50	-	0	-
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	326	11	27	766	11	5

Major/Minor	Major1		Major2		Minor1	
Conflicting Flow All	0	0	337	0	1153	332
Stage 1	-	-	-	-	332	-
Stage 2	-	-	-	-	821	-
Critical Hdwy	-	-	4.12	-	6.42	6.22
Critical Hdwy Stg 1	-	-	-	-	5.42	-
Critical Hdwy Stg 2	-	-	-	-	5.42	-
Follow-up Hdwy	-	-	2.218	-	3.518	3.318
Pot Cap-1 Maneuver	-	-	1222	-	218	710
Stage 1	-	-	-	-	727	-
Stage 2	-	-	-	-	432	-
Platoon blocked, %	-	-		-		
Mov Cap-1 Maneuver	-	-	1222	-	213	710
Mov Cap-2 Maneuver	-	-	-	-	213	-
Stage 1	-	-	-	-	727	-
Stage 2	-	-	-	-	422	-

Approach	EB	WB	NB
HCM Control Delay, s	0	0.3	18.8
HCM LOS			C

Minor Lane/Major Mvmt	NBLn1	EBT	EBR	WBL	WBT
Capacity (veh/h)	278	-	-	1222	-
HCM Lane V/C Ratio	0.059	-	-	0.022	-
HCM Control Delay (s)	18.8	-	-	8	-
HCM Lane LOS	C	-	-	A	-
HCM 95th %tile Q(veh)	0.2	-	-	0.1	-

Intersection	
Int Delay, s/veh	0

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Vol, veh/h	0	305	0	0	745	0	0	0	0	0	0	0
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Free	Free	Stop	Stop	Stop	Stop	Stop	Stop
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	-	-	-	-	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	92	92	92	92	92	92	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2	2	2	2	2	2	2
Mvmt Flow	0	332	0	0	810	0	0	0	0	0	0	0

Major/Minor	Major1			Major2			Minor1			Minor2		
Conflicting Flow All	810	0	0	332	0	0	1142	1142	332	1142	1142	810
Stage 1	-	-	-	-	-	-	332	332	-	810	810	-
Stage 2	-	-	-	-	-	-	810	810	-	332	332	-
Critical Hdwy	4.12	-	-	4.12	-	-	7.12	6.52	6.22	7.12	6.52	6.22
Critical Hdwy Stg 1	-	-	-	-	-	-	6.12	5.52	-	6.12	5.52	-
Critical Hdwy Stg 2	-	-	-	-	-	-	6.12	5.52	-	6.12	5.52	-
Follow-up Hdwy	2.218	-	-	2.218	-	-	3.518	4.018	3.318	3.518	4.018	3.318
Pot Cap-1 Maneuver	816	-	-	1227	-	-	177	200	710	177	200	380
Stage 1	-	-	-	-	-	-	681	644	-	374	393	-
Stage 2	-	-	-	-	-	-	374	393	-	681	644	-
Platoon blocked, %		-	-		-	-						
Mov Cap-1 Maneuver	816	-	-	1227	-	-	177	200	710	177	200	380
Mov Cap-2 Maneuver	-	-	-	-	-	-	177	200	-	177	200	-
Stage 1	-	-	-	-	-	-	681	644	-	374	393	-
Stage 2	-	-	-	-	-	-	374	393	-	681	644	-

Approach	EB	WB	NB	SB
HCM Control Delay, s	0	0	0	0
HCM LOS			A	A

Minor Lane/Major Mvmt	NBLn1	EBL	EBT	EBR	WBL	WBT	WBR	SBLn1
Capacity (veh/h)	-	816	-	-	1227	-	-	-
HCM Lane V/C Ratio	-	-	-	-	-	-	-	-
HCM Control Delay (s)	0	0	-	-	0	-	-	0
HCM Lane LOS	A	A	-	-	A	-	-	A
HCM 95th %tile Q(veh)	-	0	-	-	0	-	-	-

Intersection	
Int Delay, s/veh	0.4

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Vol, veh/h	5	300	730	30	10	10
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	-	-	0	-
Veh in Median Storage, #	-	0	0	-	0	-
Grade, %	-	0	0	-	0	-
Peak Hour Factor	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	5	326	793	33	11	11

Major/Minor	Major1		Major2		Minor2	
Conflicting Flow All	826	0	-	0	1147	810
Stage 1	-	-	-	-	810	-
Stage 2	-	-	-	-	337	-
Critical Hdwy	4.12	-	-	-	6.42	6.22
Critical Hdwy Stg 1	-	-	-	-	5.42	-
Critical Hdwy Stg 2	-	-	-	-	5.42	-
Follow-up Hdwy	2.218	-	-	-	3.518	3.318
Pot Cap-1 Maneuver	805	-	-	-	220	380
Stage 1	-	-	-	-	438	-
Stage 2	-	-	-	-	723	-
Platoon blocked, %		-	-	-		
Mov Cap-1 Maneuver	805	-	-	-	218	380
Mov Cap-2 Maneuver	-	-	-	-	218	-
Stage 1	-	-	-	-	438	-
Stage 2	-	-	-	-	717	-

Approach	EB	WB	SB
HCM Control Delay, s	0.2	0	19.1
HCM LOS			C

Minor Lane/Major Mvmt	EBL	EBT	WBT	WBR	SBLn1
Capacity (veh/h)	805	-	-	-	277
HCM Lane V/C Ratio	0.007	-	-	-	0.078
HCM Control Delay (s)	9.5	0	-	-	19.1
HCM Lane LOS	A	A	-	-	C
HCM 95th %tile Q(veh)	0	-	-	-	0.3

Intersection	
Int Delay, s/veh	0.3

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Vol, veh/h	10	290	0	0	750	50	0	0	0	5	0	10
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Free	Free	Stop	Stop	Stop	Stop	Stop	Stop
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	-	-	-	-	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	92	92	92	92	92	92	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2	2	2	2	2	2	2
Mvmt Flow	11	315	0	0	815	54	0	0	0	5	0	11

Major/Minor	Major1			Major2			Minor1			Minor2		
Conflicting Flow All	870	0	0	315	0	0	1185	1207	315	1179	1179	842
Stage 1	-	-	-	-	-	-	337	337	-	842	842	-
Stage 2	-	-	-	-	-	-	848	870	-	337	337	-
Critical Hdwy	4.12	-	-	4.12	-	-	7.12	6.52	6.22	7.12	6.52	6.22
Critical Hdwy Stg 1	-	-	-	-	-	-	6.12	5.52	-	6.12	5.52	-
Critical Hdwy Stg 2	-	-	-	-	-	-	6.12	5.52	-	6.12	5.52	-
Follow-up Hdwy	2.218	-	-	2.218	-	-	3.518	4.018	3.318	3.518	4.018	3.318
Pot Cap-1 Maneuver	775	-	-	1245	-	-	166	183	725	167	190	364
Stage 1	-	-	-	-	-	-	677	641	-	359	380	-
Stage 2	-	-	-	-	-	-	356	369	-	677	641	-
Platoon blocked, %		-	-		-	-						
Mov Cap-1 Maneuver	775	-	-	1245	-	-	159	180	725	165	187	364
Mov Cap-2 Maneuver	-	-	-	-	-	-	159	180	-	165	187	-
Stage 1	-	-	-	-	-	-	665	630	-	353	380	-
Stage 2	-	-	-	-	-	-	345	369	-	665	630	-

Approach	EB	WB	NB	SB
HCM Control Delay, s	0.3	0	0	19.8
HCM LOS			A	C

Minor Lane/Major Mvmt	NBLn1	EBL	EBT	EBR	WBL	WBT	WBR	SBLn1
Capacity (veh/h)	-	775	-	-	1245	-	-	260
HCM Lane V/C Ratio	-	0.014	-	-	-	-	-	0.063
HCM Control Delay (s)	0	9.7	0	-	0	-	-	19.8
HCM Lane LOS	A	A	A	-	A	-	-	C
HCM 95th %tile Q(veh)	-	0	-	-	0	-	-	0.2

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	10	130	185	95	350	235	435	1015	180	160	720	50
Number	7	4	14	3	8	18	5	2	12	1	6	16
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1863	1863	1900	1863	1863	1863	1863	1863	1863	1863	1863	1863
Adj Flow Rate, veh/h	11	141	19	103	380	77	473	1103	109	174	783	12
Adj No. of Lanes	1	2	0	1	1	1	1	2	1	1	2	1
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Percent Heavy Veh, %	2	2	2	2	2	2	2	2	2	2	2	2
Cap, veh/h	18	549	73	129	442	375	501	1580	707	203	984	440
Arrive On Green	0.01	0.17	0.17	0.07	0.24	0.24	0.28	0.45	0.45	0.11	0.28	0.28
Sat Flow, veh/h	1774	3142	417	1774	1863	1583	1774	3539	1583	1774	3539	1583
Grp Volume(v), veh/h	11	78	82	103	380	77	473	1103	109	174	783	12
Grp Sat Flow(s),veh/h/ln	1774	1770	1789	1774	1863	1583	1774	1770	1583	1774	1770	1583
Q Serve(g_s), s	0.8	4.8	4.9	7.1	24.4	4.9	32.6	31.3	5.1	12.0	25.6	0.7
Cycle Q Clear(g_c), s	0.8	4.8	4.9	7.1	24.4	4.9	32.6	31.3	5.1	12.0	25.6	0.7
Prop In Lane	1.00		0.23	1.00		1.00	1.00		1.00	1.00		1.00
Lane Grp Cap(c), veh/h	18	309	313	129	442	375	501	1580	707	203	984	440
V/C Ratio(X)	0.61	0.25	0.26	0.80	0.86	0.21	0.94	0.70	0.15	0.86	0.80	0.03
Avail Cap(c_a), veh/h	242	525	530	313	627	533	554	1580	707	313	1077	482
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	61.5	44.5	44.5	57.0	45.6	38.2	43.8	27.8	20.6	54.3	41.8	32.8
Incr Delay (d2), s/veh	29.0	0.4	0.4	10.8	8.5	0.3	23.9	1.4	0.1	13.5	3.9	0.0
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	0.5	2.4	2.5	3.9	13.6	2.2	19.2	15.6	2.3	6.7	13.0	0.3
LnGrp Delay(d),s/veh	90.5	44.9	45.0	67.8	54.1	38.5	67.7	29.2	20.7	67.8	45.7	32.8
LnGrp LOS	F	D	D	E	D	D	E	C	C	E	D	C
Approach Vol, veh/h		171			560			1685			969	
Approach Delay, s/veh		47.9			54.5			39.4			49.5	
Approach LOS		D			D			D			D	

Timer	1	2	3	4	5	6	7	8
Assigned Phs	1	2	3	4	5	6	7	8
Phs Duration (G+Y+Rc), s	20.3	61.7	15.1	27.8	41.3	40.7	7.3	35.6
Change Period (Y+Rc), s	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0
Max Green Setting (Gmax), s	22.0	55.0	22.0	37.0	39.0	38.0	17.0	42.0
Max Q Clear Time (g_c+I1), s	14.0	33.3	9.1	6.9	34.6	27.6	2.8	26.4
Green Ext Time (p_c), s	0.3	14.6	0.2	3.8	0.7	7.1	0.0	3.2

Intersection Summary	
HCM 2010 Ctrl Delay	45.2
HCM 2010 LOS	D

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	295	145	185	55	240	285	250	1365	5	185	950	150
Ideal Flow (vphpl)	1900	1900	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	6.0	4.0	4.0	6.0
Lane Util. Factor	0.91	0.91	1.00	1.00	1.00	0.88	0.97	0.91	1.00	0.97	0.91	1.00
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	0.98	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	1610	3307	1583	1770	1863	2787	3433	5085	1583	3433	5085	1583
Flt Permitted	0.95	0.98	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)	1610	3307	1583	1770	1863	2787	3433	5085	1583	3433	5085	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)	321	158	201	60	261	310	272	1484	5	201	1033	163
RTOR Reduction (vph)	0	0	62	0	0	200	0	0	2	0	0	82
Lane Group Flow (vph)	160	319	139	60	261	110	272	1484	3	201	1033	81
Turn Type	Split	NA	Perm	Split	NA	Perm	Prot	NA	Perm	Prot	NA	Perm
Protected Phases	3	3		4	4		5	2		1	6	
Permitted Phases			3			4			2			6
Actuated Green, G (s)	33.0	33.0	33.0	39.9	39.9	39.9	23.3	123.0	123.0	19.1	118.8	118.8
Effective Green, g (s)	35.0	35.0	35.0	41.9	41.9	41.9	25.3	126.0	124.0	21.1	121.8	119.8
Actuated g/C Ratio	0.15	0.15	0.15	0.17	0.17	0.17	0.11	0.52	0.52	0.09	0.51	0.50
Clearance Time (s)	6.0	6.0	6.0	6.0	6.0	6.0	6.0	7.0	7.0	6.0	7.0	7.0
Vehicle Extension (s)	5.0	5.0	5.0	5.0	5.0	5.0	3.0	5.0	5.0	3.0	5.0	5.0
Lane Grp Cap (vph)	234	482	230	309	325	486	361	2669	817	301	2580	790
v/s Ratio Prot	c0.10	0.10		0.03	c0.14		c0.08	c0.29		0.06	0.20	
v/s Ratio Perm			0.09			0.04			0.00			0.05
v/c Ratio	0.68	0.66	0.60	0.19	0.80	0.23	0.75	0.56	0.00	0.67	0.40	0.10
Uniform Delay, d1	97.2	96.9	96.0	84.6	95.1	85.1	104.3	38.2	28.1	106.1	36.5	31.7
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.73	1.62	7.45
Incremental Delay, d2	10.2	4.5	6.4	0.6	15.1	0.5	8.6	0.8	0.0	5.0	0.4	0.2
Delay (s)	107.4	101.4	102.4	85.3	110.1	85.6	112.9	39.1	28.1	82.7	59.5	236.8
Level of Service	F	F	F	F	F	F	F	D	C	F	E	F
Approach Delay (s)		103.1			95.7			50.5			83.5	
Approach LOS		F			F			D			F	

Intersection Summary			
HCM 2000 Control Delay	75.2	HCM 2000 Level of Service	E
HCM 2000 Volume to Capacity ratio	0.65		
Actuated Cycle Length (s)	240.0	Sum of lost time (s)	16.0
Intersection Capacity Utilization	66.5%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	420	5	135	5	15	15	250	2630	20	75	1275	365
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		6.0	4.0	6.0	5.0	6.0	4.0	5.0	7.0
Lane Util. Factor	0.95	0.95	1.00		1.00	1.00	1.00	0.91	1.00	1.00	0.91	1.00
Frpb, ped/bikes	1.00	1.00	0.91		1.00	1.00	1.00	1.00	0.83	1.00	1.00	0.97
Flpb, ped/bikes	1.00	1.00	1.00		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Frt	1.00	1.00	0.85		1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	0.95	1.00		0.99	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	1681	1687	1434		1841	1583	1770	5085	1311	1770	5085	1536
Flt Permitted	0.95	0.95	1.00		0.99	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)	1681	1687	1434		1841	1583	1770	5085	1311	1770	5085	1536
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	457	5	147	5	16	16	272	2859	22	82	1386	397
RTOR Reduction (vph)	0	0	83	0	0	15	0	0	8	0	0	191
Lane Group Flow (vph)	233	229	64	0	21	1	272	2859	14	82	1386	206
Confl. Peds. (#/hr)			43						31			2
Turn Type	Split	NA	Perm	Split	NA	Perm	Prot	NA	Perm	Prot	NA	Perm
Protected Phases	4	4		3	3		5	2		1	6	
Permitted Phases			4			3			2			6
Actuated Green, G (s)	41.3	41.3	41.3		7.1	7.1	43.3	152.9	152.9	14.7	124.3	124.3
Effective Green, g (s)	41.3	41.3	41.3		7.1	9.1	43.3	154.9	153.9	16.7	126.3	124.3
Actuated g/C Ratio	0.17	0.17	0.17		0.03	0.04	0.18	0.65	0.64	0.07	0.53	0.52
Clearance Time (s)	5.0	5.0	5.0		6.0	6.0	6.0	7.0	7.0	6.0	7.0	7.0
Vehicle Extension (s)	4.0	4.0	4.0		3.0	3.0	5.0	6.0	6.0	3.0	6.0	6.0
Lane Grp Cap (vph)	289	290	246		54	60	319	3281	840	123	2675	795
v/s Ratio Prot	c0.14	0.14			c0.01		c0.15	c0.56		0.05	0.27	
v/s Ratio Perm			0.04			0.00			0.01			0.13
v/c Ratio	0.81	0.79	0.26		0.39	0.01	0.85	0.87	0.02	0.67	0.52	0.26
Uniform Delay, d1	95.5	95.2	86.1		114.3	111.1	95.3	34.5	15.6	108.9	37.0	32.2
Progression Factor	1.00	1.00	1.00		1.00	1.00	1.22	0.62	1.00	1.06	1.00	1.79
Incremental Delay, d2	15.8	14.0	0.8		4.6	0.1	9.9	1.5	0.0	12.3	0.7	0.8
Delay (s)	111.3	109.2	86.9		118.9	111.2	125.7	22.8	15.6	128.3	37.8	58.3
Level of Service	F	F	F		F	F	F	C	B	F	D	E
Approach Delay (s)		104.6			115.6			31.6			46.1	
Approach LOS		F			F			C			D	

Intersection Summary			
HCM 2000 Control Delay	44.8	HCM 2000 Level of Service	D
HCM 2000 Volume to Capacity ratio	0.86		
Actuated Cycle Length (s)	240.0	Sum of lost time (s)	22.0
Intersection Capacity Utilization	94.5%	ICU Level of Service	F
Analysis Period (min)	15		

c Critical Lane Group

Intersection	
Int Delay, s/veh	0.2

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Vol, veh/h	5	295	795	40	5	0
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	-	-	0	-
Veh in Median Storage, #	-	0	0	-	0	-
Grade, %	-	0	0	-	0	-
Peak Hour Factor	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	5	321	864	43	5	0

Major/Minor	Major1		Major2		Minor2	
Conflicting Flow All	908	0	-	0	1218	886
Stage 1	-	-	-	-	886	-
Stage 2	-	-	-	-	332	-
Critical Hdwy	4.12	-	-	-	6.42	6.22
Critical Hdwy Stg 1	-	-	-	-	5.42	-
Critical Hdwy Stg 2	-	-	-	-	5.42	-
Follow-up Hdwy	2.218	-	-	-	3.518	3.318
Pot Cap-1 Maneuver	750	-	-	-	199	343
Stage 1	-	-	-	-	403	-
Stage 2	-	-	-	-	727	-
Platoon blocked, %		-	-	-		
Mov Cap-1 Maneuver	750	-	-	-	197	343
Mov Cap-2 Maneuver	-	-	-	-	197	-
Stage 1	-	-	-	-	403	-
Stage 2	-	-	-	-	721	-

Approach	EB	WB	SB
HCM Control Delay, s	0.2	0	23.8
HCM LOS			C

Minor Lane/Major Mvmt	EBL	EBT	WBT	WBR	SBLn1
Capacity (veh/h)	750	-	-	-	197
HCM Lane V/C Ratio	0.007	-	-	-	0.028
HCM Control Delay (s)	9.8	0	-	-	23.8
HCM Lane LOS	A	A	-	-	C
HCM 95th %tile Q(veh)	0	-	-	-	0.1

Intersection	
Int Delay, s/veh	0.1

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Vol, veh/h	10	315	670	25	0	0
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	-	-	0	-
Veh in Median Storage, #	-	0	0	-	0	-
Grade, %	-	0	0	-	0	-
Peak Hour Factor	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	11	342	728	27	0	0

Major/Minor	Major1		Major2		Minor2	
Conflicting Flow All	755	0	-	0	1106	742
Stage 1	-	-	-	-	742	-
Stage 2	-	-	-	-	364	-
Critical Hdwy	4.12	-	-	-	6.42	6.22
Critical Hdwy Stg 1	-	-	-	-	5.42	-
Critical Hdwy Stg 2	-	-	-	-	5.42	-
Follow-up Hdwy	2.218	-	-	-	3.518	3.318
Pot Cap-1 Maneuver	855	-	-	-	233	416
Stage 1	-	-	-	-	471	-
Stage 2	-	-	-	-	703	-
Platoon blocked, %		-	-	-		
Mov Cap-1 Maneuver	855	-	-	-	229	416
Mov Cap-2 Maneuver	-	-	-	-	229	-
Stage 1	-	-	-	-	471	-
Stage 2	-	-	-	-	692	-

Approach	EB	WB	SB
HCM Control Delay, s	0.3	0	0
HCM LOS			A

Minor Lane/Major Mvmt	EBL	EBT	WBT	WBR	SBLn1
Capacity (veh/h)	855	-	-	-	-
HCM Lane V/C Ratio	0.013	-	-	-	-
HCM Control Delay (s)	9.3	0	-	-	0
HCM Lane LOS	A	A	-	-	A
HCM 95th %tile Q(veh)	0	-	-	-	-

Intersection	
Int Delay, s/veh	1.7

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Vol, veh/h	90	0	75	200	0	5
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	0	-	0	-
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	98	0	82	217	0	5

Major/Minor	Major1		Major2		Minor1	
Conflicting Flow All	0	0	98	0	478	98
Stage 1	-	-	-	-	98	-
Stage 2	-	-	-	-	380	-
Critical Hdwy	-	-	4.12	-	6.42	6.22
Critical Hdwy Stg 1	-	-	-	-	5.42	-
Critical Hdwy Stg 2	-	-	-	-	5.42	-
Follow-up Hdwy	-	-	2.218	-	3.518	3.318
Pot Cap-1 Maneuver	-	-	1495	-	546	958
Stage 1	-	-	-	-	926	-
Stage 2	-	-	-	-	691	-
Platoon blocked, %	-	-		-		
Mov Cap-1 Maneuver	-	-	1495	-	516	958
Mov Cap-2 Maneuver	-	-	-	-	516	-
Stage 1	-	-	-	-	926	-
Stage 2	-	-	-	-	653	-

Approach	EB	WB	NB
HCM Control Delay, s	0	2.1	8.8
HCM LOS			A

Minor Lane/Major Mvmt	NBLn1	EBT	EBR	WBL	WBT
Capacity (veh/h)	958	-	-	1495	-
HCM Lane V/C Ratio	0.006	-	-	0.055	-
HCM Control Delay (s)	8.8	-	-	7.5	-
HCM Lane LOS	A	-	-	A	-
HCM 95th %tile Q(veh)	0	-	-	0.2	-

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	750	650	10	230	415	540	55	345	130	630	350	655
Number	7	4	14	3	8	18	5	2	12	1	6	16
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1863	1863	1900	1863	1863	1863	1863	1863	1900	1863	1863	1863
Adj Flow Rate, veh/h	815	707	11	250	451	533	60	375	18	685	380	447
Adj No. of Lanes	2	3	0	2	3	2	1	2	0	2	2	2
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Percent Heavy Veh, %	2	2	2	2	2	2	2	2	2	2	2	2
Cap, veh/h	896	1876	29	318	995	1153	78	523	25	751	1154	1631
Arrive On Green	0.26	0.36	0.36	0.09	0.20	0.20	0.04	0.15	0.15	0.22	0.33	0.33
Sat Flow, veh/h	3442	5159	80	3442	5085	2787	1774	3439	165	3442	3539	2776
Grp Volume(v), veh/h	815	464	254	250	451	533	60	192	201	685	380	447
Grp Sat Flow(s),veh/h/ln	1721	1695	1849	1721	1695	1393	1774	1770	1834	1721	1770	1388
Q Serve(g_s), s	30.4	13.4	13.4	9.4	10.4	18.4	4.4	13.7	13.8	25.7	10.7	10.5
Cycle Q Clear(g_c), s	30.4	13.4	13.4	9.4	10.4	18.4	4.4	13.7	13.8	25.7	10.7	10.5
Prop In Lane	1.00		0.04	1.00		1.00	1.00		0.09	1.00		1.00
Lane Grp Cap(c), veh/h	896	1233	672	318	995	1153	78	269	279	751	1154	1631
V/C Ratio(X)	0.91	0.38	0.38	0.78	0.45	0.46	0.77	0.72	0.72	0.91	0.33	0.27
Avail Cap(c_a), veh/h	1039	1233	672	935	1458	1407	509	628	650	831	1154	1631
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	47.5	31.1	31.1	58.8	47.0	28.1	62.7	53.4	53.5	50.6	33.7	13.5
Incr Delay (d2), s/veh	10.6	0.2	0.4	4.3	0.3	0.3	14.3	3.5	3.5	13.5	0.2	0.1
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	15.8	6.3	6.9	4.7	4.9	7.1	2.5	6.9	7.3	13.7	5.3	4.0
LnGrp Delay(d),s/veh	58.1	31.3	31.4	63.1	47.4	28.4	77.0	57.0	57.0	64.0	33.9	13.6
LnGrp LOS	E	C	C	E	D	C	E	E	E	E	C	B
Approach Vol, veh/h		1533			1234			453			1512	
Approach Delay, s/veh		45.5			42.4			59.6			41.5	
Approach LOS		D			D			E			D	

Timer	1	2	3	4	5	6	7	8
Assigned Phs	1	2	3	4	5	6	7	8
Phs Duration (G+Y+Rc), s	33.9	26.2	18.3	54.2	10.8	49.2	40.5	31.9
Change Period (Y+Rc), s	5.0	6.0	6.0	6.0	5.0	6.0	6.0	6.0
Max Green Setting (Gmax), s	32.0	47.0	36.0	42.0	38.0	41.0	40.0	38.0
Max Q Clear Time (g_c+I1), s	27.7	15.8	11.4	15.4	6.4	12.7	32.4	20.4
Green Ext Time (p_c), s	1.2	3.3	0.8	12.0	0.1	7.8	2.1	5.6

Intersection Summary	
HCM 2010 Ctrl Delay	44.8
HCM 2010 LOS	D

Notes

User approved changes to right turn type.

