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JUN 23 2019

DEPARTMENT OF DESIGN AND CONSTRUCTION

CITY AND COUNTY OF HONOLULU

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CDD-A 19-774983

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OFC. OF ENVIRONMENTAL QUALITY CONTROL

June 7, 2019

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

Dear Mr. Glenn:

SUBJECT: Draft Environmental Assessment
Wailele Stream Flood Risk Management Project
Laie, Island of Oahu, Hawaii
TMK(s): Portions of [1] 5-5-006: 001, :005, :010,
[1] 5-5-001: 018, :057, and :058

With this letter, the City and County of Honolulu, Department of Design and Construction (DDC), in partnership with the Honolulu District, U.S. Army Corps of Engineers hereby transmits the Draft Environmental Assessment and Anticipated Finding of No Significant Impact (DEA-AFONSI) for the subject project in Wailele Stream located in Laie, Island of Oahu, Hawaii. Please publish the enclosed DEA-AFONSI in the next available issue of the Environmental Notice.

Enclosed a completed OEQC Publication Form, four (4) digital copies of the DEA-AFONSI, and an electronic copy of the publication form in MS Word.

Should you have any questions, please contact Dennis Toyama from our Civil Division at (808) 768-8837.

Very truly yours,

Robert J. Kroning, P.E.
Director

DT:pto
Enclosures

19-390

AGENCY
PUBLICATION FORM

Project Name:	Wailele Stream Flood Risk Management Project
Project Short Name:	Wailele Stream Flood Risk Management Project
HRS §343-5 Trigger(s):	Use of County funds
Island(s):	Oahu Island
Judicial District(s):	Koolauloa
TMK(s):	155006001, 155006005, 155006010, 155001018, 155001057, 155001058
Permit(s)/Approval(s):	Compliance with NEPA (National Environmental Policy Act) and associated statutory requirements Endangered Species Act, Fish and Wildlife Coordination Act, Magnuson-Stevens Fishery Conservation and Management Act, National Historic Preservation Act, Clean Air Act, Coastal Zone Management Act (Federal Consistency Determination), Clean Water Act (Section 404-Discharges in Waters of the U.S. Department of the Army permit, Section 402-National Pollutant Discharge Elimination System, Section 401-Water Quality Certification) Historic Sites Review (Chapter 6e, HRS) Stream Channel Alteration Permit (potential) Special Management Area Permit (potential) Conservation District Use Permit (potential) Community Noise Control Permit (potential) Work in County Right-of-Way (potential) Grading, Grubbing, Excavating and Stockpiling Permits (potential) Executive Order 12898-Environmental Justice, Executive Order 11988-Floodplain Management
Proposing/Determining Agency:	City and County of Honolulu, Department of Design and Construction
Contact Name, Email, Telephone, Address	Robert J. Kroning, P.E., Director City and County of Honolulu, Department of Design and Construction 650 South King Street, 11th Floor Honolulu, Hawaii 96813 P: (808) 768-8480 E: *rkroning@honolulu.gov*
Accepting Authority:	n/a
Contact Name, Email, Telephone, Address	n/a
Consultant:	n/a
Contact Name, Email, Telephone, Address	n/a

Status (select one)	**Submittal Requirements**
__X_ 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.
____ 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 Honolulu District, U.S. Army Corps of Engineers (Corps) is evaluating flood risk management problems and opportunities on the Wailele Stream, in Laie, Island of Oahu, Hawaii. The enclosed Integrated Feasibility Report and Environmental Assessment documents the planning process for evaluating potential flood risk management alternatives to demonstrate consistency with Corps planning policy and compliance with the National Environmental Policy Act and the State of Hawaii Chapter 343, Hawaiʻi Revised Statutes.

The Corps is the lead federal agency conducting this study. The non-Federal sponsor is the City and County of Honolulu, Department of Design and Construction. The purpose of the study is to reduce flood risks to nearby structures, property, and critical infrastructure. The tentatively selected plan includes improvements in channel geometry, construction of a weir and overflow channel designed to capture flows in excess of 675 cubic feet per second, and appurtenant energy dissipating structures at the outlet of the overflow channel, as required.

The Recommended Plan has an estimated construction cost of $13.8 million (2019 price levels). The project's benefits to cost ratio is 8.0 with anticipated net annual National Economic Development benefits of $4.6 million.

US Army Corps of Engineers

Draft Integrated Feasibility Report, Environmental Assessment and Finding of No Significant Impact

Wailele Flood Risk Management Section 205

Laie, Oahu, Honolulu District, Pacific Ocean Division

June 2019

Prepared by:
United States Army Corps of Engineers
Honolulu District

June 2019

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Finding of No Significant Impact

In accordance with the National Environmental Policy Act of 1969 (NEPA), as amended, the Honolulu District, U.S. Army Corps of Engineers (Corps) has selected the following action for construction and assessed its potential environmental effects:

Flood Risk Management Improvements (Section 205)
Wailele Stream (Laie), Hawaii

The Corps examined the feasibility and environmental effects of implementing flood risk management measures along Wailele Stream. The recommended plan, which is identified as the tentatively selected plan in the environmental assessment, maximizes net national economic development benefits while minimizing effects on the environment. Major construction features include:

- Improvements to the existing streambed to include changing channel geometry;
- Construction of a major drainage feature to capture overland sheet flows and divert them into the improved existing channel;
- Construction of an overflow channel with an approximate bottom width of 50 feet and an approximate depth of 8 feet throughout its length. This channel would be capable of working in conjunction with the existing natural channel to pass the 0.01 annual chance of exceedance event and would discharge its flows into a confined estuary;
- Construction of a weir at the divergence of the existing channel and the overflow channel to divert flows greater than 675 cubic feet per second;
- Appurtenant structures (such as erosion protection and energy dissipaters) as required to ensure proper project operation.

The Corps determined that this flood risk management project will have no adverse effect on species protected under the Endangered Species Act or the Marine Mammals Protection Act, or on essential fish habitat. The Corps, in conjunction with the State of Hawaii Historic Preservation Officer has determined that the action may adversely affect cultural or historical resources, under the National Historic Preservation Act and will work to put in place a programmatic agreement for mitigation during construction should cultural or historical resources be encountered. The Corps's proposed action will not, in association with past, present or anticipated future actions cause appreciable cumulative impacts.

I find that the Corps's environmental assessment substantively fulfills the requirements of NEPA and supports the conclusion that construction of the flood risk management project at Wailele Stream does not constitute a major Federal action significantly affecting the human environment. Analysis of the project's effects demonstrates, therefore, that an environmental impact statement is not required.

______________________________ ____________
Kathryn P. Sanborn, PhD, PE, PMP Date
Lieutenant Colonel, U.S. Army
District Engineer

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Executive Summary

This report examines the need for construction of flood risk management measures along Wailele Stream and determines the feasibility of Federal participation in the potential improvements.

Flood-related problems on this stretch of stream derive from the steep, short nature of the stream's watershed which lead to short-duration, high-flow events. These types of watersheds are common throughout the Hawaiian Islands, where stream valleys can sometimes be less than one mile from one another

This study evaluated a number of alternatives based on economic, engineering, environmental, and other factors. The tentatively selected plan maximizes the net National Economic Development benefits and has been selected as the National Economic Development Plan. The non-Federal partner (City and County of Honolulu) supports this plan, which is carried forward as the Recommended Plan. The Recommended Plan provides improvements in channel geometry, construction of a weir and overflow channel designed to capture flows through the system in exceedance of 675 cubic feet per second, and appurtenant structures required for energy dissipation at the outlet of the overflow channel, as required.

The Recommended Plan has an estimated construction cost of approximately $15.6 million (2019 price levels). The average annual cost of the project is $756,000. The annual cost of operation and maintenance is $45,000. The project's benefits to cost ratio is 6.1 with net annual National Economic Development benefits of $3.83 million

The local sponsor, City and County of Honolulu, will be required to pay the non-Federal share of 35 percent of the costs assigned to federally cost-shared flood risk management features of the project as specified by the Flood Control Act of 1948, as amended as well as 100 percent of the cost of associated non-Federal major drainage features. The estimated non-Federal share of construction is $6.6 million. The non-Federal partner will also be responsible for operation and maintenance of the project. The Federal share of the project is $9.0 million.

Pertinent Data

Recommended Plan	
Overflow Channel	
Length	1,200 feet
Thalweg Width	50 feet
Excavation	125,000 cubic yards
BYU Diversion Channel	
Length	1,100 feet
Thalweg Width	60 feet
Excavation	12,230 cubic yards
Culverts	
Number	3

Economic Information	
Item	**Amount**
Total Design and Construction Costs (including major drainage features)	$15,600,000
Annual Operation and Maintenance	$45,000
Total Annual National Economic Development Cost (50 years, 2.875%)	$756,000
Annual Benefits	$4,581,000
Average Net Annual Benefits	**$3,826,000**
Benefit to Cost Ratio	**6.1**

Note: Totals may not sum due to rounding.

Conversion Table for SI (Metric) Units		
Multiply	By	To Obtain
Cubic Yards (cy)	0.7646	Cubic Meters
Acre (ac)	0.4049	Hectare
Feet	0.3048	Meters
Feet Per Second	0.3048	Meters Per Second
Inches	2.5400	Centimeters
Knots (international)	0.5144	Meters Per Second
Miles (U.S. Statute)	1.6093	Kilometers
Miles (Nautical)	1.8520	Kilometers
Miles Per Hour	1.6093	Kilometers Per Hour
Pounds (mass) (lb)	0.4536	Kilograms

*To obtain Celsius (C) temperature readings from Fahrenheit (F) readings, use the following formula: C = (5/9)(F-32)

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1.0 INTRODUCTION

This chapter provides information on the study authority, area of concern, study participants, previous studies that contributed to this product and tasks remaining to be completed prior to the report being finalized.

1.1 Authority

This feasibility study is being conducted under authority granted by Section 205 of the Flood Control Act of 1948 (Public Law 80-858), as amended.

1.2 Scope of the Study

This study examines the feasibility and environmental effects of implementing flood risk management measures along Wailele Stream in Laie, Oahu, Hawaii. Laie is located on the northeastern coast (windward side) of the island of Oahu, approximately 30 miles north of Honolulu. The project area is shown below in Figure 1. The non-Federal partner for the feasibility study is the City and County of Honolulu. The study area is in Hawaii's Second Congressional District, which has the following congressional delegation: Senator Mazie Hirono (D); Senator Brian Schatz (D); and, Representative Tulsi Gabbard (D).

Engineer Regulation 200-2-2, "*Procedures for Implementing NEPA*", directs the contents of environmental assessments. This document and its appendices present the information required by both regulations as an integrated feasibility report and environmental assessment. It also complies with the requirements of the Council on Environmental Quality regulations for implementing the National Environmental Policy Act of 1969 (42 United States Code 4321 et seq.).

This Integrated Feasibility Report and Environmental Assessment documents the studies and coordination conducted to determine whether the Federal Government should participate in flood risk measures along Wailele Stream, Oahu, Hawaii. Studies of potential flood risk management measures considered a wide range of alternatives and the environmental consequences of those alternatives, but focused mainly on actions that would provide efficient and effective management of flood risk to the surrounding community. U.S. Army Corps of Engineer Regulation 1105-2-100, "*Planning Guidance Notebook*" defines the contents of feasibility reports for flood risk management measures. Engineer Regulation 1105-2-100 limits Federal participation in flood risk management projects to waterways with a minimum flow of 800 cubic feet per second at the 0.1 annual chance of exceedance event that drain watersheds with an area of at least 1.5 square miles. Wailele Stream qualifies under these parameters.

Flood risk management is a high priority mission for the Corps, and flood risks due to high flows along Wailele Stream generate sufficient National Economic Development benefits to allow the U.S. Army Corps of Engineers to recommend a project to Congress. The Corps of Engineers can only recommend to Congress flood risk management measures cost-shared by non-Federal partners. The City and County of Honolulu has stated its intention to cost-share in federally constructed flood risk management measures along Wailele Stream. This partnership of Federal and non-Federal interests in flood risk management measures helps ensure that those measures will effectively serve both local and national needs.

Figure 1: Study Area

1.3 Study Participants and Coordination

The Honolulu District, U.S. Army Corps of Engineers was primarily responsible for conducting studies for flood risk management measures at Laie. The studies that provide the basis for this report were conducted with the assistance of many individuals and agencies, including the City and County of Honolulu, United State Fish and Wildlife Service, the State of Hawaii Historic Preservation Officer, the State of Hawaii Department of Fish and Game, the State of Hawaii Department of Health, the State of Hawaii Department of Land and Natural Resources, and many members of the interested public who contributed information and constructive criticism to improve the quality of this report.

1.4 Related Studies and Reports

A listing of existing studies and reports that were used to inform the decision making involved in arriving at the recommended plan is listed in footnotes in this report and in Chapter 11.0 of this document. Additionally, various appendices accompany this document to provide additional technical information on various technical disciplines.

1.5 Remaining Tasks to Complete the Report

In an effort to be transparent, the project delivery team included this section in order to inform reviewers of the current status of the team's efforts. The project delivery team is working to address all remaining issues to ensure a high-quality, policy compliant final product is delivered. Some of these tasks include: fulfilling remaining coordination requirements with other agencies, finalizing a programmatic agreement that details how any cultural resources that are encountered during construction will be handled, and updating the cost estimate documentation to reflect the costs of cultural mitigation. The team continues to coordinate with the non-Federal partner and stakeholders as this study progresses toward completion.

2.0 PLANNING CRITERIA/PURPOSE AND NEED FOR THE PROPOSED ACTION

This chapter provides information on the purpose and need for proposed Federal action and establishes that there is a Federal interest in taking part in this cost-shared investigation with the non-Federal partner.

2.1 Problem Statement/Purpose and Need

The flood risk management problem along Wailele Stream that warrants Federal involvement can best be described as follows: due to previous alterations and channelization efforts, as well as a constriction at the culvert that passes underneath the Kamehameha Highway, Wailele Stream is unable to convey flows in exceedance of 675 cubic feet per second. For events exceeding this level of flow, water from Wailele Stream enters Laie town, inundating structures, and conveying pollutants from the urbanized area into the ocean.

The majority of Oahu is subject to some degree of periodic flooding due to the many streams that drain the area. The Laie area is characterized by multiple narrow stream valleys bordered by steep mountains that drain onto alluvial fans. Each of the streams (shown in Figure 2) drains steep, small watersheds that are subject to flash floods during high-precipitation events.

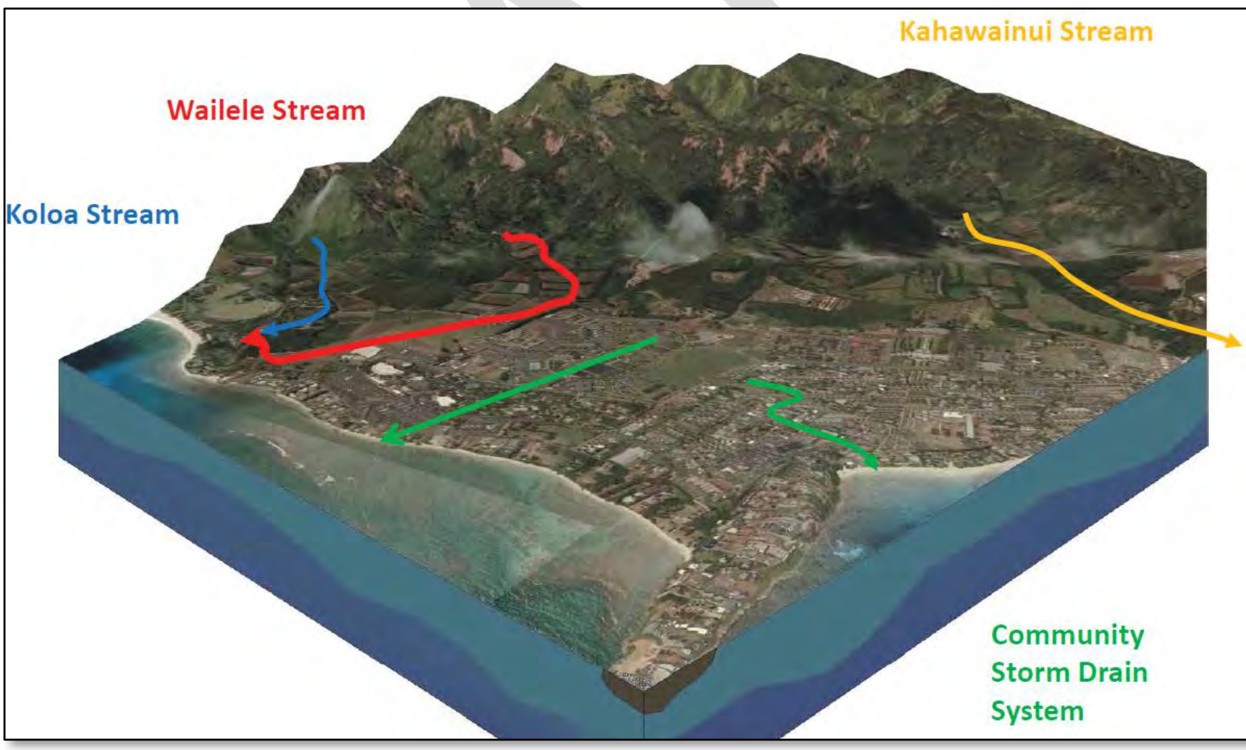


Figure 2: Laie Watersheds

As shown above, Kahawainui Stream passes to the north of Laie, while Wailele Stream passes just to the south, and with Koloa Stream, empties into a confined estuary known in local parlance as a "muliwai". The muliwai does not have an outlet to the ocean under normal flows, but avoids becoming stagnant by having freshwater discharges seep oceanward through the bordering sand berm during low tides, and saltwater seeping landward during high tides. During high flow events, the muliwai overflows and opens a channel into the ocean. Figure 3 shows the muliwai under normal conditions looking upstream toward the terminus of Wailele Stream with the terminus of Koloa Stream off picture just to the left.

Figure 3: Muliwai

During high flows, Wailele Stream jumps its left bank as it exits the mountains and flows through the urbanized area of Laie. These sheet flows pick up pollutants and trash and cause damage to structures and contents throughout the Laie Area (Figure 4). The floodwaters that enter Laie have only one exit at a culvert near the Foodland Shopping Center, approximately one mile to the north. The purpose of this study is to identify the environmentally acceptable plan that reasonably maximizes net annual National Economic Development benefits in accordance with all applicable laws and policies in order to meet the flood risk management needs of the community of Laie.

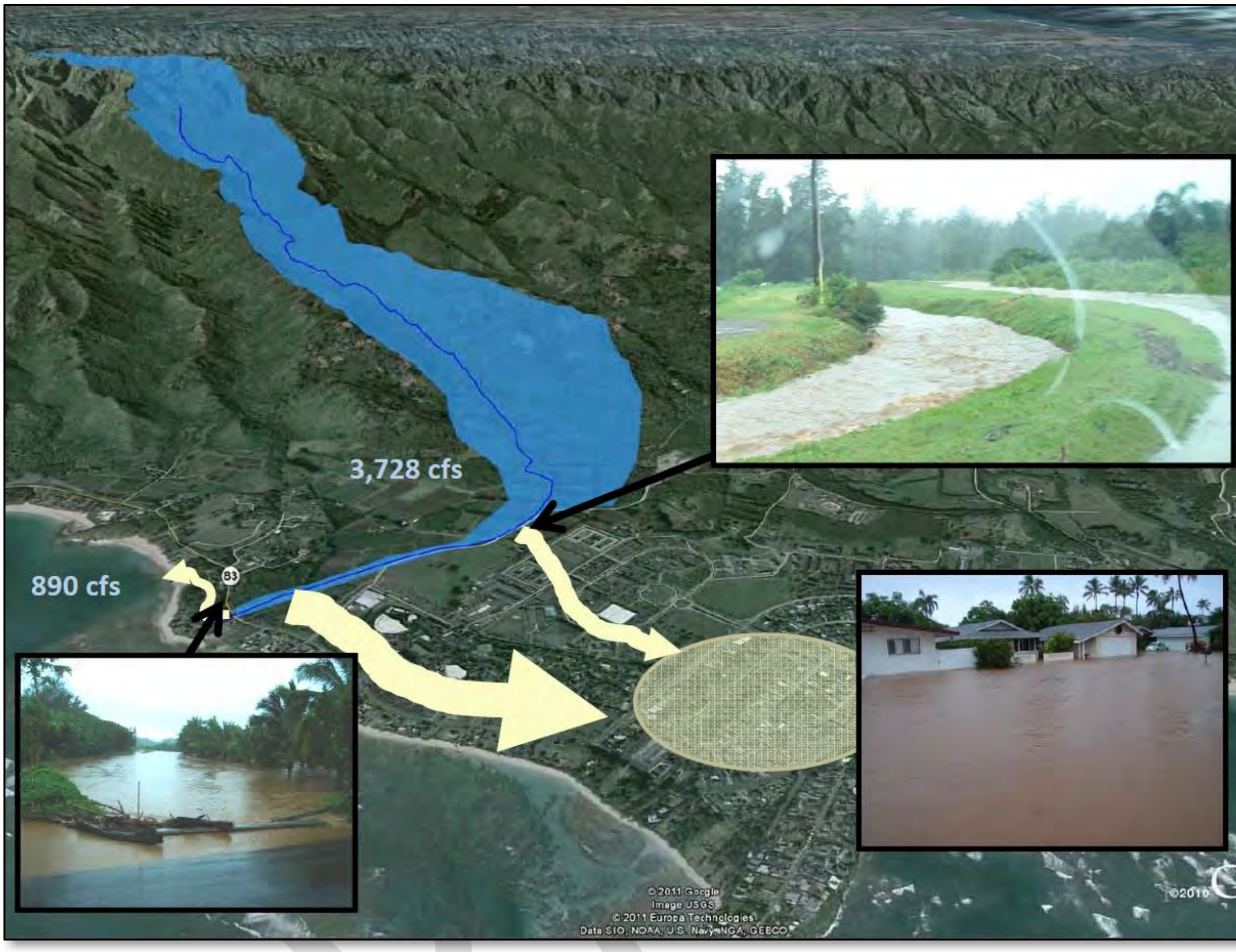


Figure 4. Wailele Stream - Laie Flooding Patterns

2.2 Opportunities and Constraints

Opportunities are instances in which the implementation of a plan has the potential to positively address an issue or impact a resource without being formulated specifically for that resource or issue. Constraints are restrictions that limit the planning process over and above those instituted specifically by laws, policies, and guidance.

2.2.1 Opportunities

- Reduce existing flood damages during high probability events
- Reduce pollution associated with floodwater runoff from a highly urbanized area

2.2.2 Constraints (Factors to avoid)

- Alternatives will not increase inundation of structures downstream of the study area through changes in stream hydraulics and hydrology.
- Alternatives will not transfer risk from one section of the population without fully mitigating for the increase in risk to those negatively affected by the project.

- Alternatives will seek to minimize impacts to private residences wherever possible. Developable real estate is scarce on Oahu as a whole. Given the study area's proximity to the ocean, acquisition of multiple residences would likely be met with large public outcry and acquisition costs could likely be sufficiently high as to make an alternative that requires a great deal of acquisition economically uncompetitive.

- Alternatives will seek to minimize environmental impacts, particularly those to pristine, undisturbed lands, or habitat that is more likely to contain species of concern. While avoidance and minimization will be employed, because of the highly urbanized nature of the area, there is a relative lack of opportunities to perform compensatory mitigation at costs that can be incrementally-justified consistent with Corps policy. In cases where alternatives are of similar cost and provide a similar level of flood risk management, the alternative with greater environmental impacts will be screened out.

2.3 Objectives

2.3.1 National Objectives

The Federal objective of water and land resources planning is to contribute to National Economic Development in a manner consistent with protecting the nation's environment. National Economic Development features increase the net value of goods and services provided to the economy of the nation as a whole. Only benefits contributing to National Economic Development may be claimed for Federal economic justification of a project. For Wailele Stream, these features may be structural measures such as levees, floodwalls or other conveyance or detention structures. Non-structural measures could include such items as structure elevations, relocations, flood warning systems, etc.

Water resource planning must be consistent with National Economic Development objectives and must consider engineering, economic, environmental, and social factors. The following objectives are guidelines for developing alternative plans and are used to evaluate those plans.

2.3.1.1 Federal Engineering Objectives

There is no minimum level of performance or protection required by Corps of Engineers projects.[1] However, residual risk presented by varying levels of protection must be adequately analyzed and communicated. Generally, the engineering solution selected will be the one that presents the greatest level of net National Economic Development benefits with an acceptable level of environmental impacts.

2.3.1.2 Federal Economic Objectives

Principles and guidelines of Federal water resources planning require identification of a plan that would produce the greatest contribution to National Economic Development. The National Economic Development plan is defined as the environmentally acceptable plan providing the greatest net annual National Economic Development benefits. Net annual National Economic Development benefits are determined by subtracting annual costs from annual benefits. Corps of Engineers policy requires recommendation of the National Economic Development plan unless there is adequate justification to do otherwise.

[1] Engineer Regulation 1105-2-100

A reasonable number of sufficiently different alternatives that would meet project needs must be presented and should be described in quantitative terms, if possible. Benefits attributed to a plan must be expressed in terms of a time value of money and must exceed equivalent economic costs for the project. To be economically feasible, each separate portion or purpose of the plan must provide benefits at least equal to its cost. The scope of development must be such that benefits exceed project costs to the maximum extent possible. The economic evaluation of alternative plans is on a common basis of 2019 prices, a period of analysis of 50 years, and the Federal fiscal year 2019 discount rate of 2.875 percent.

2.3.2 Study Objectives

Study-specific objectives consist of the following:

- Decrease the risk of inundation from Wailele Stream over the 50-year period of analysis.

- Decrease the amount of urban runoff associated with flood waters from Wailele Stream.

These objectives are limited to areas where the Corps is allowed to participate in cost-shared flood risk management in accordance with applicable laws and policies. This includes a restriction on participating in flood risk management in systems that do not exceed 800 cubic feet per second at events with a 0.1 annual chance of exceedance or in systems that drain fewer than 1.5 square miles in area.[2]

[2] Engineer Regulation 1105-2-100, Chapter 3, 3-3, b., (6)

3.0 BASELINE CONDITIONS/AFFECTED ENVIRONMENT

This chapter is meant to provide basic information to the general public about baseline environmental conditions in the study area. Greater technical detail on the topics contained in this chapter is available in the Environmental Appendix attached to this report.

3.1 Community and People

3.1.1 Community

Laie is a Census Designated Place within the City of County of Honolulu. The combined City/County encompasses the entire island of Oahu. Laie's position on the island of Oahu is shown in Figure 5. Laie has been inhabited by Native Hawaiians for many generations and lands have changed hands multiple times under feudal and royal ownership prior to Hawaii becoming part of the United States. In 1865, the Church of Jesus Christ of Latter-day Saints purchased a nearby sugar plantation to cultivate sugar and other crops. The Church still maintains a large presence in the community due to the location of a temple and Brigham Young University-Hawaii being located in the community.

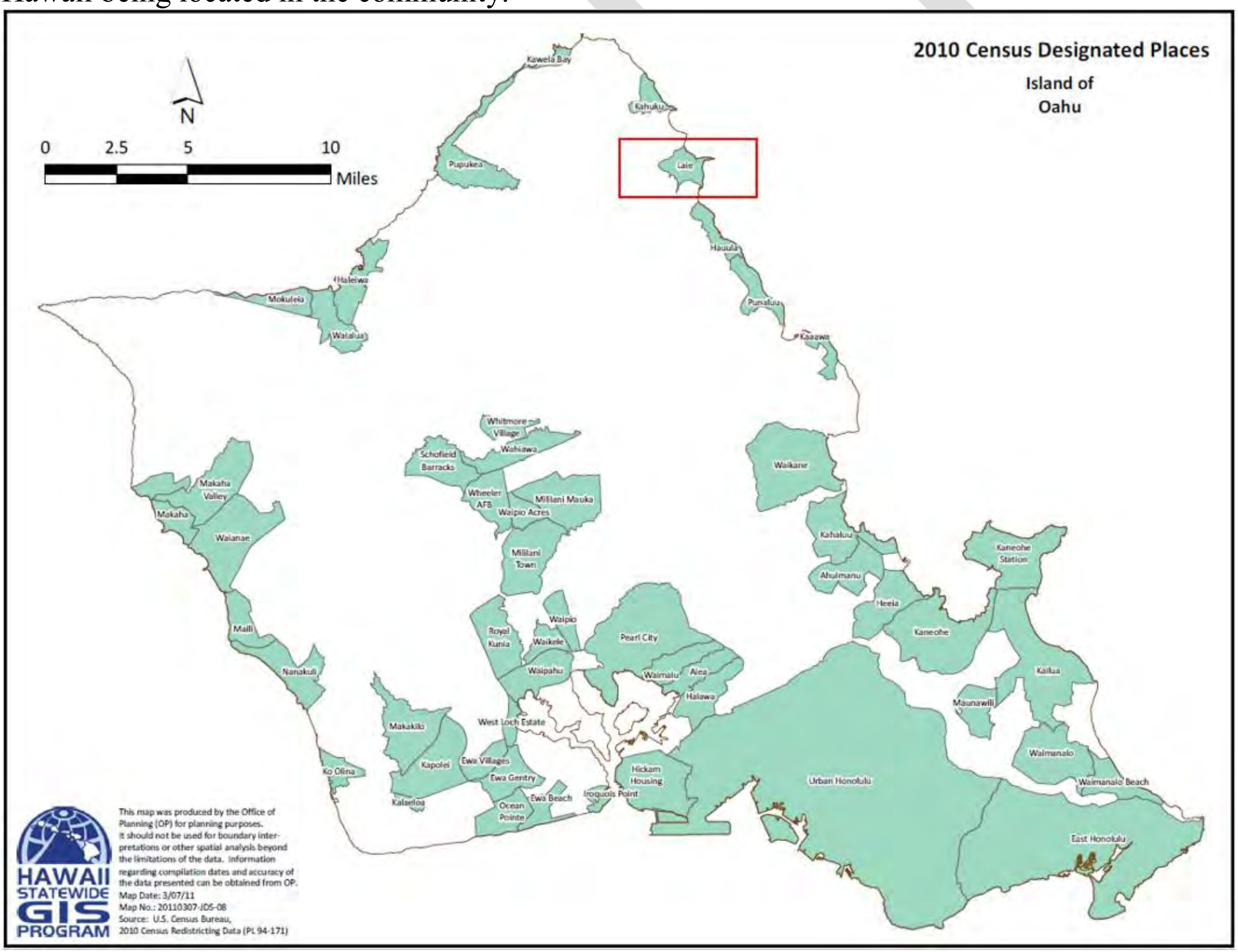


Figure 5. Location of Laie and other Census-Designated Places on the Island of Oahu.

3.1.2 Demographics

In 2010, the United States Census estimated Laie's population to be 6,138. The population is approximately 30 percent Native Hawaiian and Other Pacific Islander, 29 percent White, 25 percent two or more races, and 14 percent Asian. Approximately 5 percent of the population is Hispanic or Latino. The population is 47 percent male and 53 percent female. The median age of the population is 24 years.

3.1.3 Land Use

Land use in the upper elevations of the area can be characterized as undeveloped, mountainous, and forested with noticeable ridgelines dividing one watershed from another. Approximately 772 acres of forest (54 percent) cover the study area of approximately 1,400 acres. The valleys tend to flatten and spread as they approach the coast and their natural floodplain widens. The upper part of the floodplain consists of agricultural (17 percent) uses before transitioning into commercial (15 percent), and residential (14 percent) nearer to the coast. Figure 6 provides a visual representation of the greater land use throughout the area.

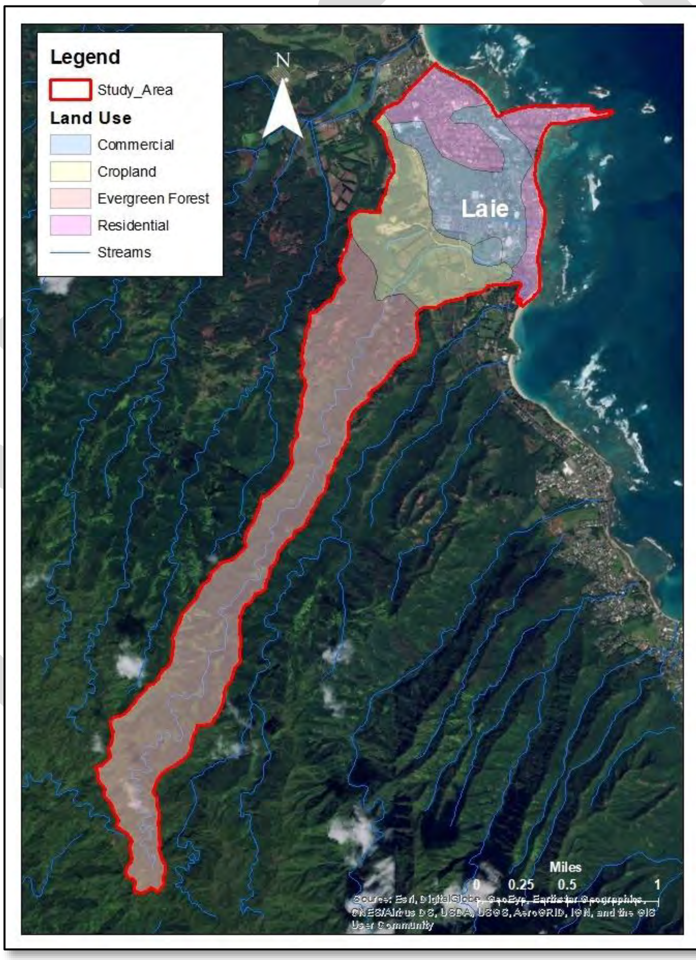


Figure 6. Land Use[3]

[3] Source: Hawaii Statewide GIS Program (1976)

Brigham Young University-Hawaii encompasses approximately 60 percent of the commercial land use in the study area with the adjacent Polynesian Cultural Center encompassing an additional 20 percent of the commercially-used lands.

3.2 Physical Environment

Laie is on the northeastern shore of Oahu, approximately 30 miles north of Honolulu. The project site is located along Wailele Stream from approximately 21°38'22.34"N and 157°55'44.70"W generally downstream to the muliwai located at approximately 21°37'58.34"N and 157°55'14.24"W.

3.2.1 Climate

The Hawaiian Islands generally experience mild and fairly uniform temperatures throughout the year. Honolulu's mean annual temperature is 76°F with a maximum of 93°F and a minimum of 56°F. Like many of Hawaii's windward watersheds, the majority of the rainfall is experienced in the upper reaches of the watershed with less precipitation falling on the coastal plain. The same is true for Wailele Stream where rainfall in the upper watershed is approximately 200 inches per year while mean annual precipitation at the mouth is approximately 50 inches.

3.2.2 Hydrology & Hydraulics

In general, Wailele Stream drains a small, steep watershed and exhibits flows that can increase rapidly depending on the length and severity of precipitation events. Flood flows are often sharp rises in water surface elevation, but short in duration. State Highway 83 (Kamehameha Highway) crosses Wailele Stream just upstream of its mouth. An undersized culvert constricts flows, resulting in an increase in head in the upstream area. During high flows, the backwater from this constriction leads to the stream exiting over its left bank, producing sheet flow through the greater Laie area. An overview of the existing stream configuration is shown in Figure 7.

3.2.1 Geology/Geomorphology

The existing physiography, soils, and geomorphology of the study area is a result of complex interactions of geological, hydrological, and meteorological processes that occurred during the Holocene and early Pleistocene epochs of the Quaternary period.

Due to the volcanic activity, the geology of the upper reaches of the Wailele watershed consist of Koolau basalts. Marine hydrological processes have transformed the geology of the lower reaches of the watershed associated with the alluvial fan of Wailele Stream. The geologic features of the alluvial fan consist of unconsolidated and consolidated material composed of calcareous dunes, marine sediments, and sediments and non-calcareous deposits.

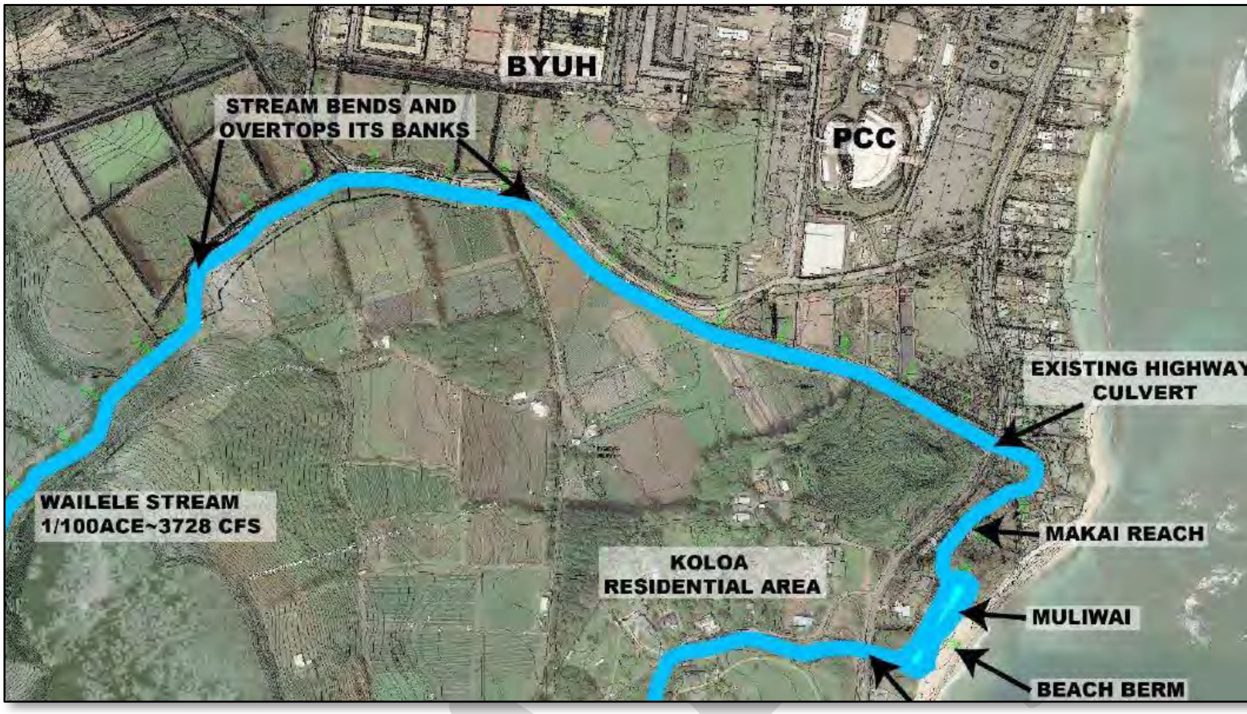


Figure 7. Wailele and Koloa Streams – Existing Conditions

3.2.2 Topography

The Koolau range has a 37-mile long ridge that is approximately 3,100-feet in elevation. The range has long, narrow ridges shaped by wind and water erosion with slopes between six and fifteen degrees away from the summit. As previously stated, as Wailele Stream approaches the sea, the topography flattens into a more characteristic floodplain where the stream naturally meandered prior to channelization and other alterations.

3.2.3 Soils/Sediments

The soils found in the upper portions of the study area are consistent with the Rough Mountainous Land – Kapaa Association. This soil association consists of very steep land broken by numerous drainageways at elevations ranging from 1,000 to 3,000 feet. The lower portion of the study area is an alluvial fan in the Kaena-Waialua Association. Soils in this area are deep, generally level, gently sloping, and poorly drained.

3.2.4 Water Quality

The Clean Water Act requires states to assess the water quality of their states and submit a report to the Environmental Protection Agency every two years. The Clean Water Act also requires states to prepare a list of impaired waters where corrective actions must be implemented. The Hawaii State Department of Health, Clean Water Branch is the action agency for this report and for enforcing water quality standards. Wailele Stream is classified as an impaired water body in the latest report due to elevated turbidity during the wet season when higher flows mobilize sediments more regularly. Due to the temporary nature of excess turbidity and lack of other concerns, particularly those of a chemical nature, Wailele Stream is listed as low in priority for implementing corrective actions.

3.2.5 Air Quality

There are no non-attainment areas within the State of Hawaii. Due to the low number of emissions sources and consistent wind activity, the study area generally experiences good air quality.

3.2.6 Noise

Noise in the study area is mainly generated by human activity including vehicular traffic and agriculture with some recreational-related noise near the muliwai.

3.2.7 Hazardous, Toxic, and Radioactive Waste (HTRW)

The results of a HTRW Phase 1 Assessment indicate that there are no existing HTRW activities located within the study area. Due to these findings, the stream's mostly pristine nature, lack of urbanized drainage into the stream, and low impact adjacent uses such as agriculture, it is considered unlikely that any HTRW is present in the area.

3.2.8 Wetlands

Approximately one-half of a mile of Wailele Stream was channelized in the 1830's to provide irrigation for agriculture. This portion of the stream has intermittent flows, while the upper and lower reaches of the stream maintain permanent flow. The largest wetland feature in the study area is the muliwai at the downstream terminus of Wailele Stream, adjacent to the ocean.

3.3 Biological Resources

3.3.1 Terrestrial Species and Habitat

The United States Fish and Wildlife Service has conducted multiple surveys of the area, both in the terrestrial and aquatic environments. Some of these have been formal surveys connected to a large storm event that breached the muliwai, temporarily connecting it directly to the ocean. Other surveys have been less formal in nature, consisting of walking the area with personnel from other agencies, identifying native from non-native species as well as identifying species and habitats of concern.

3.3.1.1 Vegetation

Within the lower reaches of the study area, the plant community was dominated by non-native species including guinea grass (*Panicum maximum*), California grass (*Brachiara mutica*), Koa haole (*Leucaena camara*), sourbush (*Pluchea symphitifolia*), ironwood (*Casuarina equisetifolia*), lantana (*Lantana camara*), and Norfolk pine (*Araucaria columnaris*). Coconut palms (*Cocos nucifera*) and bananas (*Musa* sp.) were locally abundant and small groves of papaya (*Carica papaya*) were actively being cultivated. Overstory trees along the streambank included Christmas berry (*Schinus terbinthifolius*) and strawberry guava (*Psidium cattleianum*) with African tulip-trees (*Spathodea campanulata*) and kukui (*Aleurites moluccana*) also present. Common understory plants along the stream included ti (*Cordyline fruticosa*) and ferns.

3.3.1.2 Birds

Four native birds were observed within the study area, all of which were found in the muliwai and the sand berm: Pacific Golden Plover (*Pluvialis fulva*), Sanderlings (*Calidris alba*), Ruddy Turnstones (*Arenaria interpres*), and Black-crowned Night Herons (*Nycticorax nycticorax hoactli*). These species are protected under The Migratory Bird Treaty Act (16 U.S.C. 703-721).

Non-native bird species encountered included the Zebra Dove (*Geopilia striata*), Spotted Dove (*Streptopelia chinensis*), Common Myna (*Acridotheres tristis*), Cattle Egret (*Bubulcis ibis*), and Red-vented Bulbul (*Pycnonotus cafer*). Although not observed during the survey, the endangered Hawaiian Gallinule (*Gallinula chloropus sandvicensis*) has been observed in the muliwai.

3.3.2 Aquatic Wildlife

Typical with other Hawaiian streams, native aquatic life within are adapted to the ephemeral hydrological processes of Wailele Stream. During periods when Wailele Stream is flowing and the sand bar below the muliwai is breached, juvenile amphidromous species return from the ocean and migrate upstream. Upon reaching the perennial upper reaches of the stream, these species wait for flows to return to the intermittent portions of the stream to migrate back to the ocean. The surveys identified two endemic gobies (*Eleotris sandwicensis* and *Stenogobius hawaiiensis*) and an indigenous prawn (*Macrobrachium grandimanus*) within the muliwai of Wailele and Koloa Streams. Surveys of Wailele Stream identified a primarily non-native aquatic community consisting of non-native prawns (*Macrobrachium lar*), leeches (*Myzobdella lugubris*), Chironomid midge larvae, guppies (*Poecilia sphenops*) , swordtails (*Xiphophorus helleri*), and toad tadpoles (*Bufo marinus*). Tilapia (*Tilapia* sp.) and Thiarid snails (*Melanoides tuberculata*) were other non-native species that were abundant in the stream habitats. There are a total of 26 marine mammals documented in the Hawaiian Islands, however none were observed during field surveys and would be highly unlikely to occur in the project area, given its riverine nature. No sea turtles were observed during the surveys.

3.3.3 Fish and Essential Fish Habitat

EFH consists of those habitats necessary for spawning, breeding, feeding, or growth to maturity of species managed by the Regional Fishery Management Councils, as described in a series of Fishery Management Plans, pursuant to the Act. The EFH within the study area includes:

- Hawaiian Coral Reef Ecosystem
- Amberjack/blackjack/sea bass
- Blue stripe snapper/gray jobfish
- Giant trevally
- Pink snapper
- Red snapper/long tail snapper/yellow tail snapper/pink snapper/snapper
- Silver jaw jobfish/thicklip trevally

3.3.4 Coral Reefs

Marine coral surveys have shown there to be reef flats in the area offshore of the muliwai, but were not a significant part of the benthic environment on the inner reef areas surveyed.

3.3.5 Federal and State Threatened and Endangered Species

The upper and middle reaches of Wailele Stream contains critical habitat for three endangered damselfly species (*Megalagrion nigrolineatum nigrolineatum, M. oceanicum, and M.* hawaiiense) and the Hawaiian Gallinule (*Galinula chloropus sandvicensis*). The endangered *Hesperomannia*, a plant in the Sunflower (Asteraceae) family is known to occur within the Wailele Watersed. Critical habitat for 43 other plant species has been designated within the Wailele watershed. A full listing of those species is available in the Environmental appendix.

3.4 Socio-Economic Conditions

3.4.1 Employment and Income

According to the United States Census Bureau, an average of 94 percent of the civilian labor force was employed during 2017.[4] The largest industry is Educational Services, Health Care, and Social Services with significant employment in Arts, Entertainment, Recreation, Accommodation, and Food Services as well as Construction. Mean per capita income in Laie is approximately $19,100 with a median household income of $95,100 and a median family income of $94,000. Approximately 10 percent of local residents have incomes lower than the Federal poverty threshold.

3.4.2 Existing Infrastructure and Facilities

Currently, the portion of the stream in the alluvial plain upstream of Kamehameha Highway is channelized. Roads run on either side of the stream bed, providing access to agricultural lands. The City and County of Honolulu provides regular maintenance of the channel in the form of vegetation control. The width of the stream at top of bank in this section varies, but appears to average 20-30 feet in width. Existing streambed conditions in the channelized portion of the streambed are shown in Figure 8 and Figure 9.

[4] Selected Economic Characteristics 2013-2017 American Community Survey 5-Year Estimates, Laie CDP, Hawaii

Figure 8. Typical Channel Section in Channelized Portion of Wailele Stream

Figure 9. Panoramic View, Typical Section of Channelized Portion of Wailele Stream

3.4.3 Cultural and Subsistence Activities

Present day Laie is approximately 6 percent Native Hawaiian and there is a long and established use of Native Hawaiian use of the area for a number of activities. Even among other racial groups there is strong cultural tie to the outdoors including fishing, and activities such as hiking, camping, swimming, surfing, and other recreation activities.

3.5 Historical and Archeological Resources

Multiple surveys of the area have been completed over time. Undisturbed areas within the vicinity of Wailele Stream are predicted to contain intact prehistoric and historic cultural deposits that have survived modern agricultural use. Field and archival research conducted for the Wailele Flood Risk Management Project indicates significant cultural resource concerns, particularly SIHP Site No. 50-80-02-05458. This Historic Property has been determined eligible for listing on the National Register of Historic Places under Significance Criterion D, pursuant to Section 106 of the National Historic Preservation Act of 1966 (as amended). It is likely also significant under Criteria d) and e) in accordance with Hawaii Administrative Rules (HAR) §13-13-275. Importantly, this archaeological site contains a cultural deposit and has a very high likelihood for containing traditional Hawaiian burials. In addition to this documented archaeological site, several surface features were discovered within the preferred alternative corridor that may be historic properties (Ishihara et al. 2015:61). Finally, the corridor also passes through a Mahele Period Land Claim Award parcel. Such parcels are typically assumed to have an elevated potential for the presence of early-historic archaeological remains.

4.0 FUTURE WITHOUT PROJECT CONDITIONS

This chapter presents an overview of the conditions expected to persist over the 50-year period of analysis. Further details can be found in the technical appendices.

4.1 Physical Environment/Planned Development

Development within the area can be characterized as medium density. Outside of a few buildings on the campus of Brigham Young University – Hawaii, the vast majority of structures are low rise or single story. The project footprint lies mostly within lands that are zoned “AG-1” (Restricted Agriculture) or “AG-2” (General Agriculture). Undeveloped lands within the study area are zoned AG-1, AG-2, or “C” (Country). Outside of a zoning change, dense development that would change the characteristics of flow within the watershed are unlikely. Even if the zoning of the area were to change to encourage development, the City and County of Honolulu’s development standards require on-site water management that reduces runoff that would otherwise exacerbate urban flooding. The City and County of Honolulu is enacting some minor interior drainage improvements that are underway and these will be included in the future without project conditions. These drainage features will not affect flow into Wailele Stream, but will address (decrease) some of the effects of flooding associated with Wailele Stream. Because of these factors, a significant change in contributions to stream flow from the surrounding area is considered unlikely.

Engineer and Construction Bulletin 2018-14 titled “Guidance for Incorporating Climate Change Impacts to Inland Hydrology in Civil Works Studies, Designs, and Projects” has been incorporated into engineering analyses in order to address uncertainty surrounding changes in the duration and intensity of future precipitation events due to climate change.

4.2 Economic/Political Conditions

Because of the relatively stable development environment described above and Laie serving as home to Oahu’s major Mormon Temple and Brigham Young University – Hawaii, the prevailing economic and political conditions of the area are not expected to change significantly over the period of analysis.

4.3 Future Without-Project Scenarios

In the future, the area will remain subject to inundation and sediment deposition during events exceeding 675 cubic feet per second, as this causes Wailele Stream to exit its banks. During those larger events, Wailele Stream will break out of its banks and flow into Laie Town, causing some degree of urban flooding, collecting pollutants, and depositing those pollutants into the ocean downstream of the culvert located near the Foodland supermarket.

4.4 Biological Environment

The basic nature of the area is not expected to significantly change over the 50-year period of analysis. The area is expected to continue to receive significant precipitation, supporting existing forest habitat in the upper watershed. As previously stated, absent a change in zoning, relatively little development is expected in the area and current environmental conditions are expected to persist.

4.5 Summary of Without-Project Conditions

The Without Project Condition forms the basis for impacts under the No Action Alternative. Given the nature of the area, it is unlikely that the future without project condition will differ greatly from the existing condition. The Laie area will continue to see inundation damages beginning at events with an annual chance of exceedance of 0.2 (5-year event). The 0.01 annual chance of exceedance event is estimated to cause in excess of $25 million in damage.

The existing environmental resources discussed above will persist with no expected significant changes in amount or quality of habitat, or diversity or populations of present species. Uncertainty associated with changes in stream flow have been addressed to the degree possible consistent with Engineering and Construction Bulletin 2018-14. Figure 10 shows inundation patterns expected to persist in the without-project condition.

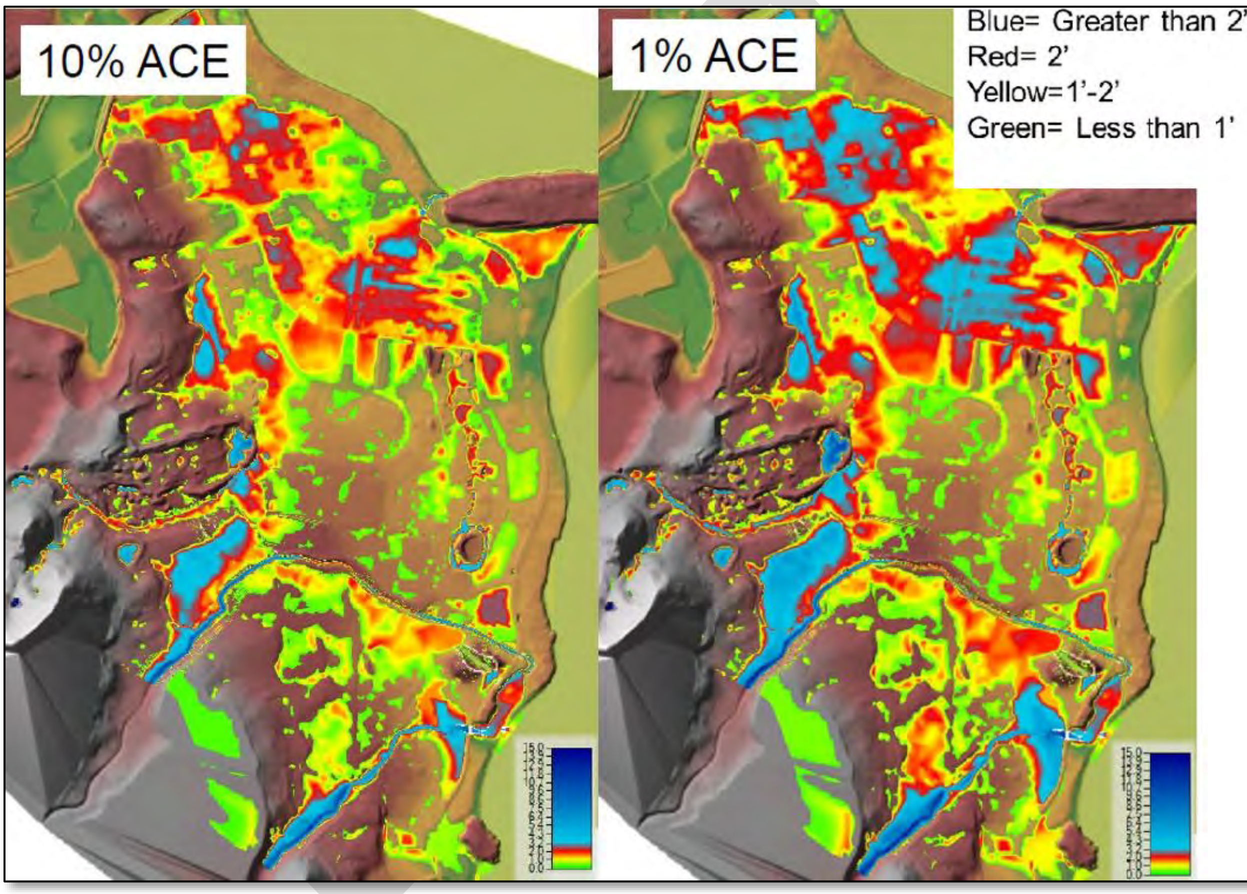


Figure 10. Future Without-Project Inundation (0.1 and 0.01 ACE events)

5.0 FORMULATION AND EVALUATION OF ALTERNATIVE PLANS

This chapter presents the process used to formulate alternatives to achieve the study objectives and realize opportunities, where possible.

5.1 Plan Formulation Rationale

Plan formulation is the process of building alternative plans that meet planning objectives and avoid planning constraints. Alternatives are a set of one or more management measures functioning together to address one or more planning objectives. A management measure is a feature or activity that can be implemented at a specific geographic location to address one or more planning objectives. A feature is a "structural" element that requires construction or assembly on-site whereas an activity is defined as a "nonstructural" action. Each alternative plan shall be formulated and screened in consideration of criteria stated below.

5.1.1 Criteria

5.1.1.1 National Evaluation Criteria

Federal Principles and Guidelines establish four criteria for evaluation of water resources projects. Those criteria and their definitions are listed below.

5.1.1.2 Acceptability

Acceptability is defined as "the viability and appropriateness of an alternative from the perspective of the Nation's general public and consistency with existing Federal laws, authorities, and public policies. It does not include local or regional preferences for particular solutions or political expediency."

5.1.1.3 Completeness

Completeness is defined as "the extent to which an alternative provides and accounts for all features, investments, and/or other actions necessary to realize the planned effects, including any necessary actions by others. It does not necessarily mean that alternative actions need to be large in scope or scale."

5.1.1.4 Effectiveness

Effectiveness is defined as "the extent to which an alternative alleviates the specified problems and achieves the specified opportunities."

5.1.1.5 Efficiency

Efficiency is defined as "the extent to which an alternative alleviates the specified problems and realizes the specified opportunities at the least cost."

5.2 Management Measures

A list of management measures is listed below. After going through a screening process based on listed criteria, each of the listed measures was carried forward for consideration.

5.2.1 Structural Measures

Structural measures are generally those measures that reduce the probability of inundation within the floodplain. These measures can include levees, floodwalls, dams, and channel training structures such as engineered berms and revetments. They can also include smaller structures such as ring levees and berms meant to protect single structures or a small group of structures. All of these measures were carried forward except for floodwalls. Generally, floodwalls are used in areas where there is insufficient open space to construct levees or other channel improvements and are generally much more expensive per linear foot than these other measures. Therefore, floodwalls were screened out based on the efficiency criteria.

5.2.2 Non-structural Measures

Non-structural measures are those measures that reduce the consequences of inundation by altering structures within the floodplain to make them less susceptible to damages related to flood events. These measures can include, but are not limited to: structure elevation, relocations, buyouts, and flood proofing. All of these measures were carried forward for further evaluation.

5.2.3 Mitigation Features

Mitigation Features include avoidance of impacts, minimization of impacts that cannot be avoided, and compensatory mitigation of impacts after avoidance and minimization, if required. Given the nature of the area and the project, mitigation for environmental impacts will be conducted through the avoidance and minimization measures, primarily the enactment of best construction practices to avoid disturbance to fish passage and nesting birds. Mitigation for impacts to cultural assets will proceed according to an agreement negotiated with the State of Hawaii's State Historic Preservation Office.

5.2.4 Major Drainage Features

Corps policy prevents Federal participation in cost-sharing the construction of features that address flooding issues in areas where flows do not exceed 800 cubic feet per second at the 0.1 annual chance of exceedance event or in drainages areas that do not exceed 1.5 square miles.[5] However, Corps policy recognizes that features referred to as "Major Drainage" may be beneficial to the overall performance of a Federal project and should be considered for inclusion as part of the project, even though they are required to be constructed at 100 percent non-Federal expense (except any outlet works).[6]

5.3 Initial Array of Alternatives

5.3.1 No Action Alternative

The No Action Alternative would not construct any flood risk management measures at Laie, Hawaii. Public concerns, issues, and environmental welfare would remain unchanged unless a non-Federal entity elected to construct measures. The identified purpose and need would not be met. The area would remain subject to periodic flooding. The No Action Alternative is carried forward as the future without project condition against which action alternatives will be evaluated.

5.3.2 Structural Alternatives

5.3.2.1 Existing Culvert Improvements

Since the cause of issues stems from an under-sized culvert at the Kamehameha Highway (Figure 11), it was pertinent to investigate the potential to enlarge the existing channel and

[5] Engineer Regulation 1105-2-100, Chapter 3, 3-3, b., (6)
[6] Engineer Regulation 1105-2-100, Chapter 3, 3-3, a., (3)

culvert. This alternative would expand the culvert under the Kamehameha Highway to a size which would be able to fully convey an event with a 0.01 annual chance of exceedance.

This would also entail constructing approximately one-half mile of channel improvements both upstream and downstream of the highway, since existing channel geometry would not be capable of conveying flows through the enlarged culvert. Modifying the channel downstream of the highway would entail acquiring multiple private properties in order to enlarge the channel's geometry. This would also require replacing an existing pedestrian bridge with a larger span that would not act as a constriction point. Failure to replace this span would negate the effectiveness of the enlarged channel and culvert. Additionally, because of the increase in velocities associated with increased flows, a significant amount of erosion mitigation would be required in order to ensure the left bank of the stream did not erode and destroy homes to the left of the existing channel. Lastly, the area on the ocean side of the highway has been identified as highly likely to contain sensitive cultural and tribal assets in greater number than those found on the landward side of the highway. A typical section of the channel downstream of the highway is shown in Figure 12.

Figure 11. Existing Culvert, Upstream Side, Kamehameha Highway

Figure 12. Typical Wailele Stream Channel, Downstream of Kamehameha Highway (Looking Downstream)

5.3.2.2 Full Detention

This alternative would construct a dam in the upper watershed that would be approximately 40 feet in height and provide approximately 185 acre feet of storage meant to detain enough water to allow for the existing channel to convey flood waters associated with an event with a 0.01 percent annual chance of exceedance.[7] The dam would be designed to survive what is referred to as the "Probable Maximum Flood", or the event that is not likely to be exceeded. That could be accomplished through either enlarging the storage area to detain flows associated with the Probable Maximum Flood, or designing the structure to be safely overtopped at events exceeding the event with a 0.01 annual chance of exceedance. This decision would be based on a number of factors including cost-effectiveness, environmental impacts, and risks to life safety.

5.3.2.3 Full Conveyance

This alternative would combine channel improvements and construction of an "overflow channel" with culverts underneath the Kamehameha Highway that would safely convey flows exceeding 675 cubic feet per second into the muliwai. Figure 13 shows a rendering of this alternative. This alternative would also include a major drainage feature termed the "BYU Diversion Channel". This feature would contribute to a reduction in residual flooding, but is located in a drainage area less than 1.5 square miles and flows do not exceed 800 cubic feet per second in this area.

[7] One acre foot is an amount of water sufficient to inundate an area one acre in size with one foot of water.

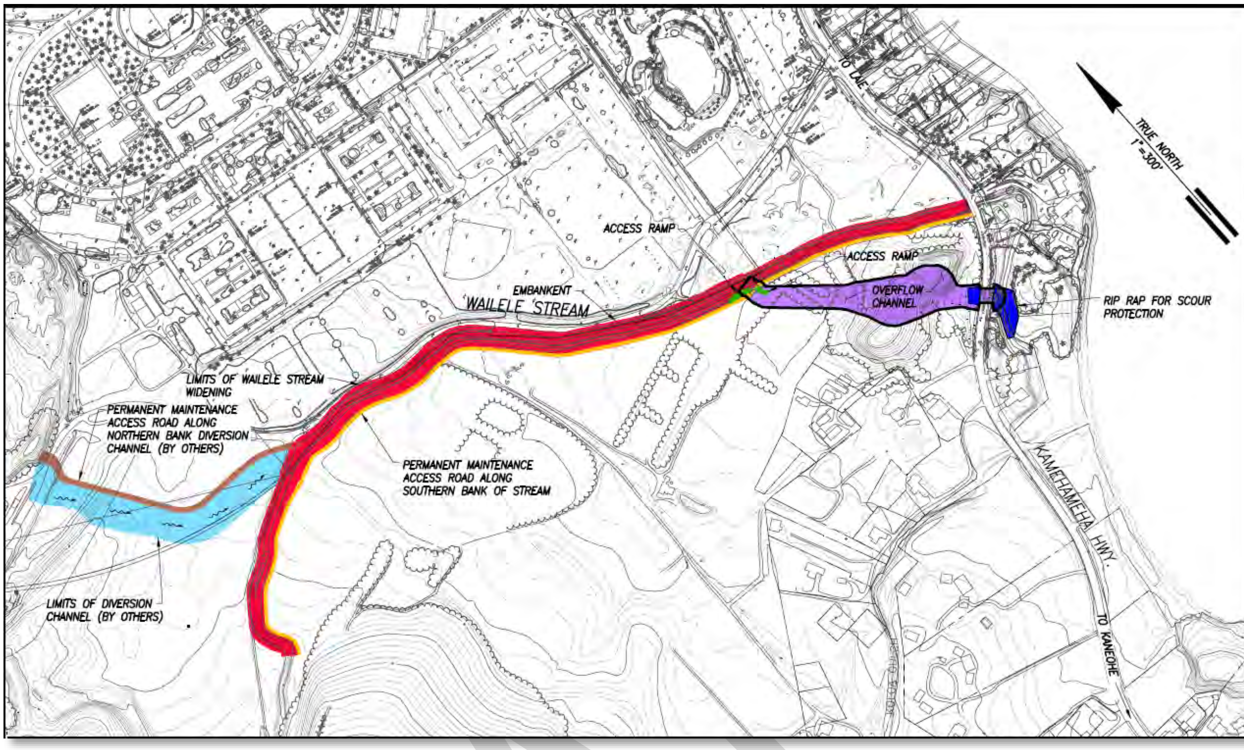


Figure 13. Full Conveyance Alternative (BYU Diversion Channel shown)

5.3.2.4 Combination of Conveyance and Detention

This alternative would construct a combination of conveyance and detention structures. An overflow channel and two basins with a cumulative 40 acre feet of storage would be constructed to manage flood risks in the study area. This alternative would also include the "BYU Diversion Channel".

Figure 14. Combination of Conveyance and Detention (BYU Diversion Channel not shown)

5.3.3 Nonstructural Alternatives

5.3.3.1 Floodplain Evacuation and Relocations

Relocations and buyouts were considered for 600 residences and commercial properties, but this method is very expensive to implement in an urbanized setting like Laie due to the fact that a large number of structures would be affected, each carrying a certain cost, whether it was to demolish the structure or to relocate it.

5.3.3.2 Structure Elevations

This measure would elevate structures within the flood plain that are of sufficient strength and type of construction so that inundation would not cause any damage to these structures. Approximately 50 percent of the 600 structures could be elevated the estimated 3 feet necessary to achieve sufficient reductions in flood damages.

5.3.3.3 Flood Proofing of Structures

Flood proofing has two forms. The first, wet flood proofing reconfigures the contents of a structure so that damages are minimized or eliminated when the structure is inundated. The limitations of this method are that very few single-story structures can successfully implement this type of flood proofing as there is not sufficient vertical space to elevate items within the existing structure. Dry flood proofing modifies the structure with impermeable surfaces and closure structures so that waters do not enter the structure. The limitations of this method are that the external pressures of water against the exterior of the structures can lead to structural damage, or collapse. Generally, both of these methods are very expensive to implement on a per-structure basis and are not generally a cost-effective method of implementing flood risk management in urbanized areas due to the number of structures that would need to be treated.

5.3.4 Screening of Initial Array of Alternatives

5.3.4.1 Structural Alternatives

5.3.4.1.1 Existing Culvert and Channel Improvements

Modifying the existing culvert and channel would have high impacts to private properties and has the potential to disturb subsurface cultural assets on the ocean side of the highway (an area that is highly sensitive from an archaeological standpoint. The culvert and channel would need to be enlarged to approximately six times its current capacity to provide flood risk management benefits against an event with a 0.01 annual chance of exceedance. A great deal of erosion protection would need to be constructed to ensure the channel continued to flow into the muliwai, instead of straightening toward the shoreline, destroying residences, and conveying large nutrient loads out into the marine environment, potentially affecting healthy coral communities. Because of these factors and anticipated costs greater than other alternatives with similar effectiveness, this alternative was screened out.

5.3.4.1.2 Full Detention

Due to anticipated high costs of construction, operation, and maintenance, as well as impacts to a large area of land, disturbance of undeveloped/pristine environment, impacts to threatened and endangered species, and potential life safety risks, the full detention alternative was screened out. Further contributing to the screening of this alternative is the large amount of uncertainty associated with the size of the project. Since, by policy (Corps and State of Hawaii) all dams must be able to survive the Probable Maximum Flood, it may be more cost efficient to construct a structure capable of detaining a Probable Maximum Flood rather than to design the structure to detain the event with a 0.01 annual chance of exceedance, but survive overtopping up to the level of a Probable Maximum Flood. In either case, due to high environmental impacts and anticipated costs greater than other alternatives with similar effectiveness, this alternative was screened out.

5.3.4.1.3 Full Conveyance

This alternative would have the fewest impacts to residences, very little disturbance of grounds on the ocean side of the Kamehameha Highway (culturally sensitive area), and utilizes the natural muliwai system as part of its solution. This alternative has received positive feedback in informal discussions with partners at the resource agencies and has the least complicated real estate requirements. This alternative also has great potential to reuse excavated materials to construct channel improvements and one of the affected land owners has indicated a desire to utilize a portion of his lot as a disposal site. This alternative is easily optimized to identify the National Economic Development Plan. Additionally, operation and maintenance costs for this alternative are likely very low. Because of these factors, this alternative is carried forward for further consideration.

5.3.4.1.4 Combination of Conveyance and Detention

This alternative appeared to have greater costs to construct, operate, and maintain and greater impacts to private lands than the Full Conveyance alternative without additional net annual National Economic Development benefits. However, at a qualitative level this alternative appeared to be a viable plan, so therefore it was carried forward for further consideration.

5.3.4.2 Nonstructural Alternatives

5.3.4.2.1 Floodplain Evacuation and Relocations

Relocations and buyouts were considered for 600 residences and commercial properties, but ruled out. The method itself is expensive to implement in an urbanized setting like Laie. There is little developable land on Oahu, and much of it is subject to flooding. Therefore, it is likely that implementing a relocation strategy would simply transfer flood risk to another watershed on the island. This would violate a study constraint and therefore this alternative was screened out.

5.3.4.2.2 Structure Elevations

This measure would elevate residences within the flood plain so that inundation would not cause any damage to the structures. Approximately 50 percent of the 600 structures could be elevated the estimated 3 feet necessary to achieve sufficient reductions in flood damages. Given the high cost of elevating structures and intolerably high residual flood impacts due to the number of structures that could not be elevated, this alternative was screened.

5.3.4.2.3 Flood Proofing

This measure would implement wet and/or dry flood proofing at structures within the floodplain. Given the high cost of implementing these measures on a per-structure basis in an urbanized area, this alternative was not carried forward.

5.3.5 Screening of Initial Array of Alternatives and Final Array of Alternatives

A previous effort compared the net annual National Economic Development benefits of the Full Conveyance alternative versus the Combination Conveyance and Detention alternative.

Table 1. Evaluation of Alternatives

Alternative	Expected Annual Damages	Expected Annual Benefits	Average Annual Costs	Net Annual Benefits	Benefit-to-Cost Ratio
No Action	$2,966,000	$0	$0	$0	-
Full Conveyance	$1,247,000	$3,766,000	$489,000	$3,277,000	7.7
Combination	$665,000	$2,367,000	$399,000	$2,068,000	5.0

Note: Evaluation conducted in FY15 price levels, 50-year period of analysis, and a 3.375% discount rate

The evaluation conducted above is sufficient to show that the Full Conveyance alternative provides greater net annual National Economic Development benefits than the Combination alternative. Though this analysis is somewhat dated, the team employed a risk-informed decision that updating this analysis would be highly unlikely to change with an update to FY19 costs and discount rates. This decision was briefed at the Major Subordinate Command Decision Milestone Meeting and the results of this analysis are considered sufficient for comparison purposes.

5.3.6 Final Array of Alternatives

In additional to carrying forward the No Action Alternative, the Full Conveyance alternative was chosen from the initial array of alternatives. Best practices and policy compliance require that the Full Conveyance alternative be evaluated at different levels of protection to properly identify the NED plan. The sections below describe the comparisons that took place and the results of the analysis.

5.3.6.1 0.02 Annual Chance of Exceedance Alternative (2 culverts)

This alternative would construct features generally in accordance with those shown in Figure 13, but would be sized to convey flows associated with an event with a 0.02 annual chance of exceedance. An overflow channel and two culverts would be constructed under Kamehameha Highway designed to pass these flows. Events with flows greater than this would continue to inundate Laie and cause flooding damages. This alternative would also include the “BYU Diversion Channel”. This alternative shows net annual benefits of $3.78 million and a benefit to cost ratio of 6.1.

5.3.6.2 0.01 Annual Chance of Exceedance Alternative (3 culverts)

This alternative would construct features generally in accordance with those shown in Figure 13. An overflow channel and three culverts would be constructed under Kamehameha Highway in order to pass flows associated with an event with a 0.01 annual chance of exceedance. This alternative would also include the “BYU Diversion Channel”. This alternative shows net annual benefits of $3.83 million and a benefit to cost ratio of 6.1.

6.0 COMPARISON AND SELECTION OF PLANS

The alternatives were designed to meet the planning objectives and criteria and were evaluated based on environmental, economic, and engineering considerations. The physical characteristics of the alternatives are shown in Table 2. Interest during construction was added to the initial cost to account for the opportunity cost incurred during the time after the funds have been spent, but before the benefits begin to accrue. Preconstruction, engineering, and design is assumed to take 9 months and construction is assumed to take 3 months, subject to funding and resource availability.

Table 2: Comparison of Alternatives: Physical Characteristics

Feature/Alternative	No Action	0.02 ACE	0.01 ACE
Annual Chance of Exceedance	0.2	0.02	0.01
Channel Length (feet)	0	1,200	1,200
Channel Width (feet)	0	50	50
Excavation (cubic yards)	0	125,000	125,000
Rip Rap at Outlet (cubic yards)	0	TBD	TBD
Culverts (number)	0	2	3
BYU Diversion Channel (cubic yards)	0	89,000	89,000
BYU Diversion Rip Rap (cubic yards)	0	12,230	12,230

6.1 Detailed Alternative Plans Descriptions

6.1.1 Without-Project Conditions (No-Action Alternative)

Without flood risk management measures at Wailele Stream, Laie will continue to experience flooding whenever flows in Wailele Stream exceed 675 cubic feet per second. Given that the 50 percent annual chance of exceedance flow is 902 cubic feet per second, Laie can expect some level of flooding on an almost annual basis. The No Action Alternative would see the without-project condition persist throughout the 50-year period of analysis.

6.1.2 With-Project Conditions

6.1.2.1 Conveyance 0.02 Annual Chance of Exceedance

In the 0.02 Plan Future With-Project Condition, Laie would see reduced inundation to structures for events with a frequency greater than 0.02 (50-year event). For those higher probability events the area and depth of inundation would be decreased. Figure 15 shows a comparison of the inundated areas and depths between the future without project condition and future with-project condition for this alternative.

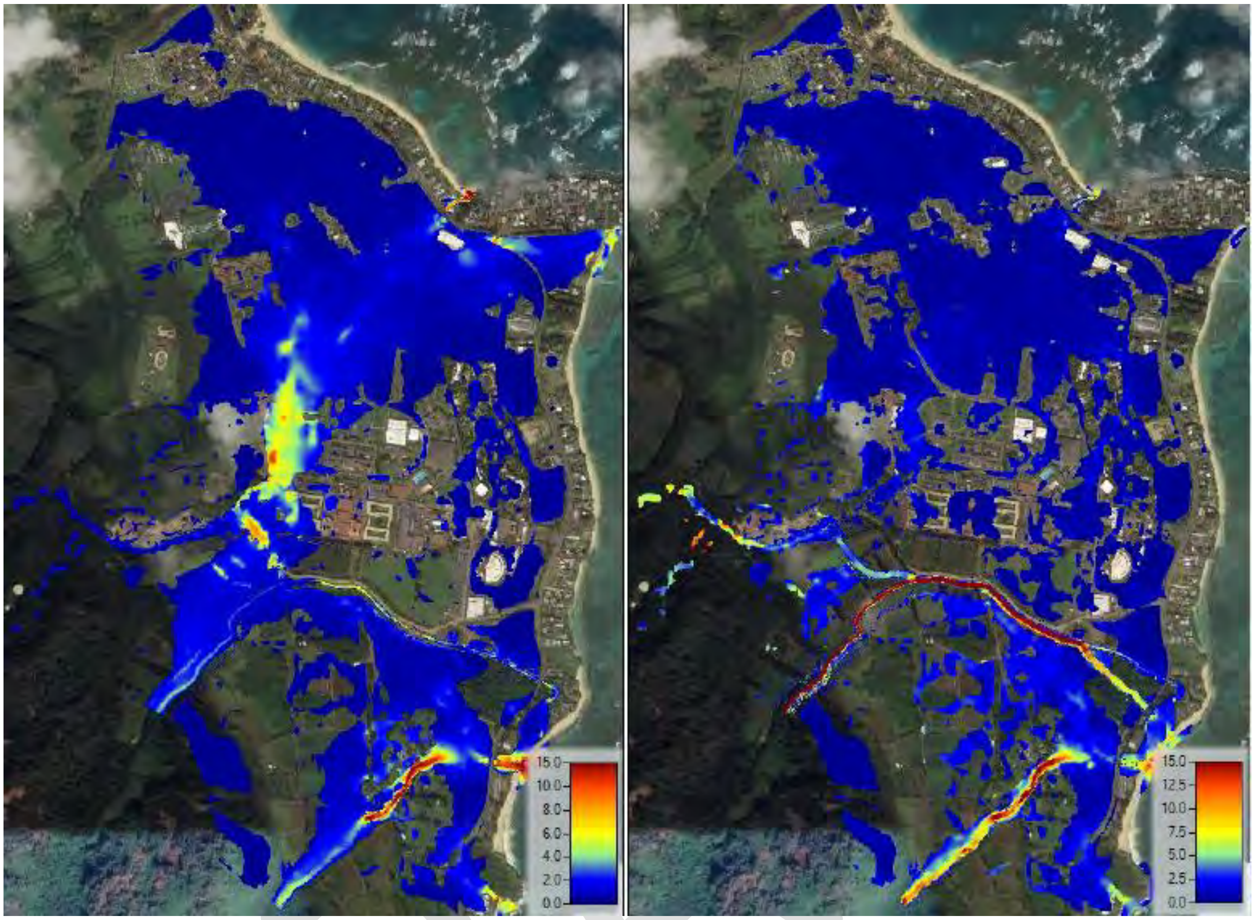


Figure 15. Inundation Area Future Without Project Condition (left) versus 0.02 Plan (right)

6.1.2.2 Conveyance 0.01 Annual Chance of Exceedance

In the 0.01 Plan Future With-Project Condition, Laie would see reduced inundation to structures for events with a frequency greater than 0.01 (100-year event). For those higher probability events the area and depth of inundation would be decreased. Figure 16 shows a comparison of the inundated areas and depths between the future without project condition and future with-project condition for this alternative.

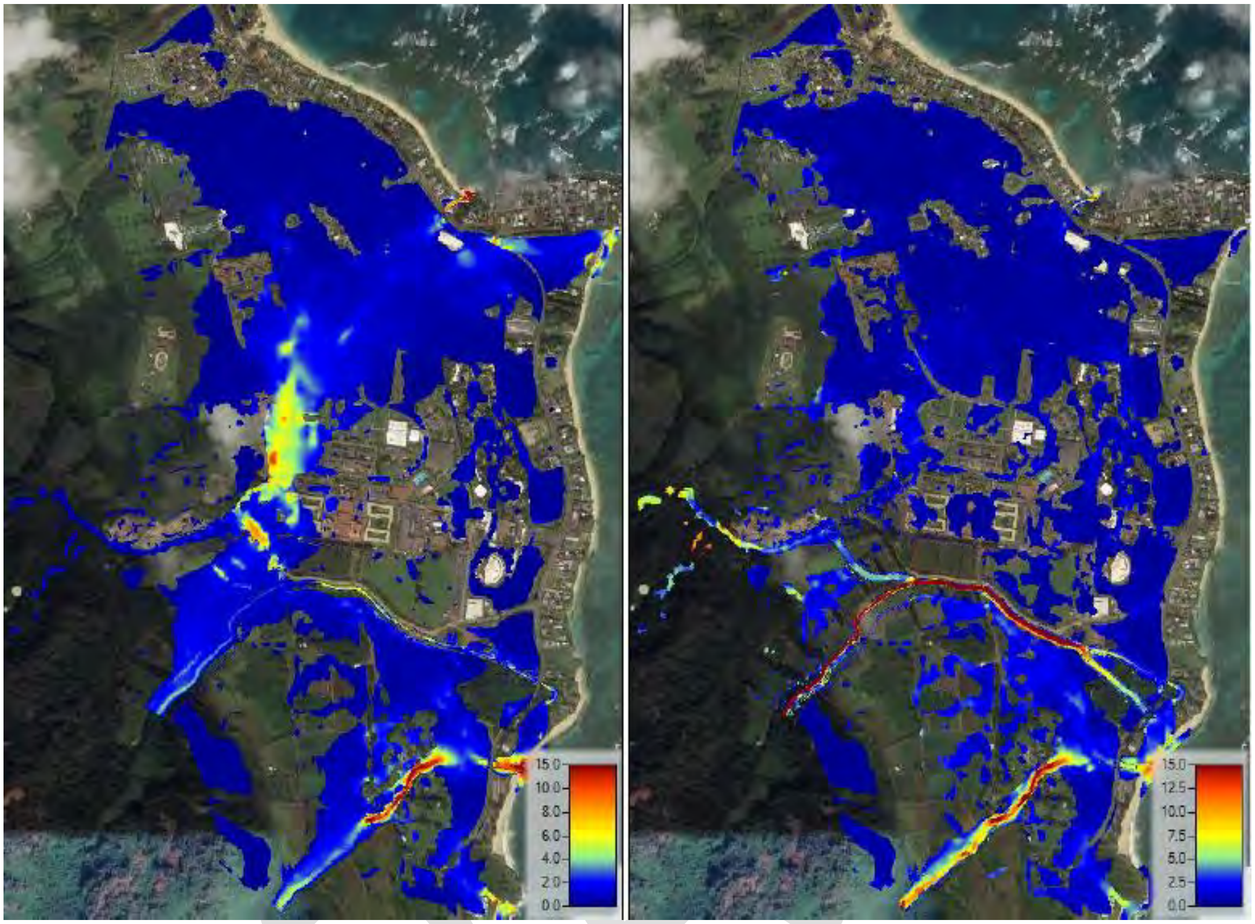


Figure 16. Inundation Area Future Without Project Condition (left) versus 0.01 Plan (right)

6.2 Alternative Plan Costs

6.2.1 Construction and Investment Costs

Construction and investment costs account for the total costs of materials and labor needed to construct the project as well as the value of foregone investment opportunities while construction is taking place. For this analysis, construction is anticipated to last 3 months during the summer of 2021 and interest during construction is calculated using the Federal fiscal year 2019 discount rate of 2.875 percent. Information presented in Table 3 shows a Work Breakdown Structure of various cost categories related to construction of the final array of alternatives.

Table 3: Initial Construction and Investment Costs, by Alternative

WBS	No Action	0.02	0.01
15 Floodway Control & Diversion Structures	$0	$8,785,000	$8,785,000
02 01 Roads, Construction Activities	$0	$319,000	$319,000
01 Lands and Damages	$0	$395,000	$395,000
30 Planning, Engineering, & Design	$0	$2,423,000	$2,423,000
31 Construction Management	$0	$1,010,000	$1,010,000
N/A Cultural Mitigation Measures	$0	$638,000	$638,000
N/A Non-Federal Structure (BYU Diversion)	$0	$2,000,000	$2,000,000
Total	$0	$15,570,000	$15,570,000

Note: All calculations utilize 2019 price levels and the Federal fiscal year 2019 discount rate of 2.875 percent. Costs for avoidance and minimization mitigation measures have been incorporated into the direct costs for construction. Totals may not sum due to rounding.

6.2.2 Operations and Maintenance Costs

Operations and Maintenance costs are assumed to occur due to two regularly reoccurring activities: annual maintenance of the gravel course atop the access road, and clearing the channel of vegetation. There is the potential that rip rap will need to be replaced on a non-reoccurring basis after larger, infrequent event. It is expected that operation and maintenance costs for both plans will be approximately $45,000 per year.

6.2.3 Total Average Annual Equivalent Costs

Using the information in the preceding sections, the total average annual equivalent costs for each alternative were calculated. These are shown below in Table 4.

Table 4: Average Annual Costs, by Alternative

Category	No Action	0.02	0.01
Average Annual Costs	$0	$751,000	$756,000

Note: All calculations utilize 2019 price levels and the Federal fiscal year 2019 discount rate of 2.875 percent.

6.3 With-Project Benefits

Each alternative provides a specific level of relief from existing and future flood damages. The differences between the expected levels of damages absent Federal action (the without-project condition) and those that will occur under the various with-project conditions are benefits that accrue to the project and form the basis for selecting a recommended plan.

6.3.1 Flood Damages Alleviated

Foregone flood damages were calculated utilizing HEC-FDA, a certified model for estimating eliminated flood damages, and therefore, flood-related benefits in the various with-project conditions. Because of the steep nature of the terrain drained by this stream, the study area was divided into 25 basins housing 379 structures to account for water surface elevation changes as they relate to the topography of the area. Figure 17 shows the basins and structures input into the HEC-FDA model.

Water surface elevations at various flow levels were calculated for each of the basins. These water surface elevations were compared to the first floor elevations of each structure within the various basins to determine damages that would occur during various flooding events. These calculations are shown in detail in the Economics appendix, with a summary shown below in Table 5.

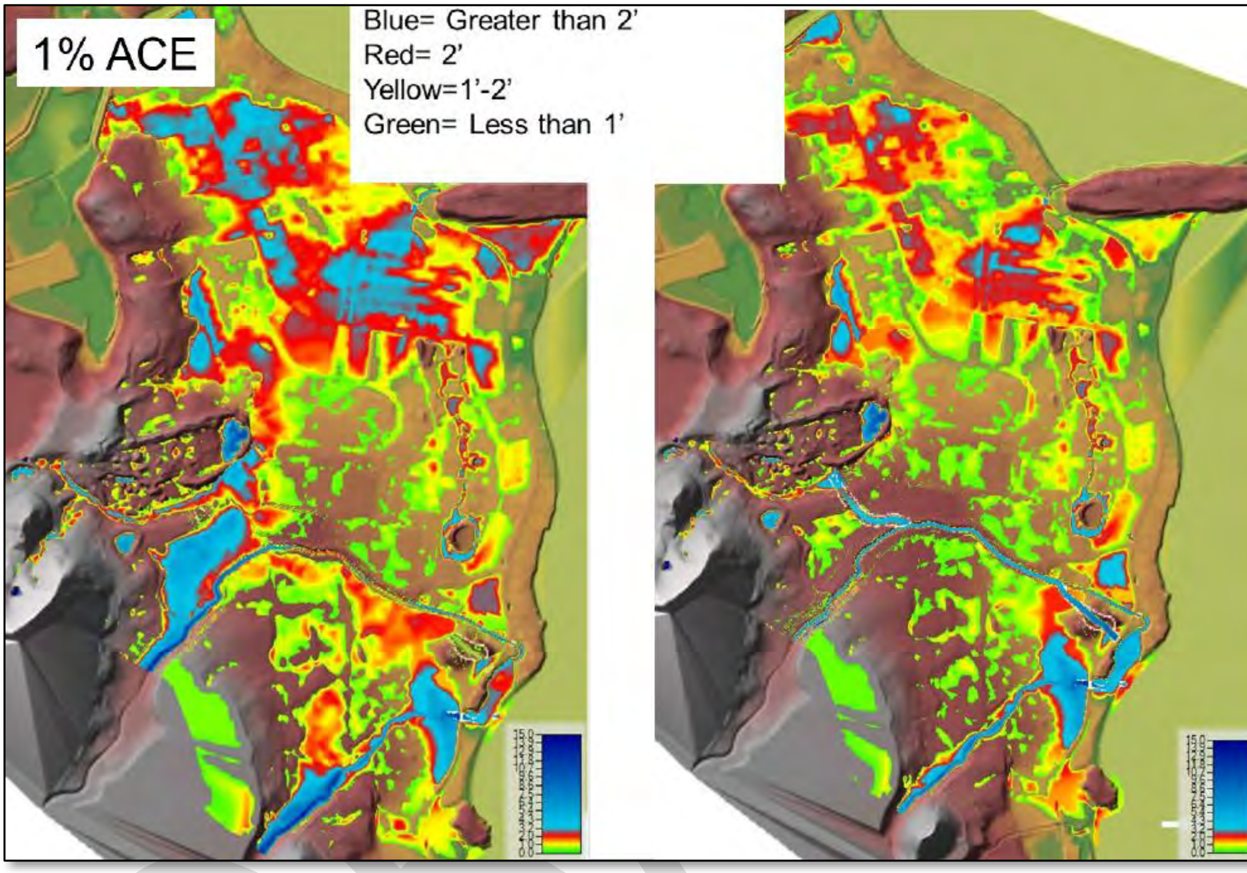


Figure 17: Expected Inundation Damages, Current (left), 0.01 Plan (right)

Table 5: Flood Related Benefits, by Alternative

Alternative	Expected Annual Damage		
	Total Without Project	Total With Project	Damage Reduced (Benefits)
No Action	$5,781,000	$5,781,000	$0
0.02 Plan (2 culverts)	$5,781,000	$1,232,000	$4,549,000
0.01 Plan (3 culverts)	$5,781,000	$1,199,000	$4,581,000

Note: All calculations utilize 2017 price levels and the Federal fiscal year 2019 discount rate of 2.875 percent. Totals may not sum due to rounding.

6.4 Net Benefits of Alternative Plans

If the No Action Alternative was to be implemented, flood risk would remain at current levels. The non-Federal partner would continue to engage in annual or semi-annual flood fighting for events with a 0.1 annual chance of exceedance.

Each of the with-action alternatives would accrue the same amount of benefits related to recreation and foregone flood fighting since the recreation facilities would not differ between the alternatives and they all would protect to a level greater than what the non-Federal partner can provide through flood-fighting activities. The main difference in the with-action alternatives is related to the degree to which they prevent flooding damages to structures within the affected area. The amount of benefits provided by each alternative is shown below in Table 6.