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	105	170	65	180	75	295	35	810	120	320	1100	55
Number	3	8	18	7	4	14	5	2	12	1	6	16
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1863	1863	1900	1863	1863	1863	1863	1863	1900	1863	1863	1900
Adj Flow Rate, veh/h	114	185	59	196	82	69	38	880	116	348	1196	57
Adj No. of Lanes	1	1	0	1	1	1	1	3	0	1	3	0
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Percent Heavy Veh, %	2	2	2	2	2	2	2	2	2	2	2	2
Cap, veh/h	434	440	140	319	606	515	48	1249	164	391	2327	111
Arrive On Green	0.33	0.33	0.33	0.33	0.33	0.33	0.03	0.27	0.27	0.22	0.47	0.47
Sat Flow, veh/h	1231	1355	432	1131	1863	1583	1774	4550	597	1774	4974	237
Grp Volume(v), veh/h	114	0	244	196	82	69	38	655	341	348	815	438
Grp Sat Flow(s),veh/h/ln	1231	0	1787	1131	1863	1583	1774	1695	1757	1774	1695	1821
Q Serve(g_s), s	7.2	0.0	10.7	16.4	3.1	3.1	2.1	17.4	17.5	19.0	16.9	16.9
Cycle Q Clear(g_c), s	10.3	0.0	10.7	27.1	3.1	3.1	2.1	17.4	17.5	19.0	16.9	16.9
Prop In Lane	1.00		0.24	1.00		1.00	1.00		0.34	1.00		0.13
Lane Grp Cap(c), veh/h	434	0	581	319	606	515	48	930	482	391	1586	852
V/C Ratio(X)	0.26	0.00	0.42	0.61	0.14	0.13	0.79	0.70	0.71	0.89	0.51	0.51
Avail Cap(c_a), veh/h	636	0	874	505	912	775	354	982	509	780	1795	964
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	0.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	27.5	0.0	26.4	37.0	23.8	23.8	48.4	32.7	32.7	37.8	18.7	18.7
Incr Delay (d2), s/veh	0.3	0.0	0.5	1.9	0.1	0.1	23.8	2.2	4.2	7.0	0.3	0.5
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	2.5	0.0	5.4	5.3	1.6	1.4	1.4	8.4	9.0	10.0	7.9	8.5
LnGrp Delay(d),s/veh	27.8	0.0	26.9	38.9	23.9	23.9	72.2	34.8	36.9	44.8	18.9	19.2
LnGrp LOS	C		C	D	C	C	E	C	D	D	B	B
Approach Vol, veh/h		358			347			1034			1601	
Approach Delay, s/veh		27.2			32.4			36.9			24.6	
Approach LOS		C			C			D			C	

Timer	1	2	3	4	5	6	7	8
Assigned Phs	1	2		4	5	6		8
Phs Duration (G+Y+Rc), s	28.1	33.5		38.6	8.7	52.8		38.6
Change Period (Y+Rc), s	6.0	6.0		6.0	6.0	6.0		6.0
Max Green Setting (Gmax), s	44.0	29.0		49.0	20.0	53.0		49.0
Max Q Clear Time (g_c+I1), s	21.0	19.5		29.1	4.1	18.9		12.7
Green Ext Time (p_c), s	1.0	8.0		3.5	0.0	21.7		3.8

Intersection Summary		
HCM 2010 Ctrl Delay		29.5
HCM 2010 LOS		C

Intersection	
Int Delay, s/veh	8.3

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Vol, veh/h	5	5	145	5	10	210
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	-	-	0	-
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	5	5	158	5	11	228

Major/Minor	Major1		Major2		Minor1	
Conflicting Flow All	0	0	11	0	329	8
Stage 1	-	-	-	-	8	-
Stage 2	-	-	-	-	321	-
Critical Hdwy	-	-	4.12	-	6.42	6.22
Critical Hdwy Stg 1	-	-	-	-	5.42	-
Critical Hdwy Stg 2	-	-	-	-	5.42	-
Follow-up Hdwy	-	-	2.218	-	3.518	3.318
Pot Cap-1 Maneuver	-	-	1608	-	665	1074
Stage 1	-	-	-	-	1015	-
Stage 2	-	-	-	-	735	-
Platoon blocked, %	-	-		-		
Mov Cap-1 Maneuver	-	-	1608	-	599	1074
Mov Cap-2 Maneuver	-	-	-	-	599	-
Stage 1	-	-	-	-	1015	-
Stage 2	-	-	-	-	662	-

Approach	EB	WB	NB
HCM Control Delay, s	0	7.2	9.5
HCM LOS			A

Minor Lane/Major Mvmt	NBLn1	EBT	EBR	WBL	WBT
Capacity (veh/h)	1037	-	-	1608	-
HCM Lane V/C Ratio	0.231	-	-	0.098	-
HCM Control Delay (s)	9.5	-	-	7.5	0
HCM Lane LOS	A	-	-	A	A
HCM 95th %tile Q(veh)	0.9	-	-	0.3	-

Intersection	
Int Delay, s/veh	4.8

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Vol, veh/h	185	680	0	0	420	20	0	0	0	20	0	135
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Free	Free	Stop	Stop	Stop	Stop	Stop	Stop
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	-	-	-	-	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	92	92	92	92	92	92	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2	2	2	2	2	2	2
Mvmt Flow	201	739	0	0	457	22	0	0	0	22	0	147

Major/Minor	Major1			Major2			Minor1			Minor2		
Conflicting Flow All	478	0	0	739	0	0	1682	1619	739	1608	1608	467
Stage 1	-	-	-	-	-	-	1141	1141	-	467	467	-
Stage 2	-	-	-	-	-	-	541	478	-	1141	1141	-
Critical Hdwy	4.12	-	-	4.12	-	-	7.12	6.52	6.22	7.12	6.52	6.22
Critical Hdwy Stg 1	-	-	-	-	-	-	6.12	5.52	-	6.12	5.52	-
Critical Hdwy Stg 2	-	-	-	-	-	-	6.12	5.52	-	6.12	5.52	-
Follow-up Hdwy	2.218	-	-	2.218	-	-	3.518	4.018	3.318	3.518	4.018	3.318
Pot Cap-1 Maneuver	1084	-	-	867	-	-	75	103	417	84	105	596
Stage 1	-	-	-	-	-	-	244	275	-	576	562	-
Stage 2	-	-	-	-	-	-	525	556	-	244	275	-
Platoon blocked, %		-	-		-	-						
Mov Cap-1 Maneuver	1084	-	-	867	-	-	43	71	417	63	72	596
Mov Cap-2 Maneuver	-	-	-	-	-	-	43	71	-	63	72	-
Stage 1	-	-	-	-	-	-	167	188	-	395	562	-
Stage 2	-	-	-	-	-	-	396	556	-	167	188	-

Approach	EB	WB	NB	SB
HCM Control Delay, s	1.9	0	0	34.4
HCM LOS			A	D

Minor Lane/Major Mvmt	NBLn1	EBL	EBT	EBR	WBL	WBT	WBR	SBLn1
Capacity (veh/h)	-	1084	-	-	867	-	-	285
HCM Lane V/C Ratio	-	0.186	-	-	-	-	-	0.591
HCM Control Delay (s)	0	9.1	0	-	0	-	-	34.4
HCM Lane LOS	A	A	A	-	A	-	-	D
HCM 95th %tile Q(veh)	-	0.7	-	-	0	-	-	3.5

Intersection	
Int Delay, s/veh	0.6

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Vol, veh/h	740	15	15	430	10	20
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	50	-	0	-
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	804	16	16	467	11	22

Major/Minor	Major1		Major2		Minor1	
Conflicting Flow All	0	0	821	0	1313	813
Stage 1	-	-	-	-	813	-
Stage 2	-	-	-	-	500	-
Critical Hdwy	-	-	4.12	-	6.42	6.22
Critical Hdwy Stg 1	-	-	-	-	5.42	-
Critical Hdwy Stg 2	-	-	-	-	5.42	-
Follow-up Hdwy	-	-	2.218	-	3.518	3.318
Pot Cap-1 Maneuver	-	-	808	-	175	378
Stage 1	-	-	-	-	436	-
Stage 2	-	-	-	-	609	-
Platoon blocked, %	-	-		-		
Mov Cap-1 Maneuver	-	-	808	-	172	378
Mov Cap-2 Maneuver	-	-	-	-	172	-
Stage 1	-	-	-	-	436	-
Stage 2	-	-	-	-	597	-

Approach	EB	WB	NB
HCM Control Delay, s	0	0.3	20.2
HCM LOS			C

Minor Lane/Major Mvmt	NBLn1	EBT	EBR	WBL	WBT
Capacity (veh/h)	270	-	-	808	-
HCM Lane V/C Ratio	0.121	-	-	0.02	-
HCM Control Delay (s)	20.2	-	-	9.5	-
HCM Lane LOS	C	-	-	A	-
HCM 95th %tile Q(veh)	0.4	-	-	0.1	-

Intersection	
Int Delay, s/veh	0.1

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Vol, veh/h	5	730	0	0	435	5	0	0	0	0	0	0
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Free	Free	Stop	Stop	Stop	Stop	Stop	Stop
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	-	-	-	-	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	92	92	92	92	92	92	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2	2	2	2	2	2	2
Mvmt Flow	5	793	0	0	473	5	0	0	0	0	0	0

Major/Minor	Major1			Major2			Minor1			Minor2		
Conflicting Flow All	478	0	0	793	0	0	1280	1282	793	1280	1280	476
Stage 1	-	-	-	-	-	-	804	804	-	476	476	-
Stage 2	-	-	-	-	-	-	476	478	-	804	804	-
Critical Hdwy	4.12	-	-	4.12	-	-	7.12	6.52	6.22	7.12	6.52	6.22
Critical Hdwy Stg 1	-	-	-	-	-	-	6.12	5.52	-	6.12	5.52	-
Critical Hdwy Stg 2	-	-	-	-	-	-	6.12	5.52	-	6.12	5.52	-
Follow-up Hdwy	2.218	-	-	2.218	-	-	3.518	4.018	3.318	3.518	4.018	3.318
Pot Cap-1 Maneuver	1084	-	-	828	-	-	143	165	389	143	166	589
Stage 1	-	-	-	-	-	-	377	396	-	570	557	-
Stage 2	-	-	-	-	-	-	570	556	-	377	396	-
Platoon blocked, %		-	-		-	-						
Mov Cap-1 Maneuver	1084	-	-	828	-	-	142	164	389	142	165	589
Mov Cap-2 Maneuver	-	-	-	-	-	-	142	164	-	142	165	-
Stage 1	-	-	-	-	-	-	374	393	-	565	557	-
Stage 2	-	-	-	-	-	-	570	556	-	374	393	-

Approach	EB	WB	NB	SB
HCM Control Delay, s	0.1	0	0	0
HCM LOS			A	A

Minor Lane/Major Mvmt	NBLn1	EBL	EBT	EBR	WBL	WBT	WBR	SBLn1
Capacity (veh/h)	-	1084	-	-	828	-	-	-
HCM Lane V/C Ratio	-	0.005	-	-	-	-	-	-
HCM Control Delay (s)	0	8.3	0	-	0	-	-	0
HCM Lane LOS	A	A	A	-	A	-	-	A
HCM 95th %tile Q(veh)	-	0	-	-	0	-	-	-

Intersection	
Int Delay, s/veh	0.8

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Vol, veh/h	0	760	435	5	30	5
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	-	-	0	-
Veh in Median Storage, #	-	0	0	-	0	-
Grade, %	-	0	0	-	0	-
Peak Hour Factor	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	0	826	473	5	33	5

Major/Minor	Major1		Major2		Minor2	
Conflicting Flow All	478	0	-	0	1302	476
Stage 1	-	-	-	-	476	-
Stage 2	-	-	-	-	826	-
Critical Hdwy	4.12	-	-	-	6.42	6.22
Critical Hdwy Stg 1	-	-	-	-	5.42	-
Critical Hdwy Stg 2	-	-	-	-	5.42	-
Follow-up Hdwy	2.218	-	-	-	3.518	3.318
Pot Cap-1 Maneuver	1084	-	-	-	177	589
Stage 1	-	-	-	-	625	-
Stage 2	-	-	-	-	430	-
Platoon blocked, %		-	-	-		
Mov Cap-1 Maneuver	1084	-	-	-	177	589
Mov Cap-2 Maneuver	-	-	-	-	177	-
Stage 1	-	-	-	-	625	-
Stage 2	-	-	-	-	430	-

Approach	EB	WB	SB
HCM Control Delay, s	0	0	27.6
HCM LOS			D

Minor Lane/Major Mvmt	EBL	EBT	WBT	WBR	SBLn1
Capacity (veh/h)	1084	-	-	-	197
HCM Lane V/C Ratio	-	-	-	-	0.193
HCM Control Delay (s)	0	-	-	-	27.6
HCM Lane LOS	A	-	-	-	D
HCM 95th %tile Q(veh)	0	-	-	-	0.7

Intersection	
Int Delay, s/veh	2.4

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Vol, veh/h	10	765	0	0	415	20	0	0	0	50	0	20
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Free	Free	Stop	Stop	Stop	Stop	Stop	Stop
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	-	-	-	-	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	92	92	92	92	92	92	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2	2	2	2	2	2	2
Mvmt Flow	11	832	0	0	451	22	0	0	0	54	0	22

Major/Minor	Major1			Major2			Minor1			Minor2		
Conflicting Flow All	473	0	0	832	0	0	1326	1326	832	1315	1315	462
Stage 1	-	-	-	-	-	-	853	853	-	462	462	-
Stage 2	-	-	-	-	-	-	473	473	-	853	853	-
Critical Hdwy	4.12	-	-	4.12	-	-	7.12	6.52	6.22	7.12	6.52	6.22
Critical Hdwy Stg 1	-	-	-	-	-	-	6.12	5.52	-	6.12	5.52	-
Critical Hdwy Stg 2	-	-	-	-	-	-	6.12	5.52	-	6.12	5.52	-
Follow-up Hdwy	2.218	-	-	2.218	-	-	3.518	4.018	3.318	3.518	4.018	3.318
Pot Cap-1 Maneuver	1089	-	-	801	-	-	133	156	369	135	158	600
Stage 1	-	-	-	-	-	-	354	376	-	580	565	-
Stage 2	-	-	-	-	-	-	572	558	-	354	376	-
Platoon blocked, %		-	-		-	-						
Mov Cap-1 Maneuver	1089	-	-	801	-	-	126	153	369	133	155	600
Mov Cap-2 Maneuver	-	-	-	-	-	-	126	153	-	133	155	-
Stage 1	-	-	-	-	-	-	347	369	-	569	565	-
Stage 2	-	-	-	-	-	-	551	558	-	347	369	-

Approach	EB	WB	NB	SB
HCM Control Delay, s	0.1	0	0	41.9
HCM LOS			A	E

Minor Lane/Major Mvmt	NBLn1	EBL	EBT	EBR	WBL	WBT	WBR	SBLn1
Capacity (veh/h)	-	1089	-	-	801	-	-	171
HCM Lane V/C Ratio	-	0.01	-	-	-	-	-	0.445
HCM Control Delay (s)	0	8.3	0	-	0	-	-	41.9
HCM Lane LOS	A	A	A	-	A	-	-	E
HCM 95th %tile Q(veh)	-	0	-	-	0	-	-	2.1

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	50	335	485	155	215	250	205	715	100	170	910	30
Number	7	4	14	3	8	18	5	2	12	1	6	16
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1863	1863	1900	1863	1863	1863	1863	1863	1863	1863	1863	1863
Adj Flow Rate, veh/h	54	364	341	168	234	74	223	777	30	185	989	8
Adj No. of Lanes	1	2	0	1	1	1	1	2	1	1	2	1
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Percent Heavy Veh, %	2	2	2	2	2	2	2	2	2	2	2	2
Cap, veh/h	70	449	402	195	603	513	252	1163	520	214	1087	486
Arrive On Green	0.04	0.25	0.25	0.11	0.32	0.32	0.14	0.33	0.33	0.12	0.31	0.31
Sat Flow, veh/h	1774	1770	1583	1774	1863	1583	1774	3539	1583	1774	3539	1583
Grp Volume(v), veh/h	54	364	341	168	234	74	223	777	30	185	989	8
Grp Sat Flow(s),veh/h/ln	1774	1770	1583	1774	1863	1583	1774	1770	1583	1774	1770	1583
Q Serve(g_s), s	3.9	24.7	26.2	11.9	12.4	4.2	15.8	24.2	1.7	13.1	34.4	0.5
Cycle Q Clear(g_c), s	3.9	24.7	26.2	11.9	12.4	4.2	15.8	24.2	1.7	13.1	34.4	0.5
Prop In Lane	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Lane Grp Cap(c), veh/h	70	449	402	195	603	513	252	1163	520	214	1087	486
V/C Ratio(X)	0.77	0.81	0.85	0.86	0.39	0.14	0.89	0.67	0.06	0.86	0.91	0.02
Avail Cap(c_a), veh/h	374	636	569	249	603	513	360	1163	520	360	1133	507
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	60.9	44.9	45.5	56.1	33.5	30.7	53.9	37.0	29.4	55.3	42.7	30.9
Incr Delay (d2), s/veh	15.8	5.3	8.3	21.2	0.4	0.1	16.8	1.5	0.0	10.8	10.6	0.0
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	2.2	12.8	12.4	7.0	6.5	1.9	8.9	12.0	0.7	7.1	18.4	0.2
LnGrp Delay(d),s/veh	76.7	50.2	53.8	77.3	33.9	30.9	70.7	38.5	29.5	66.1	53.2	30.9
LnGrp LOS	E	D	D	E	C	C	E	D	C	E	D	C
Approach Vol, veh/h		759			476			1030			1182	
Approach Delay, s/veh		53.7			48.7			45.2			55.1	
Approach LOS		D			D			D			E	

Timer	1	2	3	4	5	6	7	8
Assigned Phs	1	2	3	4	5	6	7	8
Phs Duration (G+Y+Rc), s	21.4	48.1	20.0	38.5	24.2	45.3	11.1	47.5
Change Period (Y+Rc), s	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0
Max Green Setting (Gmax), s	26.0	41.0	18.0	46.0	26.0	41.0	27.0	37.0
Max Q Clear Time (g_c+I1), s	15.1	26.2	13.9	28.2	17.8	36.4	5.9	14.4
Green Ext Time (p_c), s	0.4	10.3	0.2	4.3	0.4	2.9	0.1	6.7

Intersection Summary	
HCM 2010 Ctrl Delay	51.0
HCM 2010 LOS	D

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	230	225	250	15	220	150	215	870	15	350	1545	220
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	6.0	4.0	4.0	6.0
Lane Util. Factor	0.91	0.91	1.00	1.00	1.00	0.88	0.97	0.91	1.00	0.97	0.91	1.00
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	0.99	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	1610	3345	1583	1770	1863	2787	3433	5085	1583	3433	5085	1583
Flt Permitted	0.95	0.99	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)	1610	3345	1583	1770	1863	2787	3433	5085	1583	3433	5085	1583
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	250	245	272	16	239	163	234	946	16	380	1679	239
RTOR Reduction (vph)	0	0	68	0	0	113	0	0	8	0	0	73
Lane Group Flow (vph)	160	335	204	16	239	50	234	946	8	380	1679	166
Turn Type	Split	NA	Perm	Split	NA	Perm	Prot	NA	Perm	Prot	NA	Perm
Protected Phases	3	3		4	4		5	2		1	6	
Permitted Phases			3			4			2			6
Actuated Green, G (s)	36.9	36.9	36.9	34.1	34.1	34.1	21.6	112.9	112.9	31.1	122.4	122.4
Effective Green, g (s)	38.9	38.9	38.9	36.1	36.1	36.1	23.6	115.9	113.9	33.1	125.4	123.4
Actuated g/C Ratio	0.16	0.16	0.16	0.15	0.15	0.15	0.10	0.48	0.47	0.14	0.52	0.51
Clearance Time (s)	6.0	6.0	6.0	6.0	6.0	6.0	6.0	7.0	7.0	6.0	7.0	7.0
Vehicle Extension (s)	5.0	5.0	5.0	5.0	5.0	5.0	3.0	5.0	5.0	3.0	5.0	5.0
Lane Grp Cap (vph)	260	542	256	266	280	419	337	2455	751	473	2656	813
v/s Ratio Prot	0.10	0.10		0.01	c0.13		0.07	0.19		c0.11	c0.33	
v/s Ratio Perm			c0.13			0.02			0.00			0.10
v/c Ratio	0.62	0.62	0.80	0.06	0.85	0.12	0.69	0.39	0.01	0.80	0.63	0.20
Uniform Delay, d1	93.6	93.6	96.8	87.4	99.4	88.2	104.7	39.4	33.3	100.3	40.9	31.6
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.14	0.93	1.18
Incremental Delay, d2	6.1	3.0	17.8	0.2	23.3	0.3	6.1	0.5	0.0	9.4	1.1	0.6
Delay (s)	99.7	96.7	114.6	87.6	122.6	88.5	110.8	39.9	33.3	123.7	39.0	37.9
Level of Service	F	F	F	F	F	F	F	D	C	F	D	D
Approach Delay (s)		103.6			108.0			53.7			52.9	
Approach LOS		F			F			D			D	

Intersection Summary			
HCM 2000 Control Delay	66.3	HCM 2000 Level of Service	E
HCM 2000 Volume to Capacity ratio	0.73		
Actuated Cycle Length (s)	240.0	Sum of lost time (s)	16.0
Intersection Capacity Utilization	69.5%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	440	40	135	35	35	25	125	1510	60	75	2635	385
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		6.0	4.0	6.0	5.0	6.0	4.0	5.0	7.0
Lane Util. Factor	0.95	0.95	1.00		1.00	1.00	1.00	0.91	1.00	1.00	0.91	1.00
Frpb, ped/bikes	1.00	1.00	0.91		1.00	1.00	1.00	1.00	0.83	1.00	1.00	0.97
Flpb, ped/bikes	1.00	1.00	1.00		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Frt	1.00	1.00	0.85		1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	0.96	1.00		0.98	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	1681	1699	1434		1817	1583	1770	5085	1311	1770	5085	1536
Flt Permitted	0.95	0.96	1.00		0.98	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)	1681	1699	1434		1817	1583	1770	5085	1311	1770	5085	1536
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	478	43	147	38	38	27	136	1641	65	82	2864	418
RTOR Reduction (vph)	0	0	82	0	0	25	0	0	27	0	0	189
Lane Group Flow (vph)	258	263	65	0	76	2	136	1641	38	82	2864	229
Confl. Peds. (#/hr)			43						31			2
Turn Type	Split	NA	Perm	Split	NA	Perm	Prot	NA	Perm	Prot	NA	Perm
Protected Phases	4	4		3	3		5	2		1	6	
Permitted Phases			4			3			2			6
Actuated Green, G (s)	44.1	44.1	44.1		15.4	15.4	25.1	140.6	140.6	15.9	131.4	131.4
Effective Green, g (s)	44.1	44.1	44.1		15.4	17.4	25.1	142.6	141.6	17.9	133.4	131.4
Actuated g/C Ratio	0.18	0.18	0.18		0.06	0.07	0.10	0.59	0.59	0.07	0.56	0.55
Clearance Time (s)	5.0	5.0	5.0		6.0	6.0	6.0	7.0	7.0	6.0	7.0	7.0
Vehicle Extension (s)	4.0	4.0	4.0		3.0	3.0	5.0	6.0	6.0	3.0	6.0	6.0
Lane Grp Cap (vph)	308	312	263		116	114	185	3021	773	132	2826	840
v/s Ratio Prot	0.15	c0.15			c0.04		c0.08	0.32		0.05	c0.56	
v/s Ratio Perm			0.05			0.00			0.03			0.15
v/c Ratio	0.84	0.84	0.25		0.66	0.02	0.74	0.54	0.05	0.62	1.01	0.27
Uniform Delay, d1	94.5	94.6	83.8		109.7	103.4	104.2	29.2	20.8	107.8	53.3	28.9
Progression Factor	1.00	1.00	1.00		1.00	1.00	0.90	1.15	2.12	0.98	0.99	1.44
Incremental Delay, d2	18.4	18.9	0.7		12.5	0.1	7.1	0.3	0.0	8.7	20.3	0.8
Delay (s)	112.9	113.6	84.5		122.3	103.4	100.5	33.7	44.2	113.8	73.1	42.4
Level of Service	F	F	F		F	F	F	C	D	F	E	D
Approach Delay (s)		106.9			117.3			39.0			70.2	
Approach LOS		F			F			D			E	

Intersection Summary			
HCM 2000 Control Delay	65.5	HCM 2000 Level of Service	E
HCM 2000 Volume to Capacity ratio	0.92		
Actuated Cycle Length (s)	240.0	Sum of lost time (s)	22.0
Intersection Capacity Utilization	99.4%	ICU Level of Service	F
Analysis Period (min)	15		

c Critical Lane Group

Intersection	
Int Delay, s/veh	1

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Vol, veh/h	0	810	430	5	35	5
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	-	-	0	-
Veh in Median Storage, #	-	0	0	-	0	-
Grade, %	-	0	0	-	0	-
Peak Hour Factor	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	0	880	467	5	38	5

Major/Minor	Major1		Major2		Minor2	
Conflicting Flow All	473	0	-	0	1350	470
Stage 1	-	-	-	-	470	-
Stage 2	-	-	-	-	880	-
Critical Hdwy	4.12	-	-	-	6.42	6.22
Critical Hdwy Stg 1	-	-	-	-	5.42	-
Critical Hdwy Stg 2	-	-	-	-	5.42	-
Follow-up Hdwy	2.218	-	-	-	3.518	3.318
Pot Cap-1 Maneuver	1089	-	-	-	166	594
Stage 1	-	-	-	-	629	-
Stage 2	-	-	-	-	406	-
Platoon blocked, %		-	-	-		
Mov Cap-1 Maneuver	1089	-	-	-	166	594
Mov Cap-2 Maneuver	-	-	-	-	166	-
Stage 1	-	-	-	-	629	-
Stage 2	-	-	-	-	406	-

Approach	EB	WB	SB
HCM Control Delay, s	0	0	30.9
HCM LOS			D

Minor Lane/Major Mvmt	EBL	EBT	WBT	WBR	SBLn1
Capacity (veh/h)	1089	-	-	-	182
HCM Lane V/C Ratio	-	-	-	-	0.239
HCM Control Delay (s)	0	-	-	-	30.9
HCM Lane LOS	A	-	-	-	D
HCM 95th %tile Q(veh)	0	-	-	-	0.9

Intersection	
Int Delay, s/veh	0.6

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Vol, veh/h	0	695	435	0	20	10
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	-	-	0	-
Veh in Median Storage, #	-	0	0	-	0	-
Grade, %	-	0	0	-	0	-
Peak Hour Factor	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	0	755	473	0	22	11

Major/Minor	Major1		Major2		Minor2	
Conflicting Flow All	473	0	-	0	1228	473
Stage 1	-	-	-	-	473	-
Stage 2	-	-	-	-	755	-
Critical Hdwy	4.12	-	-	-	6.42	6.22
Critical Hdwy Stg 1	-	-	-	-	5.42	-
Critical Hdwy Stg 2	-	-	-	-	5.42	-
Follow-up Hdwy	2.218	-	-	-	3.518	3.318
Pot Cap-1 Maneuver	1089	-	-	-	197	591
Stage 1	-	-	-	-	627	-
Stage 2	-	-	-	-	464	-
Platoon blocked, %		-	-	-		
Mov Cap-1 Maneuver	1089	-	-	-	197	591
Mov Cap-2 Maneuver	-	-	-	-	197	-
Stage 1	-	-	-	-	627	-
Stage 2	-	-	-	-	464	-

Approach	EB	WB	SB
HCM Control Delay, s	0	0	21.3
HCM LOS			C

Minor Lane/Major Mvmt	EBL	EBT	WBT	WBR	SBLn1
Capacity (veh/h)	1089	-	-	-	253
HCM Lane V/C Ratio	-	-	-	-	0.129
HCM Control Delay (s)	0	-	-	-	21.3
HCM Lane LOS	A	-	-	-	C
HCM 95th %tile Q(veh)	0	-	-	-	0.4

Intersection	
Int Delay, s/veh	2

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Vol, veh/h	210	0	5	150	0	85
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	0	-	0	-
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	228	0	5	163	0	92

Major/Minor	Major1		Major2		Minor1	
Conflicting Flow All	0	0	228	0	402	228
Stage 1	-	-	-	-	228	-
Stage 2	-	-	-	-	174	-
Critical Hdwy	-	-	4.12	-	6.42	6.22
Critical Hdwy Stg 1	-	-	-	-	5.42	-
Critical Hdwy Stg 2	-	-	-	-	5.42	-
Follow-up Hdwy	-	-	2.218	-	3.518	3.318
Pot Cap-1 Maneuver	-	-	1340	-	604	811
Stage 1	-	-	-	-	810	-
Stage 2	-	-	-	-	856	-
Platoon blocked, %	-	-		-		
Mov Cap-1 Maneuver	-	-	1340	-	602	811
Mov Cap-2 Maneuver	-	-	-	-	602	-
Stage 1	-	-	-	-	810	-
Stage 2	-	-	-	-	853	-

Approach	EB	WB	NB
HCM Control Delay, s	0	0.2	10
HCM LOS			B

Minor Lane/Major Mvmt	NBLn1	EBT	EBR	WBL	WBT
Capacity (veh/h)	811	-	-	1340	-
HCM Lane V/C Ratio	0.114	-	-	0.004	-
HCM Control Delay (s)	10	-	-	7.7	-
HCM Lane LOS	B	-	-	A	-
HCM 95th %tile Q(veh)	0.4	-	-	0	-

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	680	700	5	120	860	540	5	105	15	435	140	465
Number	7	4	14	3	8	18	5	2	12	1	6	16
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1863	1863	1900	1863	1863	1863	1863	1863	1900	1863	1863	1863
Adj Flow Rate, veh/h	739	761	5	130	935	587	5	114	3	473	152	318
Adj No. of Lanes	2	3	0	2	3	2	1	2	0	2	2	2
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Percent Heavy Veh, %	2	2	2	2	2	2	2	2	2	2	2	2
Cap, veh/h	855	2379	16	206	1362	1196	9	335	9	556	890	1390
Arrive On Green	0.25	0.46	0.46	0.06	0.27	0.27	0.01	0.10	0.10	0.16	0.25	0.25
Sat Flow, veh/h	3442	5213	34	3442	5085	2787	1774	3524	92	3442	3539	2773
Grp Volume(v), veh/h	739	495	271	130	935	587	5	57	60	473	152	318
Grp Sat Flow(s),veh/h/ln	1721	1695	1857	1721	1695	1393	1774	1770	1846	1721	1770	1387
Q Serve(g_s), s	21.7	9.8	9.8	3.9	17.4	16.1	0.3	3.2	3.2	14.1	3.6	6.8
Cycle Q Clear(g_c), s	21.7	9.8	9.8	3.9	17.4	16.1	0.3	3.2	3.2	14.1	3.6	6.8
Prop In Lane	1.00		0.02	1.00		1.00	1.00		0.05	1.00		1.00
Lane Grp Cap(c), veh/h	855	1548	848	206	1362	1196	9	168	176	556	890	1390
V/C Ratio(X)	0.86	0.32	0.32	0.63	0.69	0.49	0.55	0.34	0.34	0.85	0.17	0.23
Avail Cap(c_a), veh/h	1237	1548	848	1237	1828	1452	201	636	664	716	1607	1952
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	38.0	18.3	18.3	48.6	34.7	21.8	52.5	44.7	44.7	43.1	30.9	14.9
Incr Delay (d2), s/veh	4.6	0.1	0.2	3.2	0.7	0.3	42.2	1.2	1.1	7.8	0.1	0.1
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	10.8	4.6	5.1	2.0	8.2	6.2	0.3	1.6	1.7	7.3	1.7	2.6
LnGrp Delay(d),s/veh	42.6	18.4	18.5	51.7	35.4	22.1	94.7	45.9	45.9	50.8	31.0	15.0
LnGrp LOS	D	B	B	D	D	C	F	D	D	D	C	B
Approach Vol, veh/h		1505			1652			122			943	
Approach Delay, s/veh		30.3			32.0			47.9			35.6	
Approach LOS		C			C			D			D	

Timer	1	2	3	4	5	6	7	8
Assigned Phs	1	2	3	4	5	6	7	8
Phs Duration (G+Y+Rc), s	23.1	16.1	12.3	54.3	6.5	32.6	32.3	34.3
Change Period (Y+Rc), s	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0
Max Green Setting (Gmax), s	22.0	38.0	38.0	38.0	12.0	48.0	38.0	38.0
Max Q Clear Time (g_c+I1), s	16.1	5.2	5.9	11.8	2.3	8.8	23.7	19.4
Green Ext Time (p_c), s	0.9	3.1	0.4	17.1	0.0	3.2	2.5	8.9

Intersection Summary	
HCM 2010 Ctrl Delay	32.6
HCM 2010 LOS	C

Notes

User approved changes to right turn type.

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	90	140	20	315	200	410	60	1130	475	275	580	75
Number	3	8	18	7	4	14	5	2	12	1	6	16
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1863	1863	1900	1863	1863	1863	1863	1863	1900	1863	1863	1900
Adj Flow Rate, veh/h	98	152	19	342	217	139	65	1228	462	299	630	69
Adj No. of Lanes	1	1	0	1	1	1	1	3	0	2	3	0
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Percent Heavy Veh, %	2	2	2	2	2	2	2	2	2	2	2	2
Cap, veh/h	347	590	74	422	677	576	84	1357	509	380	2028	220
Arrive On Green	0.36	0.36	0.36	0.36	0.36	0.36	0.05	0.37	0.37	0.11	0.44	0.44
Sat Flow, veh/h	1021	1624	203	1209	1863	1583	1774	3645	1367	3442	4658	505
Grp Volume(v), veh/h	98	0	171	342	217	139	65	1142	548	299	457	242
Grp Sat Flow(s),veh/h/ln	1021	0	1827	1209	1863	1583	1774	1695	1621	1721	1695	1774
Q Serve(g_s), s	9.0	0.0	7.7	32.4	9.8	7.2	4.2	37.4	37.5	9.9	10.3	10.5
Cycle Q Clear(g_c), s	18.8	0.0	7.7	40.1	9.8	7.2	4.2	37.4	37.5	9.9	10.3	10.5
Prop In Lane	1.00		0.11	1.00		1.00	1.00		0.84	1.00		0.28
Lane Grp Cap(c), veh/h	347	0	664	422	677	576	84	1262	604	380	1476	772
V/C Ratio(X)	0.28	0.00	0.26	0.81	0.32	0.24	0.77	0.90	0.91	0.79	0.31	0.31
Avail Cap(c_a), veh/h	351	0	670	426	684	581	257	1273	609	1028	1794	938
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	0.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	33.6	0.0	26.2	40.3	26.9	26.0	55.2	34.8	34.9	50.8	21.6	21.6
Incr Delay (d2), s/veh	0.4	0.0	0.2	11.2	0.3	0.2	13.8	9.3	17.4	3.6	0.1	0.2
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	2.6	0.0	3.9	12.1	5.1	3.2	2.4	19.1	19.7	4.9	4.8	5.2
LnGrp Delay(d),s/veh	34.1	0.0	26.4	51.5	27.1	26.2	68.9	44.1	52.3	54.4	21.7	21.9
LnGrp LOS	C		C	D	C	C	E	D	D	D	C	C
Approach Vol, veh/h		269			698			1755			998	
Approach Delay, s/veh		29.2			38.9			47.6			31.5	
Approach LOS		C			D			D			C	

Timer	1	2	3	4	5	6	7	8
Assigned Phs	1	2		4	5	6		8
Phs Duration (G+Y+Rc), s	18.9	49.6		48.6	11.6	57.0		48.6
Change Period (Y+Rc), s	6.0	6.0		6.0	6.0	6.0		6.0
Max Green Setting (Gmax), s	35.0	44.0		43.0	17.0	62.0		43.0
Max Q Clear Time (g_c+I1), s	11.9	39.5		42.1	6.2	12.5		20.8
Green Ext Time (p_c), s	1.0	4.1		0.5	0.1	30.4		4.9

Intersection Summary			
HCM 2010 Ctrl Delay			40.3
HCM 2010 LOS			D

Intersection	
Int Delay, s/veh	0

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Vol, veh/h	0	0	215	5	5	95
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	-	-	0	-
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	0	0	234	5	5	103

Major/Minor	Major1		Major2		Minor1	
Conflicting Flow All	0	0	0	0	473	0
Stage 1	-	-	-	-	0	-
Stage 2	-	-	-	-	473	-
Critical Hdwy	-	-	4.12	-	6.42	6.22
Critical Hdwy Stg 1	-	-	-	-	5.42	-
Critical Hdwy Stg 2	-	-	-	-	5.42	-
Follow-up Hdwy	-	-	2.218	-	3.518	3.318
Pot Cap-1 Maneuver	-	-	-	-	550	-
Stage 1	-	-	-	-	-	-
Stage 2	-	-	-	-	627	-
Platoon blocked, %	-	-		-		
Mov Cap-1 Maneuver	-	-	-	-	550	-
Mov Cap-2 Maneuver	-	-	-	-	550	-
Stage 1	-	-	-	-	-	-
Stage 2	-	-	-	-	627	-

Approach	EB	WB	NB
HCM Control Delay, s	0		
HCM LOS			-

Minor Lane/Major Mvmt	NBLn1	EBT	EBR	WBL	WBT
Capacity (veh/h)	-	-	-	-	-
HCM Lane V/C Ratio	-	-	-	-	-
HCM Control Delay (s)	-	-	-	-	-
HCM Lane LOS	-	-	-	-	-
HCM 95th %tile Q(veh)	-	-	-	-	-

Intersection	
Int Delay, s/veh	7.7

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Vol, veh/h	80	320	0	0	800	20	0	0	0	15	0	195
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Free	Free	Stop	Stop	Stop	Stop	Stop	Stop
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	-	-	-	-	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	92	92	92	92	92	92	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2	2	2	2	2	2	2
Mvmt Flow	87	348	0	0	870	22	0	0	0	16	0	212

Major/Minor	Major1			Major2			Minor1			Minor2		
Conflicting Flow All	891	0	0	348	0	0	1508	1413	348	1402	1402	880
Stage 1	-	-	-	-	-	-	522	522	-	880	880	-
Stage 2	-	-	-	-	-	-	986	891	-	522	522	-
Critical Hdwy	4.12	-	-	4.12	-	-	7.12	6.52	6.22	7.12	6.52	6.22
Critical Hdwy Stg 1	-	-	-	-	-	-	6.12	5.52	-	6.12	5.52	-
Critical Hdwy Stg 2	-	-	-	-	-	-	6.12	5.52	-	6.12	5.52	-
Follow-up Hdwy	2.218	-	-	2.218	-	-	3.518	4.018	3.318	3.518	4.018	3.318
Pot Cap-1 Maneuver	761	-	-	1211	-	-	99	138	695	117	140	346
Stage 1	-	-	-	-	-	-	538	531	-	342	365	-
Stage 2	-	-	-	-	-	-	298	361	-	538	531	-
Platoon blocked, %		-	-		-	-						
Mov Cap-1 Maneuver	761	-	-	1211	-	-	34	118	695	104	120	346
Mov Cap-2 Maneuver	-	-	-	-	-	-	34	118	-	104	120	-
Stage 1	-	-	-	-	-	-	462	456	-	293	365	-
Stage 2	-	-	-	-	-	-	115	361	-	462	456	-

Approach	EB	WB	NB	SB
HCM Control Delay, s	2.1	0	0	48.1
HCM LOS			A	E

Minor Lane/Major Mvmt	NBLn1	EBL	EBT	EBR	WBL	WBT	WBR	SBLn1
Capacity (veh/h)	-	761	-	-	1211	-	-	297
HCM Lane V/C Ratio	-	0.114	-	-	-	-	-	0.769
HCM Control Delay (s)	0	10.3	0	-	0	-	-	48.1
HCM Lane LOS	A	B	A	-	A	-	-	E
HCM 95th %tile Q(veh)	-	0.4	-	-	0	-	-	5.9

Intersection	
Int Delay, s/veh	0.4

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Vol, veh/h	325	10	25	845	10	5
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	50	-	0	-
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	353	11	27	918	11	5

Major/Minor	Major1		Major2		Minor1	
Conflicting Flow All	0	0	364	0	1332	359
Stage 1	-	-	-	-	359	-
Stage 2	-	-	-	-	973	-
Critical Hdwy	-	-	4.12	-	6.42	6.22
Critical Hdwy Stg 1	-	-	-	-	5.42	-
Critical Hdwy Stg 2	-	-	-	-	5.42	-
Follow-up Hdwy	-	-	2.218	-	3.518	3.318
Pot Cap-1 Maneuver	-	-	1195	-	170	685
Stage 1	-	-	-	-	707	-
Stage 2	-	-	-	-	366	-
Platoon blocked, %	-	-		-		
Mov Cap-1 Maneuver	-	-	1195	-	166	685
Mov Cap-2 Maneuver	-	-	-	-	166	-
Stage 1	-	-	-	-	707	-
Stage 2	-	-	-	-	358	-

Approach	EB	WB	NB
HCM Control Delay, s	0	0.2	22.5
HCM LOS			C

Minor Lane/Major Mvmt	NBLn1	EBT	EBR	WBL	WBT
Capacity (veh/h)	222	-	-	1195	-
HCM Lane V/C Ratio	0.073	-	-	0.023	-
HCM Control Delay (s)	22.5	-	-	8.1	-
HCM Lane LOS	C	-	-	A	-
HCM 95th %tile Q(veh)	0.2	-	-	0.1	-

Intersection	
Int Delay, s/veh	0

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Vol, veh/h	0	330	0	0	895	0	0	0	0	0	0	0
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Free	Free	Stop	Stop	Stop	Stop	Stop	Stop
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	-	-	-	-	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	92	92	92	92	92	92	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2	2	2	2	2	2	2
Mvmt Flow	0	359	0	0	973	0	0	0	0	0	0	0

Major/Minor	Major1			Major2			Minor1			Minor2		
Conflicting Flow All	973	0	0	359	0	0	1332	1332	359	1332	1332	973
Stage 1	-	-	-	-	-	-	359	359	-	973	973	-
Stage 2	-	-	-	-	-	-	973	973	-	359	359	-
Critical Hdwy	4.12	-	-	4.12	-	-	7.12	6.52	6.22	7.12	6.52	6.22
Critical Hdwy Stg 1	-	-	-	-	-	-	6.12	5.52	-	6.12	5.52	-
Critical Hdwy Stg 2	-	-	-	-	-	-	6.12	5.52	-	6.12	5.52	-
Follow-up Hdwy	2.218	-	-	2.218	-	-	3.518	4.018	3.318	3.518	4.018	3.318
Pot Cap-1 Maneuver	709	-	-	1200	-	-	131	154	685	131	154	306
Stage 1	-	-	-	-	-	-	659	627	-	303	330	-
Stage 2	-	-	-	-	-	-	303	330	-	659	627	-
Platoon blocked, %		-	-		-	-						
Mov Cap-1 Maneuver	709	-	-	1200	-	-	131	154	685	131	154	306
Mov Cap-2 Maneuver	-	-	-	-	-	-	131	154	-	131	154	-
Stage 1	-	-	-	-	-	-	659	627	-	303	330	-
Stage 2	-	-	-	-	-	-	303	330	-	659	627	-