Table 6: Summary of Net Annual Benefits, by Alternative

Benefits	No Action	0.02 (2 culverts)	0.01 (3 culverts)
Total	$0	$3,798,000	$3,826,000

Note: 50-year period of analysis, Federal fiscal year 2019 discount rate of 2.875 percent. Totals may not sum due to rounding.

6.5 Plan Comparison and Remaining Tasks

The Tentatively Selected Plan is the 0.01 Plan. There are multiple reasons for this, and the majority of those reasons lie with the tasks remaining to complete this study. Due to time and resource constraints, the project delivery team was unable to update costs to 2019 price levels and therefore, it is unclear what the current difference is between the 0.02 Plan and 0.01 Plan given that the only difference between the two is one additional culvert and the real estate required to place that culvert. Additionally, the 0.01 Plan shows a reduction in water surface elevation (inundation of structure) at the 0.01 event. The project delivery team is working the refine the economics associated with both plans and suspects that once final modeling is complete, the 0.01 Plan will be the plan that reasonably maximizes net annual benefits. The project delivery team acknowledges the remaining tasks to be accomplished to ensure a policy-compliant product is delivered at the end of the study.

6.6 Description of Tentatively Selected Plan

The tentatively selected plan is the 3 culvert, or 0.01 ACE Plan. This plan maximized net National Economic Development benefits and was selected as the National Economic Development plan. The plan is the largest acceptable project to the non-Federal partner and was selected as the Recommended Plan. Major construction items include:

- BYU-Diversion Channel Major Drainage Feature (non-Federal);
- Wailele Stream channel geometry improvements;
- Construction of an overflow channel;
- Construction of a weir that would divert flows in exceedance of 675 cubic feet per second into the overflow channel;
- Placing three culverts underneath the Kamehameha Highway; and,
- Erosion protection on the ocean-side of the Kamehameha Highway as required

6.6.1 Plan Components

The recommended plan contains four major components, which are listed below.

- BYU Diversion Channel
- Wailele Stream Channel Upgrades
- Culverts under the Kamehameha Highway
- Rip Rap throughout the project as required to reduce and eliminate scour

6.6.2 Implementation of Recommended Plan

6.6.2.1.1 Design and Construction Tasks

Major design activities include geotechnical borings to verify subsurface conditions, survey activities, ongoing coordination with other agencies, ongoing public involvement, project management, contracting, and construction-level design of the project features.

Construction activities include real estate acquisition, clearing and grubbing, excavation, fill, disposal/placement of excavated materials, placement of new materials, installation of the culverts, placement of rip rap, and construction of a temporary bypass to ensure passage of traffic on the Kamehameha Highway.

6.6.2.1.2 Cost Sharing

The Federal government will provide 65 percent of funds required for design and construction of flood risk management measures and 50 percent of funds required for design and construction of recreation measures associated with the recommended project. The non-Federal partner will provide 35 percent of funds required for design and construction of flood risk management measures and 50 percent of funds required for design and construction of recreation measures associated with the recommended project. The non-Federal partner will be required to provide 100 percent of all funds associated with operation and maintenance of the project once construction has been completed. An estimate of total cost allocation is provided in Table 7.

Table 7: Cost Allocation

Item	Total Cost	Federal Share	%	Non-Federal Share	%
Flood Risk Management Features	$9,104,000	$5,918,000	65	$3,186,000	35
Cultural Mitigation Measures	$638,000	$415,000	65	223,000	35
Major Drainage Features	$2,000,000	$0	0	$2,000,000	100
Construction Estimate Total	$11,742,000	$6,332,000		$5,409,000	
LERRD	$395,000	$0	NA	$395,000	NA
Planning, Engineering & Design	$2,423,000	$1,575,000	65	$848,000	35
Construction Management	$1,010,000	$657,000	65	$354,000	35
TOTAL PROJECT COST	$15,600,000	$8,564,000		$7,006,000	
Adjustment for LERRD Credit	$395,000	$395,000		($395,000)	
FINAL COST ALLOCATION		**$8,959,000**	**57**	**$6,611,000**	**43**

Note: Totals may not sum due to rounding.

6.6.2.2 Construction

6.6.2.2.1 Federal

The Corps will be responsible for providing the Federal portion of design and construction funds as indicated in Table 7, as well as construction of the Wailele channel improvements, BYU Diversion Channel-Wailele confluence outlet works, overflow channel, culverts, and associated armoring.

6.6.2.2.2 Non-Federal

The non-Federal partner will be responsible for providing the non-Federal funding portion of the project features as indicated in Table 7, acquiring all lands, easements, and rights-of-way, and performing any relocations and disposals prior to construction.

6.6.2.2.3 Residual Risk

Implementation of the Tentatively Selected Plan will not eliminate flood risk within Laie. Due to topography of the area and a lack of internal drainage infrastructure, there will still be structures that will experience inundation at events with a 0.2 ACE. However, the number of structures inundated at each event level and the depth to which they are inundated will be decreased. At an event with a 0.01 ACE, the number of structures inundated decreases from 213 to 101 with implementation of the Tentatively Selected Plan. Further information on residual flood risk is available in the Economic Appendix to this report.

Additionally, the project will not eliminate incremental flooding risk for events greater than 0.01 ACE. In larger events, it is expected that flood waters from Wailele Stream will still enter Laie Town.

6.6.2.2.4 Transfer of Risk

Implementation of the Tentatively Selected Plan is not expected to transfer risk from one area of the floodplain to another or from one floodplain to another.

6.6.2.3 Operations and Maintenance

The Non-Federal partner will be responsible for the operation and adequate maintenance of the constructed project.

6.6.2.4 Mitigation

Efforts to minimize and avoid environmental impacts have been implemented to the extent possible. Mitigation measures are currently being developed with the State of Hawaii Historic Preservation Officer and will be part of a Programmatic Agreement or Memorandum of Agreement that is currently being negotiated. This agreement is expected to be finalized prior to the end of the feasibility study.

6.6.2.5 Implementation Schedule

The schedule shown in Table 8 details major activities to be accomplished during the design and implementation phase and assumes funding and resource availability. A lack of either funding or resources may cause significant changes to this schedule.

Table 8: Design and Implementation Schedule

Item	Date
Submit Final Decision Document	September 2019
Decision Document Approval	October 2019
Initiate Design and Implementation Phase	November 2019
PPA approval by Pacific Ocean Division	March 2020
Execute Project Partnership Agreement	April 2020
Construction Contract Award	September 2021
Project Completion	September 2023

6.7 Integration of Environmental Operating Principles

The following environmental operating principles have been integrated into the planning process:

Foster sustainability as a way of life throughout the organization: This project contributes to a more sustainable waterway.

Proactively consider environmental consequences of all Corps activities and act accordingly: Environmental consequences were considered throughout the planning process and every effort has been made to avoid, minimize, or mitigate all anticipated impacts. Construction of the Tentatively-Selected Plan would eliminate pollution currently conveyed into the ocean as a result of Wailele Stream flooding through Laie. It is anticipated that there will be some impacts to historical/archeological resources. A Programmatic Agreement is currently being negotiated with the State of Hawaii.

Create mutually supporting economic and environmentally sustainable solutions: The recommended plan is the National Economic Development plan and therefore provides the maximum amount of benefits to the nation. The project was formulated in a way that makes it lasting, requiring very little in maintenance, and avoids long term environmental impacts wherever possible.

Continue to meet our corporate responsibility and accountability under the law for activities undertaken by the Corps which may impact human and natural environments: A full environmental assessment was conducted as required by the National Environmental Policy Act. In addition, the principles of avoidance, minimization, and mitigation were enacted to the extent possible.

Consider the environment in employing a risk management and systems approach throughout the life cycles of projects and programs: For this study, a systems approach was utilized to examine the interaction between in-channel flows and the associated floodplain.

Leverage scientific, economic and social knowledge to understand the environmental context and effects of Corps actions in a collaborative manner: The Corps worked closely with the Non-Federal partner throughout this study. The non-Federal partner has an abundance of institutional knowledge about the environment surrounding the stream.

Employ an open, transparent process that respects the views of individuals and groups interested in Corps activities: The Corps made every effort to be responsive to stakeholder concerns. Public input was solicited and used for both environmental and economic analysis purposes.

6.8 Real Estate Considerations

The Non-Federal partner will acquire all lands, easements, rights-of-way, and disposal areas and perform any necessary relocations prior to construction. Further information is available in the real estate appendix of this report.

6.9 Summary of Accounts

6.9.1 National Economic Development

The recommended plan is the National Economic Development plan and provides the greatest amount of net annual benefits to the nation.

6.9.2 Regional Economic Development

Economic benefits that accrue to the region but not necessarily the nation include enhanced employment to the local workforce during construction.

6.9.3 Environmental Quality

Qualitative enhancements to the environment include elimination of pollutant conveyance into the ocean associated with Wailele Stream flooding for all events with higher probability than 0.01.

6.9.4 Other Social Effects

The project contributes to the human environment by reducing anxiety and costs of recovery from inundation events.

6.10 Risk and Uncertainty

In any planning decision, it is important to take into account the risk and uncertainty that is invariably present. For this study, there are a number of risk and uncertainty categories that were identified and evaluated during the planning process including flood damages, flow conditions, material prices, recreational usage, etc. Further information on these calculations can be found in the various appendices.

The recommended plan protects against flows with a 0.01 annual chance of exceedance. Under conditions with a lower annual chance of exceedance, the project would not be expected to provide additional benefits.

7.0 ENVIRONMENTAL CONSEQUENCES

This chapter provides an overview of anticipated environmental consequences. Further detail can be found in the environmental appendix. The environmental consequences of the various alternatives were evaluated in comparison to the no action alternative. While this consequence analysis focuses on the Tentatively Selected Plan (0.01 ACE/3 culverts Plan), the impacts of the other alternatives are similar to the Tentatively Selected Plan unless otherwise noted.

7.1 Physical Environment

7.1.1 Water Quality

7.1.1.1 No Action Plan

During inundation events, water from Wailele Stream will enter Laie, collect pollutants, and discharge them into the Pacific Ocean via the Foodland culvert.

7.1.1.2 Tentatively Selected Plan

Conveyance of urban pollutants into the Pacific Ocean will be eliminated for events with an annual chance of exceedance greater than 0.01.

7.1.2 Air Quality

7.1.2.1 No Action Plan

Air quality will continue to be relatively good and the area would not be expected to become a non-attainment area.

7.1.2.2 Tentatively Selected Plan

Air quality may be affected during the construction period due to resultant suspended particulates from equipment movement and material excavation and placement as well as emissions from equipment. Traffic delays associated with construction across Kamehameha Highway may also lead to temporary and less than significant increases in emissions. Any degraded air quality conditions that may be caused by the project are believed to be transient, highly localized, and likely to entirely dissipate at the end of the construction phase. The Corps and its contractors will comply with all applicable air quality regulations and policies of the landowner, local authorities, and the State and Federal governments. Impacts to air quality are expected to be less than significant.

7.1.3 Aesthetic Quality

7.1.3.1 No Action Plan

The project area will continue to be agricultural in nature.

7.1.3.2 Tentatively Selected Plan

Aesthetic quality is expected to be neutral after construction is complete. The majority of the project will be located on agricultural lands that are not open to the general public. The only changes in aesthetics for the general public will be immediately upstream of the Kamehameha Highway and visible to passersby. Effects to aesthetics are expected to be less than significant.

7.1.4 Noise

7.1.4.1 No Action Plan
Existing activities will continue to generate a wide variety of noise.

7.1.4.2 Tentatively Selected Plan
There is no expected adverse change in noise after construction. During construction, any adverse change in noise is expected to be less than significant.

7.1.5 Human Activity

7.1.5.1 No Action Plan
Human activity will continue at current levels into the foreseeable future.

7.1.5.2 Tentatively Selected Plan
There is not expected to be any significant change in human activity in the project area as a result of construction of this project.

7.2 Biological Resources

7.2.1 Terrestrial Habitat

7.2.1.1 No Action Plan
There is not expected to be any significant change in terrestrial habitat under the No Action Plan, as no future development projects are proposed for the area.

7.2.1.2 Tentatively Selected Plan
There will be a minor impact to some terrestrial habitat due to the construction of the project features. The number of trees felled during construction will not significantly impact terrestrial habitat. It is likely that felled trees will either be transported to a landfill or offered to the public. There will be no loss of specialized bird habitat due to construction of the project and no mitigation is proposed for the loss of terrestrial habitat. Any impacts to terrestrial habitat are expected to be less than significant.

7.2.2 Federal and State Threatened and Endangered Species

7.2.2.1 No Action Plan
There are not expected to be any significant changes in either the presence or habitat of listed species under the No Action Plan.

7.2.2.2 Tentatively Selected Plan
The Tentatively Selected Plan is expected to have no effect on any Federally-listed, threatened, or endangered species, or designated critical habitat.

7.2.3 Fishery Resources and Essential Fish Habitat

7.2.3.1 No Action Plan
The No Action Plan will have no effect on fishery resources and essential fish habitat.

7.2.3.2 Tentatively Selected Plan

The No Action Plan will have no effect on fishery resources and essential fish habitat.

7.3 Coastal Zone Resource Management

The Corps is working to meet requirements under the Coastal Zone Resource Management Act of 1972 (16 United States Code 33 § 1451 et seq). It is expected that at completion of the study, all Coastal Zone Resource Management requirements will have been met.

7.4 Historical and Archaeological Resources

Based on anticipated impacts to known and expected archaeological resources, it has been determined that the Wailele Flood Risk Management Project will have an adverse effect on Historic Properties (36 CFR 800.5; HAR §13-275-7). Consultation on the extent and magnitude of the adverse effect, and potential mitigation options, is currently ongoing with the Hawaii State Historic Preservation Division, the Office of Hawaiian Affairs, Ko'olauloa Hawaiian Civic Club, and the Advisory Council on Historic Preservation. The outcome of the consultation will be formalized in a binding Memorandum of Agreement or Programmatic Agreement among the consulting parties. Based on the nature of the resources involved, and in light of past mitigation for comparable resources, it is expected that the agreement document will contain requirements for Archaeological Monitoring and Archaeological Data Recovery as the principal mitigation tools for all impacts to historical and archaeological resources. While adverse impacts are anticipated, these impacts will be fully mitigated.

7.5 Environmental Justice and Protection of Children

Executive Order 12898, "Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations", requires Federal agencies to identify and address any disproportionately high and adverse human health effects of its programs and activities on minority and low-income populations. Approximately, 70 percent of the area's population is of minority descent and 10 percent of the population falls below the Federal poverty line. This project is expected to provide proportionate benefits to the population as a whole, but given the unique demographics of this community, it would have a positive impact on a community where minorities comprise the majority of the population. Negative impacts to these populations are expected to be less than significant and is expected to be higher under the No Action Plan than the Tentatively Selected Plan.

7.6 Cumulative and Long-term Impacts

Federal law (33 Code of Federal Regulations 230 et seq.) and Engineer Regulation 200-2-2, "*Procedures for Implementing NEPA,*" require that National Environmental Policy Act documents assess cumulative effects, which are the impact on the environment resulting from the incremental impacts of the action when added to other past, present, and reasonably foreseeable future actions. Construction of the Tentatively Selected Plan is not expected to have any cumulative or long-term adverse impacts.

7.7 Summary of Mitigation Measures

7.7.1 No Action Plan

There would be no mitigation measures associated with the No Action Plan.

7.7.2 Tentatively Selected Plan

Mitigation measures include avoidance, minimization, employment of best construction practices, and items included in the Programmatic Agreement or Memorandum of Agreement with the State of Hawaii regarding impacts to historical/archaeological resources.

7.8 Plan Selection

After thorough consideration of the environmental and economic effects of both the No Action Plan and Tentatively Selection Plan the Tentatively Selected Plan was identified as the preferred path forward. Any adverse effects resulting from implementation of the Recommended Plan will be temporary and less than significant or fully mitigated.

8.0 PUBLIC AND AGENCY INVOLVEMENT

This chapter provides an overview of efforts to engage the public and other agencies throughout the course of this study. The status of compliance with relevant laws and policies is shown in Table 9.

8.1 Public/Scoping Meetings

A public meeting was held at Laie Elementary School on 6 May 2019. Approximately 75 people attended the meeting. Feedback on the project was largely positive and any concerns voiced by the community were considered and addressed.

While public feedback has been solicited throughout the study process, a formal 30-day public review period will be conducted in June and July 2019. Feedback from that review period will be incorporated into the study consistent with Corps policy.

8.2 Federal and State Agency Coordination

Coordination with all required state and Federal agencies has been sought. To date, none of these agencies has voiced concern over long term impacts.

8.3 Status of Environmental Compliance (Compliance Table)

8.3.1 Relationship to Environmental Laws and Compliance

The following sections detail the status of compliance with project-applicable laws.

8.3.1.1 National Environmental Policy Act of 1969 (42 United States Code 4321 et seq.)

This Act requires that environmental consequences and project alternatives be considered before a decision is made to implement a Federal project. The National Environmental Policy Act established the requirements for preparation of an Environmental Impact Statement for projects potentially having significant environmental impacts and an Environmental Assessment for projects with no significant environmental impacts. This Environmental Assessment has been prepared to address impacts and propose avoidance and minimization steps for the proposed project, as discussed in the Council on Environmental Quality regulations on implementing National Environmental Policy Act (40 Code of Federal Regulations 1500 et seq.). This document presents sufficient information regarding the generic impacts of the proposed construction activities to guide future studies and is intended to satisfy all National Environmental Policy Act requirements.

In accordance with National Environmental Policy Act and Corps regulations and policies, the Environmental Assessment and unsigned Finding of No Significant Impact have been released for public and agency review, and the Environmental Assessment has been made available on the Honolulu District website to the interested public prior to the implementation of this proposed action.

8.3.1.2 Clean Water Act of 1972 (33 United States Code 1251 et seq.)

The objective of the Federal Water Pollution Control Act of 1972, as amended by the Clean Water Act (Public Law 92-500, 33 U.S.C. 1251 et seq.), is to restore and maintain the chemical, physical, and biological integrity of the Nation's waters.

Various sections of the Clean Water Act regulate the discharge of pollutants and wastes into aquatic and marine environments. The specific sections of the Clean Water Act that apply to the proposed project are Section 404, addressing the discharge of fill material to the waters of the United States, and Section 401, which requires certification that the permitted project complies with the State Water Quality Standards for actions within State waters. The major Federal actions invoking this regulation are channel geometry improvements and the proposed placement of rock below the ordinary high water line of Wailele Stream for purposes of grade and/or erosion control.

Although the enforcement agency for Section 404 is normally the Corps, the Corps does not issue permits to itself. Instead, the Corps has prepared a 404(b)(1) evaluation to determine Federal consistency with Section 404 of the Clean Water Act. The 404(b)(1) evaluation for this project has been completed and submitted to the State of Hawaii Department of Health. If the State concurs with the Corps determination that there is reasonable assurance that the proposed project would meet and maintain State water quality standards, a Section 401 water quality certificate will be issued. State water quality certification will be obtained prior to finalization of the Environmental Assessment and signing of the Finding of No Significant Impact.

8.3.1.3 Rivers and Harbors Act of 1899 (33 United States Code 403 et seq.)

Section 10 of this Act prohibits the obstruction or alteration of navigable waters of the United States without a permit from the Corps. Generally, navigable waters are those waters of the United States subject to the ebb and flow of the tide shoreward to the mean high water mark, and/or are presently used, or have been used in the past, or may be susceptible to use to transport interstate or foreign commerce. Wailele Stream does not meet the definition of a navigable waterway as defined by 33 Code of Federal Regulations Part 328, so the Rivers and Harbors Act of 1899 does not apply.

8.3.1.4 Endangered Species Act of 1973 (16 United States Code 1531 et seq.)

The Endangered Species Act protects threatened and endangered species by requiring federal agencies, in consultation with the U.S. Fish and Wildlife Service and/or the National Marine Fisheries Service, to ensure that actions they authorize, fund, or carry out are not likely to jeopardize the continued existence of any listed species or result in the destruction or adverse modification of designated critical habitat of such species. The law also prohibits any action that causes a "taking" of any listed species of endangered fish or wildlife. The proposed project is not expected to have an effect on any Federally-listed threatened or endangered species.

8.3.1.5 Fish and Wildlife Coordination Act (16 United States Code 661 et seq.)

The Fish and Wildlife Coordination Act requires the Corps to consult with the United States Fish and Wildlife Service whenever the waters of any stream or other body of water are proposed to be impounded, diverted, or otherwise modified. The U.S. Fish and Wildlife Service was consulted on this project, and did not raise any concerns. The Corps is continuing to consult with the United States Fish and Wildlife Service to obtain documentation that consultation was completed in accordance with this act.

8.3.1.6 Magnuson-Stevens Fishery Conservation and Management Act Fishery Conservation Reauthorization Act of 2006, as amended, (16 United States Code 1801 et seq.)

The Magnuson-Stevens Fishery Conservation and Management Act provides for the conservation and management of all fishery resources between 3 and 200 nautical miles offshore. The 1996 amendments to this act require regional fisheries management councils, with assistance from the National Marine Fisheries Service, to delineate Essential Fish Habitat in Fishery Management Plans for all managed species. Essential Fish Habitat is defined as an area that consists of "waters and substrate necessary for spawning, breeding, feeding or growth to maturity" for certain fish species. Federal action agencies that carry out activities that may adversely impact Essential Fish Habitat are required to consult with the National Marine Fisheries Service regarding potential adverse effects of their actions on Essential Fish Habitat.

The Corps contacted the National Marine Fisheries Service to inquire if they had any interest in this project. They stated that given the non-marine nature of the project, they did not have any concerns about the project. The Corps has conducted an assessment of Essential Fish Habitat for the proposed project and it has been determined that this project will have no effect on Essential Fish Habitat. No future coordination with the National Marine Fisheries Service is expected at this time. Should the scope of the project change, then further coordination may be required.

8.3.1.7 Marine Mammal Protection Act of 1972, as amended (16 United States Code 1361 et seq.)

The Marine Mammal Protection Act provides protection to marine mammals in both State waters (within 3 nautical miles from the coastline) and the ocean waters beyond. As specified in the Marine Mammal Protection Act, the United States Fish and Wildlife Service is responsible for the management of polar bears, walrus, and sea otters; the National Marine Fisheries Service is responsible for all other marine mammals. The project area does not occur in any marine waters. Therefore the Marine Mammal Protection Act does not apply to this action.

8.3.1.8 Migratory Bird Treaty Act of 1918, as amended (16 United States Code 703 et seq.)

The essential provision of the Migratory Bird Treaty Act makes it unlawful, except as permitted by regulations, "to pursue, hunt, take, capture, kill…any migratory bird, any part, nest or egg," or any product of any bird species protected by the convention. Significant populations of migratory birds are not expected to be present in the project area. Should this change, the Corps will coordinate with Unites States Fish and Wildlife Service to minimize any risk posed to migratory birds by the project.

8.3.1.9 National Historic Preservation Act of 1966, as amended (16 United States Code 470 et seq.)

The purpose of the National Historic Preservation Act is to preserve and protect historic and prehistoric resources that may be damaged, destroyed, or made less available by a project. Under this Act, Federal agencies are required to identify cultural or historic resources that may be affected by a project and to consult with the State Historic Preservation Officer when a Federal action may affect cultural resources.

As discussed previously, the Corps is negotiating a Programmatic Agreement or Memorandum of Agreement with the State of Hawaii to properly address all anticipated impacts to historical/archaeological resources.

8.3.1.10 Executive Order 11988, Floodplain Management

The City and County of Honolulu's Revised Ordinances of Honolulu state that all new structures in the area must be constructed with a first floor elevation at or above the base flood elevation, or in special cases to be designed to incorporate wet flood proofing measures. Therefore, any new development will be done so in a flood-responsible manner.

The construction of the recommended project is not expected to increase or encourage construction within the floodplain above what would have occurred in the without-project condition and therefore the project is in compliance with Executive Order 11988.

8.3.1.11 Clean Air Act of 1963, as amended (42 United States Code 85 et seq.)

The project is not located in either a maintenance or non-attainment area for any pollutant under the Clean Air Act. None of the construction activities are expected to produce any pollutants in quantities that would exceed Federal thresholds.

8.3.1.12 Executive Order 13112, Invasive Species

The non-native and invasive plants that are present in the area are not expected to proliferate due to construction of the project.

Table 9: Summary of Relevant Federal Statutory Authorities

Federal Statutory Authority	Compliance Status
Archaeological and Historic Act of 1974*	Full Compliance
Clean Air Act, as amended*	Full Compliance
Clean Water Act of 1977, as amended*	Full Compliance
Coastal Zone Management Act of 1982*	Full Compliance
Endangered Species Act of 1973, as amended*	Full Compliance
Fish and Wildlife Coordination Act, as amended*	Full Compliance
Marine Mammal Protection Act*	Full Compliance
Marine Protection, Research, and Sanctuaries Act of 1972*	Full Compliance
Migratory Bird Treaty Act of 1918*	Full Compliance
Magnuson-Stevens Fishery Conservation and Management Act*	Full Compliance
National Environmental Policy Act of 1969, as amended*	Full Compliance
National Historic Preservation Act of 1966, as amended*	Full Compliance
Protection of Wetlands (Executive Order 11990)*	Full Compliance
Rivers and Harbors Act of 1899*	Full Compliance

*- Full compliance will be attained upon completion of the public review process and/or further coordination with responsible agencies
Note: This list is not exhaustive.

8.4 Views of the Non-Federal Partner

The non-Federal partner supports the findings of this study. In addition, the public is supportive of the project due to the reduction in flood risks.

9.0 PREPARERS OF THE ENVIRONMENTAL ASSESSMENT

This integrated feasibility report and environmental assessment was prepared by Jeff Herzog (Project Manager), Lana Murashige (Cost Engineer), and Mike Desilets (Archaeologist) of the Civil Works Civil and Project Branch, Honolulu District, U.S. Army Corps of Engineers, Jason Norris (Planner) of the Dam Safety Modification Mandatory Center of Expertise, Huntington District, U.S. Army Corps of Engineers, Danny Allen (Environmental Resources), Regional Planning and Environmental Center, Southwestern Division, U.S. Army Corps of Engineers, Andrew Branard (Hydraulics and Hydrology), Engineering Branch, Huntington District, U.S. Army Corps of Engineers, and other Corps and non-Corps elements as required.

10.0 CONCLUSIONS AND RECOMMENDATIONS

10.1 Conclusions

The proposed construction of the tentatively selected plan as discussed in this document would have minor but largely controllable short term impacts. However, in the long term it would help improve the overall quality of the human environment. This assessment supports the conclusion that the proposed project does not constitute a major Federal action significantly affecting the quality of the human environment. Therefore, a finding of no significant impact will be prepared.

10.2 Recommendations

I recommend that the flood risk management measures at Laie, Hawaii be constructed generally in accordance with the plan herein, and with such modifications thereof as at the discretion of the Chief of Engineers may be advisable at an estimated total Federal cost of $9.0 million and $0 annually for Federal maintenance.

Federal implementation of the recommended project would be subject to the non-Federal partner agreeing to comply with applicable Federal laws and policies, including but not limited to:

a. Provide a minimum of 35 percent, but not to exceed 50 percent of total flood risk management costs as further specified below:
    1. Provide, during the design and implementation phase, a contribution of funds equal to 5 percent of total flood risk management costs;
    2. Provide all lands, easements, and rights-of-way, including those required for relocations, the borrowing of material, and the disposal of dredged or excavated material; perform or ensure the performance of all relocations; and construct all improvements required on lands, easements, and rights-of-way to enable the disposal of dredged or excavated material all as determined by the Government to be required or to be necessary for the construction, operation, and maintenance of the flood risk management features;
    3. Provide, during the design and implementation phase, any additional funds necessary to make its total contribution equal to at least 35 percent of total flood risk management costs;

b. Provide 50 percent of total recreation costs as further specified below:
    1. Provide all lands, easements, and rights-of-way, including those required for relocations, the borrowing of material, and the disposal of dredged or excavated material; perform or ensure the performance of all relocations; and construct all improvements required on lands, easements, and rights-of-way to enable the disposal of dredged or excavated material all as determined by the Government to be required or to be necessary for the construction, operation, and maintenance of the recreation features;
    2. Provide, during the design and implementation phase, any funds necessary to make its total contribution equal to 50 percent of total recreation costs;

c. Provide, during the design and implementation phase, 100 percent of the total recreation costs that exceed an amount equal to 10 percent of the Federal share of total flood risk management costs;

d. Provide, during the design and implementation phase, 100 percent of all costs of planning, design, and construction for the project that exceed $10,000,000;

e. Shall not use funds from other Federal programs, including any non-Federal contribution required as a matching share therefor, to meet any of the non-Federal obligations for the project unless the Federal agency providing the funds verifies in writing that the funds are authorized to be used to carry out the project;

f. Not less than once each year, inform affected interests of the extent of protection afforded by the flood risk management features;

g. Agree to participate in and comply with applicable Federal floodplain management and flood insurance programs;

h. Comply with Section 402 of the Water Resources Development Act of 1986, as amended (33 U.S.C. 701b-12), which requires a non-Federal interest to prepare a floodplain management plan within one year after the date of signing a project partnership agreement, and to implement such plan not later than one year after completion of construction of the flood risk management features;

i. Publicize floodplain information in the area concerned and provide this information to zoning and other regulatory agencies for their use in adopting regulations, or taking other actions, to prevent unwise future development and to ensure compatibility with protection levels provided by the flood risk management features;

j. Prevent obstructions or encroachments on the project (including prescribing and enforcing regulations to prevent such obstructions or encroachments) such as any new developments on project lands, easements, and rights-of-way or the addition of facilities which might reduce the level of protection the flood risk management features afford, hinder operation and maintenance of the project, or interfere with the project's proper function;

k. Keep the recreation features, and access roads, parking areas, and other associated public use facilities, open and available to all on equal terms;

l. Comply with all applicable provisions of the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970, Public Law 91-646, as amended (42 U.S.C. 4601-4655), and the Uniform Regulations contained in 49 Code of Federal Regulations (CFR) Part 24, in acquiring lands, easements, and rights-of-way required for construction, operation, and maintenance of the project, including those necessary for relocations, the borrowing of materials, or the disposal of dredged or excavated material;

and inform all affected persons of applicable benefits, policies, and procedures in connection with said Act;

m. For so long as the project remains authorized, operate, maintain, repair, rehabilitate, and replace the project, or functional portions of the project, including any mitigation features, at no cost to the Federal Government, in a manner compatible with the project's authorized purposes and in accordance with applicable Federal and State laws and regulations and any specific directions prescribed by the Federal Government;

n. Give the Federal Government a right to enter, at reasonable times and in a reasonable manner, upon property that the non-Federal partner owns or controls for access to the project for the purpose of completing, inspecting, operating, maintaining, repairing, rehabilitating, or replacing the project;

o. Hold and save the United States free from all damages arising from the design, construction, operation, maintenance, repair, rehabilitation, and replacement of the project and any betterments, except for damages due to the fault or negligence of the United States or its contractors;

p. Keep and maintain books, records, documents, or other evidence pertaining to costs and expenses incurred pursuant to the project, for a minimum of 3 years after completion of the accounting for which such books, records, documents, or other evidence are required, to the extent and in such detail as will properly reflect total project costs, and in accordance with the standards for financial management systems set forth in the Uniform Administrative Requirements for Grants and Cooperative Agreements to State and Local Governments at 32 CFR Section 33.20;

q. Comply with all the requirements of applicable Federal laws and implementing regulations, including, but not limited to: Section 601 of the Civil Rights Act of 1964, as amended (42 U.S.C. 2000d), and Department of Defense Directive 5500.11 issued pursuant thereto; the Age Discrimination Act of 1975 (42 U.S.C. 6102); the Rehabilitation Act of 1973, as amended (29 U.S.C. 794), and Army Regulation 600-7 issued pursuant thereto; and 40 U.S.C. 3141-3148 and 40 U.S.C. 3701-3708 (labor standards originally enacted as the Davis-Bacon Act, the Contract Work Hours and Safety Standards Act, and the Copeland Anti-Kick Act);

r. Perform, or ensure performance of, any investigations for hazardous substances that are determined necessary to identify the existence and extent of any hazardous substances regulated under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), Public Law 96-510, as amended (42 U.S.C. 9601-9675), that may exist in, on, or under lands, easements, or rights-of-way that the Federal Government determines to be required for construction, operation, and maintenance of the project. However, for lands that the Federal Government determines to be subject to the navigation servitude, only the Federal Government shall perform such investigations unless the Federal Government provides the non-Federal partner with prior specific written direction, in which case the non-Federal partner shall perform such investigations in accordance with such written direction;

s. Assume, as between the Federal Government and the non-Federal partner, complete financial responsibility for all necessary cleanup and response costs of any hazardous substances regulated under CERCLA that are located in, on, or under lands, easements, or rights-of-way that the Federal Government determines to be required for construction, operation, and maintenance of the project;

t. Agree, as between the Federal Government and the non-Federal partner, that the non-Federal partner shall be considered the operator of the project for the purpose of CERCLA liability, and to the maximum extent practicable, operate, maintain, repair, rehabilitate, and replace the project in a manner that will not cause liability to arise under CERCLA;

u. Provide, during the design and implementation phase, a percentage of all costs that exceed $100,000 for data recovery activities associated with historic preservation for the project as follows: 35 percent of such costs that are attributable to the flood risk management features and 50 percent of such costs that are attributable to the recreation features; and

v. Comply with Section 221 of Public Law 91-611, Flood Control Act of 1970, as amended (42 U.S.C. 1962d-5b), and Section 103(j) of the Water Resources Development Act of 1986, Public Law 99-662, as amended (33 U.S.C. 2213(j)), which provides that the Secretary of the Army shall not commence the construction of any water resources project or separable element thereof, until each non-Federal interest has entered into a written agreement to furnish its required cooperation for the project or separable element.

The recommendations for implementation of flood risk management at Laie, Hawaii reflect the policies governing formulation of individual projects and the information available at this time. They do not necessarily reflect the program and budgeting priorities inherent in the local and State programs or the formulation of a national civil works water resources program. Consequently, the recommendations may be changed at higher review levels of the executive branch outside Hawaii before they are used to support funding.

Date: ______________________

____
Kathryn P. Sanborn, PhD, PE, PMP
Lieutenant Colonel, U.S. Army
District Engineer

11.0 REFERENCES AND PRIOR STUDIES

"OCE Memorandum for Record, "Standard Project Storm Determinations, Hawaiian Islands, 1962

"Hydrograph Study and Peak Discharge Determination of Hawaiian Small Watersheds: Islands of Oahu", Islands of Oahu, 1969

"Rainfall Frequency Study for Oahu, Report R-73", State of Hawaii, Department of Land and Natural Resources, Division of Water and Land Development, 1984

"Final Detailed Project Report and Environmental Impact Statement, Kahawainui Stream, Laie, Island of Oahu, Hawaii", Honolulu District, United States Army Corps of Engineers, 1985.

"Rainfall Atlas of Hawaii, Report R76", State of Hawaii, Department of Land and Natural Resources, 1986

"Wailele Stream Flood Control Study. Laie, Oahu, Hawaii, Final Reconnaissance Report", Honolulu District, United States Army Corps of Engineers, 1992

"Storm Drainage Standards" City and County of Honolulu, 2000

"Wailele Stream Flood Damage Reduction Project, Feasibility Investigation: Hydrology & Hydraulics", Honolulu District, United States Army Corps of Engineers, 2001

"Flood-Frequency Estimates for Streams on Kauai, Oahu, Molokai, Maui, and Hawaii, State of Hawaii, Scientific Investigations Report 2010-5035", United States Geological Survey, 2010

"Ko'olau Loa Sustainable Communities Plan", City and County of Honolulu, 2012

"Flood Insurance Study 15003CV001C", Federal Emergency Management Agency, 2013

"The Precipitation Frequency Data Server", National Oceanic and Atmospheric Administration, 2014

"Laie Watershed Study and Drainage Master Plan", R.M. Towill Corporation, 2015

"Wailele Stream Flood Risk Management Project, General Site Plan, Revised TSP, Figure 1B", R.M. Towill Corporation 2016

Appendix A

404(b)(1) Evaluation

EVALUATION OF SECTION 404(b)(1) GUIDELINES
(SHORT FORM)

PROPOSED PROJECT: Wailele FRM Feasibility Study

	Yes	No*
1. Review of Compliance (230.10(a)-(d))		
A review of the proposed project indicates that:		
a. The placement represents the least environmentally damaging practicable alternative and, if in a special aquatic site, the activity associated with the placement must have direct access or proximity to, or be located in the aquatic ecosystem, to fulfill its basic purpose (if no, see section 2 and information gathered for EA alternative).	X	
b. The activity does not appear to:		
1) Violate applicable state water quality standards or effluent standards prohibited under Section 307 of the Clean Water Act;	X	
2) Jeopardize the existence of Federally-listed endangered or threatened species or their habitat; and	X	
3) Violate requirements of any Federally-designated marine sanctuary (if no, see section 2b and check responses from resource and water quality certifying agencies).	X	
c. The activity will not cause or contribute to significant degradation of waters of the U.S. including adverse effects on human health, life stages of organisms dependent on the aquatic ecosystem, ecosystem diversity, productivity and stability, and recreational, aesthetic, an economic values (if no, see values, Section 2)	X	
d. Appropriate and practicable steps have been taken to minimize potential adverse impacts of the discharge on the aquatic ecosystem (if no, see Section 5)	X	

Documentation of 230.10(a-d) is provided in the Wailele FRM Integrated Feasibility Report/Environmental Assessment (IFR/EA) and the associated Environmental Appendix

	Not Applicable	Not Significant	Significant*
2. Technical Evaluation Factors (Subparts C-F) (where a 'Significant' category is checked, add explanation below.)			
a. Physical and Chemical Characteristics of the Aquatic Ecosystem (Subpart C)			
1) Substrate impacts		X	
2) Suspended particulates/turbidity impacts		X	
3) Water column impacts		X	
4) Alteration of current patterns and water circulation		X*	
5) Alteration of normal water fluctuation/hydroperiod		X	
6) Alteration of salinity gradients		X	
b. Biological Characteristics of the Aquatic Ecosystem (Subpart D)			
1) Effect on threatened/endangered species and their habitat		X	
2) Effect on the aquatic food web		X	

	Not Applicable	Not Significant	Significant*
3) Effect on other wildlife (mammals, birds, reptiles and amphibians)		**X**	
	Not Applicable	**Not Significant**	**Significant***
2. Technical Evaluation Factors (Subparts C-F) (where a 'Significant' category is checked, add explanation below.)			
c. Special Aquatic Sites (Subpart E)			
1) Sanctuaries and refuges	**X**		
2) Wetlands		**X**	
3) Mud flats			
4) Vegetated shallows	**X**		
5) Coral reefs		**X**	
6) Riffle and pool complexes		**X**	
d. Human Use Characteristics (Subpart F)			
1) Effects on municipal and private water supplies		**X**	
2) Recreational and Commercial fisheries impacts		**X**	
3) Effects on water-related recreation		**X**	
4) Aesthetic impacts		**X**	
5) Effects on parks, national and historical monuments, national seashores, wilderness areas, research sites, and similar preserves		**X**	

2(a)(4): The Overflow Diversion Channel would funnel the higher flows from storm water events on Wialele Stream and divert the further downstream. Because the diversion would only be utilized during the less frequent and more intense precipitation events, the impacts on the water pattern and circulation was considered insignificant.

Documentation of Subparts C-F is provided in the Wailele FRM IFR/EA and the associated Environmental Appendix

	Yes
3. Evaluation of Dredged or Fill Material (Subpart G)	**n/a**
a. The following information has been considered in evaluating the biological availability of possible contaminants in dredged or fill material (check only those appropriate)	
1) Physical characteristics	**n/a**
2) Hydrography in relation to known or anticipated sources of contaminants	**n/a**
3) Results from previous testing of the material or similar material in the vicinity of the project	**n/a**
4) Known, significant sources of persistent pesticides from land runoff or percolation	**n/a**
5) Spill records for petroleum products or designated (Section 311 of Clean Water Act) hazardous substances	**n/a**
6) Other public records of significant introduction of contaminants from industries, municipalities or other sources	**n/a**
7) Known existence of substantial material deposits of substances which could be released in harmful quantities to the aquatic environment by man-induced discharge activities	**n/a**

As documented in the Waialele FRM IFR/EA and the Environmental Appendix of that document, the proposed action includes the construction of and overflow channel. There is no excavation requiring disposal of dredge materials or other material as fill into waters of the U.S.

	Yes	No
b. An evaluation of the appropriate information in 3a above indicates that there is reason to believe the proposed dredged or fill material is not a carrier of contaminants, or that levels of contaminants are substantively similar at extraction and placement sites and not likely to degrade the placement sites, or the material meets the testing exclusion criteria.	**n/a**	

As documented in the Wailele FRM IFR/EA and the associated Environmental Appendix, there is no excavation requiring disposal of dredged materials or fill.

	Yes
4. Placement Site Delineation (230.11(f))	**n/a**
a. The following factors as appropriate, have been considered in evaluating the placement site:	
1) Depth of water at placement site	**n/a**
2) Current velocity, direction, and variability at placement site	**n/a**
3) Degree of turbulence	**n/a**
4) Water column stratification	**n/a**
5) Discharge vessel speed and direction	**n/a**
6) Rate of discharge	**n/a**
7) Fill material characteristics (constituents, amount, and type of material, settling velocities)	**n/a**
8) Number of discharges per unit of time	**n/a**
9) Other factors affecting rates and patterns of mixing (specify)	**n/a**

As documented in the Wailele FRM Integrated Feasibility Report/Environmental Assessment (IFR/EA) and the associated Environmental Appendix, there is no excavation requiring disposal of dredged materials.

	Yes	No
b. An evaluation of the appropriate factors in 4a above indicates that the placement site and/or size of mixing zone are acceptable.	**n/a**	**n/a**

As documented in the Wailele FRM IFR/EA and the associated Environmental Appendix, there is no excavation requiring disposal of materials.

	Yes	No
5. Actions to Minimize Adverse Effects (Subpart H)		
All appropriate and practicable steps have been taken, through application of recommendations of 230.70-230.77 to ensure minimal adverse effects of the proposed discharge.	**n/a**	

As documented in the Wailele FRM IFR/EA and the associated Environmental Appendix, there is no excavation requiring disposal of materials.

	Yes	No*
6. Factual Determination (230.11)		
A review of appropriate information as identified in items 2-5 above indicates that there is minimal potential for short- or long-term environmental effects of the proposed discharge as related to:		
a. Physical substrate at the placement site (review Sections 2a. 3, 4, and 5 above)	**n/a**	
b. Water circulation, fluctuation and salinity (review Sections 2a. 3, 4, and 5)	**X**	
c. Suspended particulates/turbidity (review Sections 2a. 3, 4, and 5)	**X**	
d. Contaminant availability (review Sections 2a. 3, and 4)	**X**	
e. Aquatic ecosystem structure and function (review Sections 2b and c, 3, and 5)	**X**	
f. Placement site (review Sections 2, 4, and 5)	**n/a**	
g. Cumulative impacts on the aquatic ecosystem	**X**	
h. Secondary impacts on the aquatic ecosystem	**X**	

Documentation of 230.11(a-h) is provided in the Wailele FRM IFR/EA and the associated Environmental Appendix

7. Evaluation Responsibility
a. This evaluation was prepared by: Daniel Allen Position: Wildlife Biologist, CESWF-PEC-CC

8. Findings	**Yes**
a. The proposed placement site for discharge of or fill material complies with the Section 404(b)(1) Guidelines.	**X**
b. The proposed placement site for discharge of dredged or fill material complies with the Section 404(b)(1) Guidelines with the inclusion of the following conditions:	X

List of conditions:

c. The proposed placement site for discharge of dredged or fill material does not comply with the Section 404(b)(1) Guidelines for the following reason(s):	**n/a**
1) There is a less damaging practicable alternative	**n/a**
2) The proposed discharge will result in significant degradation of the aquatic ecosystem	**n/a**
3) The proposed discharge does not include all practicable and appropriate measures to minimize potential harm to the aquatic ecosystem	**n/a**

____________________ Date	____

NOTES:

* A negative, significant, or unknown response indicates that the permit application may not be in compliance with the Section 404(b)(1) Guidelines.

Negative responses to three or more of the compliance criteria at the preliminary stage indicate that the proposed projects may not be evaluated using this "short form" procedure. Care should be used in assessing pertinent portions of the technical information of items 2a-e before completing the final review of compliance.

Negative response to one of the compliance criteria at the final stage indicates that the proposed project does not comply with the Guidelines. If the economics of navigation and anchorage of Section 404(b)(2) are to be evaluated in the decision-making process, the "short form" evaluation process is inappropriate.

Appendix B
Essential Fish Habitat Assessment

ESSENTIAL FISH HABITAT ASSESSMENT FOR THE WAIALELE SECTION 206 FLOOD RISK MANAGEMENT FEASIBILITY STUDY, LAIE, ISLAND OF OAHU, HAWAII

1.0 SCOPE OF ANALYSIS

This document constitutes the Honolulu District, U.S. Army Corps of Engineers' (Corps) written assessment of the effects of the proposed action on Essential Fish Habitat (EFH). The EFH Assessment has been prepared in accordance with paragraph (e) of Title 50 Code of Federal Regulations Part 600, Subpart K to include a level of detail that is commensurate with the complexity and magnitude of the potential adverse effects of the proposed action and the following mandatory: a description of the action, an analysis of the potential adverse effects of the action on EFH and the managed species, the Corps' conclusions regarding the effects of the action on EFH and any proposed mitigation, if applicable.

The extent of the Corps' review area for the purposes of consultation under the Magnuson-Stevens Fishery Conservation and Management Act (MSA) is the federally managed marine waters adjacent to the muliwai fed by Wailele and Koloa Streams.

2.0 PROPOSED ACTION

The Wailele Stream FRM project would better contain flood waters with the Waillele Stream channel during large storm events. Currently, an undersized culvert at the King Kamehameha Highway results in floodwaters backing up behind the highway. The backed up water in combination with a bend in Wailele Stream upstream from the Brigham Young University – Hawaii (BYUH) campus causes floodwaters to jump the bank at this bend during large storm events. The resulting flows spread out over the landscape resulting in sheet flow flooding throughout the community of Laie and portions of the BYUH campus. The sheet flow through the community results in flood damages and the mobilization of non-point source pollution and debris from the residential and commercial areas while eventually flows into the Pacific Ocean north of Laie Point.

2.1 Project Scope

The proposed Wailele Section 205 Flood Risk Management (FRM) project entails the construction of channel modifications and an overflow channel on Wailele Creek approximately 1,000 feet upstream of the Kamehameha Highway and returns flows to the Wailele Stream immediately downstream of the highway (Figure 1). Approximately 0.5 miles of channel improvements would be required upstream of the highway, including erosion mitigation on the left bank of the stream. The culvert at the highway and associated pedestrian bridge would be replaced and enlarged. The overflow channel would be convey Wailele Stream flows in excess of 675 cubic feet per second (cfs) up to the event with a 0.01 annual chance of exceedance. The overflow channel would require the construction of a water control structure that would allow base flows to continue to flow in the existing Wailele Stream, but divert stormwater from the stream during larger storm events. A properly sized culvert would be required to convey flows under the highway that would be combined with an outfall structure directly below the highway where the channel would reenter Wailele Creek approximately 500 feet above the Wailele/Koloa muliwai. The proposed project also includes a major drainage feature (BYU Diversion Channel) that would contribute to a reduction in residual flooding in Laie (Figure 1). The BYU Diversion Channel would divert runoff from the Lanilea watershed, an area of less than 1.5 square miles. Resulting flows from the channel would not exceed 800 cfs.

Figure 1: Proposed Wailele FRM Project Area

2.2 Avoidance/Minimization

The following avoidance and minimization measures are intended to mitigate potential adverse effects to EFH from the proposed action and are, as such, considered part of the proposed action.

<u>Avoidance Areas</u>: No construction activities would occur in the Wailele/Koloa muliwai, the beach, or ocean habitats.

<u>Best Management Practices (BMPs)</u>: The Corps has proposed a number of BMPs to be implemented before, during, and after construction activities to avoid and/or minimize potential adverse impacts to EFH. All Corps personnel, including its contractors, will be required to adhere to and comply with the BMPs during project implementation. The BMPs proposed below may be further modified based on input from the contractor or resource agencies and are not all inclusive:

1. Development and implementation of a Stormwater Pollution Prevention Plan (SWPPP);
2. Silt fences or other erosion and sediment management features installed prior to any ground disturbance activity to reduce suspended solids from overland runoff;
3. If feasible, schedule construction activities would occur during the dry season;
4. Development and implementation of a spill prevention and response plan;
5. Proper disposal of waste and daily collection of litter and debris from construction site;

6. Phased revegetation of disturbed areas with temporary vegetation and permanent vegetation established once a project component has been completed;
7. Providing a buffer between staging areas and the stream;
8. And, maintenance of vehicles and equipment in the staging areas outside of the stream and riparian habitats.

3.0 ENVIRONMENTAL BASELINE

3.1 Site Description

Marine surveys have been conducted in the broad sand channel off of Pounder's Beach and the reef flats north and south of the channel in the spring of 1992 and summer of 1994 (AECOS 2014). The reef flats north of the channel were dominated by macroalgae including *Dictyopteris australis, Padina japonica, Sargassum echinocarpum, Gracilaria* sp., and the coralline algae, *Porolithion gardineri* and *P. onkodes*. No macroalgae were observed in the channel except immediately seaward of Pounder's Beach wher *Ulva* and *Enteromorpha* were growing on rubble at the foot of the beach.

Relatively few fish species were identified during the AECOS surveys. Common species observed during the surveys include surgeonfishes (*Acanthus triostegus* and *A. leucopareius*) and wrasses (*Stethojulis balteata*).

Corals were not a significant part of the benthic assemblages on the inner reef, except along parts of the channel margin. Coral species included *Porites lobata, Montipora capitata, Montipora patula,* and *Pocillopora meandrina*. These corals supported the majority of the fishes observed during the surveys.

On 9 November 1999, the USFWS conducted aquatic surveys in the Wailele/Koloa muliwai after a large storm breached the sand berm separating the muliwai from the ocean and water was flowing freely in and out of the muliwai. Hawaiian flagtails (*Kuhlia sandvicensis*) were observed foraging inside the estuary. During follow up surveys on 1 December 1999 and 11 January 2000, the sand berm was intact and endemic juvenile amphidromous fishes (*Eleotris sandwicensis* and *Stenogobius hawaiiensis*) and indigenous prawns (iMacrobrachium grandimanus) were observed in the muliwai. The USFWS Draft Coordination Act Report (USFWS, 2000) attributed the presence of these species to the high habitat quality associated with Koloa Stream which also feeds into the muliwai.

3.2 Designated EFH

According to the NOAA EFH Mapper (NOAA, 2019), EFH is currently designated downstream of the project area for the following management species (MUS):

- Bottomfish MUS (except seamount Groundfish)(BMUS): all life stages for shallow complex, eggs and post-hatch pelagic for intermediate and deep complexes;
- Coral Reef Ecosystem MUS (CREMUS): all life stages;
- And, Pelagic MUS (PMUS): all life stages

There are no designated Habitats of Particular Concern within or near the Pounder's Beach. These textual designations are found in the Western Pacific Region Fishery Management Council (Council) Fishery Ecosystem Plans (FEP) for the Hawaii Archipelago (WPRFMC 2016).

Overall EFH for BMUS is the water column and bottom habitat from the surface to 400 meter depth from the shoreline to the Exclusive Economic Zone (EEZ). Overall EFH for the CREMUS is defined as the water column and all benthic substrate to a 50 fathom depth from the shoreline to the EEZ. Overall EFH for PMUS eggs and larvae is the water column to a 200 meter depth from the shoreline to the EEZ; EFH for the juveniles and adults is the water column to a 1,000 meter depth from the shoreline to the EEZ.

It should be noted that on 13 September 2018, NMFS published a proposal in the Federal Register to reclassify certain MUS in the Pacific Islands as ecosystem component species, in order to prioritize conservation and management efforts and improve efficiency of fishery management in the region. The proposal constitutes the fifth amendment to the FEP for the Hawaii Archipelago. The proposed amendment indicates the number of managed species would be from 173 to 20; however, the overlapping and broad-sweeping EFH designations for the Hawaii Archipelago would remain as: the water column to 1,000-meter depth, from the shoreline to the EEZ and all bottom habitat from the shoreline to a 400-meter depth (and the outer reef slopes at 400- to 700-meter depth). Additionally, NMFS proposed that all species of the CREMUS would be reclassified; however, the habitat composites, i.e. “bottom habitats”, previously designated as EFH for this MUS would remain EFH for the remaining MUSs dependent upon such habitat. The Corps understands that the textual descriptions of any final amendment to the FEP would be the legal designation for EFH for federally managed fisheries under MSA. The final rule was proposed for issuance in December 2018, to be published to the Federal Register; however, the amendment has not been published to date.

4.0 IMPACT ASSESSMENT

Because no construction activities would occur within any EFH-designated habitats, no direct impacts to EFH would occur. Temporary, minor indirect impacts may occur from increased sediments mobilized during the construction of the project features. These potential impacts would be avoided and/or minimized to the greatest extent through the implementation of BMPs before, during, and after construction. Permanent indirect impacts may result during large storm events as floodwater that would have previously flooded the community of Laie would be retained in Wailele Creek, increasing the energy and volume of the stream flows.

4.1 Direct Impacts to EFH

No activities would occur within designated EFH; therefore, there would be no direct impacts to EFH resources.

4.2 Indirect Impacts to EFH

Increased erosion and sedimentation could result from the construction of the channel modifications and would temporarily elevate turbidity levels during/after a storm event large enough to breach the sand bar of the muliwai or when the muliwai was open. When the muliwai is disconnected from the marine habitat, there would be no indirect impact to EFH.

After construction and implementation of the FRM project, indirect impacts would only occur during storm events that would have been large enough to leave the banks of Wailele Stream in its existing condition as these flows would not have reached the ocean by way by way of sheet flow across the community of Laie and into the ocean north of Laie Point instead of Wailele Stream. The incremental difference in the quantities of sediment mobilized under existing conditions and future conditions would have the potential to be distributed in the near shore EFH at the muliwai outflow point.

4.2.1 Assessment of Indirect Impacts to Water Column EFH

Construction: Because the potential temporary impacts to water column EFH would be mitigated through the use of established erosion and sedimentation control BMPs; indirect impacts to EFH would not be substantial.

Operation: During large, infrequent storm events, operation of the proposed Wailele Stream FRM project would convey increased stream velocities that could result in the transport of higher levels of sediments that would have otherwise been distributed to areas that would have been flooded. With the addition of the BYU Diversion Channel, additional flows would be conveyed by the improved system further increasing potential sediment transport. These sediments could temporarily increase turbidity during these storm events. The exact indirect impact associated with any increased turbidity would be the incremental difference in the turbidity under existing conditions and the future conditions during storm events that are large enough to breach the muliwai berm or that would occur during times when the mulwai was open.

4.2.2 Assessment of Indirect Impacts to Substrate EFH

Construction: Because the potential temporary impacts to substrate EFH would be mitigated through the use of established erosion and sedimentation control BMPs; indirect impacts to EFH would be insignificant.

Operation: During large, infrequent storm events, operation of the proposed Wailele Stream FRM project would convey increased stream velocities that could result in the transport of higher levels of sediments that would have otherwise been distributed to areas that would have been flooded. With the addition of the BYU Diversion Channel, additional flows would be conveyed by the improved system further increasing potential sediment transport. The exact indirect impact associated with any increased sedimentation of the substrate would be the incremental difference in the sedimentation under existing conditions and the future conditions during storm events that are large enough to breach the muliwai berm or that would occur during times when the muliwai was open.

4.3 Impact Summary

Because no construction activities would occur in EFH-designated habitats, there would be no direct impacts on EFH. The primary project indirect impacts on EFH would occur during infrequent storm events when stream flow would exceed the existing channel capacity of the stream channel's existing condition. However, the erosion control improvements to Wailele Stream resulting from the project would reduce the existing potential for sediment mobilization during storm events below the existing conditions, further minimizing the potential future sediment loading and turbidity within the EFH.

Furthermore, the reduction of flood waters that sheet flow over the community of Laie would have ancillary water quality benefits. Existing floodwaters mobilize non-point source pollutants, nutrient loads, and sediments and currently flush them into the Pacific Ocean north of Laie Point. The proposed project would decrease this impact to EFH north of Laie Point.

5.0 EFFECT DETERMINATION

Although the proposed Wailele Stream FRM project may result in temporary, indirect impacts to EFH during construction, these impacts would be mitigated (avoided and minimized) with the implementation of BMPs. Furthermore, these potential temporary impacts would only occur during times when the muliwai is open or breached during a stormwater runoff event. Therefore, the indirect impacts to EFH resulting from construction activities would be minimal to non-existent.

During operation of the proposed FRM project, the potential indirect impacts would only occur during infrequent storm events and would only entail the incremental difference between the cumulative sediment load between the existing and with project condition. This increment would be further decreased with the erosion control channel improvement features of the project. Improvements in the erosion protection of the Wailele Stream Channel. Furthermore, there may be water quality benefits resulting from the implementation of the FRM project that may further mitigate any impacts resulting from changes in sediment loads.

The Corps has determined that the proposed action does not have the potential to cause substantial adverse impacts to EFH.

6.0 REFERENCES

AECOS, Inc. 2014. A natural resources review (water quality, aquatic biology, botanical resources, and marine resources) for Wailele Watershed, O'ahu, Hawai'i. Draft Report AECOS No. 1382B. 16 April 2014. 56 pp.

USFWS. 2000. Draft Fish and Wildlife Coordination Act Report, Wailele Stream Flood Control Project, Laie, Oahu, Hawaii. 29 pp.

Western Pacific Regional Fishery Management Council. 2009. Fishery Ecosystem Plan for the Hawaii Archipelago. September 24, 2009. 266 pp.

Appendix C

CZMA

HAWAII CZM PROGRAM
FEDERAL CONSISTENCY ASSESSMENT FORM

RECREATIONAL RESOURCES

Objective: Provide coastal recreational opportunities accessible to the public.

Policies:

1) Improve coordination and funding of coastal recreational planning and management.
2) Provide adequate, accessible, and diverse recreational opportunities in the coastal zone management area by:
   a) Protecting coastal resources uniquely suited for recreational activities that cannot be provided in other areas.
   b) Requiring replacement of coastal resources having significant recreational value including, but not limited to surfing sites, fishponds, and sand beaches, when such resources will be unavoidably damaged by development; or requiring reasonable monetary compensation to the State for recreation when replacement is not feasible or desirable.
   c) Providing and managing adequate public access, consistent with conservation of natural resources, to and along shorelines with recreational value.
   d) Providing an adequate supply of shoreline parks and other recreational facilities suitable for public recreation.
   e) Ensuring public recreational uses of county, state, and federally owned or controlled shoreline lands and waters having recreational value consistent with public safety standards and conservation of natural resources.
   f) Adopting water quality standards and regulating point and non-point sources of pollution to protect, and where feasible, restore the recreational value of coastal waters.
   g) Developing new shoreline recreational opportunities, where appropriate, such as artificial lagoons, artificial beaches, and artificial reefs for surfing and fishing.
   h) Encouraging reasonable dedication of shoreline areas with recreational value for public use as part of discretionary approvals or permits by the land use commission, board of land and natural resources, and county authorities; and crediting such dedication against the requirements of Hawaii Revised Statutes, section 46-6.

RECREATIONAL RESOURCES (continued)

Check either Yes or No for each of the following questions, and provide an explanation or information for Yes responses in the Discussion section:

	Yes	No
1. Will the proposed action occur in or adjacent to a dedicated public right-of-way, e.g., public beach access, hiking trail, shared-use path?	✔	☐
2. Will the proposed action affect public access to and along the shoreline?	☐	✔
3. Does the project site abut the shoreline?	✔	☐
4. Is the project site on or adjacent to a sandy beach?	✔	☐
5. Is the project site in or adjacent to a state or county park?	✔	☐
6. Is the project site in or adjacent to a water body such as a stream, river, pond, lake, or ocean?	✔	☐
7. Will the proposed action occur in or affect an ocean recreation area, swimming area, surf site, fishing area, or boating area?	☐	✔

Discussion: (If more space is needed, attach a separate sheet.)

1) The overflow diversion channel would be constructed under Highway 83 (Kamehameha Hwy). Although the overflow channel construction would not ccur on or adjacent to a beach, the diversion channel's terminal outfall structure is located approximately 400 feet upstream of the Wailele/Koloa muliwai at Pounder's Beach.

3,4,5) The proposed overflow diversion channel terminal outfall structure is located approximately 400 feet upstream from the Wailele/Koloa muliwai situated at Pounder's Beach Park.

6) The proposed project would divert high flood flows from Wailele Stream and reconnect flows upstream of the Stream's muliwai.

HISTORIC RESOURCES

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

Policies:

1) Identify and analyze significant archaeological resources.
2) Maximize information retention through preservation of remains and artifacts or salvage operations.
3) Support state goals for protection, restoration, interpretation, and display of historic resources.

Check either Yes or No for each of the following questions, and provide an explanation or information for Yes responses in the Discussion section:

	Yes	No
1. Is the project site within a designated historic or cultural district?	☐	☑
2. Is the project site listed on or nominated to the Hawaii or National Register of Historic Places?	☐	☑
3. Has the project site been surveyed for historic or archaeological resources?	☑	☐
4. Does the project parcel include undeveloped land which has not been surveyed by an archaeologist?	☐	☑
5. Is the project site within or adjacent to a Hawaiian fishpond or historic settlement area?	☐	☑

Discussion: (If more space is needed, attach a separate sheet.)

3) A Archaeological Inventory Survey report was produced in April 2001 (Potential Burial Site?)

SCENIC AND OPEN SPACE RESOURCES

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

Policies:

1) Identify valued scenic resources in the coastal zone management area.
2) Ensure that new developments are compatible with their visual environment by designing and locating such developments to minimize the alteration of natural landforms and existing public views to and along the shoreline.
3) Preserve, maintain, and, where desirable, improve and restore shoreline open space and scenic resources.
4) Encourage those developments that are not coastal dependent to locate in inland areas.

Check either Yes or No for each of the following questions, and provide an explanation or information for Yes responses in the Discussion section:

	Yes	No
1. Will the proposed action alter any natural landforms or existing public views to and along the shoreline?	☐	☑
2. Does the proposed action involve the construction of a multi-story structure?	☐	☑
3. Is the project site located on or adjacent to an undeveloped parcel, including a beach or oceanfront land?	☑	☐
4. Does the proposed action involve the construction of a structure visible between the nearest coastal roadway and the shoreline?	☑	☐
5. Will the proposed action involve constructing or placing a structure in waters seaward of the shoreline?	☐	☑

Discussion: (If more space is needed, attach a separate sheet.)

3) The Wailele overflow diversion channel would be located on an undeveloped coral outcrop and adjacent cropland. The terminus of the project (the outfall structure of the diversion channel) is located approximately 400 feet upstream from Pounder's Beach.

4) The outfall structure of the diversion channel would be constructed adjacent to the proposed box culvert under Highway 83. The diversion channel and outfall structure would be visible from the roadway; however, due to the dense vegetation, the channel and channel features would not be visible from the shoreline or beach.

COASTAL ECOSYSTEMS

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

Policies:

1) Exercise an overall conservation ethic, and practice stewardship in the protection, use, and development of marine and coastal resources.
2) Improve the technical basis for natural resource management.
3) Preserve valuable coastal ecosystems, including reefs, of significant biological or economic importance.
4) Minimize disruption or degradation of coastal water ecosystems by effective regulation of stream diversions, channelization, and similar land water uses, recognizing competing water needs.
5) 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.

Check either Yes or No for each of the following questions, and provide an explanation or information for Yes responses in the Discussion section:

	Question	Yes	No
1.	Does the proposed action involve dredge or fill activities?	☐	☑
2.	Is the project site within the Special Management Area (SMA) or the Shoreline Setback Area?	☐	☐
3.	Is the project site within the State Conservation District?	☐	☑
4.	Will the proposed action involve some form of discharge or placement of material into a body of water or wetland?	☐	☑
5.	Will the proposed action require earthwork, grading, clearing, or grubbing?	☑	☐
6.	Will the proposed action include the construction of waste treatment facilities, such as injection wells, discharge pipes, or septic systems?	☐	☑
7.	Is an intermittent or perennial stream located on or adjacent to the project parcel?	☑	☐
8.	Does the project site provide habitat for endangered species of plants, birds, or mammals?	☐	☑
9.	Is any such habitat located in close proximity to the project site?	☐	☑

COASTAL ECOSYSTEMS (continued)

	Yes	No
10. Is a wetland located on the project site or parcel?	✔	☐
11. Is the project site situated in or abutting a Natural Area Reserve, a Marine Life Conservation District, or an estuary?	☐	✔
12. Will the proposed action occur on or in close proximity to a reef or coral colonies?	✔	☐

Discussion: (If more space is needed, attach a separate sheet.)

5) The construction of the overflow diversion channel would require clearing and excavation of the channel over upland areas.

7) Within the project area, Wailele Stream is classified as an intermittent stream.

10) Wailele Stream is classified as a palustrine water of the U.S. with intermittent flow. The proposed project would entail the construction of a weir at the upstream segment of the diversion channel and an outfall structure at the end of the channel. The muliwai, 400 feet downstream of the project area, is the nearest wetland.

12) The proposed project area is not located within a reef; however, coral reef habitat exists offshore of Pounder's Beach downstream from the diversion channel.

ECONOMIC USES

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

Policies:

1) Concentrate coastal development in appropriate areas.
2) Ensure that coastal dependent development such as harbors and ports, and coastal related development such as visitor industry facilities and energy generating facilities, are located, designed, and constructed to minimize adverse social, visual, and environmental impacts in the coastal zone management area.
3) Direct the location and expansion of coastal dependent developments to areas presently designated and used for such development and permit reasonable long-term growth at such areas, and permit coastal dependent development outside of presently designated areas when:
   a) Use of presently designated locations is not feasible;
   b) Adverse environmental effects are minimized; and
   c) The development is important to the State's economy.

Check either Yes or No for each of the following questions, and provide an explanation or information for Yes responses in the Discussion section:

	Yes	No
1. Does the proposed action involve a harbor or port?	☐	☑
2. Is the proposed action a visitor industry facility or a visitor industry related activity?	☐	☑
3. Does the project site include agricultural lands or lands designated for such use?	☑	☐
4. Does the proposed action relate to commercial fishing or seafood production?	☐	☑
5. Is the proposed action related to energy production or transmission?	☐	☑
6. Is the proposed action related to seabed mining?	☐	☑

Discussion: (If more space is needed, attach a separate sheet.)

3) The proposed Wailele Stream overflow diversion channel would be located within and adjacent to cultivated cropland.

COASTAL HAZARDS

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

Policies:

1) Develop and communicate adequate information about storm wave, tsunami, flood, erosion, subsidence, and point and nonpoint source pollution hazards.
2) Control development in areas subject to storm wave, tsunami, flood, erosion, hurricane, wind, subsidence, and point and nonpoint source pollution hazards.
3) Ensure that developments comply with requirements of the Federal Flood Insurance Program.
4) Prevent coastal flooding from inland projects.

Check either Yes or No for each of the following questions, and provide an explanation or information for Yes responses in the Discussion section:

	Yes	No
1. Is the project site on or abutting a sandy beach?	☑	☐
2. If "Yes" to question no. 1, has the project parcel or adjoining shoreline areas experienced erosion?	☐	☑
3. Is the project site within a potential tsunami inundation area? Refer to tsunami evacuation maps at http://www.scd.hawaii.gov	☐	☐
4. Is the project site within a flood hazard area according to a FEMA Flood Insurance Rate Map (https://msc.fema.gov)?	☑	☐
5. Is the project site within a subsidence hazard area?	☐	☑

Discussion: (If more space is needed, attach a separate sheet.)

4) The proposed action is a Flood Risk Management project to alleviate flooding hazard peaks to downstream communities. The proposed action will not increase flood risk, but will decrease flood risk for properties located in the floodplain.

MANAGING DEVELOPMENT

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

Policies:

1) Use, implement, and enforce existing law effectively to the maximum extent possible in managing present and future coastal zone development.
2) Facilitate timely processing of applications for development permits and resolve overlapping or conflicting permit requirements.
3) Communicate the potential short and long-term impacts of proposed significant coastal developments early in their life cycle and in terms understandable to the public to facilitate public participation in the planning and review process.

Check either Yes or No for each of the following questions, and provide an explanation or information for Yes responses in the Discussion section:

	Yes	No
1. List the permits or approvals required for the proposed action and provide the status of each in the Discussion section below.		
2. Does the proposed action conform with state and county land use designations for the site?	☑	☐
3. Has the public been notified of the proposed action?	☑	☐
4. Has an environmental impact statement or environmental assessment been prepared for the proposed action?	☐	☑

Discussion: (If more space is needed, attach a separate sheet.)

1) [To be filled in]

2) The feasibility study of the project has been under different stages since 2004. Over that time the local people have been made aware of the proposed project.

4) An Integrated Feasibility Report/Environmental Assessment (EA) is currently being prepared. The CZM federal consistency determination is required to complete the EA.

PUBLIC PARTICIPATION

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

Policies:

1) Promote public involvement in coastal zone management processes.
2) Disseminate information on coastal management issues by means of educational materials, published reports, staff contact, and public workshops for persons and organizations concerned with coastal issues, developments, and government activities.
3) Organize workshops, policy dialogues, and site-specific mediations to respond to coastal issues and conflicts.

Check either Yes or No for each of the following questions, and provide an explanation or information for Yes responses in the Discussion section:

	Yes	No
1. Has information about the proposed action been disseminated to the public?	☑	☐
2. Has the public been provided an opportunity to comment on the proposed action?	☐	☑
3. Has or will a public hearing or public informational meeting be held?	☐	☑

Discussion: (If more space is needed, attach a separate sheet.)

1) The feasibility study of the project has been under different stages since 2004. Over that time the local people have been made aware of the proposed project.

2) The public has currently not been afforded the opportunity to comment on the project; however, the public will be provided a 30-day comment period upon release of the Draft EA.

3) Due to the support of the proposed action, USACE does not currently plan on holding a public hearing or information meeting.

BEACH PROTECTION

Objective: Protect beaches for public use and recreation.

Policies:

1) Locate new structures inland from the shoreline setback to conserve open space, minimize interference with natural shoreline processes, and minimize loss of improvements due to erosion.
2) Prohibit construction of private erosion-protection structures seaward of the shoreline, except when they result in improved aesthetic and engineering solutions to erosion at the sites and do not interfere with existing recreational and waterline activities.
3) Minimize the construction of public erosion-protection structures seaward of the shoreline.
4) Prohibit private property owners from creating a public nuisance by inducing or cultivating the private property owner's vegetation in a beach transit corridor.
5) Prohibit private property owners from creating a public nuisance by allowing the private property owner's unmaintained vegetation to interfere or encroach upon a beach transit corridor.

Check either Yes or No for each of the following questions, and provide an explanation or information for Yes responses in the Discussion section:

	Yes	No
1. Will the proposed action occur on or adjacent to a beach?	☑	☐
2. Is the proposed action located within the shoreline setback area?	☐	☐
3. Will the proposed action affect natural shoreline processes?	☐	☑
4. Will the proposed action affect recreational activities?	☐	☑
5. Will the proposed action affect public access to and along the shoreline?	☐	☑

Discussion: (If more space is needed, attach a separate sheet.)

MARINE RESOURCES

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

Policies:

1) Ensure that the use and development of marine and coastal resources are ecologically and environmentally sound and economically beneficial.
2) Coordinate the management of marine and coastal resources and activities to improve effectiveness and efficiency.
4) Assert and articulate the interests of the State as a partner with federal agencies in the sound management of ocean resources within the United States exclusive economic zone.
5) Promote research, study, and understanding of ocean processes, marine life, and other ocean resources to acquire and inventory information necessary to understand how ocean development activities relate to and impact upon ocean and coastal resources.
6) Encourage research and development of new, innovative technologies for exploring, using, or protecting marine and coastal resources.

Check either Yes or No for each of the following questions, and provide an explanation or information for Yes responses in the Discussion section:

	Yes	No
1. Will the proposed action involve the use or development of marine or coastal resources?	☐	☑
2. Will the proposed action affect the use or development of marine or coastal resources?	☐	☑
3. Does the proposed action involve research of ocean processes or resources?	☐	☑

Discussion: (If more space is needed, attach a separate sheet.)

Appendix D

Economics

Draft Economic Appendix
Wailele Stream, Section 205,
Continuing Authorities Program
June 2019

The Purpose

The effectiveness of floodplain management plans is determined by comparing estimates of flood damage reduction resulting from implementing specific flood risk management measures against their corresponding costs. The community inhabiting the coastal floodplain surrounding Wailele Stream, including the community of Lāʻie, Brigham Young University Hawaii, (BYUH) and the Polynesian Cultural Center (PCC), is consistently exposed to flood hazards associated with the flooding of the stream. The purpose of this study was to analyze the feasibility of managing flood risks within the Wailele Stream watershed, with a focus on reducing flood hazards to property and life safety. More specifically, the purpose of the economic portion of the investigation is to evaluate the economic feasibility of project alternatives that would reduce property damage and, by doing so, better manage the risk of losing lives due to flooding from Wailele Stream. The economic analysis determines the alternative that will reasonably maximize net benefits. This is accomplished by comparing the average annual benefits and costs of the alternatives being considered. The alternative with a benefit-cost ratio greater than one and the highest net benefits will be designated as the National Economic Development (NED) Plan and, in all probability, the Tentatively Selected Plan (TSP) as well. This study develops alternative flood risk management plans for the watershed and recommends a TSP from a final array of alternative plans. Alternatives include detention, conveyance, berms and levees and nonstructural measures.

The Problem

The areas surrounding Wailele Stream, including the Lāʻie residences, BYUH, and PCC are consistently threatened by the flooding of the stream and the associated property damage, economic losses, and human suffering. Located on Oahu's windward side, Lāʻie's annual rainfall totals are considerably higher than the State of Hawaii's average, and when the ground is saturated, ponding conditions can last for days at a time. The nature of flooding in this area is a combination of storm run-off, primarily an effect of Wailele stream overflow, and ponding due to the accumulation of intense rainfall. The overall flood problem is also aggravated by the topography of the Lā'ie community. With Koolau Mountain peaks of greater than 1,000 feet less than 3 miles west of the Lāʻie shoreline, the run-off is steep and fast, and flooding can be flashy. The Lā'ie drainage area is bounded by steep mountains and high beach berms with a limited number of drainage outlets across Kamehameha Highway that contributes to ponding within the low lying areas that Lā'ie occupies.

During large rainfall events, Wailele Stream has overtopped Kamehameha Highway, which serves as the only access route for the Ko'olau Loa Community. This essentially cuts off the only highway around the Island of Oahu, and can have life threatening consequences, not to mention significant interruption of traffic flow of more than 24,000 vehicles per day. Through the implementation of a flood risk management system that uses both structural and nonstructural measures, the opportunity exists to reduce flood risks from Wailele Stream.

Currently, there are no existing Federal, State, or County flood control improvements on Wailele Stream. The Kahawainui Stream Flood Control Project was completed by the COE in May 1990. This project prevents flooding to Lāʻie from the north; however, the south side of Lāʻie remains unprotected and open to flooding from Wailele Stream. Lāʻie has experienced 14 floods since 1879.

Historical Flooding

December 2008. A major storm event hit Hawaiʻi and as a result, Wailele Stream flooded. The State of Hawaiʻi and the Federal Government declared that the event was a state and national disaster. Residential damages were about $2 million (Figure 1), plus $1.5 million to BYUH facilities and about $600,000 to the Polynesian Cultural Center.

Figure 1: Picture of the flooding in Lāʻie town during the December 2008 flood.

March 1991. A flood occurred on March 19-20, 1991 in the town of Lāʻie as a result of overbanking of Wailele Stream. Damages from this flood were significant and pointed to the need for flood protection. The March 1991 flood caused an estimated $200,000 in damages to the Brigham Young University (BYU) facilities and $500,000 in damages to homes, public facilities, and emergency costs. The flood affected approximately 300 homes. Flooding resulted primarily from water overtopping Wailele Stream banks and flowing into Lāʻie Town.

Other Significant Events. Approximately 12 other damaging floods have affected the Lāʻie area since 1879. Although floods are a common occurrence in Lāʻie, the depth of flooding and number of homes impacted is not well documented. The scarcity of this information may be attributed to the fact that until the 1970's, most of the homes were elevated above ground by post-and-beam construction.

Based on a first floor elevation data collected during 1982 and 1983 for the Kahawainui Stream Flood Control Project, it is estimated that the average first floor elevation in Lāʻie Town prior to the early 1970's was between 10 and 11 feet mean sea level (msl). Flooding prior to the early 1970's was considered "nuisance" type flooding and was not considered a real cause for concern. Constructing and expanding the PCC, BYUH, and the Mormon Tabernacle created an increased demand for housing in Lāʻie. Newly constructed residential structures were typically built using the "slab-on-grade" method.

In addition, houses built in the 1950's that became dilapidated were rebuilt on concrete slabs. First floor elevations are now considerably lower than before; therefore, what was once considered nuisance type flooding has become a major flood problem. This slab-on-grade construction method was practiced in Lāʻie until 1980 when the C&C of Honolulu implemented floodplain management regulations in Lāʻie. Although no record of major flood damage from tsunamis or storm surges could be found, the recently updated tsunami hazard maps show that large portions of Lāʻie and the coastal portion of the project area are located within the tsunami hazard area (see Figure 2). The 1946 tsunami caused run up to heights of 9 to 14 feet above sea level in the vicinity. However, implementing this project would have no effect on the potential devastating effects of a major tsunami on the Lāʻie community. On the contrary, this project is to help the community deal with heavy rainfall runoff coming from the steep mountain slopes to the west of Lāʻie.

Figure 2. Tsunami Hazard Map, Northeast Coast of Oahu, Hawaii

The Scope

This document presents the results of the economic analysis in support of the flood risk management project for Wailele Stream and the town of Lāʻie, Island of Oahu, Hawaii. The primary benefit associated with a flood risk management project is the reduction in inundation damages to structures and their contents. Reducing potential flood damages to structures and contents are the only categories of benefits analyzed in the economic justification for this project. These are unquestionably the most significant NED benefits in terms of monetary impacts and the economic justification of the recommended plan. However, these are not the only NED benefits that would be realized by implementing the recommended plan. Additional economic impacts would undoubtedly include other NED benefits, such as reductions in flood damages to utilities, roadways, automobiles, landscaping and emergency relief costs. With the history of flood related road closures in Lāʻie along the only highway around the Island of Oahu, fewer traffic delays would be another benefit category if the risk of flooding could be reduced. Kamehameha Highway is the only road connecting the towns along the northwest coast of Oahu. If one wants to travel from Lāʻie to the Turtle Bay Resort, or further west to Waimea, the only alternative route when the road is blocked is to drive south to Kaneohe Bay, take H3 Freeway to Honolulu, and then drive up the H2 Freeway to the North Coast, a trip of about 80 miles length and at least two and a half hours duration. If the driver is blocked from going south, the alternative is to make the same 80 mile trip through Honolulu in the opposite direction. However, if one wishes to go from Lāʻie to

Honolulu, the trip takes about the same amount of time either going South to Kaneohe and the H3 Freeway, or going west to Waimea and south to the H2 Freeway– about one and one-quarter hours and 40 miles if no traffic or weather delays are encountered.

In addition to these other monetary, NED benefit categories, there are other intangible, but important, benefits of implementing a project including eliminating or reducing the risk of the threat to human safety and the reducing trauma and stress to the residents in the flood plain. These other categories of benefits, both monetary and non-monetary, are difficult to forecast to a reasonably degree of accuracy and create problems when added to structure and content damages which have been computed to a greater level of reliability and account for uncertainty within key variables. Further, these secondary benefits altogether would likely make up no more than an additional 20 percent of the total structural and content damages and the project already demonstrates a strong benefit-cost ratio (BCR) without them. Most importantly, inclusion of these secondary benefits would not impact the plan selection since they tend to be closely correlated with reductions in flood damages to structures and contents, and they would be roughly the same for all the structural alternatives considered; thus, they would not change the ranking order of structural solutions considered, and contribute far less to nonstructural plans. Therefore, this economic analysis did not attempt to quantify these secondary benefits. Nor does it evaluate regional economic development (RED) benefits such as reducing sales and revenue losses due to lowering the risk of local business closures during flood events (PCC averages 1000 visitors each day), or reducing the days of college attendance missed. A thorough, quantitative analysis of the effects of flooding on the regional economy is beyond the scope of this study and these kinds of economic impacts are generally not accounted for in the NED-based benefit cost ratio.

General

Economic benefits for reducing structure and content damages are calculated using hydrologic and economic data. The official Corps model, HEC-RAS calculated the water surface profiles associated with the different probability events. The economic analysis utilizes FY2019 (October 2018) price levels and a 2.875 percent discount rate. The base year for all with-project conditions is assumed to be 2025. The analyses were performed over a 50-year period of analysis from 2025 to 2075.

Population at Risk

Lāʻie's population from the 2010 census is 6,138, most of whom live in 965 households. Lāʻie is known as a community of large families. According to the U.S. Census Bureau, American Fact Finder, 35 percent of these households have 6 or more occupants. Using an average of 5 people per household for the 509 homes in this floodplain's structure file, means about 2,565 people live in or on the fringe of the Wailele Stream floodplain. Add to that total the fact that BYUH has an enrollment of about 5,000 students and 500 employees, all of whom could be on campus at any point in time since most of these students either live on campus or in nearby houses. In addition, PCC has about 100 employees and as many as 1,000 visitors during their day and night performances. And, Lāʻie Elementary School has an enrollment of about 800 and about 50 teachers and workers. Lastly, only one highway encircles the island of Oahu and that is the only road people can use to enter or pass through Lāʻie. The Hawaii Department of Transportation estimates 24,000 vehicles passed through Lāʻie on this highway daily in 2012; that is a figure that is projected to increase to 38,000 vehicles by 2027. All in all, there could be as many as 10,000 people in harm's way during a Wailele Stream flood event. Reducing the risk of losing lives to a flood is a critical factor in evaluating the worth of a flood risk management project. Given a projected annual growth rate of 0.5 percent as forecasted by the 2014 Hawaii Data Book, 10,000 people today will increase to 13,350 people by the year 2075, the end of the planning horizon of this study.

Damageable Property Inventory

For the purposes of this study, the area designated as the Wailele Stream is generally defined by its 0.2 percent (or 1/500) annual chance exceedance (ACE) floodplain. However, when inventorying the structures to include in the FDA model, in order to capture everything of value at risk of being flooded, a buffer is added to the 0.2 percent ACE floodplain and more structures than might be affected are accounted for in the model. Otherwise, structures on the fringes of the 0.2 percent ACE floodplain that might be flooded today or in the future could be excluded from the model. This also ensures that the model includes structures where the floor elevation may exceed the 0.2 percent ACE flood height, but the ground elevation of the structure's foundation does not. FDA results generally show that many of these fringe structures in the inventory do not show any damages. This 0.2 percent ACE floodplain plus its buffer is referred to, herein, as the "project area" and "study area."

Table 1 breaks down by use category all the structures that are within the project area and included in the HEC-FDA inventory. About 82 percent of these structures are residential, and flooding to these homes generates about 95 percent of the damage totals. The economic model includes 616 structures; however, the 0.2 percent ACE event is predicted to exceed the first finished floor elevation of 260 of these structures.

Table 1. Structure Use Categories in the Project Area FY2019

Residential	Commercial	Public	Total
502	103	9	616

The majority of the structures are situated north (left bank) of Wailele Stream in what is considered Lāʻie town. As shown in Table 1, the damageable property inventory includes more than 500 homes; these are mostly wood or masonry single-story structures. Only a few of these homes have basements. The majority of these residences are single family and one-story as shown in Table 2. Lāʻie homes in the Wailele floodplain average about $260,000 in depreciated replacement value. Most of the homes in Lāʻie were built between the 1930s and 1970s.

Following a recent field inspection, it has been determined that the majority of these structures have been generally well maintained and many have been upgraded over the years. It appears that the construction trend with Lāʻie housing is to replace those structures that are showing their age before they become unsightly with larger, modern homes. Residential contents were based on generic depth-damage curves for residential structures and contents provided by the Institute of Water Resources.

Table 2. Number of Structures and Average Depreciated Replacement Value by Occupancy Type (October 2019 price levels)

Structure Category	Number	Avg Depreciated Replacement Value
Single Family Residential 1-story	353	$259,100
Single Family Residential 2-story	149	$408,800
Miscellaneous Commercial 1-Story	103	$3,265,500
Public Classroom Building 1-Story	9	$123,000
Total	614	$797,000

Also included in the inventory is a shopping center and other various commercial establishments that account for about 40 separate businesses; the PCC, a complex that features 11 major facilities and structures and 23 minor buildings; the BYUH campus that is comprised of more than 60 educational, administrative, and residential buildings; and 20 structures on the grounds of the Lāʻie Elementary School. The structure counts in Tables 1 and 2 do not reflect these same numbers since some of these buildings are outside the designated floodplain. Structure and content values for all but the standard type commercial buildings were obtained through personal interviews.

Altogether, there is an estimated $700 million worth of structures and $370 million worth of contents, for a total of about $10.7 billion worth of property within the Wailele Stream floodplain. For the purposes of evaluating flood reduction benefits, no value is assigned to the land.

First Floor Elevations

The other critical variable that goes into the structure file is the first floor elevation of the homes and commercial and institutional buildings. Ground elevations in the study area range from about 5 feet mean sea level (msl) within the heart of residential development to more than 11 feet msl at Kamehameha Highway. About 60 percent of the project area's homes are slab on grade construction; the remainder have post and beam foundations. In most cases, the first floor elevations of the structures in the floodplain were measured by surveyors using an automatic level during previous USACE flood studies conducted in the area. Where these floor elevations were not available for newer buildings, former studies were used and generally supplied good estimates. BYUH and PCC personnel were also helpful in furnishing precise elevation data on most of their structures. Table 1 shows a breakdown of the number of structures in the Wailele Stream floodplain broken down by structure categories. Table 3 shows the number of structures in the floodplain by first floor elevations.

Table 3. Number of structures in the floodplain by floor elevations

From Elev.	To Elev.	No. of Bldgs. At Floor Elev.	Bldgs. %	Cumm. Total Bldgs.
5.0	5.9	0	0%	0
6.0	6.4	0	0%	0
6.5	6.9	0	0%	0
7.0	7.4	16	2.6%	16
7.5	7.9	39	6.4%	55
8.0	8.4	53	8.6%	108
8.5	8.9	110	17.9%	218
9.0	9.4	61	9.9%	279
9.5	9.9	87	14.2%	366
10.0	10.4	72	11.7%	438
10.5	10.9	25	4.1%	463
11.0	11.9	36	5.9%	499
12.0	30.0	115	18.7%	614
TOTAL		614	100.0%	

The HEC-FDA Model

Expected annual damages (EAD) for without-project conditions and selected with-project conditions were estimated using the HEC-FDA (or FDA) model. Benefits are the measured differences between conditions with and without a flood control project in place. Project benefits were estimated primarily in the form of a reduction in EAD to the structures and their contents that are located within the study area. This comparison of without-project EAD and the with-project EAD for the various plans to reduce flood damages yields the principal Expected Annual Benefits, which, in turn, were weighed against the Expected Annual Costs, and result in the Benefit Cost Ratio.

Benefits resulting from the proposed projects include reduction in damages to structures, their contents, and other personal property; elimination of emergency relief costs; lowering the operating cost of the National Flood Insurance Program; and alleviating travel delays. Intangible, but important, benefits of installing a project include elimination of the threat to human safety and the reduction of trauma and stress to the residents in the flood plain.

HEC-FDA (or FDA) requires three data functions of the existing conditions: discharge-frequency, depth-discharge, and depth-damage. From these functions, the frequency-damage function can be derived. Once this occurs, a depth-damage curve, certified by the Institute of Water Resources (IWR) or the USACE Center of Expertise, can be applied to the structure inventory, which leads to the EAD value.

Inundation damages were computed by combining the estimated structure and content values with the anticipated extent of the flooding from various storms. The areas of flooding and the depths associated with the different events were computed as described in the hydraulic section. The effects of flooding on the structures in these reaches were measured using depth-damage relationships. These depth-damage "curves" relate depth of flooding to percent damages to structures and contents.

For typical kinds of residential structures and contents found in Lāʻie, depth-damage relationships used in this analysis were derived from a large sample size and are the results of rigorous testing as explained in the IWR report, EGM 04-01, *Generic Depth-Damage Relationships for Residential Structures*. For non-residential structures and contents, 12 depth-damage curves were taken from USACE, New Orleans District flood studies (USACE, 2006) for use in this analysis. Like the residential depth-damage curves, they represent the effects of short duration and freshwater flooding.