Approach	EB	WB	NB	SB
HCM Control Delay, s	0	0	0	0
HCM LOS			A	A

Minor Lane/Major Mvmt	NBLn1	EBL	EBT	EBR	WBL	WBT	WBR	SBLn1
Capacity (veh/h)	-	709	-	-	1200	-	-	-
HCM Lane V/C Ratio	-	-	-	-	-	-	-	-
HCM Control Delay (s)	0	0	-	-	0	-	-	0
HCM Lane LOS	A	A	-	-	A	-	-	A
HCM 95th %tile Q(veh)	-	0	-	-	0	-	-	-

Intersection	
Int Delay, s/veh	0.8

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Vol, veh/h	5	325	870	25	20	15
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	-	-	0	-
Veh in Median Storage, #	-	0	0	-	0	-
Grade, %	-	0	0	-	0	-
Peak Hour Factor	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	5	353	946	27	22	16

Major/Minor	Major1		Major2		Minor2	
Conflicting Flow All	973	0	-	0	1323	959
Stage 1	-	-	-	-	959	-
Stage 2	-	-	-	-	364	-
Critical Hdwy	4.12	-	-	-	6.42	6.22
Critical Hdwy Stg 1	-	-	-	-	5.42	-
Critical Hdwy Stg 2	-	-	-	-	5.42	-
Follow-up Hdwy	2.218	-	-	-	3.518	3.318
Pot Cap-1 Maneuver	709	-	-	-	172	312
Stage 1	-	-	-	-	372	-
Stage 2	-	-	-	-	703	-
Platoon blocked, %		-	-	-		
Mov Cap-1 Maneuver	709	-	-	-	170	312
Mov Cap-2 Maneuver	-	-	-	-	170	-
Stage 1	-	-	-	-	372	-
Stage 2	-	-	-	-	697	-

Approach	EB	WB	SB
HCM Control Delay, s	0.2	0	25.8
HCM LOS			D

Minor Lane/Major Mvmt	EBL	EBT	WBT	WBR	SBLn1
Capacity (veh/h)	709	-	-	-	211
HCM Lane V/C Ratio	0.008	-	-	-	0.18
HCM Control Delay (s)	10.1	0	-	-	25.8
HCM Lane LOS	B	A	-	-	D
HCM 95th %tile Q(veh)	0	-	-	-	0.6

Intersection	
Int Delay, s/veh	1.2

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Vol, veh/h	10	325	0	0	875	40	0	0	0	25	0	15
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Free	Free	Stop	Stop	Stop	Stop	Stop	Stop
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	-	-	-	-	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	92	92	92	92	92	92	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2	2	2	2	2	2	2
Mvmt Flow	11	353	0	0	951	43	0	0	0	27	0	16

Major/Minor	Major1			Major2			Minor1			Minor2		
Conflicting Flow All	995	0	0	353	0	0	1356	1370	353	1348	1348	973
Stage 1	-	-	-	-	-	-	375	375	-	973	973	-
Stage 2	-	-	-	-	-	-	981	995	-	375	375	-
Critical Hdwy	4.12	-	-	4.12	-	-	7.12	6.52	6.22	7.12	6.52	6.22
Critical Hdwy Stg 1	-	-	-	-	-	-	6.12	5.52	-	6.12	5.52	-
Critical Hdwy Stg 2	-	-	-	-	-	-	6.12	5.52	-	6.12	5.52	-
Follow-up Hdwy	2.218	-	-	2.218	-	-	3.518	4.018	3.318	3.518	4.018	3.318
Pot Cap-1 Maneuver	695	-	-	1206	-	-	126	146	691	128	151	306
Stage 1	-	-	-	-	-	-	646	617	-	303	330	-
Stage 2	-	-	-	-	-	-	300	323	-	646	617	-
Platoon blocked, %		-	-		-	-						
Mov Cap-1 Maneuver	695	-	-	1206	-	-	117	143	691	126	148	306
Mov Cap-2 Maneuver	-	-	-	-	-	-	117	143	-	126	148	-
Stage 1	-	-	-	-	-	-	633	605	-	297	330	-
Stage 2	-	-	-	-	-	-	284	323	-	633	605	-

Approach	EB	WB	NB	SB
HCM Control Delay, s	0.3	0	0	35.2
HCM LOS			A	E

Minor Lane/Major Mvmt	NBLn1	EBL	EBT	EBR	WBL	WBT	WBR	SBLn1
Capacity (veh/h)	-	695	-	-	1206	-	-	162
HCM Lane V/C Ratio	-	0.016	-	-	-	-	-	0.268
HCM Control Delay (s)	0	10.3	0	-	0	-	-	35.2
HCM Lane LOS	A	B	A	-	A	-	-	E
HCM 95th %tile Q(veh)	-	0	-	-	0	-	-	1

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	10	170	215	100	380	290	505	1265	245	175	805	60
Number	7	4	14	3	8	18	5	2	12	1	6	16
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1863	1863	1863	1863	1863	1863	1863	1863	1863	1863	1863	1863
Adj Flow Rate, veh/h	11	185	30	109	413	80	549	1375	159	190	875	17
Adj No. of Lanes	1	1	1	1	1	1	2	2	1	1	2	1
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Percent Heavy Veh, %	2	2	2	2	2	2	2	2	2	2	2	2
Cap, veh/h	18	351	298	134	473	402	646	1451	649	218	1222	547
Arrive On Green	0.01	0.19	0.19	0.08	0.25	0.25	0.19	0.41	0.41	0.12	0.35	0.35
Sat Flow, veh/h	1774	1863	1583	1774	1863	1583	3442	3539	1583	1774	3539	1583
Grp Volume(v), veh/h	11	185	30	109	413	80	549	1375	159	190	875	17
Grp Sat Flow(s),veh/h/ln	1774	1863	1583	1774	1863	1583	1721	1770	1583	1774	1770	1583
Q Serve(g_s), s	0.7	10.6	1.9	7.2	25.1	4.7	18.2	44.4	7.8	12.4	25.4	0.8
Cycle Q Clear(g_c), s	0.7	10.6	1.9	7.2	25.1	4.7	18.2	44.4	7.8	12.4	25.4	0.8
Prop In Lane	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Lane Grp Cap(c), veh/h	18	351	298	134	473	402	646	1451	649	218	1222	547
V/C Ratio(X)	0.60	0.53	0.10	0.81	0.87	0.20	0.85	0.95	0.24	0.87	0.72	0.03
Avail Cap(c_a), veh/h	180	582	495	180	582	495	1163	1495	669	255	1222	547
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	58.3	43.3	39.7	53.9	42.3	34.7	46.4	33.7	22.9	51.0	33.7	25.6
Incr Delay (d2), s/veh	28.2	1.2	0.1	18.1	11.8	0.2	3.2	12.7	0.2	23.8	2.0	0.0
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	0.5	5.6	0.8	4.2	14.5	2.1	9.0	24.1	3.4	7.6	12.7	0.4
LnGrp Delay(d),s/veh	86.5	44.5	39.9	72.0	54.1	34.9	49.7	46.4	23.1	74.8	35.7	25.7
LnGrp LOS	F	D	D	E	D	C	D	D	C	E	D	C
Approach Vol, veh/h		226			602			2083			1082	
Approach Delay, s/veh		45.9			54.8			45.5			42.4	
Approach LOS		D			D			D			D	

Timer	1	2	3	4	5	6	7	8
Assigned Phs	1	2	3	4	5	6	7	8
Phs Duration (G+Y+Rc), s	20.5	54.5	15.0	28.3	28.2	46.9	7.2	36.1
Change Period (Y+Rc), s	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0
Max Green Setting (Gmax), s	17.0	50.0	12.0	37.0	40.0	27.0	12.0	37.0
Max Q Clear Time (g_c+I1), s	14.4	46.4	9.2	12.6	20.2	27.4	2.7	27.1
Green Ext Time (p_c), s	0.1	2.2	0.1	4.2	2.0	0.0	0.0	2.9

Intersection Summary	
HCM 2010 Ctrl Delay	46.1
HCM 2010 LOS	D

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	355	170	235	60	260	315	245	1460	10	220	1210	170
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	6.0	4.0	4.0	6.0
Lane Util. Factor	0.91	0.91	1.00	1.00	1.00	0.88	0.97	0.91	1.00	0.97	0.91	1.00
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	0.98	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	1610	3306	1583	1770	1863	2787	3433	5085	1583	3433	5085	1583
Flt Permitted	0.95	0.98	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)	1610	3306	1583	1770	1863	2787	3433	5085	1583	3433	5085	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)	386	185	255	65	283	342	266	1587	11	239	1315	185
RTOR Reduction (vph)	0	0	61	0	0	202	0	0	6	0	0	75
Lane Group Flow (vph)	193	378	194	65	283	140	266	1587	5	239	1315	110
Turn Type	Split	NA	Perm	Split	NA	Perm	Prot	NA	Perm	Prot	NA	Perm
Protected Phases	3	3		4	4		5	2		1	6	
Permitted Phases			3			4			2			6
Actuated Green, G (s)	36.1	36.1	36.1	41.4	41.4	41.4	23.1	116.6	116.6	20.9	114.4	114.4
Effective Green, g (s)	38.1	38.1	38.1	43.4	43.4	43.4	25.1	119.6	117.6	22.9	117.4	115.4
Actuated g/C Ratio	0.16	0.16	0.16	0.18	0.18	0.18	0.10	0.50	0.49	0.10	0.49	0.48
Clearance Time (s)	6.0	6.0	6.0	6.0	6.0	6.0	6.0	7.0	7.0	6.0	7.0	7.0
Vehicle Extension (s)	5.0	5.0	5.0	5.0	5.0	5.0	3.0	5.0	5.0	3.0	5.0	5.0
Lane Grp Cap (vph)	255	524	251	320	336	503	359	2534	775	327	2487	761
v/s Ratio Prot	0.12	0.11		0.04	c0.15		c0.08	c0.31		0.07	0.26	
v/s Ratio Perm			c0.12			0.05			0.00			0.07
v/c Ratio	0.76	0.72	0.77	0.20	0.84	0.28	0.74	0.63	0.01	0.73	0.53	0.14
Uniform Delay, d1	96.5	95.9	96.8	83.6	95.0	84.8	104.3	43.9	31.3	105.6	42.2	34.8
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.85	1.53	3.84
Incremental Delay, d2	14.2	5.9	15.7	0.7	18.7	0.6	8.0	1.2	0.0	7.7	0.8	0.4
Delay (s)	110.7	101.9	112.5	84.3	113.7	85.4	112.3	45.1	31.3	98.0	65.2	133.7
Level of Service	F	F	F	F	F	F	F	D	C	F	E	F
Approach Delay (s)		107.2			96.9			54.6			77.0	
Approach LOS		F			F			D			E	

Intersection Summary			
HCM 2000 Control Delay	76.4	HCM 2000 Level of Service	E
HCM 2000 Volume to Capacity ratio	0.71		
Actuated Cycle Length (s)	240.0	Sum of lost time (s)	16.0
Intersection Capacity Utilization	71.5%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	470	5	125	10	15	15	330	2675	20	80	1570	440
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		6.0	4.0	6.0	5.0	6.0	4.0	5.0	7.0
Lane Util. Factor	0.95	0.95	1.00		1.00	1.00	1.00	0.91	1.00	1.00	0.91	1.00
Frpb, ped/bikes	1.00	1.00	0.91		1.00	1.00	1.00	1.00	0.83	1.00	1.00	0.97
Flpb, ped/bikes	1.00	1.00	1.00		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Frt	1.00	1.00	0.85		1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	0.95	1.00		0.98	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	1681	1687	1434		1826	1583	1770	5085	1311	1770	5085	1536
Flt Permitted	0.95	0.95	1.00		0.98	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)	1681	1687	1434		1826	1583	1770	5085	1311	1770	5085	1536
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	511	5	136	11	16	16	359	2908	22	87	1707	478
RTOR Reduction (vph)	0	0	81	0	0	15	0	0	8	0	0	256
Lane Group Flow (vph)	255	261	55	0	27	1	359	2908	14	87	1707	222
Confl. Peds. (#/hr)			43						31			2
Turn Type	Split	NA	Perm	Split	NA	Perm	Prot	NA	Perm	Prot	NA	Perm
Protected Phases	4	4		3	3		5	2		1	6	
Permitted Phases			4			3			2			6
Actuated Green, G (s)	45.2	45.2	45.2		7.8	7.8	51.4	148.3	148.3	14.7	111.6	111.6
Effective Green, g (s)	45.2	45.2	45.2		7.8	9.8	51.4	150.3	149.3	16.7	113.6	111.6
Actuated g/C Ratio	0.19	0.19	0.19		0.03	0.04	0.21	0.63	0.62	0.07	0.47	0.46
Clearance Time (s)	5.0	5.0	5.0		6.0	6.0	6.0	7.0	7.0	6.0	7.0	7.0
Vehicle Extension (s)	4.0	4.0	4.0		3.0	3.0	5.0	6.0	6.0	3.0	6.0	6.0
Lane Grp Cap (vph)	316	317	270		59	64	379	3184	815	123	2406	714
v/s Ratio Prot	0.15	c0.15			c0.01		c0.20	c0.57		0.05	0.34	
v/s Ratio Perm			0.04			0.00			0.01			0.14
v/c Ratio	0.81	0.82	0.20		0.46	0.01	0.95	0.91	0.02	0.71	0.71	0.31
Uniform Delay, d1	93.2	93.6	82.2		114.0	110.4	93.0	39.2	17.3	109.3	50.1	40.2
Progression Factor	1.00	1.00	1.00		1.00	1.00	1.30	0.63	1.00	1.05	0.98	1.68
Incremental Delay, d2	14.7	16.4	0.5		5.5	0.1	18.6	2.3	0.0	16.5	1.8	1.1
Delay (s)	107.9	110.0	82.7		119.6	110.5	139.8	27.0	17.3	131.7	51.1	68.7
Level of Service	F	F	F		F	F	F	C	B	F	D	E
Approach Delay (s)		103.5			116.2			39.3			57.9	
Approach LOS		F			F			D			E	

Intersection Summary			
HCM 2000 Control Delay	53.3	HCM 2000 Level of Service	D
HCM 2000 Volume to Capacity ratio	0.90		
Actuated Cycle Length (s)	240.0	Sum of lost time (s)	22.0
Intersection Capacity Utilization	96.0%	ICU Level of Service	F
Analysis Period (min)	15		

c Critical Lane Group

Intersection	
Int Delay, s/veh	0.6

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Vol, veh/h	5	350	915	25	20	5
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	-	-	0	-
Veh in Median Storage, #	-	0	0	-	0	-
Grade, %	-	0	0	-	0	-
Peak Hour Factor	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	5	380	995	27	22	5

Major/Minor	Major1		Major2		Minor2	
Conflicting Flow All	1022	0	-	0	1399	1008
Stage 1	-	-	-	-	1008	-
Stage 2	-	-	-	-	391	-
Critical Hdwy	4.12	-	-	-	6.42	6.22
Critical Hdwy Stg 1	-	-	-	-	5.42	-
Critical Hdwy Stg 2	-	-	-	-	5.42	-
Follow-up Hdwy	2.218	-	-	-	3.518	3.318
Pot Cap-1 Maneuver	679	-	-	-	155	292
Stage 1	-	-	-	-	353	-
Stage 2	-	-	-	-	683	-
Platoon blocked, %		-	-	-		
Mov Cap-1 Maneuver	679	-	-	-	154	292
Mov Cap-2 Maneuver	-	-	-	-	154	-
Stage 1	-	-	-	-	353	-
Stage 2	-	-	-	-	677	-

Approach	EB	WB	SB
HCM Control Delay, s	0.1	0	30.2
HCM LOS			D

Minor Lane/Major Mvmt	EBL	EBT	WBT	WBR	SBLn1
Capacity (veh/h)	679	-	-	-	170
HCM Lane V/C Ratio	0.008	-	-	-	0.16
HCM Control Delay (s)	10.3	0	-	-	30.2
HCM Lane LOS	B	A	-	-	D
HCM 95th %tile Q(veh)	0	-	-	-	0.6

Intersection	
Int Delay, s/veh	0.5

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Vol, veh/h	5	325	805	20	15	10
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	-	-	0	-
Veh in Median Storage, #	-	0	0	-	0	-
Grade, %	-	0	0	-	0	-
Peak Hour Factor	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	5	353	875	22	16	11

Major/Minor	Major1		Major2		Minor2	
Conflicting Flow All	897	0	-	0	1250	886
Stage 1	-	-	-	-	886	-
Stage 2	-	-	-	-	364	-
Critical Hdwy	4.12	-	-	-	6.42	6.22
Critical Hdwy Stg 1	-	-	-	-	5.42	-
Critical Hdwy Stg 2	-	-	-	-	5.42	-
Follow-up Hdwy	2.218	-	-	-	3.518	3.318
Pot Cap-1 Maneuver	757	-	-	-	191	343
Stage 1	-	-	-	-	403	-
Stage 2	-	-	-	-	703	-
Platoon blocked, %		-	-	-		
Mov Cap-1 Maneuver	757	-	-	-	189	343
Mov Cap-2 Maneuver	-	-	-	-	189	-
Stage 1	-	-	-	-	403	-
Stage 2	-	-	-	-	697	-

Approach	EB	WB	SB
HCM Control Delay, s	0.1	0	22.7
HCM LOS			C

Minor Lane/Major Mvmt	EBL	EBT	WBT	WBR	SBLn1
Capacity (veh/h)	757	-	-	-	230
HCM Lane V/C Ratio	0.007	-	-	-	0.118
HCM Control Delay (s)	9.8	0	-	-	22.7
HCM Lane LOS	A	A	-	-	C
HCM 95th %tile Q(veh)	0	-	-	-	0.4

Intersection	
Int Delay, s/veh	3.2

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Vol, veh/h	95	0	55	215	0	125
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	0	-	0	-
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	103	0	60	234	0	136

Major/Minor	Major1		Major2		Minor1	
Conflicting Flow All	0	0	103	0	456	103
Stage 1	-	-	-	-	103	-
Stage 2	-	-	-	-	353	-
Critical Hdwy	-	-	4.12	-	6.42	6.22
Critical Hdwy Stg 1	-	-	-	-	5.42	-
Critical Hdwy Stg 2	-	-	-	-	5.42	-
Follow-up Hdwy	-	-	2.218	-	3.518	3.318
Pot Cap-1 Maneuver	-	-	1489	-	562	952
Stage 1	-	-	-	-	921	-
Stage 2	-	-	-	-	711	-
Platoon blocked, %	-	-		-		
Mov Cap-1 Maneuver	-	-	1489	-	539	952
Mov Cap-2 Maneuver	-	-	-	-	539	-
Stage 1	-	-	-	-	921	-
Stage 2	-	-	-	-	682	-

Approach	EB	WB	NB
HCM Control Delay, s	0	1.5	9.4
HCM LOS			A

Minor Lane/Major Mvmt	NBLn1	EBT	EBR	WBL	WBT
Capacity (veh/h)	952	-	-	1489	-
HCM Lane V/C Ratio	0.143	-	-	0.04	-
HCM Control Delay (s)	9.4	-	-	7.5	-
HCM Lane LOS	A	-	-	A	-
HCM 95th %tile Q(veh)	0.5	-	-	0.1	-

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	870	805	10	230	485	585	55	370	130	625	370	655
Number	7	4	14	3	8	18	5	2	12	1	6	16
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1863	1863	1900	1863	1863	1863	1863	1863	1900	1863	1863	1863
Adj Flow Rate, veh/h	946	875	11	250	527	582	60	402	5	679	402	423
Adj No. of Lanes	2	3	0	2	3	2	1	2	0	2	2	2
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Percent Heavy Veh, %	2	2	2	2	2	2	2	2	2	2	2	2
Cap, veh/h	986	2054	26	310	1019	1145	78	541	7	724	1125	1681
Arrive On Green	0.29	0.40	0.40	0.09	0.20	0.20	0.04	0.15	0.15	0.21	0.32	0.32
Sat Flow, veh/h	3442	5176	65	3442	5085	2787	1774	3580	44	3442	3539	2776
Grp Volume(v), veh/h	946	573	313	250	527	582	60	199	208	679	402	423
Grp Sat Flow(s),veh/h/ln	1721	1695	1851	1721	1695	1393	1774	1770	1855	1721	1770	1388
Q Serve(g_s), s	41.1	18.6	18.7	10.8	14.0	23.6	5.1	16.3	16.3	29.5	13.3	10.8
Cycle Q Clear(g_c), s	41.1	18.6	18.7	10.8	14.0	23.6	5.1	16.3	16.3	29.5	13.3	10.8
Prop In Lane	1.00		0.04	1.00		1.00	1.00		0.02	1.00		1.00
Lane Grp Cap(c), veh/h	986	1345	734	310	1019	1145	78	268	280	724	1125	1681
V/C Ratio(X)	0.96	0.43	0.43	0.81	0.52	0.51	0.77	0.74	0.74	0.94	0.36	0.25
Avail Cap(c_a), veh/h	997	1345	734	997	1272	1284	456	606	635	748	1125	1681
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	53.3	33.3	33.3	67.8	54.2	33.3	71.9	61.6	61.6	59.0	39.9	14.0
Incr Delay (d2), s/veh	19.3	0.2	0.4	4.9	0.4	0.4	14.9	4.0	3.9	19.0	0.2	0.1
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	22.2	8.8	9.6	5.4	6.6	9.1	2.8	8.3	8.7	16.0	6.5	4.1
LnGrp Delay(d),s/veh	72.6	33.5	33.7	72.7	54.6	33.7	86.7	65.7	65.5	78.0	40.1	14.1
LnGrp LOS	E	C	C	E	D	C	F	E	E	E	D	B
Approach Vol, veh/h		1832			1359			467			1504	
Approach Delay, s/veh		53.7			48.9			68.3			49.9	
Approach LOS		D			D			E			D	

Timer	1	2	3	4	5	6	7	8
Assigned Phs	1	2	3	4	5	6	7	8
Phs Duration (G+Y+Rc), s	37.0	29.0	19.7	66.2	11.6	54.3	49.5	36.4
Change Period (Y+Rc), s	5.0	6.0	6.0	6.0	5.0	6.0	6.0	6.0
Max Green Setting (Gmax), s	33.0	52.0	44.0	38.0	39.0	46.0	44.0	38.0
Max Q Clear Time (g_c+I1), s	31.5	18.3	12.8	20.7	7.1	15.3	43.1	25.6
Green Ext Time (p_c), s	0.5	3.7	0.9	11.2	0.1	8.1	0.4	4.8

Intersection Summary	
HCM 2010 Ctrl Delay	52.7
HCM 2010 LOS	D

Notes

User approved changes to right turn type.