The study area, encompassing most of the community of Lāʻie, primarily south and west of Kamehameha Highway, has been broken down into multiple storage or small drainage areas according to its regional hydrologic and hydraulic (H&H) characteristics. The following represents a crude breakdown of the study area:

- Lāʻie Town (i.e., Left Bank)
  - BYUH buildings, fields and parking lots
  - PCC
  - Residential Lāʻie Town
  - Commercial outlying areas (shopping center, new hotel, and elementary school)
- Right Bank homes
- Muliwai area

Basically, the goal from the H&H and economic modeling standpoint is to group together various floodplain areas with like relationships between flood stage (i.e., water surface elevation) and probability (i.e., event frequency). Because of its relative flatness and source of flood water, the entire developed portion of the left bank of the Wailele Stream, can be modeled with a single source point of flooding. This includes most of the residential community of Lāʻie, the Lāʻie Elementary School, a strip shopping center, the PCC complex and the Hawaii campus of Brigham Young University (BYUH). While an existing USACE project, the Kahawainui Stream levee, protects this area from flooding from the northern side of this community, the southern side remains unprotected from the threat of flooding from Wailele Stream. The other two portions of the study area breakdown, namely, the right bank homes and the muliwai area, represent a small percentage of the flooding problem in the study area. In fact, no project benefits are taken for the muliwai area and very little benefit accrues as a result of a project to the right bank homes.

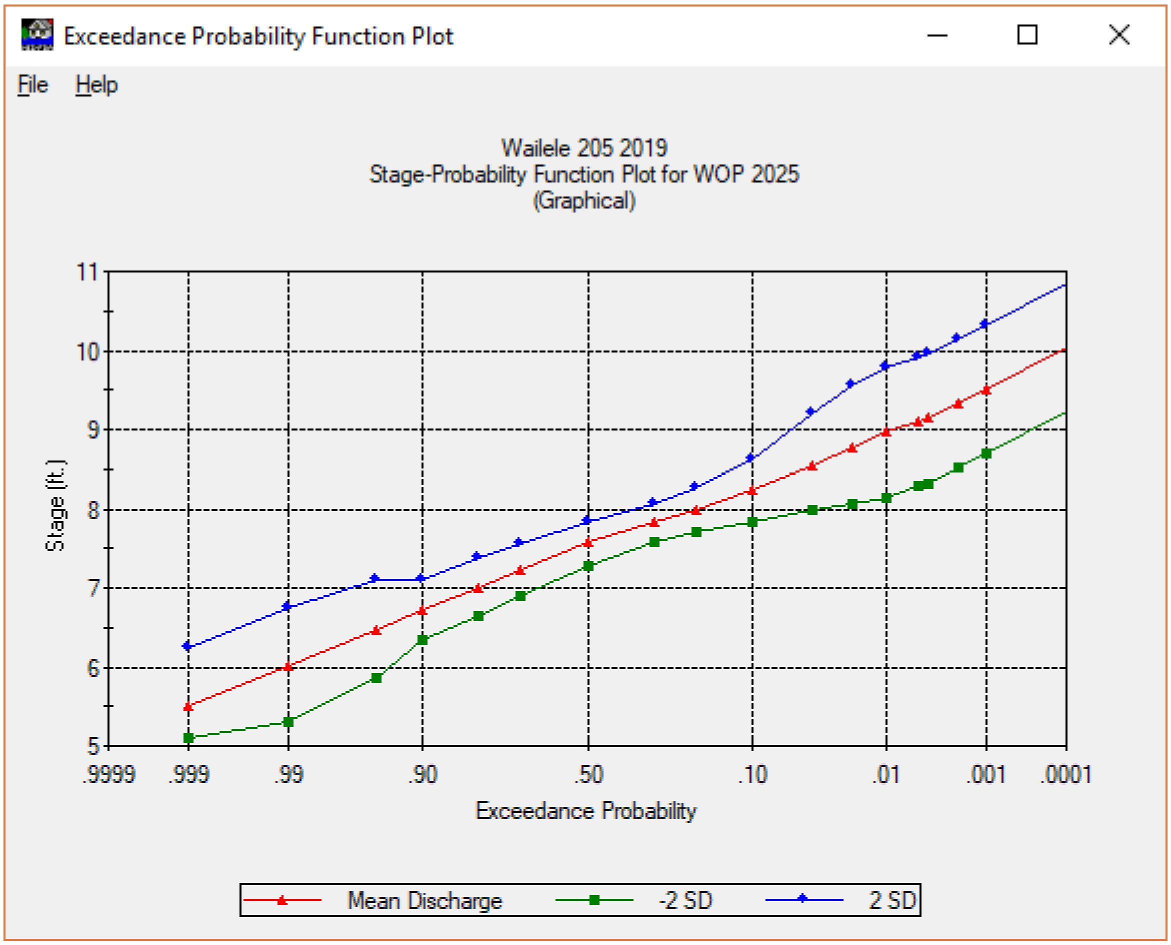
Lāʻie town, which includes the PCC and BYUH, is the primary damage center of the Wailele Stream floodplain. The source of flooding from Wailele Stream for all Lāʻie town (excluding the interior drainage) is where flood waters initially overtop Wailele Stream's left bank. Flood waters then flow north over much of the town, ponding in streets and rising on homes, BYU and PCC buildings, parking lots and athletic facilities. The pathway these floodwaters have historically taken into the town's damage center is called the "jump reach." The hydrologic rating curve for a single stream station on the jump reach, No. 56.443, is used in the H&H and economic models to represent the event frequency versus water surface elevation relationship for all Lāʻie Town and the left bank flooding. The bulk of this area, known as Basin 9 in the H&H model, is the first to flood.

Similarly, on the right bank, a low point in the stream bank allows flood water to escape at Station No. 1093.342. Therefore, the right bank rating curve at Station No. 1093.342 is used in the models to represent the hydrologic relationship between WSELs and frequency. However, the consequences of right bank flooding of these 15 homes, for the most part, above the 1/100 ACE floodplain, are minuscule compared to those of the left bank.

Historically, there has also been some agricultural losses associated with Wailele Stream flooding, particularly along the right bank. However, the assumption for this flood damage model is that these agricultural losses will be accounted for in the easement costs of the land rather than attempting to compute them through a certified agricultural flood damage computer program, an analysis beyond the scope of this CAP study.

The areas of flooding and the depths associated with the different events were computed as discussed in the hydrology section of the main report. The zero-damage point for the without project condition computer runs was assigned as the 50 percent chance (2-year) event. At this frequency, water would not overtop the banks of Wailele Stream, yet number of Lāʻie homes with the lowest floor elevations may experience some flooding due to ponding of localized rainfall and existing interior drainage constraints. Recent historical events have demonstrated that the overtopping of Wailele probably occurs at about the 20 percent chance (5-year) event. This is reflected in the H&H and economic models developed for this study. Figure 3 illustrates the Stage-Probability for the without project condition for the study area, as well as the uncertainty associated with the index point water surface elevations. In addition, Table 7 (below) shows the stage-probability statistics for the alternatives investigated. This further captures the stage-probability circumstances for the study.

Figure 3: Stage-Probability Function Plot for Without Project Condition at the Representative Index Point



Without-Project Inundation Damages

Inundation damages under the without-project condition were computed by combining the structure inventory with the anticipated effects of flooding from various storms. The flooding associated with the 1/2, 1/5, 1/10, 1/25, 1/50, 1/100, 1/200, and 1/500 ACE were estimated using the Corps of Engineers' HEC-FDA model version 1.4.2. This program was developed by the Hydrologic Engineering Center in Davis, California to perform an integrated hydrologic engineering and economic analysis during the formulation and evaluation of flood risk management plans. The software stores hydrologic and economic data necessary for analysis, and computes expected annual damages (EAD) using a risk-based methodology.

The areas of flooding and the depths associated with the different events were computed as discussed in the hydrology section of the main report. The zero-damage point for the without project condition computer runs was assigned as the 1/2 ACE. At this frequency, water probably does not begin to overtop the banks of Wailele Stream, but reaches some of the first floor elevations due to ponding of localized rainfall. Recent historical events have demonstrated that the overtopping of Wailele probably occurs at about the 1/5 ACE.

Table 4 shows the number of structures by use category that would be damaged for the entire array of event frequencies. An estimated 260 structures in the Wailele floodplain would be flooded above their first floor elevation. More than 100 more would be surrounded by flood waters creeping up their foundations and/or lots. Similarly, Table 5 displays without-project total inundation damages for by damage category as calculated by FDA. As the table shows, the 1 percent ACE flood would cause an estimated \$25.3 million in damages to structures and contents. This figure is calculated by FDA as a primary number without uncertainty boundaries. When calculated by the Monte Carlo methodology, as EAD is, using standard deviations and probability limits, the results can run two to three times higher. Whichever methodology is used, residential damage would be the largest category comprising about 95 percent of the total damage picture. The term "total damage" in this economic model refers to flood damages to structures and contents only. Other less significant damages and other NED benefit categories, such as landscape damages and travel delay reductions, could add an additional 20 percent or more to the total damage figures.

The without-project expected annual flood damages (EAD) has been calculated to be over \$5 million (\$5,780,600). This without project condition EAD is the baseline from which all improved conditions are measured. Again, it is important to note that project benefits are estimated primarily in the form of a reduction in damages to the structures and their contents that are located within the study area. Secondary benefits, which come in many other forms, have not been quantified in this economic analysis.

Table 4. No. of Structures Damaged, WITHOUT-PROJECT, by Category and Event

Annual Chance Exceedance (ACE) Event	Residential	Commercial	Public	Total
0.5 (2 yr)	0	0	0	0
0.20 (5 yr)	69	2	0	71
0.10 (10 yr)	84	2	0	86
0.04 (25 yr)	114	4	0	118
0.02 (50 yr)	172	7	0	179
0.01 (100 yr)	202	11	0	213
0.005 (200 yr)	228	14	0	242
0.002 (500 yr)	244	16	0	260

Table 5. Total Damages (in $000), WITHOUT-PROJECT, by Category and Event

Annual Chance Exceedance (ACE) Event	Residential	Commercial	Public	Total
0.5 (2 yr)	$0	$0	$0	$0
0.20 (5 yr)	$6,516	$207	$0	$6,723
0.10 (10 yr)	$8,563	$166	$0	$8,729
0.04 (25 yr)	$12,492	$308	$0	$12,800
0.02 (50 yr)	$19,525	$600	$0	$20,126
0.01 (100 yr)	$24,231	$1,096	$0	$25,327
0.005 (200 yr)	$28,102	$1,365	$0	$29,467
0.002 (500 yr)	$31,899	$1,674	$0	$33,573

Future Without-Project Condition Forecast

Given the great degree of uncertainty, the future condition represents a best guess of conditions in the watershed over the 50-year planning horizon. The guidance states that the planning process accounts for such future conditions such as climate variability, sea-level rise, subsidence, seismic influences, geomorphological changes, and changes from development which can place demands on the project systems during their life-cycle. The most significant of these changes over the next 50 years will likely be changes in development patterns and sea-level rise (SLR).

Given the degree of uncertainty, projections were not made of the future residential and non-residential development to take place in the study area under without-project conditions. Most of the developable land within the Wailele floodplain under current zoning ordinances is already fully developed. With the nearly built-out status of the present watershed, new development will be almost entirely restricted to replacing old structures with new ones. It is highly unlikely that these redevelopment efforts will include any high-rise, residential towers in the foreseeable future. Similarly, commercial development is expected to follow suit. Exactly which buildings will be replaced and by what is impossible to say. Therefore, this study assumes that no significant changes will occur to the structure inventories or other assets on which damage categories are based, and that future conditions will be the same as present conditions for the purposes of calculating damages or costs. However, given the continued anticipated increase in Hawaii County population and the aggressive growth projections for the BYUH campus, it is very likely that the number of people potentially placed in harm's way from a flood in the Wailele watershed, whether they are residents, students, workers, shoppers, tourists or motorists traveling through the floodplain, will increase over the 50-year planning horizon. Therefore, life safety issues associated with repeated flood events will only get worse over time.

Although relatively little new growth is expected within the existing residential neighborhoods of Lāʻie Town, older homes will undoubtedly be replaced by newer ones over time. Development trends will likely produce more costly homes, more duplexes, and less slab on grade construction in flood prone areas. In addition, BYUH officials are planning some new faculty housing and student dorms around the campus. The student population of BYUH is expected to increase from approximately 2,500 at current to 5,000 students over the next 15 years. An increase in the university's footprint is currently going through the entitlement process to be included in the City and County of Honolulu's Koʻolauloa Sustainable Communities Plan. Further entitlements and permitting will need to be granted before the expansion may be implemented. All new development will be above the base flood (1/100 ACE) elevation.

Another significant development within the project area includes the redevelopment of the Lā'ie Inn. The recently completed hotel, Lā'ie Courtyard by Marriot, has 144 rooms plus conference space, and is already accounted for in the structural inventory of the FDA model.

The PCC is currently undergoing several improvements as part of a $100 million renovation and redevelopment effort. Over the past five years, PCC has built a new theater and is making phased improvements to existing exhibits and venues. They recently completed a new 119,000-square foot "marketplace" consisting of commercial dining and retail space. All of these recent improvements at the PCC are above the base flood elevation and presently accounted for in the FDA model.

With-Project Conditions--Measure and Alternative Evaluation

The HEC-RAS model has been used to determine water surface profiles, extent of floodplains for different frequency events, the velocity and shear stress within the channel under existing conditions, and compared results with different alternative flood control measures in place. The model includes a reach labeled "Jump". The Jump reach was developed to simulate the flow that "jumps" over the left bank and flows into the BYUH campus.

Many flood control measures were theorized at the planning charrette. EA Engineering, Science and Technology, Inc. (EA) was tasked with evaluating the measures and computing their effectiveness for flood control. The measures were grouped into conveyance measures and detention measures. Conveyance measures included stream widening, diversion channels, culverts, bridges, and cutoff ditches. Detention measures included detention basins, dry dams, first flush basins, check dams, and underground detention. Stage storage tables were developed for many proposed detention sites, and channel capacity was calculated using Manning's open channel flow equations for many different stream realignments or modifications.

The measures were combined into several alternative designs by the USACE's contractor, HHF Planners. HHF's subcontractor responsible for the hydrologic model, EA, used the HydroCAD modeling software to model the alternatives and provide recommendations for layout and geometry of the alternatives. HydroCAD was used only as a tool for evaluating the technical feasibility and capacity of the initial array of alternatives. HEC-RAS was be used for final hydraulic modeling.

Several of the conceptual measures included the option to divert flow from Wailele Stream to Koloa Stream. EA evaluated these measures by estimating the impact of the additional flows to the water surface elevation within the Koloa Stream reach.

The Initial Array of Alternatives

Table 6 shows the initial array of alternatives, along with a short description, that were formulated in a collaborative effort by the entire project delivery team (PDT). The initial array of alternatives was developed in 2015 and prior iterations of this study, but still remain relevant today.

Table 6. The Initial Array of Alternatives

Alternative	Description
0	No Action
1	Large Dam Upstream
2	Channelization - Full Conveyance
3A With Basins	Combination -- Channelization & Detention
3A No Basins	Combination -- Channelization & Detention
3B	with First Flush Basin
3C	with Upland Detention
3D	Smaller Dam in Wailele Valley
3E	Combination Dam and Channelization
4	Nonstructural Plan

Should the no action alternative be selected, obviously, there would be no USACE-funded construction to implement and the community's flooding problem would not be addressed. The expected inundation of private property and the highway would continue to be a constant threat because of restricted stream outlets and the occupation of the floodplain. The overall flood problem would continue to be aggravated by the steep mountains and limited number of drainage outlets across the highway that contributes to ponding within the low lying areas which Lāʻie occupies. The no action alternative was eliminated from consideration since it does nothing to address the study objectives and mitigate the life threatening and property damaging effects of the recurrent flood problem in Lāʻie.

Alternative 1 provides for a large dam to be located on Wailele Stream upstream of Lāʻie town. This alternative was eliminated from consideration during the alternatives screening process due to the high initial cost of the dam, the extensive operations and maintenance requirements, public aversion to dams, and the significant amount of usable land required to detain floodwaters.

To provide the conveyance capacity needed to handle the 1/100 ACE, significant improvements and additions to the existing Wailele Stream channel are required. Alternative 2, which involves fully conveyance with an overflow channel and no detention basins, was carried forward for further study.

Alternative 3A was also carried forward for further study. This alternative provides a complete, effective, and efficient plan to reduce flood risk and attempts to mitigate potential environmental impacts. These alternatives provide complete, effective, and efficient plan to reduce flood risk and attempts to mitigate potential environmental impacts.

Alternative 3B was eliminated from consideration during the alternatives screening process. This alternative provides a complete and effective plan to reduce flood risk, but the inclusion of a first flush basin is not justified to efficiently address the primary project objective of reducing flood risks.

Alternative 3C was eliminated from consideration during the alternatives screening process. This alternative provides a complete and effective plan to reduce flood risk but its attempt to mitigate potential environmental impacts is significantly less efficient than Alternatives 3A & 3B, and there remains technical feasibility issues with the implementation of the proposed upland detention basin. To reduce the required conveyance capacity underneath Kamehameha Highway,

Alternative 3D proposes a dam in Wailele Valley, upstream from the alluvial fan apex. This dam would be slightly smaller than the dam proposed in Alternative 1, but it was eliminated from consideration during the alternatives screening process due to essentially the same problems faced by Alternative 1; namely, high initial and O&M costs, of the dam, large land requirements and adverse public reaction to dams. Basically, it boiled down to other alternatives could achieve the same level of flood protection for much less cost.

Alternative 3E would include the channel improvements and overflow channel described in Alternative 2, but would require less width through the improved channel and a smaller bridge/culvert at the highway. To reduce the required conveyance capacity underneath Kamehameha Highway, this alternative proposes seven different detention basins along both banks of the stream in the alluvial plain. Alternative 3E was eliminated from consideration during the alternatives screening process due to the high cost, the extensive operations and maintenance requirements, and the significant amount of usable land required to detain floodwaters.

Alternative 4, a standalone nonstructural alternative has yet to be fully formulated and evaluated. This can be formulated prior to Final Feasibility report submittal.

The Final Array of Alternatives

The results of this screening analysis determined that the following plans would be included in the final array of alternatives.

- No Action Plan (Future without Project)

- Alternative 2: Full Conveyance (Overflow Channel and No Detention Basins)
- Alternative 3A: Combination (Overflow Channel and Peak Flow Reduction)

Alternative 3A: Combination (Overflow Channel and Peak Flow Reduction)

This alternative proposes to maintain an existing stream flow of 675 CFS within the existing Wailele channel and culvert, and includes conveyance improvements that are the similar to those described in Alternative 2 (channel improvements, weir, overflow channel, and a new highway culvert/bridge). The only changes would be that the overflow channel could be narrowed to a bottom width of 36', and only two 18'X 8' box culverts would be required to convey the 1/100ACE under the highway. The overflow channel and highway culverts would be downsized because of the inclusion of detention basins 1 and 9 which would reduce peak flood flow rates. Basin 9 would drain into the existing Wailele Channel, and Basin 1 would drain into the new overflow channel. Due to their topography and layout, basins 1 ($7,626/AC-FT) and 9 ($10,896/AC-FT) are estimated to be the two most cost effective detention basins that were analyzed. This alternative is largely similar to Alternative 2 with the exception that it attempts to reduce the environmental impact associated increased conveyance through the development of two different detention basins near Kamehameha Highway. Basins 1 and 9 would help reduce peak flows from large flooding events (greater than the 1/25 ACE). By reducing the peak flows of major flood events, the basins would help to reduce the intensity of the freshwater plume that extends into the near shore environments. They would also increase groundwater recharge and help to reduce sedimentation during these large events.

A potential benefit provided by constructing detention basins is that they may attenuate the peak flow enough to reduce the size and cost of downstream conveyance infrastructure. The two basins included in Alternative 3A may potentially be sized to allow for a smaller conveyance structure in the Overflow Channel where it will pass under Kamehameha Highway. EA evaluated the required detention basin capacity with this potential conveyance size reduction in mind.

Detention basins 1 and 9 were included in the proposed HEC-RAS model. They are represented as storage areas. The stage storage tables for the detention basins were developed from the proposed basin geometry developed for Alternative 3A. The unsteady flow boundary conditions were modified to include rainfall directly onto the detention basins.

While evaluating Alternative 3A, a version of Alternative 3A was developed which does not include detention basins. Removing the detention basins will result in a higher peak flow rate through the Overflow Channel and necessitate some design changes. In the spirit of SMART Planning and concentrating PDT efforts where they would be most beneficial, HEC-FDA computer modeling was limited to only the without project condition and just two alternatives, namely, Alternative 3A with and without detention basins. Given that the reductions in water surface elevations (WSELs) are less than those associated with either version of Alternative 3A, and the projected cost of Alternative 2 would be higher, there was no need to run FDA for Alternative 2.

Table 7 illustrates the changes in water surface elevations (WSELs) resulting from incorporating various combinations of measures in conjunction with alternative 3A. The last three columns on the right side of the table represent the effects on the WSELs of further, internal drainage features when added to Alternative 3A. Dealing with internal drainage issues are beyond what the USACE project can provide and will have to be dealt with by other local agencies. For the purposes of this study, the reduced WSELs are maximized with Alternative 3A, and the reductions are slightly better when basins are included.

Table 7. Maximum Water Surface Elevation (WSEL) In Lāʻie Storage Area

Interval	Existing Without Project	With Project Alternative 3A	With Project Alternative 2 – No Basins	Without Project and with Storm Drainage Upgrade	With Project Alternative 3A and Storm Drainage Upgrade	With Project Alternative 3A and Storm Drainage Upgrade, and Cane Haul Road Cutoff Berm
Year	**Max WSE (ft)**	**Max WSE (ft)**	**Max WSE (ft)**	**Max WSE (ft)**	**Max WSE (ft)**	**Max WSE (ft)**
2	6.93	6.41	6.43	6	4.23	4.23
5	7.7	6.75	6.77	6.45	5.13	5.13
10	8.05	7.01	4.04	6.82	6.1	6.09
25	8.53	7.38	7.42	7.48	6.37	6.34
50	8.89	7.61	7.64	7.77	6.59	6.54
100	9.26	7.81	7.84	8.08	6.8	6.73
200	9.51	8.02	8.05	8.37	7.03	6.95
Plate 6	9.68	8.02	8.05	8.58	7.03	6.95
500	9.8	8.27	8.31	8.79	7.33	7.22
SPS	10.03	9.12	9.23	10.25	7.91	7.77

Note: The numbers noted above are from the screening of alternatives analyzed in 2015 and prior years.

NED Plan is the Same as the TSP

Based on these WSELs, one can clearly see that Alternative 3A with detention basins is slightly more effective at reducing flooding in Lāʻie than Alternative 3A with no basins. The resulting expected annual damages (EAD) totals from those runs, along with the residual damages that would remain with those alternatives in place, are shown in Table 8.

Table 8. Economic Data for Deciding on TSP

Condition	Expected Annual Damages (EAD)	Expected Annual Benefits	Expected Annual Costs	Net Annual Benefits	Benefit Cost Ratio
Without Project	$3,215,200				
Alt 3A With Basins	$665,000	$2,301,000	$701,700	$1,508,000	2.9
Alt 3A Without Basins	$848,500	$2,366,700	$398,600	$2,068,100	5.0

Note: The numbers show above were from the 2015 analysis and prior years during the screening of alternatives.

Table 8 shows the only two with-project conditions for which FDA results were calculated. Both use the measures of Alternative 3A, but the second one does not have detention basins. Instead it uses an overflow channel 15 feet wider than the with-project condition with basins, and it has 3, not 2, box culverts under the main road. This drives the initial investment cost of the plan with basins to be about twice as high as the cost of the version of Alternative 3A with no basins. The slightly higher peak flow rates under the with-project condition of Alternative 3A, no basins, than the plan with basins, yield less in the way of expected annual benefits, but the higher costs associated with the plan with basins yields far less net benefits. Maximizing net benefits is the key to selecting the NED Plan, as well as the most economically efficient TSP; that is clearly Alternative 3A with no basins as shown in Table 8. Alternative 3A Without Basins yields higher net benefits of $2,068,000 annually and an exceptional BCR of 5.0.

At this point in the study process, HEC-RAS was refined and prepared in accordance with current engineer regulations and requirements. As a result, water surface elevations were lowered for most parts of the study area. The economic values of structures in the study area were also updated to current price levels (October 2019) and were analyzed using the current discount rate of 2.875 percent. The HEC-RAS results and economic updates were input into HEC-FDA and the model was re-run. The previously selected TSP (Alt 3A without basins) plan was selected in the previous iteration (Table 8) was run once again. However, in this iteration, the TSP was fine-tuned to include two different culverts scenarios with the TSP. These plan results are shown in Table 9 below. The plans are identified as TSP01 and TSP02.

The TSP01 plan is the same as Alt 3A (without basins), however, this alternative includes three culverts. The TSP02 is also the same as Alt 3A (without basins), however two culverts were included in the analysis.

As shown in Table 9, the TSP plans have virtually the same costs and benefits, and identical BCRs. The TSP01 plan with three culverts actually represents the NED plan and is the plan that will be carried forward.

Table 9. The Economics of the Refined and Updated TSP/NED Plan (FY19 Price Levels and Updated Economics and H&H)

Condition	Expected Annual Damages (EAD)	Expected Annual Benefits	Expected Annual Costs	Net Annual Benefits	Benefit Cost Ratio
Without Project	$5,780,600				
TSP01 (no basins, 3 culverts)	$1,199,300	$4,581,300	$755,500	$3,825,800	6.1
TSP02 (no basins, 2 culverts)	$1,231,900	$4,548,700	$751,100	$3,797,600	6.1

Note: The numbers shown above result from the updated economics and hydraulics and hydrology from 2019.

Expected Annual Costs

Expected annual cost (EAC) is used in economic analysis to compare costs and benefits on an annual basis from a consistent point in time. EAC begins with a detailed estimate of a project's total construction cost and annualizes it much the same as a typical home mortgage is converted to a monthly payment. The formula for the calculation of EAC involves applying the appropriate discount rate and time period to the total cost of an alternative, including costs for mitigation, real estate, further planning and design studies, management of the construction and operation, maintenance, repairs, rehabilitations, and replacements (OMRR&R). The O&M costs were not updated to current price levels, therefore the previously utilized estimates for O&M for Alternative

3A were used. The assumption was made that the O&M for the two TSP alternatives would be almost the same. The O&M will need to be updated prior to finalizing this analysis. EAC also includes an economic cost, interest during construction, to account for the opportunity costs of the investment itself. The construction costs were initially calculated using FY 15 price levels and later updated to FY 19 price levels using the Civil Works Construction Cost Index System (CWCCIS). Beginning with the initial construction contract cost for the two variations of the TSP,

Mitigation costs were added and are the same for the two TSP plans.

In addition to the federal project, the local sponsor is constructing a complementary project of its own. This project is considered to be an economic cost for analysis purposes. The non-federal project falls under associated costs and the first cost of its construction is $2.0M. Table 10 illustrates the EAC calculations of the two plans. These EAC are used in Table 9 to determine the BCR and net benefits.

Table 10. Calculating Expected Annual Costs for Alternative 3A with and without basins (in 000's)

Tentatively Selected Plan	TSP01	TSP02
First Costs Construction @ EPL Oct 2018	$14,670	$14,554
First Costs - Associated Construction	$2,000	$2,000
Mitigation Costs	$638	$638
Total First Costs	$17,308	$17,192
Interest During Construction	$230	$228
Total Investment Cost	$17,538	$17,420
Interest and Annualization	$711	$706
Total O&M Costs	$45	$45
Expected Annual Costs	$756	$751

Residual Risk With-TSP in Place

Residual risk is the risk remaining after implementation of a plan; that is, it is the difference in damages between the with- and without-project conditions. Depending on the current conditions and the changes created by the alternative plan, inundation at a reach usually starts to occur at different ACEs. These changes in ACEs are correlated to structure and content dollar damages. In the case of the Wailele Stream Project, the residual risk is computed as the remaining dollar damages to commercial, public, and residential structures and contents after implementing the TSP.

By implementing the TSP, expected annual damages (EAD) to structures and contents within the watershed are anticipated to decrease from about $5,780,600 to about $1,199,300, a 79 percent reduction. Other losses associated with flooding beyond the scope of this investigation (structure and content damages only) should follow suit and experience similar reduction. This reduction in NED benefits yields an estimated net benefit of about $4,581,300. Tables showing without-project number of structures damage and estimates of total damages are shown below, Tables 11 and 13. With-TSP results showing the reduction magnitude are shown in Tables 12 and 14. By comparing Tables 11 and 12, it can been seen that structures have been shifted to less-frequent flood zones. However, structure still remain within the 1/10 ACE flood zone. This is due to the nature of the study area. Several residences that remain in the frequent zone sit at ground level and in very flat areas. This makes it difficult to actually improve the plight of these structures with any flood mitigation measures.

Table 11. No. of Structures Damaged, WITHOUT-PROJECT, by Category and Event

Annual Chance Exceedance (ACE) Event	Residential	Commercial	Public	Total
0.5 (2 yr)	0	0	0	0
0.20 (5 yr)	69	2	0	71
0.10 (10 yr)	84	2	0	86
0.04 (25 yr)	114	4	0	118
0.02 (50 yr)	172	7	0	179
0.01 (100 yr)	202	11	0	213
0.005 (200 yr)	228	14	0	242
0.002 (500 yr)	244	16	0	260

Table 12. Number of Structures Damaged, WITH-TSP, by Category and Event

Annual Chance Exceedance (ACE) Event	Residential	Commercial	Public	Total
0.5 (2 yr)	0	0	0	0
0.20 (5 yr)	0	0	0	0
0.10 (10 yr)	15	1	0	16
0.04 (25 yr)	39	1	0	40
0.02 (50 yr)	64	2	0	66
0.01 (100 yr)	99	2	0	101
0.005 (200 yr)	114	4	0	118
0.002 (500 yr)	172	7	0	179

Table 13. Total Damages (in $000), WITHOUT-PROJECT, by Category and Event

Annual Chance Exceedance (ACE) Event	Residential	Commercial	Public	Total
0.5 (2 yr)	$0	$0	$0	$0
0.20 (5 yr)	$6,516	$207	$0	$6,723
0.10 (10 yr)	$8,563	$166	$0	$8,729
0.04 (25 yr)	$12,492	$308	$0	$12,800
0.02 (50 yr)	$19,525	$600	$0	$20,126
0.01 (100 yr)	$24,231	$1,096	$0	$25,327
0.005 (200 yr)	$28,102	$1,365	$0	$29,467
0.002 (500 yr)	$31,899	$1,674	$0	$33,573

Table 14. Total Damages (in $000), WITH-TSP, by Category and Event

Annual Chance Exceedance (ACE) Event	Residential	Commercial	Public	Total
0.5 (2 yr)	$0	$0	$0	$0
0.20 (5 yr)	$0	$0	$0	$0
0.10 (10 yr)	$1,159	$61	$0	$1,220
0.04 (25 yr)	$3,459	$78	$0	$3,537
0.02 (50 yr)	$6,396	$149	$0	$6,545
0.01 (100 yr)	$9,943	$173	$0	$10,116
0.005 (200 yr)	$12,248	$300	$0	$12,548
0.002 (500 yr)	$19,525	$600	$0	$20,126

The effects on life safety are not as easily measured. For the most part, Wailele Stream is not a floodplain with a high risk for loss of life from flooding. That is not to say that lives would not be endangered in the event of a major flood; flooding can be flashy or come with little warning. However, these extremely dangerous conditions exist primarily where no one lives, in the steeply sloped hillsides. In the lower floodplain like Lāʻie town, it is much flatter and floodwaters rise more slowly, giving residents time to move to safety. Plus, with the addition of a new, basin-wide flood warning system, people should have adequate warning and time to move to higher ground or upper floors and out of harm's way.

Critical Infrastructure Inventory and Community Resilience

Other than containing the only highway that traverses the Island of Oahu, an elementary school and the BYUH campus, there is surprising little critical infrastructure in the Wailele Stream floodplain. There are no hospitals, fire stations, police stations, senior citizen's homes or utility plants in this floodplain. From the standpoint of critical infrastructure, perhaps this means that the community of Lāʻie could be considered fairly resilient following a major flood. Resiliency in this context has to do with how well a community can recover from a major storm event. In the case of this TSP, there is no levee system that could be overtopped. With the TSP in place, the risk of flooding would be practically eliminated for any of the critical infrastructure identified, herein, (i.e., the highway, elementary school or BYUH campus buildings). However, there is always some level of risk associated with the possibility of project failure. With the project consisting primarily of channelization and not levees, there is little chance that an extremely rare rainfall event capable of totally overwhelming the project would cause more damage than if it was never implemented.

Additional Work to Do

Minor work remains to be done between this Draft Feasibility Report and the Final Feasibility Report, as well as in the Pre-engineering and Design Phase (PED), as this proposed flood risk management project moves closer to possible authorization and appropriation. For instance, another look may be warranted at including nonstructural components for individual structures that remain flood prone after the implementation of the TSP. More precise finished floor elevations and comprehensive structural engineering evaluations will be required for selective buildings where buying out, relocating, ring walling, elevating or flood proofing might be economically justified. Or, given the effectiveness of the TSP at reducing flood damages, there might not be sufficient remaining damages to justify and add nonstructural components to the structural measures.

Also, assurances need to be made that updated costs and alternative nomenclature has been thoroughly vetted by the entire team. Annual O&M costs need to be updated appropriately. Project costs will be recomputed to reflect 35% design completion and will be presented at current price levels. Despite this additional work needed, it is highly unlikely that the TSP will change.

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Appendix E
Hydraulics & Hydrology

Wailele 205 – Hydraulic and Hydrologic Evaluation Analysis - DDR

April 2019

U.S. Army Corps of Engineers
Lakes and Rivers Division – Huntington District
502 8th Street
Huntington, WV

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Introduction

Purpose & Scope

The hydrologic and hydraulic analysis performed for the Wailele Flood Risk Management Project consisted of using existing hydrologic runoff estimates defined in previous study as conveyed to a newly developed HEC-RAS model. The primary warrant for developing a new hydraulic model was simply that the topographic area's hydrologic response to storm events were complex and varied in water surface elevation results across the entire area of interest, therefore updated 2-Dimensional Hydraulic Model was developed. The hydraulic modeling utilized plan drawings and provided schematics to define the geometrical features of the project.

Project Overview and Features

The project consists of main flood control channel, overflow channel, and BYU diversion channel see Figure 1 for schematic. The BYU diversion channel is to be constructed by others while the main flood control channel and overflow channels are to be constructed under USACE contract. The existing conditions are defined by channel geometries found in the DEM elevation data used to define the topographical terrain with three main features Kamehameha Hwy Culvert Crossing, Waloo Stream Bridge Crossing, the existing Wailele Stream Channel, and the Foodland culvert crossing through the Kamehameha Highway to the North in the City of Laie (not shown in schematic). The proposed conditions include channel widening (shown in red), overflow channel (purple), and two variations for the Kamehameha crossing at the termination point of the overflow channel (dark blue), and the BYU diversion channel (light blue), and an inline constructed flow throttling feature just downstream of the confluence with the overflow channel and the main flood control channel (not labeled).

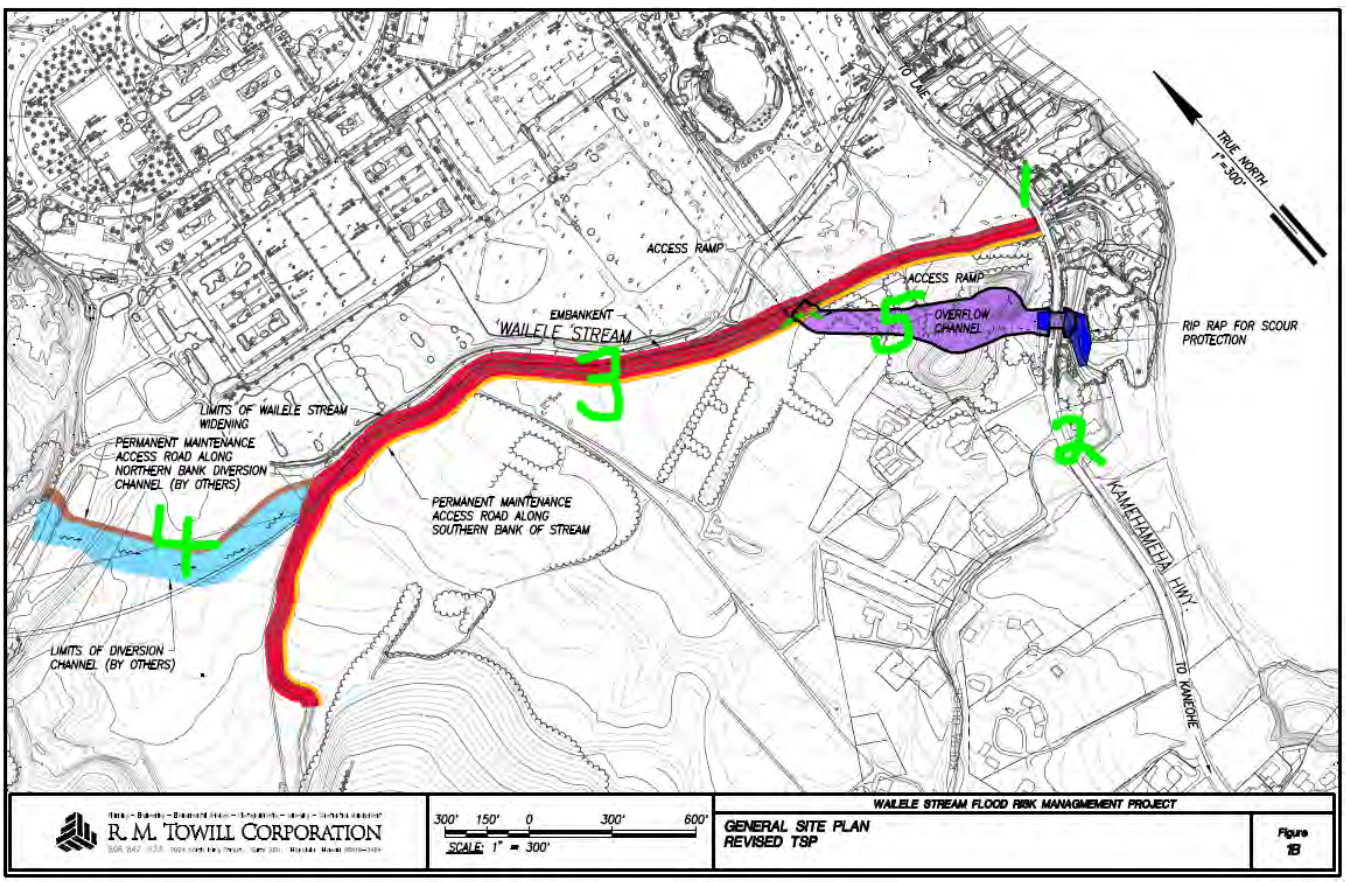

Figure 1: Plan Schematic for Existing and Proposed Project Features

Existing Conditions

The existing conditions include three hydraulic features as previously defined. The foodland culvert consists of one single barrel culvert 50’ span by 6’ rise having an invert elevation of 2.14 ft-MSL with flared wingwalls see Figure 2. The existing Kamehameha Highway culvert crossing conveys the Wailele Stream through the highway embankment and consists of one single barrel culvert 12’ span by 8’ rise having an invert elevation of 2ft-MSL with flared wingwalls see Figure 3. The Waloo Bridge crossing consists of a bridge spanning 50’ span by 8’ rise with bottom elevation of 0ft-MSL with flared wingwalls see Figure 4.

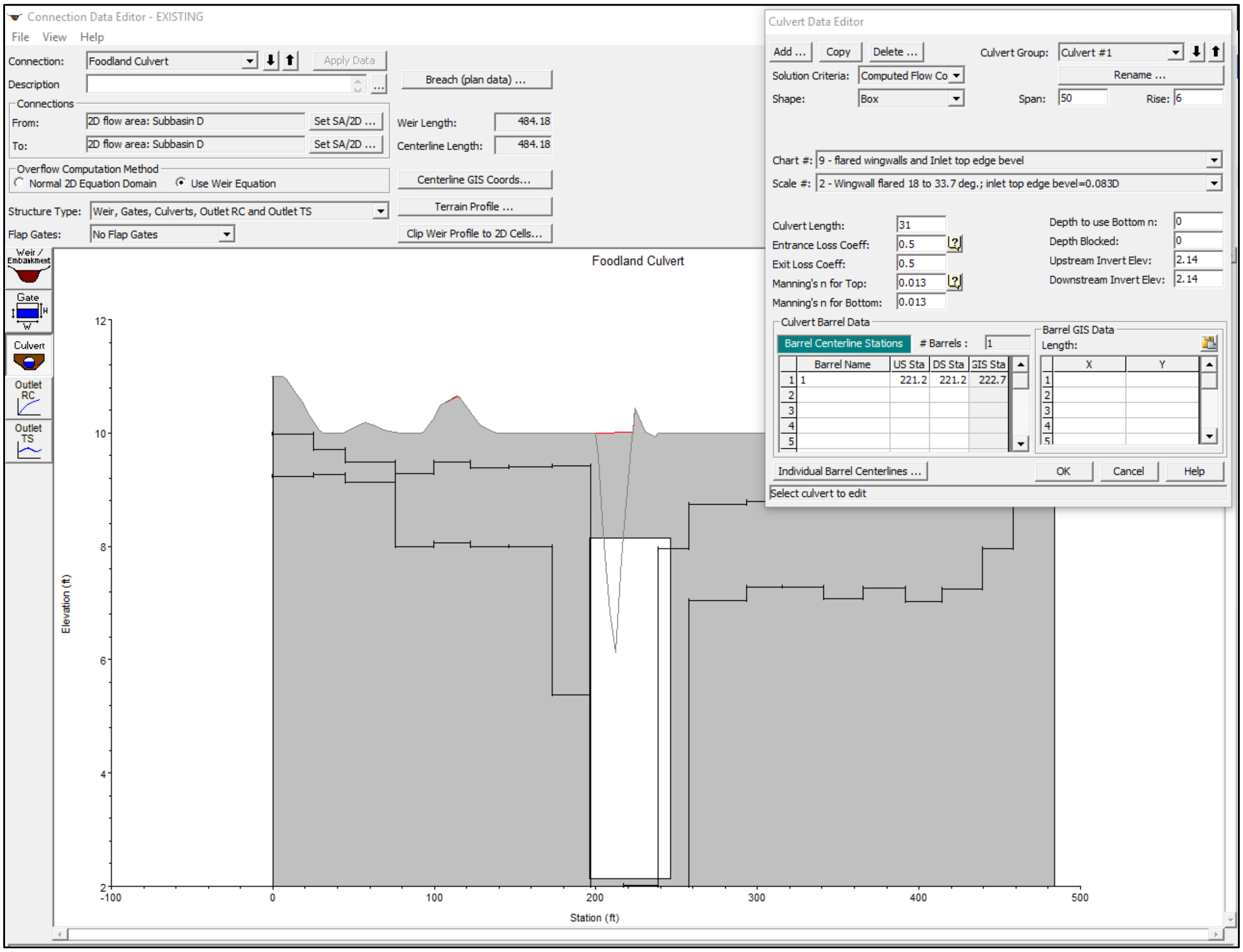

Figure 2: Existing Foodland Culvert in Downstream within the City of Laie

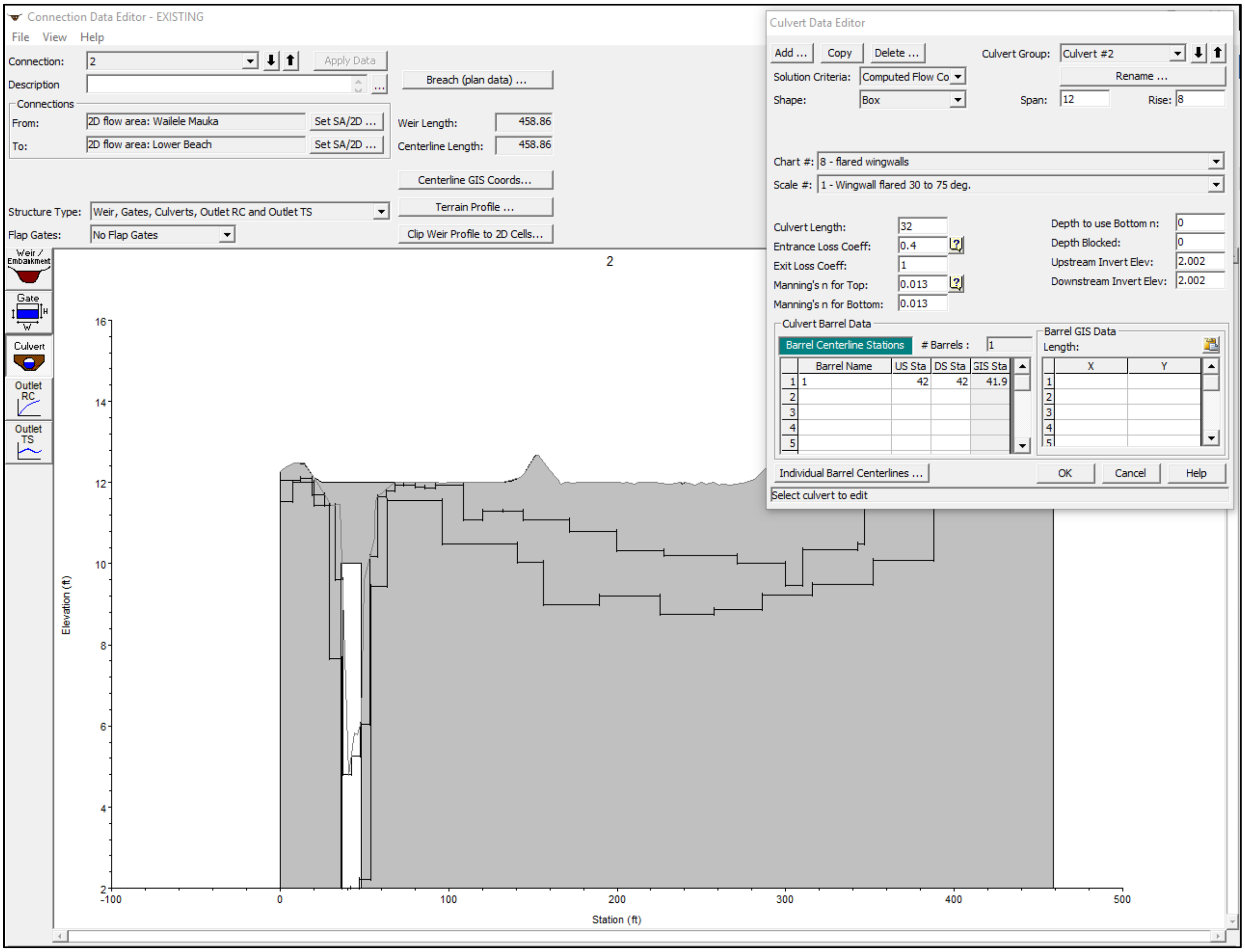

Figure 3: Kamehameha Highway, Existing Culvert Crossing

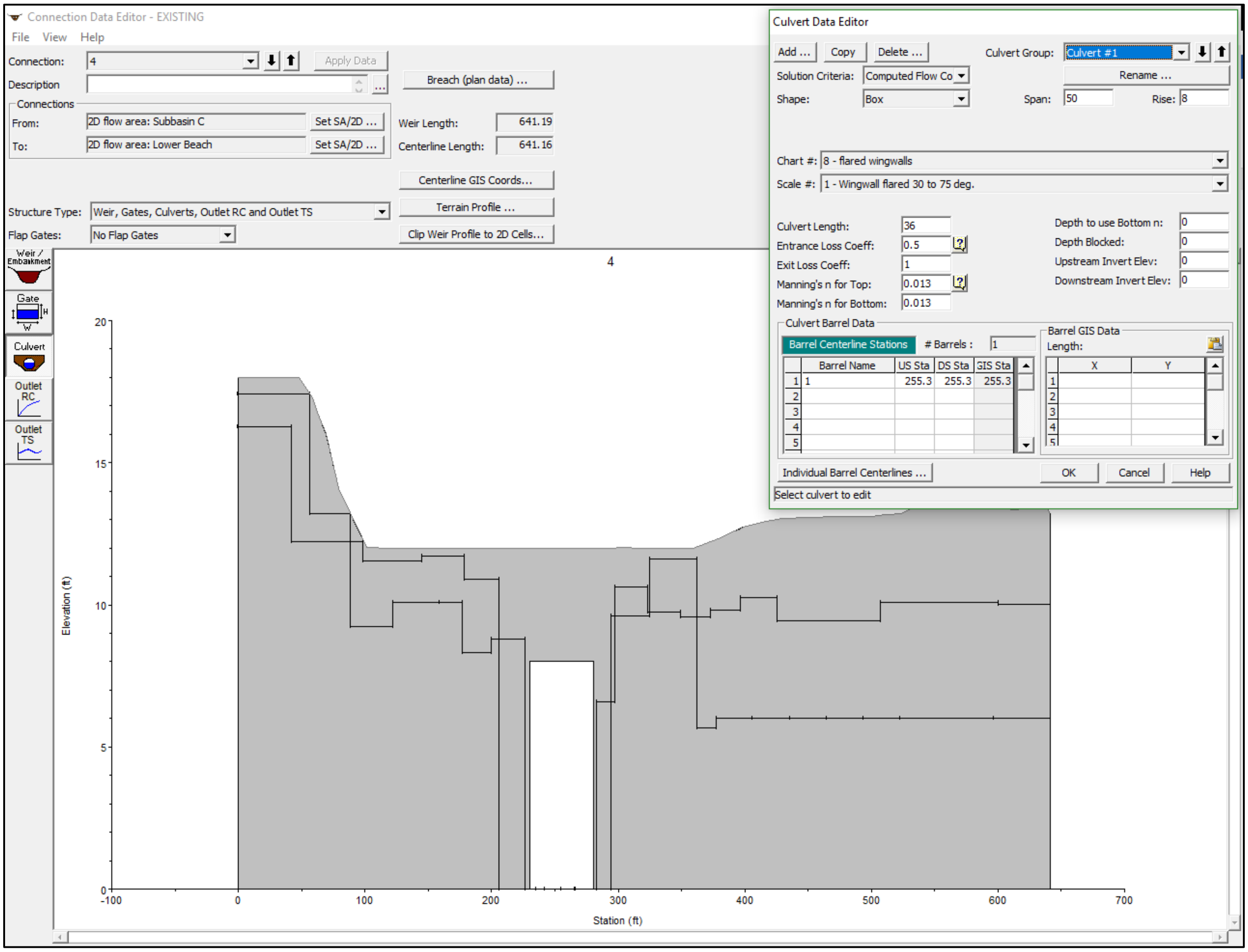

Figure 4: Existing Waloo Bridge Crossing, beneath Kamehameha Highway

Proposed TSP01 Conditions

The first alternative (TSP01) considered adding four features 1) the BYU diversion channel, 2) overflow channel, 3) main Wailele flood control channel, and 4) three culverts terminal to the overflow channel through the Kamehameha Highway. As previously defined, the BYU diversion channel is to be constructed by others, however was included in both geometrical configurations to define proposed project conditions. The channel consists of a 60' wide channel with side slopes of 3:1 flanked to the left bank by a 20' wide maintenance road constructed to a grade crest elevation see Figure 5 for standard typical. The overflow channel consists of a 51' wide channel with side slopes of 3:1 flanked to the left bank by a 20' maintenance road constructed to a grade crest elevation see Figure 6 for standard typical. The overflow channel terminates at the Kamehameha Highway, where three proposed culverts 17.25' span and 6.8' rise, constructed with invert elevation 2-ft MSL. The major project design feature is the main flood control channel widened to various dimensions as defined by the proposed plan drawings. This flood control channel varies in widths ranging from 8' to 35' having an invert profile as defined by the construction drawings. The channel is to be constructed using four standard typical drawings contained in the plan set with the addition of maintenance access roads providing freeboard to the design storm under major flood events. The final design feature consists of an inline flow throttling feature approximately 14' wide and located 75' downstream of the confluence between the main flood control channel and the overflow channel.

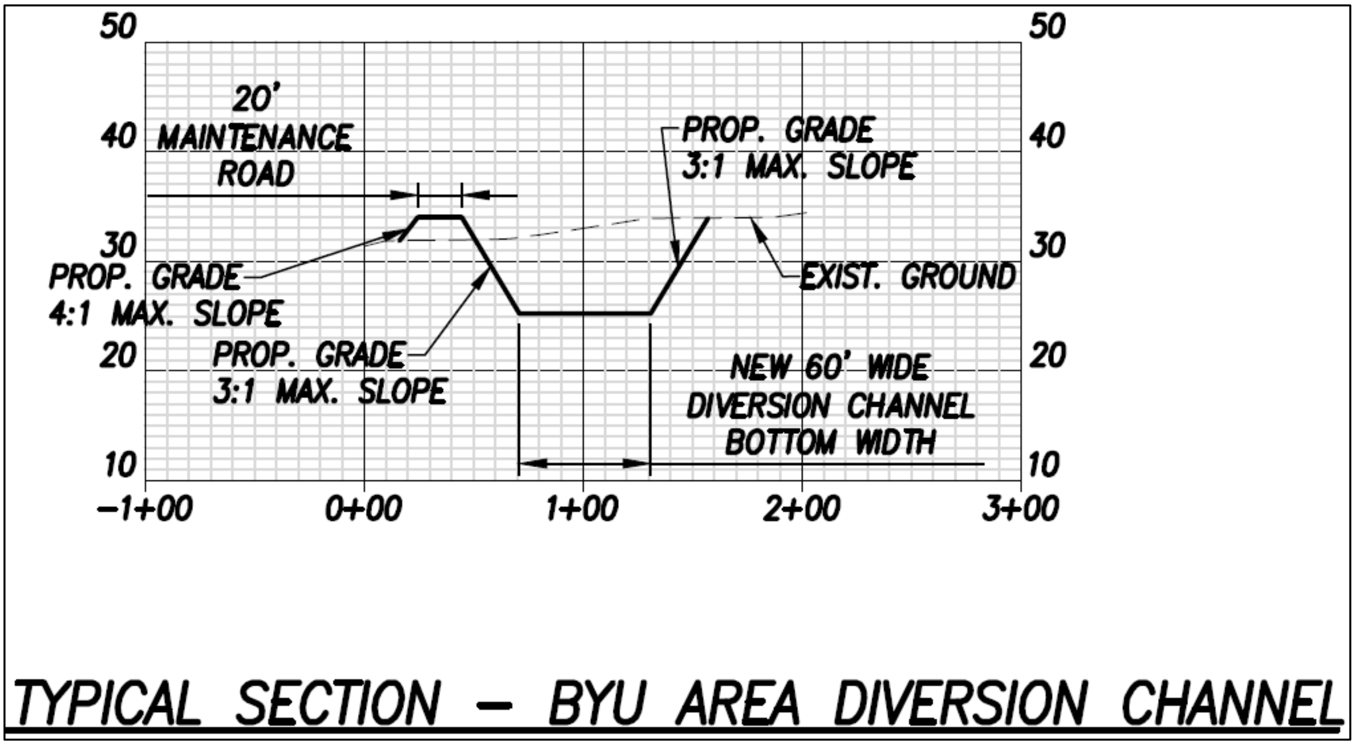

Figure 5: Proposed BYU Diversion Channel Typical

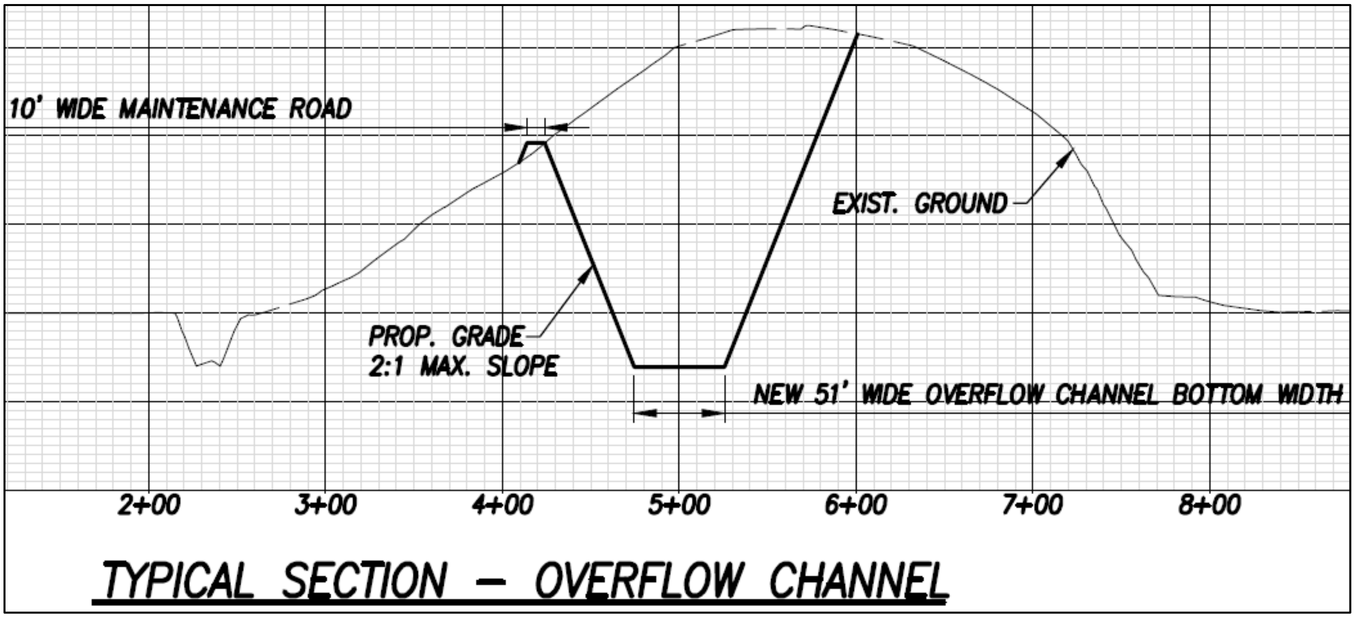

Figure 6: Overflow Channel Standard Typical Dimensions

Proposed TSP02 Conditions

The second proposed alternative consists of the same features as the first alternative. The difference being only 2 proposed culverts at the termination point of the overflow channel. Comparisons were generated in the hydraulic model in order to determine reduction benefits for the project with a less expensive alternative.

HEC-RAS Modeling and HEC-HMS Modeling

Overview

The existing hydrologic/hydraulic modeling utilized two software's offered by the Hydrologic Engineering Center, HMS and RAS. The original hydraulic modeling consisted of 1-Dimensional model containing cross sections, storage areas, culvert crossings, and lateral structures. It was determined at the time of analysis that the existing modeling did not adequately provide detail to support the complex nature of hydrodynamic runoff for the consideration of damage reduction estimation, therefore a 2-Dimensional RAS model was developed. Both analyses estimated return frequencies as defined in table Table 1. A total of 7 subbasins were delineated in order to estimate hydrologic runoff for the surrounding watersheds of interest as summarized in Table 2 and displayed in Figure 7.

Table 1: Frequency Return Periods

Return Periods Used for Study
2 YEAR
5 YEAR
10 YEAR
25 YEAR
50 YEAR
100 YEAR
200 YEAR
500 YEAR
Standard Project Storm

Table 2: Subbasin Delineation Details

Sub Basin Name:	Sub Basin Description:	Area (acres):	RAS Model Application:
Wailele Mauka	Wailele Stream Channel Area	14	Rain Excess Precipitation
BYU Diversion Area	Watershed upstream from BYU Diversion	97	Rain Excess Precipitation
A	Adjacent campus area for BYU Hawaii	6	Rain Excess Precipitation
B	Adjacent campus area for BYU Hawaii	12	Rain Excess Precipitation
C	Adjacent campus area for BYU Hawaii	98	Rain Excess Precipitation
Subbasin C	Waloo Local Subbasin	278	Rain Excess Precipitation
Subbasin D	City of Laie, Urbanized Area	453	Rain Excess Precipitation
Wailele Stream	Rural mountainous watershed	794	Inflow Runoff Hydrograph
Koloa Gulch	Rural mountainous watershed	1037	Inflow Runoff Hydrograph (scaled)

In order to most appropriately apply hydrologic runoff estimates, a rainfall excess precipitation hyetograph was applied to interior subbasins and upstream inflow hydrographs were used for the Waloo Gulch and Wailele Streams as inflow hydrograph boundary condition. It is important to note additionally that additional 2D flow areas were added in order to adequately capture inundated areas outside of the delineated subbasins from the hydrologic model. This was developed because the previously delineated hydraulic areas didn't not accuracy model these overflow areas therefore the following 2D flow areas were added including: Upper Beach, Middle Beach, Lower Beach, and Perimeter 1. All subbasins delineated for the hydrologic/hydraulic models can be found in Figure 7.

Figure 7: Left Hydrologic Subbasins, Right Hydraulic 2D Flow Areas

Hydrologic Analysis

The hydrologic analysis computed flow hydrographs as conveyed by an upstream boundary condition specified as inflow for the RAS model for Wailele Stream and Waloo Gulch watersheds. The Wailele Stream watershed is much similar to the Waloo Gulch watershed in runoff characterization, therefore a scaled inflow hydrograph approach was used in order to simulate runoff discharges for each return frequency analyzed for the Waloo Gulch subbasin. An example for the rainfall excess precipitation applied to the interior subbasins is shown for each internal subbasin in Figure 8 . An example for the inflow hydrographs applied to the external flow hydrograph boundary conditions can be found in Figure 9. In the estimation of rainfall frequency NOAA Atlas 14 hyetographs were generated using the following climatic stations summarized in Table 3.

Table 3: Summary of Rainfall Record Data used for the study

Station Name	Station ID	Source of Data	Latitude	Longitude	Elevation (feet)	Period Start	Period End	Record Length
BYU LAIE 903.1	51-0242	NCDC	21.6431	-157.9317	20	01/1942	07/1999	**57**
HELEMANO INTAKE 881	51-1384	NCDC	21.5500	-158.0000	1270	01/1942	04/1979	**37**
KAHUKU 912	51-2570	NCDC	21.6950	-157.9803	15	01/1905	12/2004	**99**
KAWAILOA	51-3754	NCDC	21.6167	-158.0833	171	08/1916	06/1984	**68**
OPAEULA 870	51-7150	NCDC	21.5786	-158.0414	1000	10/1949	12/2005	**56**
PUNALUU 884	51-8310	NCDC	21.5833	-157.9000	39	01/1906	04/1971	**65**
PUPUKEA ALAPIO	53-0086	State	21.6483	-158.0336	540	01/1977	12/2001	**24**
WAIMEA 892	51-9593	NCDC	21.6261	-158.0678	330	01/1915	12/2004	**89**

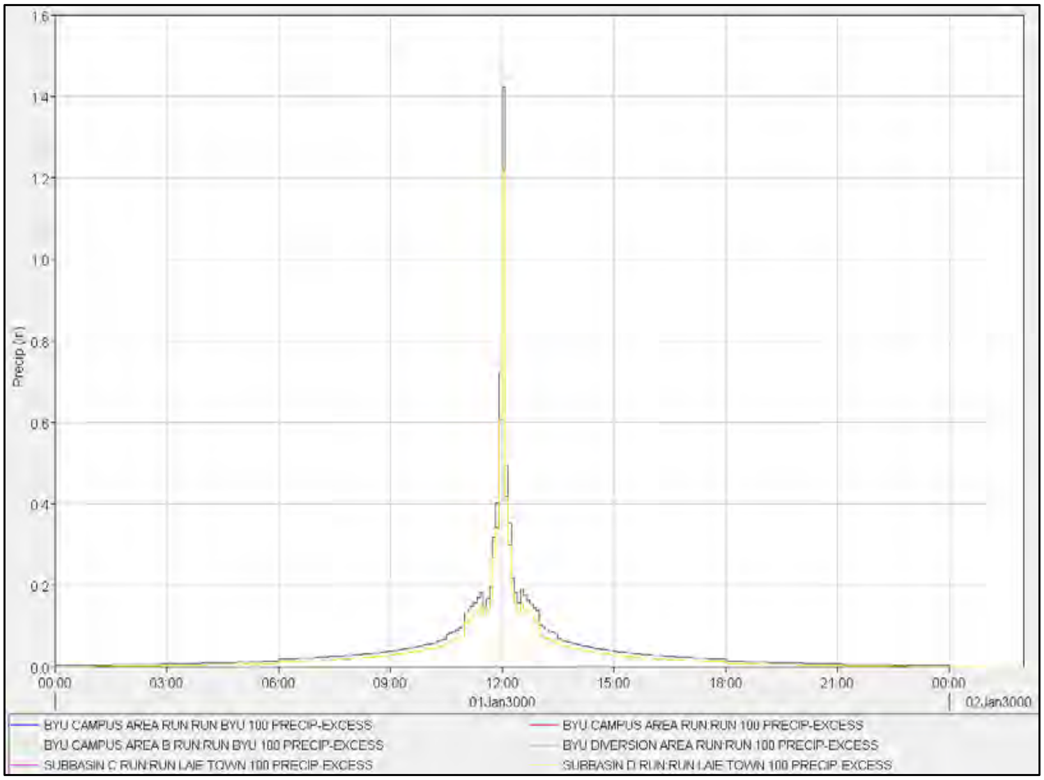

Figure 8: Excess Rainfall Precipitation Example for the 100 YEAR Frequency

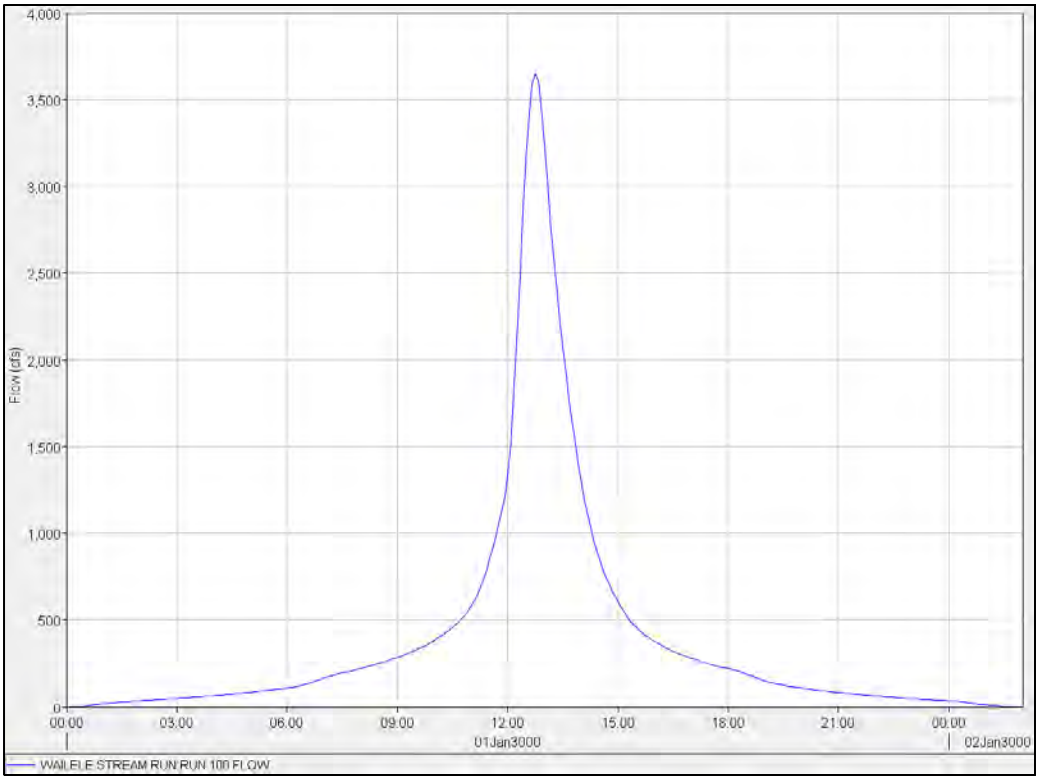

Figure 9: Inflow hydrograph for the Wailele Stream External Boundary Condition for the 100 YEAR Frequency

Hydraulic Analysis

The hydraulic model utilized a total of 11 2D flow areas with various hydraulic computational cells and connections summarized in Table 4. The BYU diversion channel, overflow channel, main flood control channel, cell mesh has been included in Figure 10 and Figure 11 in order to convey resolution. These figures have been included to provide detail for the number of cells required to adequately model each feature. Additionally, the crossing features being the existing Kamehameha Highway Culvert, Proposed 17.25' x 6.8' Culvert Crossing, and the Maloo Bridge Crossing combine in a downstream Mulawi beach area contained within the Lower Beach 2D flow area. This area was handled with care during the cell meshing development in order to establish confidence in the flow combinations of the three crossings. Figure 12 depicts the cell mesh resolution developed in order to provide confidence in hydraulic model output for velocity, water surface elevation, and water surface depths.

Table 4: Summary of 2D Flow Areas used in Hydraulic Model

2D Flow Area Name:	Hydrologic Input:	Number of Cells:	External Boundary Condidtion:
BYU Diversion Area	*Excess Precipitation*	*2,079*	*Hydraulic Connection*
A	*Excess Precipitation*	*449*	*Hydraulic Connection*
B	*Excess Precipitation*	*915*	*Hydraulic Connection*
C	*Excess Precipitation*	*1,007*	*Hydraulic Connection*
Wailele Mauka	*Excess Precipitation*	*7,757*	*Wailele Stream Inflow, Hydraulic Connection*
Subbasin C	*Excess Precipitation*	*3,659*	*Waloo Gulch Inflow, Hydraulic Connection*
Subbasin D	*Excess Precipitation*	*4,952*	*Hydraulic Connection, Stage Hydrograph DS BC*
Upper Beach	*Later Hydraulic Connection*	*592*	*Hydraulic Connection, Stage Hydrograph DS BC*
Middle Beach	*Later Hydraulic Connection*	*693*	*Hydraulic Connection, Stage Hydrograph DS BC*
Lower Beach	*Later Hydraulic Connection*	*1,287*	*Hydraulic Connection, Stage Hydrograph DS BC*
Perimeter 1	*Later Hydraulic Connection*	*171*	*Hydraulic Connection, Stage Hydrograph DS BC*
Total:		*23,561*	*7 External, 7 Internal Boundary Conditions*

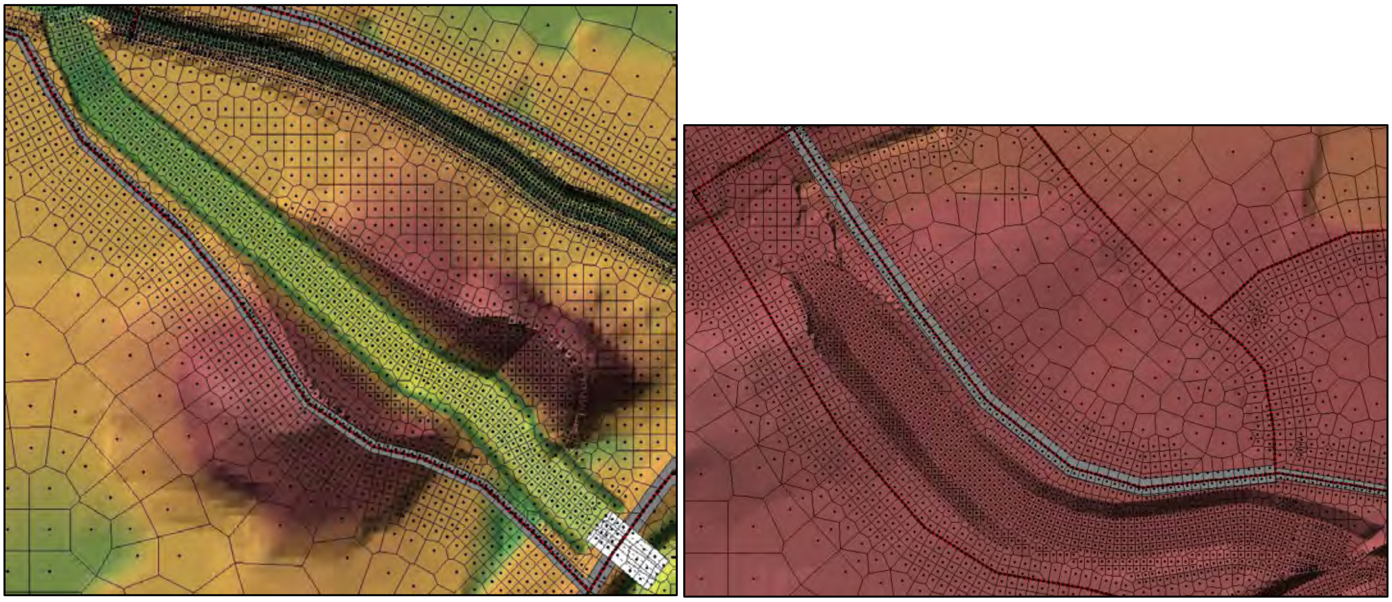

Figure 10: Left Overflow Channel Cell Resolution, Right BYU Diversion Channel Cell Resolution

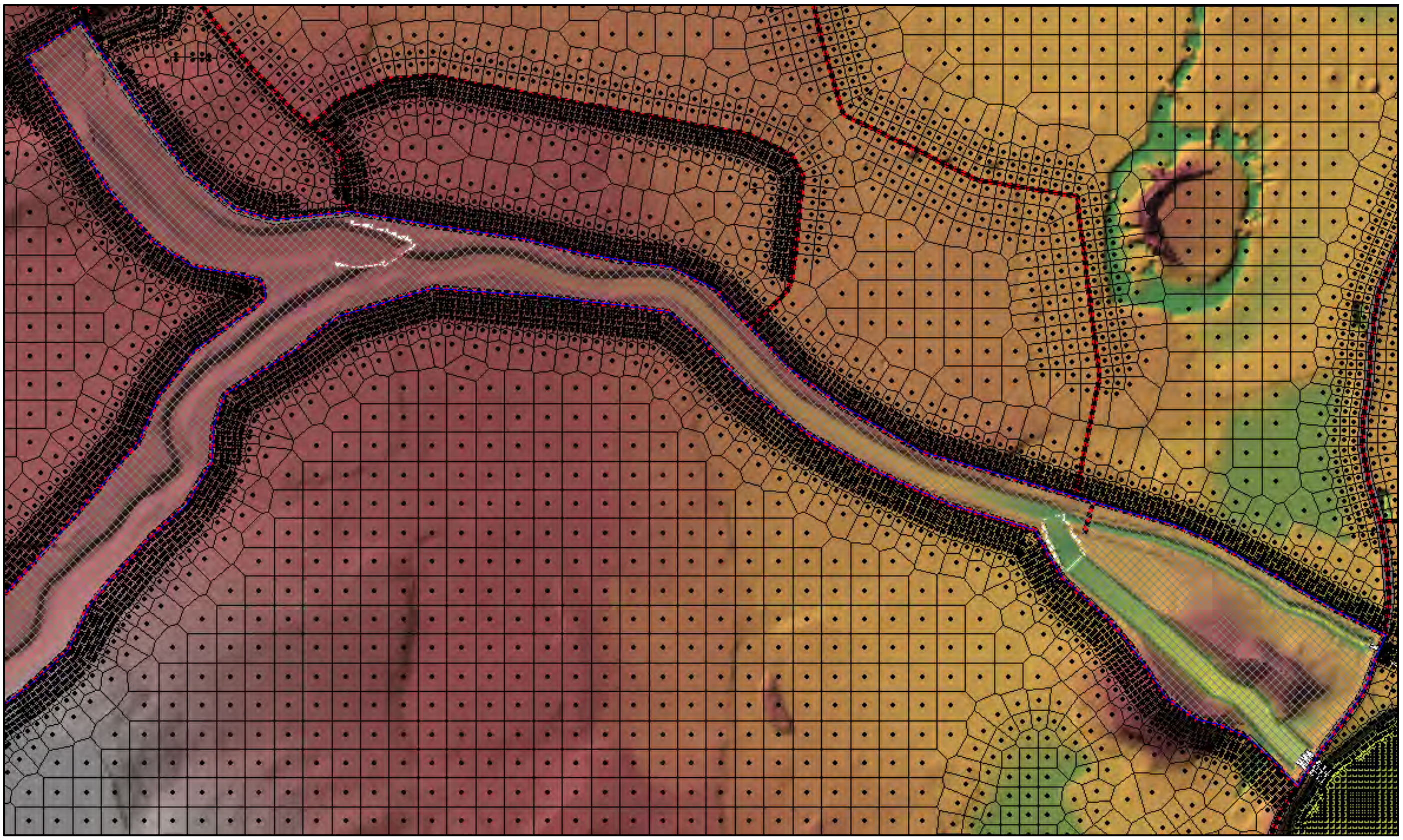

Figure 11: Main Flood Control Channel (Wailele Stream) Cell Mesh Resolution

Figure 12: Downstream Mulawi Cell Mesh Resolution

Hydraulic Crossings

As previously mentioned, there are a total of three existing crossings and one proposed crossing for the TSP. The two proposed alternatives consider the addition of 3 and 2 culverts at the termination point of the overflow channel and the Kamehameha Highway. This crossing proposes culvert at invert elevation 2.0ft-MSL having 17.25' span and 6.8' rise. The three culvert alternative is shown in Figure 13 and the two culvert alternative is shown in Figure 14.

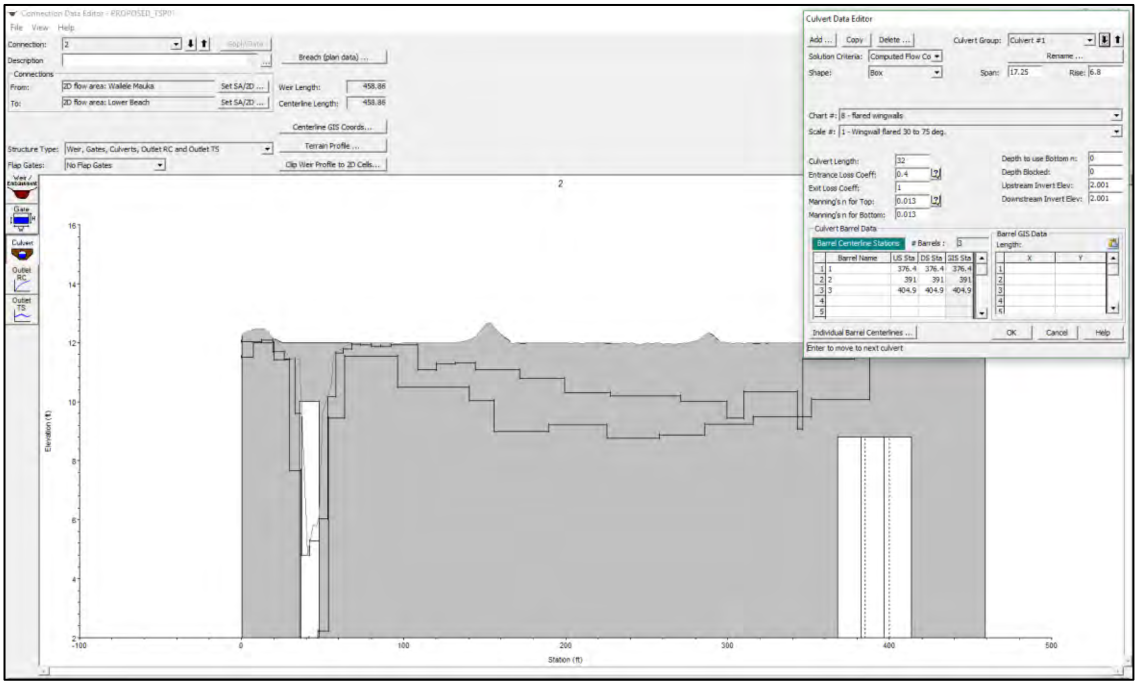

Figure 13: Three Culvert Alternative (TSP01)

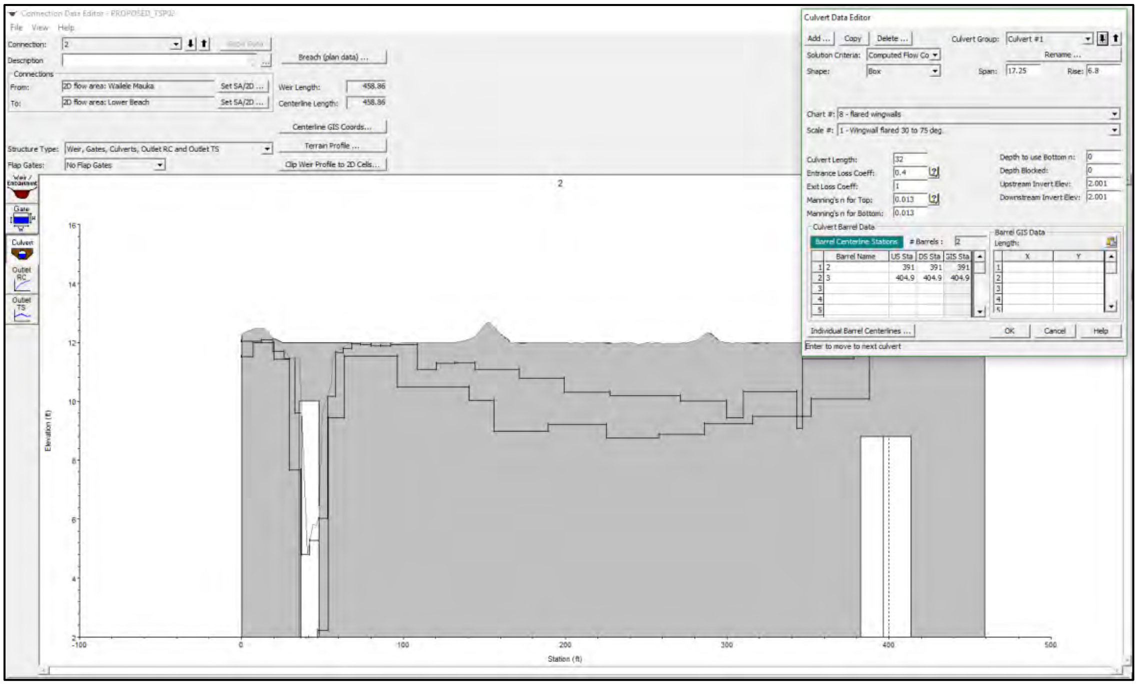

Figure 14: Two Culvert Alternative (TSP02)

Hydraulic Modeling Results

Water Surface Resultant Elevations

The resultant water surface elevations measured at the City of Laie were a result of the three conditions; existing conditions, TSP01 Three Culvert Alternative, and TSP02 Two Culvert Alternative. A summary of comparisons can be found in Table 5.

Table 5: Summary of Water Surface Elevations and Resultant Discharge Reduction

Return Period	Name	Existing Conditions	TSP01: Three Culverts	Reductions, feet/cfs	TSP01: Two Culverts	Reductions, feet/cfs
2 YEAR	Discharge, cfs	919	57	862	57	862
	WSEL ft-MSL	7.57	6.78	0.79	6.78	0.79
5 YEAR	Discharge, cfs	1464	104	1360	104	1360
	WSEL ft-MSL	7.98	7.23	0.75	7.23	0.75
10 YEAR	Discharge, cfs	1873	186	1687	186	1687
	WSEL ft-MSL	8.23	7.48	0.75	7.48	0.75
25 YEAR	Discharge, cfs	2407	357	2050	357	2050
	WSEL ft-MSL	8.55	7.82	0.73	7.82	0.73
50 YEAR	Discharge, cfs	2819	472	2348	472	2348
	WSEL ft-MSL	8.77	8.06	0.71	8.06	0.71
100 YEAR	Discharge, cfs	3227	560	2667	560	2667
	WSEL ft-MSL	8.97	8.24	0.73	8.30	0.67
200 YEAR	Discharge, cfs	3607	638	2968	638	2968
	WSEL ft-MSL	9.14	8.41	0.73	8.51	0.63
500 YEAR	Discharge, cfs	4077	749	3328	749	3328
	WSEL ft-MSL	9.33	8.64	0.68	8.77	0.56

Velocity Results

Below in Figure 15 and Figure 16 are the velocity output results summarizing the overland velocity and inundation results.

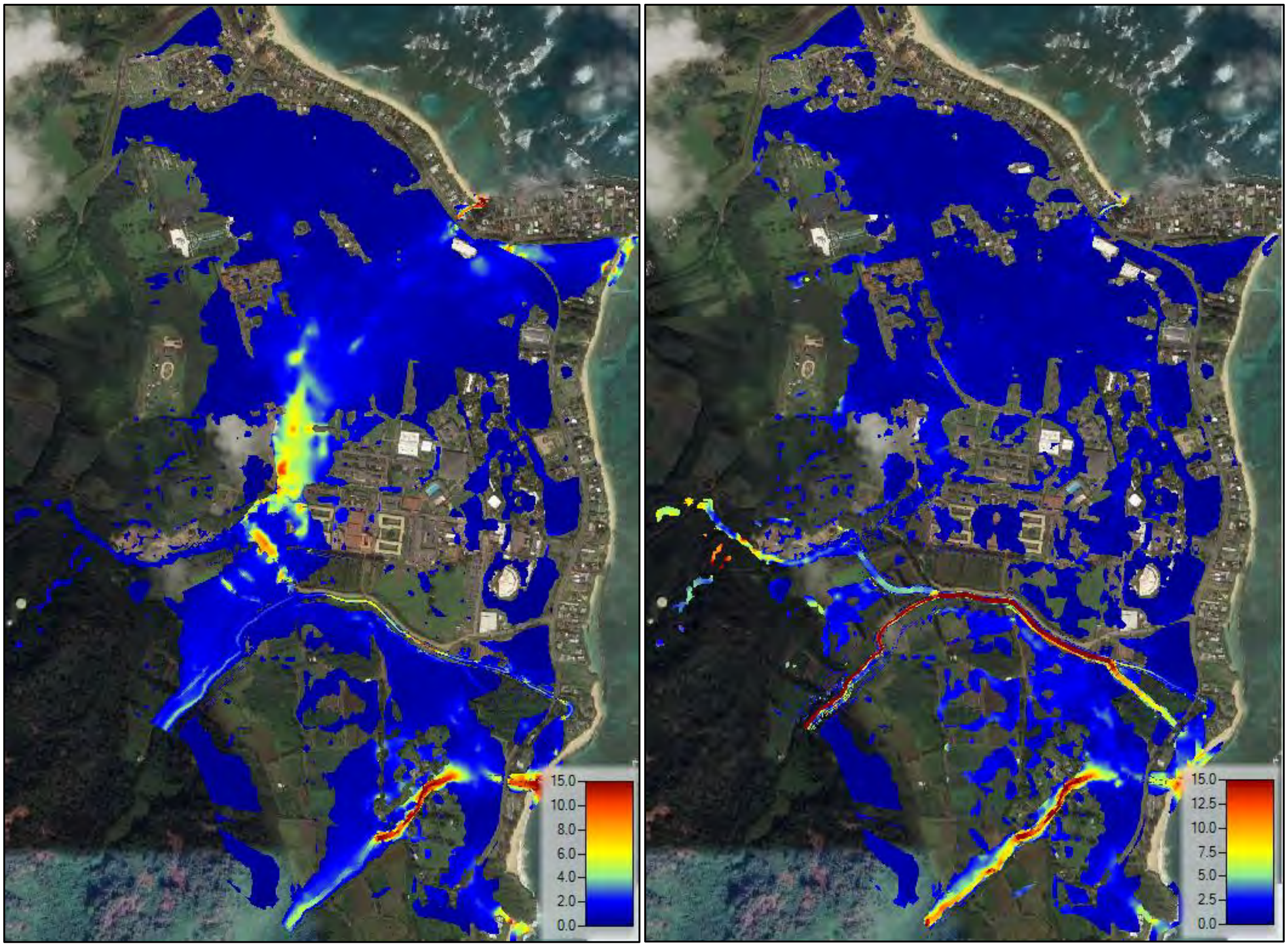

Figure 15: Left Existing Conditions, Right Three Culvert Alternative, 100 YEAR Frequency

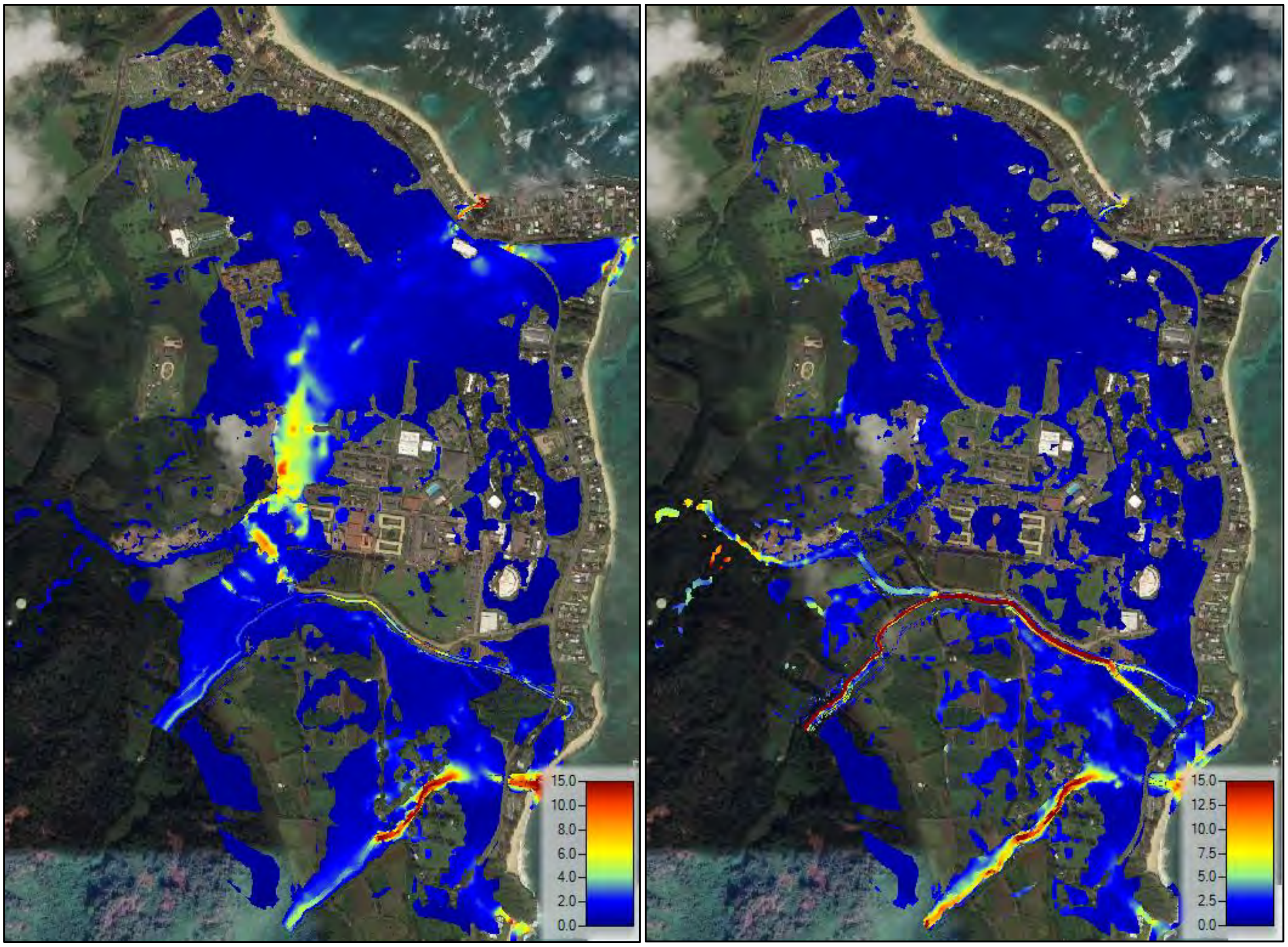

Figure 16: Left Existing Conditions, Right Two Culvert Alternative, 100 YEAR Frequency

Proposed channel erosion countermeasures have been proposed for the proposed alternative which utilizes the max velocity produced from the hydraulic model results. Figure 17 shows a detailed velocity map of the Mulawi area for the 100 Year Frequency. Once the final alternative and design storm for which erosion protection has been determined an energy dissipation feature will be designed.

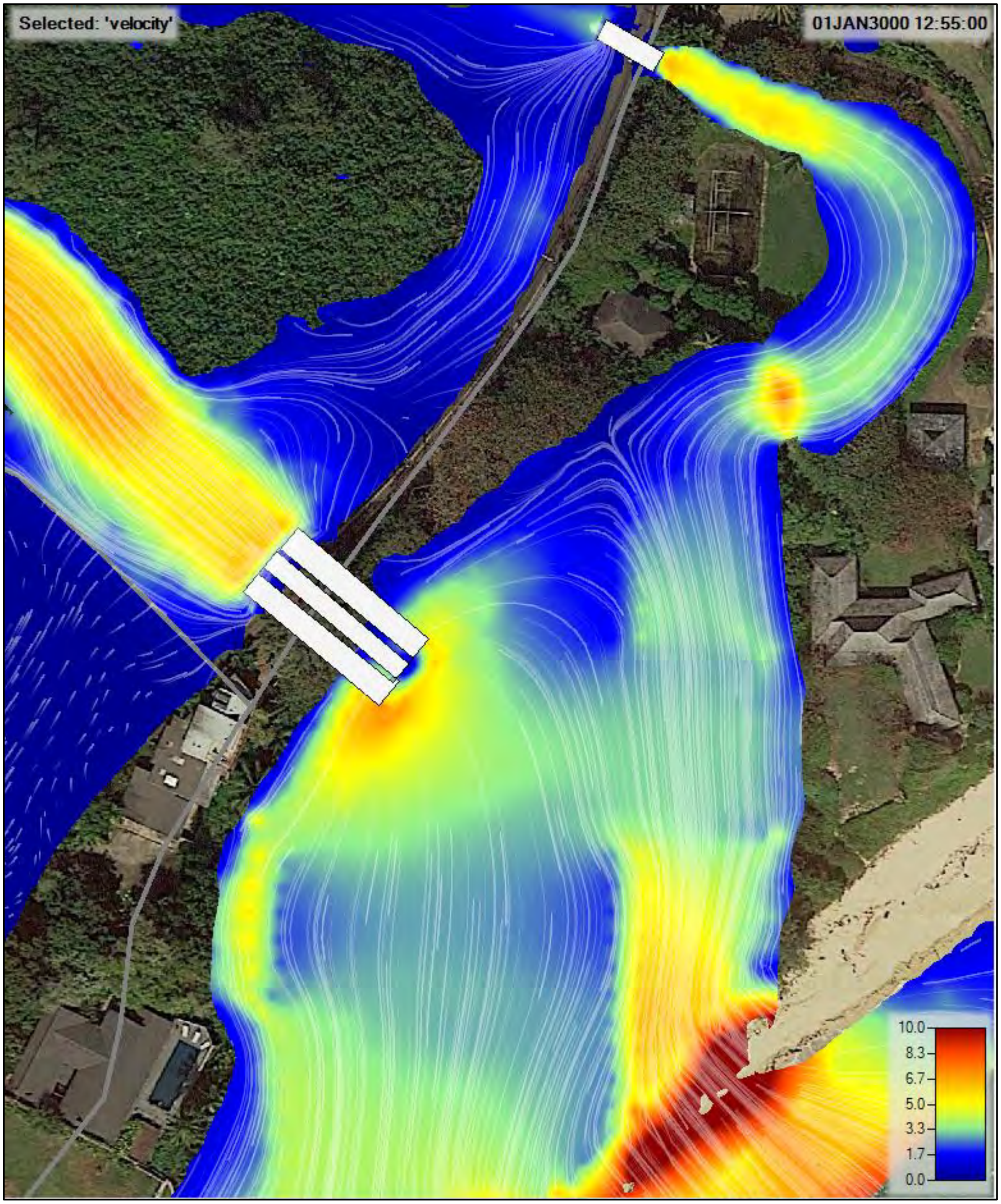

Figure 17: Downstream Muliwai Area Velocity Distribution for Future Design Refinement

DQC Certification Sheet

US Army Corps of Engineers ® Huntington District

Huntington District
US Army Corps of Engineers
502 8th St, Huntington, WV 25701

Wailele Section 205 Flood Damage Reduction: Hydraulic RAS Modeling Study
District Quality Control (DQC) Certification Sheet
100% Review

As the District Quality Control Review submitting review, Andrew Branard (CELRH-EC-GW-W) for the ***HEC-RAS Model*** used in the estimation of the ***Future With and Without Project Conditions*** for the Wailele Section 205 Flood Damage Reduction Project, I certify the following work shown herein was completed using the appropriate USACE guidance or industry standard. I certify the work is based on:

- Appropriate assumptions, methods, procedures, computations, and materials used in the analysis.
- Evaluation of alternative design, if applicable.
- Appropriate data and level of data chosen.
- Reasonable results that meet the customer's needs consistent with law and existing USACE policy.

I certify that the HEC-RAS Model developed for the intent of damage reduction estimation meets the customer requirements shown herein according to the model constituents defined in the following table, with model output for depth, water surface elevation, and grid-based velocity.

Proposed TSP01, Proposed TSP02, and Existing Conditions Geometries
Weir Coefficients for all hydraulic connections are reasonable
The supplied hydrologic rain/runoff DSS records have the correct associated paths.
Resultant inundation mapping is reasonable and appropriate for the intended use.
The project design features are correctly applied according to plans provided.
The error associated with internal hydraulic connections are acceptable.
The culvert crossings have accurately placed invert elevations existing/proposed.
The mesh cell sizes contained in the model existing/proposed are appropriate.
Constituent boundary conditions are appropriate and reasonable.

For items previously designed by others and included as the applied use shown herein, I certify that I have verified the work for adequacy, completeness, and accuracy.

The official data and models preserved with the intent of documentation preservation will be stored in the following directory, found on the Huntington District Water Resources Network Server.

<\\poh-netapp1.poh.ds.usace.army.mil\POH_P\pohpp\CIVIL WORKS PM\Wailele FRM>

Andrew Branard, P.E. CELRH-EC-GW-W
April 2019

BRANARD.ANDREW.R.1514832974 Digitally signed by BRANARD.ANDREW.R.1514832974 Date: 2019.04.30 15:21:43 -04'00'

As the Reviewer/Checker I have performed DQC and concur with the findings of the submitting Engineer for the ***HEC-RAS Model*** used to estimate damage reduction estimates.

Ed Stowasser, P.E. CELRH-DSPC-TS
April 2019

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Appendix F
Historical and Cultural Resources

Appendix F

Archaeological Literature Review and Field Inspection

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Draft

Archaeological Literature Review and Field Inspection for the Wailele Stream Flood Control Project Lāʻie Maloʻo Ahupuaʻa, Koʻolauloa District, Oʻahu TMKs: [1] 5-5-001 and 006

Prepared for
Helber Hastert & Fee, Planners

Prepared by
Nicole Ishihara, B.A.,
David Shideler, M.A.,
and
Hallett H. Hammatt, Ph.D.

Cultural Surveys Hawaiʻi, Inc.
Kailua, Hawaiʻi
(Job Code: LAIE 7)

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Management Summary

Reference	Archaeological Literature Review and Field Inspection for the Wailele Stream Flood Control Project, Lāʻie Maloʻo Ahupuaʻa, Koʻolauloa District, Oʻahu TMKs: [1] 5-5-001 and 006 (Ishihara, Shideler, and Hammatt 2015)
Date	January 2015
Project Number (s)	Cultural Surveys Hawaiʻi Inc. (CSH) Job Code: LAIE 7
Investigation Permit Number	The archaeological monitoring fieldwork was carried out under archaeological permit number 14-04 issued by the Hawaiʻi State Historic Preservation Division/Department of Land and Natural Resources (SHPD)
Project Location	The project is located within the Lāʻie Maloʻo Ahupuaʻa. The project area spans from below Wailele Gulch toward Lāʻie Beach Park, encompassing the lower portions of the Wailele Stream and Kōloa Stream.
Land Jurisdiction	Hawaiʻi Reserves, Inc.
Agencies	State of Hawaiʻi Department of Land and Natural Resources/State Historic Preservation Division (DLNR)
Project Description	The goal of the Wailele Stream Flood Control project is to manage the flood risk in the Wailele Stream watershed, with a focus on reducing flood hazards.
Project Acreage	The Wailele Stream is approximately 5 miles long with a drainage basin that covers 1.52 square miles south of the Brigham Young University (BYU)–Hawaiʻi campus and the Polynesian Cultural Center (PCC).
Historic Preservation Regulatory Context	The proposed project is subject to Hawaiʻi State environmental and historic preservation review legislation (Hawaiʻi Revised Statutes [HRS] §343 and HRS 6E-8/Hawaiʻi Administrative Rules [HAR] §13-275, respectively).
Fieldwork Effort	Fieldwork was conducted on 7 and 14 November 2014 by Nicole Ishihara, B.A. and David Shideler, M.A., under the general supervision of principal investigator Hallett Hammatt, Ph.D.
Recommendations	Based on information and findings gathered from historical documents, previous archaeological reports, and a field inspection detailed in this report, CSH recommends an archaeological inventory survey (AIS) be conducted for the proposed Wailele Stream Flood Control project. Due to the pre- and post-Contact utilization of this area, it is likely subsurface cultural material could be encountered.

Table of Contents

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Section 1 Introduction

1.1 Project Background

At the request of Helber Hastert & Fee, Planners, Cultural Surveys Hawaiʻi Inc. (CSH) conducted an archaeological literature review and field inspection for the proposed Wailele Stream Flood Control project, Lāʻie Maloʻo Ahupuaʻa, Koʻolaupoko District, Oʻahu, TMKs: [1] 5-5-001 and 006. The project area is depicted on a portion of the U.S. Geological Survey (USGS) 7.5-minute topographic map (Figure 1, Figure 2), and tax map plats (Figure 3, Figure 4).

The Wailele Stream is approximately 5 miles long with a drainage basin that covers 1.52 square miles south of the Brigham Young University (BYU)–Hawaiʻi campus and the Polynesian Cultural Center (PCC) complex. The Kahawainui Stream is adjacent to Wailele Stream and located on the northern side of Lāʻie. The Kahawainui Stream Flood project was conducted in 1990 to provide flood protection to the northern side of Lāʻie town. However, the southern side of the town is vulnerable to flooding via Wailele Stream. The goal of the Wailele Flood Control project is to manage the flood risk in the Wailele Stream watershed with a focus on reducing flood hazards.

1.2 Environmental Setting

The project area is situated along the coastal plain of the north windward coast of Oʻahu in the town of Lāʻie at an elevation of 5-10 ft AMSL (above mean sea level). The project area receives 60-80 inches of rain annually, however, the rainfall gradient increases rapidly to nearly 150 inches near the Koʻolau summit (Juvik and Juvik 1998). The northeast margin of the Koʻolau Mountain Range is deeply dissected by numerous narrow and small gulches.

1.2.1 Natural Environment

Soils within the project area consist of Beaches (BS); Coral outcrop (CR); Haleiwa silty clay, 0 to 2% slopes (HeA); Mokuleia loam (Ms); Kawaihapai clay loam, 0 to 2% slopes (KIA); and Jaucas sand, 0 to 15% slopes (JaC) (Foote et al. 1972). The various soil types are illustrated in Figure 5.

Beaches (BS) occur on all Hawaiian Islands. Sandy, gravelly, and/or cobbly areas are washed and rewashed by ocean waves on shore (Foote et al. 1972:28). Coral and seashells are usually scattered about. Beaches have no value in farming and are highly suitable for recreation and resort development.

Coral Outcrop are areas of coral or cemented calcareous sand, formed in shallow ocean water during the time the ocean sand was at a higher level. Vegetation consists of *kiawe*, *koa haole*, and fingergrass (Foote et al. 1972).

Haleiwa silty clay, 0 to 2% slopes (HeA), consists of well-drained soils on large alluvial fans or as long, narrow areas in drainage ways along coastal plains on Oʻahu and Molokaʻi (Foote et al. 1972:33). These particular soils are used for sugar cane, truck crops, and pasture. Natural vegetation consists of *koa haole* (*Leucaena leucocephala*), lantana, guava, Christmas berry, bermudagrass, and fingergrass.

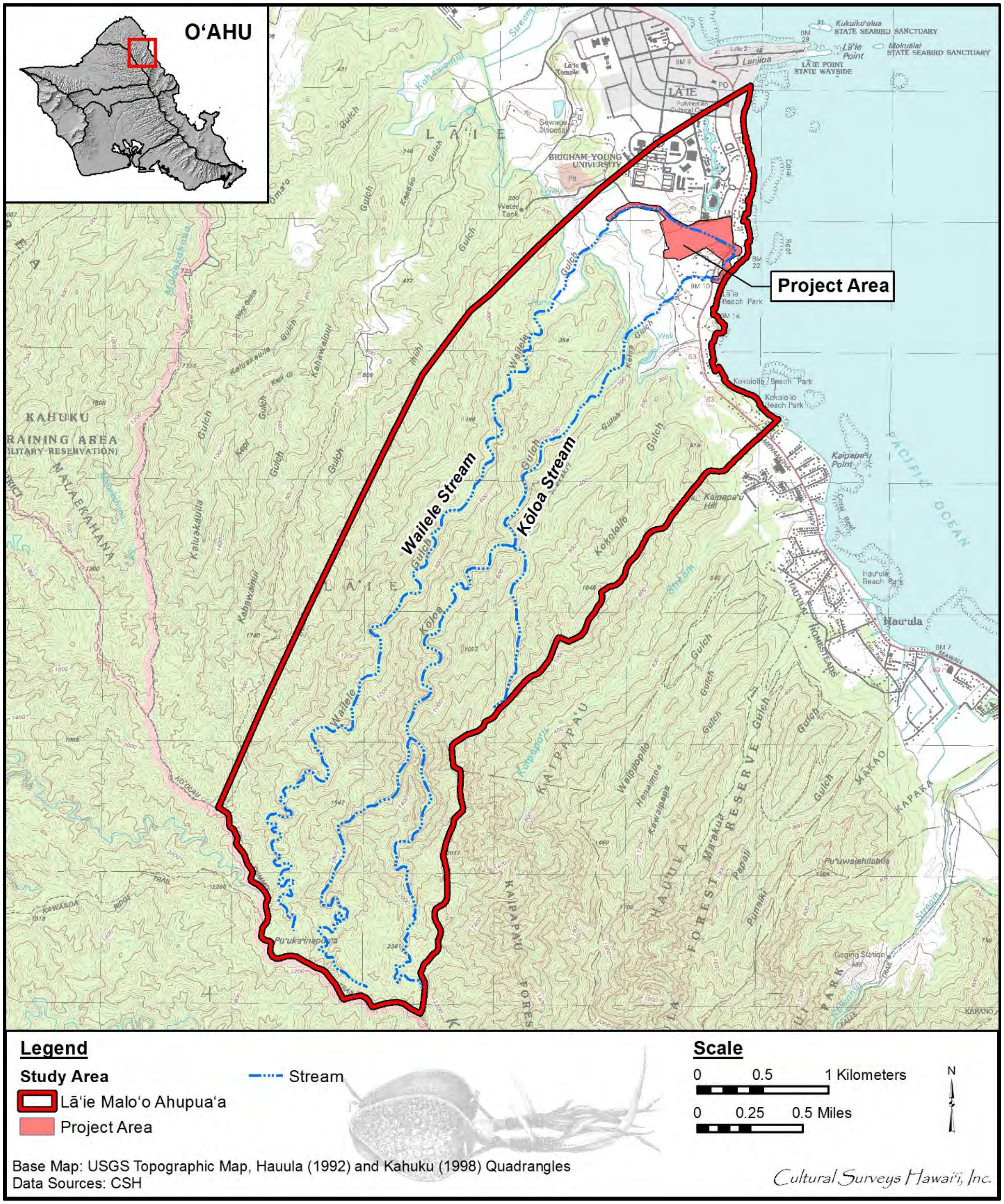

Figure 1. 1992 Hauula and 1998 Kahuku USGS Topographic Quadrangles depicting project area

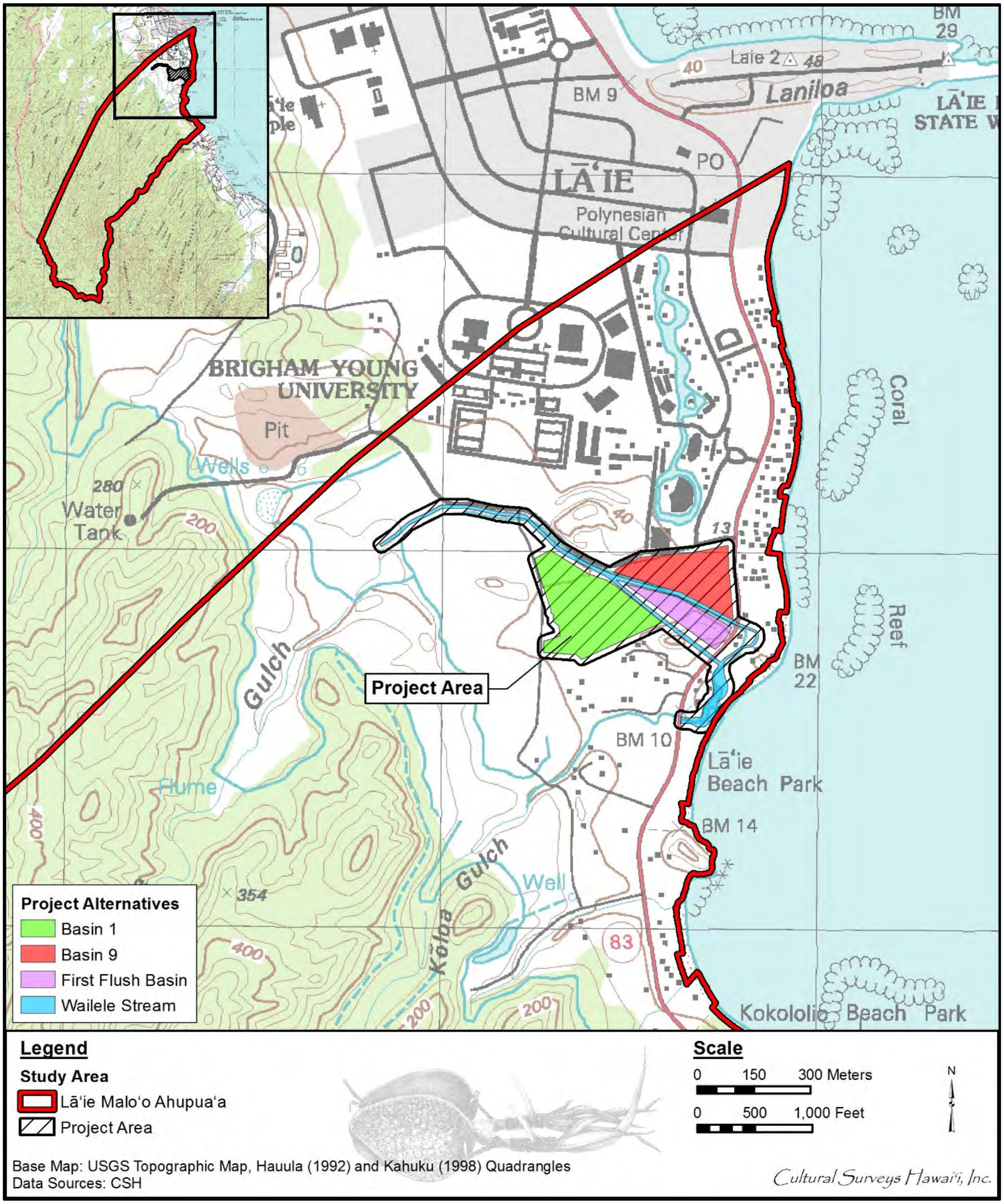

Figure 2. Portion of 1992 Hauula and 1998 Kahuku USGS Topographic Quadrangles depicting project area with project alternatives

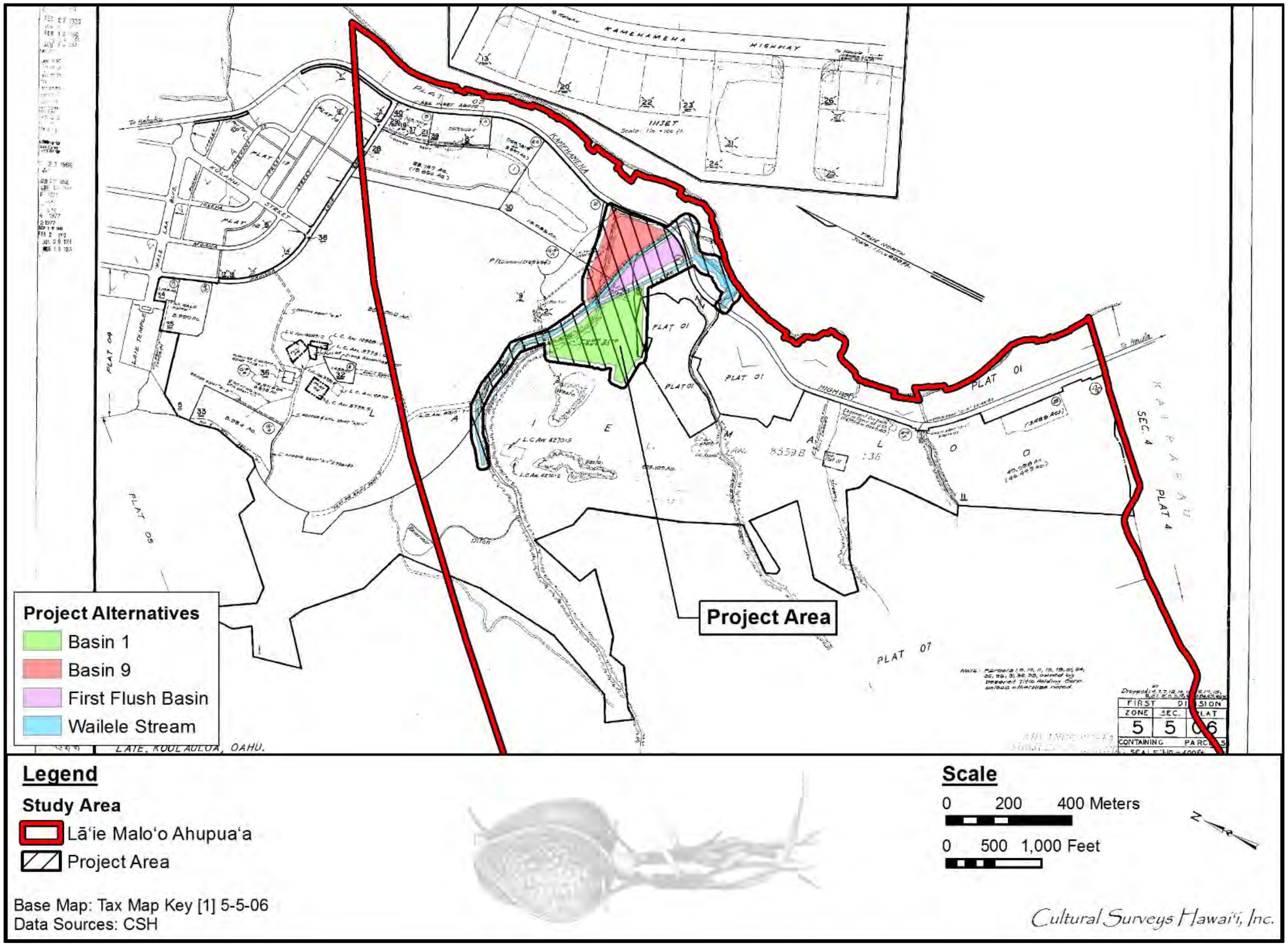

Figure 3. Tax Map Key (TMK) [1] 5-5-006 depicting project area with project alternatives (Hawai‘i TMK Service 2014)

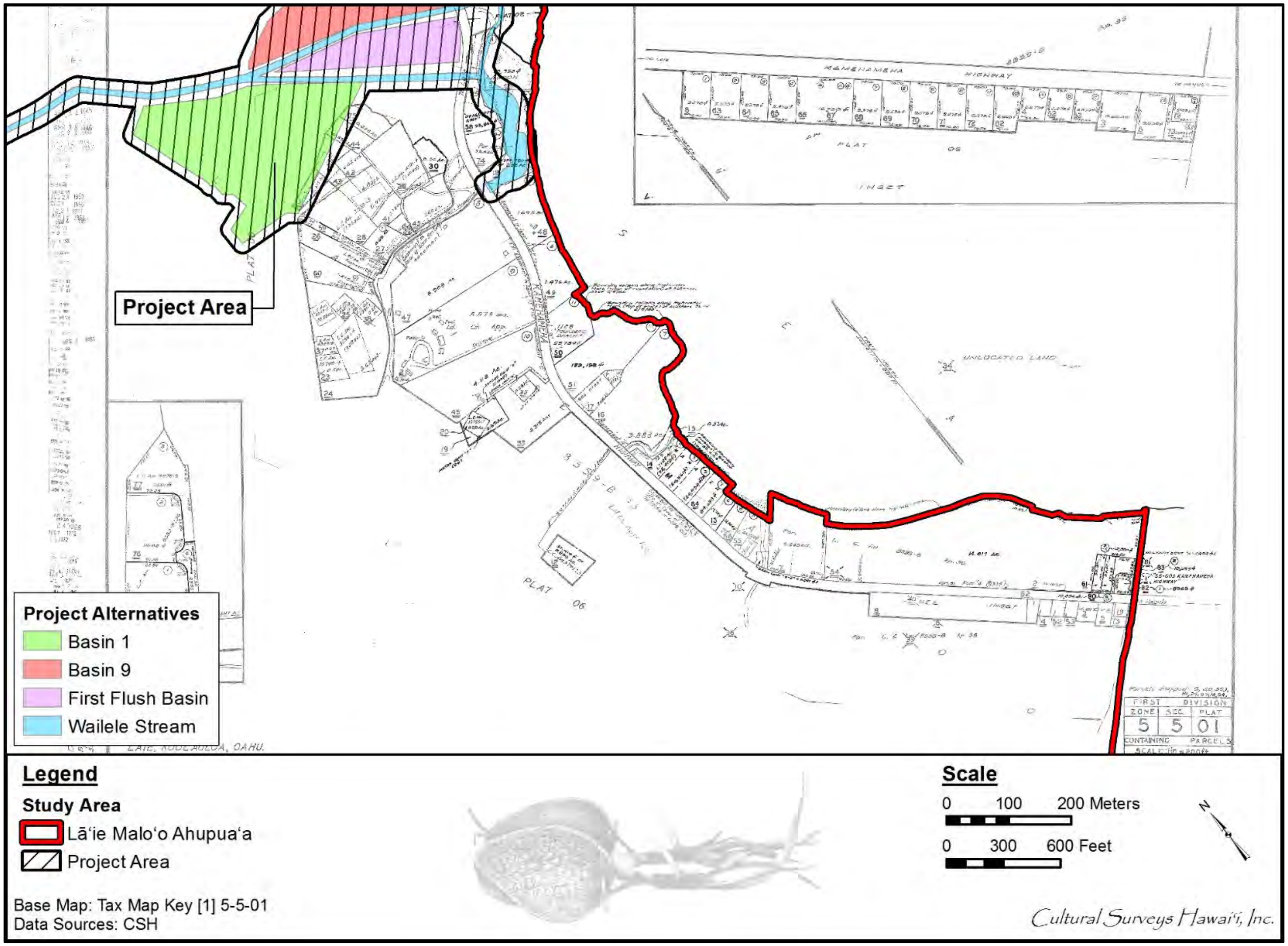

Figure 4. TMK: [1] 5-5-001 depicting project area with project alternatives (Hawai‘i TMK Service 2014)

The Mokuleia Series consists of well-drained soils and can be found along coastal plains (Foote et al. 1972:95). These soils have formed in recent alluvium deposited over coral and elevations ranges from sea level to 100 ft. The Mokuleia Series are used for sugar cane, truck crops, and pasture. The natural vegetation consists of *kiawe*, klu, and *koa haole*. Bermudagrass can be found in drier areas while napiergrass, guava, and joee are in the wetter areas.

Kawaihapai clay loam, 0 to 2% slopes (KIA) consists of well-drained soils in drainage ways and alluvial fans on the coastal plains of O‘ahu and Moloka‘i (Foote et al. 1972:64). This particular soil is found on smooth slopes. Natural vegetation consists of guava, *honohono* (*Commelina diffusa*), *kukui* (*Aleurites moluccana*), and *hala* (*Pandanus odortissimu*s).

The Jaucas Series consists of excessively drained, calcerous soils that occur on narrow strips on coastal plains adjacent to the ocean (Foot et al. 1972:48). This particular type of soil can be found on all the Hawaiian Islands. The Jaucas Series is the sediment most likely to contain Native Hawaiian burials. The workability for Jaucas sand, 0 to 15% slopes consists of loose soil and lacks stability making it ideal for burials. Other uses for this particular type of soil include pasture, sugar cane, truck crops, and urban development. Figure 5 shows soils within the project area.

1.2.2 Built Environment

The project area encompasses a large portion of cultivated land, residences, private roads, and Kamehameha Highway. Various project alternatives including cutoff berms, diversion channels, flood proofing, flood walls, levees, and overflows can be found within the proposed project area.

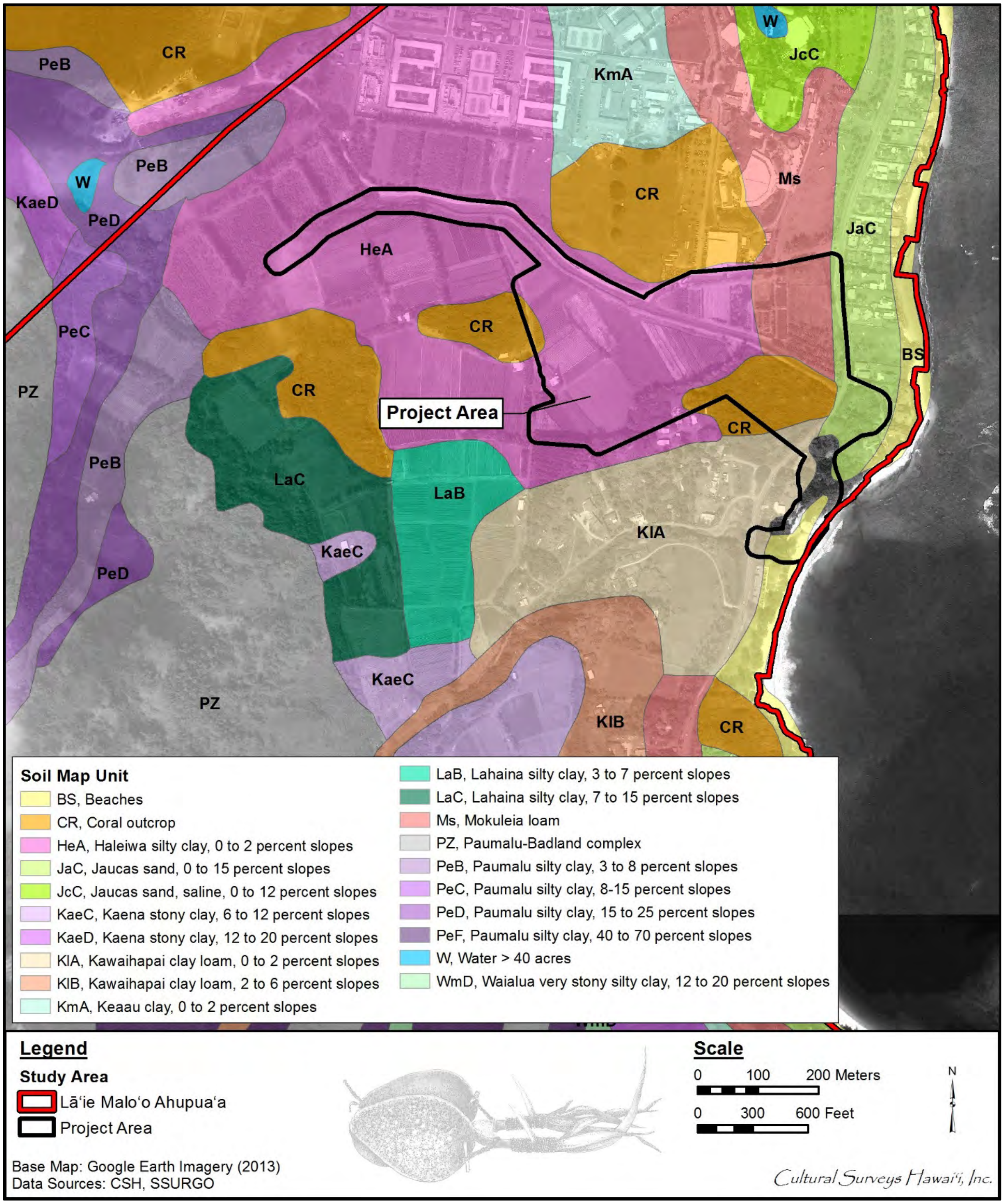

Figure 5. Google Earth Imagery (2013) with project area and soil survey overlay by Foote et al. 1972

Section 2 Methods

2.1 Field Methods

The fieldwork component of this project was carried out under archaeological permit number 14-04, issued by the Hawaiʻi State Historic Preservation Division/Department of Land and Natural Resources (SHPD), per Hawaiʻi Administrative Rules (HAR) §13-282. Fieldwork was conducted on 7 and 14 November 2014 by CSH cultural researcher Nicole Ishihara, B.A. and archaeologist and CSH office manager David Shideler, M.A. under the general supervision of principal investigator Hallett H. Hammatt, Ph.D. The purpose of the field inspection was to identify any surface archaeological features and to investigate and assess the potential for impact to such sites. Fieldwork consisted of the systematic traverse of the study area and photographic documentation of the landscape and any above ground structures. This work required approximately 2 person-days to complete.

2.2 Archival Research

Background research included a review of previous archaeological studies on file at the State Historic Preservation Division (SHPD); review of documents at Hamilton Library at the University of Hawaiʻi at Mānoa, the Hawaiʻi State Archives, the Mission Houses Museum Library, the Hawaiʻi Public Library, and the Bishop Museum Archives; viewing of historic photographs at the Hawaiʻi State Archives and the Bishop Museum Archives; and viewing of historic maps at the Survey Office of the Department of Land and Natural Resources. Historic maps and photographs from the CSH library were also consulted. In addition, Māhele records were examined from the Waihona ʻAina Database (Waihona ʻAina 2000) and the Office of Hawaiian Affairs' Papakilo Database (Office of Hawaiian Affairs 2013).

Section 3 Background Research

Oʻahu was divided into six *moku* (district)—Kona, ʻEwa, Waiʻanae, Waialua, Koʻolauloa, and Koʻolaupoko—that were further divided into 86 *ahupuaʻa* (land division) (Kameʻeleihiwa 1992:330). These lands, in turn, were further divided as private property during the Māhele of 1848; modern maps and land boundaries still generally follow the ancient system of land division. The project area lies in the district of Koʻolauloa within the *ahupuaʻa* of Lāʻie Maloʻo.

3.1 Traditional and Historical Background

Lāʻie Maloʻo Ahupuaʻa extends from the ocean to the crest of the Koʻolau Mountains and is bound by Lāʻie Wai Ahupuaʻa to the north and Kaipapaʻu Ahupuaʻa to the south. The *ahupuaʻa* was named after the legendary Hawaiian beauty, Lāʻieikawai, whose name means "Lāʻie of the water" (Pukui et al. 1974:127; see Section 3.2.1 for an expanded version of the story). The word *lāʻie* is a shortened version of two Hawaiian words, *lau ʻie*, the name of the *ʻie* (*Freycinetia arborea*) vine leaf, which was a symbol of royalty. The word *maloʻo* is defined as dry, together meaning "dry Lāʻie" (Pukui et al. 1974:128). Long-time *kamaʻāina* (native-born) residents have a different interpretation of the name as "day of reckoning," an association of the tradition that Lāʻie was a *puʻuhonua* (place of refuge) for *kapu* (taboo) breakers (Faris 1929:127; Maly and Rosendahl 1995:12).

3.1.1 Coastal Lāʻie

The following section on coastal place names is summarized from John Clark's (1977:138-146) *Beaches of Oahu*, unless otherwise noted.

The coastal section of Lāʻie Maloʻo stretches from just south of Lāʻie Point (also known as Laniloa, Figure 6) to the end of Kokololio Beach to the south. Kalanai Point is also sometimes referred to as Cookes' Point, named after a prominent family who leased a country house in this area in the early 1900s. Near the point, there was once a fishing *koʻa*, or shrine (Site 274; McAllister 1933:156). At this shrine, the fishermen offered *kala* (surgeonfish and unicornfish; *Naso* spp.) and *enenue* (pilot fish; *Kyphosus* spp.). On the south side of the point is a coral reef called Luaʻawa ("*awa* fish hole"), a known fishing spot for the *awa* (milkfish; *Chanos chanos*).

Laniloa Point (or Lāʻie Point) is a protrusion of rock separating Lāʻie Beach to the south from Laniloa Beach to the north. Laniloa literally means "tall, majesty" and was named for two *moʻo*, lizard-like creatures, which were slain by the demi-hero Kana and his brother Nīheu (see Section 3.2.3 for an expanded version of the story). Laniloa is also the name of a supernatural dog, who was killed by the Hawaiian pig-god, Kamapuaʻa.

On the south side of the point is a reef called ʻŌnini ("slight breeze"). A plane, sent up to observe the 1957 tsunami, once crashed on this reef. The beach in front of this reef is sometimes called Clissold Beach, after the former director of Zion Securities, who had a beach home there (Clark 2002:49). To the south of ʻŌnini, are two shallow pockets of sand, good for swimming.

Continuing to the south was a reef offshore from Laniloa Beach called Pahuʻula, meaning "lobster box." Live lobsters were kept in traps in a section of this reef that had three protruding rocks, forming a natural "box." The beach from Pahaʻula to the southern end was once called Scott's Beach, for Alvin Scott, who had a large house near the shore at the mouth of Wailele

Figure 6. Photo of Lā‘ie Point (foreground) with off-shore islands ca. 2009 (CSH 2009)

Stream. On this beach, McAllister (1933:158) recorded the meager remains of a fishing shrine called Kaihuku‘una (Site 285), where fishermen once left offerings of the *‘anae* (mullet, *Mugil cephalus*). Between Kēhuku‘una Point and Pali Kilo I‘a Point, the beach area was known to fishermen as Lā‘ie Malo‘o Beach (Lā‘ie Beach Park), but since around 1955 it has been called Pounders Beach for the off-shore break that makes these good waters for body surfing. In the historic period, sections of the beach have also been called Pahumoa, in honor of the Hawaiian fisherman who lived near Kōloa Stream and was generous with his catch, and Kikila (Hawaiian for “Cecil”), named for the home of Mr. Cecil Brown, who had a large estate in the area in the late 1800s.

Both Kēhuku‘una Point and Pali Kilo I‘a Point (“fish watchers’ cliff”) were places where spotters would stand and direct off-shore fishermen to schools of fish. The pier at Lā‘ie Landing, built in 1887 and used to load sugar and other crops on steamships headed for Honolulu, was also located between these two points. According to Clark (1977:144), the fishermen went to the waters off Pounders Beach for *‘ō‘io* (bonefish; *Albula vulpes*), *pāpio* (crevally; *Carangidae*), and *moi* (threadfish; *Polydactylus sexfilis*).

The beach from Pali Kilo I‘a to the border with Kaipapa‘u Ahupua‘a is called Kokololio Beach, named for a gusty wind. Although Pukui et al. (1974:116) translate this name simply as “gusty,” Clark (1977) believes this is a post-Contact name meaning “creeping horse.”

> Kokololio . . . takes its name from a peculiar wind that blows from the mountains in this region. Rather than blowing steadily, this wind rushes down upon the shoreline in very sharp, vigorous gusts. This characteristic reminded the Hawaiians of a high-spirited, prankish horse, one that would amble along at a walk and then suddenly run off at a gallop, much to the consternation of his rider. They named the wind Kokololio ‘creeping horse,’ because of the humorous relationship they noted between such a horse and the changeable, undependable, unpredictable wind. [Clark 1977:145]

The northern section of Kokololio Beach is sometimes called Mahakea Beach, named for the Hawaiian man who had a Land Commission Award (LCA) in this area. The southern section is called Kakela Beach, for the Castle family (Kakela is Hawaiian for Castle), who had a large estate in this area. They had many statues on their estate, including a famous one called “La Carita” of a woman and two children. Based on this, a surfing spot off the beach was called “Statues.” The dunes near this statue was called Haleweke; in later years the area was simply called “The Dunes.” There are two coral reefs off this beach, Papa‘a‘ula (“lobster enclosure”), near Pali Kilo I‘a Point, and an unnamed reef extending from Haleweke to the south end of the beach (Clark 1977:145).

3.1.2 Inland Lā‘ie

Place name translations presented without attribution in this subsection on inland areas are from *Place Names of Hawaii* (Pukui et al. 1974), unless indicated otherwise.

The *ahupua‘a* is divided into two sections, Lā‘ie Malo‘o (“dry Lā‘ie”) on the south side and Lā‘ie Wai (“wet Lā‘ie”) on the north (Pukui et al. 1974:128). The dividing line extends from Laniloa Point on the coast to the Ko‘olau Mountains. Lā‘ie Malo‘o Ahupua‘a is drained by a number of perennial and non-perennial streams: Kahawainui, Wailele (“waterfall”), and Kōloa. Laniloa Stream begins *mauka* (towards the mountain) of Brigham Young University then disappears. The non-perennial stream begins again on the *makai* (toward the ocean) facing portion of Brigham Young University before draining at Laniloa Beach, suggesting the stream traverses below the school.

From south to north, the gulches extending from the uplands to the sea are Kokololio (“gusty”); ‘A‘akaki‘i; Kōloa (“tall sugarcane” according to Pukui et al. 1974; “wild duck,” according to Handy and Handy 1972:461), also called Lā‘iemalo‘o in the lower reaches; and Wailele.

Lā‘ieloa Stream is so short it is not usually pictured or labeled on most maps. It seems to originate not from the uplands but from the swampland that once covered the area adjacent to and *mauka* of Kamehameha Highway.

Only a few *pu‘u* (peaks) are labeled on historic maps. Kaipapa‘u (“shallow sea”) is located on the Kaipapa‘u–Lā‘ie border. These may not be traditional names, but instead may be the names of triangulation stations used by early surveyors. At the highest point of the *ahupua‘a*, along the *mauka* boundary at the Ko‘olau Mountain Range, is one peak called Pu‘u Ka‘inapua‘a (“pig procession hill”).

3.2 *Mo‘olelo* (Story)

Hawaiian traditions describe the whole region as an agriculturally rich land including cultivation of taro, sugar cane, bananas, and sweet potatoes, but tend to focus on the sea, and particularly the migratory mullet that came in great numbers to Lā‘ie Bay.

3.2.1 The Romanace of Lā‘ieikawai

Lā‘ie is named after the *mo‘olelo* (story, myth) of Lā‘ieikawai, the story of twin girls from the *ahupua‘a*, raised separately, who later had entangled marriages (Beckwith 1970:526–528; Kalākaua 1990:457–480; Paki 1972:52). Mary Kawena Pukui (1983) associates the poetical saying, *Lā‘ie i ka ‘ēheu o na manu* (“Lā‘ie, borne of the wings of birds”), with this *mo‘olelo* of the twin girls. Paki (1972:52) places this story at the site of what is now the Laie Hawaii Temple of the Church of Jesus Christ of Latter-day Saints.

The romance of the beautiful Hawaiian twins Lā‘ieikawai and Lā‘ielohelohe is closely related to Wai‘āpuka, a pond or spring with an underground cavern on the Lā‘ie side of the Mālaekahana-Lā‘ie border:

> The romance of Laie-i-ka-wai (Laie in the water) is the story of a high tapu chiefess concealed at birth in a cave reached by diving through a pool of water and later reared under tapu in an earthly paradise prepared for her in Paliuli in the uplands of Puna by her mo‘o guardian Waka, who hopes to gain wealth and position by arranging a marriage for her to some high chief. An impostor steps in on the eve of marriage and she is abandoned by Waka and her twin sister substituted in her place. Through a group of guardian girls, the abandoned sisters of a rejected suitor who has tried to use their kupua [supernatural] powers to win the chiefess and has then attempted to storm her tapu house by force, she wins a very high tapu chief from the heavens as a husband, her foes are punished, and she herself goes to dwell in the heavens with her husband. He proves unfaithful, his parents cast him out, and his wife joins her sister and is worshiped today as a goddess. [Beckwith 1970:526]

This pool was still intact in 1885, when a traveling party described it:

> Entering the district of Koʻolauloa, and approaching the coast over a broad stretch of grassy meadow but slightly above the level of the ocean, our party was suddenly brought to a halt beside a pool of clear water, nearly round, and perhaps a hundred feet in diameter. The surface of the pool was ten or twelve feet below the level of the surrounding plain, and its even banks of solid rock dropped almost perpendicularly into water of unknown depth. The volume of the pool is affected neither by rain nor drought, and the native belief is that it is fed by springs at the bottom, and has a subterranean drainage to the ocean, some two or three miles distant.
>
> All of them (the legends) speak of a cavern somewhere beyond the walls of the pool, and to be reached only by diving into the water and finding the narrow passage leading up into it.
>
> An old native plunged into the pool. Swimming to the northern wall, he clung for a moment to a slight projection, and then disappeared. Three or four minutes elapsed when the salutation of aloha greeted us from the opposite wall, and the next moment a pair of black eyes were seen glistening through a small opening into the cavern about four feet above the surface of the water. The swimmer then returned to the pool by the passage through which he had left it.
>
> To the many questions with which he was asked the old man returned but brief answers on his return, and when importuned to explain the method of his entrance to the cavern, that the secret might not be lost, he pointed significantly to the sea, and declared that there would be found the bodies of those who sought to solve the mystery of the passage and failed. [Dagget 1888 in Kalākaua 1990:455–480]

McAllister was guided to Waiʻāpuka pond during his archaeological survey of Oʻahu in the early 1930s for the Bishop Museum. Its location can be clearly seen on modern topographic maps. McAllister described its importance to the Hawaiians thus:

> Waiapuka is made famous by the legend of Laieikawai. Without guidance it is difficult to find for it is hidden from sight even from the surrounding elevations or from the tops of the highest pines which line the road. The pool is oval in shape, measuring about 30 ft. by 60 ft. with the water about 10 ft. below the level of the surrounding plain. Tides are said to affect the pool. On the Laie side is a small crevice in the rock, which is said to open into the cavern in which Laieikawai was hidden. Natives of the region remember when it was possible to swim through an underwater entrance, and it is said that the chamber could accommodate three or four people. Within the last 15 years silt has filled the pool, and it is no longer possible to enter the hidden chamber. The pool is significant in the minds of the Hawaiians because it was here that Waka hid Laieikawai until she reached maturity. [McAllister 1933:156–157]

The *moʻolelo* of Lāʻieikawai was printed in the Hawaiian language newspaper *Ka Hiwahiwa o Paliuli*, 11 April 1863 and later translated by Martha Beckwith (1918). In this *moʻolelo* the chief Kahauokapaka told his wife Mālaekahana that if their first-born child was a boy, it would live and all subsequent children would be raised as their children, but if the first-born was a female, it should be killed and all females thereafter, until a boy was born. Mālaekahana bore five daughters in succession and each time her husband ordered the baby girl to be killed. During her sixth pregnancy, Mālaekahana consulted the priest Waka, asking how she could save the next child. He told her to suggest to her husband to go out fishing when her labor pains began and to bear the child in secret. She followed the priest's advice, and when her husband was away, bore not one female child, but twins, and gave them into the care of the priest and his wife, Kapukaihaoa, to be raised. They hid the child Lāʻieikawai in the pool of Waiʻāpuka, and the second girl, Lāʻielohelohe in the uplands of Wahiawā:

> When Waka and Kapukaihaoa had taken their foster children away, Waka said to Kapukaihaoa, 'How shall we hide our foster children from Kahauokapaka?'
>
> Said the priest, 'You had better hide your foster child in the water hole of Waiapuka; a cave is there which no one knows about, and it will be my business to seek a place of protection for my foster child.'
>
> Waka took Laieikawai where Kapukaihaoa had directed, and there she kept Laieikawai hidden until she was come to maturity.
>
> Now, Kapukaihaoa took Laielohelohe to the uplands of Wahiawa, to the place called Kukaniloko.
>
> All the days that Laieikawai was at Waiapuka a rainbow arch was there constantly, in rain or calm, yet no one understood the nature of this rainbow, but such signs as attend a chief were always present wherever the twins were guarded. [Beckwith 1918:64–65]

3.2.2 Manōnihokahi, the One-Toothed Shark

The *moʻolelo* of Manōnihokahi ("shark with one tooth"), according to Rice (1977:122, 124), takes place in Lāʻie and Mālaekahana Ahupuaʻa. In this story, Manōnihokahi would often pass through a tunnel or water hole in Lāʻie into the ocean in his shark form to kill lone fishermen. During McAllister's archaeological survey in the 1930s, the general location of this tunnel was pointed out to him (Site 279; McAllister 1933:157).

Once back in his mortal form, Manōnihokahi's deeds were discovered and he was put to death:

> Near the water hole in Mālaekahana, between Laʻie and Kahuku, lived a man called Mano-niho-kahi ('Shark-with-one-tooth'), who was possessed of the power to turn himself into a shark. Mano-niho-kahi appeared as other men except that he always wore a kapa cloth [bark cloth] which concealed the shark's mouth in his back. Whenever he saw women going to the sea to fish or to get limu (edible seaweed), he would call out, 'Are you going into the sea to fish?' Upon hearing that they were, he would hasten in a roundabout way to reach the sea, where he would come upon them and, biting them with his one shark's tooth, kill them. This happened many times. Many women were killed by Mano-niho-kahi. At last the chief of the region became alarmed and ordered all the people to gather together on the plain. Standing with his kahuna [priest], the chief commanded all the people to disrobe. All obeyed but Mano-niho-kahi. So his kapa was dragged off and there on his back was seen

> the shark's mouth. He was put to death at once and there were no more deaths among the women. [Rice 1977:124]

Pukui (as cited in Sterling and Summers 1978:159) tells of a different shark with one tooth, an *akua* (god) named Kaunihokahi (meaning "One-Toothed-U"), who protected the local community of Lāʻie. He lived in a *lua* (pit) in Lāʻie, and to warn people not to go further into the ocean, Kaunihokahi would nip like a *pāpaʻi* (crab) and cut the person with just one tooth, or else he would appear in the form of a small fish. Pukui's account in Sterling and Summers further contends that this shark could have some connection with Kaunihokahi Heiau (Site 286; McAllister 1933:158) in Hauʻula (the *ahupuaʻa* to the south of Kaipapaʻu, which borders Lāʻie on the south).

3.2.3 Laniloa, the *Moʻo*

This *moʻolelo* concerns the creation of Laniloa Point (as known as Laniloa Point and Lāʻie Point) and the five islands that are offshore Mālaekahana and Lāʻie bays (Armitage and Judd 1944:141; Rice 1977:124). The islands were created out of a *moʻo* (lizard) who stood upright in ancient times (Pukui and Elbert 1986:253). The *moʻo* would kill people who passed through the area. Kana and his brother had rescued their mother from the island of Molokaʻi and taken her back to Hawaiʻi Island. Kana then set out on a journey around the islands to kill all the *moʻo*. He eventually reached Lāʻie where the *moʻo* was killing many people. Kana fought the monster and defeated it. He then took the head of the *moʻo* and cut it into five pieces and threw them into the ocean (Rice 1977:124). Today the five pieces represent the small islands off the area: Malualai, Keauakaluapaaa, Pulemoku, Mokuaaniwa, and Kihewamoku. A deep hole demarcates the spot where Kana severed the head of the *moʻo*.

In Pukui's version of Laniloa, she notes that the hole has since been "filled in" (Pukui et al. 1974:129). However, there is some confusion concerning this hole. Pukui and Korn (1973:60) state that the "hole where Kana severed Lani-loa's head can easily be seen from the lookout at the end of the promontory." Pukui and Korn seem to be referring to the hole in the offshore island of Keauakaluapaʻaʻa, also called Kukuihoʻolua. This hole can clearly be seen from the shore (Figure 7).

This particular hole has been confused with a pool known as the "Beauty Hole," discovered in the 1930s during construction of Kamehameha Highway, when excavation led to the collapse of a sinkhole. The hole was filled in 1969 for safety reasons. In modern narrations of the story, the "Beauty Hole" is erroneously identified as the original home for Laniloa (Handy and Handy 1972:461), or the hole left by his severed head (Sterling and Summers 1978:158), or even as the pool in which Lāʻieikawai was hidden by her guardian (Craig 2004:154).

3.2.4 The Mullet of Pearl Harbor and their Journey to Lāʻie

McAllister (1933:155) recorded the remains of a fishing shrine at Makahoa Point at the north end of Mālaekahana Bay. At Makahoa Point was a fishpond called Waipunaea, which according to legend was the place where mullet came that traveled all the way from Pearl Harbor. McAllister (1933:155) noted, "To this day schools of mullet come around the island to this northern point of Mālaekahana. They go no farther, and their apparent disappearance still mystifies the Hawaiians." The mullet traveled from their home in Pearl Harbor and went east (counter-clockwise) around the island, thus passing the shoreline of Lāʻie.

Figure 7. Photo of Keauakaluapaʻaʻa (also known as Kukuikoʻolua), the off-shore island facing Lāʻie Point associated with the *moʻolelo* of Laniloa, the *moʻo*, ca. 2009 (CSH 2009)

One version of the migrating mullet (Fornander 1919, *Legend of Maikoha*, 5(2):270-273) concerns a man named Maikoha, who was exiled by his father for breaking several *kapu*. Maikoha settled in Kaupō, Maui and changed into the first *wauke* (paper mulberry; *Broussonetia papyrifera*) plant. His four sisters, Kaihuopala‘ai, Kaihuko‘a, Ihukoko, and Kaihuku‘una, came in search of him, and found his *piko* (umbilical cord) beneath the *wauke* plant. They left their brother in Kaupō and returned to O‘ahu, landing first in ‘Ewa (near Pearl Harbor) and then traveled along the coast to Wai‘anae, Waialua, and then to Lā‘ie. At each of the three places, one sister married a local man, and a certain type of fish that accompanied them, also stayed in that place. At the first and last stops, Pearl Harbor and Lā‘ie, the associated fish were the mullet. At Lā‘ie, the last sister married a man named Laniloa, which is an alternate name for Lā‘ie Point.

> *. . . hele mai la lakou a hiki ma Oahu.*
>
> *Ike aku la o Kaihuopalaai i ka maikai o Kapapaapuhi, he kane e noho ana ma Honouliuli, ma Ewa. Moe iho la laua, a noho iho la o Kaihuopalaai i laila a hiki i keia la. Oia kela loko kai e hoopuni ia nei i ka anae, nona na ia he nui loa, a hiki i keia kakau ana.*
>
> *A noho o Kaihuopalaai i laila, hele aku la kona mau hoahanau a hiki ma Waianae, moe o Kaihukoa me Kaena, he kane ia e noho ana i laila. He kanaka maikai loa o Kaena, a he ‘lii no hoi no Waianae. Nolaila, noho o Kaihukoa malaila a hiki i keia la, oia kela koa ma waho o ka lae o kaena. A o na ia i hele pu mai me i, oia ka ulua, ke kahala, ka mahimahi.*
>
> *A noho ia i Waianae, hele aku kona mau hoahanau a hiki ma Waialua, loaa o Kawailoa ia Ihukoko, he kane ia, a noho iho la me ia. O ka ia i hele pu mai me Ihukoko, o ke aholehole.*
>
> *A noho ia i laila, hele aku la o Kaihukuuna, a hiki i Laie, loaa o Laniloa, he kane ia, a noho iho la laua. O ka ia i hele mai me Kaihukuuna, he anae, a hiki i keia la.*
>
> <u>Translation:</u>
>
> Upon their arrival on O‘ahu, Kaihuopalaai saw a goodly man by the name of Kapapaapuhi [meaning ‘the eel flats’] who was living at Honouliuli, Ewa; she fell in love with him and they were united, so Kaihuopalaai has remained in ‘Ewa to this day. She was changed into that fish pond [Kapapa‘apuhi] in which mullet [*‘anae*] are kept and fattened, and this fish pond is used for that purpose to this day.
>
> When Kaihuopalaai decided to stay in Ewa, her sisters proceeded on to Waianae, where Kaihukoa decided to make her home and she was married to Kaena, a man who was living at this place, a very handsome man and a chief of Waianae. So she remained in Waianae and she is there to this day. She changed into that fishing ground directly out from the Kaena Point, and the fishes that came with her were the ulua [crevalle], the kahala [amberjack], and the *mahimahi* [dolphin fish].
>
> When Kaihukoa decided to stay in Waianae, the remaining sisters continued on to Waialua, where Kawailoa met Ihukoko. Kawailoa was a single man and as he fell in love with Ihukoko the two were united and they became husband and wife.

Ihukoko remained here, and the fish that accompanied her from their home was the *aholehole* [flagtail].

When Ihukoko decided to remain in Waialua, the sister that was left, Kaihukuuna, continued on her way until she came to Laie where she met Laniloa, a goodly man, and they lived together as husband and wife. The fish that came with her was the mullet and it too remained there to this day. [Fornander 1919, *Legend of Maikoha*, 5(2):270-273]

The name of Maikoha's sister, Kaihuopalaʻai, which means "the nose of Palaʻai" (Pukui et al. 1974:68) is also the name the Hawaiians used for the West Loch of Pearl Harbor. Beckwith (1918:354) says that Kaihuopalaʻai changed into the fishpond near Kapapaʻapuhi, which means "the eel flats." Kapapaʻapuhi is identified on old maps as a point that juts into the loch; early Hawaiian settlement was focused on this area.

Raphaelson (1925) gives another version of this tale, and explains why the mullet stop at Mālaekahana:

. . . This is the story of Malaekahana, the place where the mullet stops. This is the story of the unpractical fisherman who would not heed the wise warning of his practical wife.

But he had spells of genius, that fisherman, in spite of the fact that he was a stubborn, willful man.

'It is ridiculous,' his wife had said to him when he had planted great quantities of sweet potatoes. 'What will you do with them? We cannot eat them; you cannot sell them; they will rot.'

But he was stubborn. He gave no heed. And later his wife had a chance to say, 'I told you so,' which she said again and again, until finally, after a day of quarrelling, she made him promise to take the potatoes over to Pearl Harbor, where perhaps they could be sold. She went with him. But there to their dismay, they found that everyone in Pearl Harbor had plenty of sweet potatoes of their own.

Night came, and the fisherman and his wife bickered and quarreled. She nagged and grumbled all the while cooking a mess of the hated potatoes so that they could have something for supper. But he was angry and refused to eat. So she picked up the pototoes [*sic*] and, in a fit of temper, threw them into the sea.

Immediately then great schools of fish came crowding toward the shore. The eyes of the fisherman grew big. But he had no net, no way to catch the fish. He had nothing but sweet potatoes.

At last there came the big idea. The fisherman took his sweet potatoes and started back toward Kahana bay. At each inlet, he had his wife cook some of the potatoes and threw them into the sea. It took a long time to get home, but when at last they reached Kahana bay they were followed by great swarms of hungry mullet, which he caught in this net.

> This is the explanation that is given of a strange phenomenon that occurs on the island of Oahu. The mullet appear every year, first in Pearl Harbor, then in each successive inlet, around the island until it finally reaches Malaekahana bay. Beyond this inlet there is mullet, but it is not the kind that swims from bay to bay.
>
> Why did the fish not stop at Kahana bay? It is not told. It may be that they went on a little way in hopes of more sweet potatoes. No one seems to know.
>
> And after Malaekahana? Where does the mullet go from here? That too, no one knows. Unless, as the Hawaiians tell you, there is an underground tunnel through which they swim. [Raphaelson 1925]

In a third version (Nakuina 1998a), Ihuopala‘ai is the brother of a woman living in Lā‘ie. As the fish were scarce in Lā‘ie, this woman sent her husband to Ihuopala‘ai, at Pearl Harbor, who had the mullet follow her husband on his return trip, which was made along the shore around Makapu‘u Point with the mullet following in the water. Makea says that Ihuopoala‘ai’s sister was named Mālaekahana.

> The home of the anae-holo is at Honouliuli, Pearl Harbor, at a place called Ihuopalaai. They make periodical journeys around to the opposite side of the island, starting from Puuloa and going to windward, passing successively Kumumanu, Kalihi, Kou, Kalia, Waikiki, Kaalawai and so on, around to the Koolau side, ending at Laie, and then returned by the same course to their starting point. This fish is not caught at Waianae, Kaena, Waialua, Waimea or Kahuku because they do not run that way, though these places are well supplied with other kinds. The reason given for this is as follows:
>
> Ihuopalaai had a Ku-ula, and this fish-god supplied anae. Ihuopalaai’s sister took a husband and went and lived with him at Laie, Koolauloa. In course of time a day came when there were no fish to be had. In her distress and desire for some she bethought herself of her brother, so she sent her husband to Honouliuli to ask Ihuopalaai for a supply, saying: ‘Go to Ihuopalaai, my brother, and ask him for fish. If he offers you dried fish refuse it by all means, do not take it, because it is such a long distance that you would not be able to carry enough to last us for any length of time.’
>
> When her husband arrived at Honouliuli he went to Ihuopalaai and asked him for fish. His brother-in-law gave him several large bundles of dried fish, one of which he could not very well lift, let alone carry a distance. This offer was refused and reply given according to instruction. Ihuopalaai sat thinking for some time and then told him to return home, saying: ‘You take the road on the Kona side of the island; do not sit, nor sleep on the way till you reach your own house.’
>
> The man started as directed and Ihuopalaai asked Ku-ula to send fish for his sister, and while journeying homeward as directed a school of fish was following in the sea, within the breakers. He did not obey fully the words of Ihuopalaai for he became so tired that he sat down on the way, but noticed whenever he did so that the fish rested too. The people seeing the school of fish went and caught them. Of

> course not knowing that this was his supply he did not realize that the people were taking his fish.
>
> Reaching home he met his wife and told her he had brought no fish but had seen many all the way, and pointed out to her the school of anae-holo which was then resting abreast of their house. She told him it was their supply, sent by Ihuopalaai, his brother-in-law. They fished and got all they desired, whereupon the remainder returned by the same way till they reached Honouliuli where Ihuopalaai was living, and ever afterwards this variety of fish has come and gone the same way every year to this day, commencing sometime in October and ending in March or April. [Nakuina 1998a:270-272]

Beckwith (1970:100) states that Kaihukuʻuna becomes the wife of chief Laniloa at Lāʻie and then "changes into a famous fishing ground for mullet."

Titcomb (1972:65) relates a similar version in which there were two keepers of the mullet at Pearl Harbor who could talk to the fish, the man Kaulu, and the woman Apokaʻa. They had four children, two humans—a daughter named Awawalei (a Hawaiian name for Pearl Harbor) and a son named Laniloa—and two supernatural children, an *ʻamaʻama* (middle stage of the mullet; *Mugil cephalus*), and a *puhi* (eel). Laniloa later went to Lāʻie to live, where he heard that the descendants of the *ʻamaʻama* multiplied, filling up the waters of Pearl Harbor. Laniloa lamented that there were no *ʻamaʻama* in Lāʻie and traveled to ʻEwa to ask his supernatural sister, the *ʻamaʻama*, for some of this fish. The sister traveled back to Lāʻie with her brother in her human form. The large school of fish stayed underwater and unseen for most of the trip and then came to the surface. Finally they reached Lāʻie, and the route taken by the brother and sister is the same the mullet take in their migration up to today.

Pukui (1960:48-51) tells a similar story in which Lāʻie is lauded as a land of taro, sugar cane, bananas, sweet potatoes, shellfish, seaweed and ultimately a bay "silver with mullet." According to Nakuina (1998b:249), ʻAiʻai, a god of fishermen, established a fish stone called Kaihukuʻuna at Lāʻiemaloʻo, the only such shrine he established between Waimea and Kou (old name for Honolulu) on Oʻahu. McAllister (Site 285; McAllister 1933:158) found the remains of this shrine during the early 1930s, and recorded the location on Laniloa Beach, east of Kēhukuʻuna Point. The mullet were the fish offered at this shrine.

3.3 Early Post-Contact History

The first historical reference to windward Oʻahu was in 1779 when the HMS *Resolution* passed along the north side of Oʻahu. Lieutenant James King wrote, "It [Oʻahu] is by far the finest island of the whole group. Nothing can exceed the verdure of the hills, the variety of wood and lawn, and the rich cultivated valleys, which the whole face of the country displayed" (McAllister 1933:153).

On 28 February 1779, in the journal of the *Resolution* now captained by Charles Clerk, due to the untimely death of Captain James Cook at Kealakekua Bay on February 14, we find a description of the northwest coast of Oʻahu:

> Run round the Noern [Northern] Extreme of the Isle which terminates in a low point rather projecting [Kahuku Point]; off it lay a ledge of rocks extending a full Mile into the Sea, many of them above the surface of the Water: the Country in this

> neighborhood is exceedingly fine and fertile: here is a large Village, in the midst of it is run up a high pyramid doubtlessly part of a Morai [*heiau*]. I stood into a Bay just to the Westward of this point the Eastern Shore of which was far the most beautifull [*sic*] Country we have as yet seen among these Islands, here was a fine expanse of Low Land bounteously cloath'd with Verdure, on which were situated many large Villages and extensive plantations; at the Water side it terminated in a fine sloping, sandy Beach . . . [Beaglehole 1967:572]

In 1794, British Captain George Vancouver noted,

> . . . In every other respect our examination confirmed the remarks of Captain King: excepting, that in point of cultivation or fertility, the country did not appear in so flourishing a state, nor to be so numerously inhabited, as he represented it to have been at that time, occasioned most probably by the constant hostilities that had existed since that period. [Vancouver 1798:71]

It is presumed from these early descriptions that in the 13 years that separated Captain King's voyage from Captain Vancouver's, the cultural landscape of the north shore of Oʻahu had undergone significant changes. The probable cause for the decrease in cultivation was the decline in population due not only to "the constant hostilities" of the inhabitants, but also to the spread of venereal and other diseases introduced by Cook's expedition in 1778, as well as other visiting ships in the years that followed.

In 1826, the missionary Levi Chamberlain (1926:15) made the first of two trips around the island of Oʻahu to inspect English language schools and communities. On this section of the coast, travelling clockwise around the island, he stopped at Kahuku, travelled to Lāʻie Wai village to inspect a school, stopped at a house in Lāʻie Maloʻo to rest, and then did not stop again until he got to Hauʻula where he inspected a school with 108 scholars. According to his account, Chamberlain and his assistants

> . . . arrived at Laiewai [Lāʻie Wai] where we found a school assembled of 60 scholars, belonging to this place and the adjoining land of Laiemoro [Lāʻie Maloʻo]. Here we stopped 3 hours & 20 min. and had time to get dry as we had been wet in a shower. – We took dinner at this place and set out at 10 minutes after two. Stopped at one of the last houses in Laiemoro and filled up a sheet of paper with copies for the writing scholars of the school we had last examined. [Chamberlain 1926:15]

Yent and Estioko-Griffin (1980:16) believe this figure of 60 students in the area is indicative of a large population for the Lāʻie and Mālaekahana coastline. Chamberlain would stop wherever the population was large enough to support a school, indicating that Lāʻie village was the population center for this section of northwest Oʻahu.

In 1828, Chamberlain made his second trip around Oʻahu, travelling counter-clockwise, and found two schools in Hauʻula, two schools in the Lāʻie–Mālaekahana area, and one schoolhouse at Kahuku:

> Tuesday Feb. 5th. After breakfast I examined two schools, belonging to Laie & Malaekahana, and was pleased with the appearance of the scholars. At a quarter before 11 A.M. we set out for Kahuku, and after traveling about two hours over a

> level sandy country, arrived at the school house, where we found 83 scholars assembled, waiting to be examined. [Chamberlain 1956:35]

From this account, it would seem the population of the area was increasing, as there were more schools along the coast in 1828 than in 1826, but this instead probably represents the trend in the early historic period for Hawaiians to move to house lots in villages, rather than live in homesteads scattered along the coast and in the uplands. A mission census from 1831/1832 recorded 452 people in Lā‘ie, seemingly the most populous *ahupua‘a* in Ko‘olauloa District (Schmitt 1973:19). By 1835, the reported population had dropped to 375, a 17% population drop over four years, probably resulting from introduced diseases and out-migration. In 1838, E.O. Hall wrote of the Ko‘olauloa District, “Much taro land lies waste, because the diminished population of the district does not require its cultivation” (McAllister 1933:153).

Handy (1940:89-91) has a great deal of information on Lā‘ie. He says there were terraces along Kaho‘oleināpe‘a Stream, still in use during his later 1930s survey. There were old terrace areas noted along the lower and middle reaches of Kahawainui Stream, terraces about 2.5 miles up Wailele Stream, and terraces 2 miles inland along Kōloa Stream. All of the flat land along the coast was used for wet taro cultivation, including a 60-acre area in back of the Lā‘ie Temple, surrounding the confluence of the tributaries of Kahawainui Stream. The area was called Kapuna (“the spring”), since the taro fields were watered from a spring. Handy (1940:75) also notes that “Sweet potatoes were grown on the northwest coast from Kaena to Laie.”

3.4 The Māhele

The Organic Acts of 1845 and 1846 initiated the process of the Māhele, the division of Hawaiian lands, which introduced private property into Hawaiian society. In 1848, the Crown and the *ali‘i* (chiefs) received their land titles. The common people received their *kuleana* (individual parcels) in 1850. These records for Land Commission Awards (LCAs) offer the first specific documentation of life in Lā‘ie up to the mid-nineteenth century.

Stewardship of Lā‘ie passed from Kamehameha I to his half-brother Kalaimamahū, then to his daughter Kekāuluohi and on to her son William C. Lunalilo. In the Māhele of 1848, Lunalilo retained most of Lā‘ie, 6,194 acres. *Kuleana* awards for individual parcels within the *ahupua‘a* were subsequently granted in 1850. These LCAs were presented to tenants—Native Hawaiians, naturalized foreigners, non-Hawaiians born in the Islands, or long-term resident foreigners—who could prove occupancy on the parcels before 1845. LCA documents further clarify our understanding of the *‘āina* (land) from the perspective of the Hawaiian planter and fisherman in traditional times, as land claims included traditional uses of the land.

Approximately 65 *kuleana* were awarded to native tenants in Lā‘ie. Over half the claims included house lots and associated habitation features. Most of the claims included *lo‘i* (irrigated terrace) and many had *kula* (area for dryland crops or pasture) lands. Also within the claims were scattered *‘āpana* (lots) in the mountains, fisheries, fishponds, *muliwai* (river, river mouth), and even a place for drying *kapa* (cloth made from bark) in Hau‘ula Ahupua‘a. Historic influences can be seen in claims listing horse pastures and *pā* (a fenced piece of land).

Other parcels awarded within Lā‘ie Ahupua‘a, however, indicate much of the lowlands in the mid-1800s was being utilized for subsistence gardening, including many *lo‘i* irrigated by *‘auwai* (ditch) systems. The *lo‘i* were interspersed with the *kula* lands fringing the foothills, with taro being the dominant crop. Other crops described in Land Commission documents here included melon and watermelon, coffee, gourd, *‘awa* (kava; *Piper methysticum*), and *weuweu* (grasses). Table 1 displays LCAs awarded within Lā‘ie Malo‘o Ahupua‘a that fall within and in the vicinity of the project area. The table displays LCA number, claimant name, *‘ili* name (if available), and notes on land use (if available). Figure 8 depicts LCAs found within and in the vicinity of the project area.

Table 1. LCAs Awarded in Lā‘ie Malo‘o Ahupua‘a (asterisk [*] indicates parcel is within the project area)

LCA Number	Claimant	*‘Ili*	Land Use
3699	Mahakea	Kaakau, Nahuluo, Akakii, Koloa, Kikilolio, Paukauila, Kaipapau	*‘Āpana* 1: Four *lo‘i kalo* (taro patch) *‘Āpana* 2: Three *lo‘i kalo* *‘Āpana* 3: One *lo‘i kalo* *‘Āpana* 4: *Kula ‘āina* (farm land) of tobacco and potatoes; enclosed *‘Āpana* 5: House lot
3714	Maii	Kamapuna, Kawaieli, Paeo, Kumupali	*‘Āpana* 1: Seven *lo‘i kalo* *‘Āpana* 2: *Kula ‘āina*; partially enclosed *‘Āpana* 3: House lot*
3741	Waha	Kohelepo, Aakakii, Poohina, Kolololio	*‘Āpana* 1: Four *lo‘i kalo* *‘Āpana* 2: *Kula ‘āina* *‘Āpana* 3: House lot; two homes on lot
3939	Nahelehele	Kapuna, Laie Maloo, Kaohe, Akakai, Kokololio	*‘Āpana* 1: Six *lo‘i kalo* *‘Āpana* 2: *Lo‘i kalo* *‘Āpana* 3: *Lo‘i kalo** *‘Āpana* 4: *Kula ‘āina* with potatoes; enclosed with stone wall *‘Āpana* 5: House lot
4270	Keao	Puapua, Kawaieli, Kahaumaloo	*‘Āpana* 1: House lot *‘Āpana* 2: Two *lo‘i kalo* *‘Āpana 3*: Three *lo‘i kalo* *‘Āpana* 4: One *lo‘i kalo* *‘Āpana* 5: *Kula ‘āina* *‘Āpana* 6: *Kula ‘āina* *‘Āpana* 7: *Kula ‘āina*
4272	Koi	Aakukuii, Kokolokio, Kahaumaloo, Koohe, Kalaiahui	*‘Āpana* 1: Five *lo‘i kalo* *‘Āpana* 2: *Kula ‘āina* *‘Āpana* 3: House lot
4281	Kaunahi	Kanepanui, Hahakulou, Koloa	*‘Āpana* 1: House lot *‘Āpana* 2: Eight *lo‘i kalo*
4286	Kanekoa	Kekulu, Kawawao, Koloa, Laie Maloo	*‘Āpana* 1: House lot

LCA Number	Claimant	*ʻIli*	Land Use
4301	Kanakanui	Koloa, Puapuaneinei, Kapaka, Kaloawai, Paukuwila, Kauhaumalo, Kaluaolohe	*ʻĀpana* 1: Four *loʻi kalo* *ʻĀpana* 2: One *loʻi kalo* *ʻĀpana* 3: One *loʻi kalo* *ʻĀpana* 4: Not available
4329	Kalua	Kumupali, Kahikaele	*ʻĀpana* 1: *Kula ʻāina* *ʻĀpana* 2: House lot *ʻĀpana* 3: *Kula ʻāina*
4331	Kamano	Koloa	ʻĀpana 3: One fishpond
4333	Kahookua	Paakea, Kumupali	*ʻĀpana* 1: Five *loʻi kalo* *ʻĀpana* 2: *Kula ʻāina** *ʻĀpana* 3: House lot*
4342	Kapuaokahala	Not available	*ʻĀpana* 1: House lot *ʻĀpana* 2: *Kula ʻāina* *ʻĀpana* 3: *Kula ʻāina*
10748	Punipaka/ Puhipaka	Paeomuliwai, Kapuna	*ʻĀpana* 1: One *loʻi kalo* *ʻĀpana* 2: One *loʻi kalo* *ʻĀpana* 3: One *loʻi kalo* *ʻĀpana* 4: *Kula ʻāina*
10763	Puni	Kumupali, Kamapuni, Kapaakea	*ʻĀpana* 1: One *loʻi kalo* *ʻĀpana* 2: House lot *ʻĀpana* 3: *Loʻi kalo*

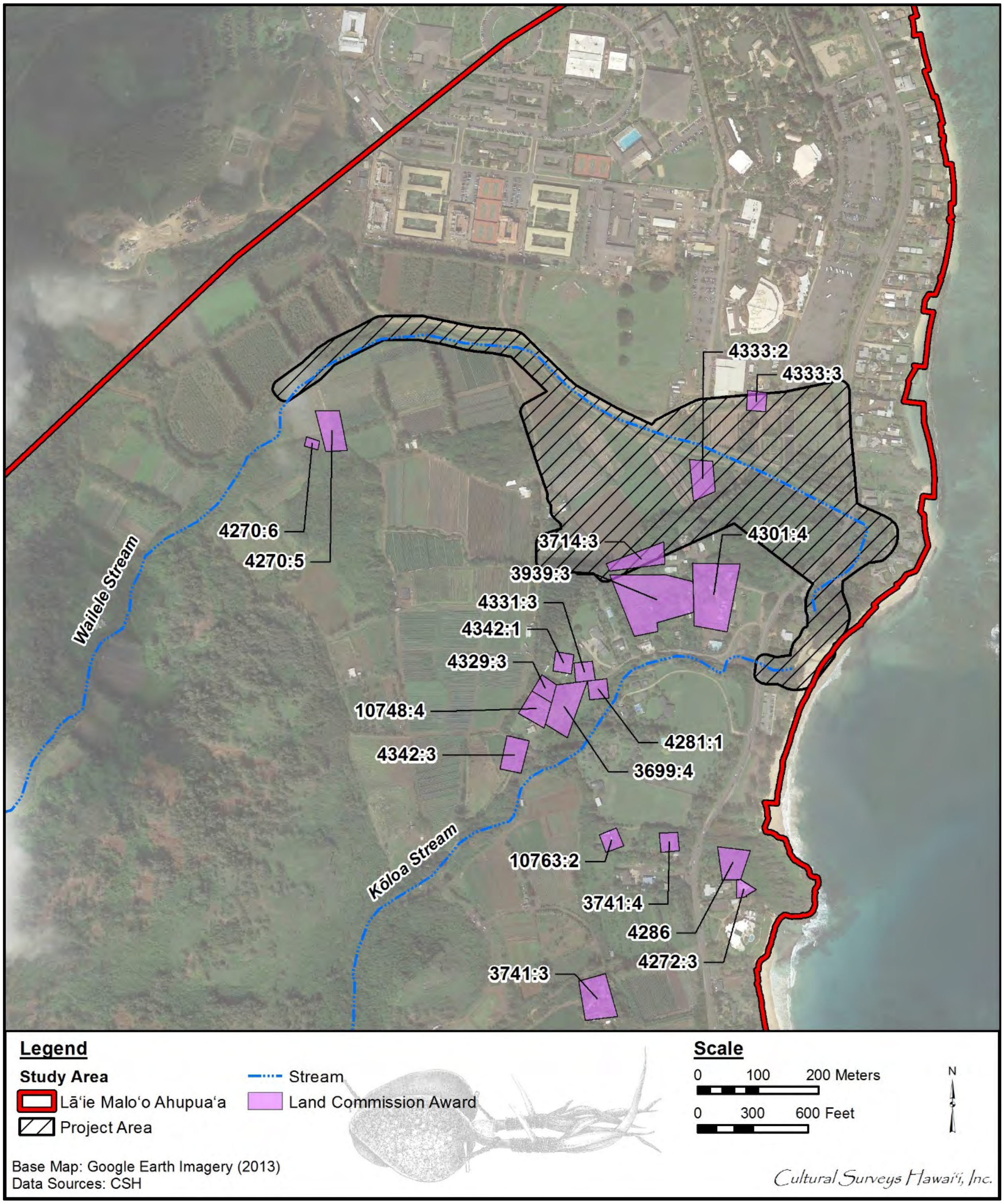

Figure 8. 2013 Google Earth Imagery with LCA overlay depicting parcels located within and in the vicinity of the project area

3.5 Ranching in Northwestern Oʻahu

The subsequent history of land changes in the *ahupuaʻa* of northwestern Oʻahu, including Lāʻie and neighboring Mālaekahana, have been extensively researched by Yent and Estioko-Griffin (1980:18-21); their research is a major source for the following discussion. In 1861, the Lāʻie Wai and Lāʻie Maloʻo lands of the estate of Lunalilo were sold to Henry H. Howland. In 1863, Howland sold 298½ acres of the land in Lāʻie Wai to Robert Moffitt, who in the same year conveyed the land to Charles Hopkins.

Charles Gordon Hopkins was an Englishman who had made his way to Hawaiʻi to work in various posts of the Hawaiian government, including acting as the secretary for Queen Emma and at one time as the agent for the rental and sale of Crown lands. He was a friend to Kauikeaouli (Kamehameha III) and the young Alexander Liholiho (later Kamehameha IV) (Korn 1958:212). In 1850 to 1851, Hopkins purchased the entire *ahupuaʻa* of Kahuku and other lands on the north shore of Oʻahu, totaling 8,000 acres. By 1863, Hopkins had extensive lands in Lāʻie Wai, Mālaekahana, and Kahuku, on which he established a cattle and sheep ranch known as the Kahuku Ranch (Korn 1958:211-212).

The ranching venture had dire consequences for the native inhabitants, as it resulted in extensive damage to the environment and was a major factor in the area's depopulation.

> The natives became concerned for their lush and legend-filled homeland. Kahuku and the hala trees in whose shade it had slept through the centuries, was being threatened by a new kind of white stranger. The herds and flocks ran over the small homesteads scattered here and there through the land, stripping it of verdure. The Hawaiians asked in vain for protection of their trees and vegetable patches. They wrote to the missionary, Emerson, who urged them to build fences and appealed to authorities on their behalf asking that government pounds be set up to enforce newly established trespass laws. At the same time the hala forests began to disappear, the Hawaiian population also began to disappear. Once well-populated, Kahuku became a lonely sheep and cattle ranch, famous for its prize English breeds and its imported water fowl. [Wilcox 1975:16]

J.G. McAllister (1933:153) wrote of an informant, "She [Mrs. John Kaleo] remembers the time when trees, now found only on the mountains, covered the Kahuku plain, now a rather desolate, windswept area." One can surmise that Mrs. Kaleo could remember the Kahuku plain before and during the depletion of its vegetation due to over-grazing by the sheep and cattle of Kahuku Ranch. The relationship between cattle and the natural environment of Hawaiʻi has been described as follows:

> Since the coming of the whites there have been many causes . . . that have been at work bringing about a change in the natural conditions. Chief among the disturbing elements, however, have been the cattle. As early as 1815 they were recognized as a serious menace to the native forests. Roaming at will through the forests they and other animals, as goats and pigs, have done untold damage, and brought about conditions that have been most serious in many places. [Bryan 1915:226-227]

In 1866, an Irish cattleman, Robert Moffitt, purchased the Kahuku Ranch from Hopkins. His pastures, used for cattle, sheep, and imported waterfowl, extended along 12 miles of the coast from the sea to the mountains. The foreign livestock quickly decimated the native *hala* forests and overran the gardens of the native tenants.

In 1867, Hopkins conveyed a half interest of the *ahupua‘a* of Mālaekahana to Judge Herman A. Widemann, and in 1872 he conveyed his remaining interest in Mālaekahana Ahupua‘a, 298.5 acres in Lā‘ie Wai, and other lands in Keana and Kahuku to Widemann. By 1874, Judge H.A. Widemann had gained control and ownership of the entire Kahuku Ranch, which by then included the *ahupua‘a* of Kaunala, Pahipahi‘ālua, ‘Ōpana 1 and 2, Kawela, Hanakaoe, ‘Ō‘io 1 and 2, Ulupehupehu, Punalu‘u, Kahuku, Mālaekahana, Keana, and a part of Lā‘ie, totaling about 15,000 acres (Kuykendall 1967:138). Hopkin's sales to H.A. Widemann also included branded cattle and horses on these lands.

In 1874, Kahuku Ranch was renamed Kahuku and Mālaekahana Ranch and was sold to Julius L. Richardson (Thayer 1934:138), who in turn sold the 15,000-acre ranch to James Campbell in 1876 (Wilcox 1975:37). The sale of Kahuku and Mālaekahana Ranch included the livestock, which then numbered 3,000 cattle, 90 horses, and 1,700 sheep. This purchase was described in an 1876 newspaper account:

> It includes 25,000 acres in fee simple, and large tracts of mountain land under long leases, with $34,000 worth of live stock, including 3,000 head of cattle, with the choice band of merino sheep and horses now on it. It is unquestionably the best stock ranch of these islands, and it has been brought to a high state of perfection under the management of the late proprietors, who divided the plain into ten or twelve large paddocks, walled with heavy stone walls. It stretches from Laie to Waimea, a distance of thirteen miles, and those who have ever visited it must have admired its lovely green pastures of manienie grass so fattening to stock. It is the intention of Mr. Campbell to increase his band of sheep to 30,000 of the choicest breed. The price paid is a handsome one, securing to its present proprietor the most desirable ranch of the Islands, and to Mr. Richardson a comfortable fortune, the result in part of his industry and good management, and in part of the Reciprocity Treaty, the first fruit from which he has been so fortunate as to reap. [*Hawaiian Gazette* 4 October 1876:3:2]

The *manienie* grass referred to is probably Bermuda grass (*Cynodon dactylon*), a valuable pasture grass, said to have been introduced into the Hawaiian Islands by Dr. Gerritt P. Judd around 1835 (Neal 1965:67-68).

James Campbell had arrived in Hawai‘i in 1849 and joined a sugar cane enterprise. He made the Pioneer Mill Company on Maui a prosperous sugar enterprise, sold his interests, and then moved to O‘ahu. He purchased several large tracts of land at Honouliuli west of Pearl Harbor in addition to the acreage at Kahuku, which he operated as livestock ranches (Kuykendall 1967:67). In 1880, George Bowser described Campbell's Kahuku Ranch:

> Kahuku Ranch. Main Road, Kahuku: Proprietor, James Campbell, Esq., of Honouliuli: Manager, W.R. Buchanan: postoffice address, Kahuku, 38 miles from Honolulu, at the northern point of Oahu: 23,608 acres occupied as a cattle ranch: extends 14 miles along the coast, in close proximity to the sea. A valuable fishery is attached to this property. [Bowser 1880:409]

In 1889, Campbell leased the Kahuku Ranch to B.F. Dillingham, who commissioned a study of the water supply at Kahuku. The water supply study noted the following:

> The Kahuku Rancho. This well-known rancho occupies the extreme northerly point of the island, extending from the crest of the mountains to the sea, and from Waimea river on the west to Laie on the east. It is thirty-eight miles distant from Honolulu, either by the Waialua or the Pali road. Its position on the windward side, with high mountains rearing up rapidly from the level of the belt of valley land along the coast, gives it abundant moisture and clothes it in perpetual verdure.
>
> Cattle roaming over its hills and valleys are all fat and sleek, and water is bursting out in places all along the coast, generally near the foot of the hills, or about midway between the foot-hills and the ocean. [Schuyler and Allardt 1889:3]

Eventually Kahuku Sugar Plantation became the major industry focus of Kahuku and adjacent *ahupua'a*; Kahuku Ranch continued operations until the mid-twentieth century.