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	145	230	75	205	145	325	40	890	130	320	1180	135
Number	3	8	18	7	4	14	5	2	12	1	6	16
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1863	1863	1900	1863	1863	1863	1863	1863	1900	1863	1863	1900
Adj Flow Rate, veh/h	158	250	73	223	158	106	43	967	129	348	1283	137
Adj No. of Lanes	1	1	0	1	1	1	1	3	0	2	3	0
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Percent Heavy Veh, %	2	2	2	2	2	2	2	2	2	2	2	2
Cap, veh/h	440	542	158	338	729	619	55	1412	188	443	1906	203
Arrive On Green	0.39	0.39	0.39	0.39	0.39	0.39	0.03	0.31	0.31	0.13	0.41	0.41
Sat Flow, veh/h	1111	1386	405	1052	1863	1583	1774	4542	604	3442	4667	498
Grp Volume(v), veh/h	158	0	323	223	158	106	43	721	375	348	932	488
Grp Sat Flow(s),veh/h/ln	1111	0	1791	1052	1863	1583	1774	1695	1756	1721	1695	1775
Q Serve(g_s), s	11.7	0.0	14.2	21.2	6.0	4.6	2.6	19.8	19.9	10.4	23.9	23.9
Cycle Q Clear(g_c), s	17.7	0.0	14.2	35.5	6.0	4.6	2.6	19.8	19.9	10.4	23.9	23.9
Prop In Lane	1.00		0.23	1.00		1.00	1.00		0.34	1.00		0.28
Lane Grp Cap(c), veh/h	440	0	701	338	729	619	55	1054	546	443	1384	725
V/C Ratio(X)	0.36	0.00	0.46	0.66	0.22	0.17	0.78	0.68	0.69	0.79	0.67	0.67
Avail Cap(c_a), veh/h	517	0	825	412	858	730	334	1054	546	1424	1690	885
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	0.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	27.4	0.0	24.0	37.2	21.5	21.1	51.1	32.1	32.1	44.9	25.7	25.7
Incr Delay (d2), s/veh	0.5	0.0	0.5	2.8	0.1	0.1	20.3	1.8	3.6	3.1	0.8	1.5
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	3.7	0.0	7.1	6.4	3.1	2.0	1.6	9.5	10.1	5.2	11.3	12.0
LnGrp Delay(d),s/veh	27.9	0.0	24.5	40.1	21.7	21.3	71.4	33.9	35.7	48.0	26.5	27.2
LnGrp LOS	C		C	D	C	C	E	C	D	D	C	C
Approach Vol, veh/h		481			487			1139			1768	
Approach Delay, s/veh		25.6			30.0			35.9			30.9	
Approach LOS		C			C			D			C	

Timer	1	2	3	4	5	6	7	8
Assigned Phs	1	2		4	5	6		8
Phs Duration (G+Y+Rc), s	19.7	39.1		47.6	9.3	49.4		47.6
Change Period (Y+Rc), s	6.0	6.0		6.0	6.0	6.0		6.0
Max Green Setting (Gmax), s	44.0	29.0		49.0	20.0	53.0		49.0
Max Q Clear Time (g_c+I1), s	12.4	21.9		37.5	4.6	25.9		19.7
Green Ext Time (p_c), s	1.3	6.4		4.1	0.1	17.6		5.8

Intersection Summary	
HCM 2010 Ctrl Delay	31.6
HCM 2010 LOS	C

Intersection	
Int Delay, s/veh	8.5

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Vol, veh/h	5	5	160	5	10	230
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	-	-	0	-
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	5	5	174	5	11	250

Major/Minor	Major1		Major2		Minor1	
Conflicting Flow All	0	0	11	0	361	8
Stage 1	-	-	-	-	8	-
Stage 2	-	-	-	-	353	-
Critical Hdwy	-	-	4.12	-	6.42	6.22
Critical Hdwy Stg 1	-	-	-	-	5.42	-
Critical Hdwy Stg 2	-	-	-	-	5.42	-
Follow-up Hdwy	-	-	2.218	-	3.518	3.318
Pot Cap-1 Maneuver	-	-	1608	-	638	1074
Stage 1	-	-	-	-	1015	-
Stage 2	-	-	-	-	711	-
Platoon blocked, %	-	-		-		
Mov Cap-1 Maneuver	-	-	1608	-	568	1074
Mov Cap-2 Maneuver	-	-	-	-	568	-
Stage 1	-	-	-	-	1015	-
Stage 2	-	-	-	-	634	-

Approach	EB	WB	NB
HCM Control Delay, s	0	7.3	9.6
HCM LOS			A

Minor Lane/Major Mvmt	NBLn1	EBT	EBR	WBL	WBT
Capacity (veh/h)	1036	-	-	1608	-
HCM Lane V/C Ratio	0.252	-	-	0.108	-
HCM Control Delay (s)	9.6	-	-	7.5	0
HCM Lane LOS	A	-	-	A	A
HCM 95th %tile Q(veh)	1	-	-	0.4	-

Intersection	
Int Delay, s/veh	6.4

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Vol, veh/h	205	725	0	0	445	20	0	0	0	20	0	145
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Free	Free	Stop	Stop	Stop	Stop	Stop	Stop
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	-	-	-	-	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	92	92	92	92	92	92	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2	2	2	2	2	2	2
Mvmt Flow	223	788	0	0	484	22	0	0	0	22	0	158

Major/Minor	Major1			Major2			Minor1			Minor2		
Conflicting Flow All	505	0	0	788	0	0	1807	1739	788	1729	1729	495
Stage 1	-	-	-	-	-	-	1234	1234	-	495	495	-
Stage 2	-	-	-	-	-	-	573	505	-	1234	1234	-
Critical Hdwy	4.12	-	-	4.12	-	-	7.12	6.52	6.22	7.12	6.52	6.22
Critical Hdwy Stg 1	-	-	-	-	-	-	6.12	5.52	-	6.12	5.52	-
Critical Hdwy Stg 2	-	-	-	-	-	-	6.12	5.52	-	6.12	5.52	-
Follow-up Hdwy	2.218	-	-	2.218	-	-	3.518	4.018	3.318	3.518	4.018	3.318
Pot Cap-1 Maneuver	1060	-	-	831	-	-	61	87	391	69	88	575
Stage 1	-	-	-	-	-	-	216	249	-	556	546	-
Stage 2	-	-	-	-	-	-	505	540	-	216	249	-
Platoon blocked, %		-	-		-	-						
Mov Cap-1 Maneuver	1060	-	-	831	-	-	31	54	391	49	55	575
Mov Cap-2 Maneuver	-	-	-	-	-	-	31	54	-	49	55	-
Stage 1	-	-	-	-	-	-	135	156	-	348	546	-
Stage 2	-	-	-	-	-	-	367	540	-	135	156	-

Approach	EB	WB	NB	SB
HCM Control Delay, s	2	0	0	49
HCM LOS			A	E

Minor Lane/Major Mvmt	NBLn1	EBL	EBT	EBR	WBL	WBT	WBR	SBLn1
Capacity (veh/h)	-	1060	-	-	831	-	-	250
HCM Lane V/C Ratio	-	0.21	-	-	-	-	-	0.717
HCM Control Delay (s)	0	9.3	0	-	0	-	-	49
HCM Lane LOS	A	A	A	-	A	-	-	E
HCM 95th %tile Q(veh)	-	0.8	-	-	0	-	-	4.9

Intersection	
Int Delay, s/veh	0.7

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Vol, veh/h	790	15	15	465	10	25
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	50	-	0	-
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	859	16	16	505	11	27

Major/Minor	Major1		Major2		Minor1	
Conflicting Flow All	0	0	875	0	1405	867
Stage 1	-	-	-	-	867	-
Stage 2	-	-	-	-	538	-
Critical Hdwy	-	-	4.12	-	6.42	6.22
Critical Hdwy Stg 1	-	-	-	-	5.42	-
Critical Hdwy Stg 2	-	-	-	-	5.42	-
Follow-up Hdwy	-	-	2.218	-	3.518	3.318
Pot Cap-1 Maneuver	-	-	771	-	154	352
Stage 1	-	-	-	-	411	-
Stage 2	-	-	-	-	585	-
Platoon blocked, %	-	-		-		
Mov Cap-1 Maneuver	-	-	771	-	151	352
Mov Cap-2 Maneuver	-	-	-	-	151	-
Stage 1	-	-	-	-	411	-
Stage 2	-	-	-	-	573	-

Approach	EB	WB	NB
HCM Control Delay, s	0	0.3	21.6
HCM LOS			C

Minor Lane/Major Mvmt	NBLn1	EBT	EBR	WBL	WBT
Capacity (veh/h)	255	-	-	771	-
HCM Lane V/C Ratio	0.149	-	-	0.021	-
HCM Control Delay (s)	21.6	-	-	9.8	-
HCM Lane LOS	C	-	-	A	-
HCM 95th %tile Q(veh)	0.5	-	-	0.1	-

Intersection	
Int Delay, s/veh	0.1

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Vol, veh/h	5	785	0	0	475	5	0	0	0	0	0	0
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Free	Free	Stop	Stop	Stop	Stop	Stop	Stop
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	-	-	-	-	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	92	92	92	92	92	92	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2	2	2	2	2	2	2
Mvmt Flow	5	853	0	0	516	5	0	0	0	0	0	0

Major/Minor	Major1			Major2			Minor1			Minor2		
Conflicting Flow All	522	0	0	853	0	0	1383	1386	853	1383	1383	519
Stage 1	-	-	-	-	-	-	864	864	-	519	519	-
Stage 2	-	-	-	-	-	-	519	522	-	864	864	-
Critical Hdwy	4.12	-	-	4.12	-	-	7.12	6.52	6.22	7.12	6.52	6.22
Critical Hdwy Stg 1	-	-	-	-	-	-	6.12	5.52	-	6.12	5.52	-
Critical Hdwy Stg 2	-	-	-	-	-	-	6.12	5.52	-	6.12	5.52	-
Follow-up Hdwy	2.218	-	-	2.218	-	-	3.518	4.018	3.318	3.518	4.018	3.318
Pot Cap-1 Maneuver	1044	-	-	786	-	-	121	143	359	121	144	557
Stage 1	-	-	-	-	-	-	349	371	-	540	533	-
Stage 2	-	-	-	-	-	-	540	531	-	349	371	-
Platoon blocked, %		-	-		-	-						
Mov Cap-1 Maneuver	1044	-	-	786	-	-	120	142	359	120	143	557
Mov Cap-2 Maneuver	-	-	-	-	-	-	120	142	-	120	143	-
Stage 1	-	-	-	-	-	-	346	368	-	535	533	-
Stage 2	-	-	-	-	-	-	540	531	-	346	368	-

Approach	EB	WB	NB	SB
HCM Control Delay, s	0.1	0	0	0
HCM LOS			A	A

Minor Lane/Major Mvmt	NBLn1	EBL	EBT	EBR	WBL	WBT	WBR	SBLn1
Capacity (veh/h)	-	1044	-	-	786	-	-	-
HCM Lane V/C Ratio	-	0.005	-	-	-	-	-	-
HCM Control Delay (s)	0	8.5	0	-	0	-	-	0
HCM Lane LOS	A	A	A	-	A	-	-	A
HCM 95th %tile Q(veh)	-	0	-	-	0	-	-	-

Intersection	
Int Delay, s/veh	1.5

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Vol, veh/h	5	810	470	20	45	10
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	-	-	0	-
Veh in Median Storage, #	-	0	0	-	0	-
Grade, %	-	0	0	-	0	-
Peak Hour Factor	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	5	880	511	22	49	11

Major/Minor	Major1		Major2		Minor2	
Conflicting Flow All	533	0	-	0	1413	522
Stage 1	-	-	-	-	522	-
Stage 2	-	-	-	-	891	-
Critical Hdwy	4.12	-	-	-	6.42	6.22
Critical Hdwy Stg 1	-	-	-	-	5.42	-
Critical Hdwy Stg 2	-	-	-	-	5.42	-
Follow-up Hdwy	2.218	-	-	-	3.518	3.318
Pot Cap-1 Maneuver	1035	-	-	-	152	555
Stage 1	-	-	-	-	595	-
Stage 2	-	-	-	-	401	-
Platoon blocked, %		-	-	-		
Mov Cap-1 Maneuver	1035	-	-	-	151	555
Mov Cap-2 Maneuver	-	-	-	-	151	-
Stage 1	-	-	-	-	595	-
Stage 2	-	-	-	-	397	-

Approach	EB	WB	SB
HCM Control Delay, s	0.1	0	36.1
HCM LOS			E

Minor Lane/Major Mvmt	EBL	EBT	WBT	WBR	SBLn1
Capacity (veh/h)	1035	-	-	-	174
HCM Lane V/C Ratio	0.005	-	-	-	0.344
HCM Control Delay (s)	8.5	0	-	-	36.1
HCM Lane LOS	A	A	-	-	E
HCM 95th %tile Q(veh)	0	-	-	-	1.4

Intersection	
Int Delay, s/veh	5.8

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Vol, veh/h	15	820	0	0	460	45	0	0	0	70	0	20
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Free	Free	Stop	Stop	Stop	Stop	Stop	Stop
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	-	-	-	-	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	92	92	92	92	92	92	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2	2	2	2	2	2	2
Mvmt Flow	16	891	0	0	500	49	0	0	0	76	0	22

Major/Minor	Major1			Major2			Minor1			Minor2		
Conflicting Flow All	549	0	0	891	0	0	1459	1473	891	1448	1448	524
Stage 1	-	-	-	-	-	-	924	924	-	524	524	-
Stage 2	-	-	-	-	-	-	535	549	-	924	924	-
Critical Hdwy	4.12	-	-	4.12	-	-	7.12	6.52	6.22	7.12	6.52	6.22
Critical Hdwy Stg 1	-	-	-	-	-	-	6.12	5.52	-	6.12	5.52	-
Critical Hdwy Stg 2	-	-	-	-	-	-	6.12	5.52	-	6.12	5.52	-
Follow-up Hdwy	2.218	-	-	2.218	-	-	3.518	4.018	3.318	3.518	4.018	3.318
Pot Cap-1 Maneuver	1021	-	-	761	-	-	107	127	341	109	131	553
Stage 1	-	-	-	-	-	-	323	348	-	537	530	-
Stage 2	-	-	-	-	-	-	529	516	-	323	348	-
Platoon blocked, %		-	-		-	-						
Mov Cap-1 Maneuver	1021	-	-	761	-	-	100	123	341	106	127	553
Mov Cap-2 Maneuver	-	-	-	-	-	-	100	123	-	106	127	-
Stage 1	-	-	-	-	-	-	313	337	-	520	530	-
Stage 2	-	-	-	-	-	-	508	516	-	313	337	-

Approach	EB	WB	NB	SB
HCM Control Delay, s	0.2	0	0	90.2
HCM LOS			A	F

Minor Lane/Major Mvmt	NBLn1	EBL	EBT	EBR	WBL	WBT	WBR	SBLn1
Capacity (veh/h)	-	1021	-	-	761	-	-	129
HCM Lane V/C Ratio	-	0.016	-	-	-	-	-	0.758
HCM Control Delay (s)	0	8.6	0	-	0	-	-	90.2
HCM Lane LOS	A	A	A	-	A	-	-	F
HCM 95th %tile Q(veh)	-	0	-	-	0	-	-	4.4

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	50	375	535	200	265	275	250	785	110	195	975	30
Number	7	4	14	3	8	18	5	2	12	1	6	16
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1863	1863	1863	1863	1863	1863	1863	1863	1863	1863	1863	1863
Adj Flow Rate, veh/h	54	408	353	217	288	94	272	853	24	212	1060	8
Adj No. of Lanes	1	1	1	1	1	1	2	2	1	1	2	1
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Percent Heavy Veh, %	2	2	2	2	2	2	2	2	2	2	2	2
Cap, veh/h	71	483	410	244	665	565	331	1013	453	240	1151	515
Arrive On Green	0.04	0.26	0.26	0.14	0.36	0.36	0.10	0.29	0.29	0.14	0.33	0.33
Sat Flow, veh/h	1774	1863	1583	1774	1863	1583	3442	3539	1583	1774	3539	1583
Grp Volume(v), veh/h	54	408	353	217	288	94	272	853	24	212	1060	8
Grp Sat Flow(s),veh/h/ln	1774	1863	1583	1774	1863	1583	1721	1770	1583	1774	1770	1583
Q Serve(g_s), s	4.0	27.4	28.0	15.8	15.5	5.4	10.2	29.9	1.4	15.5	38.0	0.5
Cycle Q Clear(g_c), s	4.0	27.4	28.0	15.8	15.5	5.4	10.2	29.9	1.4	15.5	38.0	0.5
Prop In Lane	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Lane Grp Cap(c), veh/h	71	483	410	244	665	565	331	1013	453	240	1151	515
V/C Ratio(X)	0.77	0.85	0.86	0.89	0.43	0.17	0.82	0.84	0.05	0.88	0.92	0.02
Avail Cap(c_a), veh/h	431	721	613	310	665	565	470	1013	453	336	1181	529
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	62.7	46.3	46.6	55.9	32.3	29.0	58.5	44.2	34.1	56.0	42.8	30.2
Incr Delay (d2), s/veh	15.7	6.0	8.0	22.0	0.4	0.1	7.7	6.5	0.0	17.9	11.6	0.0
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	2.3	14.9	13.1	9.3	8.1	2.4	5.2	15.5	0.6	8.8	20.4	0.2
LnGrp Delay(d),s/veh	78.4	52.3	54.6	77.9	32.7	29.1	66.2	50.7	34.1	73.9	54.4	30.2
LnGrp LOS	E	D	D	E	C	C	E	D	C	E	D	C
Approach Vol, veh/h		815			599			1149			1280	
Approach Delay, s/veh		55.0			48.5			54.1			57.5	
Approach LOS		E			D			D			E	

Timer	1	2	3	4	5	6	7	8
Assigned Phs	1	2	3	4	5	6	7	8
Phs Duration (G+Y+Rc), s	23.8	43.7	24.1	40.2	18.7	48.9	11.2	53.0
Change Period (Y+Rc), s	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0
Max Green Setting (Gmax), s	25.0	37.0	23.0	51.0	18.0	44.0	32.0	42.0
Max Q Clear Time (g_c+I1), s	17.5	31.9	17.8	30.0	12.2	40.0	6.0	17.5
Green Ext Time (p_c), s	0.3	4.3	0.3	4.1	0.5	2.8	0.1	6.4

Intersection Summary	
HCM 2010 Ctrl Delay	54.5
HCM 2010 LOS	D

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	250	245	290	15	275	185	270	1065	15	360	1775	240
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	6.0	4.0	4.0	6.0
Lane Util. Factor	0.91	0.91	1.00	1.00	1.00	0.88	0.97	0.91	1.00	0.97	0.91	1.00
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	0.99	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	1610	3345	1583	1770	1863	2787	3433	5085	1583	3433	5085	1583
Flt Permitted	0.95	0.99	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)	1610	3345	1583	1770	1863	2787	3433	5085	1583	3433	5085	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)	272	266	315	16	299	201	293	1158	16	391	1929	261
RTOR Reduction (vph)	0	0	72	0	0	110	0	0	9	0	0	75
Lane Group Flow (vph)	174	364	243	16	299	91	293	1158	7	391	1929	186
Turn Type	Split	NA	Perm	Split	NA	Perm	Prot	NA	Perm	Prot	NA	Perm
Protected Phases	3	3		4	4		5	2		1	6	
Permitted Phases			3			4			2			6
Actuated Green, G (s)	40.2	40.2	40.2	36.8	36.8	36.8	25.2	106.4	106.4	31.6	112.8	112.8
Effective Green, g (s)	42.2	42.2	42.2	38.8	38.8	38.8	27.2	109.4	107.4	33.6	115.8	113.8
Actuated g/C Ratio	0.18	0.18	0.18	0.16	0.16	0.16	0.11	0.46	0.45	0.14	0.48	0.47
Clearance Time (s)	6.0	6.0	6.0	6.0	6.0	6.0	6.0	7.0	7.0	6.0	7.0	7.0
Vehicle Extension (s)	5.0	5.0	5.0	5.0	5.0	5.0	3.0	5.0	5.0	3.0	5.0	5.0
Lane Grp Cap (vph)	283	588	278	286	301	450	389	2317	708	480	2453	750
v/s Ratio Prot	0.11	0.11		0.01	c0.16		0.09	0.23		c0.11	c0.38	
v/s Ratio Perm			c0.15			0.03			0.00			0.12
v/c Ratio	0.61	0.62	0.88	0.06	0.99	0.20	0.75	0.50	0.01	0.81	0.79	0.25
Uniform Delay, d1	91.4	91.5	96.3	85.1	100.5	87.2	103.1	46.0	36.8	100.2	51.8	37.6
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.15	0.92	1.07
Incremental Delay, d2	5.6	2.8	26.6	0.2	50.0	0.5	8.0	0.8	0.0	10.1	2.6	0.8
Delay (s)	97.0	94.3	122.9	85.3	150.4	87.7	111.2	46.8	36.8	125.1	50.0	41.2
Level of Service	F	F	F	F	F	F	F	D	D	F	D	D
Approach Delay (s)		105.4			124.0			59.5			60.5	
Approach LOS		F			F			E			E	

Intersection Summary			
HCM 2000 Control Delay	73.4	HCM 2000 Level of Service	E
HCM 2000 Volume to Capacity ratio	0.85		
Actuated Cycle Length (s)	240.0	Sum of lost time (s)	16.0
Intersection Capacity Utilization	79.2%	ICU Level of Service	D
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	450	40	125	35	35	30	130	1760	65	80	2845	450
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		6.0	4.0	6.0	5.0	6.0	4.0	5.0	7.0
Lane Util. Factor	0.95	0.95	1.00		1.00	1.00	1.00	0.91	1.00	1.00	0.91	1.00
Frpb, ped/bikes	1.00	1.00	0.91		1.00	1.00	1.00	1.00	0.83	1.00	1.00	0.97
Flpb, ped/bikes	1.00	1.00	1.00		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Frt	1.00	1.00	0.85		1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	0.96	1.00		0.98	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	1681	1698	1434		1817	1583	1770	5085	1311	1770	5085	1536
Flt Permitted	0.95	0.96	1.00		0.98	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)	1681	1698	1434		1817	1583	1770	5085	1311	1770	5085	1536
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	489	43	136	38	38	33	141	1913	71	87	3092	489
RTOR Reduction (vph)	0	0	81	0	0	31	0	0	28	0	0	223
Lane Group Flow (vph)	264	268	55	0	76	2	141	1913	43	87	3092	266
Confl. Peds. (#/hr)			43						31			2
Turn Type	Split	NA	Perm	Split	NA	Perm	Prot	NA	Perm	Prot	NA	Perm
Protected Phases	4	4		3	3		5	2		1	6	
Permitted Phases			4			3			2			6
Actuated Green, G (s)	44.6	44.6	44.6		15.4	15.4	25.6	139.6	139.6	16.4	130.4	130.4
Effective Green, g (s)	44.6	44.6	44.6		15.4	17.4	25.6	141.6	140.6	18.4	132.4	130.4
Actuated g/C Ratio	0.19	0.19	0.19		0.06	0.07	0.11	0.59	0.59	0.08	0.55	0.54
Clearance Time (s)	5.0	5.0	5.0		6.0	6.0	6.0	7.0	7.0	6.0	7.0	7.0
Vehicle Extension (s)	4.0	4.0	4.0		3.0	3.0	5.0	6.0	6.0	3.0	6.0	6.0
Lane Grp Cap (vph)	312	315	266		116	114	188	3000	768	135	2805	834
v/s Ratio Prot	0.16	c0.16			c0.04		c0.08	c0.38		0.05	c0.61	
v/s Ratio Perm			0.04			0.00			0.03			0.17
v/c Ratio	0.85	0.85	0.21		0.66	0.02	0.75	0.64	0.06	0.64	1.10	0.32
Uniform Delay, d1	94.4	94.5	82.7		109.7	103.4	104.1	32.3	21.3	107.6	53.8	30.3
Progression Factor	1.00	1.00	1.00		1.00	1.00	0.88	1.15	2.07	0.98	0.99	1.42
Incremental Delay, d2	19.3	19.9	0.5		12.5	0.1	7.6	0.4	0.1	10.0	52.1	1.0
Delay (s)	113.6	114.3	83.2		122.3	103.5	99.4	37.7	44.1	115.1	105.5	44.0
Level of Service	F	F	F		F	F	F	D	D	F	F	D
Approach Delay (s)		107.7			116.6			42.0			97.5	
Approach LOS		F			F			D			F	