3.6 History of the Kahuku Sugar Company

On 19 November 1889, James Campbell leased much of his Kahuku Ranch lands in Lā'ie Wai, Mālaekahana, and Kahuku and his Honouliuli lands to B.F. (Benjamin Franklin) Dillingham (Kuykendall 1967:69). This lease, from 1 January 1890 to 31 December 1935, was a part of Dillingham's development plan involving the sugar industry and a railroad on O'ahu (Kuykendall 1967:68). Dillingham's proposed plan of 1886, called the "Great Land Colonization Scheme," involved the development, at Kahuku and Honouliuli, of sugar cane plantations that would be irrigated by artesian well water (Dillingham 1886:73-80).

In 1890, Dillingham subleased some of these lands to the Oahu Railway and Land Company (chartered in 1888), whose president was James B. Castle. Dillingham received the franchise to build his "Oahu Steam Railway" in 1888, and in 1890 the first rails were laid between Honolulu and 'Aiea. The railway was extended to Wai'anae in 1895. On 10 December 1889, Dillingham subleased 2,800 acres of the Kahuku tract to James B. Castle, who founded the Kahuku Plantation Company (Kuykendall 1967:69). James Campbell, Benjamin F. Dillingham, and James B. Castle, together with Lorrin A. Thurston as a principal, were the key players in the development of the Kahuku Plantation Company. The first agents were M.S. Grinbaum & Company.

In the first nine years of the plantation, transportation to Honolulu from Kahuku was provided by coastal vessels, which picked up the sugar at Kahuku Landing and delivered it to Honolulu (Figure 9). In 1899, the Oahu Railway finally completed its track to the terminal at Kahuku, and the sugar could be transported directly to Honolulu by train around the west side of the island (Hungerford 1963:10). In 1890, 5 miles of 36-inch gauge railway, with some portable portions, were laid to haul cane from the sugar cane fields to the mill.

In the business arrangements between members of the Castle family and Alexander and Baldwin, the plantation agency was changed in 1900 to Alexander & Baldwin Ltd. (A & B), with Castle, who was still president of Kahuku Plantation Company, as treasurer. This co-partnership brought about expansions in the rail system, and by 1903 the rails extended all the way through the Lā'ie Plantation, which had a contract with the Kahuku Mill to handle their cane.

Figure 9. Photo of Laie Plantation Railroad ca. 1900-1920 (BYU Archives)

In 1916, the Kahuku Plantation leased some of its land for pineapple cultivation to one large grower (C. Okayama) and other individual growers on small pieces of land. The growers were obligated to sell their crop to the Hawaiian Pineapple Company, Libby, McNeill & Libby of Honolulu, and the California Packing Corporation (which later became the Del Monte Corporation).

The Kahuku Plantation remained relatively small, with less than 4,000 acres under cultivation until the early 1900s, when it expanded to the southeast as far as Hau‘ula. The Kahuku Plantation Company expanded by buying or incorporating other sugar plantation lands. In 1924, it bought the fields of the Koolau Agricultural Company as far south as Kahana Bay. In 1931, the Laie Plantation Corporation was dissolved and their sugar lands, totally 2,700 acres, were purchased and added to the Kahuku Plantation (Dorrance and Morgan 2000:46-47).

Under the caption of “Laie Purchase,” the 1931 Kahuku Plantation Manager’s report for the year comments as follows:

> Your company acquired the lease of Zion Securities agricultural lands and the transfer of leases previously held by them through Laie Plantation for a period of 25 years, dating from July 1, 1931. Koolau Railway Company Ltd. was also bought from the Zion Securities Corporation. This railroad will be disincorporated as soon as possible and become purely a plantation railroad. [Kahuku Plantation, Manager’s Report for 1931 in Condé and Best 1973:298]

The end for the cane hauling railroad at the Kahuku Plantation came in 1972, when this notice in the *Honolulu Advertiser* appeared:

> The company had been losing money on the plantation for the last few years. In 1968, A & B announced the closing of the plantation and the mill. The last crop was harvested in 1968, the last cane was ground at the mill on November 25, 1971, and the final paperwork was completed on February 1972, when the mill was locked to prevent vandalism. [Wilcox 1975:37]

3.7 History of the Latter-day Saints in Lā‘ie

In 1850, Brigham Young sent the first eight Mormon missionaries to the Hawaiian Islands. They arrived on 12 December in Honolulu and then split up, traveling in groups of two or three to the other islands. Their original mission to convert the mainly foreign-born (*haole*) population proved to be difficult. The missionaries were discouraged and discussed returning home, but they instead decided to stay, to learn the Hawaiian language, and to preach to the Native Hawaiians (Britsch 1989:1–14). The number of Hawaiian converts quickly grew and in 1853, they decided to buy land on Lāna‘i to start a colony where all the brethren could live and work.

The Lāna‘i colony was not a success for a wide variety of reasons and the mission decided to found a new gathering place. In 1864, two Latter-day Saints Mission presidents, Francis A. Hammond and George Nebecker, traveled to Hawai‘i to purchase land for a new Mormon settlement. Land was fairly cheap at this time in Hawai‘i as the end of the Civil War in the U.S. had led to a depression in the sugar market, leading to sugar planters’ eagerness to sell land (Britsch 1989:64). In 1865, Hammond purchased a 6,000-acre plantation called “Lā‘ie” from Thomas T. Dougherty. By 1865, the church had 6,000 acres, probably all the land in Lā‘ie Malo‘o and a portion of the land in Lāʻie Wai (minus the 298 acres owned by the Kahuku Ranch and Kahuku Sugar Company).

On this land was 600 head of cattle, 500 sheep, 250 goats, 20 horses, a large frame house, five native houses, and 5 acres of cotton (Britsch 1989:73). The first order of business for the new owners was to establish a cash crop that would sustain the settlement. Although corn and cotton were grown for the first two years, it soon became evident that sugar would be the salvation of the growing community. A mill was purchased and set up in Lāʻie in 1868, as shown on an 1883 map of Lāʻie Bay. The problem of insufficient water in some years was solved in the early 1880s, when a flume was built to bring water down from the Koʻolau Mountains. A new, more efficient mill was built in 1879.

By 1866, about 200 Hawaiians, mostly members of the church, were living at the Lāʻie mission settlement (Britsch 1989:79). Growth of the community was slow through the 1870s, due to most Hawaiians wishing to stay near their own homes. In 1874, only about 377 members lived near the mission (Britsch 1989:87). However, church membership as a whole did increase during this time; in 1865 the island-wide membership of the Hawaiian mission was recorded as 500; by 1906, it was 7,212 strong (Britsch 1989:88). In the early years, Hawaiians workers still lived in scattered grass huts but by the 1890s, the mission families lived in neat cottages or communal mission houses such as the Lanihuli Mission House.

In 1870, Elder H.H. Cluff wrote the following:

> Our little colony now consists of seven families from Zion, one Scotchman and about 300 natives, who occupy the land known as Laie, which embraces 6,000 acres . . . . Stock to the amount of 1,000 head could find good pasturage, while the mountains and gulches or canons furnish an immense quantity of timber. Many kinds of fruit grow in the gulches and the honey bees, when we are able to find them, furnish sweet. One hundred and fifty acres of three or four hundred acres of arable land, by the indefatigable zeal and exertion of brother Nebeder, assisted by the brethren who have labored with him, have been brought into a successful state of cultivation and produce renumerative [*sic*] crops of sugar cane. A good mill, by the same untiring exertion, has been erected, besides considerable fencing, which has raised the value to the place from fourteen thousand to about fifty thousand. [Cluff 1870:281]

In addition to sugar cane, other crops continued to be grown. Taro was cultivated in the coastal marshlands, and alfalfa was grown for livestock feed. As the farms and dairies prospered, the settlement of Lāʻie and Lāʻie Maloʻo grew. A tourist guide for 1895 describes the colony:

> LAIE,—thirty-two miles from Honolulu, is a colony and the headquarters of the Mormons on these Islands. The settlement possesses a small sugar plantation, (with a somewhat primitive mill) a cattle ranch, a number of taro patches, and land for sweet potatoes and other products. A number of white Mormons, under a head man from Salt Lake City, occupy the mission premises, which are situated on a hill overlooking the whole settlement. . . . There is a considerable and quite a posperous [*sic*] native settlement, all Mormons. The converts have land given them, rent free, and are assisted in building their houses. . . .

> The Mormons first came to the Islands in 1850. They have a large number of converts in all parts of the group, estimated at one-tenth in 1890. The Temple at Laie, will accommodate considerably over 1,000 people. A valley behind the mission-house contains several artesian wells and is cultivated in rice by Chinese. An artesian well also supplies the plantation with water. [Whitney 1895:46-47]

The "primitive" mill referred to presented a problem of expansion to the Lāʻie sugar plantation managers. In 1892, this was resolved by forming an association with the newly formed Kahuku Plantation Company. Matthew Noall, the plantation manager at that time recalled:

> Just north of Laie, on a piece of land called Kahuku, a corporation was starting a new sugar plantation and a mill. I thought it wisdom to negotiate with the corporation owners to mill the sugar from our cane on a fifty-fifty basis. I successfully closed the deal, in which it was agreed that the Kahuku Corporation should cut and haul our cane to their mill, and deliver our sugar to the Port of Laie, where it would go by steamer to Honolulu. Instead of the old fashioned method of hauling by ox team and a two-wheeled cart which we had employed at the plantation, the Kahuku People laid a portable track and used a steam engine for power.
>
> When I arrived at Laie for the second mission there were about thirty acres of cane ready to be harvested, and there were a thousand cords of wood ready for fuel. I sold the crop to the Kahuku people to start their own crops, and the wood to run their mill. These negotiations opened the way toward the continuation of our plantation work. And thus at one stroke the revenue problem at Laie was at least partly solved, Though we could save by discontinuing the mill, we needed the work of growing the crops, for this labor was the main avenue of support for the natives at Laie. [Gardner and Gardner n.d:65-66]

Up to the 1892s, the work force at the Lāʻie plantation was mainly Hawaiians, due to the practice of leasing the land to the Hawaiian converts and allowing them to use some of their land to cultivate their traditional crops such as taro. Eventually, the northern Oʻahu sugar plantations needed additional help to harvest their sugar cane fields. The first immigrants were Chinese, who branched out to become rice farmers, shop owners, and managers. A few Japanese workers were in the Islands in 1865, but the main Japanese immigration took place around 1885. Eventually they supplanted the Chinese on not only the sugar plantations, but as renters on the rice lands (Haraguchi 1987:xiv). In 1898, the workforce of Lāʻie consisted of 80% Hawaiian, 3% Chinese, and 14% Japanese. By 1910, the workforce was made up of only 33% Hawaiians and 57% Asian, mainly Japanese (Compton 2005:189-190). By 1930, the work force was 11% Hawaiian, 77% Filipino, and 1% Japanese (Compton 2005:270). Each ethnic group generally lived in segregated camps, but the entire population mixed together at schools and in community activities.

Joseph F. Smith, a missionary whose first mission to Hawaiʻi was in 1854, visited Lāʻie in 1915, and remarked on the great changes made by the missionaries since his first visit.

> Besides the almost omnipresent automobile, a railroad nearly circumscribes this Island, with vast networks or rails permeating the sugar-cane fields. The old grass-thatched huts have given place to comfortable and pleasant homes and grounds

> beautified with evergreens and flowers. Modern furniture, comforts, and conveniences of homes have supplanted the gourds, calabashes and pandanus-leaf mats, on which the natives slept, and the native kapa, which furnished their clothing and the covering of their beds. To a great extent the ancient and dim light of the kukui-nut and the oil lamp has given place to the brilliant illumination of modern electric lights. [Jenson n.d. in Compton 2005:231]

In 1926, the Laie Plantation purchased the Koolau Agricultural Company. This not only doubled the size of the sugar cane acreage, but also led to a great expansion in the population. Most of this population expansion came from new sugar plantation workers. A few of the new families were Hawaiian Mormon converts who had moved to the mainland and set up ethnic enclaves in such places as Alaska, California, and Utah. With a temple close to their native home, they returned to Hawaiʻi, moving to Lāʻie or other parts of Oʻahu (Compton 2005:243-244). The profitability of the small sugar plantation began to decline in the 1920s, and in 1931, the church leased most of its sugar cane lands to the Kahuku Sugar Company, which planted sugar cane there until Kahuku Sugar Company itself shut down in the late 1960s (Compton 2005:273).

The first Latter-day Saints Chapel made of stone, ʻĪhemolele, was built in 1883, but an accidental fire destroyed the original building in 1940 (Figure 10). By the early years of the twentieth century, it was evident that a new, larger church was necessary, and plans were made to build a temple on the Lāʻie land (Figure 11). On the site of the first chapel, the Latter-day Saints Temple Hale Laʻa was dedicated in 1919 (Britsch 1998:97, 136).

The history of Brigham Young University-Hawaii Campus began in 1921, when Latter-day Saints Elder David O. McKay attended a flag-raising devotional service at Lāʻie Grade School. It was at this ceremony that McKay had the inspiration for an institution of higher learning that would serve an international student body. This concept was realized in 1955 with the school's groundbreaking in February and its opening in September as the Church College of Hawaiʻi. On 26 January 1973, the college's name was changed to its current title of Brigham Young University-Hawaiʻi Campus (BYUH).

The creation of the Polynesian Center in 1963 had not only a financial impact on the Lāʻie community, but on their cultural make-up as well. As described in a 1968 news article (Char and Char 1988:117), "Immigrants from the South Pacific moved into Laie to go to school, work at the center and . . . attend services at the Mormon Temple." The Polynesian Cultural Center continues to serve as a major place of employment for the local residents and BYUH students, and as a tourist mecca on Oʻahu.

3.8 Historic Maps

A series of historic maps illustrates the dramatic changes that occurred within the project area as Western commercial interests supplanted the traditional Native Hawaiian way of life.

An 1881 map by Covington shows no real development within Lāiʻe Maloʻo Ahupuaʻa (Figure 12). However, Lā'ie Wai Ahupuaʻa depicts Kahuku Ranch, the Mormon Mission, and a plantation. Lāʻie Point is marked as "Dangerous Entrance" possibly indicating it as an unsafe place to anchor off-shore. The *ahupuaʻa* of Kaipapaʻu and Hauʻula have a marker indicating the area is safe to anchor off-shore. A road-way is located near the shoreline.

Figure 10. Photo of the Laie Chapel built in 1883 (Hawai‘i State Archives)

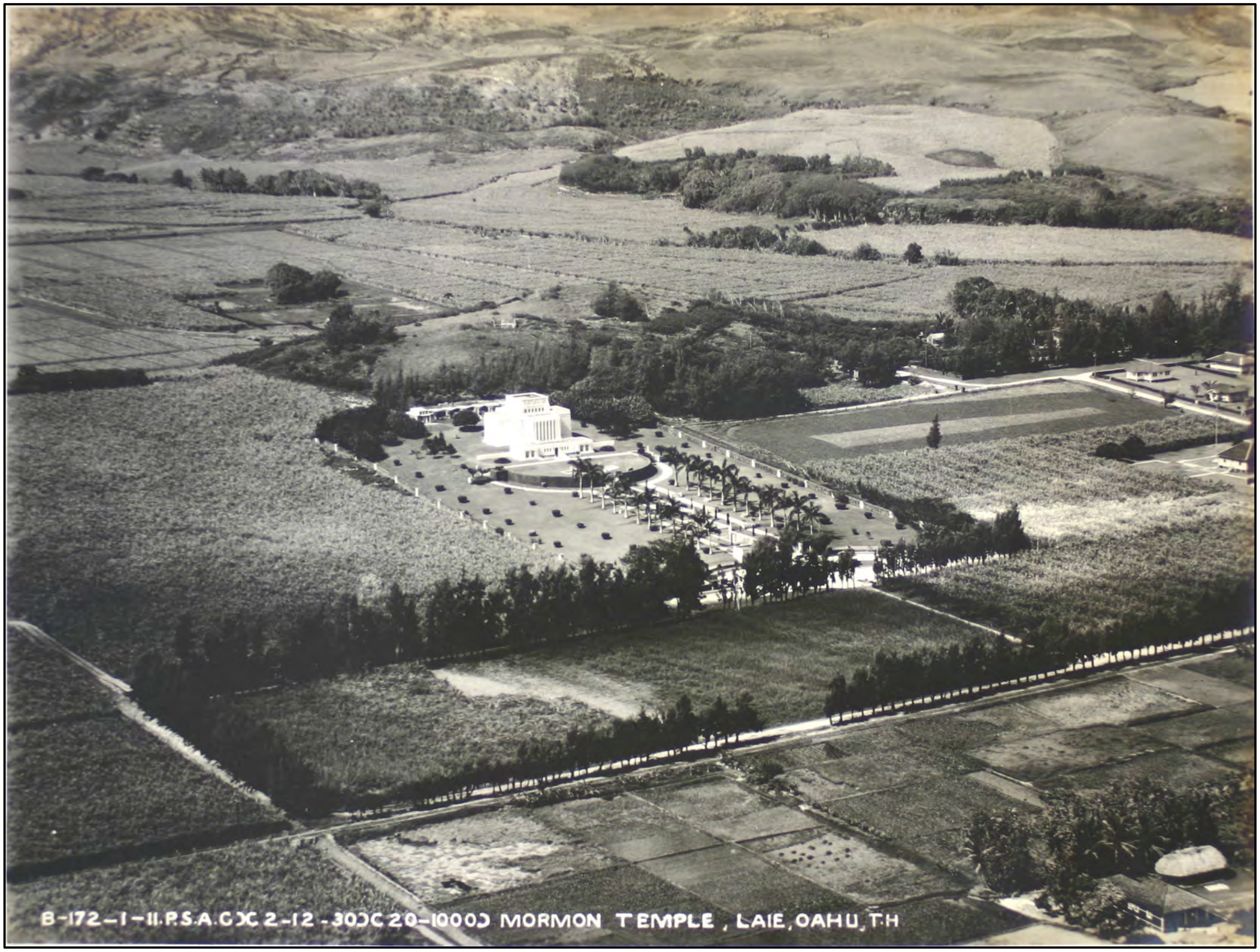

Figure 11. Photo of the Mormon Temple in Lāʻie ca. 1930 (Hawaiʻi State Archives)

Figure 12. 1881 Covington Map of O‘ahu depicting project area and tributaries

An 1884 map by Jackson is similar to the latter indicating the location of the Mormon Settlement and Church as well as a sugar mill (Figure 13). The northern portion of the project area, just above Wailele Stream, was once planted in sugar cane. Like the 1881 Covington map, a road travels parallel to the shoreline. It appears there is an elevation, a possible hill, just north of Wailele Stream.

A U.S. Army War Department fire control map, Kahuku, Kahana, and Waialua (1919) quadrangles indicates some major changes for the area (Figure 14). Roadways are evident in Lāʻie Wai Ahupuaʻa as well as more private residences. Evidence of a hill is north of Wailele Stream. A rail line runs parallel *mauka* of the roadway. It appears the rail station was located in the southern portion of the project area or just south of the project area. Homes dot the southern portion of the project area.

A 1928 Lāʻie Coast aerial photograph (UH SOEST) depicts farm land north of Wailele Stream (Figure 15). A hill with an access road lies north of Wailele Stream. Between Wailele Stream and Kōloa Stream are several homes. South of Kōloa Stream, several house lots are along the banks.

A U.S. Army War Department terrain map, Laie (1935), Kaipapau (1935), and Kahana (1936) quadrangles is similar to previous maps indicating more private residences in Lāʻie Wai Ahupuaʻa *makai* of the Mormon Temple (Figure 16). The rail line also travels *mauka* of the Mormon Temple towards Kaaoao Gulch. A road has been built on Lāʻie Point. Ditches, pumps, reservoirs, and wells are present in Lāʻie Wai and Lāʻie Maloʻo Ahupuaʻa. Homes can be found along the banks of Kōloa Stream. The rail line runs north to south in the middle of the project area. The roadway parallel to the shoreline is now labeled as Kamehameha Highway.

U.S. Army War Department terrain map, Kahuku, Kahana, and Paalaa (1943) quadrangles is similar to the previous maps (Figure 17). The only difference is the presence of more private residences and side streets in Kaipapaʻu Ahupuaʻa.

A 1949 Lāʻie Coast aerial photograph (UH SOEST) indicates the project area and north of the project area are being heavily cultivated (Figure 18). The hill north of Wailele Stream appears to have an access road, a possible home, and water tank on the plateau. The area *makai* of Wailele and Kōloa streams appears to be more developed; *mauka* of the developed area is a smaller hill with heavy vegetation. It appears the rail line no longer exists. House lots dot the coastline within and north of the project area.

A USGS topographic map, Kahuku (1954), Kahana (1954), and Hauula (1953) quadrangles indicates the rail line is still in use within the project area (Figure 19). However, just south of the project area, the rail line is labeled "abandoned." More homes are evident in Kaipapaʻu Ahupuaʻa.

A USGS topographic map, Kahuku (1965), Kahana (1967), and Hauula (1966) quadrangles shows the construction of the Church College of Hawaiʻi and the Polynesian Cultural Center in Lāʻie Wai Ahupuaʻa (Figure 20). Private residences, the Mormon Temple, and streets are also present in Lāʻie Wai Ahupuaʻa. The hill north of Wailele Stream is labeled "Gravel Pit." The rail line appears on the map, however, it stops 0.25-miles out of the project area. The *ahupuaʻa* of Kaipapaʻu and Hauʻula appear to be more heavily populated than before.

A 1971 Lāʻie Coast aerial photograph (UH SOEST) shows the construction of Brigham Young University (BYU) to the north of the project area (Figure 21). More private residences dot the coastline of Lāʻie Maloʻo Ahupuaʻa. The hill north of Wailele Stream appears to be partially

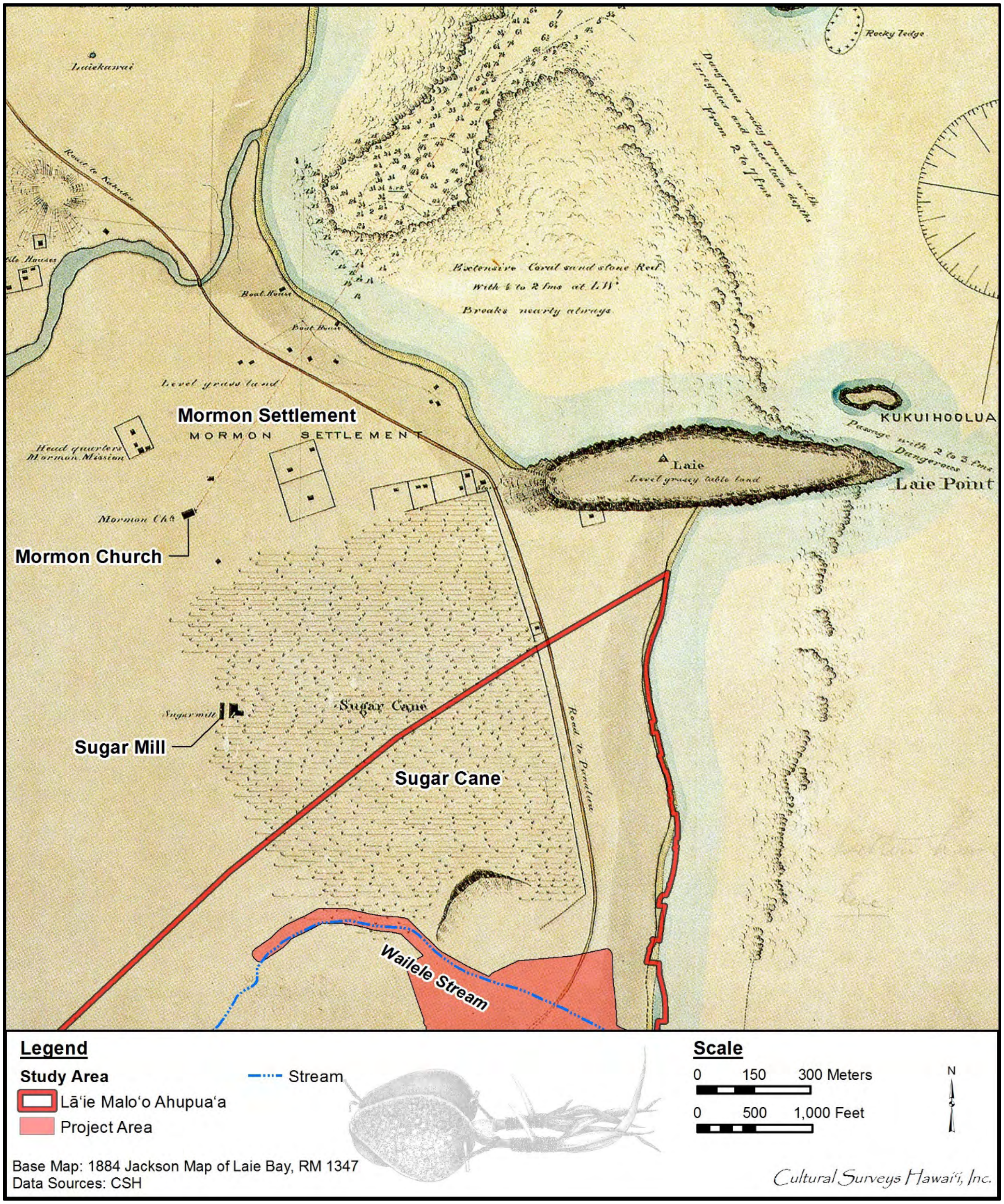

Figure 13. 1884 Jackson map of Lā‘ie Bay depicting portion of project area and tributaries; note Mormon Settlement, Mormon Church, Sugar Mill, and sugarcane fields in Lā‘ie Wai Ahupua‘a

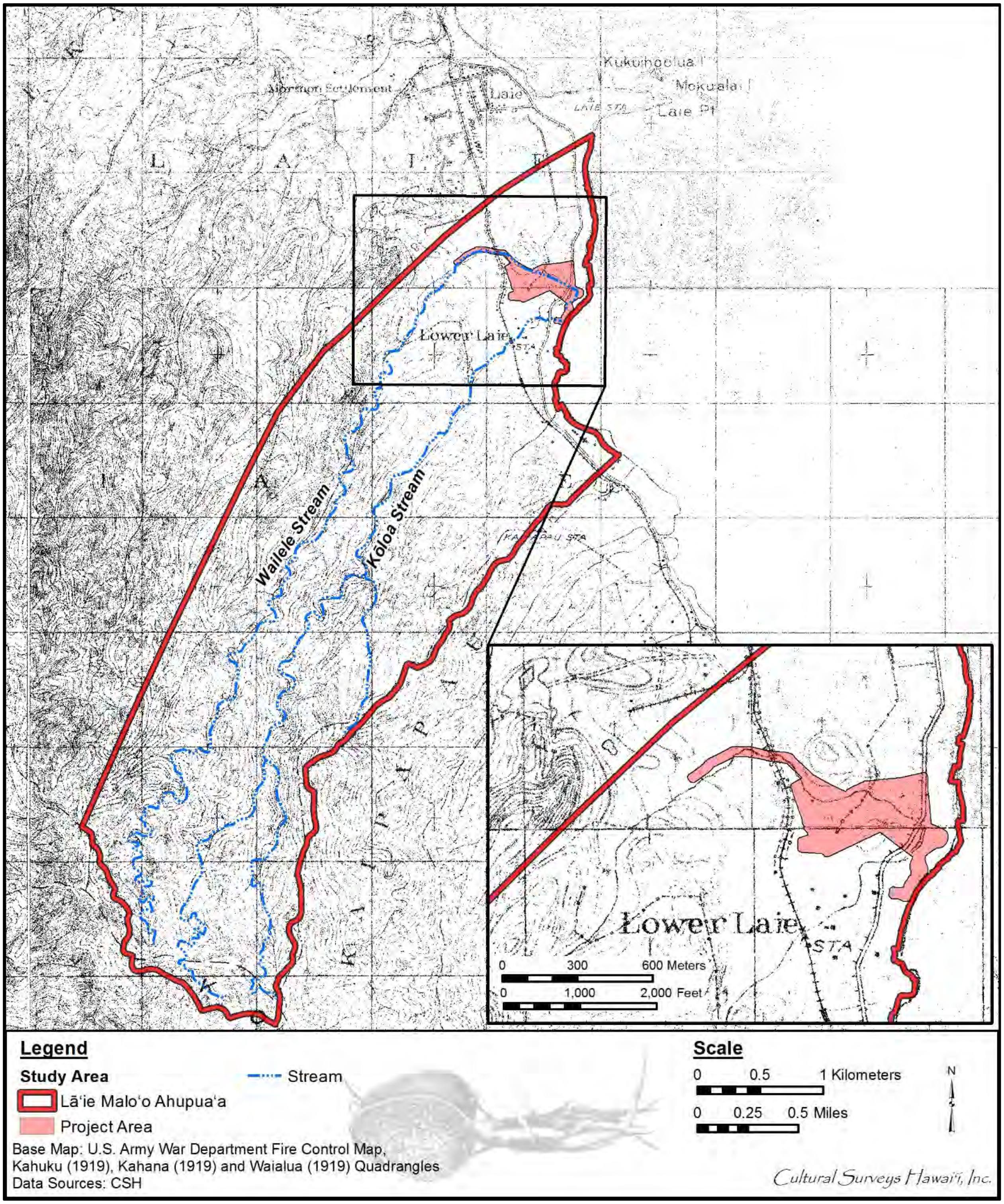

Figure 14. U.S. Army War Department Fire Control Map, Kahuku, Kahana, and Waialua (1919) Quadrangles with project area and tributaries; note inset depicts rail line traveling through the project area

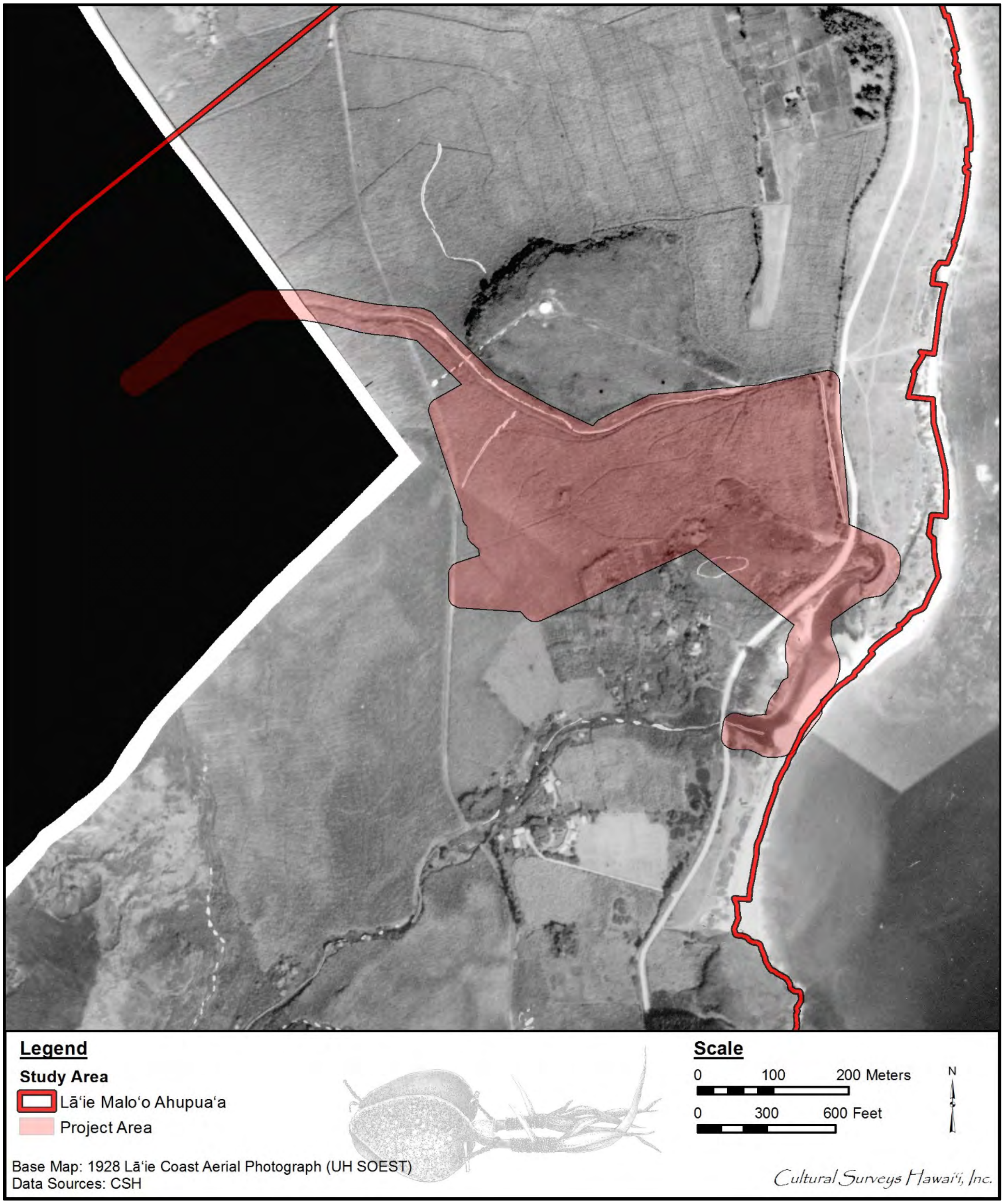

Figure 15. 1928 Lāʻie Coast Aerial Photograph (UH SOEST) depicting portion of project area

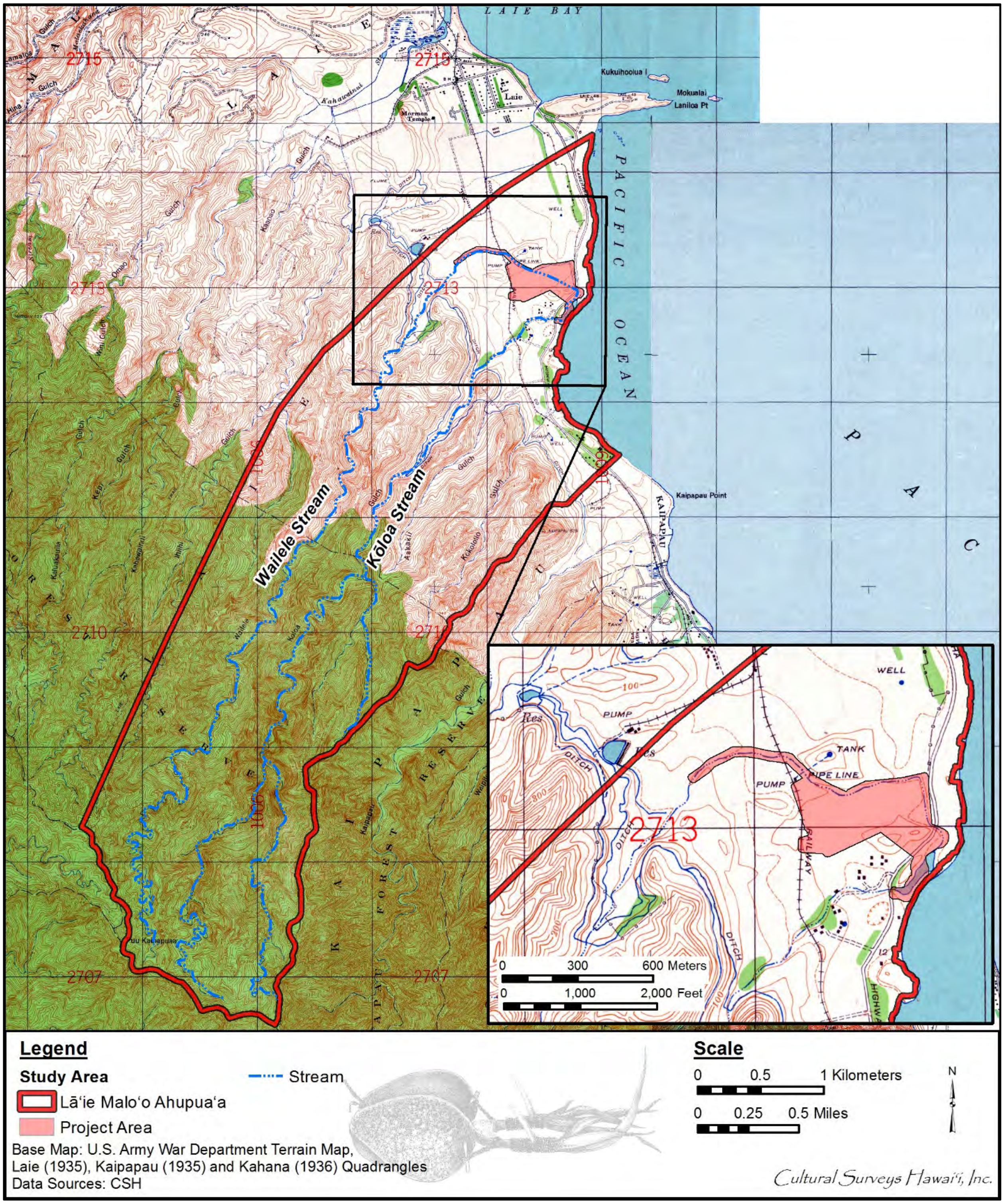

Figure 16. U.S. Army War Department Terrain Map, Laie (1935), Kaipapau (1935), and Kahuku (1936) Quadrangles depicting project area with tributaries

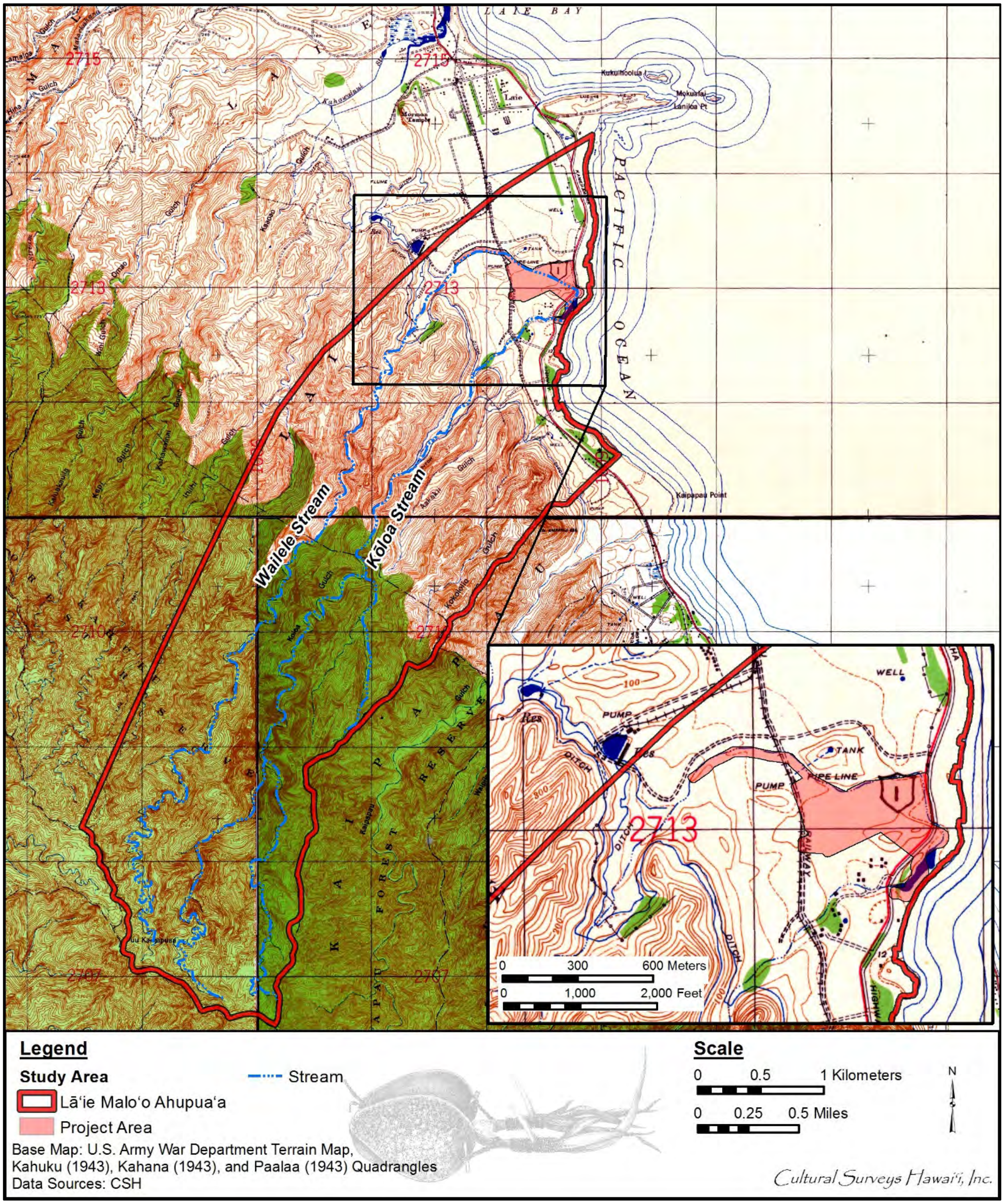

Figure 17. U.S. Army War Department Terrain Map, Kahuku, Kahana, and Paalaa (1943) Quadrangles with project area and streams; note evidence of water tanks, pumps, and other access roads within and in the vicinity of the project area

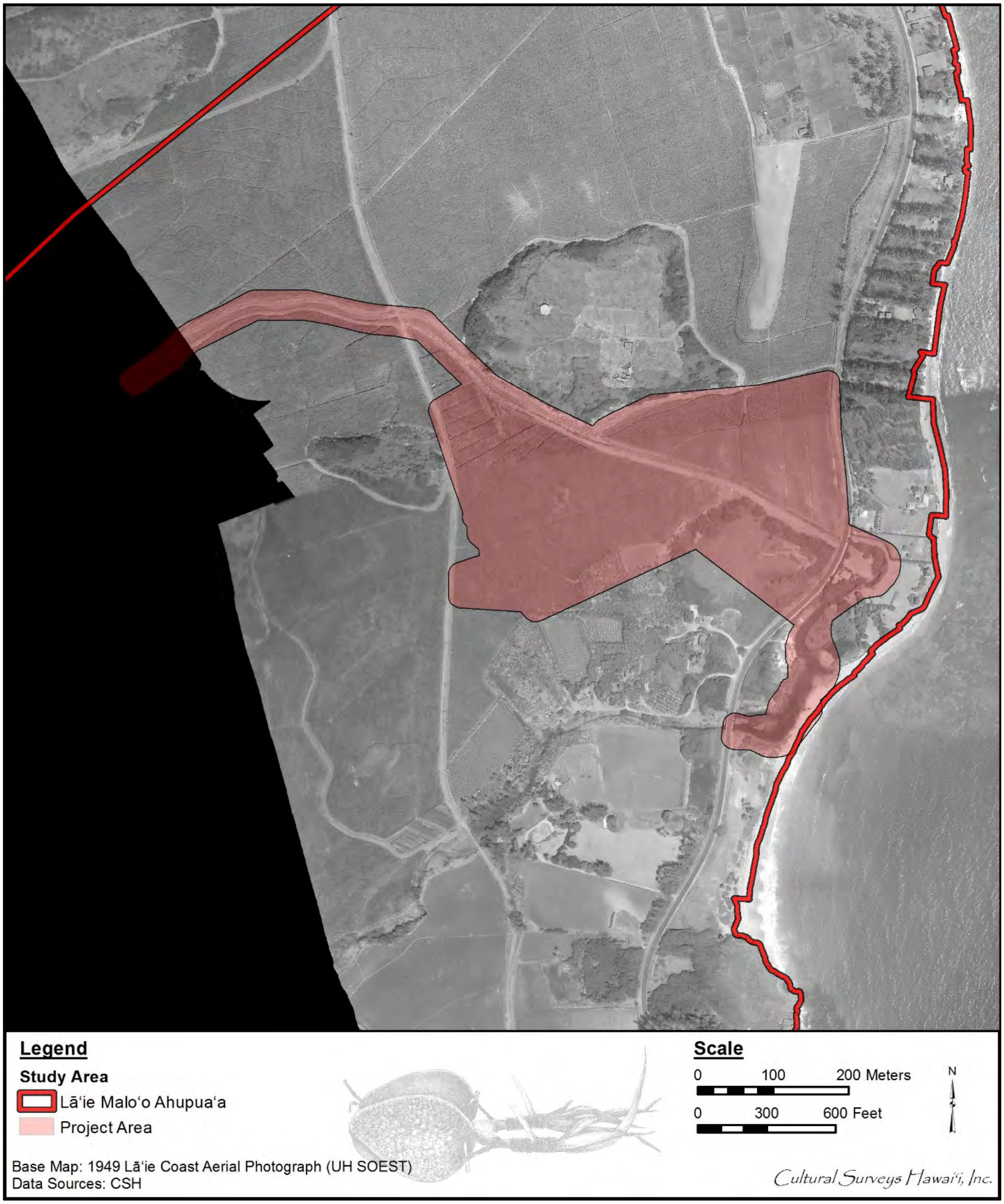

Figure 18. 1949 Lāʻie Coast Aerial Photograph (UH SOEST) with project area; note more development and cultivation within and in the vicinity of the project area

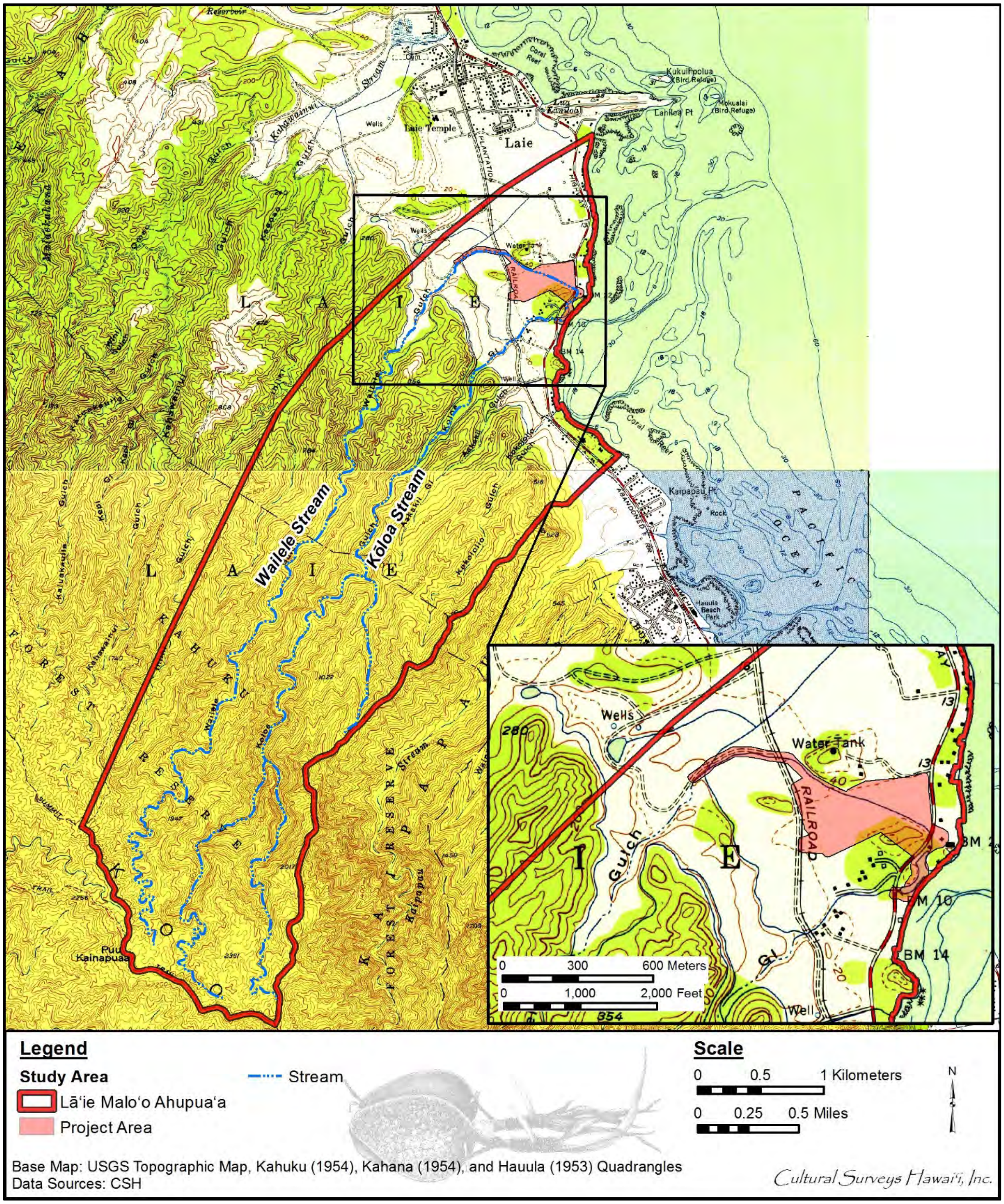

Figure 19. 1953 Hauula, 1954 Kahuku and Kahana USGS Topographic Quadrangles with project area and tributaries; note the multiple access roads within the project area and in Lā'ie Wai Ahupua'a

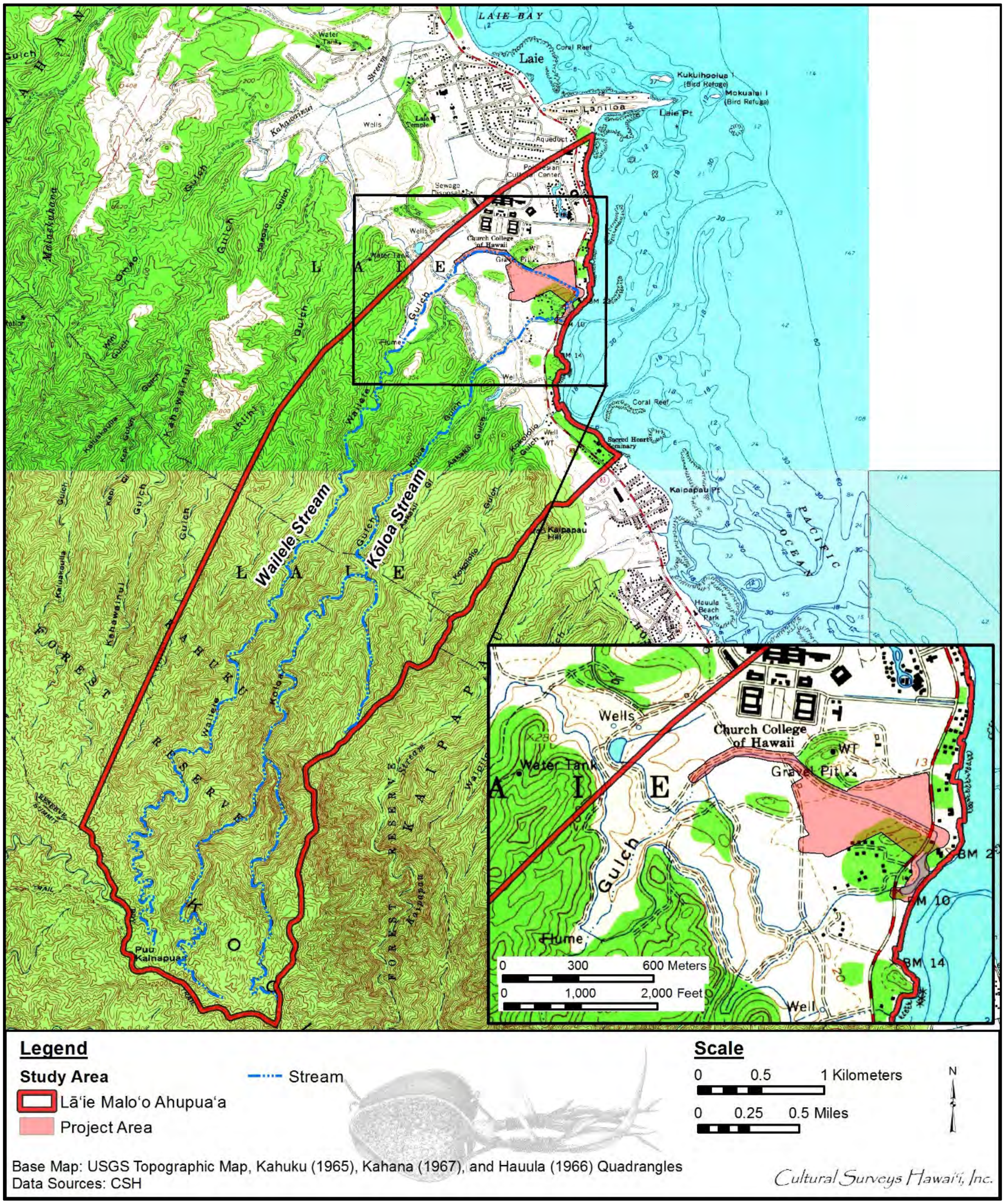

Figure 20. 1965 Kahuku, 1966 Hauula, and 1967 Kahana USGS Topographic Quadrangles with project area and tributaries; note north of the project area is Church College of Hawai‘i; private residences dot the coastline and can be found within the project area

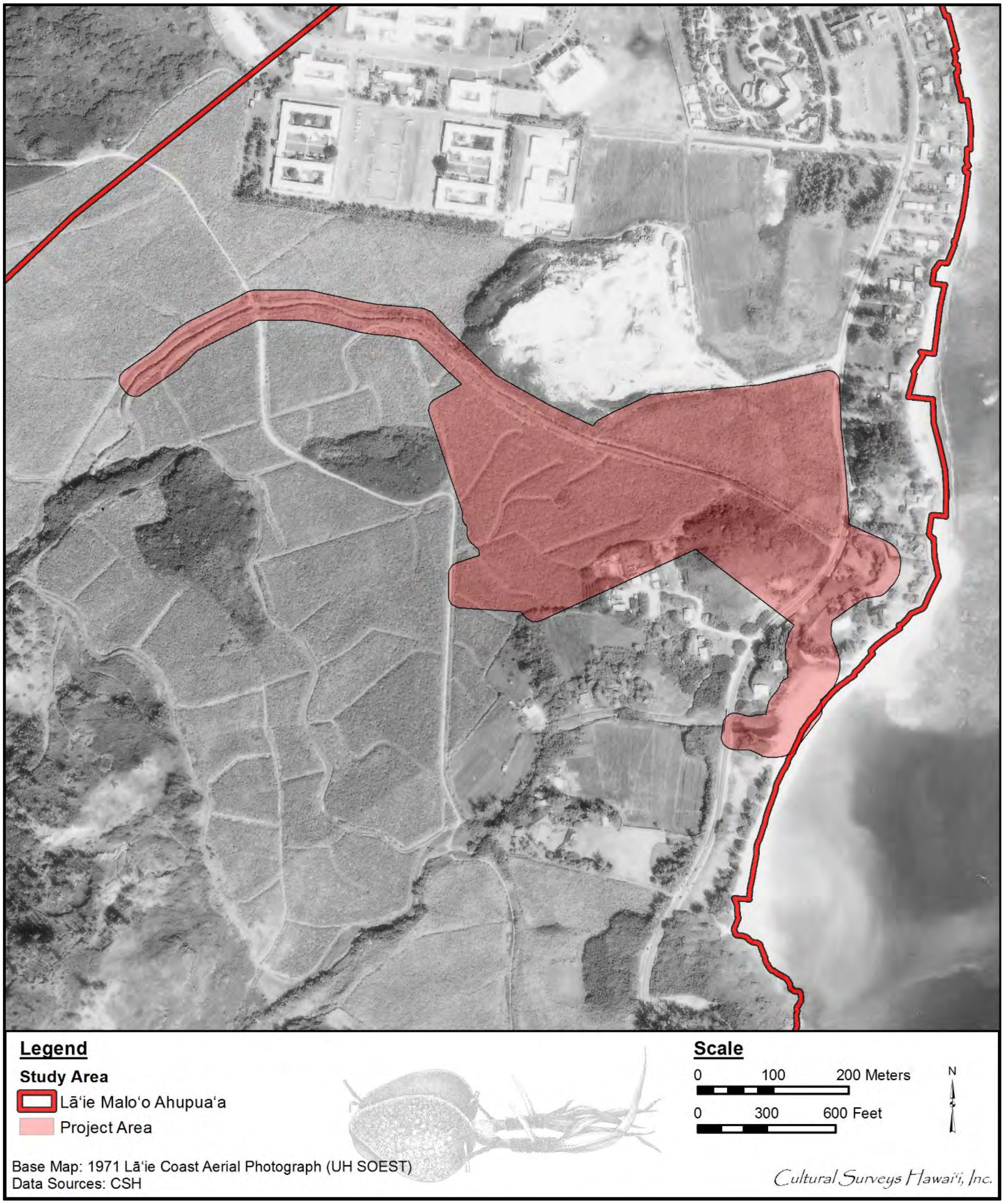

Figure 21. 1971 Lāʻie Coast Aerial Photograph (UH SOEST) with project area; note the hill north of Wailele Stream is now partially leveled and appears to be composed of sand

leveled and primarily composed of sand. Between Wailele Stream and Kōloa Stream, the heavily vegetated hill still exists. The project area is being cultivated and appears to have more access roads. Kōloa Stream is not as well defined as it once appeared in previous maps.

A USGS Orthophotoquad aerial photograph, Kahuku (1977), Kahana (1978), and Hauula (1977) quadrangles shows the BYU campus has been constructed (Figure 22). More buildings are evident between the BYU campus and the shoreline. The shoreline above the project area is dense with private residences. The hill that was once north of Wailele Stream has been completely leveled and appears to be sand. It appears the project area is no longer being cultivated.

3.9 Previous Archaeological Research

Twentieth century archaeological findings from reconnaissance, inventory surveys, and inadvertent finds are the main source of our knowledge about the archaeological record in Lā‘ie Ahupua‘a. Archaeological work in the last 20 years in this area has not been extensive. Previous archaeological reports are shown in Table 2 and their locations can be seen in Figure 23. Previously identified State Inventory of Historic Properties (SIHP) numbers can be seen in Table 3 and their locations can be seen in Figure 24.

In the 1930s, Gilbert McAllister (1933) undertook the first comprehensive survey of archaeological sites on O‘ahu. He identified one site within Lā‘ie Malo‘o Ahupua‘a: Site 285, Kaihukuuna (on the Hau‘ula side of Laniloa Point), a *ko‘a* (McAllister 1933:158). All that remains of the *ko‘a* are a few stones on the beach. It is said that mullet was offered to the *ko‘a*.

In 1980, Archaeological Research Associates conducted an intensive subsurface archaeological reconnaissance survey at Lā‘ie Beach Park (Connolly 1980). A total of 13 test pits were excavated throughout Lā‘ie Beach Park. A total of 15 features were recorded, of these features, three possible postmolds were recorded. However, the three postmold features could also be root stains. The remaining 12 features consisted of fire pits and other undetermined pits, suggesting temporary habitation use. A total of 56 prehistoric artifacts were found including volcanic glass fragments, basalt flakes, adze flakes, a possible sling stone, perforated shells, coral abraders, basalt file, micro-adze, fishhook tab, whetstone fragments, basalt hammerstone, and a grinding stone. These artifacts indicated temporary habitation as well. Midden found in the test pits included small amounts of fish and mammal, most likely pig.

In 1980, Martha Yent and Agnes Estioko-Griffin conducted archaeological investigations at Mālaekahana State Recreation Area, Phase I as part of park development. Archaeological work consisted of mapping, testing, excavation, and analysis of the cultural resources observed in the Phase I section of the park, designated SIHP # 50-80-02-2801 and defined by Kamehameha Highway on the west, the Pacific Ocean on the east, and Kahawainui Stream on the south. Archaeological features observed consisted of a single surface structure, a fishing shrine at Kalanai Point (previously identified by McAllister as Site 274) and a sequence of subsurface deposits containing fishhook forms, shellfish midden, post holes, rock-lined fire pits, and thick charcoal deposits indicative of extensive cooking activities and the use of *imu* (cooking ovens). Excavations revealed three major cultural occupations dating to the late prehistoric period (ca. AD 1600-1780). Two human skeletons were also found; one was located adjacent to Site 274 and seemed to be contemporaneous with the structure. McAllister (1933:156) had found a skeleton during his examination of the feature in the early 1930s. All three occupations are characterized by an

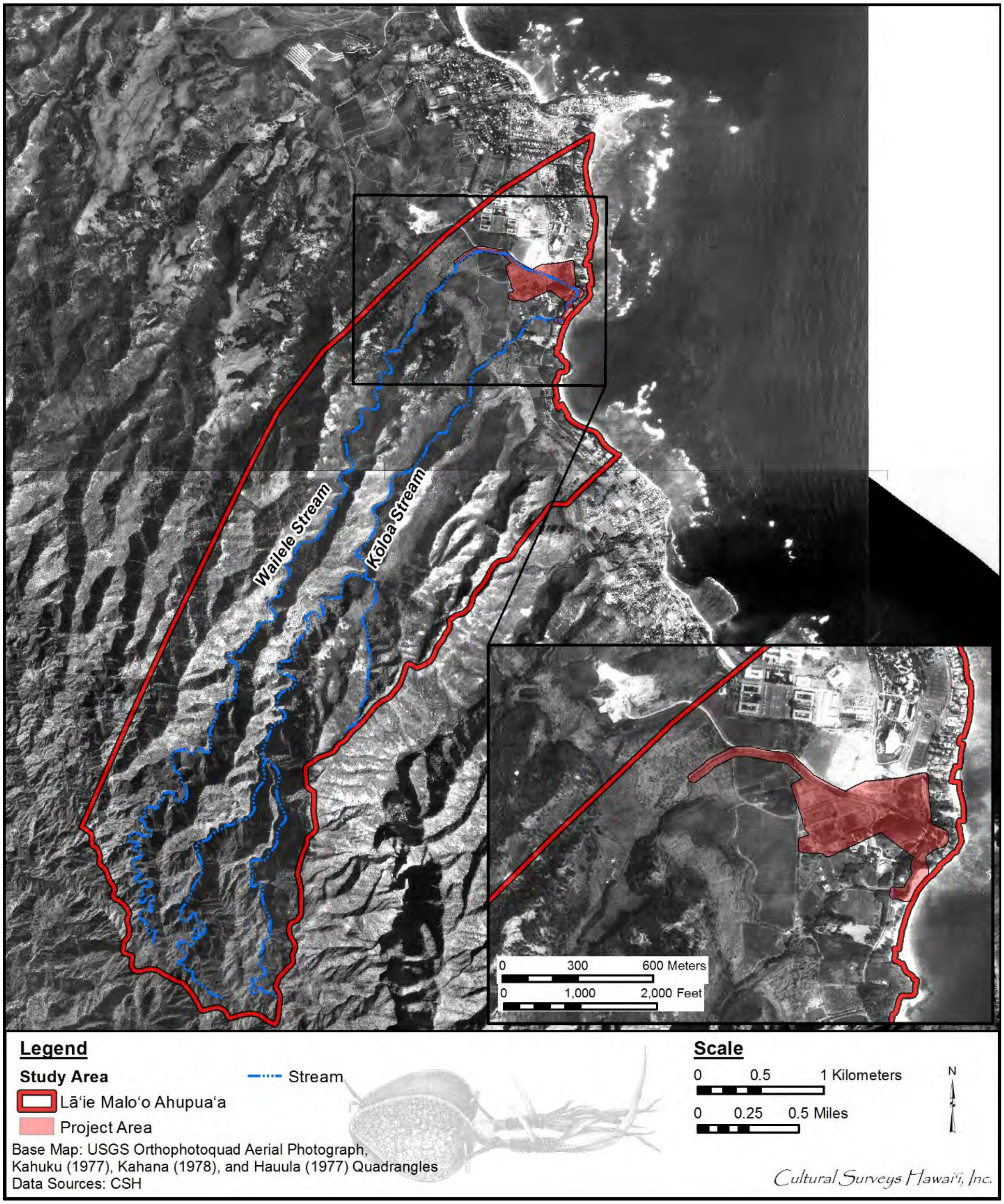

Figure 22. USGS Orthophotoquad Aerial Photograph, Kahuku (1977), Kahana (1978), and Hauula (1977) Quadrangles with project area and tributaries

Table 2. Previous Archaeological Studies within and in the Vicinity of the Project Area

Author	Location of Study	Nature of Study	Results (SIHP # 50-80-02)
McAllister 1933	Island-wide	Archaeology of O‘ahu	Site 285, Kaihukuuna Ko‘a
Connolly 1980	Lā‘ie Beach Park	Subsurface reconnaissance survey	Thirteen test pits and auguring; deemed temporary habitation site
Yent and Estioko-Griffin 1980	Mālaekahana (SIHP # -2801)	Archaeological investigation	Fishing shrine identified at Kalanai Point; subsurface deposits with fishhook forms, shellfish midden, post holes, rock-lined fire pits, and thick charcoal deposits; site dated to AD 1600-1780
Ahlo and Hommon 1981	Kahawainui Stream, Lā‘ie Wai	Archaeological inventory survey	No significant finds; extensive land disturbance; mentions remnant of Shinto *tori* and cemetery
Barrera 1984	Board of Water Supply well located on ridge between Kaaoao and Ihiihi Gulches	Field inspection	No significant finds
Neller 1984a	Lā‘ie Wai Stream, Lā‘ie Wai	Comments on Kahawainui Stream Flood Control Study	Comments to Ahlo and Hommon (1981) documenting remains of Japanese cemetery and Shinto shrine, plantation camp, a railroad bed, sacred stone of Hauwahine, house ruins
Neller 1984b	Lā‘ie Wai Stream, Lā‘ie Wai	Comments on Kahawainui Stream Flood Control Study including results of archaeological reconnaissance along Lā‘ie Wai Stream	Supplemental investigations to Ahlo and Hommon (1981) documenting remains of Japanese cemetery and Shinto shrine, plantation camp, a railroad bed, sacred stone of Hauwahine, house ruins

Author	**Location of Study**	**Nature of Study**	**Results (SIHP # 50-80-02)**
Bath 1985	Kahawainui Stream, Lā‘ie Wai	Archaeological testing (excavations, auger coring) and mapping	Discusses five surface features; two graveyards, one alignment, one solution cave and one mound, two “prehistoric” layers
Hammatt 1989	South of Lā‘ie Beach Park	Archaeological reconnaissance	Five auger holes and three shovel test pits; cave found on *makai* side of property containing scattered fragments of human bone dating to prehistoric or early historic era; historic litter including bottles, metal, and an immature goat skeleton present
Jensen 1989	Kawela Bay	Mitigation plan	Mitigation involving SIHP # 50-80-01-2899, Kawela Bay Archaeological Area, and SIHP # 50-80-01-2912, Punahoolapa Marsh
Kennedy 1990	Kahuku Village	Archaeological subsurface testing	No human or cultural layers; early to mid-twentieth century dump with typical household refuse, shallow irrigation channels related to recent gardening activities in vicinity, fragments of bones in topsoil determined to be small, feral animals
Hammatt 1991	Lā‘ie Wastewater Treatment Plant	Archaeological inventory survey	No significant finds
Dunn and Rosendahl 1992	Mālaekahana and Lā‘ie Ahupua‘a	Archaeological inventory survey	121 features found in both *ahupua‘a*

Author	Location of Study	Nature of Study	Results (SIHP # 50-80-02)
Kennedy, Denham, and Moore 1992	Kokololio Beach Park	Archaeological inventory survey and subsurface testing	Three new burials (SIHP #s -4476, -4477, and -4478), 12 possibly historic fire pits (-4479, -4480, -4481, -4482), and cultural materials recovered during AIS; no remains removed from property; radio carbon dating indicated habitation between AD 1422-1896
Kennedy, Moore, and Reintsema 1992	Kokololio Beach Park	Archaeological data recovery	Midden, faunal remains, and artifacts recovered during data recovery
Kennedy 1993	Kokololio (Kakela) Beach Park	Archaeological monitoring	No significant finds
Kennedy and Denham 1992	Kakela Beach Park	Data recovery results for excavations	Midden deposit (SIHP # -4308) intensively excavated; variety of artifacts and midden recovered in multiple layers; no other cultural layers or burials found
Moore and Kennedy 1994	Kokololio Beach Park	Archaeological monitoring	Seven new burials (SIHP #s --4830 to -4836)
Collins 1995	Lā‘ie Wastewater Reclamation Facility	Field visit	Human bone collected in three locales near Nioi Heiau
Halpern and Rosendahl 1995	Lands of Mālaekahana and Lā‘ie	Archaeological inventory survey	Addendum for Lā‘ie Master Plan project
Sarvak et al. 1996	Kokololio Beach Park	Archaeological monitoring	Inadvertent human burial (SIHP # -5369) and several artifacts including a sling stone, two *‘ulu maika*, seven pieces of worked stone, one piece of bone cut with a metal implement

Author	**Location of Study**	**Nature of Study**	**Results (SIHP # 50-80-02)**
Masterson et al. 1997	Kapaka to Lāʻie Ahupuaʻa	Archaeological monitoring	Total of 63 features recorded; 19 of 63 features human burials; four of burials left in situ while remaining 15 curated at SHPD awaiting reinterment; SIHP #s 50-80-06-4792 to -4798; and -5457 and -5458
Buffum and Dega 2001	South of Polynesian Cultural Center	Archaeological inventory survey	Seven sites including two rock shelters (SIHP #s -5866 and -5867), a series of six overhangs (SIHP # -5868), a historic *ʻauwai* (irrigated ditch) (SIHP # -5869), a remnant historic bridge foundation (SIHP # -5870), a historic ditch (SIHP # -5871), and one retaining wall (SIHP # -4474, Feature D)
Perzinski and Hammatt 2002	Kokololio Bridge	Archaeological assessment	Previous burials and documented cultural layers found in vicinity of Kokololio Stream; no surface traditional Hawaiian sites or features observed; archaeological monitoring recommended
Monahan 2005	Lāʻie Inn	Surface survey with limited subsurface testing	A historic *imu*
McElroy 2006	TMK: [1] 5-5-002:003 on coast north of Lāʻie Beach Park	Archaeological inventory survey	No in situ finds; fragmentary human tibia recovered
Cordy et al. 2008	Kokololio Bridge	Archaeological monitoring	No significant finds

Author	Location of Study	Nature of Study	Results (SIHP # 50-80-02)
McElroy 2008	TMK: [1] 5-5-002:003	Archaeological monitoring	Human remains previously discovered at property; cultural layer including a fire pit feature (SIHP # -7030); marine shell, sea urchin, crab, land snail, animal bone, volcanic glass, and charcoal also collected; two isolated bone fragments discovered including a rib and mandible fragment; *ʻiwi* reinterred on property

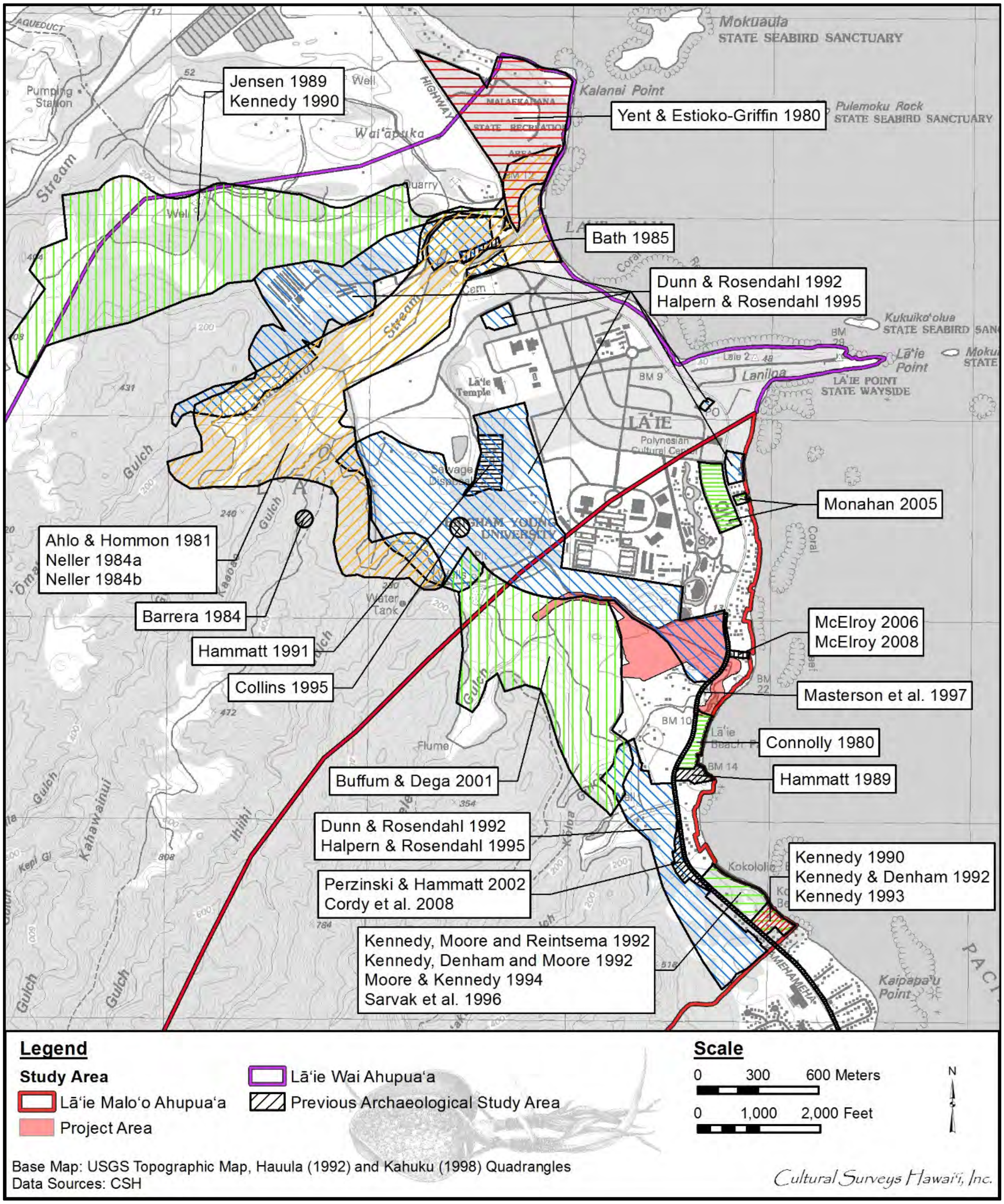

Figure 23. Portion of the 1992 Hauula and 1998 Kahuku USGS 7.5-Minute Topographic Quadrangles showing the project area and previous archaeological work in the vicinity

Table 3. Previously Identified SIHP #s in Lā‘ie Malo‘o Ahupua‘a

SIHP # 50-80-02	**Description**	**Author**
-4049	Pre- and post-Contact subsurface cultural deposit	Connolly 1980
-4050	Wall	Connolly 1980
-4467	Pre- and post-Contact subsurface cultural deposit	Dunn and Rosendahl 1992
-4474 A–C	Post-Contact retaining walls	Dunn and Rosendahl 1992
-4474 D	Post-Contact retaining wall	Buffum and Dega 2001
-4705	Pre-Contact overhang shelter	Hammatt 1989
-5457	Pre-Contact subsurface cultural deposit	Masterson et al. 1997
-5458	Pre-Contact subsurface cultural deposit and human burial	Masterson et al. 1997
-5866	Rock shelter with lithics and fragmented human remains	Buffum and Dega 2001
-5867	Rock shelter with traditional artifacts and fragmented human remains	Buffum and Dega 2001
-5868	Series of six overhangs along a limestone cliff facing	Buffum and Dega 2001
-5868 Fea. 3	Scattered human remains	Buffum and Dega 2001
-5869	Post-Contact irrigation ditch	Buffum and Dega 2001
-5870	Post-Contact historic bridge foundation	Buffum and Dega 2001
-5871	Post-Contact irrigation ditch	Buffum and Dega 2001
-6851	Fragmented human remains	McElroy 2008
-7030	Pre- and post-Contact subsurface cultural deposit	McElroy 2008

Image Redacted

Figure 24. Aerial photograph showing project alternatives with project area, LCAs, burials, historic properties, and former railroad tracks (Google Earth 2013)

abundance of shellfish midden suggesting subsistence patterns utilizing the inshore reef of Mālaekahana and Lāʻie bays (Yent and Estioko-Griffin 1980).

In 1981, an archaeological reconnaissance survey was conducted for a flood control study of Kahawainui Stream (Ahlo and Hommon 1981). The study was intended to determine the feasibility of Kahawainui Stream and the extent to which the Federal government might participate. The study area was split into three groups: Areas A, B, and C. Area A was *makai* of Kamehameha Highway. Area B began *mauka* of Kamehameha Highway and extended to the Cackle Fresh Egg Farm in Lāʻie Wai Ahupuaʻa. Area C began from the Cackle Fresh Egg Farm and extended *mauka* with a portion traveling south toward the sand quarry behind Brigham Young University. No significant finds were located from the survey. Extensive land disturbance was evident and most likely obliterated any evidence of archaeological or cultural sites. Graves were found in Area B and are most likely 100 years old. A *tori* (shrine) was discovered in Area B.

From December 1983 to January 1984, archaeological reconnaissance surveys were performed at several locations of existing and proposed Board of Water Supply well sites on the windward coast of Oʻahu. The purpose of the survey was to locate and identify archaeological and historical remains which might be impacted by construction activities associated with development of the wells. No significant finds were discovered during the survey of the well sites (Barrera 1984).

In 1984, Earl “Buddy” Neller of SHPD commented on the Kahawainui Stream Flood Control Study from the perspective of historic preservation and cultural resource management (Neller 1984a). Neller discusses cultural sites that would be jeopardized, the importance of better documentation and research, and the importance of inclusion of sites regardless of condition. Neller produced a second report to follow up based on his concerns (Neller 1984b). However, he now includes the results of an archaeological reconnaissance survey that he performed.

In 1985, archaeological testing and mapping was conducted at Kahawainui Stream in Lāʻie Wai Ahupuaʻa. Investigations included review of historical documents, the excavation of six test units, boring of 12 auger tests, and mapping. Five surface features including two graveyards, one alignment, one solution cave, one mound, and two prehistoric layers were discovered (Bath 1985).

In 1989, CSH conducted an archaeological reconnaissance of a 2.8-acre parcel in Lāʻie (Hammatt 1989). Five auger holes were excavated to bedrock to characterize the deposits and the potential for buried cultural layers. No cultural materials or archaeological deposits were encountered in the auger trenches except for fragments of modern trash in the upper layers. In addition, three shovel test pits were also excavated on the *mauka* portion of the property. No cultural layers or archaeological features were observed. On the *makai* side of the property, a cave was located. The opening to the cave is approximately 8 ft wide and 3 ft high. The cave floor is comprised of roof-fall boulders. The cave extends to a length of approximately 50 ft from the main entrance opening into a chamber 3.5 ft in width. The chamber contained scattered fragments of a human bone and a few water-rounded manuports. Due to the number of fragments within the cave, an estimated two burials of prehistoric or early historic era origin were present. Historic litter was observed in the cave including bottles, metal, and a skeleton of an immature goat.

In 1989, an archaeological mitigation plan was developed to address development conditions related to archaeological and historical concerns. The sites of concern were SIHP # 50-80-01-2899, Kawela Bay; and SIHP # 50-80-01-2912, Punahoʻolapa Marsh (Jensen 1989). Under the plan, an archaeological monitor would be present during all ground disturbing activities. If any archaeological remains were found during excavation, data would be collected immediately.

In 1990, Archaeological Consultants of Hawaiʻi, Inc. conducted an archaeological reconnaissance and subsurface testing in Kahuku Village (Kennedy 1990). No human remains or cultural layers were identified. An early to mid-twentieth century dump containing typical household refuse was located with some shallow irrigation channels related to recent gardening activity in the vicinity. Fragmentary bones collected were found in the upper regions of topsoil and were determined to be the remains of small, feral animals.

In 1991, CSH conducted an archaeological survey of the Lāʻie Sewer Plant (Hammatt 1991). No archaeological or historical sites were found and no sites had been previously recorded in the vicinity.

In 1992, Archaeological Consultants of Hawaiʻi, Inc. conducted an inventory survey and subsurface testing for the proposed Kokololio Beach Park (Kennedy et al. 1992a). During this survey, three new human burials were discovered (SIHP #s -4476, -4477, and -4478). In addition, 12 possibly historic fire pits (SIHP #s -4479, -4480, -4481, and -4482), and a number of cultural materials were discovered. Two cultural deposits were radiocarbon dated with a return date of AD 1422-1896. The same year, Archaeological Consultants of Hawaiʻi, Inc. conducted data recovery investigations at Kokololio Beach Park (Kennedy et al. 1992b). Six test units were manually excavated in specified areas. Samples were obtained for radiocarbon analysis from several fire pits. Midden, faunal remains, and artifacts were also recovered during excavations. The results of these excavations indicate temporary occupation at this particular area as early as the thirteenth century and continuing until the present.

A 1992 inventory survey (Dunn and Rosendahl 1992) identified over 121 features in the lands of Mālaekahana and Lāʻie. The nearest recorded sites to the current project area were an historic concrete habitation foundation (SIHP # -4455), and a modified outcrop (SIHP # -4456), probably the result of a bulldozer push, located over 1 km to the west.

In 1992, Archaeological Consultants of Hawaiʻi, Inc. conducted data recovery at Kokololio Beach Park (Kennedy and Denham 1992). A midden deposit (SIHP # -4308) was intensively excavated. A variety of artifacts and midden were recovered from a subsurface deposit with multiple layers. The multiple layers were interpreted as evidence of early use (thirteenth century) to present use. Results of further subsurface testing were negative with cultural materials and/or human remains.

The following year, Archaeological Consultants of Hawaiʻi, Inc. conducted archaeological monitoring at Kakela (also known as Kokololio) Beach Park during construction activities to ensure the protection of previously identified cultural sites and burials encountered during the archaeological survey conducted the prior year (Kennedy 1993). During monitoring, no significant cultural deposits were encountered during excavations.

The following year, archaeological monitoring was conducted at Kokololio Beach Park (Moore and Kennedy 1994). Seven previously unidentified burials were inadvertently discovered during construction activities associated with park improvements (SIHP #s -4830 to -4836).

In 1995, SHPD conducted a field visit to the vicinity of Nioi Heiau (Collins 1995). The area around Nioi Heiau was recently bulldozed. SHPD attempted to locate the limestone pavings that were from Nioi Heiau. Although no structures were located, they did find human bone on the surface. Bone fragments were visible on the surface at four locales in the vicinity of Nioi Heiau. At Locale #1, 11 non-bone items were collected including coral fragments, a crab claw, and a land snail. Mammal bone and probable human bone were also collected. Identifiable human bone included two fragments of a metacarpal shaft, vertebral spinous process, femoral and tibial shafts. Locale #2 consisted of two non-bone items, crumbling pieces of mammal bone, and crumbling probable human bone. Identifiable human bone at Locale #2 consisted of six fragments of mandible, five mandibular molars, one mandibular premolar, and one mandibular incisor, parts of vertebrae, portions of the right radius and ulna, and distal shaft portion of an ulna side. Locale #3 consisted of one non-mammal bone. Locale #4 consisted of one non-bone item and crumbling probable human bone. Identifiable human bone found at Locale #4 included portions of the cranial-vault, vertebral articular facet, right hipbone portions, head and neck portion of the right femur, and a portion of the right femoral shaft.

In 1996, Archaeological Consultants of the Pacific, Inc. conducted archaeological monitoring at Kokololio Beach Park (Sarvak et al. 1996). During monitoring activities, an inadvertent human burial was identified and assigned SIHP # -5369. Several artifacts were also recovered including a sling stone, two *ʻulu maika* (game stone), and seven pieces of worked stone. One piece of bone cut with a metal implement was also recovered from Kokololio Beach Park.

In 1997, CSH conducted archaeological monitoring for the Kapaka to Lāʻie water line (Masterson et al. 1997). Archaeological monitoring of a new 14-inch water main throughout Koʻolauloa District first began in 1992. The water line would travel through the *ahupuaʻa* of Kapaka, Mākao, Hauʻula, Kaipapaʻu, and Lāʻie. During the course of water line trench excavations, a total of 63 features were recorded. Of the 63 features, 19 were human burials and 44 were archaeologically significant localities. The localities were grouped into nine SIHP #s: 50-80-06-4792 through -4798; and 50-80-06-5457 and -5458. Four of the burials were left in situ while the remaining 15 were curated at SHPD awaiting reinterment.

Buffum and Dega (2001) conducted an AIS of 74 acres of land in Lāʻie just south of the Polynesian Cultural Center. Seven sites were recorded including "two rock shelters (Sites -5866 and -5867), a series of six overhangs along a limestone cliff facing (Site 5868), an historic *ʻauwai* (Site 5869), a remnant historic bridge foundation (Site 5870), a historic ditch (Site 5871), and one retaining wall (Site 4474, Fe. D)" (Buffum and Dega 2001).

CSH (Perzinski and Hammatt 2002) conducted an archaeological assessment for the proposed replacement of Kokololio Bridge. Previous archaeology indicated cultural layers with associated human burials. During the assessment a probable modern wall (less than 50 years old) and a drainage canal parallel to Kamehameha Highway were noted. However, no surface traditional Hawaiian sites or features were observed during the assessment.

In 2005, Chris Monahan conducted a surface survey and limited subsurface testing on a 10.5-acre parcel for the Lāʻie Inn Redevelopment. This project area is approximately 400 m south of the current project area. The only recorded feature was an historic *imu*.

In 2006, Garcia & Associates (GANDA) conducted an archaeological inventory survey of TMK: [1] 5-5-002:003 in Lāʻie Maloʻo Ahupuaʻa (McElroy 2006). The previous year, fragmented human remains were found on the property and collected by the Honolulu Police Department, which were later turned over to SHPD. No surface features were observed during the survey. Ground penetrating radar (GPR) detected a compact layer fill, a root mass, and a large natural stone. A fragmented human tibia was found in the fill mixed with modern debris and was clearly not part of a primary or in situ burial. Because human remains had been previously found on the property, archaeological monitoring was recommended for any ground disturbing activities that might take place during construction.

In 2008, CSH conducted archaeological monitoring for the Kokololio Bridge project (Cordy et al. 2008). Based on previous research, prior field inspection, and consultation with knowledgeable *kamaʻāina* (native born) of the area, there was a moderate to high probability of encountering traditional Hawaiian burials and/or cultural layers in subsurface deposits. However, no significant cultural resources were encountered during monitoring.

In 2008, GANDA conducted archaeological monitoring at a private property located at TMK: [1] 5-5-002:003 where human remains had been previously discovered (McElroy 2008). Excavations included 36 small trenches for house footings, four longer trenches for a house foundation, seven utility trenches, and a small pit for the reinterment of human remains. A cultural layer including a fire pit feature (SIHP # -7030) was found in the eastern portion of the property. Marine shell, sea urchin, crab, land snail, animal bone, volcanic glass, and charcoal were also collected. Two fragments of human remains were recovered during monitoring, a rib and a mandible fragment. Both fragments were isolated finds, unassociated with an intact burial. All the remains were reinterred in a reburial pit on the property. The *ʻiwi* (bones) were wrapped in *kapa* (bark cloth) and placed in *lauhala* (pandanus leaves) baskets. The baskets were then placed in the base of the pit and covered with sand. A quarter and two nails were placed on the baskets to detect their location with a metal detector. Pieces of coral were also placed below the surface.

In summary, there have been a number of significant archaeological finds on the Lāʻie Coast, from Kalanai Point (Mālaekahana State Recreation Area) in the north to Kokololio Beach to the south. At least 20 burials have been reported from this area (Bath 1988; Kennedy, Denham, and Moore 1992; Kennedy, Moore, and Reintsema 1992; Masterson et al. 1997; Moore and Kennedy 1994; Sarvak et al. 1996). While the works of Connolly and Kennedy have emphasized that the Lāʻie coastal area was the locus of temporary habitations with permanent coastal habitation focused further inland, it seems also that the Lāʻie coast was a significant area for burials. The archaeological monitoring report of work along Kamehameha Highway (Masterson et al. 1997) encountered cultural layers and associated burials within 2 km of the Kokololio Bridge on either side. Substantial Hawaiian activity in the Lāʻie vicinity in pre-Contact times is therefore indicated.

Section 4 Field Inspection Results

The fieldwork portion of this project consisted of a pedestrian inspection of the project area with particular focus on Alternative 3 which includes Basin 1, Basin 9, First Flush Basin, and the Wailele Stream. The fieldwork was conducted by CSH cultural researcher Nicole Ishihara, B.A., and archaeologist and CSH office manager David Shideler, M.A. under the general supervision of Dr. Hallett H. Hammatt on 7 and 14 November 2014. Ms. Ishihara and Mr. Shideler traversed all open, accessible areas of Alternative 3 and took photographs of points of interest. The area near the mouth of Wailele Stream where residential homes are situated was inspected with limitations.

On 7 November 2014, the project area was accessed from Cane Haul Road just south of the Polynesian Cultural Center. Basin 9 consists of an agricultural farm and an equipment shed. The general farm area under cultivation consists of hibiscus (*Hibiscus* sp.), banana (*Musa*), plumeria, ti (*Cordyline terminalis*), breadfruit (*Artocarpus altilis*), and taro (*Colocasia esculenta*) (Figure 25). Other various plants scattered within Basin 9 include *loulu* palm (*Pritichardia*), pandanus (*Pandanus odoratissimus*), *ʻape* (*Alocsia macrorrhiza*), *noni* (*Morinda citrifolia*; Indian mulberry), Norfolk Island pine (*Araucaria heterophylla*), and *hau* (*Hibiscus tiliaceus*). Near the northern perimeter of Basin 9, a plantation irrigation valve was found to the west of the equipment shed (Figure 26). It is located in an uncultivated area and is surrounded by short grass, dirt, and scattered rocks.

First Flush Basin was accessed on 7 November 2014 from Kamehameha Highway. It was noted that the perimeter of First Flush Basin consists of Jaucas sand. The vegetation on the eastern limits of First Flush Basin consists of a dense *hau* grove, guinea grass (*Megathyrsus maximus*), *kamani* (*Calophyllum inophyllum*), coconut (*Cocos nucifera*), Common Ironwood (*Casuarina equisetifolia*), and Castor oil plants (*Ricinus communis*) (Figure 27). After entering from the southeastern corner of First Flush Basin, a large portion of the area consists of limestone with Banyan trees (*F. benghalensis*) scattered about (Figure 28). To the center of First Flush Basin a passenger bus was found. It appeared the windows, floor, engine, and license plates were missing. Approximately 2 to 3 m east of the passenger bus was a small mound of broken limestone pieces. The mound was approximately 1 m in diameter and 0.5 m in height (Figure 29).

Basin 1 was accessed 7 November 2014. The majority of Basin 1 consists of an agricultural farm. A caretaker's home is located just west of the Basin 1 project area (Figure 30). The southeastern portion of Basin 1 consists of *kukui* (*Aleurites moluccana*), Common Ironwood, bamboo (*Bambuseae*), and Christmas berry (*Schinus terebinthifolius*). Bananas, papaya (*Carica papaya*), beans, tomatoes, and peppers are the main crops within Basin 1.

On 14 November 2014, the project area was accessed from Cane Haul Road. CSH staff traversed the Wailele Stream bed and banks (Figure 31). At the fork where Cane Haul Road and Wailele Stream begin to run parallel, a water control feature and ford were located (Figure 32, Figure 33). The Wailele Stream forks at the western apex of First Flush Basin. The north fork of Wailele Stream is between Basin and First Flush Basin. The south fork of Wailele Stream is between First Flush Basin and Basin 1. On the southern fork of the Wailele Stream, approximately 25 m southeast of Basin 1, possible alignment uprights were found in a dense grove of Christmas berry (Figure 34). On the northern fork of the Wailele Stream, *makai* of Kamehameha Highway, a water channel with cut basalt blocks was also located (Figure 35). A composite of all findings found during the pedestrian survey is depicted in Figure 36.

Figure 25. Photo of southern border of Basin 1 facing *makai* with north fork of Wailele Stream in the center (CSH 2014)

Figure 26. Photo of historic plantation irrigation valve located toward the northern border of Basin 1 (CSH 2014)

Figure 27. Photo of dense *hau* grove on the northeast-eastern portion of First Flush Basin (CSH 2014)

Figure 28. Photo of banyan and limestone in First Flush Basin project area (CSH 2014)

Figure 29. Photo of rock mound in foreground and passenger bus in background found within First Flush Basin (CSH 2014)

Figure 30. Photo of cultivated farm area and caretaker's home within First Flush Basin (CSH 2014)

Figure 31. Photo of Wailele Streambed looking *makai* (CSH 2014)

Figure 32. Photo of water control feature found in Wailele Streambed (CSH 2014)

Figure 33. Photo of stream ford in Wailele Streambed (CSH 2014)

Figure 34. Photo of possible alignment of upright stones in Wailele Stream; note dense Christmas berry (CSH 2014)

Figure 35. Photo of Wailele Stream *makai* of Kamehameha Highway with cut basalt blocks (CSH 2014)

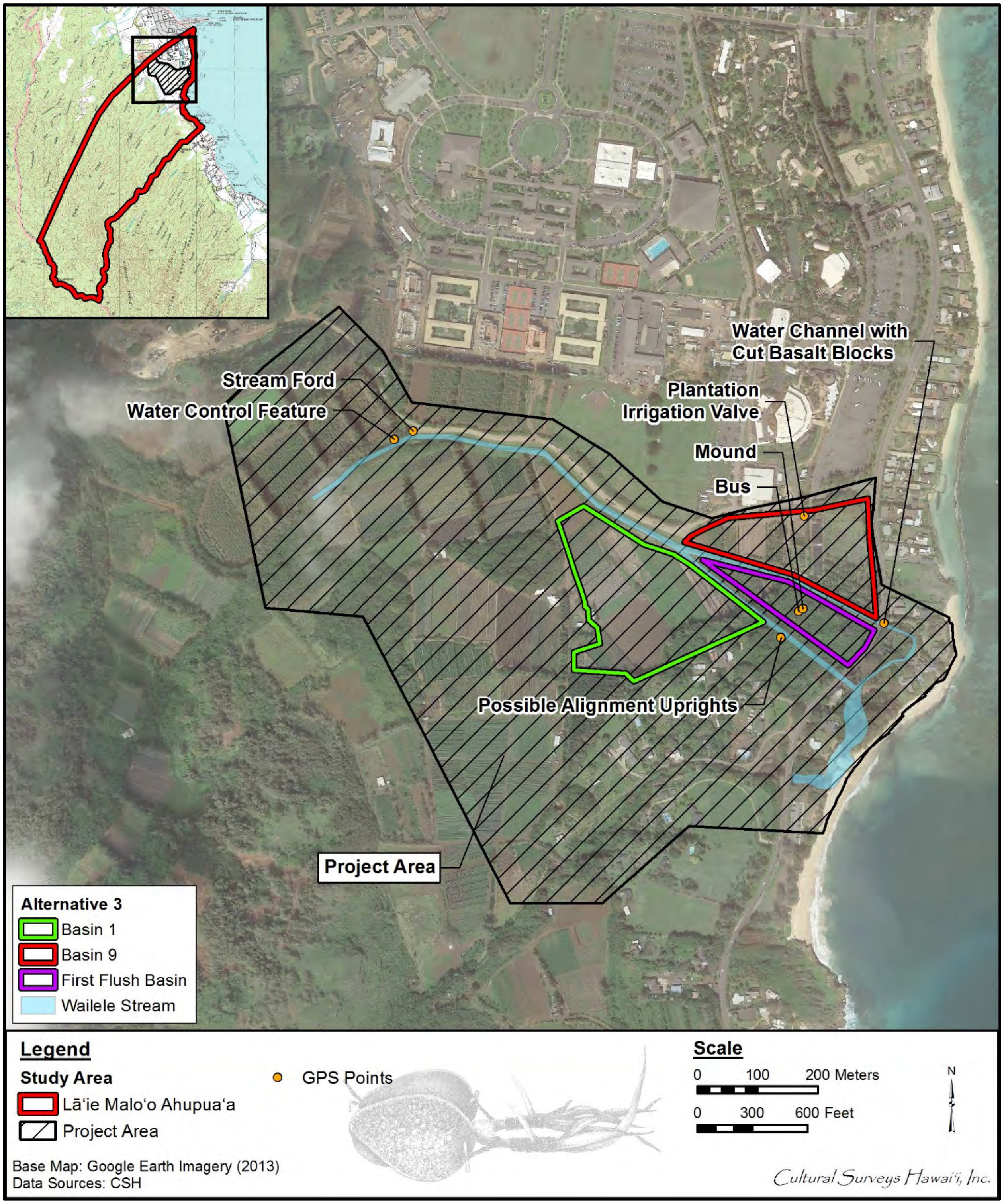

Figure 36. Composite of features found within the project area

Section 5 Summary and Recommendations

Background research conducted indicates potential for historically significant findings. A portion of the project area is comprised of Jaucas sand, a sediment known to most likely contain Native Hawaiian burials. Previous archaeology of Lāʻie Maloʻo Ahupuaʻa has not been extensive, however, the area is rich in pre-Contact and historical history and archaeological finds. In 2006, an archaeological inventory survey was conducted on a property *makai* of Kamehameha Highway within the project area (McElroy 2006). A fragment of a human tibia was recovered. In 2008, archaeological monitoring was conducted on the same property *makai* of Kamehameha Highway (McElroy 2008). That study yielded a cultural layer that included a fire pit (SIHP # -7030) as well as a rib and a mandible fragment (SIHP # -6851). A former railroad track also traverses the project area north to south, but no SIHP number was assigned.

Several findings during the pedestrian inspection of the project area provide some historical and archaeological evidence that meets Hawaiʻi State historical property criteria (in accordance with HAR §13-13-275-6 or §13-13-284-6) qualified by at least one of the following:

a. Be associated with events that have made an important contribution to the broad patterns of our history;
b. Be associated with the lives of persons important in our past;
c. Embody the distinctive characteristics of a type, period, or method of construction, represent the work of a master, or possess high artistic value;
d. Have yielded, or is likely to yield, information important for research on prehistory of history; or
e. Have an important value to the native Hawaiian people or to another ethnic group of the state due to associations with cultural practices once carried out, or still carried out, at the property or due to associations with traditional beliefs, events or oral accounts—these associations being important to the group's history and cultural identity.

Based on information and findings gathered from historical documents, previous archaeological reports, and a field inspection detailed in this report, CSH recommends an archaeological inventory survey (AIS) be conducted for the proposed Wailele Stream Flood Control project. Due to the pre- and post-Contact utilization of this area, it is likely subsurface cultural material could be encountered.

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1928 UH SOEST Lā‘ie coast aerial photograph. University of Hawai‘i at Mānoa School of Ocean and Earth Science and Technology–Coastal Geology Group. Online at http://soest.hawaii.edu/coastal/webftp/Oahu/mosaics/

1949 UH SOEST Lā‘ie coast aerial photograph. University of Hawai‘i at Mānoa School of Ocean and Earth Science and Technology–Coastal Geology Group. Online at http://soest.hawaii.edu/coastal/webftp/Oahu/mosaics/

1971 UH SOEST Lā‘ie coast aerial photograph. University of Hawai‘i at Mānoa School of Ocean and Earth Science and Technology–Coastal Geology Group. Online at http://soest.hawaii.edu/coastal/webftp/Oahu/mosaics/

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1919 Fire Control Map, Kahuku, Kahana, Waialua Quadrangles. USGS Information Services, Denver, Colorado.

1935 Terrain Map, Laie, Kaipapau, Kahuku Quadrangles. USGS Information Services, Denver, Colorado.

1943 Terrain Map, Kahuku, Kahana, Paalaa Quadrangles. USGS Information Services, Denver, Colorado.

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1965 Kahuku USGS 7.5-minute topographic quadrangle. USGS Information Services, Denver, Colorado.

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1977 USGS Orthoimagery, Kahuku and Hauula Quads (Aerial photograph). USGS Information Services, Denver, Colorado.

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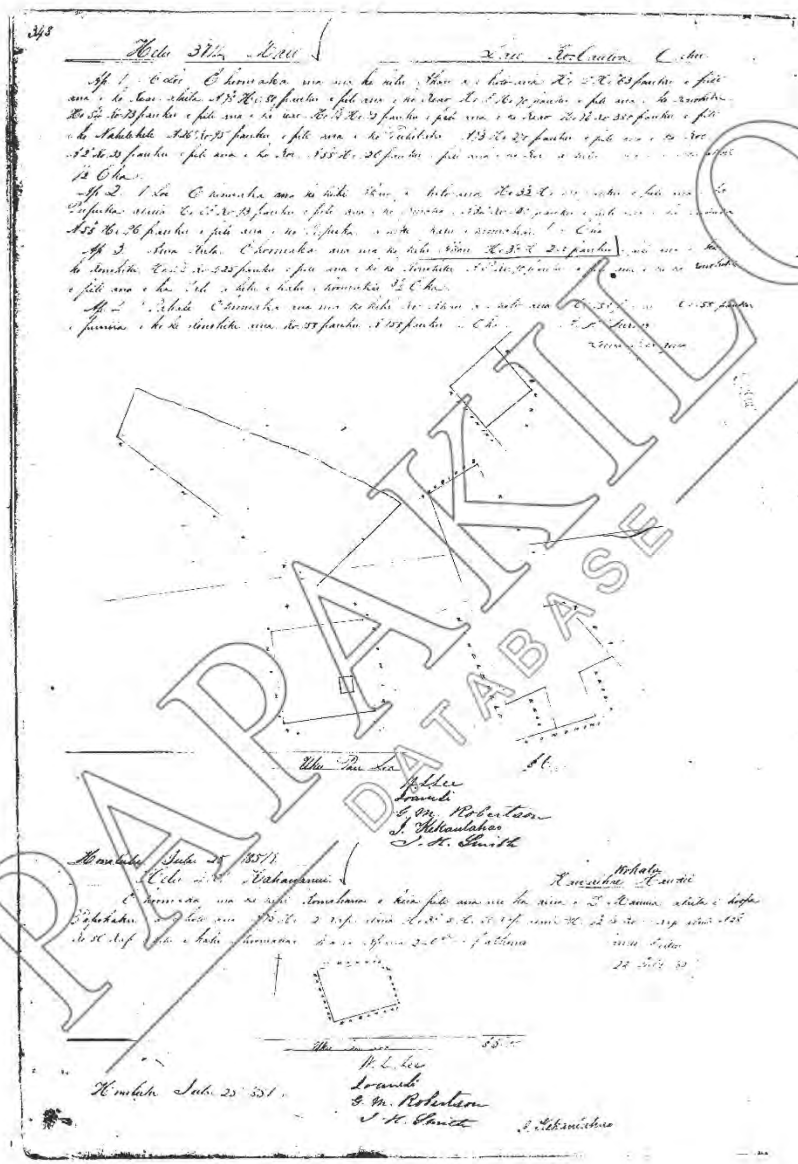
Appendix A LCA Documentation



Pahumoa

Laie Koolauloa Oahu

[illegible] ana ma ke kihi He a e holo ana A 35° Ko 363 [illegible]; alaila A 56° He 150 pauku e pili ana i ko [illegible] 36° Hi 347 pauku e pili ana i ko [illegible] e pili ana i ko [illegible] a hiki i kahi i hoomakai

[illegible] ana ma ke kihi Hema Hik a e holo ana A [illegible], alaila Hikina 100 pauku e pili ana [illegible] pauku e pili ana i ko Konohiki Ko 100 pauku hiki i kahi i hoomakai. 1/4 Eka.

A. J. Inma

Luna ana aina

[illegible] 4.00

Robertson J. H. Smith J. Kekaulahao

Laie, Koolauloa Oahu

[illegible] ana ma ke kihi Ak a e holo ana [illegible] i ko [illegible], He 63° Ko 100 pauku e pili ana 100 pauku e pili ana i ko [illegible] A 63° Hi [illegible] a hiki i kahi i hoomakai 1/10 Eka.

[illegible] ana ma ke kihi [illegible] a e holo ana He [illegible] i ko Hi alaila A 62° Ko 108 pauku e pili [illegible] 60 pauku e pili ana i ko Konohiki A 4° Ho [illegible] a hiki i kahi i hoomakai 1/10 Eka.

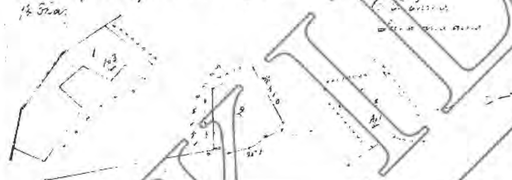
[illegible] Hoomaka ana ma ke kihi Ko A e holo [illegible] ana i ko [illegible] He 50° Hi 30 pauku [illegible] 47 Ko 40 pauku e pili ana i ko Kamano

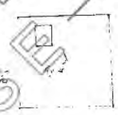
He 39° Hi 38 pauku e pili ana i ko Kamano, He 3° Ko 55 pauku e pili ana i ko Kamano, He 38° Hi 55 pauku e pili ana i ko Kamano A 40° Hi 47 pauku e pili ana i ko Kamano He 45° Hi 138 pauku e pili ana i ko Kamano He 38° [illegible] 60 pauku e pili ana i ko Kamano [illegible] ana i ka [illegible] a hiki i kahi i hoomakai 15 Eka.

Apana 4. Pahale. Hoomaka ana ma ke kihi Ak. [illegible] a e holo ana He 4° Ko 156 pauku e pili ana i ka [illegible] A 6° Hi 100 pauku e pili ana i ko Konohiki A 4° Hi 158 pauku e pili ana i ko Konohiki A 35° Ko 158 pauku e pili ana i ko Konohiki a hiki i kahi i hoomakai. 1/4 Eka.

[illegible]

Luna ana aina





Uku pau loa 4.00

W. L. Lee [illegible] G. H. Robinson J. H. Smith J. Kekaulahao

Honolulu [illegible] 25. 1851.

Helu. 8959. Nahelehele

Laie Koolauloa Oahu

Ap. 1. 1 Loi Kalo. Hoomaka ana ma ke kihi Ak a e holo ana He 51° Ko 100 pauku e pili ana i ko [illegible], alaila He 2° Hi 128 pauku e pili ana i ko [illegible] A 60° He 62 pauku e pili ana i ko [illegible] A 21° [illegible] 41 pauku e pili ana i ko [illegible] A 2° Ko 120 pauku e pili ana i ko [illegible] a hiki i kahi i hoomakai. 13/100 Eka.

Ap. 2. 1 Loi. Hoomaka ana ma ke kihi [illegible] He 8° He 63 pauku e pili ana i ko Konohiki, alaila A 13° Ko 130 pauku e pili ana i ko [illegible], alaila A 62° Ko 47 pauku e pili ana i ko [illegible] alaila He 8° Ko 144 pauku e pili ana i ko [illegible] a hiki i kahi i hoomakai. 8/100 Eka.

Ap. 3. 4 Loi Kalo 1 Pahale 1 aina kula. Hoomaka ana ma ke kihi [illegible] a e holo ana A 62° Hi 100 pauku e pili ana i ko ke Konohiki. A 67° Hi 250 pauku e pili ana i ko ke Konohiki A 4° Ko 170 pauku e pili ana i ko ke Konohiki, A 57° Ko 20 pauku e pili ana i ko ke Konohiki [illegible] 15° pauku e pili ana i ko ke Konohiki A 57° Ko 133 pauku e pili ana i ko ke Konohiki He 70 Ko 45 pauku e pili ana i ko ke Konohiki [illegible] 2° He

529

Uku Pau Loa $5.00

W. L. Lee
G. M. Robertson
J. Kekaulahao
W. L. Lee
Ioane Ii

J. H. Smith

Honolulu October 21. 1851.

Helu 2689 Ehuiki — Halawaiuka Ewa Koolaupoko Oahu

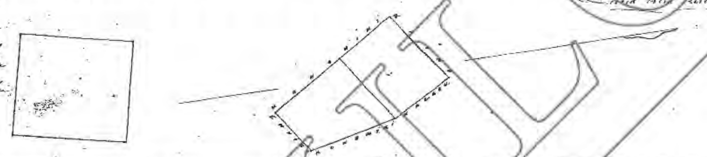
Apana 1. 2 Loi — Ehomaka ana ma ke kihi Hema A 3½ Komohana 221 [illegible] e pili ana i ko Kauamu. Akau 57 Hikina 125 [illegible] e pili ana i ko Kaina Hema 31 Hikina 100 [illegible] e pili ana i ko Kalani Hema Hikina 130 [illegible] e pili ana i ko Konohiki Hema 57 Komohana 75 [illegible] e pili ana i ko Ohuiki i ke kihi mua ¼ Eka.

Apana 2. Pahale — Ehomaka ana ma ke kihi Akau Hema 17 Hikina 158 [illegible] e pili ana i ko ke Konohiki. Hema 13 Komohana 158 [illegible] e pili ana i ko ke Konohiki. Akau 77 Komohana 155 [illegible] e pili ana i ko ke Konohiki. Akau 13 Hikina 158 [illegible] e pili ana i ko ke Konohiki i ke kihi mua ¼ Eka.

N. F. [illegible]
[illegible]

July 21. 1851.

Eia ka Helu kipona no keia Kuleana, Helu 26



Uku Pau Loa

W. L. Lee
G. M. Robertson
W. L. Lee
Ioane Ii
J. Kekaulahao

J. H. Smith

Honolulu October 21. 1851.

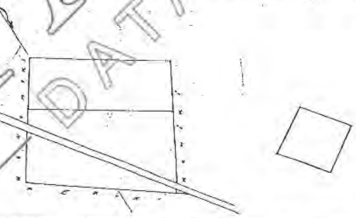
Helu 7510 Kauaua — [illegible] Ewa [illegible]

Apana 1. 3 Loi — Ehomaka ana ma ke kihi Akau Hema 59½ Hikina 400 [illegible] e pili ana [illegible]. Hema 29½ Komohana 4.20 [illegible] e pili ana i ko ke Konohiki. Akau 55 Komohana 415 [illegible] e pili ana i ko [illegible]. Akau 31½ Hikina 3.90 [illegible] e pili ana i ko Konohiki i ke kihi mua 1.044 Eka.

Apana 2. Pahale — Ehomaka ana ma ke kihi Akau Hema 38 Hikina 158 [illegible] e pili ana [illegible]. Hema 52 Komohana 158 [illegible] e pili ana i ko ke Konohiki. Akau 38 Komohana 158 [illegible] e pili ana i ko ke Konohiki. Akau 52 Hikina 158 [illegible] e pili ana i ko ke Konohiki i ke kihi mua ¼ Eka.

N. F. [illegible]
[illegible]

July 21. 1851.



Uku Pau Loa $5.00

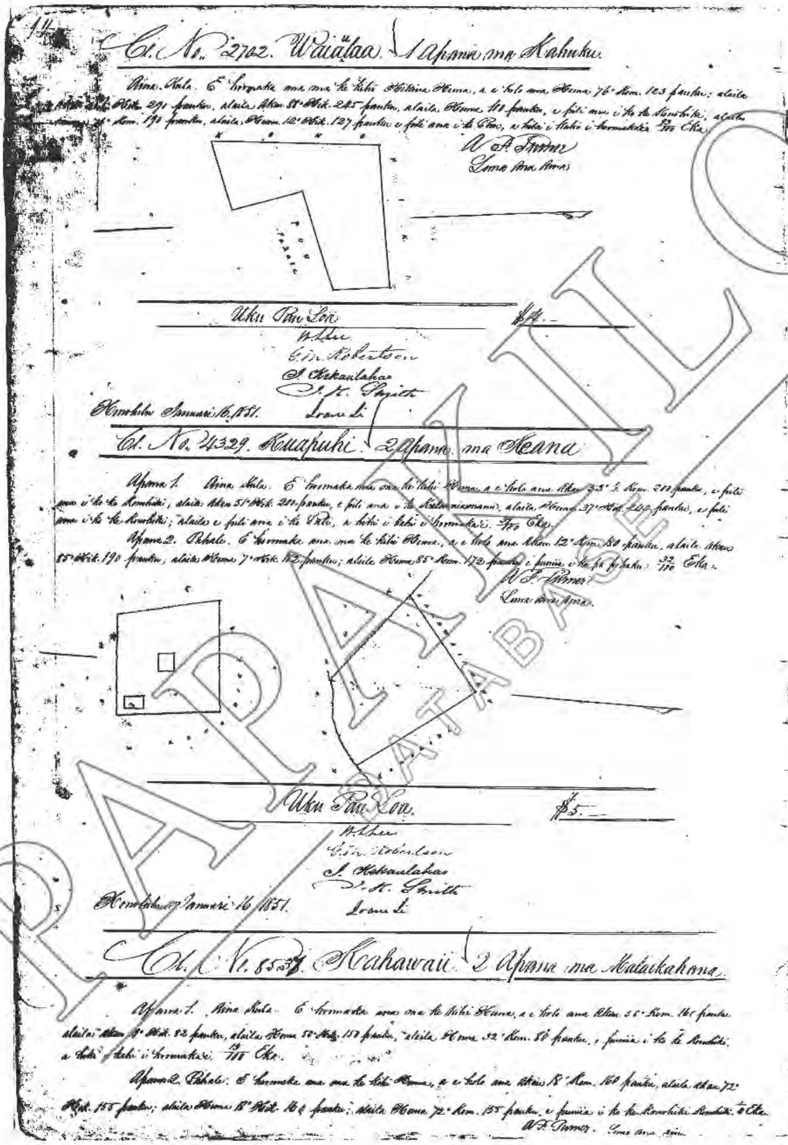
W. L. Lee
G. M. Robertson
W. L. Lee
Ioane Ii
J. Kekaulahao

J. H. Smith

Honolulu October 21. 1851.

Helu 4301 Kamakaneu (+ 5031 V) — Laie Koolauloa Oahu.

Apana 1. 1 Loi Hale — Ehomaka ana ma ke kihi Akau [illegible] Hema 20 Hikina 195 [illegible] e pili ana i ko [illegible] Hema 72 Komohana 380 [illegible] e pili ana i ko Koolaukane [illegible] Akau 36 [illegible] 10 [illegible] e pili ana i ko Koolaukane [illegible] Akau 22½ Komohana 96 [illegible] e pili ana i ko [illegible] Akau 61 Hikina 457 [illegible] e pili ana i ko Kahuakua [illegible] ke kihi [illegible] Eka.



Cl. No. 2702. Waiaulaa } 1 Apana ma Kahuku.

[illegible]

W. F. Turner
Luna Ana Aina

Uku Pau Loa $4.—

W. Lee
G. M. Robertson
J. Kekaulahao
J. H. Smith
Ioane Ii

Honolulu Ianuari 16, 1851.

Cl. No. 4329. Kuapuhi } 2 Apana ma Keana

Apana 1. Aina Kula. [illegible] Eka.

Apana 2. Pahale. [illegible] 32/100 Eka.

W. F. Turner
Luna Ana Aina

Uku Pau Loa $5.—

W. Lee
G. M. Robertson
J. Kekaulahao
J. H. Smith
Ioane Ii

Honolulu Ianuari 16, 1851.

Cl. No. 855[illegible]. Kahawaii } 2 Apana ma Malaekahana.

Apana 1. Aina Kula. [illegible] 13/100 Eka.

Apana 2. Pahale. [illegible] Eka.

W. F. Turner. Luna Ana Aina

368.

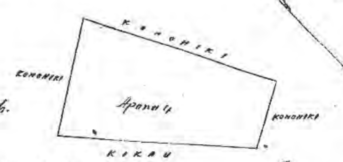
Helu 4331 Kamano — Kapaka. Koolauloa. Oahu.

Apana 4. 1 Loko. ma Kapaka. Koolauloa Oahu. E hoomaka ana ma ke kihi Akau, a e holo ana i ka.

Hema	55°	Komohana	3.16	Kaul. pili i Konohiki.
Hema	42°½	Hikina	5.20	" " Kikau
Akau	57°½	Hikina	1.82	" " Konohiki
Akau	28°	Komohana.	5.36	" " " i ke kihi i hoomaka ai.

Ka ili 1⅕ Eka.

Asa. H.
Kameanna.



Mai Ka aoao 352. 4.6.

2 Kh – inika

Ukupaulua $ 4.00

W. L. Lee
G. M. Robertson
J. H. Smith
J. Kekaulahao

Honolulu October 18. 1854

Helu 2766. Naloloa. — Waiale. Koolauloa. Oahu.

He Kuleana ma Waiale. Koolauloa. Oahu. Hookahi Apana.

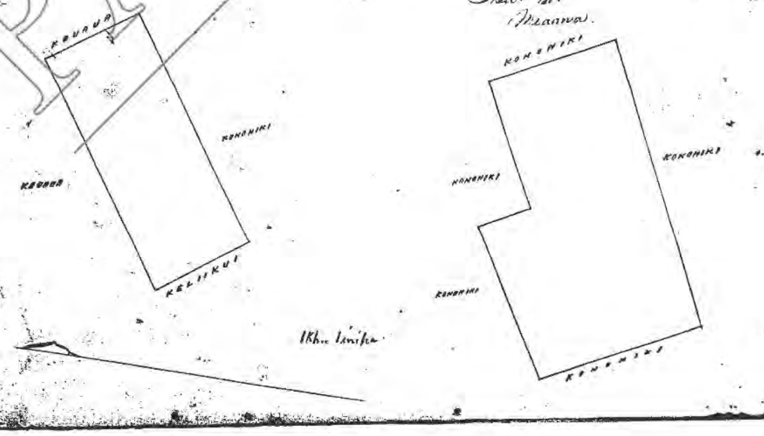
Apana 1. Mahele 1. 2 Loi. E hoomaka ana ma ke kihi Hikina, a mai aku i ka.

Akau	28°	Komohana	175	pauku, kahi i pili ia Konohiki.
Hema	62°	Komohana	177	" "
Akau	27°½	Komohana	0.72	" "
Hema	58°	Komohana	218	" "
Hema	27°½	Hikina	222	" "
Akau	63°	Hikina	373	" " " i ke kihi mua. Ka ili 4/5 Eka.

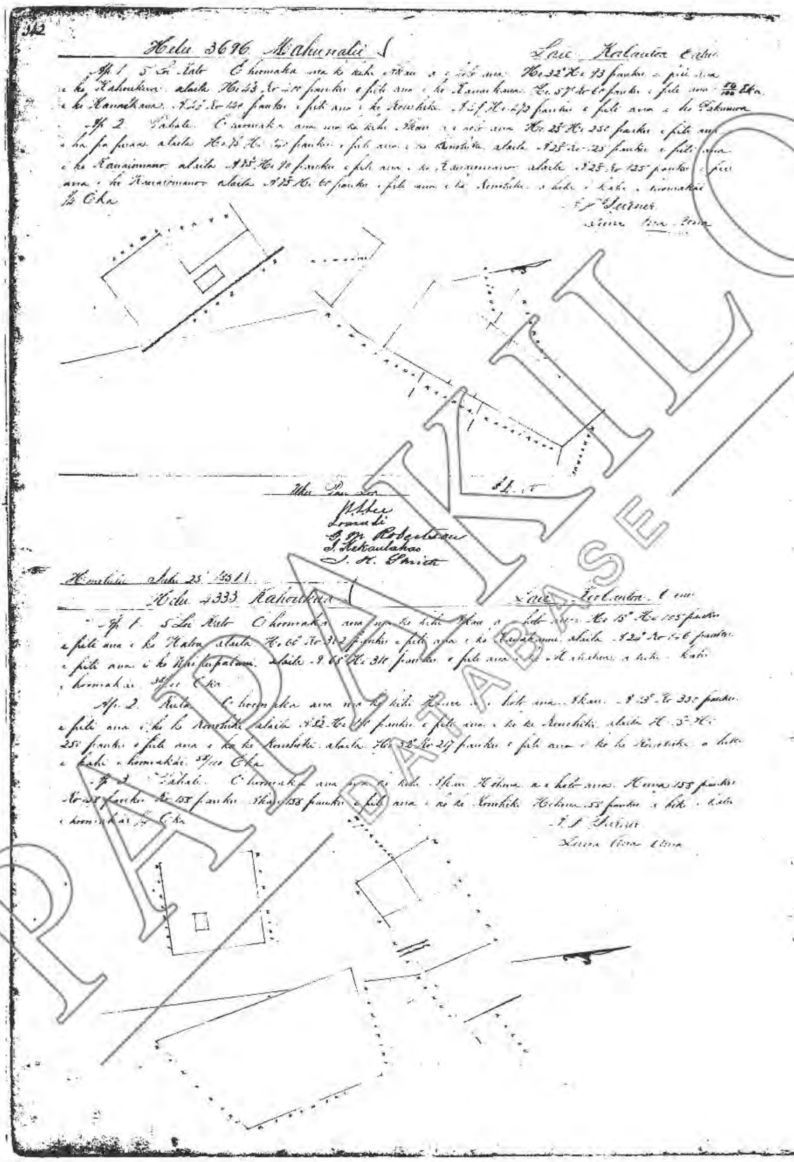
Apana 1. Mahele 2. Pahale. E hoomaka ana ma ke kihi Hikina, a e holo ana

Akau	35°¾	Komohana	1.36	Kaul. pili me Kauaua.
Hema	54°¼	Komohana	3.38	" "
Hema	35°¾	Hikina	1.36	" " Keliikui
Akau	54°¼	Hikina	3.38	" " Konohiki. i ke kihi mua. 0. ⅖ Eka.

Asa. H.
Meaawa.



1 Kh.. inika


342

Helu 3696 Mahunalii 1 Laie Koolauloa Oahu

Ap. 1 5 Lo Kalo [illegible]

Ap. 2 Pahale [illegible]

½ Eka

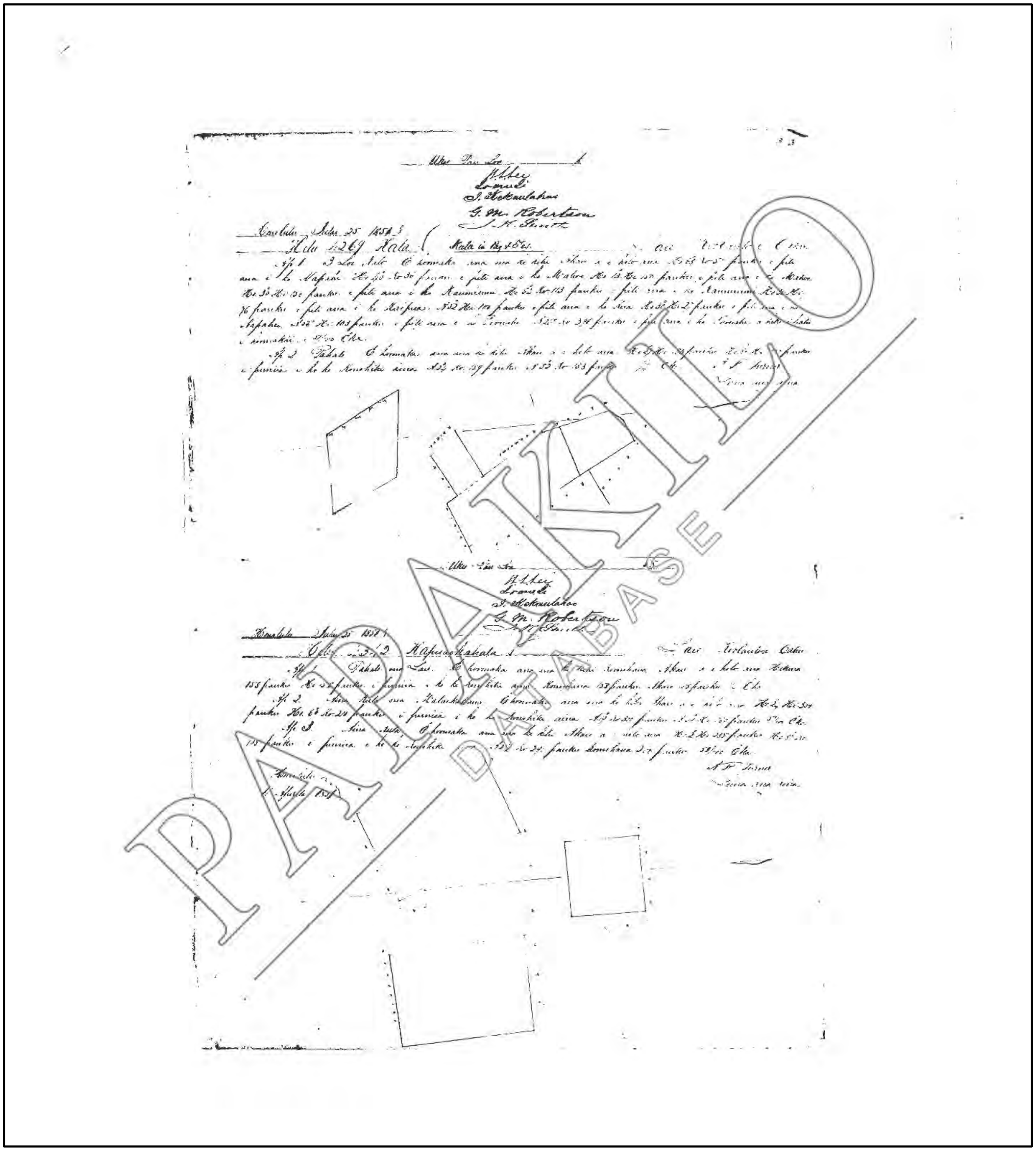
[illegible]

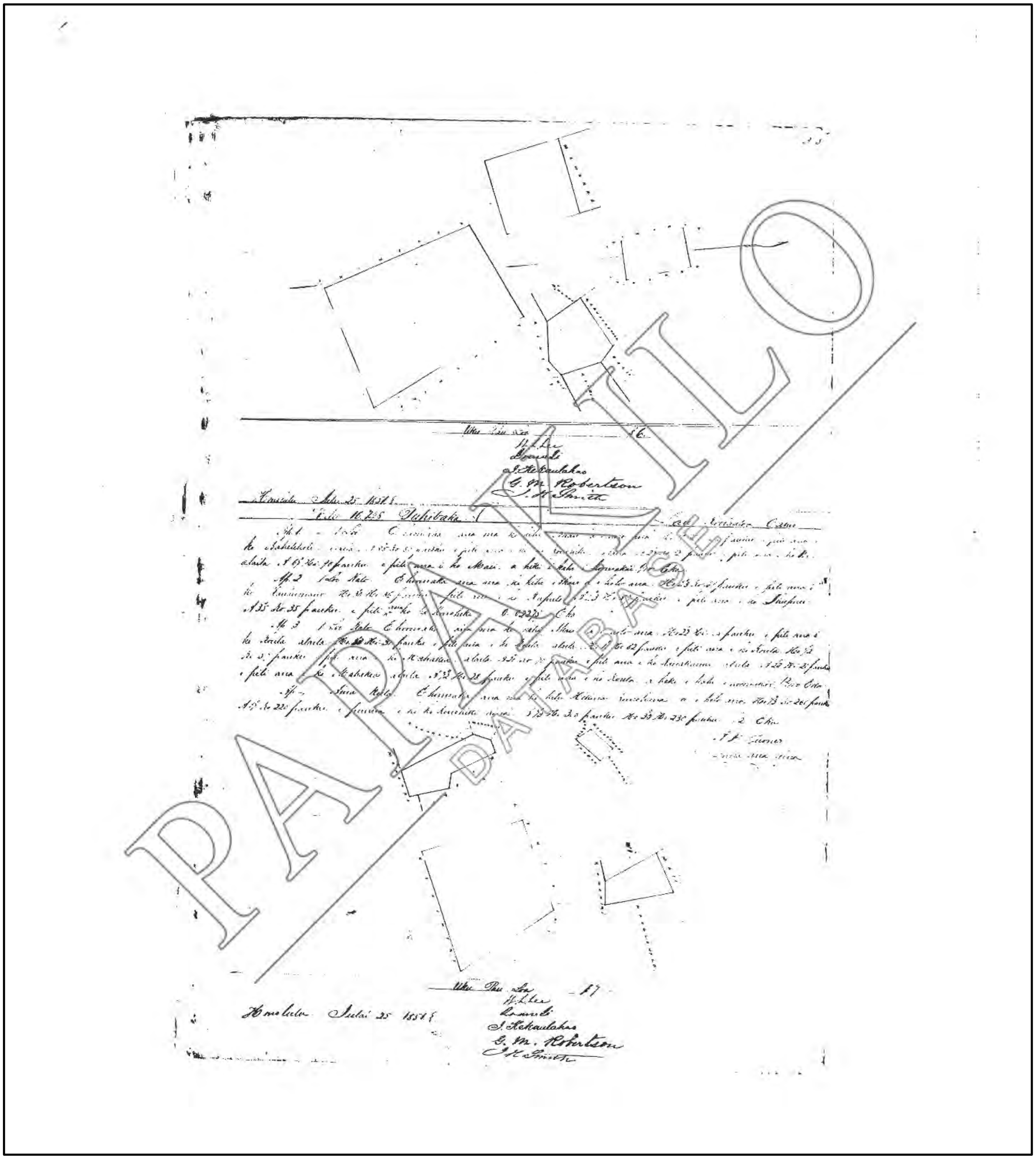
Helu 4333 Kahoohanohano 1 Laie Koolauloa Oahu

Ap. 1 5 Lo Kalo [illegible]

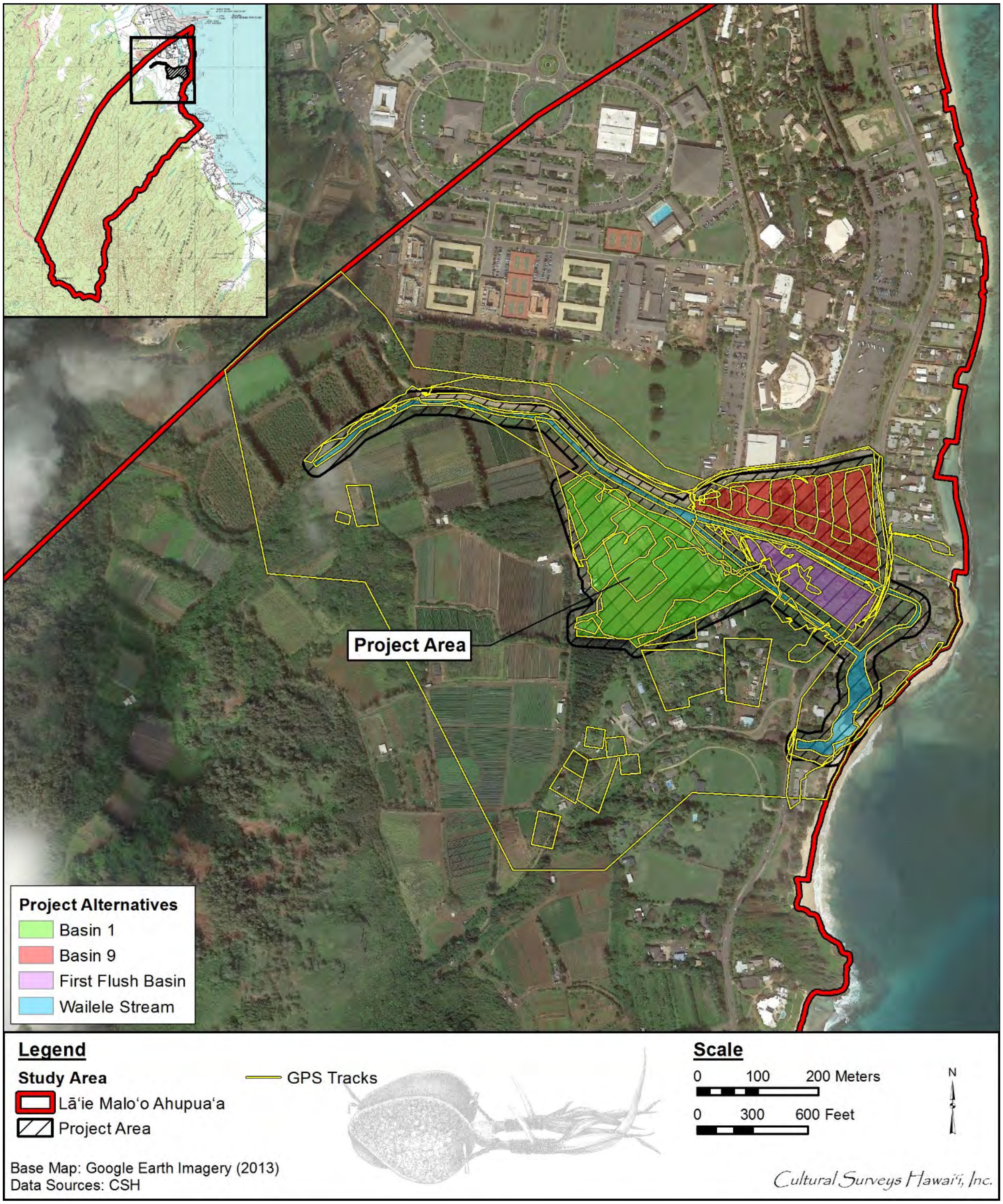
Ap. 2 Kula [illegible]

Ap. 3 Pahale [illegible]


Ukau Pau Loa
J. Kekaulahao
G. M. Robertson
J. H. Smith
Ukau Pau Loa
J. Kekaulahao
G. M. Robertson
PAPAKILO
DATABASE


G. M. Robertson
PAPAKILO
DATABASE

Appendix B Field Inspection Track Log



Appendix G
Real Estate

Real Estate Planning Report

Waialele Flood Control Project
Waialele Stream, Oahu, Hawaii

Authorized under
Section 205 of the Flood Control Act of 1948,
As amended

Prepared for
Honolulu District, USACE

Prepared by:

Patrick Dwyer
Realty Specialist
Honolulu District, Pacific Ocean Division

23 May 2019
Date

Reviewed by:

James Nelson
Chief of Real Estate Branch
Honolulu District, Pacific Ocean Division

23 May 2019
Date

Table of Contents Real Estate Planning Report

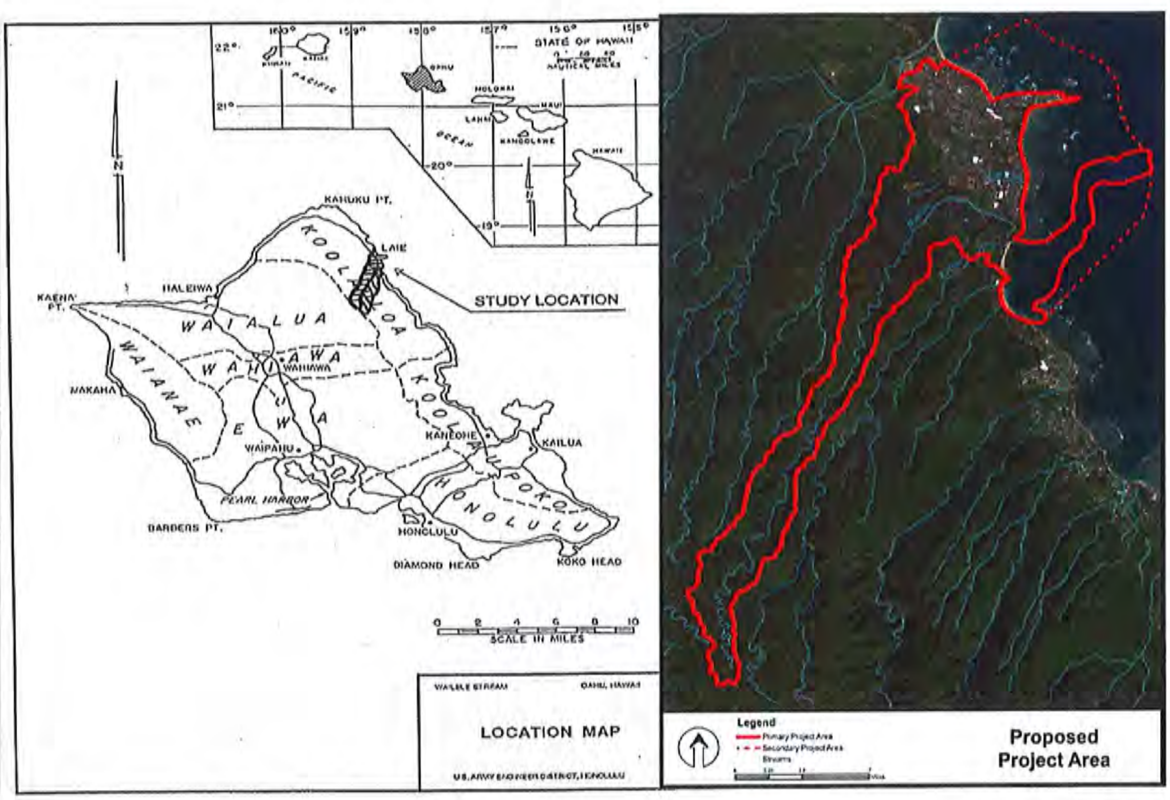
1. AUTHORITY/PURPOSE

The Project is authorized under Section 205 of the Flood Control Act of 1948, as amended. The Corps' Continuing Authorities Program (CAP) is a group of nine legislative authorities under which the Corps of Engineers can plan, design, and implement certain types of water resources projects without additional project specific congressional authorization. The purpose of the CAP is to plan and implement projects of limited size, cost, scope and complexity.

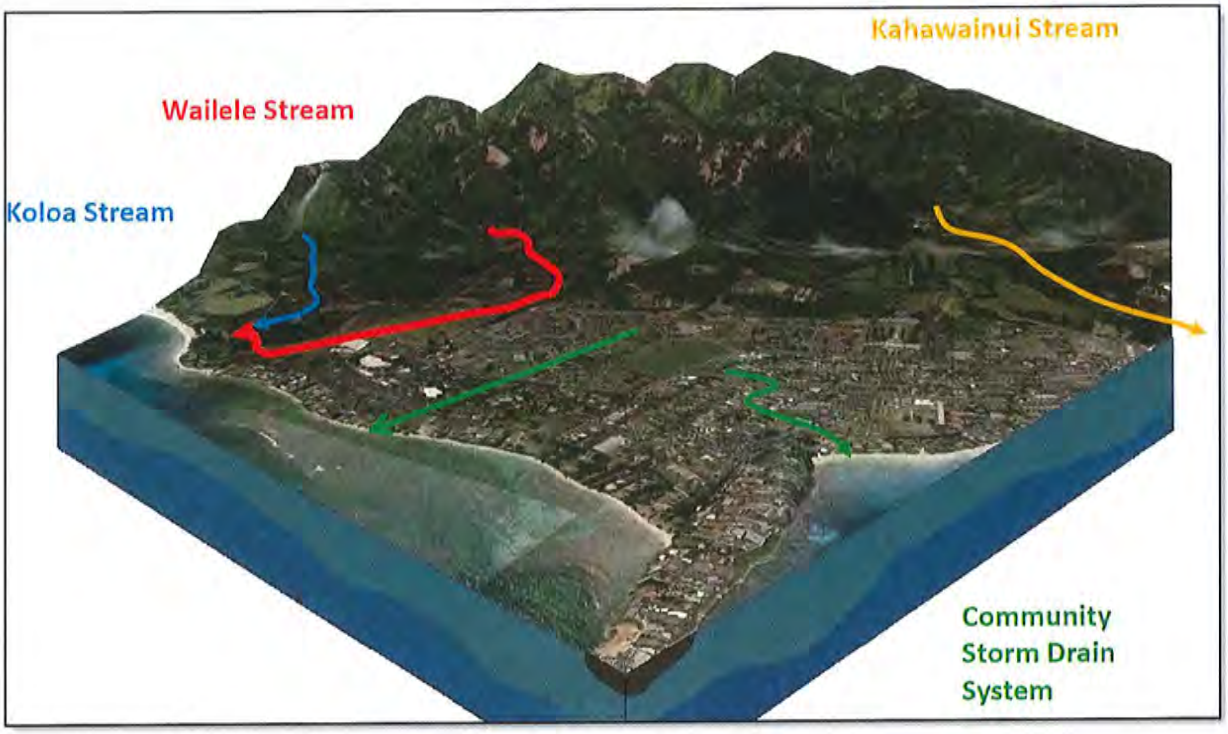
The purpose of the proposed Federal action is to reduce flood risks to life, property, and critical infrastructure in the Waialele Stream study area, Laie, Oahu, Hawaii. There are no existing federal flood risk management projects located on Wailele Stream within the study area.

2. DESCRIPTION

This study examines the feasibility and environmental effects of implementing flood risk management measures along Wailele Stream in Laie, Oahu, Hawaii. Laie is located on the northeastern coast (windward side) of the island of Oahu, approximately 30 miles north of Honolulu. The project area is shown below. The non-Federal partner for the feasibility study is the City and County of Honolulu, Isle of Oahu.



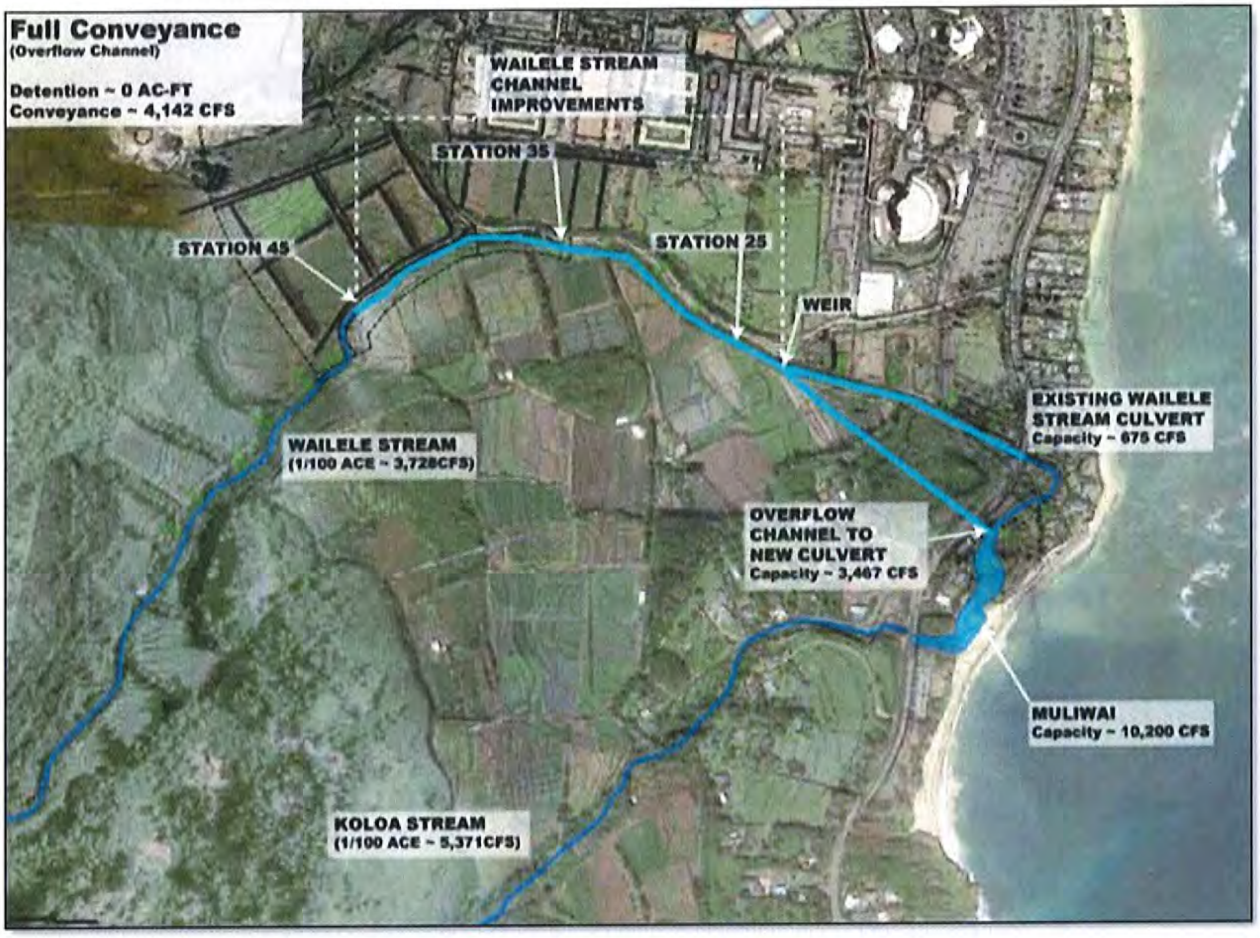
The majority of Oahu is subject to some degree of periodic flooding due to the many streams that drain the area. The Laie area is characterized by multiple narrow stream valleys bordered by steep mountains that drain onto an alluvial fan. Each of the streams (shown below) drains steep, small watersheds that are subject to flash-floods during high-precipitation events.



Laie Watersheds

During high flows, Wailele Stream jumps its left bank as it exits the mountains and flows through the urbanized area of Laie. These sheet flows pick up pollutants and trash and cause damage to structures and contents throughout the Laie Area. The floodwaters that enter Laie have only one exit at a culvert near the Foodland Shopping Center, approximately one mile to the north. The purpose of this study is to identify the environmentally acceptable plan that reasonably maximizes net annual National Economic Development benefits in accordance with all applicable laws and policies in order to meet the flood risk management needs of the community of Laie.

This alternative would combine channel improvements and construction of an "overflow channel" with culverts underneath the Kamehameha Highway that would safely convey flows exceeding 675 cubic feet per second up to the event with a 0.01 annual chance of exceedance into the muliwai. The project system is shown below.



This alternative would have the fewest impacts to residences, very little disturbance of grounds on the ocean side of the Kamehameha Highway (culturally sensitive area), and utilizes the natural muliwai system as part of its solution. This alternative has received positive feedback in informal discussions with partners at the resource agencies and has the least complicated real estate requirements. This alternative also has great potential to reuse excavated materials to construct channel improvements and one of the affected land owners has indicated a desire to utilize a portion of his lot as a disposal site. This alternative is easily optimized to identify the National Economic Development Plan. Additionally, operation and maintenance costs for this alternative are likely very low. Because of these factors, this alternative is carried forward for further consideration.

The alternative involves construction including: Widening Wailele Stream, Constructing an Overflow Channel, Culvert, detour, Relocations, and Bank Protection. The following table describes parcel owners and estimated LERRDs value in the proposed project footprint.

LERRDs Table								
TMK	Assessed Land Value $	Parcel Acreage	Assessed $ Per Acre	Ownership	Estimated LERRDs Req	Estimate Value $	Improvement	Estate
550060010000	3,551,000.00	275.00	12,912.00	PROPERTY RESERVE INC Fee Owner AGG	1.3AC	$16,785.60	Wailele Stream Widening	Channel Improvement/ Levee Easement
550060010000	3,551,000.00	275.00	12,912.00	PROPERTY RESERVE INC Fee Owner AGG	0.5 AC	$6,456.00	Overflow Channel	Channel Improvement / Levee Easement
550060050000	2,250,400.00	70.322	32,001.00	BYU - HAWAII CAMPUS AGG	1.3AC	$41,601.30	Wailele Stream Widening	Channel Improvement/ Levee Easement
550060100000	216,700.00	9.630	22,502.00	PROPERTY RESERVE INC Fee Owner AGG (Remnant)	6.0 AC	$135,012.00	Overflow Channel & Kamehameha Highway Culvert Headwall	Channel Improvement/ Levee Easement
550060010000				PROPERTY RESERVE INC Fee Owner AGG	0.3 AC	$5,000.00	Kamehameha Highway Detour	TWE
550060010000				PROPERTY RESERVE INC Fee Owner AGG	0.007AC	$2,500.00	Water Line Relocation	TWE
550010570000	138,900.00	1.620	85,740.00	Private Residential FEE	0.103AC	$8,831.22	Rip Rap for Scour Protection	Bank Protection Easement
550010580000			DRAGONFLY'S REST CONDO MASTER - for 550010580001 & 550010580002 below					
550010580001	641,600.00	0.608	1,055,263.00	Private Residential FEE	0.05AC	$52,763.15	Rip Rap for Scour Protection	Bank Protection Easement
550010580002	494,800.00	0.162	3,054,320.00	Private Residential FEE	0.05AC	$152,716.00	Rip Rap for Scour Protection	Bank Protection Easement
550010180000	48,500.00	2.320	20,905.00	PROPERTY RESERVE INC Fee Owner - Lessees Residential	0.189AC	$3,951.00	Rip Rap for Scour Protection & Kamehameha HWY Culvert Outlet Headwall	Bank Protection Easement
				Property Acquisition Estimate		$425,616.27		

3. SPONSOR'S REAL ESTATE INTERESTS

As shown above, the feature sites are neither wholly nor partially owned by the local sponsor. These sites will require acquisitions.

4. ESTATES TO BE ACQUIRED

For general purposes, the recommended estates are as follows,

Channel Improvement Easement
Flood Protection Levee Easement
Temporary Work Area Easement
Bank Protection Easement

CHANNEL IMPROVEMENT EASEMENT

A perpetual and assignable right and easement to construct, operate, and maintain channel improvement works on, over and across (the land described in Schedule A) (Tracts Nos. _____, _____ and _____) for the purposes as authorized by the Act of Congress approved_______________, including the right to clear, cut, fell, remove and dispose of any and all timber, trees, underbrush, buildings, improvements and/or other obstructions therefrom; to excavate: dredge, cut away, and remove any or all of said land and to place thereon dredge or spoil material; and for such other purposes as may be required in connection with said work of improvement; reserving, however, to the owners, their heirs and assigns, all such rights and privileges as may be used without interfering with or abridging the rights and easement hereby acquired; subject, however, to existing easements far public roads and highways, public utilities, railroads and pipelines.

FLOOD PROTECTION LEVEE EASEMENT

A perpetual and assignable right and easement in (to construct, maintain, repair, operate, patrol and replace a flood protection (levee) (floodwall)(gate closure) (sandbag closure), including all appurtenances thereto; reserving, however, to the owners, their heirs and assigns, all such rights and privileges in the land as may be used without interfering with or abridging the rights and easement hereby acquired; subject, however, to existing easements for public roads and highways, public utilities, railroads and pipelines.

BANK PROTECTION EASEMENT.

A perpetual and assignable easement and right-of-way in, on, over and across the land hereinafter described for the location, construction, operation, maintenance, alteration, repair, rehabilitation and replacement of a bank protection works, and for the placement of stone, riprap and other materials for the protection of the bank against erosion; together with the continuing right to trim, cut, fell, remove and dispose therefrom all trees, underbrush, obstructions, and other vegetation; and to remove and dispose of structures or obstructions within the limits of the right-of-way; and to place thereon dredged, excavated or other fill material, to shape and grade said land to desired slopes and contour, and to prevent erosion by structural and vegetative methods and to do any other work necessary and incident to the project; together with the right of ingress and egress for such work; reserving, however, to the landowners, their heirs and assigns, all such rights and privileges as may be used without interfering with or abridging the rights and easement hereby acquired; subject, however to existing easements for public roads and highways, public utilities, railroads and pipelines.

TEMPORARY WORK AREA EASEMENT

A temporary easement and right-of-way in, on, over and across the land, for a period not to exceed 12 months, beginning with date possession of the land is granted to the United States, for use by the United States, its representatives, agents, and contractors as a (borrow area) (work area), including the right to borrow and/or deposit fill, spoil and waste material thereon). (move, store and remove equipment and supplies, and erect and remove temporary * structures on the land and to perform any other work necessary and incident to the construction of the Project, together with the right to trim, cut, fell and remove, therefore all trees, underbrush, obstructions, and any other vegetation, structures, or obstacles within the limits of the right-of-way; reserving, however, to the landowners, their heirs and assigns, all such rights and privileges as may be used without interfering with or abridging the rights and easement hereby acquired; subject, however, to existing easements for public roads and highways, public utilities, railroads and pipelines.

5. FEDERAL PROJECTS/OWNERSHIP

The Waialele Flood Control Project is a federal cost share project, the Government has never held federal real estate interest in the flood control project. There are no federal owned lands in the immediately vicinity.

6. NAVIGATION SERVITUDE

Lands required for the channel repairs project are not located within navigable waters and no lands are available by navigation servitude.

7. MAPS

Real Estate mapping is not typically provided by the District at this stage of the project. Detailed mapping will be provided prior to the notification to the sponsor to provide the required LERRDs. Preliminary Real Estate mapping is provided as an Addendum.

8. INDUCED FLOODING

The purpose of the project is to reduce damages caused by flood waters. The project is not anticipated to induce flooding outside of the footprint of the proposed flood control features

9. REAL ESTATE PGL NO. 31-REAL ESTATE SUPPORT TO CIVIL WORKS

PGL 31 discusses the level of detail for Real Estate cost estimates. A quick summary follows:

For projects in which the value of real estate (lands, improvements, and severance damages) are not expected to exceed ten percent of total project costs (total cost to implement project), a cost estimate (or rough order of magnitude) will be acceptable for purposes of the feasibility phase.

For projects in which the value of real estate (lands, improvements, and severance damages) do not exceed 30 percent of total project costs (total cost to implement project), a brief gross appraisal will be acceptable for purposes of the feasibility phase. A brief gross appraisal will follow format issued by Chief Appraiser.

For projects in which the value of real estate (lands, improvements, and severance damages) exceed 30 percent of total project costs (total cost to implement project), a full gross appraisal will be prepared in accordance with the appraisal regulation and guidance provided by EC 405-1-04 and the Chief Appraiser.

10. BASELINE COST ESTIMATE FOR REAL ESTATE

The initial cost estimate for real estate cost was derived from the tax map key at full replacement. Market cost will be determined at TSP level by an appraiser. Based on Real Estate's judgment, TMK costs are typically much lower than market costs. Even considering this level of the TMK cost the cost is still not expected to exceed ten percent of total project costs limit referenced in PGL 31.

Estimated Total from LERRDs Table is $425,616.27

For the Waialele project, the existing LERRDs estimate $425,616.27 is less than 10% of total project costs ($11,003,000). A gross appraisal or brief gross appraisal is not required at this time.

11. PL 91-646 RELOCATION BENEFITS

Public Law 91-646, The Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970, as amended, commonly called the Uniform Act, is the primary law for acquisition and relocation activities on Federal or federally assisted projects and programs. The non-federal sponsor is required to follow the guidance in this public law. The sponsor is aware of this and has experience in the Uniform Act policies. As the project is currently laid out it appears that there will be no displaced families or businesses.

12. MINERALS

There are no known surface or subsurface minerals that would impact the project.

The State of Hawaii owns all mineral rights within the state and there are no surface or subsurface minerals that would impact the project or acquisition.

13. ASSESSMENT OF SPONSOR'S ACQUISITION CAPABILITY

An assessment of the sponsor's acquisition capabilities to acquire the land necessary for this project has not been done as of the writing of this REP. However, the local sponsors has partnered in other projects on the island of Oahu. The County of Oahu is considered fully capable and has Eminent Domain authority. In compliance with the Water Resources Development Act of 1986 (WRDA 86), Pub. L. 99-

662, the Uniform Act and 49 CFR Part 24, Real Estate will request that the sponsor provide an assessment of their acquisition capability when the design is finalized.

14. ZONING

Lands involved in the project are currently zoned as either residential, commercial, industrial or agricultural. No impacts of this project will result in a taking of a real property interest due to enactment or enforcement of the zoning ordinance.

15. MILESTONES

The following real estate milestones have been coordinated with Real Estate, and the Project Manager. For any parcels found that are currently owned in fee by the local sponsor, they will need to demonstrate possession of the title prior to construction execution. For the private parcels that will be acquired, the sponsor will have to accomplish the acquisition prior to advertisement of the construction contract.

Real Estate Acquisition Schedule is pending completion of design		
Estimated Start	Estimated End	Estimated Midpoint

16. PUBLIC FACILITY / UTILITIES RELOCATIONS

There are no known public facility or utilities that are expected to be impacted by the project.

If public facilities or utilities are subsequently identified to be impacted, they will be handled by one of two types of relocations.

1) Temporary relocations in which all work will be commenced and resolved under construction contract(s) within the same footprint; and

2) Permanent relocations which require action on the part of the Non-Federal Sponsor in advance of the project to acquire lands for a permanent resettlement of the utility(s) on a different footprint. The LERRDs crediting on the costs of the relocations which fall into the two above categories will be provided in the Attorney's Opinion of Compensability, which is scheduled to be completed later in the Design Phase of this Project. Any conclusions or categorization contained in this report that an item is a utility or facility relocation to be performed by the Non-Federal Sponsor as part of its LERRD responsibilities is preliminary only. The Government will make a final determination of the relocations necessary for the construction, operation, or maintenance of the project after further analysis and completion and approval of Final Attorney's Opinions of Compensability for each of the impacted utilities and facilities.

A detailed description of any required facility or utility relocations, i.e. any impacted sport facilities, pipelines etc. will include information regarding the general nature of the impact to each facility or utility; the identity of the owners of the affected facilities and utilities; and the purpose of the affected facilities and utilities will be prepared in a future Draft Utility/Facility Assessment Report.

17. ENVIRONMENTAL IMPACTS

Environmental impacts, if any, are discussed in other sections of the Project Information Report. A supplemental Environmental Assessment is being prepared to address any environmental concerns but none are anticipated. A cultural assessment is also ongoing for this project.

18. ATTITUDES OF LANDOWNERS

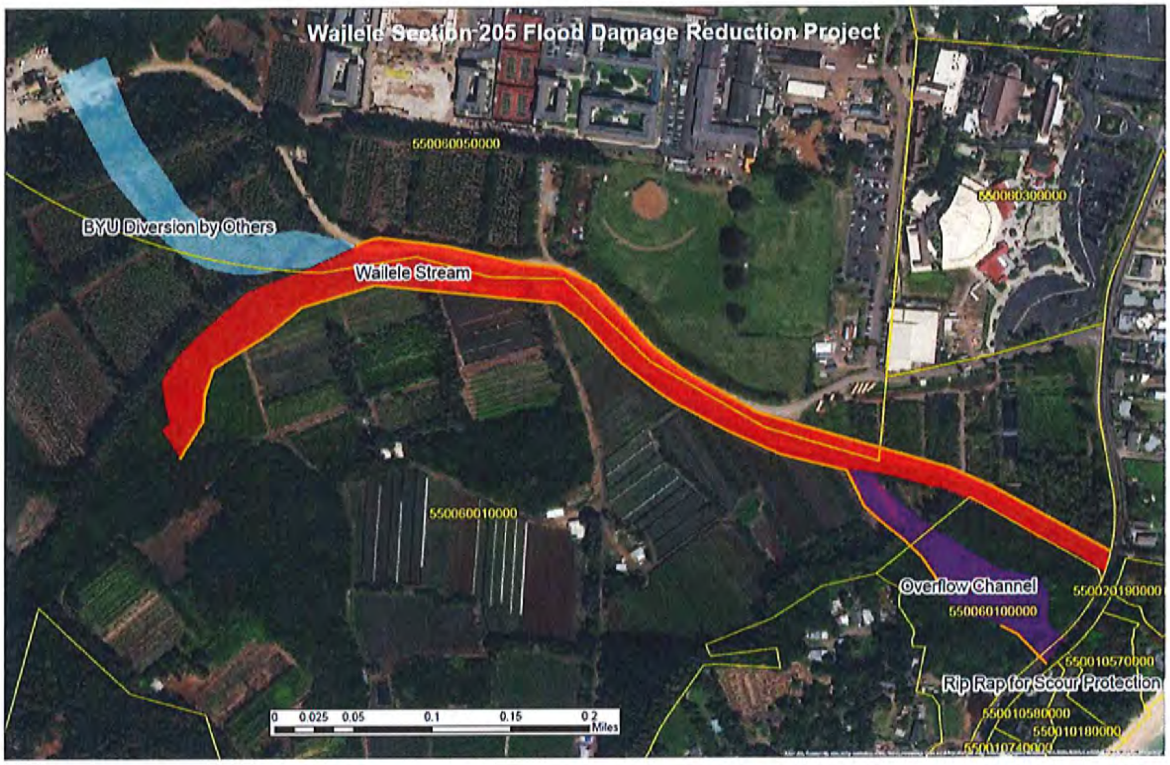
There is no known opposition to the project.

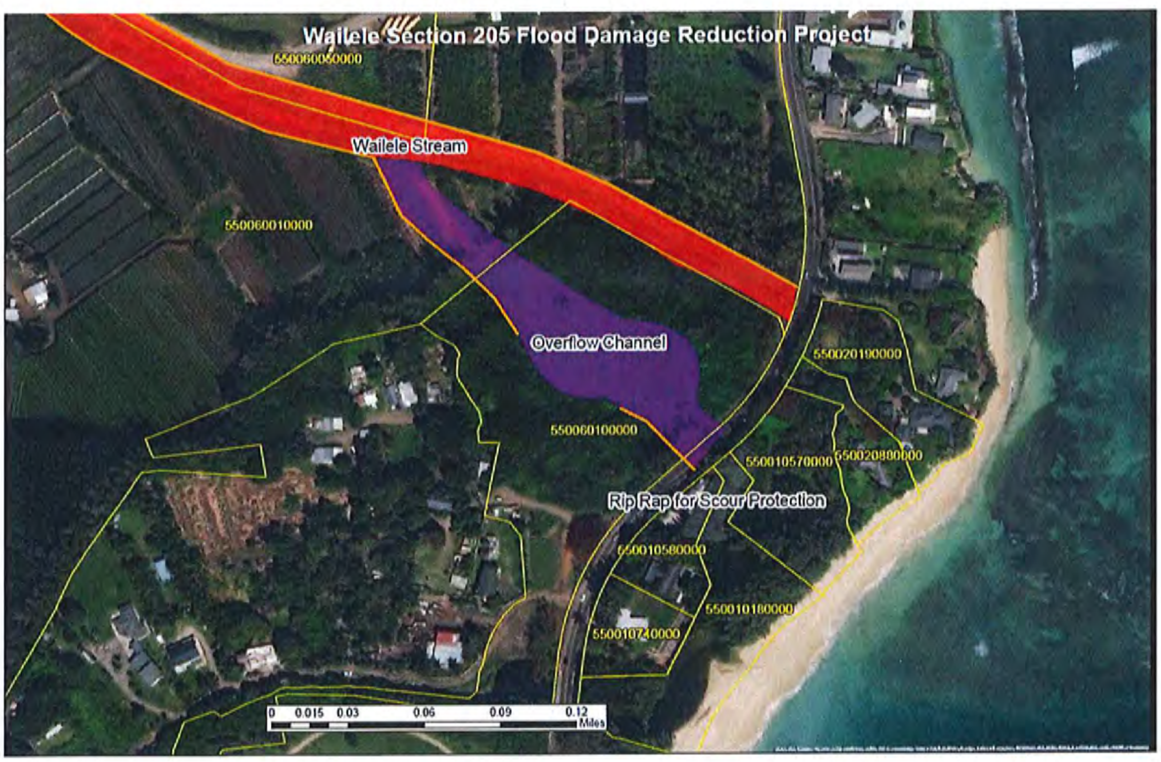
19. SPONSOR INVOLVEMENT

The non-Federal sponsor, the City and County of Honolulu, Isle of Oahu are fully involved in the planning process. They are also experienced in working with US Army Corps of Engineers on similar projects.

ADDENDUM

Island of Oahu/ Project Location Project Feature Map(s)





Appendix H
Environmental

Environmental Appendix

Wailele Flood Risk Management, La‘ie, Island of O‘ahu, Hawai‘i

June 2019

Table of Contents

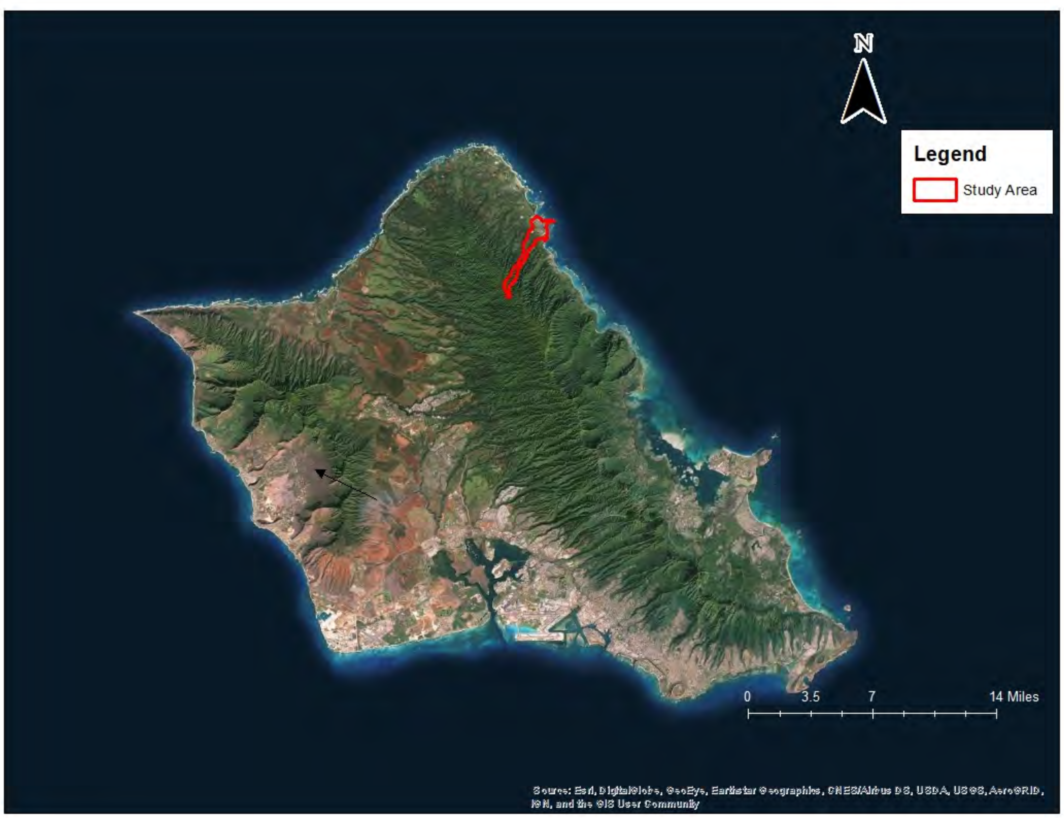
INTRODUCTION

The U.S. Army Corps of Engineers, Honolulu District (USACE), in partnership with the City and County of Honolulu, is assessing the reduction of flood risk resulting from the Wailele Stream in the Laʻie community. The study is authorized under Section 205 of the Flood Control Act of 1948, as amended (33 U.S.C. 701s; Public Law 93-251, as amended; Public Laws 97-140 and 99-662). This environmental appendix supplements the Wailele Integrated Feasibility Report/Environmental Assessment (IFR/EA) in compliance with the National Environmental Policy Act (NEPA) of 1969, the Council of Environmental Quality (CEQ) regulations 40 CFR 1500-1508 and incorporates the requirements of the Hawaiʻi Revised Statutes (HRS) and the Hawaiʻi State Office of Environmental Quality Control (OEQC). The IFR/EA meets the appropriate State filing and notification requirements, as applicable. The IFR/EA evaluates proposed solutions to reduce flood risk to the Laʻie community resulting from flooding of the Wailele Stream.

1 STUDY AREA

The study area is located on the Island of Oʻahu located in the southeast portion of the 1,600-mile Hawaiian archipelago. The study area encompasses the Wailele watershed on the windward side of the Koolau Mountain Range in northern Oʻahu. The 16.5 mile long stream originates on the upper slopes of the mountain range and flows along the southern limits of Laʻie near the bottom of the watershed before draining into the Pacific Ocean (***Figure 1***). The watershed (study area) covers approximately 2.5 square miles.

Figure 1: Wailele Stream Flood Risk Management (FRM) Study Area



2 FRM ALTERNATIVES

During high flood events, Wailele Creek jumps the left bank of the stream opposite the agricultural fields (***Figure 2***). The resulting floodwaters result in sheet flow flooding across the University of Hawai'i – Brigham Young University and the Town of La'ie. Each of the FRM alternatives redirect and/or retain floodwaters so that floodwaters remain inside the stream banks.

Figure 2: Proposed Wailele FRM Alternatives

2.1 Alternative 2 - Wailele Stream Overflow Channel

The Wailele Stream overflow channel (***Figure 2***) would relieve the backwater effects caused by the constriction under Kamehameha Highway. The alternative would combine channel improvements of the stream with the construction of an "overflow channel" with culverts underneath the Kamehameha Highway. A weir would be constructed within the existing channel to direct high flows out of Wailele Stream into the overflow channel. The overflow channel would then safely convey flows exceeding 675 cubic feet per second up to the event with a 0.01 annual chance of exceedance. The overflow channel would then flow back into Wailele Creek east of the highway before the stream enters the mulaiwai at the terminus.

2.2 Alternative 3 - Wailele Stream Detention

The stream detention alternative entails the construction of a 25-acre feet detention basin adjacent to the right bank of Wailele Stream. The proposed weir identified above would be used to redirect flows into the detention basin and reduce the flood flow peaks in the hydrograph during flood events.

2.3 Combination Alternative

The combination alternative entails the construction of both the overflow channel and the detention basin. The proposed weir would redirect high flood flows into the detention basin and overflow channel. The stream, detention basin, and overflow channel would be connected to ensure the conveyance of a 0.01 annual chance of exceedance.

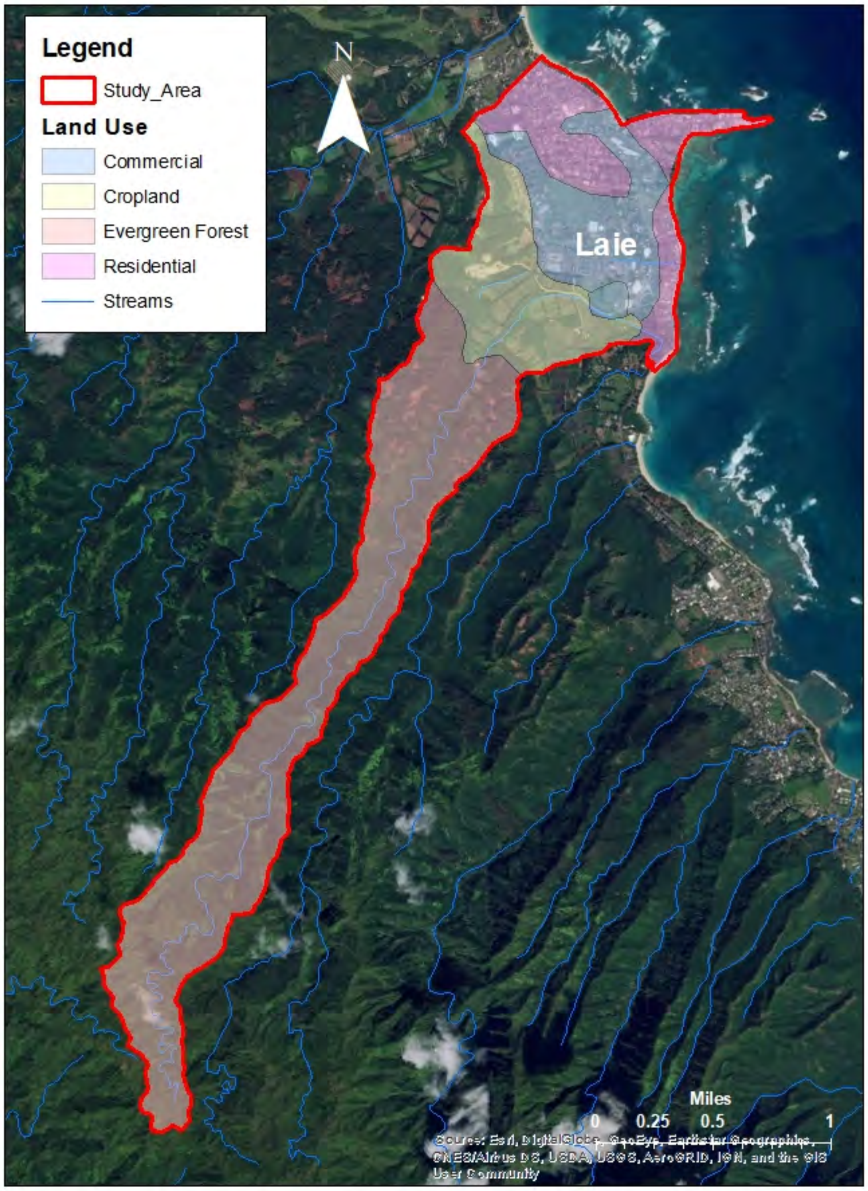
3 EXISTING CONDITIONS

The following section describes the existing conditions of the study area. This analysis established a baseline, or existing condition, to provide a frame of reference to evaluate the performance of alternative plans.

3.1 Land Use

Land use in the upper watershed of the Wailele Stream consists of natural areas of undeveloped evergreen forest land. The land use of the watershed transitions downstream through cultivated cropland before flowing through commercial and residential areas to the coastline. The extent of land uses within the study area are illustrated in ***Figure 3*** and ***Table 1*** below.

Figure 3: Land Use in the Wailele Stream FRM Study Area



Land Use Source: Hawai'i Statewide GIS Program (1976)

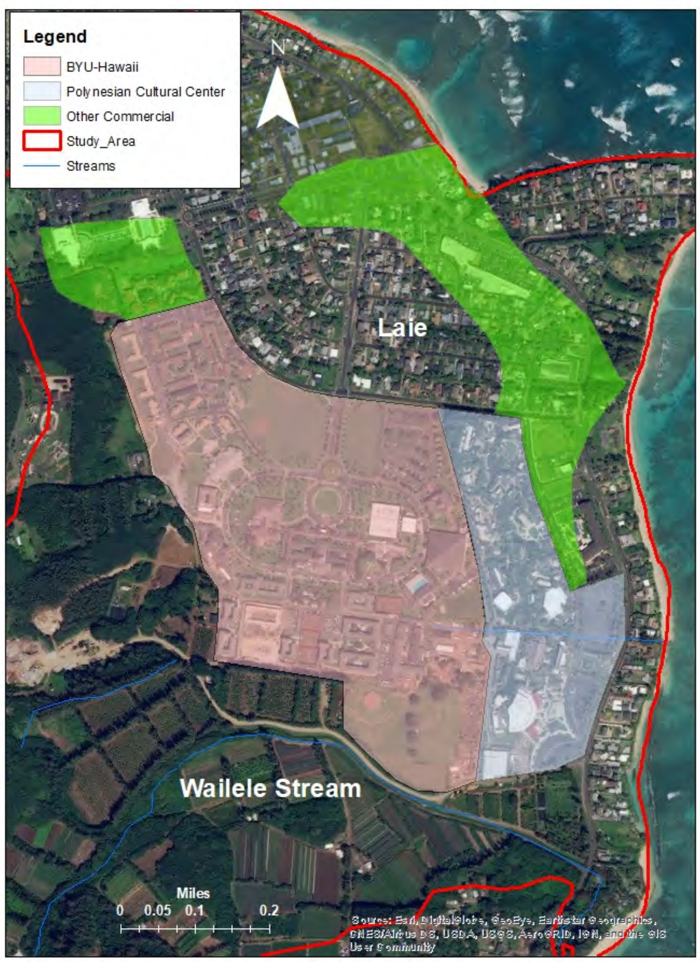
Table 1: Land Use within the Wailele Stream FRM Study Area.

Land Use Category	Aerial Extent (acres)	Percent the Study Area
Residential	203	14.2%
Commercial	207	14.5%
BYU-Hawaii	121	9% (59% of Commercial LU*)
Polynesian Cultural Center	43	3% (21% of Commercial LU)
Other Commercial	42	2% (20% of Commercial LU)
Cropland/Pasture	241	17.0%
Evergreen Forest	772	54.3%
Total	**1,423**	**100%**

*LU = Land Use; Source: Hawaiʻi Statewide GIS Program (1976)

Brigham Young University - Hawaiʻi encompasses approximately 60-percent of the commercial land use in the Laʻie community. The adjacent Polynesian Cultural Center (PCC) takes up an additional 20-percent of the commercial land leaving approximately 20-percent (42 acres) of the area to other commercial businesses (*Figure 4*).

Figure 4**: Commercial Land Uses for the Wailele Stream FRM Study Area**



Land Use Source: Hawaiʻi Statewide GIS Program (1976)

3.2 Climate

Hawaiʻi has a subtropical climate with temperatures that are mild and fairly uniform throughout the year. The mean annual temperature in Honolulu is 76° F with a maximum of 93° F and a minimum of 56° F. The mean temperature in February, the coldest month, is 72.4° F and the mean temperature in August, the warmest month, is 79.4° F. The climate of the Hawaiian Islands is characterized by a two-season year marked by a 5-month summer (May through September) and a 7-month winter (October through April). The islands generally have a humid climate with prevailing trade winds coming from the northeast. During the summer months, trade winds prevail 80- to 90-percent of the time while during the winter, the prevalence of the trade winds decreases to 50- to 80-percent.

Although trade winds produce most of the annual rainfall over the Hawaiian Islands, it is during the absence of these winds that most of the flood producing rainfall occurs. In particular, southerly winds bring moist warm air which create "Kona" storms that produce the damaging floods in Hawaiʻi. These storms usually occur during the winter months. The mean annual precipitation in the Wailele Stream drainage basin varies with elevation. The upper reaches of the Wailele Stream watershed receives up to 200 inches per years while the annual precipitation at the mouth of the stream is approximately 50 inches. The spatial variation in rainfall is cause by orographic lifting of moist air masses by the tall steep-faced ridges along the Koolau Range.

3.3 Water Resources

Water resources include both surface water and groundwater resources, associated water quality, and floodplains. Surface water includes all lakes, ponds, rivers, streams, impoundments, wetlands and estuaries within the watershed. Subsurface water, commonly referred to as ground water, is typically found in certain areas known as aquifers. Aquifers are areas with high porosity rock where water can be stored within pore spaces. Water quality describes the chemical and physical composition of water affected by natural conditions and human activities.

3.3.1 Hydrology and Hydraulics

Wailele Stream flows year-round in the upper portions of the watershed and intermittently at the lower elevations. The Wailele Steam does not have any stream gages. Its flood flows are characterized by sharp rises of relatively short duration followed by sharp recessions. The sharp rises are the result of concentrated storms that produce rapid runoff from the steep valleys. Streamflows usually recede rapidly and revert to normal within a few hours. Stagnant and ponded water are typical within the lower reaches of Wailele Stream. These conditions are usually caused by sand blocking the muliwai, or small estuary, at the mouth of the stream.