Intersection Summary			
HCM 2000 Control Delay	80.9	HCM 2000 Level of Service	F
HCM 2000 Volume to Capacity ratio	0.98		
Actuated Cycle Length (s)	240.0	Sum of lost time (s)	22.0
Intersection Capacity Utilization	103.8%	ICU Level of Service	G
Analysis Period (min)	15		

c Critical Lane Group

Intersection	
Int Delay, s/veh	1.9

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Vol, veh/h	5	885	505	25	50	5
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	-	-	0	-
Veh in Median Storage, #	-	0	0	-	0	-
Grade, %	-	0	0	-	0	-
Peak Hour Factor	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	5	962	549	27	54	5

Major/Minor	Major1		Major2		Minor2	
Conflicting Flow All	576	0	-	0	1536	563
Stage 1	-	-	-	-	563	-
Stage 2	-	-	-	-	973	-
Critical Hdwy	4.12	-	-	-	6.42	6.22
Critical Hdwy Stg 1	-	-	-	-	5.42	-
Critical Hdwy Stg 2	-	-	-	-	5.42	-
Follow-up Hdwy	2.218	-	-	-	3.518	3.318
Pot Cap-1 Maneuver	997	-	-	-	128	526
Stage 1	-	-	-	-	570	-
Stage 2	-	-	-	-	366	-
Platoon blocked, %		-	-	-		
Mov Cap-1 Maneuver	997	-	-	-	127	526
Mov Cap-2 Maneuver	-	-	-	-	127	-
Stage 1	-	-	-	-	570	-
Stage 2	-	-	-	-	362	-

Approach	EB	WB	SB
HCM Control Delay, s	0	0	50.8
HCM LOS			F

Minor Lane/Major Mvmt	EBL	EBT	WBT	WBR	SBLn1
Capacity (veh/h)	997	-	-	-	136
HCM Lane V/C Ratio	0.005	-	-	-	0.44
HCM Control Delay (s)	8.6	0	-	-	50.8
HCM Lane LOS	A	A	-	-	F
HCM 95th %tile Q(veh)	0	-	-	-	2

Intersection	
Int Delay, s/veh	1.1

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Vol, veh/h	10	735	455	20	35	15
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	-	-	0	-
Veh in Median Storage, #	-	0	0	-	0	-
Grade, %	-	0	0	-	0	-
Peak Hour Factor	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	11	799	495	22	38	16

Major/Minor	Major1		Major2		Minor2	
Conflicting Flow All	516	0	-	0	1326	505
Stage 1	-	-	-	-	505	-
Stage 2	-	-	-	-	821	-
Critical Hdwy	4.12	-	-	-	6.42	6.22
Critical Hdwy Stg 1	-	-	-	-	5.42	-
Critical Hdwy Stg 2	-	-	-	-	5.42	-
Follow-up Hdwy	2.218	-	-	-	3.518	3.318
Pot Cap-1 Maneuver	1050	-	-	-	172	567
Stage 1	-	-	-	-	606	-
Stage 2	-	-	-	-	432	-
Platoon blocked, %		-	-	-		
Mov Cap-1 Maneuver	1050	-	-	-	169	567
Mov Cap-2 Maneuver	-	-	-	-	169	-
Stage 1	-	-	-	-	606	-
Stage 2	-	-	-	-	424	-

Approach	EB	WB	SB
HCM Control Delay, s	0.1	0	27.5
HCM LOS			D

Minor Lane/Major Mvmt	EBL	EBT	WBT	WBR	SBLn1
Capacity (veh/h)	1050	-	-	-	214
HCM Lane V/C Ratio	0.01	-	-	-	0.254
HCM Control Delay (s)	8.5	0	-	-	27.5
HCM Lane LOS	A	A	-	-	D
HCM 95th %tile Q(veh)	0	-	-	-	1

Intersection	
Int Delay, s/veh	3.8

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Vol, veh/h	230	0	140	165	0	135
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	0	-	0	-
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	250	0	152	179	0	147

Major/Minor	Major1		Major2		Minor1	
Conflicting Flow All	0	0	250	0	734	250
Stage 1	-	-	-	-	250	-
Stage 2	-	-	-	-	484	-
Critical Hdwy	-	-	4.12	-	6.42	6.22
Critical Hdwy Stg 1	-	-	-	-	5.42	-
Critical Hdwy Stg 2	-	-	-	-	5.42	-
Follow-up Hdwy	-	-	2.218	-	3.518	3.318
Pot Cap-1 Maneuver	-	-	1316	-	387	789
Stage 1	-	-	-	-	792	-
Stage 2	-	-	-	-	620	-
Platoon blocked, %	-	-		-		
Mov Cap-1 Maneuver	-	-	1316	-	342	789
Mov Cap-2 Maneuver	-	-	-	-	342	-
Stage 1	-	-	-	-	792	-
Stage 2	-	-	-	-	548	-

Approach	EB	WB	NB
HCM Control Delay, s	0	3.7	10.6
HCM LOS			B

Minor Lane/Major Mvmt	NBLn1	EBT	EBR	WBL	WBT
Capacity (veh/h)	789	-	-	1316	-
HCM Lane V/C Ratio	0.186	-	-	0.116	-
HCM Control Delay (s)	10.6	-	-	8.1	-
HCM Lane LOS	B	-	-	A	-
HCM 95th %tile Q(veh)	0.7	-	-	0.4	-

APPENDIX E

A Technical Memorandum for Honouliuli WWTP Facilities Plan

TECHNICAL MEMORANDUM

Estimates of Parameters for Use in Traffic Impact Analysis Report

Background

A Facilities Plan for the Honouliuli Wastewater Treatment Plant (WWTP) is being developed. As part of the Facilities Plan development, an environmental impact statement (EIS) is being prepared. One component of the EIS is a traffic impact analysis report (TIAR).

The TIAR require certain data inputs including the level and timing of projected activities for the site.

This technical memorandum provides the following data items for use by the TIAR:

- Number of WWTP employees for the existing and potential ultimate operational scenarios;
- Estimated years of peak construction and ultimate operation;
- Estimated construction activity for peak year of construction during the AM and PM peak hour traffic time periods. The construction activity information provided includes truck trips and construction worker count.

The sources of information used to provide these data items come from the Honouliuli WWTP Facilities Plan. Data sources referenced in this technical memorandum are:

- Evaluation of Services Technical Memorandum – Item 12.1- August 2012
- Honouliuli WWTP Site Layout Phase 1 Plan
- Figure 5-3: Anticipated Schedule for Two Construction Packages
- Biosolids Processing and Phase 2 Capacity expansion are additional separate packages that will also be executed during the planning period.
- Construction man-hour estimate from Task 12.N cost estimate

Number of Honouliuli WWTP Employees

Existing WWTP Employees

Table 3-1. Honouliuli WWP Current Staffing Levels from the Evaluation of Services Technical Memorandum – Item 12.1 – August 2012 documents the current staffing level at the Honouliuli WWTP at 39 full time equivalent (FTE) positions.

Potential Future WWTP Employees

There are several potential future scenarios of future employment at the Honouliuli WWTP. For the purposes of the EIS, the potential future scenario which involves relocation major components of the City and County of Honolulu wastewater staff to Honouliuli will be used. Based on Table 4-1 Functional Areas Estimated Staffing and Estimated Footprint the projected future WWTP employees are estimated at 320 FTE positions.

Table 1 summarizes the existing and projected future employment at the Honouliuli WWTP.

Table 1

Number of Honouliuli WWTP Employees

Scenario	Number of Employees (FTE)
Existing	39
Projected Ultimate	320
Notes: FTE = full-time equivalents	

Benchmark Years

The benchmark years that will be used for the TIAR are:

- Peak year of construction
- Year of operation

Peak Year of Construction

There are, potentially, four construction packages:

- Phase 1 – Package 1
- Phase 1 – Package 2
- Biosolids Processing
- Phase 2

Based on the Construction man-hour estimate from Task 12.N cost estimate, Phase 1-Package 1 will involve the largest man-hour effort of the four construction packages. Assuming that the peak year of construction would occur at the midpoint of the Package 1 construction, the man-hour estimate documents this as the year 2021.

Year of Operation

For the purposes of the EIS, the year of operation will be assumed to be the year when the non-process staff relocation to Honouliuli WWTP is complete. Based on the schedule indicated by the Construction man-hour estimate from Task 12.N cost estimate, Package 2, the non-process facilities, will be complete by 2027.

Assuming that Package 2 occurs according to this schedule and assuming it takes about 2 to 3 years to fully relocate and assimilate non-process staff to Honouliuli WWTP, a reasonable year of operation to be analyzed would be 2030.

Table 2 summarizes the Benchmark Years for use by the TIAR.

Table 2

Benchmark Years for TIAR

Scenario	Benchmark Year
Peak Year of Construction	2021
Year of Operation	2030
Notes: Based on Construction Man-Hour Estimate from Task 12-N Cost Estimate	

Intensity of Construction Activity

Two items related to construction activity are estimated:

- Construction worker count
- Number of truck trips

For the purposes of the TIAR, the time periods of interest are the AM and PM peak traffic hours of adjacent street traffic. These time periods are used because they represent the time periods when the greatest amounts of the surrounding community traffic are traveling. Therefore any traffic generated by the project, in this case the construction associated with the project, would impact the greatest amount of community traffic during these periods.

<u>Construction Worker Count</u>

The peak year of construction has been identified as the year 2021 assuming that mid-point of Phase 1 – Package 1 construction represents that maximum construction activity for the Honouliuli WWTP expansion. The estimated peak construction staffing for Package 1 is 185 construction workers. Typically, not all employees arrive and leave during the same hour. However to make the analysis conservative, all employees are assumed to arrive and leave within the same hours. The other three packages have much less earthwork and reinforced concrete construction so the peak conditions from Phase 1 – Package 1 will govern. All the other projects will have a lower construction worker count.

State of Hawaiʻi Department of Transportation (HDOT) traffic counts at Station B72007600297-Fort Weaver Road between Geiger Road and Kolowaka Road were reviewed to determine peaking characteristics of traffic in the ʻEwa area. This data was dated August 15, 2011. The bi-directional AM peak hour occurred from 6:30 AM to 7:30 AM with the makai-bound AM peak hour occurring from 6:45 AM to 7:45 AM. The makai-bound direction would be the direction impacted by construction workers driving to the Honouliuli WWTP site. Given that construction often begins very early in the day, it is likely that most construction workers inbound to Honouliuli WWTP would miss the AM peak hour associated with the commuter peak. However, to be conservative, the inbound construction workers are assumed to arrive during the AM peak hour.

The bi-directional PM peak commuter hour at the same count station occurred between 5:00 PM and 6:00 PM. Construction workers leaving the Honouliuli WWTP would leave much earlier than this peak hour. However, the mauka-bound directional peak hour occurred between 3:00 PM and 4:00 PM. Although the traffic volume involved in this directional peak hour is about half the amount of the directional peak during PM peak commuter hour, it is possible that the 3:00 PM to 4:00 PM peak could experience some impact from the departing construction workers. Therefore, for construction impacts, this 3:00 PM to 4:00 PM time period should be the PM peak hour analyzed. The later commuter peak is not likely to be affected by the construction traffic, and if the TIAR elects to evaluate the commuter PM peak hour, then the construction worker impact should be assumed to be zero.

Table 3 summarizes these estimates.

Number of Truck Trips

The number of truck trips generated during the AM and PM peak hours would vary greatly from day to day, depending on the type of construction activity occurring. The maximum truck trip activity would occur during either a concrete pour or during export of excess soil from the site. Although there is a large amount of construction in Package 1, concrete pours are likely to be divided into segments. It is estimated that a typical segment could handle 4 cement trucks per hour generating 8 truck trips per hour (4 in each direction). The other three packages have much less earthwork and reinforced concrete construction so the peak conditions from Phase 1 – Package 1 will govern. All the other projects will have a lower construction vehicle count than the values listed below. .

In either case, it would be very common for the contractor to avoid the peak hours or the specs could mandate that the contractor avoid the peak hours. Even in the unlikely scenario that concrete trucks or dump trucks do not avoid the peak hours, it is likely that these activities would probably generate only 4 truck trips each way (8 truck trips total) during the peak hour.

Table 3

Construction Activity

Item	AM Peak Hour (6:30 – 7:30 AM)	PM Peak Hour (3:00 – 4:00 PM)
Construction Worker Count	185[a]	185/0[a]
Truck Trips (two-way volume)*	8 vph	8 vph[b]

Notes: Based on Construction Man-Hour Estimate from Task 12-N Cost Estimate

*Truck trips are two-way trips. There are 4 vph into the site and 4 vph out of the site. vph=vehicles per hour.

[a] Construction workers would be inbound during the AM peak hour and outbound during the PM peak hour. This analysis assumes 1 vehicle trip per construction worker. Construction workers might overlap with the commuter AM peak hour, but would be in the opposite direction from the peak commuter direction. To be conservative, the construction worker arrivals are shown as occurring during the AM peak hour of adjacent street traffic. Construction workers leaving the site would miss the PM peak commuter hour. The could coincide with the directional PM peak hour in the mauka-bound direction which occurs between 3 PM and 4 PM. This peak is half the traffic volume of the commuter peak. If the TIAR evaluates this mid-afternoon peak, then the outbound construction workers would be 185. If the PM peak commuter hour is evaluated, the outbound construction workers would be 0.

[b] It is not likely that these truck trips would occur during the commuter peak hours, but if they did, this would be the estimated volumes.

Appendix G
Economic and Fiscal Impacts, AECOM, November 2014

Appendix G.
Economic and Fiscal Impacts

This report analyzes the potential economic and fiscal impacts of the proposed upgrading of the Honouliuli Wastewater Treatment Plant (WWTP), and relocating of non-process related functions and facilities from the Sand Island WWTP and other locations to the Honouliuli WWTP. The analysis estimates the economic impacts of the project, which cover expenditures and sales, employment, and payroll, and the fiscal impacts of the project on revenues of the State of Hawaii. The impacts from the project would occur both in the construction period and on an annual basis during operations.

G.1 Methodology

Construction period impacts are estimated using projected construction costs, and annual operations impacts are estimated using projected operations costs. In this analysis, these costs are transformed into economic and fiscal impacts by multiplying the costs or spending by multipliers from the 2007 Hawaii inter-county input-output (I-O) model updated by the Department of Business, Economic Development, and Tourism (DBEDT) in 2014 (DBEDT, 2014), as well as the 2007 Hawaii state I-O model updated by DBEDT in 2013 (DBEDT, 2013). The Hawaii state I-O model measures how money flows through the state through purchases and sales (inputs and outputs) that businesses and households make. It measures what comes in, through purchases that businesses and households make that come from outside of the state, or imports; and what goes out, through sales and services, or exports. The inter-county I-O model measures how money flows among various economic sectors within each county and between counties.

Economic and fiscal impacts were evaluated for both the initial change in the economy as a result of the project – in other words, the new money spent by the project and the new people employed – as well as the impacts of those changes on the overall economy of the City and County of Honolulu. New spending from project construction and operations would create sales for businesses, new employment (jobs), and earnings (wages). The new spending would ripple through the economy, creating direct (or initial), indirect (or successive), and induced effects. In the context of the project, these are characterized as follows:

- Direct effects measure the volume of economic activity initially produced by constructing and operating the project.
- Indirect effects measure the economic activity produced by the purchases of inputs from local industries necessary to construct and operate the project.
- Induced effects measure the economic activity produced by the construction spending by households that results from changes in earnings through the direct and indirect effects of the project.

I-O model multipliers are used to enable a fairly accurate analysis without difficult and costly survey taking. While the advantages outweigh the disadvantages, it is important to understand the following limitations of using any multipliers:

- One assumption is the accuracy of the data used. To perform the analysis, assumptions are used as a best guess of construction costs and future spending.
- Another assumption is that there are no supply constraints. For example, if operation of the project creates a greater need for energy, the price of energy could go up. However, for the analysis, there is no adjustment for this potential cost increase.
- Use of I-O model multipliers also assumes that all businesses of the same type conduct business the same way, using a certain number of employees and a certain amount of raw materials to produce sales. In reality, some companies may have ways to use fewer employees or raw materials.

- Finally, there is no way of knowing exactly when an effect will occur. If a purchase is made, for example, in 2012 or in 2030, that does not mean that effects would occur in the same year. An effect may not occur for several years or may be spread over several years. In most cases, however, it is reasonable to assume that the greatest effect will occur in the year after money is spent.

G.2 Economic and Fiscal Impacts of Construction

The project would construct process and non-process facilities at the Honouliuli WWTP. The construction expenditures would result in one-time increases in economic output, employment, and earnings, and one-time increases in fiscal revenues of the state. The economic impacts of project construction would include the impact of expenditures on construction materials, and on earnings of construction workers and professional service providers during the construction period. Construction costs were used to estimate economic and fiscal impacts during the construction period.

The project would cost an estimated $760 million to complete, inclusive of the costs of upgrading the Honouliuli WWTP and the costs of constructing facilities at the Honouliuli WWTP required to relocate non-process related functions to the plant. This amount includes both hard and soft costs. Hard costs comprise the construction materials and construction labor, while soft costs comprise engineering, commissioning, legal, and fiscal expenses not directly involved in the construction. Engineering, commissioning, legal, and fiscal costs were estimated to be 20 percent of the hard costs (AECOM, 2014b), or approximately 16.7 percent of the total construction costs. **Table G-1** shows the estimated hard costs, soft costs, and total costs of constructing the project.

Table G-1. Construction Costs

		Cost	
		%	$
Hard Costs	Heavy and Civil Engineering Construction	83.3	633,333,333
Soft Costs	Architectural and Engineering Services	16.7	126,666,667
Total Construction Costs		**100.0**	**760,000,000**

Source: AECOM, 2014c.

Multipliers for heavy and civil engineering construction were applied to hard costs; whereas, multipliers for architectural and engineering services were applied to the soft costs. **Table G-2** shows the resulting economic and fiscal impacts. On a one-time basis, project construction would have an estimated total economic impact of $1.6 billion in output, supporting a total of approximately 13,430 jobs, earnings of $520 million, and fiscal revenues of $70 million. The state taxes in the 2007 I-O model predominantly comprise general excise and use tax, and individual income tax, which together account for about 79 percent of total state taxes, as well as 11 other categories of taxes that represent lesser portions of the tax revenues of the state.

Table G-2. One-Time Economic and Fiscal Impacts of Construction

	Output	**Earnings**	Employment	State Tax
	Million $	Million $	Jobs	Million $
Direct/Indirect Impact				
Hard Construction Costs	975	298	8,487	32
Soft Construction Costs	151	82	975	11
Total Direct/Indirect Impact	1,126	380	9,462	43
Induced Impact				
Hard Construction Costs	386	108	3,103	19
Soft Construction Costs	106	29	861	6
Total Induced Impact	493	137	3,965	25
Total Impact				
Hard Construction Costs	1,362	405	11,590	51
Soft Construction Costs	257	111	1,837	18
Total Impact	1,619	517	13,427	68

The estimated construction period is 9 years (AECOM 2014a). Although construction expenditures and therefore the resulting effects actually would vary from year to year, the estimated total economic impact translates to an average annual economic impact of about $180 million, which would support approximately 1,490 jobs, earnings of $60 million, and fiscal revenues of $7.6 million per year. Providing each job or employee represents one household and assuming the current average household size of 2.98 people in Honolulu County (United States Census Bureau [USCB], 2014), direct, indirect, and induced jobs provided by project construction would support approximately 4,450 residents on average during project construction.

G.3 Economic and Fiscal Impacts of Operations

Annual expenditures from operations of the project would result in ongoing increases in economic output, employment, and earnings, and ongoing increases in fiscal revenues. Operations costs were used to estimate economic and fiscal impacts during the operation of the upgraded Honouliuli WWTP, exclusive of the non-process related functions and facilities relocated from the Sand Island WWTP and other locations to the Honouliuli WWTP. Whereas the economic and fiscal impacts of construction evaluated above cover both upgrading the Honouliuli WWTP and constructing non-process related facilities at the plant, the ongoing impacts of operating the non-process related facilities are not evaluated here, as those operating costs are undetermined at the time of writing. The annual operating expenditures for the WWTP upgrades are estimated to be approximately $19.8 million (AECOM, 2014b). This spending comprises expenditures in the utilities industry, inclusive of sewer treatment facilities, and the applicable multipliers were used. **Table G-3** shows the resulting economic and fiscal impacts.

Table G-3. Ongoing Economic and Fiscal Impacts of Operations

	Output	**Earnings**	Employment	State Tax
	Million $	Million $	Jobs	$
Direct/Indirect Impact	24.9	2.8	59	792,000
Induced Impact	3.6	1.0	30	198,000
Total Annual Impact	28.5	3.8	89	990,000

On an ongoing basis, plant operation related to the upgrading of the Honouliuli WWTP would result in an estimated annual impact of $28.5 million in output, supporting about 90 jobs, earnings of $3.8 million, and fiscal revenues of $990,000. Providing each job represents one household and assuming the current average household size of 2.98 people in Honolulu County (USCB, 2014), direct, indirect, and induced jobs provided by these operations would support approximately 270 residents on average.

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Appendix H
Response to Comments and Comment Letters for Final Environmental Assessment-Environmental Impact Statement Preparation Notice (FEA-EISPN), July 2010

CHARLES K. DJOU
1ST DISTRICT, HAWAII

COMMITTEE ON ARMED SERVICES

COMMITTEE ON THE BUDGET

Congress of the United States
House of Representatives
Washington, DC 20515-1101

1502 LONGWORTH HOUSE OFFICE BUILDING
WASHINGTON, DC 20515-1101
(202) 225-2726

300 ALA MOANA BOULEVARD
ROOM 4-104
HONOLULU, HI 96850
(808) 541-2570

www.djou.house.gov

RECEIVED
AUG 12 2010
AECOM

August 6, 2010

Mr. Lambert Yamashita
Water/ Wastewater Manager of AECOM
AECOM Technical Services, Inc.
1001 Bishop Street, Suite 1600
Honolulu, HI 96813-3698

Aloha Mr. Yamashita,

Mahalo for taking the time to contact me and for sharing your views on the Honouliuli/Waipahu/Pearl City Wastewater Facilities Plan's Final Environmental Assessment . By hearing your thoughts and concerns on the issues, I am better able to represent you in Congress.

Environmental issues are very important to me as your Representative and it is helpful for me to have the benefit of your personal perspective on this issue. I strongly believe that any infrastructure improvement in Hawai'i must not impact the local environment. Be assured that as this or related matters come before the House of Representatives, I will keep your views in mind.

Again, mahalo for contacting me. It is an honor to represent you in the U.S. House of Representatives. Please do not hesitate to contact me if my office can be of assistance to you or on any issue of importance to you.

To stay informed on other important issues, I encourage you to sign up for my electronic newsletter at www.djou.house.gov.