Just upstream from the mouth of Wailele Stream, the Highway 83 (Kamehameha Highway) bridge constrains flood flows during higher precipitation storm events resulting floodwaters backing up upstream. During these high flood flows, the backwater flooding causes Wailele Stream to jump out of the left bank and inundate much of the Laʻie community with sheet flow flooding. ***Figure 5*** shows the extent of this flooding during the 20 March 1991 storm event.

Figure 5: Extent of flooding caused by the 20 March 1991 storm event.

3.3.2 Floodplains

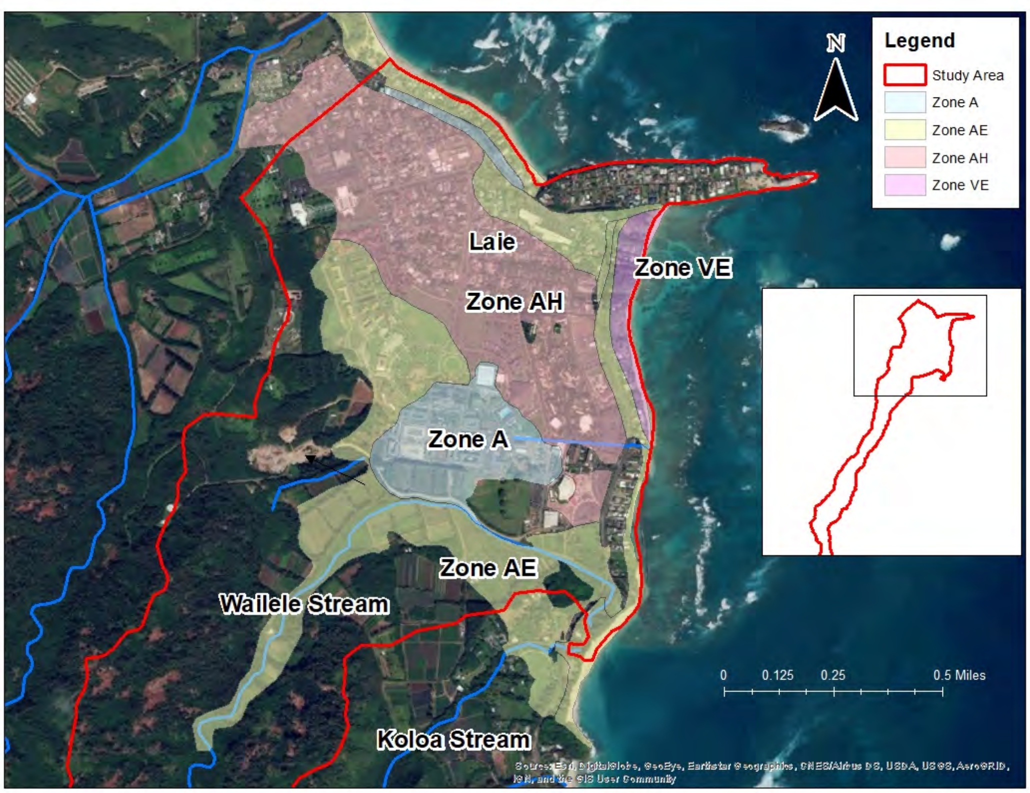
Federal Emergency Management Agency (FEMA) National Flood Insurance Maps (NFIMs) were used to delineate the 100-year floodplains for the study area (FEMA, 2019). Additional Hydrology and Hydraulic models further refined the areas inundated at various ACEs, including the 0.01 ACE. The FEMA Flood Maps delineate the watershed using different zone designations associated with the probability of flooding frequency for that area. The study area contains six different zone designations:

- A and AE – Areas subject to inundation by the one percent ACE,
- AO – Areas subject to inundation by the one percent ACE shallow flooding, usually sheet flow on sloping terrain) where average depths are between one and three feet,
- AH – Areas subject to inundation by the one percent ACE shallow flooding, usually areas of ponding) where average depths are between one and three feet,
- VE – Areas subject to inundation by the one percent ACE with additional hazards due to storm-induced velocity wave action
- X – Areas outside of the 0.2 percent floodplain
- NP – Areas not mapped by the FEMA National Flood Insurance Program.

The Department of Planning and Permitting of the City and County of Honolulu is authorized to implement their flood management regulations once a floodplain has been delineated on the NFIM prepared by FEMA. The flood maps for La'ie were first established in March 1980 and later updated in September 1990 to incorporate changes resulting from the construction of the Kahawainui Stream Flood Control Project. The NFIM flood zones for the study area are provided in ***Figure 6***. Development within the regulatory floodplain is not allowed unless proper provisions to minimize or eliminate flood damages are implemented.

La'ie is situated in a low-lying coastal area adjacent to the alluvial fans of Wailele Stream and Koloa Gulch. As depicted in***Figure 6***, Wailele Creek immediate areas adjacent to Wailele Creek are subject to 1-percent flood events (Zones A and AE), but as the flooding moves north, La'ie is inundated with sheet flow flooding (Zone AH) causing significant flood damages to the community.

Figure 6: FEMA Floodplain Zones within the Study Area.



3.4 Wetlands

Wetlands are often defined as areas where the frequent and prolonged presence of water at or near the soil surface drives the natural system. Wetlands areas require specific hydrology, soil types (i.e. hydric soils), and plant species that are characterized as requiring wetland habitats.

The USFWS (2019) has mapped wetlands within the study area as part of the National Wetlands Inventory (NWI). Although the USFWS have identified several errors in the national NWI, the database provides a good baseline prior to field identification.

Approximately 2,800 linear feet of Wailele Stream above Highway 83 was channelized (unlined channel) in the 1830's to provide irrigation for sugar cane production. The NWI categories the channelized portions of Wailele Stream as a riverine, lower perennial, unconsolidated bottom, permanently flooded, excavated channel (***Figure 7*)**. Site visits and communications with local residents indicate that the channelized portion of Wailele Creek is not permanently flooded and flows through this section of the stream as an intermittent stream dependent on storm events for flow. Above the channelized section, the NWI classifies Wailele Stream as a palustrine forested, broad-leaved evergreen, seasonally flooded channel. This description was validated in the field. Between Highway 83 and the muliwai, Wailele Stream is also designated as a palustrine forested, broad-leaved evergreen, seasonally flooded channel; however, site visits indicate that this lower section of the stream is tidally influence and exhibits conditions more appropriately described as regularly flooded. Koloa Stream is also identified as a palustrine forested channel that feeds into the opposite end of the muliai and site visits indicate that the lower segment is also tidally influenced (***Figure 7***).

The muliwai is categorized as a marine, intertidal, unconsolidated shore, regularly flooded wetland. Immediately offshore, the NWI classifies the open marine waters as subtidal, coral reef habitat (***Figure 8***). Site visits confirm these designations.

Figure 7: NWI characterization of the natural and channelized sections of Wailele Stream.

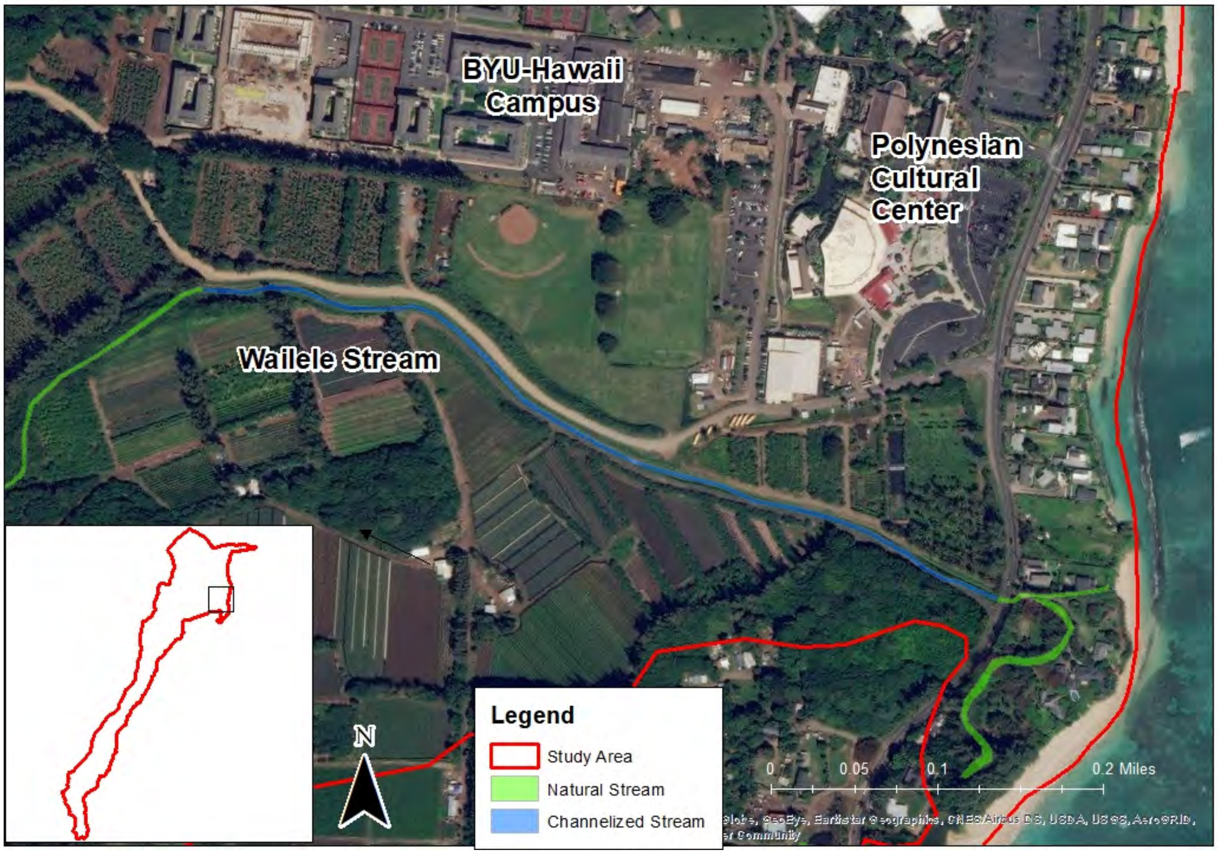
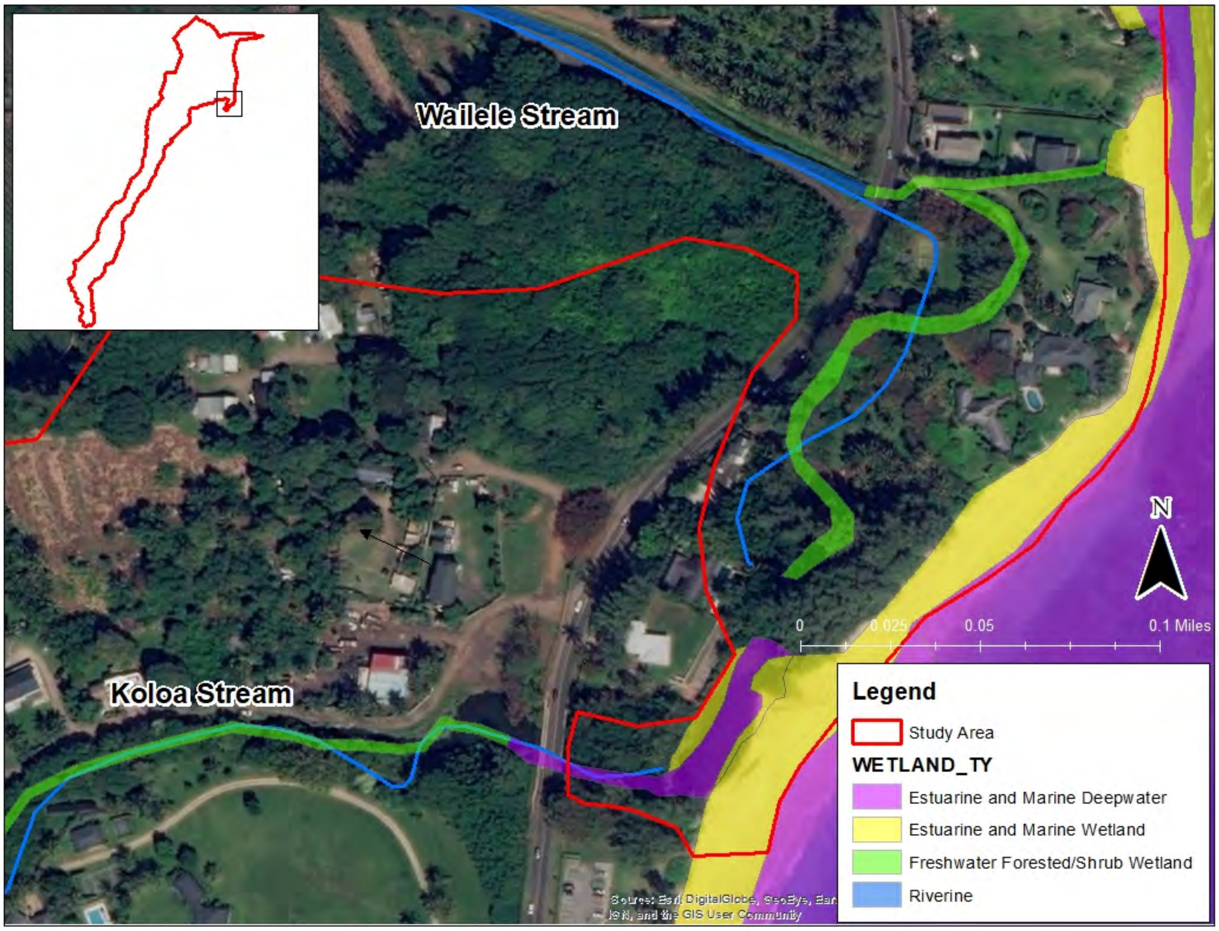


Figure 8: NWI characterization of wetlands associated with the muliwai.



3.5 Surface Waters

The State of Hawaii does not have any designated wild and scenic rivers as designated under the National Wild and Scenic Rivers Act (Publi Law 90-542; 16 U.S.C. 1271 et seq.)

The Clean Water Act (CWA)(33 U.S.C §§1251 *et seq*.) requires Federal agencies to protect waters of the U.S. The regulation implementing the Act disallows the placement of dredged or fill material into waters of the U.S. The Sections of the CWA that apply to this study include Section 401 regarding discharges to waterways and Section 404 regarding fill material in waters or wetlands.

The Clean Water Rule defines Jurisdictional Waters of the U.S. (WOTUS) as:

- Navigable waters,
- Interstate waters,
- Territorial seas,
- Impoundments,
- Tributaries to the traditional navigable waters (water features with beds, banks, and ordinary high water mark (OHWM) , and flow downstream, except for wetlands and open waters without beds, banks, or OHWMs, which will be evaluated for adjacency),

- Adjacent wetlands/waters (includes waters adjacent to WOTUS within a minimum of 100 feet and within the 100-year floodplain to a maximum of 1,500 feet from the OHWM), and
- Isolated or “other” waters, which includes specific waters as defined t=in the Final Rule ad waters with a significant nexus within the 100-year floodplain of a traditional navigable water, interstate water, or territorial seas, as well as waters with a significant nexus within 4,000 feet of jurisdictional water.

The definition excludes ditches, groundwater, gullies, rills, non-wetlands swales, and constructed components of stormwater conveyance systems, water delivery/reuse, or erosional features.

3.5.1 Wailele Stream

The headwaters of Wailele Stream begin in the upper elevations of Puʻu Kaʻinapuaʻa in the Koolau Range near the northern tip of Oahu. The relatively small Wailele Stream watershed encompasses approximately 2.3 square miles. Wailele Stream has formed a classical amphitheater headed valley from the intense rainfall typical of the windward geomorphic region and headward erosion through volcanic formations. It is a short ephemeral stream approximately 16.5 miles long with a steep gradient from 2,300 feet in elevation to sea level. As stated in **Chapter 3.4**, Wailele Stream was channelized approximately 2,800 upstream of Highway 83. Except for the shoreline floodplain, Wailele Stream has a very narrow valley of a half mile or less. Approximately two-thirds of the stream flows over the volcanic rocks of the Koolau Range and the remainder over a poorly developed floodplain and narrow coastal plain. Within the lower floodplain and coastal plain, the stream’s course is controlled by elevated and consolidated alluvial deposits and lithified sand dunes. This portion of the watershed has been developed for agriculture and the urban development of the Laʻie community. Wailele Stream empties into a muliwai that is contained by a sand berm between the muliwai and the ocean. During flood events, the dune impounding the muliwai breaches the dune and temporarily reconnects the muliawai to the ocean until the dune builds back up (USFWS, 2000).

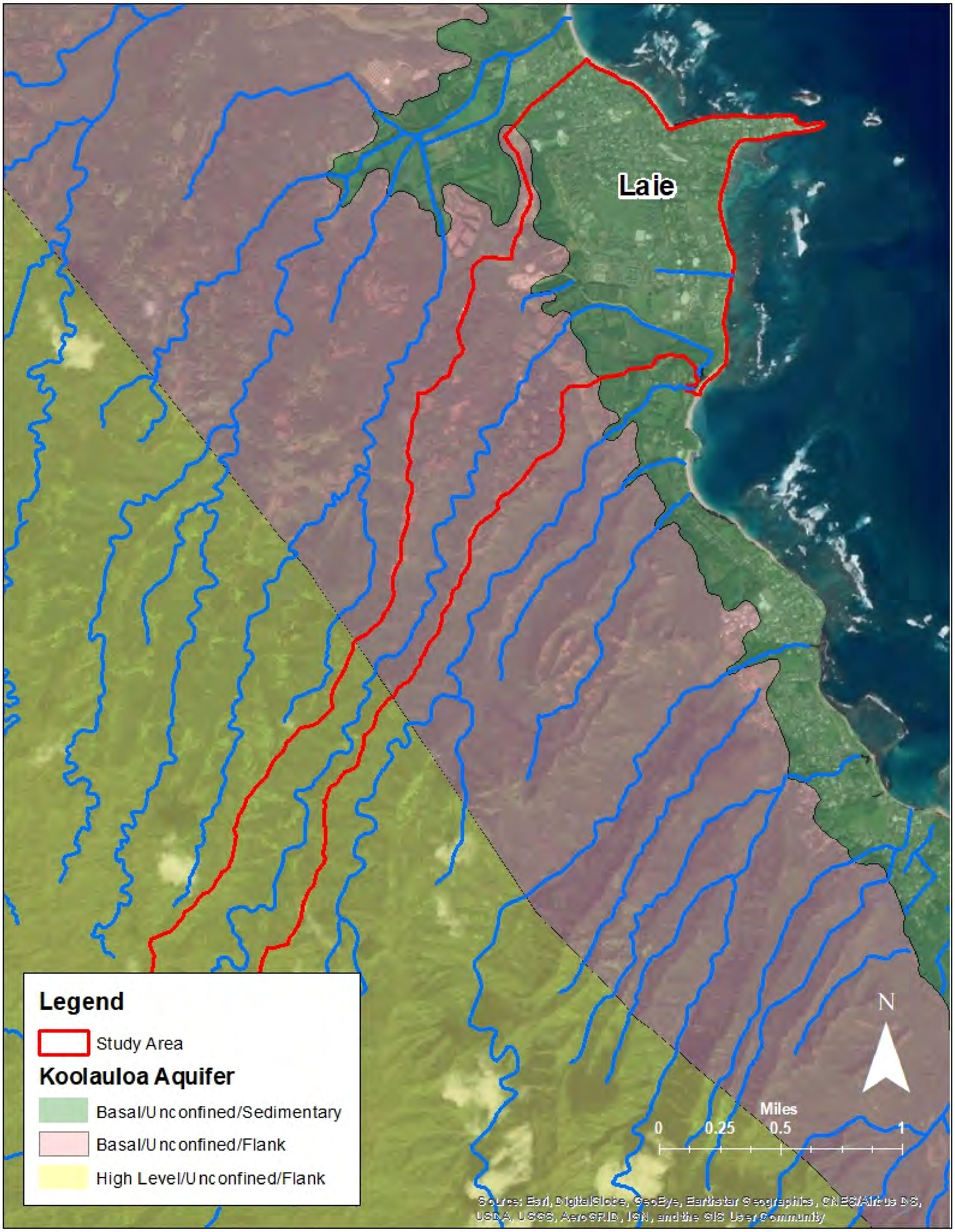
3.5.2 Koloa Stream

The geomorphology of the Koloa Stream watershed is similar to the Wailele and is located directly to the south. The Wailele watershed encompasses approximately 2.5 square miles and terminates in the same muliwai as the Wailele Stream. The Koloa watershed is slightly wider the Wailele extending up to 0.7 miles in width at its widest. As with Wailele, the lower portion of the water shed has been developed for agriculture.

3.6 Ground Water

The Koolau Aquifer extends throughout the study area consisting of three subunits (***Figure 9***). The upper reaches of the Wailele Stream Basin is underlain by a high level flank segment of the Koolau Aquifer and transitions to a basal flank aquifer on the lower slopes. Both of these subunits contain freshwater, but only the basal aquifer is utilized for drinking water. Along the coast and the Laʻie community, the underlying aquifer subunit is composed of sedimentary material and the aquifer increases in salinity closer to the shoreline.

Figure 9: Aquifers within the Study Area



3.7 Coastal Zone Management Resources

In 1972, Congress passed the Coastal Zone Management Act (CZMA), which established the federal Coastal Zone Management Program (CZMP; Public Law 92-583 Stat.1280, 16 §§ 1451-1464, Chapter 33). The CZMP is a federal-state partnership that provides a basis for protecting, restoring, and responsibly developing coastal resources. The CZMA defines coastal zones wherein development must be managed to protect areas of natural resources unique to coastal regions. Hawaiʻi has developed and enacted the Hawaiʻi Ocean Resources Management Plan (ORMP), in which any federal and local actions must be determined to be consistent with the management plan. The State of Hawaiʻi Office of Planning enforces consistency of the plan for Hawaiʻi.

States are required to define the area that will comprise their coastal zone and develop management plans that protect the unique resources through enforceable policies of the State ORMP. Hawaiʻi defines its coastal zone as all lands of the state and the area extending seaward from the shoreline to the limit of the State's police power and management authority, including the U.S. territorial sea. Therefore, the study area lies within the coastal zone as defined by the State.

The ORMP goals and policies focus management efforts on 11 management priority groups:

- Appropriate Coastal Development,
- Management of Coastal Hazards,
- Watershed Management,
- Marine Resources
- Coral Reef
- Ocean Economy
- Cultural Heritage of the Ocean
- Training, Education, and Awareness
- Collaboration and Conflict Resolution
- Community and Place-based Ocean Management Projects
- National Ocean Policy and Pacific Regional Objectives

3.8 Air Quality

The U.S. Environmental Protection Agency (EPA) has the primary responsibility for regulating air quality nationwide. The Clean Air Act (42 U.S.C. 7401 *et seq*.), as amended, requires the EPA to set National Ambient Air Quality Standards (NAAQS) for wide-spread pollutants from numerous and diverse sources considered harmful to public health and the environment.

EPA has set NAAQS for six principal pollutants, which are called "criteria" pollutants. These criteria pollutants include carbon monoxide (CO), nitrogen dioxide (NO_2), ozone (O_3), particulate matter less than 10 microns (PM_{10}), particulate matter less than 2.5 microns ($PM_{2.5}$), sulfur dioxide (SO_2), and lead (Pb). If the concentration of one or more criteria pollutants in a geographic area is found to exceed the regulated "threshold" level, the area may be classified as a non-attainment area. Areas with concentrations of criteria pollutants that are below the levels established by the NAAQS are considered either in attainment.

There are no non-attainment areas within the State of Hawaiʻi (EPA, 2019).

3.9 Water Quality

Section 305(b) of the CWA requires states to assess the water quality of the waters of the state and prepare a comprehensive report documenting the water quality. The report is to be submitted to the EPA every two years. In addition, Section 303(d) of the CWA requires states to prepare a list of impaired waters on which total maximum daily loads (TMDLs) where corrective actions must be implemented. The EPA has delegated the Hawaiʻi State Department of Health (HSDOH), Clean Water Branch as the agency in Hawaiʻi responsible for enforcing the water quality standards and preparing the comprehensive report for submittal to the EPA.

Koloa Stream meets all of the water criteria under Section 303(d) and similarly, the marine waters in the Koloa watershed also are not considered impaired waters under the Section 303(d) criteria. Wailele stream is classified as an impaired water due to elevated turbidity as measured during the wet season. Wailele meets the Section 303(d) Total Nitrogen (TN), nitrate ($NO_{2)}$ and nitrate (NO_3), ammonium (NH4), total phosphorous (TP), and chlorophyll *a* (Chl *a*). Wailele Stream is listed as a low priority for initiating the establishment of TMDLs for turbidity.

The marine waters associated with the Koloa Stream at Pounders and Kokololio Beaches meet all the water quality criteria under Section 303(d). Similarly, the marine waters at Laniloa Beach, associated with Wailele Stream, meet the water quality criteria as well.

3.10 Geologic Resources

Geologic resources are defined as the topography, geology, soils, and mining of a given area. Oahu consists of two eroded volcanic ranges: the Waianae and the Kōolau. These ranges have long, narrow ridges shaped by wind and water erosion. Nearly all of their “shield” shape has been lost. The Kōolau Range is 3,105 in elevation and 37 miles long. Lava flows from the Kōolau Range is thin, basaltic, and typically slope between six and fifteen degrees away from the summits. The existing physiography, soils, and geomorphology of the study area is a result of complex interactions of geological, hydrological, and meteorological processes that occurred during the Holocene and early Pleistocene epochs of the Quaternary period.

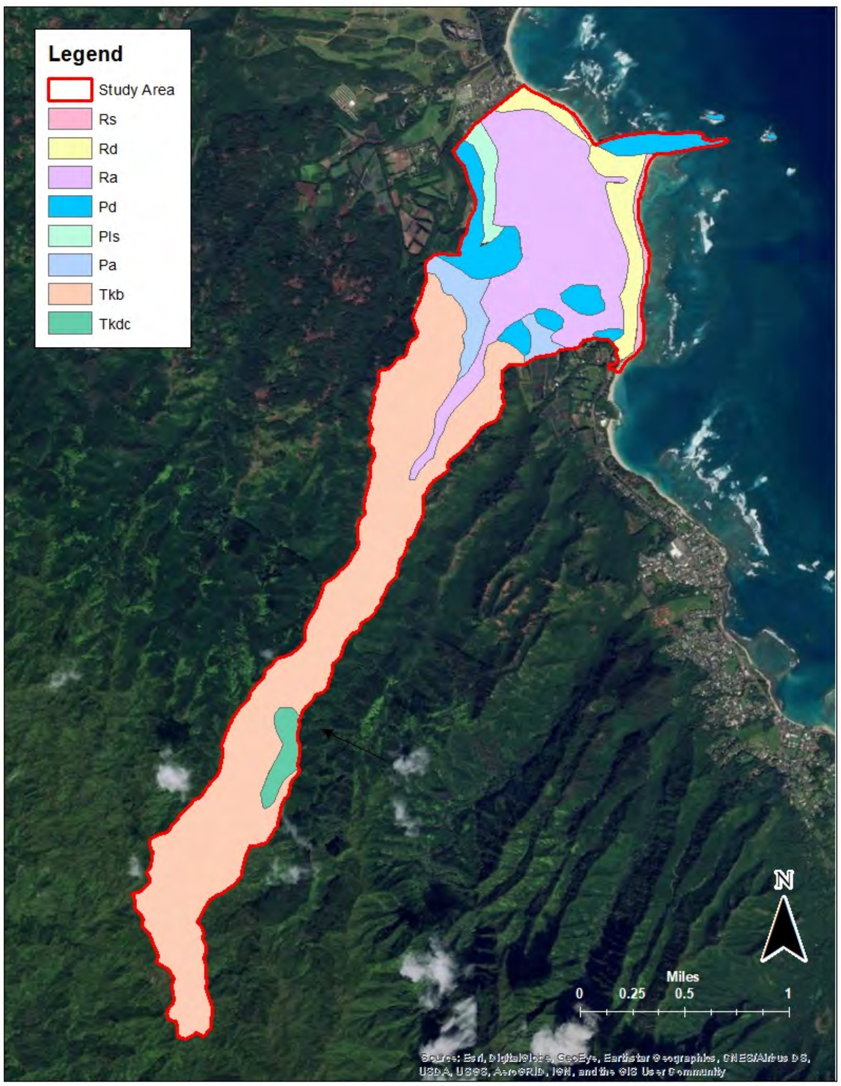
Due to the volcanic activity, the geology of the upper reaches of the Wailele watershed consists of Kōolau basalts. Marine hydrological processes have transformed the geology of the lower reaches of the watershed associated with the alluvial fan of Wailele Stream. The geologic features of the alluvial fan consist of unconsolidated and consolidate material comprised of calcareous dunes, marine sediments, and sediments and noncalcareous deposits (***Table 2*****;** ***Figure 10***).

Table 2: Geologic Features of the Wailele Stream FRM Study Area.

Geologic Symbol	Description	Area (acres)	Percent of Study Area
Rs	Unconsolidated marine calcareous sediments	18	1.2%
Rd	Unconsolidated calcareous dunes	94	6.5%
Ra	Unconsolidated noncalcareous deposits	375	25.8%
Pd	Consolidated calcareous dunes	134	9.2%
Pls	Consolidated calcareous marine sediments	29	2.0%
Pa	Consolidated noncalcareous deposits	16	1.1%
Tkb	Kōolau basalt	754	51.9%
Tkdc	Kōolau, dike complex	33	2.3%
	Total	1,453	100.0%

Source: USGS, 1938

Figure 10: Geology of the Wailele Stream FRM Study Area.



3.11 Soils

The soils found in the upper portions of the study area are consistent with the Rough Mountainous Land – Kapaa Association. This soil association consists of very steep land broken by numerous drainageways at elevations ranging from 1,000 to 3,000 feet.

The lower, or alluvial fan, portion of the watershed is comprised of soils in the Kaena-Waialua Association. Soils within this association are deep, mainly level and gently sloping, and poorly drained (USDA, 1972). ***Table 3*** lists the soil types and their extent within the study area.

The Farmland Protection Policy Act of 1981 (FPPA)(P.L. 97-98) is intended to minimize the impact of Federal actions on the conversion of prime farmland, unique farmland, or land of statewide or local importance to non-agricultural uses. Farmland consists of cropland, forest land, rangeland, and pastures. Urban lands containing prime farmland soils are not covered under the FPPA.

Prime farmland is land that has the best combination of physical and chemical properties for producing food, feed, forage, fiber, and oilseed crops. In general, prime farmland has an adequate and dependable supply of moisture from precipitation or irrigation. Unique farmland is land other than prime farmland that is used for the production of specific high-value food and fiber crops, such as citrus, tree nuts, olives, cranberries, and other fruits and vegetables. Nearness to markets is also a consideration. Unique farmland is not based on national criteria. Farmland of statewide importance do not meet the qualifications of prime or unique farmland. The criteria

Eighteen different soil types are found within the study area (***Figure 11***). The study area includes seven prime farmland soil types comprising approximately 23-percent of the study area (***Table 3***). These soils are considered prime farmland if irrigation infrastructure is present in the fields. Hydric soils are formed under conditions of saturation, flooding, or ponding long enough during the growing season to develop anaerobic conditions in the upper horizons. Two of the soils (Haleiwa silty clay, 0-2% slopes and Keaau clay, 2-10% slopes) are categorized as hydric soils representing approximately ten-percent of the study area.

Figure 11: Soil types with in the Wailele Stream FRM Study Area

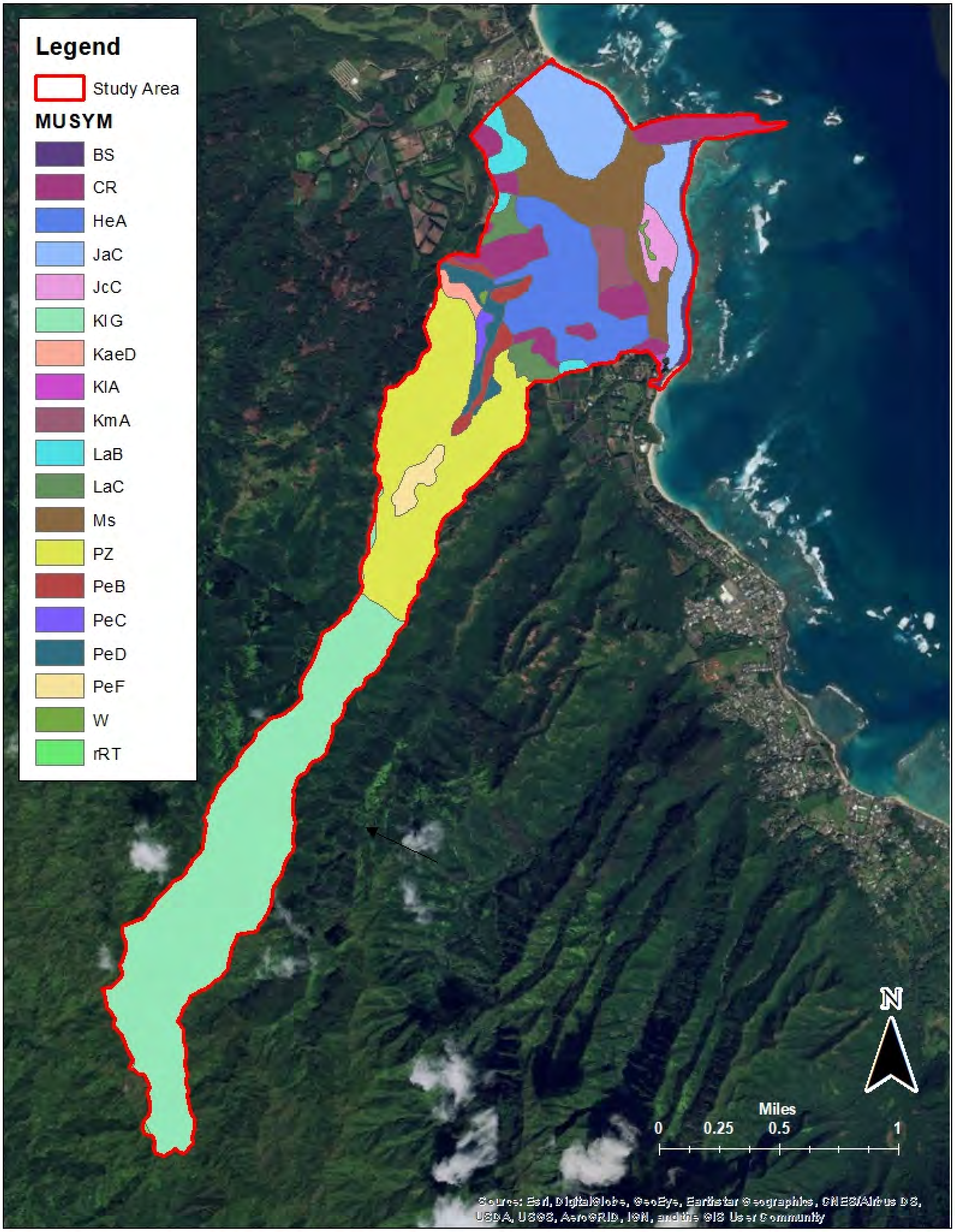


Table 3: Soil Types, Prime Farmland Soils, and Hydric Soils within the Wailele Stream FRM Study Area

Soil Map Unit	Soil Name	Acres in Study Area	Percent of Soil in Study Area	Prime Farmland Soil	Hydric Soils
BS	Beaches	16.2	1.1%		
CR	Coral Outcrop	107.3	7.4		
HeA	Haleiwa silty clay, 0-2% slopes	133.4	9.2	Yes, if irrigated	Yes
JaC	Jaucus sand, 0-15% slopes	140.4	9.7		
JcC	Jaucus sand, 0-12% slopes	19.5	1.3		
KaeD	Kaena stony clay, 12-20% slopes	8.2	0.6		
KIG	Kapaa silty clay, 40-100% slopes	470.5	32.4		
KIA	Kawaihapai clay loam, 0-2% slopes	12	0.1	Yes, if irrigated	
KmA	Keaau clay, 2-10% slopes	21.8	1.5		Yes
LaB	Lahaina silty clay, moist, 3-7% slopes	23.2	1.6	Yes, if irrigated	
LaC	Lahaina silty clay, 7-15% slopes	25.5	1.8	Yes, if irrigated	
Ms	Mokuleia loam	124.9	8.6	Yes, if irrigated	
PeB	Paumalu silty clay, 3-8% slopes	23.9	1.6	Yes, if irrigated	
PeC	Paumalu silty clay, 8-15%	5.8	0.4	Yes, if irrigated	
PeD	Paumalu silty clay, 15-25% slopes	27.7	1.9		
PeF	Paumalu silty clay, 40-70% slopes	16.8	1.2		
PZ	Paumalu-Badland Complex	276.4	19.0		
rRT	Rough mountainous land	1.7	0.1		
W	Water	2.8	0.2		
	Total	1,452.5	100%	-	

Source: NRCS Soil Data Mart (2019)

3.12 Biological Communities

Biological communities include plants and animals and the habitats in which they occur. They are important because they influence ecosystem functions and values, have intrinsic value and contribute to the human environment, and are the subject of a variety of statutory and regulatory requirements.

The USFWS conducted terrestrial plant surveys on 9 and 23 November 1999 (USFWS, 2000). An aquatic survey was conducted by biologists from the USFWS and the U.S. Geological Survey's (USGS) National Ambient Water Quality Assessment (NAWQA) program on 9 November and 1 December 1999 (USFWS, 2000). The 9 November 1999 survey was conducted after a large storm event and the sand berm of the muliwai had been breached connecting the muliwai to the ocean.

3.12.1 Vegetation

Within the lower reaches of the study area, the plant community was dominated by non-native species including guinea grass (*Panicum maximum*), California grass (*Brachiara mutica*), Koa haole (*Leucaena camara*), sourbush (*Pluchea symphitifolia*), ironwood (*Casuarina equisetifolia*), lantana (*Lantana camara*), and Norfolk pine (*Araucaria columnaris*). Coconut palms (*Cocos nucifera*) and bananas (*Musa* sp.) were locally abundant and small groves of papaya (*Carica papaya*) were actively being cultivated. Overstory trees along the streambank included Christmas berry (*Schinus terbinthifolius*) and strawberry guava (*Psidium cattleianum*) with African tulip-trees (*Spathodea campanulata*) and kukui (*Aleurites moluccana*) also present. Common understory plants along the stream included ti (*Cordyline fruticosa*) and ferns.

3.12.2 Aquatic Wildlife

Typical with other Hawaiian streams, native aquatic life within are adapted to the ephemeral hydrological processes of Wailele Stream. During periods when Wailele Stream is flowing and the sand bar below the muliwai is breached, juvenile amphidromous species return from the ocean and migrate upstream. Upon reaching the perennial upper reaches of the stream, these species wait for flows to return to the intermittent portions of the stream to migrate back to the ocean.

The surveys identified two endemic gobies (*Eleotris sandwicensis* and *Stenogobius hawaiiensis*) and an indigenous prawn (*Macrobrachium grandimanus*) within the muliwai of Wailele and Koloa Streams. Surveys of Wailele Stream identified a primarily non-native aquatic community consisting of non-native prawns (*Macrobrachium lar*), leeches (*Myzobdella lugubris*), Chironomid midge larvae, guppies (*Poecilia sphenops*) , swordtails (*Xiphophorus helleri*), and toad tadpoles (*Bufo marinus*). Tilapia (*Tilapia* sp.) and Thiarid snails (*Melanoides tuberculata*) wer other non-native species that were abundant in the stream habitats.

3.12.3 Terrestrial Species

The USFWS conducted terrestrial surveys on 9 and 23 November 1999. Four native birds were observed within the study area, all of which were found in the muliwai and the sand berm: Pacific Golden Plover (*Pluvialis fulva*), Sanderlings (*Calidris alba*), Ruddy Turnstones (*Arenaria interpres*), and Black-crowned Night Herons (*Nycticorax nycticorax hoactli*). Non-native bird species encountered included the Zebra Dove (*Geopilia striata*), Spotted Dove (*Streptopelia chinensis*), Common Myna (*Acridotheres tristis*), Cattle Egret (*Bubulcis ibis*), and Red-vented Bulbul (*Pycnonotus cafer*). Although not observed during the survey, the endangered Hawaiian Gallinule (*Gallinula chloropus sandvicensis*) has been observed in the muliwai (USACE, 1992). No sea turtles were observed during the surveys.

3.12.4 Threatened and Endangered Species

Wildlife and plant species may be classified as threatened or endangered under the Endangered Species Act (ESA) of 1973. Protection of non-marine protected species is overseen by the USFWS and NMFS is responsible for protected marine species. The purpose of the ESA is to establish and maintain a list of threatened and endangered species and establish protections for their continued survival. Section 7 of the ESA requires federal agencies to coordinate with USFWS and NMFS to ensure that any federal action is complaint with the ESA and that the action will not jeopardize the continued existence of threatened or endangered species or result in the destruction or adverse modification to their critical habitat. The

State of Hawaiʻi has also developed State list of threatened and endangered species and incorporated it in the Hawaiʻi Comprehensive Conservation Strategy (HCCS)(Mitchell et al., 2005).

The upper and middle reaches of Wailele and Koloa Streams contain 790 acres of critical habitat for three endangered damselfly species: the blackline Hawaiian damselfly (*Megalagrion nigrolineatum nigrolineatum*), the oceanic Hawaiian damselfly (*M. oceanicum*), and the Hawaiian upland damselfly (*M. hawaiiense*). As stated above, the endangered Hawaiian Gallinule has been observed in the Wailele and Koloa muliwai. Critical habitat for the monk seal occurs in the marine waters extending out to the 200 meter depth contour within the study area. The terrestrial critical habitat for the monk seal occurs from five meters inland from the shoreline. The study area is located approximately 2.5 miles south of the nearest designated terrestrial critical habitat for the seal (OA71-OH72)(NMFS, 1994).

The Wailele watershed is known to support populations of the endangered *Hesperomannia*, a plant in the Sunflower (Asteracae) family. Critical habitat for 43 plant species has also been designated within the Wailele watershed. These species include *Adenophorus periens*, ʻAkoko (*Chamaesyce rockii*), Haha (*Cyanea acuminate, C. calycina*, *C. crispa*, *C. grimesiana* ssp. *grimesiana*, *C. humboltiana*, *C. koolauensis*, *C. lanceolata*, *C. purpurellifolia*, *C. st.-johnnii*, and *C. truncate*), Haʻiwale (*Cyrtandra dentate*, *C. gracilis*, *C. kaulantha*, *C. polyantha*, *C. sessilis*, *C. subumbellata*, *C. viridiflora*, *C. waiolani*), Nanu (*Gardenia mannii*), *Hesperomannia arborescens*, *Huperzia nutans*, Aupaka (*Isodendrion longifolium*), Kamakahala (*Labordia cyrtandrae*), *Lobelia gaudichaudii* ssp. *koolauensis*, *L. oahuensisi*, Alani (*Melicope hiiakae* and *M. lydgatei*), Kolea (*Myrsine juddii*), *Phyllostegia hirsute*, *P. parviflora* var. *parviflora*, Ale (*Plantago princeps* var. *longibracteata* and *P.princeps* var. *princeps*), *Plantanthera holochila*, *Platydesma cornuta* var. *cornuta*, *Psychotria hexandra* spp. *oahuensis*, Kaulu (*Pteralyxia macrocarpa*), *Pteris lidgatei*, *Sanicula purpurea*, ʻOheʻohe (*Tetraplasandra gymnocarpa*), *Trematolobelia singularis* , *Viola oahuensis*, and Aʻe (*Zanthoxylum oahuense*)(USFWS, 2012). With the exception of the Hawaiian Gallinule siting in 1992, no listed species were observed within the lower Wailele watershed as most of these endangered species are expected to occur in the upper reaches of the watershed.

3.13 Special Status Species and Protected Habitat

3.13.1 Migratory Birds

The Migratory Bird Treaty Act (MBTA)(16 U.S.C. 703-712) prohibits the take of migratory birds resulting from activities unless authorized by the USFWS. Take includes pursuing, hunting, capturing, and killing of migratory birds or any part of their nests or eggs. The Act also prohibits the sale, purchase, or shipment of migratory birds, nests, or eggs. The MBTA is an international treaty with the U.S., Canada, Mexico, Japan and Russia. Non-native bird species are not protected under the MBTA.

As stated in the Terrestrial Chapter (3.12.3) above, the Pacific Golden Plover, Sanderling, Ruddy Turnstone, and Black-crowned Night Heron were observed in the study area. All other bird species observed were not native to Hawaiʻi and are not protected under the MBTA.

3.13.2 Marine Mammals

The Marine Mammal Protection Act of 1972 (MMPA)(16 U.S.C. 1361-1407) prohibits the take of marine mammals in U.S. waters and the importation of marine mammals and marine mammal products into the U.S. Take incudes the harassment, feeding, hunting, capture, collection, or killing of any marine mammal or part of a marine mammal. All cetaceans, (whales, dolphins, porpoises), sirenians (manatees and dugongs) and several marine carnivores (seals, sea lions, otters, walrus, and polar bears) are protected under the MMPA. The Act also established the Marine Mammal Commission, the International Dolphin Conservation Program, and the Marine Mammal Health and Stranding Response Program.

There are a total of 26 marine mammals documented in the Hawaiian Islands:

- Bottlenose dolphin (*Tursiops truncatus*)
- Pacific white-sided dolphin (*Lagenorhynchus obliquidens*)
- Pan-tropical spotted dolphin (*Stenella attenuata*)
- Risso's dolphin (*Grampus griseus*)
- Rough toothed Dolphin (*Steno bredanensis*)
- Spinner Dolphin (*Stenella longirostris*)
- Striped Dolphin (*Stenella coeruleoalba*)
- Hawaiian monk seal (*Monachus schauinslandi*)
- Northern fur seal (*Callorhinus ursinus*)
- Northern elephant seal (*Mirounga angustirostris*)
- Blainsville's beaked whale (*Mesoplodon densirostris*)
- Blue whale (*Balaenoptera musculus*)
- Bryde's whale (*Balaenoptera edeni*)
- Cuvier's beaked whale (*Ziphius cavirostris*)
- Dwarf sperm whale (*Kogia simus*)
- False killer whale (*Pseudorca crassidens*)
- Fin whale (*Balaenoptera physalus*)
- Humpback whale
- Killer whale (*Orcinus orca*)
- Melon-headed whale (*Peponcephala electra*)
- North Pacific right whale (*Eubalaena japonica*)
- Pygmy killer whale (*Feresa attenuata*)
- Pygmy sperm whale (*Kogia breviceps*)
- Sei whale (*Balaenoptera borealis*)
- Short-finned pilot whale (*Globicephala macrorhynchus*)
- Sperm whale

No marine mammals were observed during the field surveys.

3.13.3 <u>Essential Fish Habitat</u>

Congress enacted amendments to the Magnuson-Stevens Fishery and Conservation and Management Act (MSFCMA)(Public Law 94-265) in 1996 that established procedures for identifying Essential Fish Habitat (EFH) and required interagency coordination to further the conservation of federally managed fisheries. Rules published by NMFS (50 CFR Sections 600.805 – 600.930) specify that any federal agency that authorizes, funds or undertakes, or proposes to authorize, fund or undertake an activity which could adversely affect EFH is subject to consultation provisions of the MSFCMA and identifies consultation requirements.

EFH consists of those habitats necessary for spawning, breeding, feeding, or growth to maturity of species managed by the Regional Fishery Management Councils, as described in a series of Fishery Management Plans, pursuant to the Act. The EFH within the study area includes:

- Hawaiian Coral Reef Ecosystem
- Amberjack/blackjack/sea bass
- Blue stripe snapper/gray jobfish
- Giant trevally
- Pink snapper
- Red snapper/long tail snapper/yellow tail snapper/pink snapper/snapper, and
- Silver jaw jobfish/thicklip trevally

Descriptions and habitat, and potential impacts to EFH can be found in the EFH Assessment (Attachment 1).

3.13.4 Coral Reefs

Executive Order (EO) 13089, Coral Reef Protection, was enacted to preserve and protect the biodiversity, health, heritage, and ecological, social, and economic values of U.S. coral reef ecosystems and the marine environment. An interagency task force, the U.S. Coral Reef Task Force, was created in order to fulfill the EO's protection efforts. The task force works with State, territorial, commonwealth, and local government agencies, nongovernmental organizations, the scientific community, and commercial interests to develop and implement measures to restore damaged coral reefs and to mitigate further coral reef degradation (EPA, 2019).

Marine surveys were conducted in the spring of 1992 (AECOS, 1992) and in the summer of 1994 (AECOS 1994) to provide baseline data preceding the use of the La'ie Water Water Treatment Plant (WWTP) drain field. Surveys were conducted in the broad sand channel off of Pounder's Beach, located near the Wailele and Koloa muliwai, and the reef flats north and south of the sand channel.

The reef flats were dominated by macroalgae: *Dictyopteris australis*, *Padina japonica*, *Sargassum echinocarpum*, *Gracilaria* sp. The reef north of the sand channel include the coralline algae *Porolithon gardineri* and *P onkodes*, while the south reef supported *Microdictyon* sp., *Padina japonica*, *Asperagopsis taxiformis*, *Galaxaura fastigiata*, and *Porolithon gardineri*. With the exception of the channel immediately seaward of Pounder's Beach where *Ulva* and *Enteromorpha* wer growing at the foot of the beach, no macroalgae were observed in the channel.

Except along parts of the channel margin, corals were not a significant part of the benthic assemblages on the inner reef areas surveyed. Coral species common to the channel margins included *Porites lobata*, *Montipora capitata* (*M. verrucosa*), *M. patula*, and *Pocillopora meandrina* (AECOS, 1992).

3.14 Socioeconomics

Socioeconomics is defined as the basic attributes and resources associated with the human environment, particularly population, demographics, and economic development. Demographics entail population characteristics and include data pertaining to race, gender, income, housing, poverty status, and educational attainment. Economic development or activity typically includes employment, wages, business patterns, and area's industrial base, and its economic growth.

According to the 2010 census, the community of Laʻie had a population 6,138 residents (U.S. Census Bureau, 2018), comprising 0.6 percent of the population in Honolulu County. Population growth for Laʻie was 2.4 percent between 2010 and 2018.

The community of Laʻie has a higher median income and housing costs than the state and county medians (***Table 4***). The poverty rate in the community of Laʻie is higher than the county, but consistent with the state average. This data reflects the professional and educated population centered around the university.

Table 4: Mean Income of the Study Area

Geographic Unit	Median Income	Median Housing	% Population in Poverty
Hawaiʻi	$74,923	$563,900	9.5%
Honolulu County	$80,078	$626,400	8.3%
Laʻie	$95,093	$662,100	9.9%

U.S. Census Bureau, 2018

The racial distribution for the community of Laʻie is also relatively consistent with the county and state make up (***Table 5***).

Table 5: Racial Distribution for the Community of Laʻie, County of Honolulu, and the State of Hawaiʻi

Race	% of Laʻie	% of Honolulu County	% of State of Hawaiʻi
White	28.0	21.9	25.7
African American	1.9	2.8	2.2
American Indian/Alaska Native	0.1	0.3	0.4
Asian	11.1	43.0	37.8
Native Hawaiian/Pacific Islander	26.2	9.6	10.2
Two or more races	31.0	22.4	23.8
Hispanic or Latino	7.4	9.9	10.5

3.14.1 <u>Environmental Justice</u>

In order to comply with EO 1289, ethnicity and poverty status in the study area were examined and compared to regional, state, and national data to determine if any minority or low-income communities could potentially be disproportionately affected by the implementation of the proposed action. As detailed in ***Table 4*** and ***Table 5***, the Laʻie population is relatively consistent with the county and state distribution and no disproportionately minority or low income populations o cur in the study area.

3.14.2 <u>Protection of Children</u>

EO 13045 requires that federal actions consider potentially health and safety risks to children resulting from that action. The locations of areas where children may congregate within the study area include the Laʻie Elementary School located approximately one mile north of Wailele Stream at 55-109 Kulani Street in Laʻie. In addition, the Laʻie Beach Park (Pounder's Beach) is located at the terminus of Wailele Stream.

3.15 Hazardous, Toxic, and Radioactive Waste

Hazardous, Toxic, and, Radioactive Waste (HTRW) within the project area must be treated accordingly in compliance with USACE regulations AR 200-1 Environmental Protection and Enhancement, ER 200-2-3 on hazardous waste management procedures, and ER 1130-2-540 Environmental Stewardship Operations and Maintenance Policies as well as applicable Federal, State, and local environmental laws and regulations.

Under ER-1165-2-132, HTRW Guidance for Civil Works Projects, HTRW is defined as any material listed as a hazardous substance in accordance to the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). The HTRW initial assessment was conducted under USACE regulations (ER 1165-2-132). The report was completed in 26 February 2004 and is included in Attachment 2 for reference.

The results of the HTRW Phase I Assessment indicate that these are no existing HTRW activities located within the study area. A review of the Leaking Underground Storage Tank (LUST) database indicates one LUST site in the study area. The Laʻie Chevron service station located at 55-396 Kamehameha Highway. The LUST site was cleaned up in 1998 and is not expected to be a contamination issue.

3.16 Cultural Resources

The coastal context of the Wailele Stream Flood Control Project supports an elevated concern for impact to significant cultural resources within the project area, including the potential for traditional Hawaiian burials. Cultural resources literature research and field survey was conducted for the project footprint, including all alternatives, in November of 2014. Background and archival literature indicates several distinct land-use regimes that may have produced archaeological deposits. These include traditional Hawaiian occupation, Mahele period Land Claim Awards, and the Kahuku sugarcane plantation period. The last of these, the plantation period, has had an intense and broad-ranging effect on the landscape, effectively destroying most if not all surficial evidence of the earlier regimes. There is one geologically-defined exception—a limestone outcrop at the eastern end of the project area adjacent to Kamehameha Highway. This feature could not be converted to cultivated fields during the plantation period and thus was spared tillage impacts.

A cultural resource pedestrian survey was conducted across the entire project area, including the large basin areas to the north and south which are not part of the preferred alternative. This work largely verified the literature-based expectations. There are no remaining structures within most of the project area and the vast majority of the landscape is comprised of former sugarcane land which is now either fallow or utilized for small-scale farming. A plantation period irrigation valve was identified, as well as a stone mound and set of "upright" cobbles. The mound and upright cobbles are in the limestone area were preservation was expected to be best. Although these features display forms common to traditional Hawaiian construction, the extremely intensive use of the surrounding landscape during the planation period makes the survival of early Hawaiian features unlikely.

Cultural resource concerns for the project are primarily focused on the presence of, and potential for, subsurface archaeological deposits. Background research identified a number of previously-recorded archaeological sites in and around the Wailele project area. These sites appear to be instances of an originally near-continuous traditional Hawaiian cultural deposit fronting the southern part of Laie and occurring mainly in coastal Jaucas sands. The deposit has been recorded as State Inventory of Historic Places (SIHP) sites 50-80-02-05458, -05457, -04049, and -04050. Of these, Site 05458 is directly within the project area and will be intersected by the diversion channel. This site is known to contain human remains. Traditional Hawaiian burials are common along this coastal stretch. Another similar find is located immediately north of the main Wailele Stream channel (Site 06851).

3.17 Noise

Noise is generally defined as unwanted sound. Noise can be any sound that is undesirable because it interferes with communication, is intense enough to damage hearing, or is otherwise annoying. Human responses to noise vary depending on the type and characteristics of the noise, distance between the noise source and receptor, receptor sensitivity, and time of day.

Determination of noise levels are based on 1) sound pressure level generated (decibels [dB] scale); 2) distance of listener from source of noise; 3) attenuating and propagating effects of the medium between the source and the listener; and 4) period of exposure.

An A-weighted sound level, measured in dBA, is one measurement of noise. The human ear can perceive sound over a range of frequencies, which varies for individuals. In using the A-weighted scale for measurement, only the frequencies heard by most listeners are considered. This gives a more accurate representation of the perception of noise. The noise measure in a residential area, similar to conditions within the study area, is estimated at approximately 70 dBA. Normal conversational speech at a distance of five to ten feet is approximately 70 dBA. The decibel scale is logarithmic, so, for example, sound at 90 dBA would be perceived to be twice as loud as sound at 80 dBA. Passenger vehicles, motorcycles, and trucks use the roads in the vicinity of the project area. Noise levels generated by vehicles vary based on a number of factors including vehicle type, speed, and level of maintenance. Intensity of noise is attenuated with distance. Some estimates of noise levels from vehicles are listed in ***Table 6*** (Cavanaugh and Tocci, 1998).

Table 6: Typical Noise Sources

Source	Distance (ft)	Noise Level (dba)
Automobile, 40 mph	50	72
Automobile Horn	10	95
Light Automobile Traffic	100	50
Truck, 40 mph	50	84
Heavy Truck or Motorcycle	25	90

Source: Cavanaugh and Tocci, 1998

State of Hawaii HAR Title 11, Chapter 46 Community Noise Control, sets permissible noise levels in order to provide for the prevention, control, and abatement of noise pollution in the State. The regulation creates noise districts based on land use that dictate acceptable noise levels. The study area is located in a conservation/open space within the vicinity of residential use. Therefore, the study area is in a Class A zoning district, as defined by HAR 11-46. The maximum permissible sound level in a Class A district is 55 dBA from 7:00am-10:00pm and 45 dBA from 10:00pm-7:00am.

The EPA has identified a range of yearly day-night sound level (DNL) standards that are sufficient to protect public health and welfare from the effects of environmental noise (EPA, 1977). The EPA has established a goal to reduce exterior environmental noise to a DNL not exceeding 65 dBA and a future goal to further reduce exterior environmental noise to a DNL not exceeding 55 dBA. Additionally, the EPA states that these goals are not intended as regulations as it has no authority to regulate noise levels, but rather they are intended to be viewed as levels below which the general population will not be at risk from any of the identified effects of noise.

The U.S. Occupational Safety and Health Administration (OSHA) has established acceptable noise levels for workers. ***Table 7***shows permissible noise levels for varying exposure times.

Table 7: OSHA Permissible Noise Exposures

Duration per day-hours	Sound level dBA slow response
8	90
6	92
4	95
3	97
2	100
1.5	102
1	105
0.5	110
0.25 or less	115

Source: OSHA, 2012

The Noise Control Act of 1972 (42 United States Code [U.S.C.] 4901 to 4918) established a national policy to promote an environment for all Americans free from noise that jeopardizes their health and welfare. To accomplish this, the Act establishes a means for the coordination of Federal research and activities in noise control, authorizes the establishment of Federal noise emissions standards for products distributed in commerce, and provides information to the public respecting the noise emission and noise reduction characteristics of such products (42 U.S.C. 4901). The Act authorizes and directs that Federal agencies, to the fullest extent consistent with their authority under Federal laws administered by them, carry out the programs within their control in such a manner as to further the policy declared in 42 U.S.C. 4901.

Federal workplace standards for protection from hearing loss allow a time-weighted average level of 90 dBA over an 8-hour period, or 85 dBA averaged over a 16-hour period. Noise annoyance is defined by the EPA as any negative subjective reaction on the part of an individual or group (EPA, 1977). For community noise annoyance thresholds, a day-night average of 65 dBA has been established by the United States Department of Housing and Urban Development (HUD) as eligibility for federally guaranteed home loans. (Federal Interagency Committee on Noise, 1992).

Ambient noise conditions in the study area are generally low due to the rural location. The dominant noise originates from vehicular traffic along Kamehameha Highway and local roadways. Other normal daytime noise sources are typical of residential areas such as lawn mowers, barking dogs, and power tools. Residences located near the highway experience levels of traffic noise as high as 70 dBA while homes located on the coast and at higher elevations away from the main road receive neighborhood noise levels of 65 dBA or lower.

3.18 Traffic

The study area is bisected by the Kamehameha Highway at the lower extreme of the watershed. The highway is a two-lane, two-way arterial highway. The road is heavily traveled by residents going to and from Laʻie and tourists traveling by rental cars or tour buses. Results of a 1991 traffic survey indicate an average of 994 vehicles in both directions during weekday afternoon peak traffic hour and a total of 1,143 vehicles during Saturday afternoon peak hour. Public transportation includes an average of 30 buses and 15-20 mini-buses from Waikiki to the PCC every day. Buses cease operation after 9:00 PM when the evening show at the PCC ends.

3.19 Visual Aesthetics

Visual resources are defined as the natural and manufactured features that comprise the aesthetic qualities of an area. These features form the overall impressions that an observer receives of an area or its landscape character. Landforms, water surfaces, vegetation, and manufactured features are considered characteristic of an area if they are inherent to the structure and function of a landscape.

3.20 Recreation

Recreation is comprised of terrestrial- and water-based activities associated with the local population or visitors to the island. Recreation may consist of aquatic activities such as swimming, windsurfing, surfing, fishing, jet skiing, kayaking, snorkeling, scuba diving, and water skiing. Terrestrial recreational activities may consist of hiking trails, biking trails, parks, golf courses, and ball fields.

Federal regulation 36 CFR 327, supplemented by Army regulation ER 1130-2-405, contains guidelines for rules and regulations regarding USACE public use of water resource development projects. The policy of the Army is to "…manage the natural, cultural, and developed resources of each project in the public interest, providing the public with safe and healthful recreational opportunities while protecting snf enhancing these resources."

Popular recreational areas within the study area include various City and County of Honolulu beach parks. Hauula, Kokololio/kakela, and Laʻie beach parks are frequented by locals and tourists. Recreational activities include sunbathing, swimming, surfing, bodysurfing, fishing, snorkeling, and other beach activities. In 2000, the City and County of Honolulu have prepared a master plan for improvements for Laʻie Beach Park (also known as "Pounders").

The PCC is a popular commercial recreational attraction and BYU-Hawaiʻi provides campus recreational activities such as softball and tennis.

4 FUTURE WITHOUT PROJECT CONDITION

The environmental consequences chapter describes the probable effects or impacts of implementing any of the action alternatives (the Future with Project condition or FWP). Effects can be either beneficial or adverse, and are considered over a 50-year period of analysis (2022-2072).

Environmental impacts will be assessed according to state environmental regulations (HRS 343 and HAR 11-200), as well as federal guidelines (NEPA). Descriptions of the assessment criteria under both state and federal guidelines are presented below.

4.1 State Environmental Guidelines

A “significant effect” is defined by HRS Chapter 343 as “the sum of effects on the quality of the environment, including actions that irrevocably commit a natural resource, curtail the range of beneficial uses of the environment, are contrary to the State’s environmental policies or long-term environmental goals as established by law, or adversely affect the economic welfare, social welfare, or cultural practices of the community and State.”

4.2 Federal Environmental Guidelines

The CEQ regulations (40 CFR 1508.7 and 1508.8) define the impacts that must be addressed and considered by Federal agencies in satisfying the requirements of the NEPA process, which includes direct, indirect and cumulative impacts.

Direct are caused by the action and occur at the same time and place. Indirect Impacts are caused by the action and are later in time or farther removed in distance, but are still reasonably foreseeable. Indirect impacts may include growth inducing impacts and other impacts related to induced changes in the pattern of land use, population density or growth rate, and related effects on air, water and other natural systems, including ecosystems.

Impacts include ecological (such as the effects on natural resources and on the components, structures, and functioning of affected ecosystems), aesthetic, historical, cultural, economic, social, or health, whether direct, indirect, or cumulative. Impacts may also include those resulting from actions which may have both beneficial and detrimental effects, even if on balance the agency believes that the effect will be beneficial (40 CFR 1508.8).

According to the CEQ regulations (40 CFR 1500-1508), the determination of a significant impact is a function of both context and intensity. This means that the significance of an action must be analyzed in several contexts such as society as a whole (human, national), the affected region, the affected interests, and the locality. Significance varies with the setting of the Proposed Action. For instance, in the case of a site-specific action, significance would usually depend upon the effects in the locale rather than in the world as a whole. Both short- and long-term effects are relevant.

Intensity refers to the severity of impact. Responsible officials must bear in mind that more than one agency may make decisions about partial aspects of a major action. The following should be considered in evaluating intensity:

1. Impacts that may be both beneficial and adverse. A significant impact may exist even if the Federal agency believes that on balance the effect will be beneficial.
2. The degree to which the Proposed Action affects public health or safety.
3. Unique characteristics of the geographic area such as proximity to historic or cultural resources, park lands, prime farmlands, wetlands, wild and scenic rivers, or ecologically critical areas.

4. The degree to which the effects on the quality of the human environment are likely to be highly controversial.
5. The degree to which the possible effects on the human environment are highly uncertain or involve unique or unknown risks.
6. The degree to which the action may establish a precedent for future actions with significant effects or represents a decision in principle about a future consideration.
7. Whether the action is related to other actions with individually insignificant but cumulatively significant impacts. Significance exists if it is reasonable to anticipate a cumulatively significant impact on the environment. Significance cannot be avoided by terming an action temporary or by breaking it down into small component parts.
8. The degree to which the action may adversely affect districts, sites, highways, structures, or objects listed in or eligible for listing in the National Register of Historic Places or may cause loss or destruction of significant scientific, cultural, or historical resources.
9. The degree to which the action may adversely affect an endangered or threatened species or its habitat that has been determined to be critical under the Endangered Species Act of 1973.
10. Whether the action threatens a violation of Federal, State, or local law or requirements imposed for the protection of the environment (40 CFR 1508.27).

To determine significance, the severity of the impact must be examined in terms of the type, quality and sensitivity of the resource involved; the location of the proposed project; the duration of the effect (short or long-term) and other consideration of context. Significance of the impact will vary with the setting of the Proposed Action and the surrounding area (including residential, industrial, commercial, and natural sites).

The No Action Alternative and two action alternatives, as described in the Plan Formulation section of the study's Integrated Feasibility Report/Environmental Assessment (IFR/EA) were considered in analyzing impacts from the implementation of any FRM measures:

1. No Action Alternative
2. Wailele Overflow Diversion Channel
3. Wailele Overflow Diversion Channel and Detention Basin

The future without project condition (FWOP), also known as the "No Action Alternative", is the most likely condition expected to occur in the future in the absence of the proposed action or action alternatives. As with the Future with Project Conditions, the impacts to resources are projected over a 50-year window, or the designed life of the proposed project. Therefore, the FWOP conditions project changes that would occur until the year 2072. For the study area, the No Action Alternative means that no Flood Risk Management (FRM) measures will be implemented in the future, and urbanization and development will continue at its present rate.

4.3 Land Use

Under the FWOP conditions, land use is expected to continue to shift from pastoral land uses to residential, commercial, and tourism development as the community of Laʻie grows. The resulting expansion of residential and commercial land uses will result in an increase of impervious cover, exasperating the intensity and frequency of flood events.

4.4 Climate

Projected climate change caused by man-made increases in greenhouse gases will result in changes under the FWOP condition. Scientific research indicates that the Global Mean Sea Level has been increasing since the 1990s, which has seen a sea level rise (SLR) rate of approximately 0.14 inches per year or roughly twice the rate seen in the past 100 years. Rise in sea levels is linked to several climate-related factors, all induced by the ongoing global climate change including water thermal expansion, and melting of glaciers and ice sheets.

Relative sea level rise (RSLR) for Honolulu and Mokuoloe were calculated using methods described by Sweet et al. (2017) and presented on the NOAA Sea Level Trend mapper (NOAA, 2019). The RSLR for the two locations on Oʻahu are nearly identical (***Figure 12*** **and** ***Figure 13***) with RSLR expected to increase 0.16 to 0.72 feet by 2030, 0.25 to 1.53 feet by 2050, and 0.46 to 4.86 feet in 2100 (NOAA, 2019). Sea level rise not only results in the inundation of coastal areas and infrastructure, but can also exacerbate the encroachment of saline groundwater into freshwater aquifers. Climate change is predicted to influence weather patterns leading to an increase in periods of drought, higher temperatures and evaporation rates for soil and water bodies, and more intense storms and weather events. For the FWOP conditions, these factors will lead to an increased intensity of flood events within the study area.

Figure 12: Annual Mean Relative Sea Level Trends for Honolulu, Hawaii

Station 1612340 (Source – NOAA, 2019)

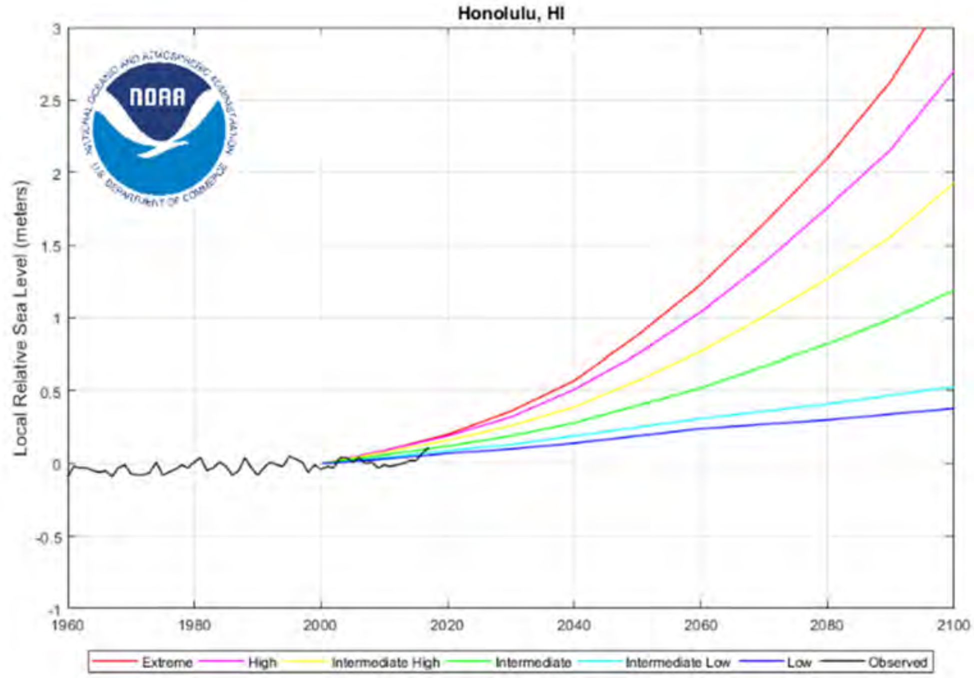
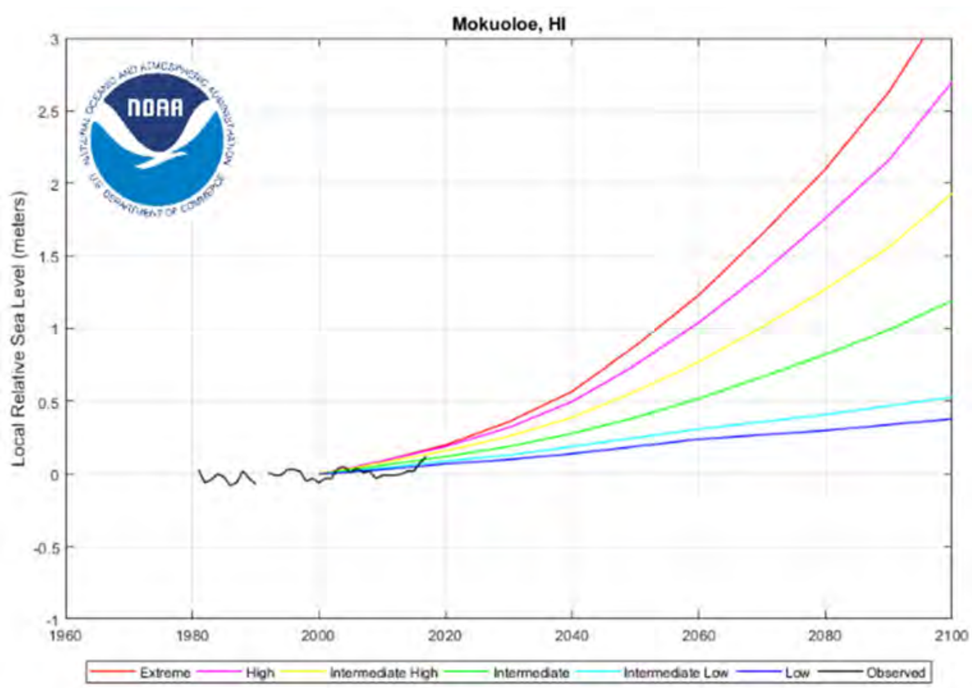


Figure 13: Annual Mean Relative Sea Level Trends for Mokuoloe, Hawaii

Station 1612480 (Source – NOAA, 2019)



4.5 Water Resources

Under the FWOP conditions, water resources would be predominantly affected by climate change as increased drought, evaporation, and intensity of storm events would alter streams, ponds, and coastal bays and estuaries.

4.5.1 Hydrology and Hydraulics

Because the streams in the study area are intermittent, the FWOP conditions will trend towards less frequent flows in the streams and a higher probability of the streams flooding due to the increase in extreme storm events. The flooding rates will be exacerbated due to a projected increase in impervious cover as the urban landscape shifts from pastoral to an increase in residential, commercial, and industrial development. This increase in impervious cover of the watershed will increase storm water runoff into the streams and magnify intensity of the flooding.

4.5.2 Floodplains

No changes to the floodplains would occur under the FWOP conditions. Significant flooding would still occur during future large rain events adversely affecting property and human safety. However, similar to the FWOP conditions for the streams, climate change will affect the 0.1 ACE floodplain as the higher intensity storm events will flood a larger footprint. Although the floodplains associated with the streams are restricted to a relatively narrow corridors along the water courses, the increased flooding intensity will expand these floodplains and increase the sheet flow flooding in adjacent areas.

4.5.3 Wetlands

Under the FWOP condition, the proposed action would not take place and wetlands within the project area would not be affected. Due to Section 404 of the CWA, no net wetland losses are expected to occur.

4.5.4 Surface Waters

In absence of the proposed project, the surface waters within the study area would not be affected by detention or diversion of the stream courses. However, as addressed in Section 3.3.1 (Existing Conditions, Hydrology and Hydraulics) above, climate change will affect surface waters as increased storm intensities and extended droughts will alter the duration and flows of the streams.

4.5.5 Groundwater

With continued climate change, the basal Koolau freshwater aquifer would be infiltrated by saline groundwater as RSLR increases in the FWOP condition. The infiltration would result in a shallower freshwater lens in which to draw irrigation and drinking water. Deeper wells may no longer be viable as the saline ground water rises.

4.6 Coastal Zone Management Resources

Under the FWOP, the FRM project would not be constructed and impacts to coastal zone management resources would continue to be affected by ongoing urban development.

4.7 Air Quality

The study area is located in an attainment area for all NAAQS (EPA, 2019). Because laws have been implemented restricting the emissions of criteria pollutants and there is an increase in clean power initiatives, future air quality in the FWOP scenario is projected to improve or remain unchanged under the FWOP.

4.8 Water Quality

HSDOH has not established turbidity TMDLs for the Wailele Stream; however, the agency is required to set turbidity limits according to the CWA. The establishment of the TMDL is the first step in addressing the water quality of the Wailele Stream. By establishing these limits, HSDOH can formalize a strategy for meeting the TMDL requirements. Furthermore, HSDOH has designated La‘ie Bay and La‘ie Beach Park as "Class A" meaning that the area is to be protected for recreational uses, aesthetic enjoyment, and protection and propagation of marine life. Because of these protections, water quality in the project area is not expected to decline under the FWOP conditions.

4.9 Geologic Resource

Changes in the geology of a region is an extremely slow process. Because of the relatively short period of analysis (50 years), geologic resources are not expected to change under the FWOP condition.

4.10 Soils

As residential, commercial, and tourism development continues in the watershed, prime farmland and hydric soils will be lost. The act of annexing adjacent farmland in and of itself is a loss of prime farmland, even if farming practices continue on the annexed land. The FWOP condition for the spatial extent of prime farmland soils is expected to decrease over the next 50 years.

4.11 Fish and Wildlife

Under the FWOP, impacts to fish and wildlife resources would not occur without the proposed alternatives. Effects of climate change on ecosystems are difficult to predict, due to both uncertainty in climate change scenarios (direction and magnitude of temperature and precipitation) and uncertainty in understanding how species will respond to those changes. These changes may increase the likelihood of species warranting conservation and protection in the upper reaches of the Wailele watershed; however, fish and wildlife habitat in the downstream reach is heavily inundated with non-native plant species that provide little habitat for native species.

4.12 Socioeconomics

Under the FWOP conditions, existing conditions would remain and there would be no changes to the health risks for children or changes in the minority/low income populations.

4.13 Hazardous, Toxic, and Radioactive Waste

The HTRW conditions in the alternative study area will most likely stay the same in the FWOP condition. Existing federal, state, county, and local environmental regulations would decrease the probability of future HTRW conditions and facilitate the remediation of any potential HTRW issues in the future.

4.14 Cultural Resources

Under the FWOP condition, no construction activities would occur and the condition of the culitural resources throughout the area would remain unchanged.

4.15 Noise

Under the FWOP condition, no construction activities would occur and the noise levels would remain consistent with the existing conditions.

4.16 Visual Aesthetics

Under the FWOP condition, no FRM features would be constructed; therefore no changes to the visual aesthetic would occur.

4.17 Recreation

Under the FWOP conditions, the proposed action would not occur and access to recreational resources would remain unchanged.

4.18 Traffic

Without the construction of the project, traffic density would be expected to remain the same or increase with population growth and tourism development.

5 ENVIRONMENTAL CONSEQUENCES

When considering impacts, it was assumed that, at a minimum, best management practices (BMPs) identified throughout this chapter would apply during project construction. Assumed BMPs are based on widely accepted industry, state, and federal standards for construction activities. Examples include, but are not limited to:

- Use of silt fencing to limit soil migration and water quality degradation
- Refueling and maintenance of vehicles and equipment in designated areas to prevent accidental spills and potential contamination of water sources and the surrounding soils; and,
- Limiting idling of vehicles and equipment to reduce emissions

The environmental consequences for the proposed alternatives are described below. The consequences of the "No Action" Alternative were presented in the Future without Project Conditions chapter (Chapter 4).

5.1 Land Use

Alternative 2: The overflow diversion channel would be constructed through a non-native, wooded area designated as an agricultural land use and the BYU Diversion would also be constructed in agricultural fields. Alternative 2 would convert a 2.6-acre corridor through the agricultural lands to an overflow diversion channel with a flood risk land use. Similarly, the BYU Diversion Channel would convert 2.5 acres of agricultural land use into flood risk infrastructure.

Alternative 3: Alternative 3 would have the same land use conversion identified in Alternative 2. The addition of the proposed detention basin included in this alternative would not change the land use of that project feature. The 11.8-acre detention area would still be managed as cropland, although it would be temporarily inundated with floodwaters during high flow storm events. However, the flood frequency when the overflow channel would be utilized is relatively infrequent. In addition, Stream drains relatively quickly and the length of time the detention basin would be inundated would not significantly affect the crops in the long term.

5.2 Climate

Both Alternatives: Under each of the action alternatives, construction activities would generate greenhouse gas (GHG) emissions as a result of the combustion of fossil fuels while operating on- and off-road mobile sources. After construction is complete, all GHG emissions would cease and the area would return to baseline conditions. There are no apparent carbon sequestration impacts that would result from the implementation, thus the total direct and indirect impacts would be constrained to very small increases in GHG emissions to the atmosphere from the construction activities. These small increases would be far below the 25,000 metric ton per year threshold for discussion of GHG impacts (CEQ, 2014). In the years in which construction activities are implemented, emissions would incrementally contribute to global emissions, but would not be of such magnitude as to make any direct correlation with climate change.

5.3 Water Resources

5.3.1 Floodplains

Both Alternatives: The action alternatives would not adversely impact the floodplains within the project area. The alternatives are designed to reduce flood risk for the Laʻie community; thereby decreasing the extent of the 1-percent floodplain. As much of the floodplain has been converted to urban uses, the environmental floodplain functions are already limited. Therefore, it is anticipated that adverse impacts to ecological floodplain functions would be minimal.

5.3.2 Wetlands

Both Alternatives: The overflow diversion channel and detention basin would be constructed on upland areas. With the exception of the weir and outfall structure of the overflow and BYU diversion channels, no wetlands would be impacted. At the overflow and BYU outfall structures, the Wailele Stream channel would be armored to protect the stream banks from the erosive forces of the floodwaters flowing through the diversion channel. In addition, a diversion structure would be constructed across Laniloa Stream to divert stormwater flow into Wailele Stream. The design of the armoring will utilize, the extent feasible, natural hard and soft armoring consistent with the USACE policy of Engineering with Nature®.

As discussed in Chapter 5.7 (Soils) below, both alternatives would impact HeA soils which are categorized as hydric soils. However, the locations where these soils occur within the project area does not support wetland vegetation and do not have the hydrology to support wetland habitats.

5.3.3 Surface Waters

Both Alternatives: For each of the alternatives, intermittent stream flow could be slightly altered if natural flow is interrupted during construction activities. However, construction activities would be planned to maintain a natural stream channel during the construction period. BMPs employed during construction (e.g. silt fencing, tarping/covering exposed and stockpiled soil, surface revegetation, etc.) would minimize impacts from storm water flow in the construction site and associated degradation of water quality. Each of the final array of alternatives would be completed in accordance with State and Federal regulations, including Section 404(b)(1) of the CWA. The 404(b)(1) analysis is include in Attachment 3.

The two action alternatives would each impact stream resources during high flood flow events. However, the proposed alternatives would not have an impact on the intermittent nature of the streams and would not affect stream resources during more frequent flood events where flows are conveyed within the existing stream channel. Impacts to Wailele Stream resulting from the two alternatives would be temporary during construction and would be localized to the project site for the construction of the overflow weir. No other changes to the Wailele stream channel would occur.

Alternative 2: The construction of an overflow diversion channel and BYU diversion ditch would result in the diversion of less frequent, higher flow storm events while allowing Wailele Stream to convey flows within its bank full channel. With the implementation of Alternative 2, the probability that Wailele Stream exceeds the existing bank full channel is minimized. Because the overflow diversion channel would only be engaged during high flow storm events, adverse impacts to Wailele Stream would be temporary and minimal. However, the BYU diversion ditch would result in higher flows during higher probability flood events due to the rerouting of stormwater flows into into Wailele Stream.

Alternative 3: Alternative 3 increases the flood water capacity of the Wailele Stream system by sequestering additional floodwaters in an off channel detention basin. The construction of the detention basin ensures that the probability of the overflow channel exceeding its capacity is decreased. The addition of the detention basin would not result in impacts to Wailele Stream as the weir structure leading to the detention basin would be incorporated into either the overflow diversion channel weir or a separate weir off of the diversion channel. Therefore, the impacts to stream resources resulting from the implementation of Alternative 3 would be the same as Alternative 2.

5.3.4 **Groundwater**

Both Alternatives/Alternative 2: Because the depth to groundwater is greater the proposed excavation of the detention basin and overflow diversion channel; therefore, the groundwater is not anticipated to be encountered during construction.

Alternative 3: It is possible that retaining floodwaters within the detention basin could facilitate some groundwater recharge; however, the benefits would be minute as the relatively short residence time of floodwaters in the basin and the infrequent use of the facility would limit the time that infiltration through the basin would occur.

5.4 Water Quality

Both Alternatives: The purpose of the proposed federal action is to reduce flooding resulting from floodwaters leaving the banks of the Wailele Stream and across the Laʻie community. The sheet flow flooding through Laʻie mobilizes petrochemical pollutants from impervious surfaces and nutrients and pesticide residues from landscaped areas. This flush of pollutants currently flows into the Pacific Ocean via an interior drainage channel north of the Foodland parking lot. The proposed alternatives would reduce the probability of the Laʻie sheet flow, thereby reducing the transport of contaminants into the confluence of the interior drainage channel and the ocean.

Construction activities associated with each of the action alternatives could temporarily affect to water quality resulting from grading and excavation. BMPs employed during construction (e.g., silt fencing, tarping/covering exposed and stockpiled soils, surface revegetation, etc.) would minimize/eliminate storm water flow from the proposed construction site, and any associated degradation of water quality. Floodwaters from Wailele Stream would still flow through the muliwai which would continue to buffer the marine habitats from sediments carried by the stormwater runoff.

Alternative 3: The detention basin would further improve the water quality of the stormwater runoff as it would function as sedimentation pond and allow sediments to settle out of the water due to the loss of stream energy once it is detained. The Proposed Action would be completed in accordance with State and Federal regulations, including Section 404 (b)(1) of the CWA, which would further minimize any impacts to water quality in Wailele Stream, the muliwai, and the adjacent marine waters. The 404 (b)(1) analysis for the Proposed Action is included in Appendix F.

5.5 Air Quality

Both Alternatives: Each of the alternatives would have relatively similar impacts to air quality. Ground disturbance could generate fugitive dust (e.g., PM) and use of construction equipment and personal vehicles to access the project area could lead to temporary increases in vehicular airborne pollutant concentrations.

These impacts would be temporary, and applicable BMPs, including silt fence and watering stockpiled soil, would be implemented. To reduce vehicle and equipment emissions, idling of vehicles and equipment would be minimized to the extent practicable and equipment would be maintained.

The CEQ requires a quantitative assessment of GHG emissions for activities that result in more than 25,000 tons of CO_2-equivalent per year. The final array of alternatives would contribute less than 25,000 tons of CO_2 into the atmosphere. With the possible exception of maintenance vehicles, each of the final array of alternatives is passive, with no further contribution of GHG.

5.6 Geologic Resources

Both Alternatives: The proposed project would result in excavation of soils to a relatively shallow depth. No adverse impacts on geologic resources are anticipated.

5.7 Soils

Four soil types occur within the project areas (***Table 8***), including Haleiwa silty clay, 0- to 2-percent slopes soil (HeA), which is categorized as a prime farmland soil and a hydric soil. The FPPA requires Federal agencies coordinate with NRCS when prime farmland soils are converted to different uses. A Farmland Conversion Impact Rating form (Form AD-1006) was completed for the study and submitted to the NRCS on 13 May 2019 and is provided in Attachment 4.

Table 8: Soil impacts for Wailele Stream FRM Alternatives

Soil Type	Soil Code	Alternative 1 Acres	Alternative 1 Percent of Project Area	Alternative 2 Acres	Alternative 2 Percent of Project Area
Coral Outcrop	CR	1.8	35%	1.8	10%
Haleiwa silty clay, 0-2% slopes[1,2]	HeA	2.5	48%	15.5	85%
Jaucus sand, 0-15% slopes	JaC	0.1	2%	0.1	<1%
Kawaihapai clay loam, 0-2% slopes	KlA	0.1	2%	0.1	<1%
Paumalu silty clay, 3-8% slopes	PeD	0.1	2%	0.1	<1%
Paumalu silty clay, 15-20% slopes	PeB	0.6	11%	0.6	3%
	Total	5.2	100%	18.2	100%

[1] Prime Farmland Soil, [2] Hydric Soil

Alternative 2: Alternative 2 would impact approximately 2.5 acres of prime farmland and hydric soils (HeA) that currently support an orchard (***Figure 14*** and). The construction of the overflow and BYU diversion channels would result in a permanent conversion of the farmland to FRM uses. Although the HeA soil type is classified as a hydric soil, the area does not support hydric vegetation and does not have the hydrology required to support wetlands.