Aloha and Best Wishes,

CHARLES K. DJOU
Member of Congress

CKD/BMS

United States Department of Agriculture

NRCS

Natural Resources Conservation Service
P.O. Box 50004 Rm. 4-118
Honolulu, HI 96850
808-541-2600

September 3, 2010

Marisol Olaes
City and County of Honolulu
Department of Environmental Services
1000 Uluohia Street, Suite 308
Kapolei, Hawaii 96707

Dear Ms. Olaes,

Thank you for providing the NRCS the opportunity to review the Final Environmental Assessment/Environmental Impact Statement Preparation Notice for the Honouliuli/Waipahu/Pearl City Wastewater Facilities Plan, Phase 1, Oahu, Hawaii. Please find enclosed the NRCS maps indicating areas of Important Farmlands and hydric soils. The Important Farmlands map has been enclosed for your aid in determining if a Farmland Impact Conversion Rating Form (AD-1006) is needed for this project. Typically, this form is required on projects that convert farmlands into non-farmland uses, and have federal dollars attached to the project. See the website link below for more information on the Farmland Protection Policy Act (FPPA), and a copy of the AD-1006 form, with instructions. Areas committed to or already in urban development are not subject to FPPA. In addition, hydric soils are located in the project area. The hydric soils map also enclosed, shows the areas of hydric soils. Hydric soils identify potential areas of wetlands. If wetlands do exist, any proposed impacts to these wetlands would need to demonstrate compliance with the "Clean Water Act", and may need an Army Corp of Engineers 404 permit.

There are numerous soil types located within the project area identified by the NRCS Soil Survey. The soils have various properties and interpretations that would inform the soils potentials for the development of wastewater facilities. If you have any questions concerning the soils in the area please contact Tony Rolfes as detailed below.

The NRCS Soil Survey is a general planning tool and does not eliminate the need for an onsite investigation. If you have any questions concerning the soils or interpretations for this project please call, Tony Rolfes, Assistant State Soil Scientist, (808) 541-2600 x129, or email, Tony.Rolfes@hi.usda.gov.

NRCS - Farmland Protection Policy Act Website:
http://www.nrcs.usda.gov/programs/fppa/

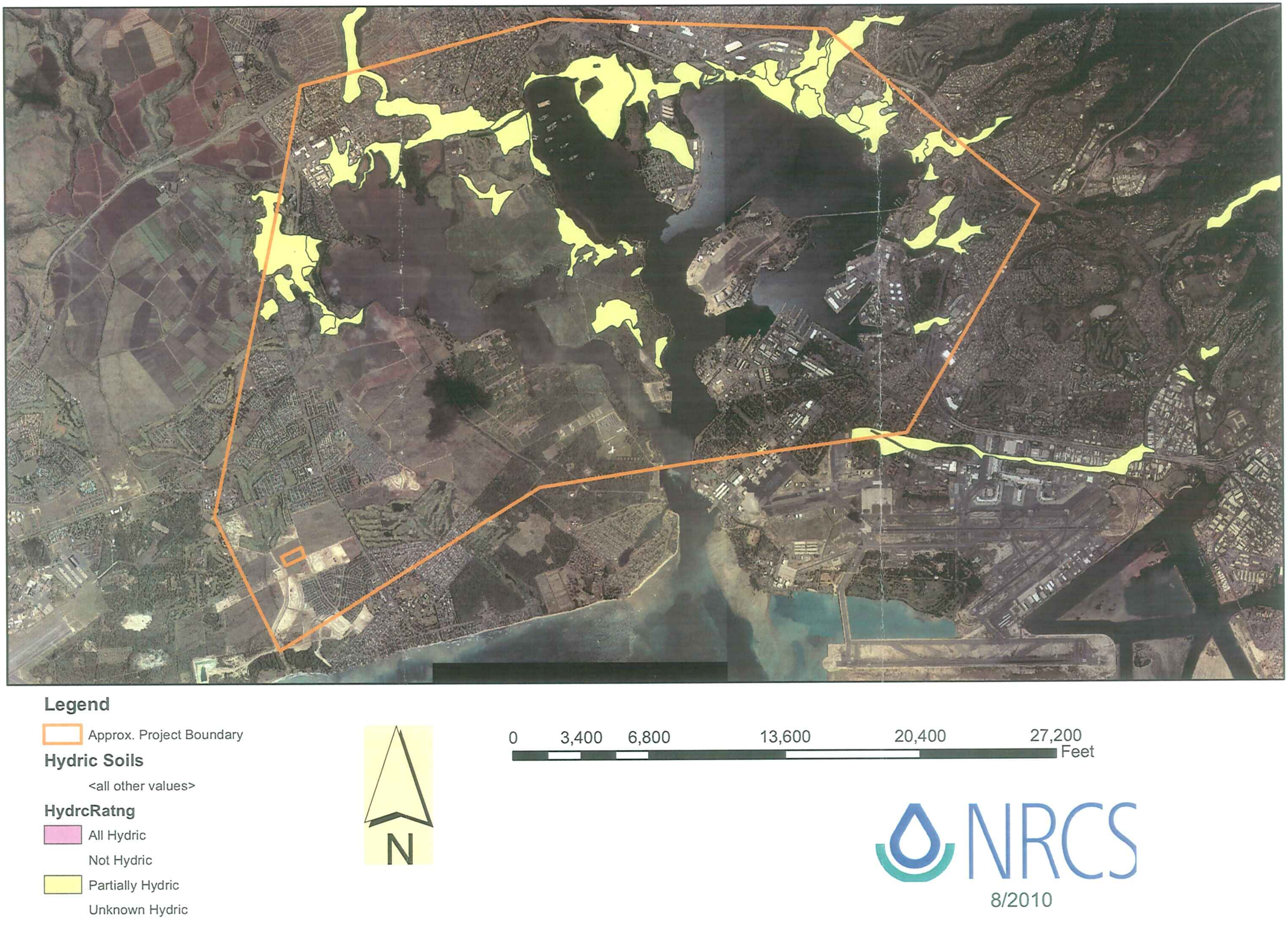
Sincerely,

LAWRENCE T. YAMAMOTO
Director
Pacific Islands Area

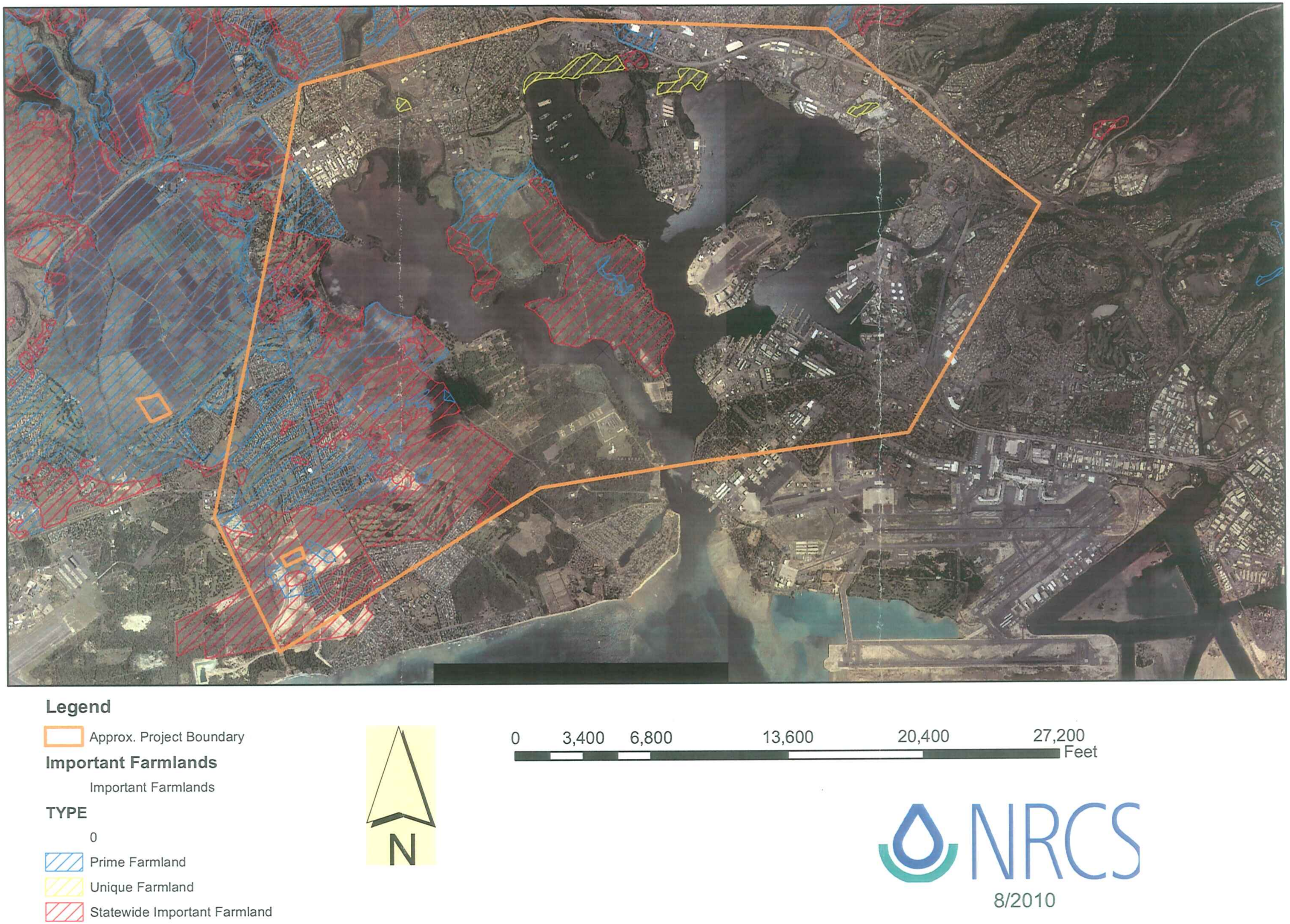
Attachments: Honouliuli/Waipahu/Pearl City Wastewater Facilities Project Important Farmlands Map
Honouliuli/Waipahu/Pearl City Wastewater Facilities Project Hydric Soils Map

cc: Michael Robotham, Asst. Director SS & NRA, Pacific Islands Area State Office

Honouliuli/Waipahu/Pearl City Wastewater Facilities Project
Hydric Soils Map



Honouliuli/Waipahu/Pearl City Wastewater Facilities Project
Important Farmlands Map



LINDA LINGLE
GOVERNOR

RUSS K. SAITO
COMPTROLLER

STATE OF HAWAI'I
DEPARTMENT OF ACCOUNTING AND GENERAL SERVICES
P.O. BOX 119, HONOLULU, HAWAII 96810-0119

OCT 12 2010

(P)1252.0

RECEIVED OCT 14 2010

Mr. Lambert Yamashita, PE
AECOM
1001 Bishop Street, Suite 1600
Honolulu, Hawai'i 96813

Dear Mr. Yamashita:

Subject: City and County of Honolulu
Honouliuli / Waipahu / Pearl City Wastewater Facilities Plan,
Ewa and Central Oahu

As discussed in our September 29, 2010 meeting, the Department of Accounting and General Services (DAGS) requests that you address the following changes in your plan regarding the segment that runs through Aloha Stadium property:

1. Realign the sewer main and easement as close to Salt Lake Boulevard and Kamehameha Highway as possible.

2. Locate a new pump station further Diamond Head of the existing station, along Salt Lake Boulevard and enable the existing pump house structure to be redeveloped into a new comfort station for stadium patrons.

3. Provide DAGS with a list of restraints relative to construction of operations/activities on/near the easement for the proposed sewer main.

If you have any questions, please call me at 586-0400 or have your staff call Mr. Ernest Lau of the Public Works Division at 586-0526.

Sincerely,

Russ K. Saito

RUSS K. SAITO
State Comptroller

DD:lnn
c: Ms. Linda Rosehill, Rosehill & Assoc.
Mr. Scott Chan, Aloha Stadium

LINDA LINGLE
GOVERNOR

RUSS K. SAITO
COMPTROLLER

STATE OF HAWAI'I
DEPARTMENT OF ACCOUNTING AND GENERAL SERVICES
P.O. BOX 119, HONOLULU, HAWAII 96810-0119

AUG 2 6 2010

(P)1226.0

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AUG 2 7 2010
AECOM

Mr. Lambert Yamashita
Water/Wastewater Manager
AECOM
1001 Bishop Street, Suite 1600
Honolulu, Hawai'i 96813

Dear Mr. Yamashita:

Subject: Final Environmental Assessment/Environmental Impact Statement Preparation Notice (FEA/EISPN) for the Honouliuli/Waipahu/Pearl City Wastewater Facilities Plan, Phase I Area Oahu, Hawai'i

Thank you for the opportunity to provide comments for the subject facility plan. The proposed project does not impact any of the Department of Accounting and General Services' projects or existing facilities, and we have no comments to offer at this time.

If you have any questions, please call me at 586-0400 or have your staff call Ms. Gayle Takasaki of the Public Works Division at 586-0584.

Sincerely,

Russ K Saito

RUSS K. SAITO
State Comptroller

GT:lnn

LINDA LINGLE
GOVERNOR

ROBERT G. F. LEE
MAJOR GENERAL
ADJUTANT GENERAL

GARY M. ISHIKAWA
BRIGADIER GENERAL
DEPUTY ADJUTANT GENERAL

STATE OF HAWAII
DEPARTMENT OF DEFENSE
OFFICE OF THE ADJUTANT GENERAL
3949 DIAMOND HEAD ROAD
HONOLULU, HAWAII 96816-4495

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SEP 15 2010
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September 10, 2010

Mr. Lambert Yamashita, P.E.
Water/Waste Water Manager
AECOM Technical Services, Inc.
1001 Bishop Street, Suite 1600
Honolulu, Hawaii 96813

Subject: Final Environmental assessment/Environmental Impact Statement Preparation Notice (FEA/EISPN), Honouliuli/Waipahu/Pearl City Wastewater Facility Plan Phase 1 Area

WE ARE SENDING YOU:

Item	Copies	Description
1	1	Jointed review responses on the Final Environmental Assessment/Environmental Impact Statement Preparation Notice (FEA/EISPN), Honouliuli/Waipahu/Pearl City Wastewater Facility Plan Phase 1 Area

This is in response to your letter regarding the subject above. Please see our attached response from the Department of the Defense.

Thank you for giving us the opportunity to comment on the above Draft Environmental Assessment.
Should you have any questions, please contact Rodney Huang in the Engineering Office at 733-4250.

Sincerely,

Neal S. Mitsuyoshi, P.E.
Lieutenant Colonel
Chief Engineering Officer

Attachment

RO060111

16 August 2010

Hawaii State Civil Defense Comments:

RE: Final Environmental Assessment/Environmental Impact Statement Preparation Notice (FEA/EISPN) for the Honouliuli/Waipahu/Pearl City Wastewater Facilities Plan, Phase 1 Area, Oahu, Hawaii

- Upon review it has been determined that the scope of the project (the main conveyance system from Halawa WWPS to Waimalu WWPS to Pearl City WWPS to Waipahu WWPS to Honouliuli WWTP) although bordering an area of concern in the event of a Tsunami, falls outside present and potential Tsunami inundation zones, except where the Phase I Area crosses West Loch.

- It was found that although consideration has been given to mitigation measures in response to the impact of hurricanes and tsunamis on construction and operation (Sec. 4.4, pg 79), this section could be expanded to include a fuller description of planned actions in response to such threats.

- All the Wastewater Pump Stations associated with the Phase I Area are outside the Tsunami Evacuation Zones. Although the Kunia WWPS, West Loch Estates WWPS, and West Lock Fairways WWPS are bordering the tsunami evacuation zones, they are not in the inundation zones and should not be adversely affected by a tsunami event.

LINDA LINGLE
GOVERNOR

~~PATRICIA HAMAMOTO~~
~~SUPERINTENDENT~~
KATHRYN S. MATAYOSHI
INTERIM SUPERINTENDENT

STATE OF HAWAI'I
DEPARTMENT OF EDUCATION
P.O. BOX 2360
HONOLULU, HAWAI'I 96804

OFFICE OF SCHOOL FACILITIES AND SUPPORT SERVICES
[redacted]

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August 17, 2010

Mr. Lambert Yamashita, P.E.
AECOM Technical Service, Inc.
1001 Bishop Street, Suite 1600
Honolulu, Hawaii 96813

Dear Mr. Yamashita:

SUBJECT: Honouliuli/Waipahu/Pearl City Wastewater Facilities Plan – Phase 1 Area Final Environmental Assessment/Environmental Impact Statement Preparation Notice (FEA/EISPN)

The Department of Education has reviewed your letter requesting comments on the Honouliuli/Waipahu/Pearl City Wastewater Facilities Plan – Phase 1 Area Final Environmental Assessment/Environmental Impact Statement Preparation Notice (FEA/EISPN). We request detailed information on any and all impacts and proposed mitigation measures that are specific to Lehua Elementary and Pearl Ridge Elementary schools.

Should you have any questions, please do not hesitate to call Roy Ikeda of the Facilities Development Branch, Planning Section at 377-8301.

Sincerely yours,

Duane Y. Kashiwai
Public Works Administrator
Facilities Development Branch

DYK:jmb

c: Marisol Olaes, City and County of Honolulu, Dept. of Environmental Services

LINDA LINGLE
GOVERNOR
STATE OF HAWAI'I

KAULANA H. R. PARK
CHAIRMAN
HAWAIIAN HOMES COMMISSION

ANITA S. WONG
DEPUTY TO THE CHAIRMAN

ROBERT J. HALL
EXECUTIVE ASSISTANT

STATE OF HAWAI'I
DEPARTMENT OF HAWAIIAN HOME LANDS
P.O. BOX 1879
HONOLULU, HAWAI'I 96805

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AUG - 4 2010
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July 30, 2010

AECOM Technical Services, Inc.
Attn: Mr. Lambert Yamashita, P.E.
Suite 1600
1001 Bishop Street
Honolulu, Hawaii 96813

Dear Mr.Yamashita:

Subject: Final Environmental Assessment/Environmental Impact Statement Preparation Notice (FEA/EISPN) for the Honuliuli/Waipahu/Pearl City Wastewater Facilities Plan, Phase I Area, Oahu, Hawaii

Thank you for the opportunity to review the subject proposal. The Department of Hawaiian Home Lands has no comment to offer at this time.

If you have any questions, please contact our Planning Office at (808) 620-9480.

Aloha and mahalo,

Kaulana H.R. Park, Chairman
Hawaiian Homes Commission

LINDA LINGLE
GOVERNOR OF HAWAII

CHIYOME L. FUKINO, M.D.
DIRECTOR OF HEALTH

STATE OF HAWAII
DEPARTMENT OF HEALTH
P.O. BOX 3378
HONOLULU, HAWAII 96801-3378

In reply, please refer to:
EMD / CWB

08016PDCL.10

August 9, 2010

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AUG 11 2010
AECOM

Mr. Lambert Yamashita, P.E.
Water/Wastewater Manager
AECOM
1001 Bishop Street, Suite 1600
Honolulu, Hawaii 96813

Dear Mr. Yamashita:

**Subject: Final Environmental Assessment/
Environmental Impact Statement Preparation Notice for the
Honouliuli/Waipahu/Pearl City Wastewater Facilities Plan, Phase 1
Island of Oahu, Hawaii**

The Department of Health (DOH), Clean Water Branch (CWB), has reviewed the subject document and has no comments at this time. The DOH-CWB provided Environmental Assessment/Environmental Impact Statement Preparation Notice Pre-Assessment Consultation comments for this project (Letter No. 12071PDCL.09, dated December 21, 2009).

As a reminder, all discharges related to the project construction or operation activities, whether or not National Pollutant Discharge Elimination System permit coverage and/or Section 401 Water Quality Certification are required, must comply with the Water Quality Standards. Noncompliance with water quality requirements contained in HAR, Chapter 11-54, and/or permitting requirements, specified in HAR, Chapter 11-55, may be subject to penalties of $25,000 per day per violation.

If you have any questions, please visit our website at http://www.hawaii.gov/health/environmental/water/cleanwater/index.html, or contact the Engineering Section, CWB, at 586-4309.

Sincerely,

Alec Wong

ALEC WONG, P.E., CHIEF
Clean Water Branch

DCL:ml

c: DOH-EPO #I-3277 (w/Land Use Document)
Ms. Marisol Olaes, CCH-DES

LINDA LINGLE
GOVERNOR OF HAWAII

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SEP - 7 2010
AECOM

STATE OF HAWAII
DEPARTMENT OF HEALTH

P.O. BOX 3378
HONOLULU, HAWAII 96801

CHIYOME LEINAALA FUKINO, M.D.
DIRECTOR OF HEALTH

In reply, please refer to:
EMD / WB
LUD-1 9 1 013 007-ID#462
Final EA EISPN
Honouliuli WW Fac Plan

September 2, 2010

Ms. Marisol Olaes
City & County of Honolulu
Department of Environmental Services
1000 Uluohia Street Suite 308
Kapolei, Oahu, Hawaii 96707

Dear Ms. Olaes:

Subject: Final Environmental Assessment / Environment Impact Statement Preparation Notice (FEA/EISPN) for the Honouliuli / Waipahu / Pearl City Wastewater Facilities Plan, Phase I Area, Oahu, Hawaii 91-1000 Gieger Road, Ewa Beach, HI 96706

Thank you for allowing us the opportunity to review the FINAL Environmental Assessment / Environment Impact Statement Preparation Notice (FEA/EISPN) document for the Honouliuli / Waipahu / Pearl City Wastewater Facilities Plan, Phase I Area.

We are always satisfied with having improvements considered for our existing wastewater systems and have no additional comments on the FINAL EA / EISPN.

Should you have any questions, please contact the Planning & Design Section of the Wastewater Branch at phone 586-4294.

Sincerely,

Sina Pruder

SINA PRUDER, P.E., ACTING CHIEF
Wastewater Branch

c: DOH's Environmental Planning Office (EPO I-3277)
✓Mr. Lambert Yamashita, AECOM

LINDA LINGLE
GOVERNOR

LILLIAN B. KOLLER
DIRECTOR

HENRY OLIVA
DEPUTY DIRECTOR

STATE OF HAWAII
DEPARTMENT OF HUMAN SERVICES
Benefit, Employment & Support Services Division
820 Mililani Street, Suite 606
Honolulu, Hawaii 96813

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AUG 19 2010
AECOM

August 13, 2010

Mr. Lambert Yamashita, P.E.
AECOM
1001 Bishop Street, Suite 1600
Honolulu, Hawaii 96813

Dear Mr. Yamashita:

Thank you for your letter dated July 23, 2010, that requests the Department review the Final Environmental Assessment/Environmental Impact Statement Preparation Notice (FEA/EISPN) for the Honouliuli/Waipahu/Pearl City Wastewater Facilities Plan, Phase I Area, Oahu, Hawaii. The Director of the Department of Human Services (DHS) has forwarded your letter to me for a response.

After a review of the proposed project, we do not have any comments regarding any environmental impacts associated with the project. We, also, foresee an impact on the child care services in the community at this time that is similar to the impact on the 15 public schools listed in the vicinity of the project area.

If you have any questions or need further information, please contact Ms. Kathy Ochikubo, Child Care Program Specialist, at (808) 586-7058.

Sincerely,

Pankaj Bhanot

Pankaj Bhanot
Division Administrator

c: Lillian B. Koller, Director/Department of Human Services
Marisol Olaes, City & County of Honolulu
Department of Environmental Services

LINDA LINGLE
GOVERNOR

PEARL IMADA IBOSHI
DIRECTOR

COLLEEN Y. LaCLAIR
DEPUTY DIRECTOR

STATE OF HAWAII
DEPARTMENT OF LABOR AND INDUSTRIAL RELATIONS
830 PUNCHBOWL STREET, ROOM 321
HONOLULU, HAWAII 96813
www.hawaii.gov/labor
Phone: (808) 586-8844 / Fax: (808) 586-9099
Email: dlir.director@hawaii.gov

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AUG - 9 2010
AECOM

August 4, 2010

Mr. Lambert Yamashita, P.E.
AECOM
1001 Bishop Street, Suite 1600
Honolulu, Hawaii 96813

Dear Mr. Yamashita:

This is in response to your letter dated July 23, 2010, requesting our comments on the Final Environmental Assessment/Environmental Impact Statement Preparation Notice for the "Honouliuli/Waipahu/Pearl City Wastewater Facilities Plan, Phase 1 Area" project on the island of Oahu. The Department of Labor and Industrial Relations does not have any comments to offer at this time.

Should you have any questions, please call me at (808) 586-8844, or Mr. Patrick Fukuki, our Business Management Officer, at (808) 586-8888.

Sincerely,

Colleen Y. LaClair

for PEARL IMADA IBOSHI
Director

c: City and County, Department of Environmental Services

LINDA LINGLE
GOVERNOR OF HAWAII

LAURA H. THIELEN
CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES
COMMISSION ON WATER RESOURCE MANAGEMENT

RUSSELL Y. TSUJI
ACTING FIRST DEPUTY

LENORE N. OHYE
DEPUTY DIRECTOR - WATER

AQUATIC RESOURCES
BOATING AND OCEAN RECREATION
BUREAU OF CONVEYANCES
COMMISSION ON WATER RESOURCE MANAGEMENT
CONSERVATION AND COASTAL LANDS
CONSERVATION AND RESOURCES ENFORCEMENT
ENGINEERING
FORESTRY AND WILDLIFE
HISTORIC PRESERVATION
KAHOOLAWE ISLAND RESERVE COMMISSION
LAND
STATE PARKS

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
DIVISION OF AQUATIC RESOURCES
1151 PUNCHBOWL STREET, ROOM 330
HONOLULU, HAWAII 96813

August 19, 2010

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AUG 26 2010
AECOM

Mr. Lambert Yamashita
AECOM
1001 Bishop Street, Suite 1600
Honolulu, HI 96813

Mr. Yamashita:

Attached you will find our comments on the Honoluiuli/Waipahu/Pearl City Wastewater Facilities Plan, Phase 1 Area FEA/EIS PN. These comments are those of the Division of Aquatic Resources and do not necessarily represent the comments of the Department of Land and Natural Resources or the State of Hawaii.

Should you have any questions, please contact Mr. Brett Schumacher of my staff at 587-0113 or at Brett.D.Schumacher@hawaii.gov.

Sincerely,

Robert Nishimoto
Program Manager

Cc: Comments on FEA/EISPN

Subject: Final Environmental Assessment/Environmental Impact Statement Preparation Notice for Honouliuli/Waipahu/Pearl City Wastewater Facilities Plan Phase 1 Area

Thank you for the opportunity to comment on the FEA/EISPN for Phase 1 of the wastewater facilities plan (FEA/EISPN).

The Division of Aquatic Resources (DAR) notes that several sanitary sewer overflows and other spills have occurred over the last several years, and strongly endorses changes and upgrades to the wastewater management system that will decrease the frequency and severity of such events.

As the FEA/EISPN indicates, the proposed project has the potential to prevent water pollution events in freshwater streams, the Pearl Harbor estuary, and nearshore marine waters. Suspended solids, pollutants and nutrient loads in these waters can have direct effects on resident aquatic organisms. The FEA/EISPN indicates that a biological assessment of the flora and fauna of these areas will be included in the DEIS. The DAR will reserve comment on specific aquatic resource species pending the results of these investigations, but has the following more general comments at this time:

1. The discharge of untreated wastewater can have profound, detrimental effects on aquatic organisms. As such, the DAR strongly supports the timely implementation of GST and other upgrades to the wastewater disposal system as a means of preventing such discharges in the future.

2. Studies at large (e.g. sewer outfall) and small (e.g. mariculture) eutrophication sites, and the experience of DAR biologists indicate that eutrophication can result in altered redox potential of benthic sediments, and in changes to algal, infaunal and associated aquatic communities. Eutrophication of epipelagic waters can result in ephemeral phytoplankton blooms that can also be detrimental to the marine ecosystem. Therefore, DAR strongly supports plans to upgrade wastewater treatment facilities to full secondary treatment, and to replace individual wastewater systems with more effective centralized treatment systems.

3. The FEA/EISPN makes frequent reference to 2-yr, 6-hr storms in reference to how the wastewater treatment system is likely to perform in response to heavy rain events. However, given that the life expectancy of the upgraded wastewater treatment system will be on the order of decades, it would be useful to include supplementary information in the DEIS about the expected performance of the alternative systems during larger, though less frequent, weather events.

Thank you again for the opportunity to comment on the proposed plan.

LINDA LINGLE
GOVERNOR

STATE OF HAWAII
DEPARTMENT OF TRANSPORTATION
869 PUNCHBOWL STREET
HONOLULU, HAWAII 96813-5097

BRENNON T. MORIOKA
DIRECTOR

Deputy Directors
MICHAEL D. FORMBY
FRANCIS PAUL KEENO
JIRO A. SUMADA

IN REPLY REFER TO:

HWY-PS
2.6468

RECEIVED
SEP 21 2010

September 20, 2010

Mr. Lambert Yamashita
AECOM Technical Services, Inc.
1001 Bishop Street, Suite 1600
Honolulu, Hawaii 96813

Dear Mr. Yamashita:

Subject: Final Environmental Assessment/Environmental Impact Statement Preparation Notice (FEA/EISPN), Honouliuli/Waipahu/Pearl City Wastewater Facilities Plan, Phase 1 Area, Oahu, Hawaii

The FEA/EISPN is for a Phase 1 project to upgrade and/or expand the wastewater conveyance system within the Honouliuli sewer contributory area to the Honouliuli Wastewater Treatment Plant.

It is anticipated that this project will not impact our State highway facilities after completion of the construction work. However, during construction there may be impacts to the State Highways. To this end, coordination and best practices shall be used to minimize traffic impacts and inconvenience to the users of the State highway during construction.

The project traffic impact report should document expected changes in staffing at project facilities, if applicable, and provide for improvements as needed.

If you have any questions, please contact Ken Tatsuguchi, Engineering Program Manager, Highways Division, Planning Branch, at 587-1830. Please reference review 2010-168.

Very truly yours,

BRENNON T. MORIOKA, Ph.D., P.E.
Director of Transportation

c: Marisol Olaes, Department of Environmental Services

BOARD OF WATER SUPPLY

CITY AND COUNTY OF HONOLULU
630 SOUTH BERETANIA STREET
HONOLULU, HI 96843

January 13, 2010

Mr. Lambert Yamashita
Water/Wastewater Manager
AECOM Pacific, Inc.
841 Bishop Street, Suite 1900
Honolulu, Hawaii 96813

Dear Mr. Yamashita:

Subject: Your Letter of November 30, 2009 Regarding the Environmental Assessment/Environmental Impact Statement Preparation Notice Pre-Assessment Consultation for the Honouliuli/Waipahu/Pearl City Wastewater Facilities Plan, Ewa and Central Oahu, Hawaii

Thank you for your letter requesting comments on the proposed Honouliuli/Waipahu/Pearl City Wastewater Facilities Plan.

We have the following comments:

1. Water system improvements in the vicinity of the Honouliuli Wastewater Treatment Plant (WWTP) may be required to improve the reliability of the existing potable water system and for the potential expansion of the Honouliuli WWTP.

2. Please submit any requests for additional potable water or recycled water for Board of Water Supply (BWS) review.

3. Construction drawings should be submitted for BWS review as part of the building permit application process.

4. The availability of water will be confirmed when the building permit application is submitted for review and approval.

5. We recommend the use of drought tolerant/low water use plants and xeriscaping principles for all landscaping. We also recommend the installation of an efficient irrigation system, such as drip irrigation, incorporating moisture sensors to avoid the operation of the system in the rain and if the ground has adequate moisture.

6. We reserve further comments until the Environmental Assessment/ Environmental Impact Statement Preparation Notice is submitted for our review.

If there are any questions, please contact Scot Muraoka at 748-5942.

Sincerely,

Wayne M Hashiro

WAYNE M. HASHIRO, P.E.
Manager and Chief Engineer

BOARD OF WATER SUPPLY

CITY AND COUNTY OF HONOLULU
630 SOUTH BERETANIA STREET
HONOLULU, HI 96843

August 19, 2010

Mr. Lambert Yamashita, P.E.
AECOM Technical Services, Inc.
1001 Bishop Street, Suite 1600
Honolulu, Hawaii 96707

Dear Mr. Yamashita:

Subject: Your Letter Dated July 23, 2010 Requesting Comments on the Final Environmental Assessment/Environmental Impact Statement Preparation Notice for the Honouliuli/Waipahu/Pearl City Wastewater Facilities Plan, Phase 1 Area

Thank you for the opportunity to comment on the proposed project.

Our comments dated January 13, 2010, which is included in the document, are still applicable.

If you have any questions, please contact Robert Chun at 748-5443.

Very truly yours,

PAUL S. KIKUCHI
Chief Financial Officer
Customer Care Division

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

KIRK CALDWELL
ACTING MAYOR

CRAIG I. NISHIMURA, P.E.
DIRECTOR

COLLINS D. LAM, P.E.
DEPUTY DIRECTOR

RECEIVED
AUG 3 1 2010
AECOM

August 26, 2010

Mr. Lambert Yamashita, P.E.
AECOM Technical Services, Inc.
1001 Bishop Street, Suite 1600
Honolulu, Hawaii 96813

Dear Mr.Yamashita:

Subject: Final Environmental Assessment/ Environmental Impact Statement Preparation Notice (FEA/ EISPN) for the Honouliuli / Waipahu/ Pearl City Wastewater Facilities Plan, Phase1 Area, Oahu, Hawaii

Thank you for inviting us to review the above Final Environmental Assessment/ Environmental Impact Statement Preparation Notice. The Department of Design and Construction does not have any comments to offer at this time.

Should you have any questions, please contact me at 768-8480.

Very truly yours,

Collins D. Lam

Craig I, Nishimura, P.E.
Director

CN:pg(376930)

DEPARTMENT OF FACILITY MAINTENANCE

CITY AND COUNTY OF HONOLULU

1000 Uluohia Street, Suite 215, Kapolei, Hawaii 96707
Phone: (808) 768-3343 • Fax: (808) 768-3381
Website: www.honolulu.gov

KIRK W. CALDWELL
ACTING MAYOR

JEOFFREY S. CUDIAMAT, P.E.
DIRECTOR AND CHIEF ENGINEER

GEORGE "KEOKI" MIYAMOTO
DEPUTY DIRECTOR

IN REPLY REFER TO:
DRM 10-628

August 19, 2010

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AUG 20 2010
AECOM

Mr. Lambert Yamashita, P.E.
AECOM Technical Services, Inc.
1001 Bishop Street, Suite 1600
Honolulu, Hawaii 96813

Dear Mr. Yamashita:

Subject: Final Environmental Assessment/Environmental Impact Statement Preparation Notice (FEA/EISPN) for the Honouliuli/Waipahu/Pearl City Wastewater Facilities Plan, Phase I Area, Oahu, Hawaii

Thank you for the opportunity to provide comments on the FEA/EISPN dated July 2010 for the subject Honouliuli/Waipahu/Pearl City Wastewater Facilities Plan.

We have no additional comments to offer. We appreciate that our earlier concerns regarding open trench construction and subsequent backfill material to be considered, expressed during the pre-assessment consultation for the project, have been addressed in this FEA/EISPN.

Should you have any questions, please call Charles Pignataro of the Division of Road Maintenance, at 768-3697.

Sincerely,

Jeoffrey S. Cudiamat, P.E.
Director and Chief Engineer

DEPARTMENT OF PARKS AND RECREATION

CITY AND COUNTY OF HONOLULU

KAPOLEI HALE, 1000 ULUOHIA STREET, STE. 309 • KAPOLEI, HAWAII 96707
Phone: (808) 768-3003 • FAX: (808) 768-3053 • Internet: www.honolulu.gov

KIRK W. CALDWELL
ACTING MAYOR

LESTER K. C. CHANG
DIRECTOR

RICHARD HARU
DEPUTY DIRECTOR

RECEIVED
AUG 17 2010
AECOM

August 13, 2010

Mr. Lambert Yamashita, P.E.
AECOM Technical Services, Inc.
1001 Bishop Street, Suite 1600
Honolulu, Hawaii 96813

Dear Mr. Yamashita:

Subject: Final Environmental Assessment/Environmental Impact Statement Preparation Notice (FEA/EISPN) for the Honouliuli/Waipahu/Pearl City Wastewater Facilities Plan, Phase I Area, Oahu, Hawaii

Thank you for the opportunity to review and comment on the Final Environmental Assessment/Environmental Impact Statement Preparation Notice for the Honouliuli/Waipahu/Pearl City Wastewater Facilities plan.

The Department of Parks and Recreation has no comment on the FEA/EISPN notice however; we appreciate that a project objective be stated to avoid any impairment of public use of the existing parks and that any unavoidable impacts will be reviewed in consultation with the department for acceptability before proceeding further.

We also want to alert you to the fact that Neal S. Blaisdell Park is subject to National Park Service 6(f) restrictions pursuant to a Land Water Conservation Grant to the City in 1990.

Should you have any questions, please contact Mr. John Reid, Planner, at 768-3017.

Sincerely,

LESTER K. C. CHANG
Director

LKCC:jr
(376785)

cc: Craig Mayeda, PMRS
Dexter Liu, D-3

DEPARTMENT OF PLANNING AND PERMITTING
CITY AND COUNTY OF HONOLULU
650 SOUTH KING STREET, 7TH FLOOR • HONOLULU, HAWAII 96813
PHONE: (808) 768-8000 • FAX: (808) 768-6041
DEPT. WEB SITE: www.honoluludpp.org • CITY WEB SITE: www.honolulu.gov

KIRK W. CALDWELL
ACTING MAYOR

DAVID K. TANOUE
DIRECTOR

ROBERT M. SUMITOMO
DEPUTY DIRECTOR

10WWB050 (SG)
2010/ELOG-1524

September 8, 2010

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SEP 10 2010
AECOM

Mr. Lambert Yamashita, P.E.
AECOM
1001 Bishop Street, Suite 1600
Honolulu, Hawaii 96813

Dear Mr. Yamashita:

Subject: Final Environmental Assessment/Environmental Impact Statement Preparation Notice (FEA/EISPN) for the Honouliuli/Waipahu/Pearl City Wastewater Facilities Plan, Phase I Area

This is in response to your July 23, 2010 letter, requesting comments for the proposed Honouliuli/Waipahu/Pearl City Wastewater Facilities Plan. We have reviewed the subject FEA/EISPN and have the following comments:

1. In Section 3.1, the population and flow projections use the year 2030. The Department of Planning and Permitting (DPP) uses the year 2035, which is available to the public and is included in our latest Annual Report (Fiscal Year 2008). The FEA/EISPN should explain why the year 2030 is deemed more appropriate than 2035. Mr. Steve Young of the Planning Research Branch (768-8037) can provide assistance on the 2035 projections.

2. Section 8.2.1 should describe how the proposed project supports relevant objectives and policies in the Oahu General Plan related to transportation and utilities. The General Plan can be viewed/printed from DPP's website: www.honoluludpp.org/Planning/OahuGenPlan.asp.

3. The term "Community Plan" in Section 8.2.2 should be changed to "Development Plan/Sustainable Communities Plan." The Phase I area encompasses portions of the Primary Urban Center Development Plan (PUC DP) area, Central Oahu Sustainable Communities Plan (CO SCP) area, and the Ewa DP area. As such, this section should be expanded by describing how the proposed project supports the relevant objectives, policies, principles, and guidelines in all three areas. The PUC and Ewa DP and CO SCP can be viewed/printed from DPP's website: www.honoluludpp.org/Planning/DevSustCommPlans.asp.

4. The project's scope affects several communities within the Ewa, CO, and PUC DP areas. As such, the project may affect other planning efforts created or under development by DPP. These plans include more detailed land use plans called Special

Area Plans (SAP) which provide more detailed policies, principles, and guidelines than those contained in the SCP or DP documents themselves. As such, the proposed project should discuss how the project would affect the "Waipahu Town Plan" (December 1995) and the "Aiea-Pearl City Livable Communities Plan" (May 2004).

The FEA/EISPN should also discuss the project's effect on the "Pearl Harbor Historic Trail Master Plan" (May 2001). While this plan is not a SAP, it involves long-range land use planning efforts along the shoreline between Waipahu and Aiea that is within the Honouliuli sewer shed.

The project proposes improvements to existing sewer facilities that run along or under major existing rights-of-way such as Farrington and Kamehameha Highways. As you may know, the City also intends to utilize portions of these major transportation corridors for its current rapid transit project. As part of the rapid transit project, DPP is currently working on several Transit-Oriented Development (TOD) plans that involve land use development around the transit stations. As such, the FEA/EISPN should discuss the project's consistency with the "Waipahu Neighborhood TOD Plan," "East Kapolei Neighborhood TOD Plan," and the ongoing "Aiea-Pearl City Neighborhood TOD Plan." Information about these TOD plans can be viewed on DPP's website: www.honoluludpp.org/Planning/, or by calling the Community Planning Branch at 768-8048.

5. All references to "Development Plan Public Facilities Map Amendment" in the Project Summary and Section 9.0 "Permits and Approvals" and other sections of the FEA/EISPN should be deleted because this term is no longer used by DPP. The new term that should be used is "Public Infrastructure Map Revision." The applicant will be required to submit applications to revise the PUC Public Infrastructure Map (PIM), CO PIM or the Ewa PIM should there be a need to develop new wastewater pump stations (WWPS) or modify existing WWPSs (including enlarging or relocating them) as part of this project. Revisions to the PIM must be approved by resolution by the City Council prior to the budgeting of land acquisition and/or construction funds for major municipal facilities such as WWPSs. A PIM revision to the Honouliuli Wastewater Treatment Plant (WWTP) will not be necessary because there are two existing symbols on the Ewa PIM (PIM #002 and #013) that will accommodate any future improvements to the Honouliuli WWTP, including expanding the existing site further north or west. Include a section in Section 8.2 to briefly discuss the PIMs and any revisions needed.

6. A Special Management Area (SMA) permit will be required before any other permits can be issued for the project. If a shoreline setback variance (SSV) is also required, a current certified shoreline survey must be obtained prior to applying for the SSV. Both the SMA and the SSV may be processed concurrently.

7. The project may require a trenching permit from DPP.

8. The project should address Section II (Storm Water Quality) of the "Rules Relating to Storm Drainage Standards."

9. Section 4.3.4 Flood Hazard - Existing Environment, page 75-76: Based on the TMK cited in the report, the Pearl City WWPS is within an AE zoned area. A large majority of this parcel is therefore subject to regulations for construction within a floodway.

10. Figures 4-8 and 4-9 seem to provide conflicting assessments of the flood potential for the Pearl City WWPS.

11. The last sentence on page 89 should read "This issue will be addressed . . ."

Should you have any questions on comment nos. 1 to 5, please contact Mr. Tim Hata of our Policy Planning Branch at 768-8043. For questions on comment no. 6 please contact Mr. Jamie Peirson of our Land Use Approval Branch at 768-8014. For questions on comment nos. 7 to 11, please contact Mr. Scott Gushi of our Wastewater Branch at 768-8207 for coordination.

Very truly yours,

Dennis M. Nishimura

For David K. Tanoue, Director
Department of Planning and Permitting

DKT:dl
[795319]

cc: Policy Planning Branch
CEB
Land Use Approval Branch

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

KIRK W. CALDWELL
ACTING MAYOR

KENNETH G. SILVA
FIRE CHIEF

ROLLAND J. HARVEST
DEPUTY FIRE CHIEF

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AUG - 5 2010
AECOM

August 3, 2010

Mr. Lambert Yamashita, P.E.
Water/Wastewater Manager
AECOM Technical Services, Inc.
1001 Bishop Street, Suite 1600
Honolulu, Hawaii 96813

Dear Mr. Yamashita:

Subject: Final Environmental Assessment/Environmental Impact Statement Preparation Notice
Honouliuli/Waipahu/Pearl City Wastewater Facilities Plan, Phase 1 Area
Tax Map Keys: 9-1-009: 112; 9-1-013: 007; 9-1-017; 006; 9-1-057: 022 and 028; 9-1-063: 113; 9-1-069: 003; 9-1-103: 001; 9-2-017: 001; 9-3-002: 009; 9-4-049: 047; 9-4-141: 086; 9-5-001: 033; 9-6-004: 005; 9-7-016: 001 and 028; 9-7-017: 002; 9-7-091: 071; 9-8-007: 008; and 9-9-003: 061 and 062

In response to your letter of July 23, 2010, regarding the above-mentioned subject, the Honolulu Fire Department (HFD) reviewed the material provided and requires that the following be complied with:

1. Provide a fire apparatus access road for every facility, building, or portion of a building hereafter constructed or moved into or within the jurisdiction when any portion of the facility or any portion of an exterior wall of the first story of the building is located more than 150 feet (45 720 mm) from a fire apparatus access road as measured by an approved route around the exterior of the building or facility. (1997 Uniform Fire Code, Section 902.2.1.)

2. Provide a water supply, approved by the county, capable of supplying the required fire flow for fire protection to all premises upon which facilities or buildings, or portions thereof, are hereafter constructed or moved into or within the county.

On-site fire hydrants and mains capable of supplying the required fire flow shall be provided when any portion of the facility or building is in excess of 150 feet (45 720 mm) from a water supply on a fire apparatus access road, as measured by an approved route around the exterior of the facility or building. (1997 Uniform Fire Code, Section 903.2 as amended.)

3. Submit civil drawings to the HFD for review and approval.

Should you have any questions, please call Battalion Chief Socrates Bratakos of our Fire Prevention Bureau at 723-7151.

Sincerely,

KENNETH G. SILVA
Fire Chief

KGS/SY:bh

cc: Marisol Olaes, Department of Environmental Services

Hawaiian Railway Society
A Chapter of the National Railway Historical Society
P.O. Box 60369, Ewa Station, Ewa Beach, HI 96706
(808) 681-5461 or Hawaiianrailway.com

November 27, 2010

RECEIVED
DEC 13 2010

Lambert Yamashita
AECOM
841 Bishop St. Suite1900
Honolulu, HI 96813

Dear Mr. Yamashita.

In response to our meeting on September 1, 2010.

It appears that Tunnel Alignment A will be sufficiently deep enough as it runs under the OR&L Right of Way that it shouldn't be a concern.

The vertical access tunnel (1Aips) is also sufficiently far enough from the OR&L corridor that our only concern with either tunnel would be damage done to the right of way or tracks caused by surface construction vehicles in the area.

Sincerely,

Pres

Robert Yatchmenoff
President, HRS