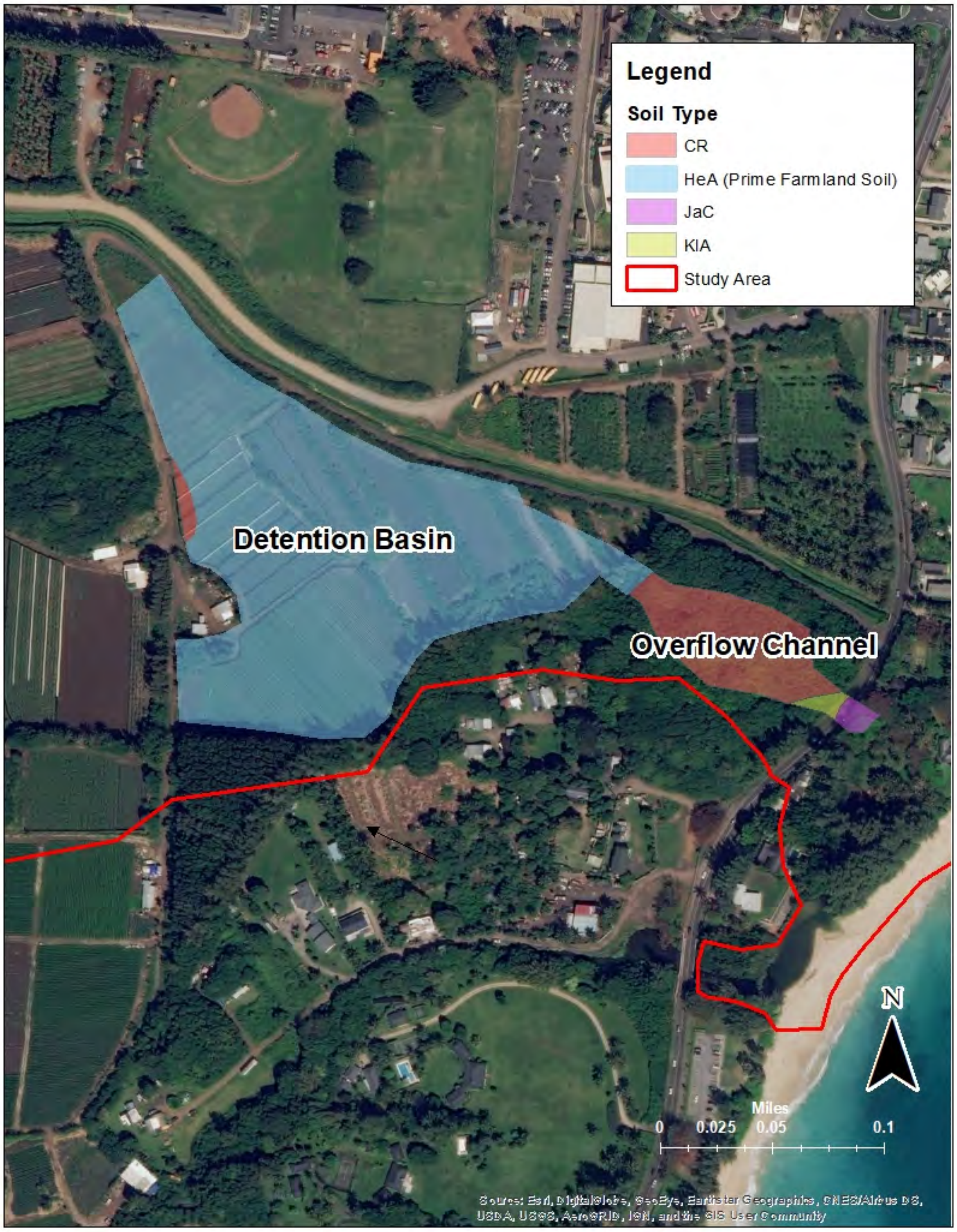
Figure 14: Alternative 2 and 3 (BYU Channel Segment) Soils and Prime Farmland Soils Impacts

Figure 15: Alternative 2 (Overflow Channel Segment) Soils and Prime Farmland Soils Impacts

***Alternative 3:** In addition to the 2.5 acres of HeA prime farmland soils that would be converted resulting from the overflow channel (*

Figure 15 and) and the BYU diversion channels (***Figure 14***), an additional 12.3 acres of HeA soils would be impacted from the construction of the detention basin (***Figure 16***). Because the detention basin would rarely be inundated from the operation of the FRM project and the basin would drain relatively quickly, the detention basin could still be farmed. However, the construction of the basin would require the excavation of topsoil to create capacity for the basin. The changes to the soil profile and soil characteristics resulting from the excavation would result in a loss of the HeA prime farmland soil.

Figure 16: Alternative 3 Soils and Prime Farmland Soil Impacts



5.8 Fish and Wildlife Resources

5.8.1 Vegetation

Both Alternatives: The overflow diversion channel associated with each alternative would be constructed through a wooded area on a coral outcrop that is populated with non-native plant species. The upper end of the channel would be constructed in an existing cultivated field. The BYU diversion ditch would be constructed through cultivated farmland. Therefore, there would be no adverse impacts to native plant species or vegetation communities. The detention basin associated with **Alternative 3**

would be constructed within an existing cultivated field and would also not adversely affect native vegetation.

5.8.2 Aquatic Resources

The final array of alternatives entail alteration of upland habitats with impacts to the stream channel occurring on the upper bank of the stream at the weir location and within the stream channel at the outfall of the overflow diversion channel. Disturbance of the aquatic habitats at the overflow channel weir and the overflow and BYU outfall structures would be temporary during construction of these features. The wier and overflow channel outfall structure will be designed to ensure that base flows along Wailele Stream are not affected. No barriers to fish passage would be incorporated into either structure. The overflow diversion channel would only be engaged during extreme flood events and the BYU diversion ditch would divert stormwater into Wailele Stream during flood events and temporarily increase stream flow; during regular storm events, the existing Wailele Stream would essentially function the same as it would under FWOP conditions. No adverse impacts to aquatic resources resulting from the diversion channel are anticipated. There would be no substantial impacts to aquatic resources associated with the construction and operation of the detention basin associated with **Alternative 3**.

5.8.3 Terrestrial Resources

Implementation of any of the final array of alternatives would have temporary, localized, minor adverse impacts during construction, with some loss of less mobile species within the footprint of the overflow diversion channel and detention basin. Mobile resident wildlife species would be temporarily displaced into adjacent habitats until construction activities were completed and permanently displaced within the footprint of the diversion channel. However, the scarcity of native wildlife species and the degraded quality of the habitat resulting from the dominance of non-native vegetation would result in minimal impacts to terrestrial wildlife species inhabiting the project areas.

5.8.4 Threatened and Endangered Species

Implementation of any of the final array of alternatives would have “no effect” on any listed species or their critical habitat.

5.9 Special Status Species

5.9.1 Migratory Birds

During field surveys in November 1999, four native migratory bird species (Black-crowned Night Heron, Pacific Golden Plover, Sanderling, and Ruddy Turnstone) were observed in the project area and a fifth (Hawaiian Coot) was observed in the muliwai during prior surveys. The Sanderling and Ruddy Turnstone are beach species and would not be affected by the proposed project alternatives. Similarly, the Hawaiian Coot specializes in aquatic and wetland habitats such as the muliwai and is not expected to occur in the proposed alternative footprints. The Pacific Golden Plover utilizes the coastal habitats, but is also found in short grasslands and plowed fields. The Black-crowned Night-heron occupies riparian and wetland habitats and would utilize these areas associated with Wailele Stream.

Both Alternatives: The proposed alternatives would have a potential temporary impact on the night-heron and plover, and any other native bird species that may be in the area, due to construction activities associated with the overflow diversion channel and the detention basin. If feasible, construction activities would occur outside of the breeding season to avoid adversely impacting these species. If construction would occur during the breeding season, the project areas would be surveyed in order to identify any active migratory bird nests. Should active nests be identified, USACE will coordinated further actions with the USFWS Migratory Bird Field Office.

5.9.2 Marine Mammals

Both Alternatives: The construction of the overflow diversion channel and detention basin would not occur within marine waters. The diversion channel outfall structure is located 400 feet upstream from the muliwai, which is intermittently connected to the ocean after high flow flood events until a sand berm is reformed to separate the muliwai from the ocean. Because no construction activities would occur on the beach or in marine waters, no impacts to marine mammals are anticipated.

5.9.3 Essential Fish Habitat

Both Alternatives: Because no construction activities would occur in EFH-designated habitats, there would be no direct impacts on EFH. The primary project indirect impacts on EFH would occur during infrequent storm events when stream flow would exceed the existing channel capacity of the stream channel's existing condition. However, the erosion control improvements to Wailele Stream resulting from the project would reduce the existing potential for sediment mobilization during storm events below the existing conditions, further minimizing the potential future sediment loading and turbidity within the EFH.

Furthermore, the reduction of flood waters that sheet flow over the community of Laie would have ancillary water quality benefits. Existing floodwaters mobilize non-point source pollutants, nutrient loads, and sediments and currently flush them into the Pacific Ocean north of Laie Point. The proposed project would decrease this impact to EFH north of Laie Point. Therefore, there would be no substantial adverse impacts to EFH.

5.9.4 Coastal Zone Management

The action alternatives would be considered compatible, consistent, and not conflict with any of the objectives of the CZM program. The action alternatives would not impact coastal recreation opportunities, impede economic uses, increase coastal hazards, or conflict with development within the coastal zone. A federal consistency determination was prepared in accordance with 15 CFR Part 930 (Attachment 5) and concurrence was received from the Hawaiʻi State Office of Planning on [DATE].

5.10 Socioeconomics

Based on the U.S. Census data and field observations, the implementation of the overflow channel, detention basin, or the combination alternatives would not have a disproportionate adverse impact on specific racial, ethnic, or socioeconomic group living in the vicinity of the project area and would not adversely impact environmental justice populations. Measures would be incorporated to ensure the safety of children in the project area such as exclusion fencing, signage, and securing construction equipment. With these mitigative measures in place, the alternative would not have substantial adverse impacts on the local population of children.

5.11 Hazardous, Toxic, and Radioactive Waste

In the short-term, the Proposed Action may generate solid waste from the clearing of vegetation and unused construction materials in the proposed project area. During construction of the Proposed Action, the contractor would be responsible for such solid waste disposal. In the long-term, the Proposed Action would require infrequent solid waste disposal of cleared debris, in accordance with applicable regulations. Overall, implementation of the Proposed Action is expected to have a less than significant impact on solid waste generation in the affected environment for the foreseeable future.

During construction of the Proposed Action, there may be the potential of petroleum and petroleum-related products spillage associated with construction vehicles and equipment. To minimize this hazard, all applicable City and County of Honolulu Spill and Prevention Control BMPs would be implemented to ensure that accidental releases are minimized and contained. For example, vehicles and equipment would be regularly inspected for leaks and performance and maintained accordingly to prevent spills from occurring. Any potentially hazardous materials required for the project or any resultant hazardous waste will be managed and disposed of in compliance with all applicable state and federal regulations, including RCRA. In the long term, the potential for petroleum spillage exists from maintenance vehicles. Again, all applicable City and County of Honolulu Spill and Prevention Control BMPs would be implemented. Implementation of the Proposed Action is expected to have less than significant solid waste generation in the affected environment for the foreseeable future.

5.12 Cultural Resources

The Wailele project preferred alternative can be expected to adversely impact at least one important cultural resource site (SIHP Site 05458) which is a significant Historic Property under National Register of Historic Places Significance Criterion D. Data recovery is typically the preferred mitigation for Criterion D-significant sites, however, exposing and analyzing this site prior to construction may be impractical. Integrating Data Recovery into the construction process and utilizing already-mobilized heavy machinery to remove overburden should be considered. Due to the high likelihood of encountering human burials during any excavation in this coastal region, full-time archaeological monitoring will likely be required in addition to, and possibly concurrent with, data recovery efforts. Archaeological monitoring will also serve to mitigate potential impacts to other areas that have a lesser, but still significant, likelihood for archaeological deposits (e.g., the Mahele Land Claim Award parcel intersected by the diversion channel).

The locales discussed above are those with the highest likelihood for encountering cultural resource sites, but based on background research, the entire diversion channel area retains a moderate likelihood for additional unrecorded sites.

5.13 Noise

For each of the alternatives in the final array, short-term noise impacts from construction activities may occur.

Sensitive receptors closest in proximity to the proposed project area include residences, church, and BYU-Hawaiʻi University. Temporary construction-related noise would be generated from equipment and vehicles. However, noise exposure from construction activities would not be continuous at any one location throughout the entire construction process and BMPs would be implemented to reduce or eliminate noise. Buffer zones between construction activities and sensitive receptors would be created, and construction work would be limited to the hours between 7:00am and 6:00pm on weekdays. Construction activities resulting in noise levels above 95 dB would be limited to the hours between 9:00am and 5:30pm. No construction activities would occur on Sundays or holidays, and activities exceeding 95dB will not occur on Saturday. In addition, sound barriers, mufflers, and other structures would be erected to reduce noise levels if they exceed Federal and State standards. Heavy truck and equipment staging areas would be located as far from noise sensitive properties as possible. As a result, short-term impacts from construction activities would be less than significant to the surrounding environment.

Upon completion, the Proposed Action would not be a source of any significant long-term noise generation. The only indirect noise generated from the Proposed Action in the long-term would be from maintenance vehicles infrequently clearing accumulated debris after significant flood events. However, the noise type and levels would be consistent with those already present in the La'ie area. Therefore, long-term noise impacts are expected to be less than significant.

5.14 Visual Aesthetics

For each of the final array of alternatives, the visual aesthetic impacts would be temporary during the construction of the FRM features. However, the study area is moderately urbanized and the equipment would be isolated within the project area and staging areas. No equipment would be placed within park, beach, or scenic vista areas. Therefore, the temporary visual aesthetic impacts of each alternative would not be substantial.

Both Alternatives: The proposed overflow diversion channel would be constructed of natural materials and would blend in with the adjacent habitat.

Alternative 3: The detention basin would be constructed in existing cropland and after construction, the basin could return to agricultural use. Other than an elevated berm around the detention basin, no changes in the visual aesthetics of the project area would occur.

5.15 Recreation

Both Alternatives: Construction activities would occur outside of any recreation areas. The outfall structure of the overflow diversion channel is located approximately 400 feet upstream of the muliwai which is located between Wailele Stream and the beach. Neither of the alternatives would restrict access nor change the nature of recreation opportunities at Pounder's Beach.

5.16 Traffic

Both Alternatives: During construction, traffic volume is expected to increase due to construction equipment and the construction workers commute. During the construction of the Traffic patterns may be altered on Kamehameha Highway during the construction of the overflow diversion channel culvert under the road. During design, a traffic plan will be developed to address traffic flow and safety along the highway during construction. The plan will potentially include traffic control, detours, construction phasing to avoid peak traffic times and/or other measures to reduce traffic hazards and congestion.

6 CUMULATIVE IMPACTS

This section presents the cumulative impacts of the TSP. NEPA regulations require that cumulative impacts of the proposed action be assessed and disclosed in an Environmental Impact Statement (EIS) or EA. CEQ regulations define a cumulative impact as "the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably future actions regardless of what agency (federal or non-federal) or person undertakes such other actions. Cumulative impacts can result from individually minor, but collectively significant actions taking place over a period of time.

NEPA guidance (40 CFR 2508.25) identifies resources that would be considered in a cumulative impacts analysis that should be evaluated in an EIS or EA. For an action to have a cumulative action on a resource, the action must have a direct or indirect effect on that resource, unless that resource is in declining or in a significantly impaired condition. From a review of the likely environmental impacts analyzed in Chapter 6 (Future without Project Conditions) and this chapter (Environmental Consequences), USACE determined that since there are no substantial direct or indirect impacts, a cumulative impact assessment is not warranted.

7 ENVIRONMENTAL COMPLIANCE

Federal projects must comply with Federal and State environmental laws, regulations, policies, rules, and guidance. The IFR/EA is compliant with NEPA, HRS 343, and ER 200-1-1 (Environmental Quality: Policy and Procedures for Implementing NEPA, 33 CFR 230). Significant coordination with local, state, and federal resource agencies has occurred from the beginning of the feasibility study. In implementing the Recommended Plan, USACE would follow provisions of all applicable laws, regulations, and policies related to the proposed actions. The status of compliance with environmental laws is presented below (***Table 9***). The following sections present summaries of federal environmental laws, regulations, and coordination requirements to this study.

Table 9: Status of Compliance with Environmental Laws, Regulations, and Policies

Policies	Compliance Status	Notes
	Public Laws	
Abandoned Shipwrecks Act of 1988, as amended	Not Applicable	
Archeological and Historic Preservation Act of 1974, as amended	In Progress	**Section 5.1.2, Attachment 8**
Bald and Golden Eagle Protection Act of 1940, as amended	Not Applicable	
Clean Air Act of 1970, as amended	Compliant	**Section 7.1.2**
Clean Water Act of 1972	Compliant/In Progress	**Section 7.1.1**
Coastal Barrier Resources Act of 1982, as amended	Not Applicable	
Coastal Zone Management Act of 1972, as amended	Compliant/In Progress	**Section 5.9.4, Attachment 5**
Endangered Species Act of 1973, as amended	Compliant/In progress	**Section 7.1.4**
Farmland Protection Policy Act of 1981	Compliant	**Section 5.7, Attachment 4**
Fish and Wildlife Coordination Act of 1934, as amended	Compliant	**Attachment 6**
Magnuson-Stevens Fisheries Conservation and Management Act of 1976, as amended	Compliant	**Section 5.9.3, Attachment 1**
Marine Mammal Protection Act of 1972, as amended	Compliant	**Section 5.9.2**
Marine Protection, Research, and Sanctuaries Act of 1972, as amended	Not Applicable	
Migratory Bird Treaty Act of 1918, as amended	Compliant	**Section 7.1.8.**
National Environmental Policy Act of 1970, as amended	In Progress	
National Historic Preservation Act of 1966, as amended	In Progress	**Section 5.1.2, Attachment 8**
Native American Graves Protection and Repatriation Act of 1990	Not Applicable	**Section 5.1.2, Attachment 8**
Rivers and Harbors Act of 1899, as amended	Not Applicable	
Wild and Scenic Rivers Act, as amended	Not Applicable	

Executive Orders		
Environmental Justice (E.O. 12898)	Compliant	**Section 7.1.9**
Flood Plain Management (E.O. 11988)	Compliant	**Section 7.1.7**
Protection of Wetlands (E.O. 11990)	Compliant	**Section 5.3.2**
Protection of Children from Environmental Health Risks (E.O. 13045)	Compliant	**Section 7.1.10**
Invasive Species (E.O. 13112)	Compliant	**Section 7.1.6**
Migratory Birds (E.O. 13186)	Compliant	**Section 7.1.8**

7.1 Environmental Compliance Discussion

The following sections present summaries of federal environmental laws, regulations, and coordination requirements to this study.

7.2 <u>Clean Water Act</u>

7.2.1 <u>Section 404(1)(1)</u>

USACE, under the direction of Congress, regulates the discharge of dredged and fill materials into waters of the U.S., including wetlands. USACE does not issue itself permits for construction activities affecting waters of the U.S., but must meet the legal requirements of the Act. A Section 404(b)(1) analysis was conducted for the Wailele Stream FRM study and reviewed by the Honolulu District (Attachment 3). Before construction, USACE, or its contractors, will obtain a National Pollutant Discharge Elimination System (NPDES) construction activities permit from DOH. The Section 404(b)(1) analysis was provided to DOH and the agency provide the water quality certification for the study in accordance with Section 401 of the CWA.

7.2.2 <u>Section 402</u>

Construction activities that disturb upland areas (land above Section 404 jurisdictional waters) are subject to the NPDES requirements of Section 402(p) of the CWA. Within Hawaii, DOH is the permitting authority and administers the federal NPDES program. Construction activities that disturb one or more acres are subject to complying with the NPDES requirements. Operators of construction activities that disturb five or more acres must prepare a Storm Water Pollution Prevention Plan (SWPPP), submit a Notice of Intent to DOH, conduct onsite posting and periodic self-inspection, and follow and maintain the requirements of the SWPPP.

During construction, the operator shall ensure that measures are taken to control erosion, reduce litter and sediment carried offsite (silt fences, hay bales, sediment retention ponds, litter pickup, etc.), promptly clean up accidental spills, utilize BMPs onsite, and stabilize against erosion before completion of the project.

7.3 Clean Air Act

Federal agencies are required by this Act to review all air emissions resulting from federally funded projects or permits to insure conformity with the SIPs in non-attainment areas. The La‘ie/Wialele Stream area is currently in attainment for all air emissions; therefore, the proposed project would be in compliance with the Clean Air Act.

7.4 National Historic Preservation Act of 1966

Federal agencies are required under Section 106 of the National Historic Preservation Act (NHPA) of 1966, as amended, to "take into account the effects of their undertakings on historic properties" and consider alternatives "to avoid, minimize, or mitigate the undertaking's adverse effects on historic properties" [(36 CFR 800.1(a-c)] in consultation with the State Historic Preservation Officer (SHPO) and appropriate federally recognized Indian Tribes (Tribal Preservation Officers – THPO)[(36 CFR 800.2(c)]. There are other applicable cultural resource laws, rules, and regulations that will inform how investigations and evaluations will proceed throughout the study and implementation phases (e.g., Archeological and Historic Preservation Act of 1974, NEPA, Native American Graves Protection and Repatriation Act, and ER 1105-2-100).

In accordance with Section 106 of the NHPA, USACE consulted with the Hawaii SHPO (there are no recognized Native American tribes in Hawaii) regarding the potential to impact properties from the proposed undertaking (Attachment 8).

[Summary to be inserted]

7.5 Endangered Species Act

Informal consultation was conducted with the USFWS and NMFS regarding potential impacts to threatened and endangered species within the project area. [Summary of results from consultation to be inserted].

7.6 Fish and Wildlife Coordination Act

The Fish and Wildlife Coordination Act (FWCA) requires federal agencies that are impounding, diverting, channelizing, controlling, or modifying the waters of any stream or other water body to consult with the USFWS and appropriate state fish and game agency to ensure that wildlife conservation receives equal consideration in the development of such projects. [Summary of FWCA actions/documentation to be inserted].

7.7 Executive Order 13112, Invasive Species

EO 13112 recognizes the significant contribution native species make to the well-being of the nation's natural environment and directs federal agencies to take preventative and responsive action to the threat of the invasion of non-native species. The EO establishes that federal agencies "will not authorize, fund, or carry out actions that it believes are likely to cause or promote the introduction or spread of invasive species in the United States or elsewhere unless, pursuant to guidelines that it has prescribed, the agency has determined and made public its determination that the benefits of such actions clearly outweigh the potential harm caused by invasive species; and that all feasible and prudent measures to minimize risk of harm will be taken in conjunction with the actions."

The habitat impacted by the proposed action is dominated with non-native species. Construction activities will implement BMPs to ensure that the spread of the non-native species outside of the project area is avoided/minimized.

7.8 Executive Order 13690, Establishing a Federal Flood Risk Management Standard and a Process for Further Soliciting and Considering Stakeholder Input; and Amendment to Executive Order 11988, Floodplain Management

EO 13690 was enacted on January 30, 2015 to amend EO 11988 , enacted May 24, 1977, in furtherance of the NEPA of 1969, as amended (42 U.S.C. 4321 et seq.), the National Flood Insurance Act of 1968, as amended (42 U.S.C. 4001 et seq.), and the Flood Disaster Protection Act of 1973 (Public Law 93-234, 87 Star.975). The purpose of the EO 11988 was to avoid to the extent possible the long and short-term adverse impacts associated with the occupancy and modification of floodplains and to avoid direct or indirect support of floodplain development wherever there is a practicable alternative. The EO 13690 builds on EO 11988 by adding climate change criteria into the analysis.

These orders state that each agency shall provide and shall take action to reduce the risk of flood loss, to minimize the impacts of floods on human safety, health, and welfare, and to restore and preserve the natural and beneficial values served by floodplains in carrying out its responsibilities for (1) acquiring, managing, and disposing of federal lands and facilities; (2) providing federally undertaken, financed, or assisted construction and improvements; and (3) conducting federal activities and programs affecting land use, including but not limited to water and related land resources planning, regulating, and licensing activities. The FEMA Digital Flood Insurance Rate Map (DFIRM) of the study area was analyzed to establish the locations of the 100-year and 500-year flood zones. All alternatives were designed to reduce flood risk to the Laʻie community. The proposed action would remain in compliance with EO 11988 and EO 13690.

7.9 Migratory Bird Treaty Act, Migratory Bird Conservation Act, and Executive Order 13186, Migratory Birds

The importance of migratory non-game birds to the nation is embodied in numerous laws, executive orders, and partnerships. The Migratory Bird Treaty Act demonstrates the federal commitment to conservation of non-game species. Amendments to the Act adopted in 1988 and 1989 direct the Secretary to undertake activities to research and conserve migratory non-game birds. EO 13186 directs federal agencies to promote the conservation of migratory bird populations, including restoring and enhancing habitat. Migratory Non-Game Birds of Management Concern is a list maintained by the USFWS. The list helps fulfill the primary goal of the USFWS to conserve avian diversity in North America. The USFWS Migratory Bird Plan is a draft strategic plan to strengthen and guide the agency's Migratory Bird Program. The proposed action would not adversely affect migratory birds and is in compliance with the applicable laws and policies.

7.10 Executive Order 12898, Environmental Justice

EO 12898 "Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations" dated February 11, 1994, requires all federal agencies to identify and address disproportionately high and adverse effects of its programs, policies, and activities on minority and low-income populations. Data was compiled to assess the potential impacts to minority and low-income populations within the study area. Environmental justice is the fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies. Even though minorities account for a large portion of the local population and the low-income population is above the national averages, construction of the proposed alternatives would not have a disproportionately high or adverse effect on these populations.

7.11 Executive Order 13045, Protection of Children

The EO 13045 “Protection of Children from Environmental Health Risks” dated April 21, 1997 requires federal agencies to identify and address the potential to generate disproportionately high environmental health and safety risks to children. This EO was prompted by the recognition that children, still undergoing physiological growth and development, are more sensitive to adverse environmental health and safety risks than adults.

Short-term impacts on the protection of children would be expected. Numerous types of construction equipment such as backhoes, bulldozers, dredgers, graders, and dump trucks, and other large construction equipment would be used throughout the duration of the construction of the proposed action. Because construction sites and equipment can be enticing to children, activity could create an increased safety risk. The risk to children would be greatest in construction areas near densely populated neighborhoods. During construction, safety measures would be followed to protect the health and safety of residents as well as construction workers. Barriers and “No Trespassing” signs would be placed around construction sites to deter children from playing in these areas, and construction vehicles and equipment would be secured when not in use. Since the construction area would be flagged or otherwise fenced, issues regarding Protection of Children are not anticipated.

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Appendix I
HTRW

The EDR Radius Map
with GeoCheck®

Wailele Stream
Cane Haul Rd.
Laie, HI 96762

Inquiry Number: 1136058.2s

February 26, 2004

EDR® Environmental Data Resources Inc

The Standard in Environmental Risk Management Information

440 Wheelers Farms Road
Milford, Connecticut 06460

Nationwide Customer Service

Telephone: 1-800-352-0050
Fax: 1-800-231-6802
Internet: www.edrnet.com

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Thank you for your business.
Please contact EDR at 1-800-352-0050
with any questions or comments.

EXECUTIVE SUMMARY

A search of available environmental records was conducted by Environmental Data Resources, Inc. (EDR). The report meets the government records search requirements of ASTM Standard Practice for Environmental Site Assessments, E 1527-00. Search distances are per ASTM standard or custom distances requested by the user.

TARGET PROPERTY INFORMATION

ADDRESS

CANE HAUL RD.
LAIE, HI 96762

COORDINATES

Latitude (North):	21.637900 - 21˚ 38’ 16.4’’
Longitude (West):	157.925900 - 157˚ 55’ 33.2’’
Universal Tranverse Mercator:	Zone 4
UTM X (Meters):	611155.3
UTM Y (Meters):	2392992.0
Elevation:	26 ft. above sea level

USGS TOPOGRAPHIC MAP ASSOCIATED WITH TARGET PROPERTY

Target Property:	21157-F8 KAHUKU, HI
Source:	USGS 7.5 min quad index

TARGET PROPERTY SEARCH RESULTS

The target property was not listed in any of the databases searched by EDR.

DATABASES WITH NO MAPPED SITES

No mapped sites were found in EDR’s search of available ("reasonably ascertainable ") government records either on the target property or within the ASTM E 1527-00 search radius around the target property for the following databases:

FEDERAL ASTM STANDARD

NPL - National Priority List
Proposed NPL - Proposed National Priority List Sites
CERCLIS - Comprehensive Environmental Response, Compensation, and Liability Information System
CERC-NFRAP - CERCLIS No Further Remedial Action Planned
CORRACTS - Corrective Action Report
RCRIS-TSD - Resource Conservation and Recovery Information System
RCRIS-LQG - Resource Conservation and Recovery Information System
RCRIS-SQG - Resource Conservation and Recovery Information System
ERNS - Emergency Response Notification System

STATE ASTM STANDARD

SHWS - Sites List

EXECUTIVE SUMMARY

SWF/LF Permitted Landfills in the State of Hawaii
UST Underground Storage Tank Database
VCP Voluntary Response Program Sites

FEDERAL ASTM SUPPLEMENTAL

CONSENT Superfund (CERCLA) Consent Decrees
ROD Records Of Decision
Delisted NPL National Priority List Deletions
FINDS Facility Index System/Facility Identification Initiative Program Summary Report
HMIRS Hazardous Materials Information Reporting System
MLTS Material Licensing Tracking System
MINES Mines Master Index File
NPL Liens Federal Superfund Liens
PADS PCB Activity Database System
US BROWNFIELDS A Listing of Brownfields Sites
DOD Department of Defense Sites
RAATS RCRA Administrative Action Tracking System
TRIS Toxic Chemical Release Inventory System
TSCA Toxic Substances Control Act
SSTS Section 7 Tracking Systems
FTTS INSP FIFRA/ TSCA Tracking System - FIFRA (Federal Insecticide, Fungicide, & Rodenticide Act)/TSCA (Toxic Substances Control Act)

STATE OR LOCAL ASTM SUPPLEMENTAL

SPILLS Release Notifications

EDR PROPRIETARY HISTORICAL DATABASES

Coal Gas Former Manufactured Gas (Coal Gas) Sites

BROWNFIELDS DATABASES

US BROWNFIELDS A Listing of Brownfields Sites
BROWNFIELDS Brownfields Sites
VCP Voluntary Response Program Sites

SURROUNDING SITES: SEARCH RESULTS

Surrounding sites were identified.

Elevations have been determined from the USGS Digital Elevation Model and should be evaluated on a relative (not an absolute) basis. Relative elevation information between sites of close proximity should be field verified. Sites with an elevation equal to or higher than the target property have been differentiated below from sites with an elevation lower than the target property.
Page numbers and map identification numbers refer to the EDR Radius Map report where detailed data on individual sites can be reviewed.

Sites listed in ***bold italics*** are in multiple databases.

Unmappable (orphan) sites are not considered in the foregoing analysis.

EXECUTIVE SUMMARY

STATE ASTM STANDARD

LUST: The Leaking Underground Storage Tank Incident Reports contain an inventory of reported leaking underground storage tank incidents. The data come from the Department of Health's Active Leaking Underground Storage Tank Log Listing.

A review of the LUST list, as provided by EDR, and dated 08/01/2003 has revealed that there is 1 LUST site within approximately 0.5 miles of the target property.

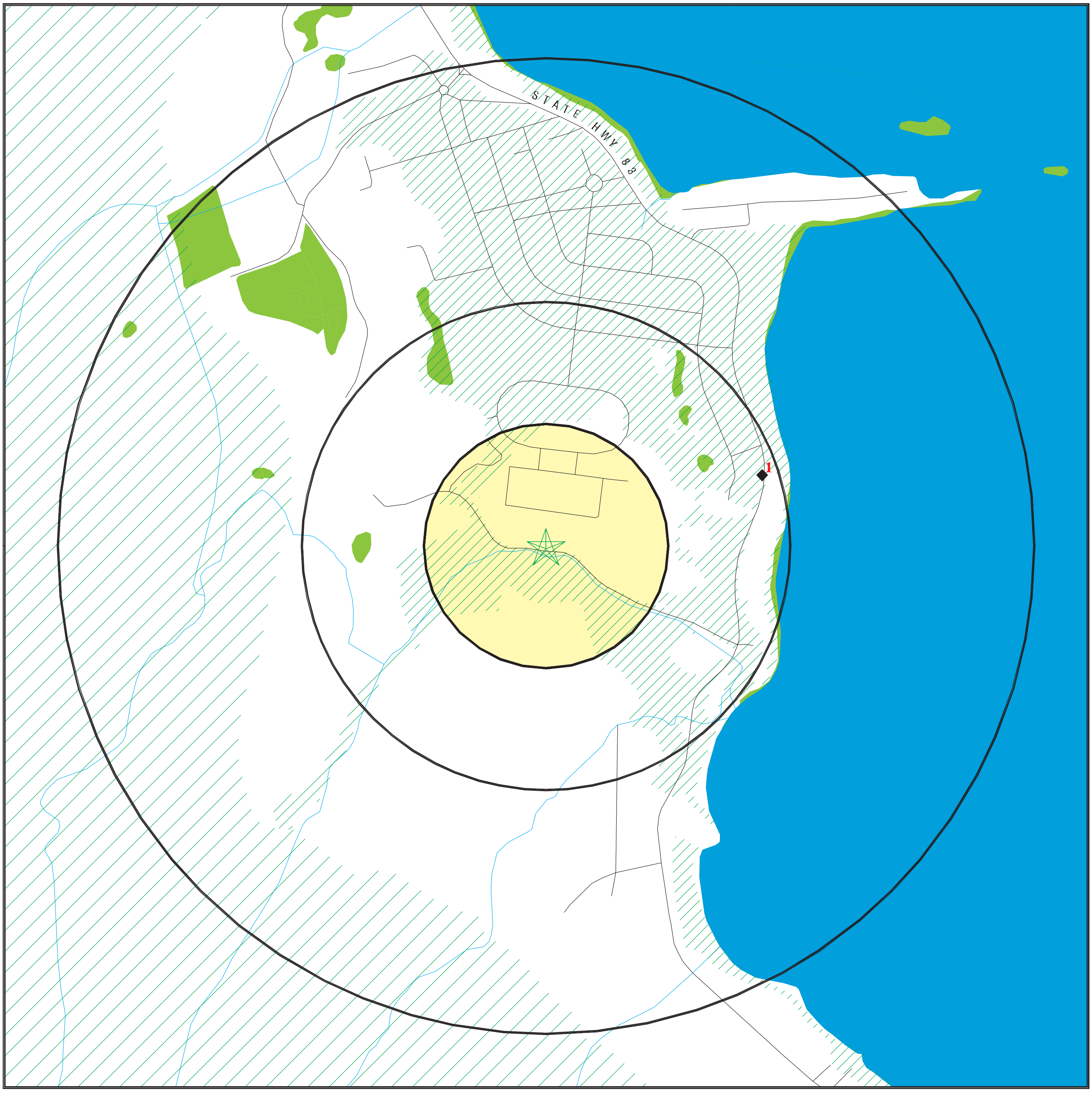
Lower Elevation	Address	Dist / Dir	Map ID	Page
LAIE CHEVRON SERVICE	*55-396 KAMEHAMEHA HWY*	*1/4 - 1/2 ENE*	*1*	*6*

EXECUTIVE SUMMARY

Due to poor or inadequate address information, the following sites were not mapped:

Site Name	Database(s)
PUNALUU WELLS MERCURY SPILL	SHWS
KAPAA LANDFILL	SWF/LF
NEW MILILANI LANDFILL	SWF/LF
OLD MILILANI LANDFILL	SWF/LF

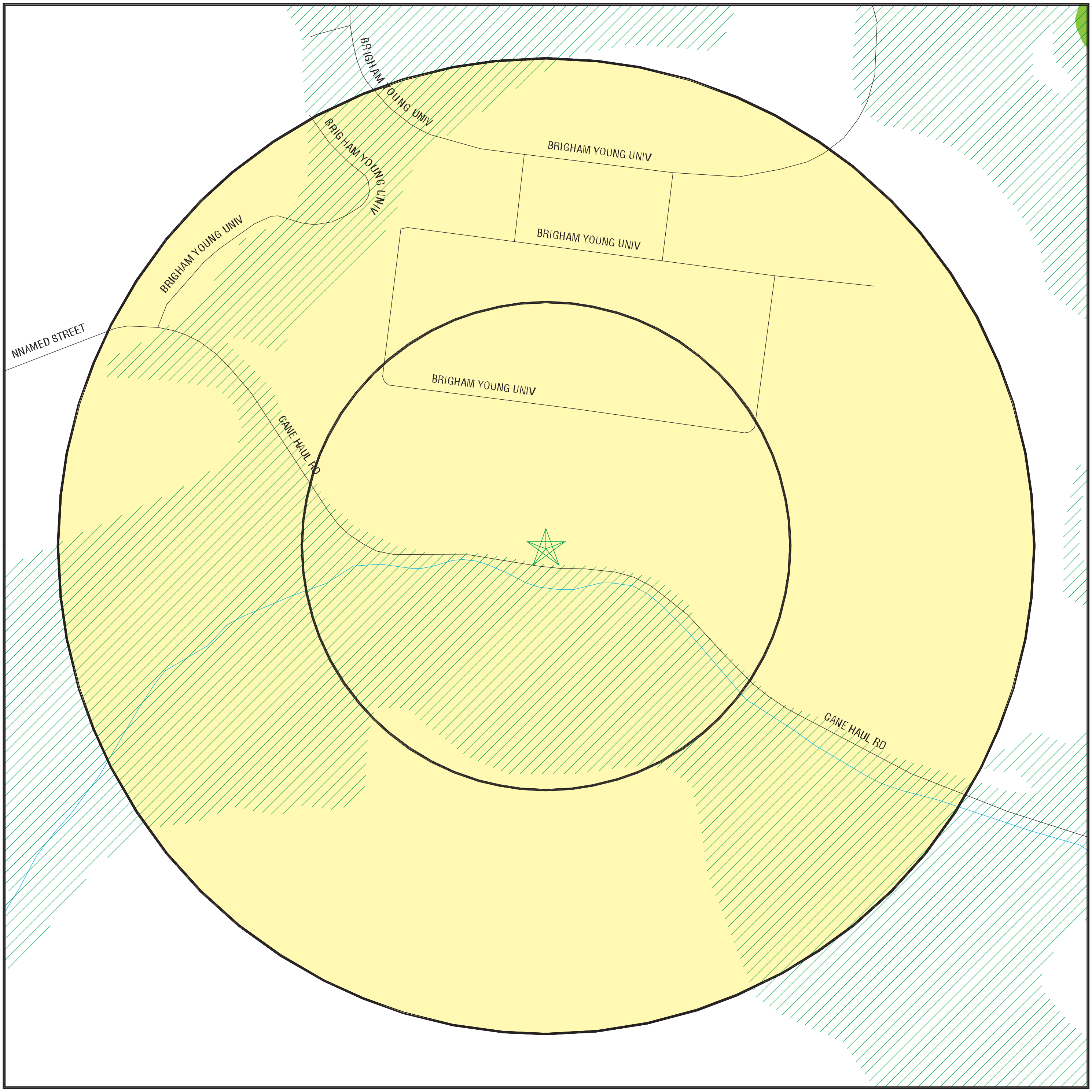
OVERVIEW MAP - 1136058.2s - Environet



- Target Property
- Sites at elevations higher than or equal to the target property
- Sites at elevations lower than the target property
- Coal Gasification Sites
- National Priority List Sites
- Landfill Sites
- Dept. Defense Sites
- Oil & Gas pipelines
- 100-year flood zone
- 500-year flood zone
- Federal Wetlands

TARGET PROPERTY:	Wailele Stream	CUSTOMER:	Environet
ADDRESS:	Cane Haul Rd.	CONTACT:	Ida Knutsen
CITY/STATE/ZIP:	Laie HI 96762	INQUIRY #:	1136058.2s
LAT/LONG:	21.6379 / 157.9259	DATE:	February 26, 2004 2:15 pm

DETAIL MAP - 1136058.2s - Environet



- Target Property
- Sites at elevations higher than or equal to the target property
- Sites at elevations lower than the target property
- Coal Gasification Sites
- Sensitive Receptors
- National Priority List Sites
- Landfill Sites
- Dept. Defense Sites
- Oil & Gas pipelines
- 100-year flood zone
- 500-year flood zone
- Federal Wetlands

TARGET PROPERTY:	Wailele Stream	CUSTOMER:	Environet
ADDRESS:	Cane Haul Rd.	CONTACT:	Ida Knutsen
CITY/STATE/ZIP:	Laie HI 96762	INQUIRY #:	1136058.2s
LAT/LONG:	21.6379 / 157.9259	DATE:	February 26, 2004 2:16 pm

MAP FINDINGS SUMMARY

Database	Target Property	Search Distance (Miles)	< 1/8	1/8 - 1/4	1/4 - 1/2	1/2 - 1	> 1	Total Plotted
FEDERAL ASTM STANDARD								
NPL		1.000	0	0	0	0	NR	0
Proposed NPL		1.000	0	0	0	0	NR	0
CERCLIS		0.500	0	0	0	NR	NR	0
CERC-NFRAP		0.250	0	0	NR	NR	NR	0
CORRACTS		1.000	0	0	0	0	NR	0
RCRIS-TSD		0.500	0	0	0	NR	NR	0
RCRIS Lg. Quan. Gen.		0.250	0	0	NR	NR	NR	0
RCRIS Sm. Quan. Gen.		0.250	0	0	NR	NR	NR	0
ERNS		TP	NR	NR	NR	NR	NR	0
STATE ASTM STANDARD								
SHWS		1.000	0	0	0	0	NR	0
State Landfill		0.500	0	0	0	NR	NR	0
LUST		0.500	0	0	1	NR	NR	1
UST		0.250	0	0	NR	NR	NR	0
VCP		0.500	0	0	0	NR	NR	0
FEDERAL ASTM SUPPLEMENTAL								
CONSENT		1.000	0	0	0	0	NR	0
ROD		1.000	0	0	0	0	NR	0
Delisted NPL		1.000	0	0	0	0	NR	0
FINDS		TP	NR	NR	NR	NR	NR	0
HMIRS		TP	NR	NR	NR	NR	NR	0
MLTS		TP	NR	NR	NR	NR	NR	0
MINES		0.250	0	0	NR	NR	NR	0
NPL Liens		TP	NR	NR	NR	NR	NR	0
PADS		TP	NR	NR	NR	NR	NR	0
US BROWNFIELDS		0.500	0	0	0	NR	NR	0
DOD		1.000	0	0	0	0	NR	0
RAATS		TP	NR	NR	NR	NR	NR	0
TRIS		TP	NR	NR	NR	NR	NR	0
TSCA		TP	NR	NR	NR	NR	NR	0
SSTS		TP	NR	NR	NR	NR	NR	0
FTTS		TP	NR	NR	NR	NR	NR	0
STATE OR LOCAL ASTM SUPPLEMENTAL								
SPILLS		TP	NR	NR	NR	NR	NR	0
EDR PROPRIETARY HISTORICAL DATABASES								
Coal Gas		1.000	0	0	0	0	NR	0
BROWNFIELDS DATABASES								
US BROWNFIELDS		0.500	0	0	0	NR	NR	0

MAP FINDINGS SUMMARY

Database	Target Property	Search Distance (Miles)	< 1/8	1/8 - 1/4	1/4 - 1/2	1/2 - 1	> 1	Total Plotted
BROWNFIELDS		0.500	0	0	0	NR	NR	0
VCP		0.500	0	0	0	NR	NR	0

NOTES:

AQUIFLOW - see EDR Physical Setting Source Addendum

TP = Target Property

NR = Not Requested at this Search Distance

Sites may be listed in more than one database

Coal Gas Site Search: No site was found in a search of Real Property Scan's ENVIROHAZ database.

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1 **ENE** **1/4-1/2** **2457 ft.**	**LAIE CHEVRON SERVICE** **55-396 KAMEHAMEHA HWY** **LAIE, HI 96762**	**LUST** **UST**	**U001236267** **N/A**

Relative:
Lower

Actual:
3 ft.

LUST:

Facility ID:	9-201116
Alternate Event ID:	950020
Facility Status Date:	09/24/1998
Facility Status:	Site Cleanup Completed
Project Officer:	Ichinotsubo

UST:

Facility ID:	9-201116	Tank ID:	R-4
Tank Status:	Permanently Out of Use		
Tank Capacity:	4000	Installed:	7/18/1982
Date Closed:	2/11/1991	Substance:	Diesel
Owner:	CHEVRON PRODUCTS COMPANY 91-480 MALAKOLE ST Laie, HI 96762		

Facility ID:	9-201116	Tank ID:	92
Tank Status:	Currently In Use		
Tank Capacity:	10000	Installed:	7/18/1982
Date Closed:	Not reported	Substance:	Gasoline
Owner:	CHEVRON PRODUCTS COMPANY 91-480 MALAKOLE ST Laie, HI 96762		

Facility ID:	9-201116	Tank ID:	89
Tank Status:	Currently In Use		
Tank Capacity:	10000	Installed:	7/18/1982
Date Closed:	Not reported	Substance:	Gasoline
Owner:	CHEVRON PRODUCTS COMPANY 91-480 MALAKOLE ST Laie, HI 96762		

Facility ID:	9-201116	Tank ID:	87
Tank Status:	Currently In Use		
Tank Capacity:	10000	Installed:	7/18/1982
Date Closed:	Not reported	Substance:	Gasoline
Owner:	CHEVRON PRODUCTS COMPANY 91-480 MALAKOLE ST Laie, HI 96762		

Facility ID:	9-201116	Tank ID:	R-5
Tank Status:	Permanently Out of Use		
Tank Capacity:	1000	Installed:	7/18/1982
Date Closed:	2/11/1991	Substance:	Used Oil
Owner:	CHEVRON PRODUCTS COMPANY 91-480 MALAKOLE ST Laie, HI 96762		

LAIE CHEVRON SERVICE (Continued) **U001236267**

ORPHAN SUMMARY

City	EDR ID	Site Name	Site Address	Zip	Database(s)
HAUULA	S104534364	PUNALUU WELLS MERCURY SPILL	END OF HALEAHA ROAD	96717	SHWS
HONOLULU COUNTY	S106100527	KAPAA LANDFILL	KAPAA QUARRY ROAD		SWF/LF
HONOLULU COUNTY	S103763647	NEW MILILANI LANDFILL	WAIPIO		SWF/LF
HONOLULU COUNTY	S103763648	OLD MILILANI LANDFILL	WAIPIO		SWF/LF

GOVERNMENT RECORDS SEARCHED / DATA CURRENCY TRACKING

To maintain currency of the following federal and state databases, EDR contacts the appropriate governmental agency on a monthly or quarterly basis, as required.

Elapsed ASTM days: Provides confirmation that this EDR report meets or exceeds the 90-day updating requirement of the ASTM standard.

FEDERAL ASTM STANDARD RECORDS

NPL: National Priority List
Source: EPA
Telephone: N/A
National Priorities List (Superfund). The NPL is a subset of CERCLIS and identifies over 1,200 sites for priority cleanup under the Superfund Program. NPL sites may encompass relatively large areas. As such, EDR provides polygon coverage for over 1,000 NPL site boundaries produced by EPA's Environmental Photographic Interpretation Center (EPIC) and regional EPA offices.

Date of Government Version: 10/21/03
Date Made Active at EDR: 12/08/03
Database Release Frequency: Semi-Annually
Date of Data Arrival at EDR: 11/03/03
Elapsed ASTM days: 35
Date of Last EDR Contact: 02/06/04

NPL Site Boundaries

Sources:

EPA's Environmental Photographic Interpretation Center (EPIC)
Telephone: 202-564-7333

EPA Region 1
Telephone 617-918-1143

EPA Region 3
Telephone 215-814-5418

EPA Region 4
Telephone 404-562-8033

EPA Region 6
Telephone: 214-655-6659

EPA Region 8
Telephone: 303-312-6774

Proposed NPL: Proposed National Priority List Sites
Source: EPA
Telephone: N/A

Date of Government Version: 10/14/03
Date Made Active at EDR: 12/08/03
Database Release Frequency: Semi-Annually
Date of Data Arrival at EDR: 12/01/03
Elapsed ASTM days: 7
Date of Last EDR Contact: 02/06/04

CERCLIS: Comprehensive Environmental Response, Compensation, and Liability Information System
Source: EPA
Telephone: 703-413-0223
CERCLIS contains data on potentially hazardous waste sites that have been reported to the USEPA by states, municipalities, private companies and private persons, pursuant to Section 103 of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). CERCLIS contains sites which are either proposed to or on the National Priorities List (NPL) and sites which are in the screening and assessment phase for possible inclusion on the NPL.

Date of Government Version: 11/17/03
Date Made Active at EDR: 02/02/04
Database Release Frequency: Quarterly
Date of Data Arrival at EDR: 12/22/03
Elapsed ASTM days: 42
Date of Last EDR Contact: 12/22/03

CERCLIS-NFRAP: CERCLIS No Further Remedial Action Planned
Source: EPA
Telephone: 703-413-0223
As of February 1995, CERCLIS sites designated "No Further Remedial Action Planned" (NFRAP) have been removed from CERCLIS. NFRAP sites may be sites where, following an initial investigation, no contamination was found, contamination was removed quickly without the need for the site to be placed on the NPL, or the contamination was not serious enough to require Federal Superfund action or NPL consideration. EPA has removed approximately 25,000 NFRAP sites to lift the unintended barriers to the redevelopment of these properties and has archived them as historical records so EPA does not needlessly repeat the investigations in the future. This policy change is part of the EPA's Brownfields Redevelopment Program to help cities, states, private investors and affected citizens to promote economic redevelopment of unproductive urban sites.

Date of Government Version: 11/17/03
Date Made Active at EDR: 02/02/04
Database Release Frequency: Quarterly
Date of Data Arrival at EDR: 12/22/03
Elapsed ASTM days: 42
Date of Last EDR Contact: 12/22/03

CORRACTS: Corrective Action Report
Source: EPA
Telephone: 800-424-9346
CORRACTS identifies hazardous waste handlers with RCRA corrective action activity.

Date of Government Version: 12/18/03
Date Made Active at EDR: 02/02/04
Database Release Frequency: Semi-Annually
Date of Data Arrival at EDR: 12/26/03
Elapsed ASTM days: 38
Date of Last EDR Contact: 12/08/03

RCRIS: Resource Conservation and Recovery Information System
Source: EPA
Telephone: 800-424-9346
Resource Conservation and Recovery Information System. RCRIS includes selective information on sites which generate, transport, store, treat and/or dispose of hazardous waste as defined by the Resource Conservation and Recovery Act (RCRA). Conditionally exempt small quantity generators (CESQGs): generate less than 100 kg of hazardous waste, or less than 1 kg of acutely hazardous waste per month. Small quantity generators (SQGs): generate between 100 kg and 1,000 kg of hazardous waste per month. Large quantity generators (LQGs): generate over 1,000 kilograms (kg) of hazardous waste, or over 1 kg of acutely hazardous waste per month. Transporters are individuals or entities that move hazardous waste from the generator off-site to a facility that can recycle, treat, store, or dispose of the waste. TSDFs treat, store, or dispose of the waste.

Date of Government Version: 01/12/04
Date Made Active at EDR: 02/10/04
Database Release Frequency: Varies
Date of Data Arrival at EDR: 01/19/04
Elapsed ASTM days: 22
Date of Last EDR Contact: 01/19/04

ERNS: Emergency Response Notification System
Source: National Response Center, United States Coast Guard
Telephone: 202-260-2342
Emergency Response Notification System. ERNS records and stores information on reported releases of oil and hazardous substances.

Date of Government Version: 12/31/02
Date Made Active at EDR: 02/03/03
Database Release Frequency: Annually
Date of Data Arrival at EDR: 01/27/03
Elapsed ASTM days: 7
Date of Last EDR Contact: 01/26/04

FEDERAL ASTM SUPPLEMENTAL RECORDS

BRS: Biennial Reporting System
Source: EPA/NTIS
Telephone: 800-424-9346
The Biennial Reporting System is a national system administered by the EPA that collects data on the generation and management of hazardous waste. BRS captures detailed data from two groups: Large Quantity Generators (LQG) and Treatment, Storage, and Disposal Facilities.

Date of Government Version: 12/01/01
Database Release Frequency: Biennially
Date of Last EDR Contact: 12/16/03
Date of Next Scheduled EDR Contact: 03/15/04

CONSENT: Superfund (CERCLA) Consent Decrees
Source: EPA Regional Offices
Telephone: Varies
Major legal settlements that establish responsibility and standards for cleanup at NPL (Superfund) sites. Released periodically by United States District Courts after settlement by parties to litigation matters.

Date of Government Version: N/A
Database Release Frequency: Varies
Date of Last EDR Contact: N/A
Date of Next Scheduled EDR Contact: N/A

ROD: Records Of Decision
Source: EPA
Telephone: 703-416-0223
Record of Decision. ROD documents mandate a permanent remedy at an NPL (Superfund) site containing technical and health information to aid in the cleanup.

Date of Government Version: 07/09/03
Database Release Frequency: Annually
Date of Last EDR Contact: 01/06/04
Date of Next Scheduled EDR Contact: 04/05/04

DELISTED NPL: National Priority List Deletions
Source: EPA
Telephone: N/A
The National Oil and Hazardous Substances Pollution Contingency Plan (NCP) establishes the criteria that the EPA uses to delete sites from the NPL. In accordance with 40 CFR 300.425.(e), sites may be deleted from the NPL where no further response is appropriate.

Date of Government Version: 10/21/03
Database Release Frequency: Quarterly
Date of Last EDR Contact: 02/06/04
Date of Next Scheduled EDR Contact: 05/01/04

FINDS: Facility Index System/Facility Identification Initiative Program Summary Report
Source: EPA
Telephone: N/A
Facility Index System. FINDS contains both facility information and 'pointers' to other sources that contain more detail. EDR includes the following FINDS databases in this report: PCS (Permit Compliance System), AIRS (Aerometric Information Retrieval System), DOCKET (Enforcement Docket used to manage and track information on civil judicial enforcement cases for all environmental statutes), FURS (Federal Underground Injection Control), C-DOCKET (Criminal Docket System used to track criminal enforcement actions for all environmental statutes), FFIS (Federal Facilities Information System), STATE (State Environmental Laws and Statutes), and PADS (PCB Activity Data System).

Date of Government Version: 10/23/03
Database Release Frequency: Quarterly
Date of Last EDR Contact: 01/06/04
Date of Next Scheduled EDR Contact: 04/05/04

HMIRS: Hazardous Materials Information Reporting System
Source: U.S. Department of Transportation
Telephone: 202-366-4555
Hazardous Materials Incident Report System. HMIRS contains hazardous material spill incidents reported to DOT.

Date of Government Version: 12/18/03
Database Release Frequency: Annually
Date of Last EDR Contact: 01/19/04
Date of Next Scheduled EDR Contact: 04/19/04

MLTS: Material Licensing Tracking System
Source: Nuclear Regulatory Commission
Telephone: 301-415-7169
MLTS is maintained by the Nuclear Regulatory Commission and contains a list of approximately 8,100 sites which possess or use radioactive materials and which are subject to NRC licensing requirements. To maintain currency, EDR contacts the Agency on a quarterly basis.

Date of Government Version: 10/16/03
Database Release Frequency: Quarterly
Date of Last EDR Contact: 01/06/04
Date of Next Scheduled EDR Contact: 04/05/04

MINES: Mines Master Index File
Source: Department of Labor, Mine Safety and Health Administration
Telephone: 303-231-5959

Date of Government Version: 11/25/03
Database Release Frequency: Semi-Annually
Date of Last EDR Contact: 12/29/03
Date of Next Scheduled EDR Contact: 03/29/04

NPL LIENS: Federal Superfund Liens
Source: EPA
Telephone: 202-564-4267
Federal Superfund Liens. Under the authority granted the USEPA by the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) of 1980, the USEPA has the authority to file liens against real property in order to recover remedial action expenditures or when the property owner receives notification of potential liability. USEPA compiles a listing of filed notices of Superfund Liens.

Date of Government Version: 10/15/91
Database Release Frequency: No Update Planned
Date of Last EDR Contact: 11/21/03
Date of Next Scheduled EDR Contact: 02/23/04

PADS: PCB Activity Database System
Source: EPA
Telephone: 202-564-3887
PCB Activity Database. PADS Identifies generators, transporters, commercial storers and/or brokers and disposers of PCB's who are required to notify the EPA of such activities.

Date of Government Version: 09/30/03
Database Release Frequency: Annually
Date of Last EDR Contact: 02/09/04
Date of Next Scheduled EDR Contact: 05/10/04

DOD: Department of Defense Sites
Source: USGS
Telephone: 703-648-5920
This data set consists of federally owned or administered lands, administered by the Department of Defense, that have any area equal to or greater than 640 acres of the United States, Puerto Rico, and the U.S. Virgin Islands.

Date of Government Version: 10/01/03
Database Release Frequency: Semi-Annually
Date of Last EDR Contact: 02/02/04
Date of Next Scheduled EDR Contact: 05/10/04

STORMWATER: Storm Water General Permits
Source: Environmental Protection Agency
Telephone: 202 564-0746
A listing of all facilities with Storm Water General Permits.

Date of Government Version: N/A
Database Release Frequency: Quarterly
Date of Last EDR Contact: N/A
Date of Next Scheduled EDR Contact: N/A

US BROWNFIELDS: A Listing of Brownfields Sites
Source: Environmental Protection Agency
Telephone: 202-566-2777
Included in the listing are brownfields properties addresses by Cooperative Agreement Recipients and brownfields properties addressed by Targeted Brownfields Assessments. Targeted Brownfields Assessments-EPA's Targeted Brownfields Assessments (TBA) program is designed to help states, tribes, and municipalities--especially those without EPA Brownfields Assessment Demonstration Pilots--minimize the uncertainties of contamination often associated with brownfields. Under the TBA program, EPA provides funding and/or technical assistance for environmental assessments at brownfields sites throughout the country. Targeted Brownfields Assessments supplement and work with other efforts under EPA's Brownfields Initiative to promote cleanup and redevelopment of brownfields. Cooperative Agreement Recipients-States, political subdivisions, territories, and Indian tribes become BCRLF cooperative agreement recipients when they enter into BCRLF cooperative agreements with the U.S. EPA. EPA selects BCRLF cooperative agreement recipients based on a proposal and application process. BCRLF cooperative agreement recipients must use EPA funds provided through BCRLF cooperative agreement for specified brownfields-related cleanup activities.

Date of Government Version: 07/15/03
Database Release Frequency: Semi-Annually
Date of Last EDR Contact: 12/17/03
Date of Next Scheduled EDR Contact: 03/15/04

RMP: Risk Management Plans
Source: Environmental Protection Agency
Telephone: 202-564-8600
When Congress passed the Clean Air Act Amendments of 1990, it required EPA to publish regulations and guidance for chemical accident prevention at facilities using extremely hazardous substances. The Risk Management Program Rule (RMP Rule) was written to implement Section 112(r) of these amendments. The rule, which built upon existing industry codes and standards, requires companies of all sizes that use certain flammable and toxic substances to develop a Risk Management Program, which includes a(n): Hazard assessment that details the potential effects of an accidental release, an accident history of the last five years, and an evaluation of worst-case and alternative accidental releases; Prevention program that includes safety precautions and maintenance, monitoring, and employee training measures; and Emergency response program that spells out emergency health care, employee training measures and procedures for informing the public and response agencies (e.g the fire department) should an accident occur.

Date of Government Version: N/A
Database Release Frequency: N/A

Date of Last EDR Contact: N/A
Date of Next Scheduled EDR Contact: N/A

RAATS: RCRA Administrative Action Tracking System
Source: EPA
Telephone: 202-564-4104
RCRA Administration Action Tracking System. RAATS contains records based on enforcement actions issued under RCRA pertaining to major violators and includes administrative and civil actions brought by the EPA. For administration actions after September 30, 1995, data entry in the RAATS database was discontinued. EPA will retain a copy of the database for historical records. It was necessary to terminate RAATS because a decrease in agency resources made it impossible to continue to update the information contained in the database.

Date of Government Version: 04/17/95
Database Release Frequency: No Update Planned

Date of Last EDR Contact: 12/08/03
Date of Next Scheduled EDR Contact: 03/08/04

TRIS: Toxic Chemical Release Inventory System
Source: EPA
Telephone: 202-566-0250
Toxic Release Inventory System. TRIS identifies facilities which release toxic chemicals to the air, water and land in reportable quantities under SARA Title III Section 313.

Date of Government Version: 12/31/01
Database Release Frequency: Annually

Date of Last EDR Contact: 12/22/03
Date of Next Scheduled EDR Contact: 03/22/04

TSCA: Toxic Substances Control Act
Source: EPA
Telephone: 202-260-5521
Toxic Substances Control Act. TSCA identifies manufacturers and importers of chemical substances included on the TSCA Chemical Substance Inventory list. It includes data on the production volume of these substances by plant site.

Date of Government Version: 12/31/02
Database Release Frequency: Every 4 Years

Date of Last EDR Contact: 12/08/03
Date of Next Scheduled EDR Contact: 03/08/04

FTTS INSP: FIFRA/ TSCA Tracking System - FIFRA (Federal Insecticide, Fungicide, & Rodenticide Act)/TSCA (Toxic Substances Control Act)
Source: EPA
Telephone: 202-564-2501

Date of Government Version: 10/16/03
Database Release Frequency: Quarterly

Date of Last EDR Contact: 12/22/03
Date of Next Scheduled EDR Contact: 03/22/04

SSTS: Section 7 Tracking Systems
Source: EPA
Telephone: 202-564-5008
Section 7 of the Federal Insecticide, Fungicide and Rodenticide Act, as amended (92 Stat. 829) requires all registered pesticide-producing establishments to submit a report to the Environmental Protection Agency by March 1st each year. Each establishment must report the types and amounts of pesticides, active ingredients and devices being produced, and those having been produced and sold or distributed in the past year.

Date of Government Version: 12/31/01
Database Release Frequency: Annually

Date of Last EDR Contact: 01/19/04
Date of Next Scheduled EDR Contact: 04/19/04

FTTS: FIFRA/ TSCA Tracking System - FIFRA (Federal Insecticide, Fungicide, & Rodenticide Act)/TSCA (Toxic Substances Control Act)
Source: EPA/Office of Prevention, Pesticides and Toxic Substances
Telephone: 202-564-2501
FTTS tracks administrative cases and pesticide enforcement actions and compliance activities related to FIFRA, TSCA and EPCRA (Emergency Planning and Community Right-to-Know Act). To maintain currency, EDR contacts the Agency on a quarterly basis.

Date of Government Version: 10/16/03
Database Release Frequency: Quarterly
Date of Last EDR Contact: 12/22/03
Date of Next Scheduled EDR Contact: 03/22/04

STATE OF HAWAII ASTM STANDARD RECORDS

SHWS: Sites List
Source: Department of Health
Telephone: 808-586-4249
Facilities, sites or areas in which the Office of Hazard Evaluation and Emergency Response has an interest, has investigated or may investigate under HRS 128D (includes CERCLIS sites).

Date of Government Version: 07/12/01
Date Made Active at EDR: 10/16/01
Database Release Frequency: Semi-Annually
Date of Data Arrival at EDR: 09/24/01
Elapsed ASTM days: 22
Date of Last EDR Contact: 12/24/03

SWF/LF: Permitted Landfills in the State of Hawaii
Source: Department of Health
Telephone: 808-586-4245
Solid Waste Facilities/Landfill Sites. SWF/LF type records typically contain an inventory of solid waste disposal facilities or landfills in a particular state. Depending on the state, these may be active or inactive facilities or open dumps that failed to meet RCRA Subtitle D Section 4004 criteria for solid waste landfills or disposal sites.

Date of Government Version: 11/01/03
Date Made Active at EDR: 01/13/04
Database Release Frequency: Varies
Date of Data Arrival at EDR: 11/24/03
Elapsed ASTM days: 50
Date of Last EDR Contact: 01/26/04

LUST: Leaking Underground Storage Tank Database
Source: Department of Health
Telephone: 808-586-4228
Leaking Underground Storage Tank Incident Reports. LUST records contain an inventory of reported leaking underground storage tank incidents. Not all states maintain these records, and the information stored varies by state.

Date of Government Version: 08/01/03
Date Made Active at EDR: 09/17/03
Database Release Frequency: Semi-Annually
Date of Data Arrival at EDR: 09/02/03
Elapsed ASTM days: 15
Date of Last EDR Contact: 12/29/03

UST: Underground Storage Tank Database
Source: Department of Health
Telephone: 808-586-4228
Registered Underground Storage Tanks. UST's are regulated under Subtitle I of the Resource Conservation and Recovery Act (RCRA) and must be registered with the state department responsible for administering the UST program. Available information varies by state program.

Date of Government Version: 08/01/03
Date Made Active at EDR: 09/11/03
Database Release Frequency: Semi-Annually
Date of Data Arrival at EDR: 09/02/03
Elapsed ASTM days: 9
Date of Last EDR Contact: 12/29/03

VCP: Voluntary Response Program Sites
Source: Department of Health
Telephone: 808-586-4249

Date of Government Version: 10/10/03
Date Made Active at EDR: 10/21/03
Database Release Frequency: Varies
Date of Data Arrival at EDR: 10/13/03
Elapsed ASTM days: 8
Date of Last EDR Contact: 12/24/03

STATE OF HAWAII ASTM SUPPLEMENTAL RECORDS

SPILLS: Release Notifications
Source: Department of Health
Telephone: 808-586-4249
Releases of hazardous substances to the environment reported to the Office of Hazard Evaluation and Emergency Response since 1988.

Date of Government Version: 09/01/00
Database Release Frequency: Varies
Date of Last EDR Contact: 12/24/03
Date of Next Scheduled EDR Contact: 03/22/04

EDR PROPRIETARY HISTORICAL DATABASES

Former Manufactured Gas (Coal Gas) Sites: The existence and location of Coal Gas sites is provided exclusively to EDR by Real Property Scan, Inc. ©Copyright 1993 Real Property Scan, Inc. For a technical description of the types of hazards which may be found at such sites, contact your EDR customer service representative.

Disclaimer Provided by Real Property Scan, Inc.

The information contained in this report has predominantly been obtained from publicly available sources produced by entities other than Real Property Scan. While reasonable steps have been taken to insure the accuracy of this report, Real Property Scan does not guarantee the accuracy of this report. Any liability on the part of Real Property Scan is strictly limited to a refund of the amount paid. No claim is made for the actual existence of toxins at any site. This report does not constitute a legal opinion.

BROWNFIELDS DATABASES

BROWNFIELDS: Brownfields Sites
Source: Department of Health
Telephone: 808-586-4249

Date of Government Version: 10/10/03
Database Release Frequency: Varies
Date of Last EDR Contact: 12/24/03
Date of Next Scheduled EDR Contact: 03/22/04

VCP: Voluntary Response Program Sites
Source: Department of Health
Telephone: 808-586-4249

Date of Government Version: 10/04/03
Database Release Frequency: Varies
Date of Last EDR Contact: 12/24/03
Date of Next Scheduled EDR Contact: 03/22/04

US BROWNFIELDS: A Listing of Brownfields Sites
Source: Environmental Protection Agency
Telephone: 202-566-2777
Included in the listing are brownfields properties addresses by Cooperative Agreement Recipients and brownfields properties addressed by Targeted Brownfields Assessments. Targeted Brownfields Assessments-EPA's Targeted Brownfields Assessments (TBA) program is designed to help states, tribes, and municipalities--especially those without EPA Brownfields Assessment Demonstration Pilots--minimize the uncertainties of contamination often associated with brownfields. Under the TBA program, EPA provides funding and/or technical assistance for environmental assessments at brownfields sites throughout the country. Targeted Brownfields Assessments supplement and work with other efforts under EPA's Brownfields Initiative to promote cleanup and redevelopment of brownfields. Cooperative Agreement Recipients-States, political subdivisions, territories, and Indian tribes become BCRLF cooperative agreement recipients when they enter into BCRLF cooperative agreements with the U.S. EPA. EPA selects BCRLF cooperative agreement recipients based on a proposal and application process. BCRLF cooperative agreement recipients must use EPA funds provided through BCRLF cooperative agreement for specified brownfields-related cleanup activities.

Date of Government Version: N/A
Database Release Frequency: Semi-Annually

Date of Last EDR Contact: N/A
Date of Next Scheduled EDR Contact: N/A

OTHER DATABASE(S)

Depending on the geographic area covered by this report, the data provided in these specialty databases may or may not be complete. For example, the existence of wetlands information data in a specific report does not mean that all wetlands in the area covered by the report are included. Moreover, the absence of any reported wetlands information does not necessarily mean that wetlands do not exist in the area covered by the report.

Oil/Gas Pipelines: This data was obtained by EDR from the USGS in 1994. It is referred to by USGS as GeoData Digital Line Graphs from 1:100,000-Scale Maps. It was extracted from the transportation category including some oil, but primarily gas pipelines.

Electric Power Transmission Line Data
Source: PennWell Corporation
Telephone: (800) 823-6277
This map includes information copyrighted by PennWell Corporation. This information is provided on a best effort basis and PennWell Corporation does not guarantee its accuracy nor warrant its fitness for any particular purpose. Such information has been reprinted with the permission of PennWell.

Sensitive Receptors: There are individuals deemed sensitive receptors due to their fragile immune systems and special sensitivity to environmental discharges. These sensitive receptors typically include the elderly, the sick, and children. While the location of all sensitive receptors cannot be determined, EDR indicates those buildings and facilities - schools, daycares, hospitals, medical centers, and nursing homes - where individuals who are sensitive receptors are likely to be located.

AHA Hospitals:
Source: American Hospital Association, Inc.
Telephone: 312-280-5991
The database includes a listing of hospitals based on the American Hospital Association's annual survey of hospitals.

Medical Centers: Provider of Services Listing
Source: Centers for Medicare & Medicaid Services
Telephone: 410-786-3000
A listing of hospitals with Medicare provider number, produced by Centers of Medicare & Medicaid Services, a federal agency within the U.S. Department of Health and Human Services.

Nursing Homes
Source: National Institutes of Health
Telephone: 301-594-6248
Information on Medicare and Medicaid certified nursing homes in the United States.

Public Schools
Source: National Center for Education Statistics
Telephone: 202-502-7300
The National Center for Education Statistics' primary database on elementary and secondary public education in the United States. It is a comprehensive, annual, national statistical database of all public elementary and secondary schools and school districts, which contains data that are comparable across all states.

Private Schools
Source: National Center for Education Statistics
Telephone: 202-502-7300
The National Center for Education Statistics' primary database on private school locations in the United States.

Flood Zone Data: This data, available in select counties across the country, was obtained by EDR in 1999 from the Federal Emergency Management Agency (FEMA). Data depicts 100-year and 500-year flood zones as defined by FEMA.

NWI: National Wetlands Inventory. This data, available in select counties across the country, was obtained by EDR in 2002 from the U.S. Fish and Wildlife Service.

GOVERNMENT RECORDS SEARCHED / DATA CURRENCY TRACKING

STREET AND ADDRESS INFORMATION

GEOCHECK ®- PHYSICAL SETTING SOURCE ADDENDUM

TARGET PROPERTY ADDRESS

WAILELE STREAM
CANE HAUL RD.
LAIE, HI 96762

TARGET PROPERTY COORDINATES

Latitude (North):	21.637899 - 21˚ 38' 16.4''
Longitude (West):	157.925903 - 157˚ 55' 33.3''
Universal Tranverse Mercator:	Zone 4
UTM X (Meters):	611155.3
UTM Y (Meters):	2392992.0
Elevation:	26 ft. above sea level

EDR's GeoCheck Physical Setting Source Addendum has been developed to assist the environmental professional with the collection of physical setting source information in accordance with ASTM 1527-00, Section 7.2.3. Section 7.2.3 requires that a current USGS 7.5 Minute Topographic Map (or equivalent, such as the USGS Digital Elevation Model) be reviewed. It also requires that one or more additional physical setting sources be sought when (1) conditions have been identified in which hazardous substances or petroleum products are likely to migrate to or from the property, and (2) more information than is provided in the current USGS 7.5 Minute Topographic Map (or equivalent) is generally obtained, pursuant to local good commercial or customary practice, to assess the impact of migration of recognized environmental conditions in connection with the property. Such additional physical setting sources generally include information about the topographic, hydrologic, hydrogeologic, and geologic characteristics of a site, and wells in the area.

Assessment of the impact of contaminant migration generally has two principle investigative components:

1. Groundwater flow direction, and
2. Groundwater flow velocity.

Groundwater flow direction may be impacted by surface topography, hydrology, hydrogeology, characteristics of the soil, and nearby wells. Groundwater flow velocity is generally impacted by the nature of the geologic strata. EDR's GeoCheck Physical Setting Source Addendum is provided to assist the environmental professional in forming an opinion about the impact of potential contaminant migration.

GEOCHECK® - PHYSICAL SETTING SOURCE SUMMARY

GROUNDWATER FLOW DIRECTION INFORMATION

Groundwater flow direction for a particular site is best determined by a qualified environmental professional using site-specific well data. If such data is not reasonably ascertainable, it may be necessary to rely on other sources of information, such as surface topographic information, hydrologic information, hydrogeologic data collected on nearby properties, and regional groundwater flow information (from deep aquifers).

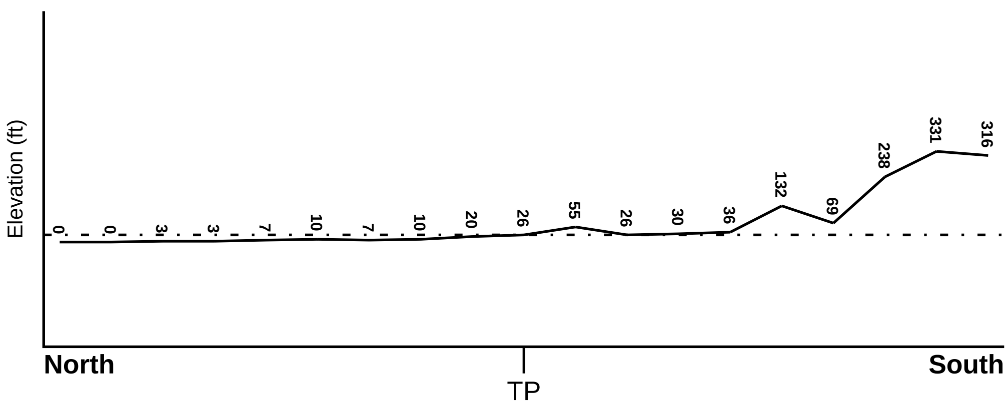
TOPOGRAPHIC INFORMATION

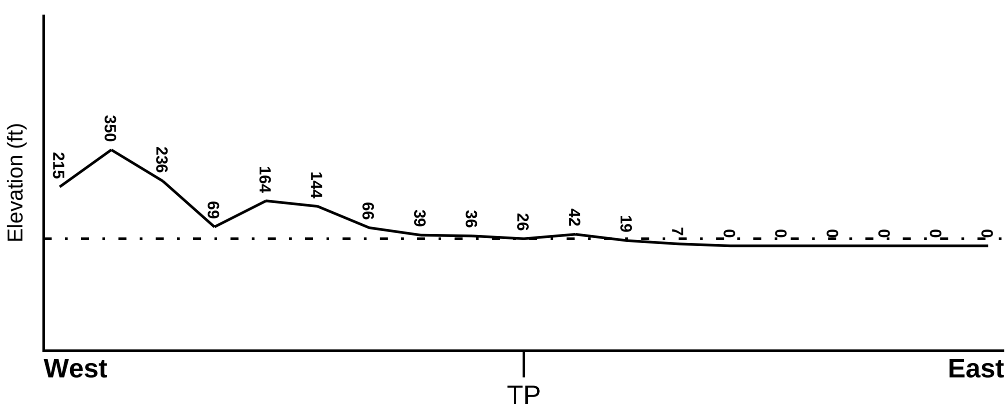
Surface topography may be indicative of the direction of surficial groundwater flow. This information can be used to assist the environmental professional in forming an opinion about the impact of nearby contaminated properties or, should contamination exist on the target property, what downgradient sites might be impacted.

TARGET PROPERTY TOPOGRAPHY

USGS Topographic Map:	21157-F8 KAHUKU, HI
General Topographic Gradient:	General NE
Source:	USGS 7.5 min quad index

SURROUNDING TOPOGRAPHY: ELEVATION PROFILES





Target Property Elevation: 26 ft.

Source: Topography has been determined from the USGS 7.5' Digital Elevation Model and should be evaluated on a relative (not an absolute) basis. Relative elevation information between sites of close proximity should be field verified.

GEOCHECK® - PHYSICAL SETTING SOURCE SUMMARY

HYDROLOGIC INFORMATION

Surface water can act as a hydrologic barrier to groundwater flow. Such hydrologic information can be used to assist the environmental professional in forming an opinion about the impact of nearby contaminated properties or, should contamination exist on the target property, what downgradient sites might be impacted.

Refer to the Physical Setting Source Map following this summary for hydrologic information (major waterways and bodies of water).

FEMA FLOOD ZONE

Target Property County	FEMA Flood Electronic Data
HONOLULU, HI	YES - refer to the Overview Map and Detail Map

Flood Plain Panel at Target Property: 1500010015C

Additional Panels in search area: Not Reported

NATIONAL WETLAND INVENTORY

NWI Quad at Target Property	NWI Electronic Data Coverage
KAHUKU	YES - refer to the Overview Map and Detail Map

HYDROGEOLOGIC INFORMATION

Hydrogeologic information obtained by installation of wells on a specific site can often be an indicator of groundwater flow direction in the immediate area. Such hydrogeologic information can be used to assist the environmental professional in forming an opinion about the impact of nearby contaminated properties or, should contamination exist on the target property, what downgradient sites might be impacted.

AQUIFLOW®

Search Radius: 1.000 Mile.

EDR has developed the AQUIFLOW Information System to provide data on the general direction of groundwater flow at specific points. EDR has reviewed reports submitted by environmental professionals to regulatory authorities at select sites and has extracted the date of the report, groundwater flow direction as determined hydrogeologically, and the depth to water table.

MAP ID	LOCATION FROM TP	GENERAL DIRECTION GROUNDWATER FLOW
Not Reported		

GEOCHECK® - PHYSICAL SETTING SOURCE SUMMARY

GROUNDWATER FLOW VELOCITY INFORMATION

Groundwater flow velocity information for a particular site is best determined by a qualified environmental professional using site specific geologic and soil strata data. If such data are not reasonably ascertainable, it may be necessary to rely on other sources of information, including geologic age identification, rock stratigraphic unit and soil characteristics data collected on nearby properties and regional soil information. In general, contaminant plumes move more quickly through sandy-gravelly types of soils than silty-clayey types of soils.

GEOLOGIC INFORMATION IN GENERAL AREA OF TARGET PROPERTY

Geologic information can be used by the environmental professional in forming an opinion about the relative speed at which contaminant migration may be occurring.

ROCK STRATIGRAPHIC UNIT

Era: -
System: -
Series: -
Code: N/A *(decoded above as Era, System & Series)*

GEOLOGIC AGE IDENTIFICATION

Category: -

Geologic Age and Rock Stratigraphic Unit Source: P.G. Schruben, R.E. Arndt and W.J. Bawiec, Geology of the Conterminous U.S. at 1:2,500,000 Scale - a digital representation of the 1974 P.B. King and H.M. Beikman Map, USGS Digital Data Series DDS - 11 (1994).

DOMINANT SOIL COMPOSITION IN GENERAL AREA OF TARGET PROPERTY

The U.S. Department of Agriculture's (USDA) Soil Conservation Service (SCS) leads the National Cooperative Soil Survey (NCSS) and is responsible for collecting, storing, maintaining and distributing soil survey information for privately owned lands in the United States. A soil map in a soil survey is a representation of soil patterns in a landscape. Soil maps for STATSGO are compiled by generalizing more detailed (SSURGO) soil survey maps. The following information is based on Soil Conservation Service STATSGO data.

Soil Component Name: KAWAIHAPAI

Soil Surface Texture: clay loam

Hydrologic Group: Class B - Moderate infiltration rates. Deep and moderately deep, moderately well and well drained soils with moderately coarse textures.

Soil Drainage Class: Well drained. Soils have intermediate water holding capacity. Depth to water table is more than 6 feet.

Hydric Status: Soil does not meet the requirements for a hydric soil.

Corrosion Potential - Uncoated Steel: MODERATE

Depth to Bedrock Min: > 60 inches

Depth to Bedrock Max: > 60 inches

Soil Layer Information							
	Boundary			Classification			
Layer	Upper	Lower	Soil Texture Class	AASHTO Group	Unified Soil	Permeability Rate (in/hr)	Soil Reaction (pH)
1	0 inches	22 inches	clay loam	Silt-Clay Materials (more than 35 pct. passing No. 200), Clayey Soils.	FINE-GRAINED SOILS, Silts and Clays (liquid limit less than 50%), Lean Clay	Max: 2.00 Min: 0.60	Max: 7.30 Min: 6.60
2	22 inches	32 inches	sandy loam	Granular materials (35 pct. or less passing No. 200), Silty, or Clayey Gravel and Sand.	COARSE-GRAINED SOILS, Sands, Sands with fines, Silty Sand.	Max: 6.00 Min: 2.00	Max: 7.30 Min: 6.60
3	32 inches	54 inches	stratified	Granular materials (35 pct. or less passing No. 200), Silty, or Clayey Gravel and Sand.	COARSE-GRAINED SOILS, Sands, Sands with fines, Silty Sand.	Max: 6.00 Min: 2.00	Max: 7.30 Min: 6.60

OTHER SOIL TYPES IN AREA

Based on Soil Conservation Service STATSGO data, the following additional subordinant soil types may appear within the general area of target property.

Soil Surface Textures: silty clay
stony - clay loam
very stony - clay loam
clay
loam

Surficial Soil Types: silty clay
stony - clay loam
very stony - clay loam
clay
loam

Shallow Soil Types: No Other Soil Types

Deeper Soil Types: silty clay
loamy sand

ADDITIONAL ENVIRONMENTAL RECORD SOURCES

According to ASTM E 1527-00, Section 7.2.2, "one or more additional state or local sources of environmental records may be checked, in the discretion of the environmental professional, to enhance and supplement federal and state sources... Factors to consider in determining which local or additional state records, if any, should be checked include (1) whether they are reasonably ascertainable, (2) whether they are sufficiently useful, accurate, and complete in light of the objective of the records review (see 7.1.1), and (3) whether they are obtained, pursuant to local, good commercial or customary practice." One of the record sources listed in Section 7.2.2 is water well information. Water well information can be used to assist the environmental professional in assessing sources that may impact groundwater flow direction, and in forming an opinion about the impact of contaminant migration on nearby drinking water wells.

GEOCHECK® - PHYSICAL SETTING SOURCE SUMMARY

WELL SEARCH DISTANCE INFORMATION

DATABASE	SEARCH DISTANCE (miles)
Federal USGS	1.000
Federal FRDS PWS	Nearest PWS within 1 mile
State Database	1.000

FEDERAL USGS WELL INFORMATION

MAP ID	WELL ID	LOCATION FROM TP
A1	USGS0225976	0 - 1/8 Mile SE
B5	USGS0226040	0 - 1/8 Mile ENE
C6	USGS0226048	1/8 - 1/4 Mile North
A8	USGS0225973	1/8 - 1/4 Mile SSE
D11	USGS0225978	1/8 - 1/4 Mile NNW
D12	USGS0225980	1/4 - 1/2 Mile NNW
D14	USGS0225981	1/4 - 1/2 Mile NNW
E15	USGS0225975	1/4 - 1/2 Mile ESE
F23	USGS0226041	1/4 - 1/2 Mile West
F24	USGS0226042	1/4 - 1/2 Mile West
F25	USGS0226043	1/4 - 1/2 Mile West
F26	USGS0226046	1/4 - 1/2 Mile West
F27	USGS0226045	1/4 - 1/2 Mile West
F28	USGS0226044	1/4 - 1/2 Mile West
F29	USGS0226047	1/4 - 1/2 Mile West
G31	USGS0225982	1/4 - 1/2 Mile North
H34	USGS0225977	1/4 - 1/2 Mile ENE
I35	USGS0225971	1/4 - 1/2 Mile SSE
I38	USGS0225970	1/4 - 1/2 Mile SSE
K42	USGS0225968	1/2 - 1 Mile South
K46	USGS0226039	1/2 - 1 Mile South
M47	USGS0226053	1/2 - 1 Mile North
L49	USGS0225969	1/2 - 1 Mile SW
N50	USGS0226049	1/2 - 1 Mile NW
O52	USGS0226054	1/2 - 1 Mile NNW
N55	USGS0226051	1/2 - 1 Mile NW
N56	USGS0226050	1/2 - 1 Mile NW
N58	USGS0226052	1/2 - 1 Mile NW
P61	USGS0225985	1/2 - 1 Mile NW
Q63	USGS0225979	1/2 - 1 Mile WNW
R66	USGS0226038	1/2 - 1 Mile SSE

FEDERAL FRDS PUBLIC WATER SUPPLY SYSTEM INFORMATION

MAP ID	WELL ID	LOCATION FROM TP
A2	HI0000325	0 - 1/8 Mile SE

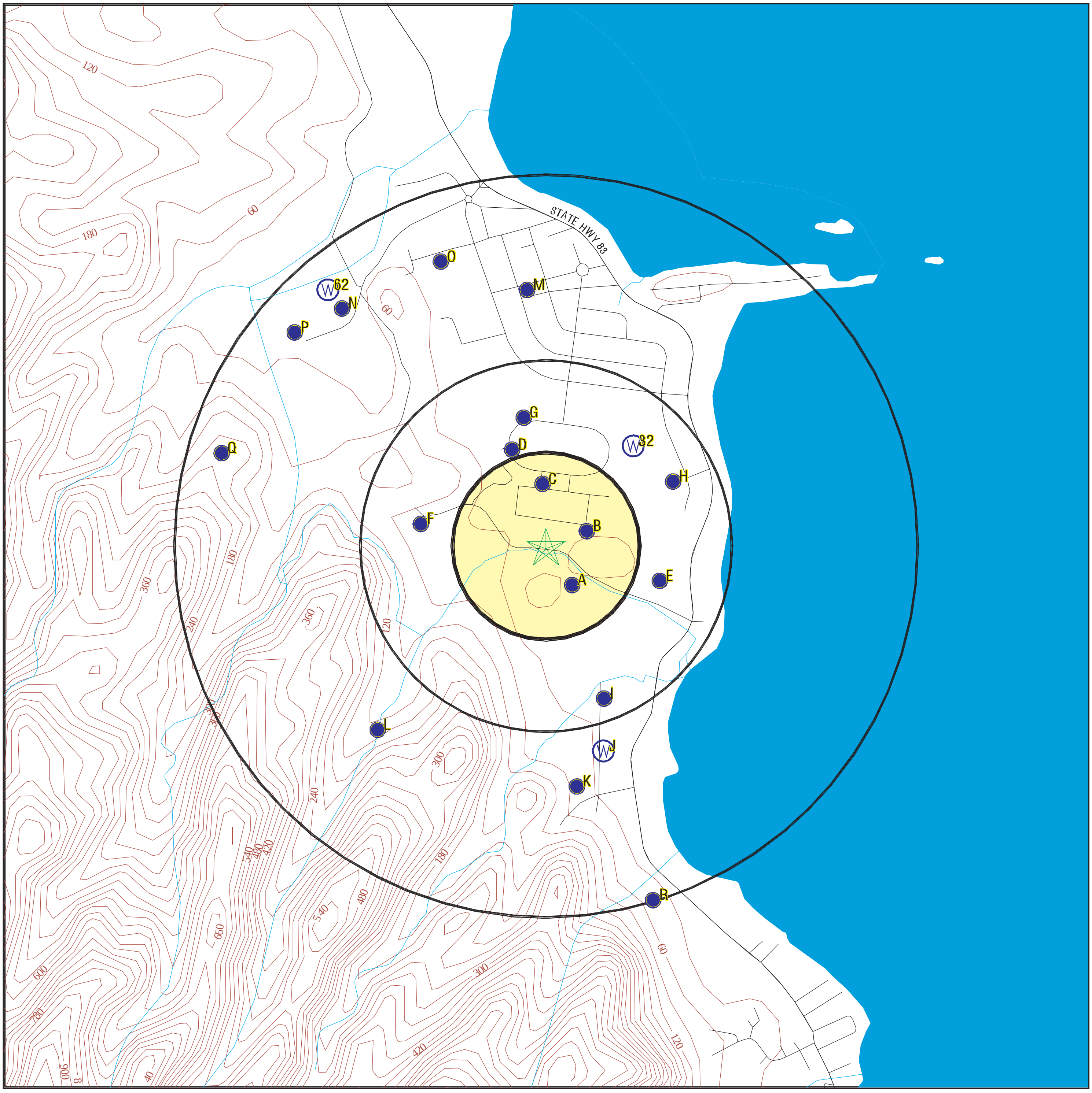
Note: PWS System location is not always the same as well location.

GEOCHECK® - PHYSICAL SETTING SOURCE SUMMARY

STATE DATABASE WELL INFORMATION

MAP ID	WELL ID	LOCATION FROM TP
A3	3-3855-010	0 - 1/8 Mile SE
B4	3-3855-002	0 - 1/8 Mile ENE
C7	3-3855-001	1/8 - 1/4 Mile North
A9	3-3855-004	1/8 - 1/4 Mile SSE
C10	3-3855-008	1/8 - 1/4 Mile North
D13	3-3855-007	1/4 - 1/2 Mile NNW
E16	3-3855-003	1/4 - 1/2 Mile ESE
F17	3-3856-003	1/4 - 1/2 Mile West
F18	3-3856-002	1/4 - 1/2 Mile West
F19	3-3856-004	1/4 - 1/2 Mile West
F20	3-3856-006	1/4 - 1/2 Mile West
F21	3-3856-005	1/4 - 1/2 Mile West
F22	3-3856-001	1/4 - 1/2 Mile West
G30	3-3855-006	1/4 - 1/2 Mile North
32	3-3855-012	1/4 - 1/2 Mile NE
H33	3-3855-009	1/4 - 1/2 Mile ENE
I36	3-3855-011	1/4 - 1/2 Mile SSE
I37	3-3855-013	1/4 - 1/2 Mile SSE
I39	3-3855-005	1/4 - 1/2 Mile SSE
J40	3-3755-008	1/2 - 1 Mile SSE
J41	3-3755-009	1/2 - 1 Mile SSE
K43	3-3755-001	1/2 - 1 Mile South
L44	3-3856-009	1/2 - 1 Mile SW
K45	3-3755-006	1/2 - 1 Mile South
M48	3-3955-002	1/2 - 1 Mile North
N51	3-3956-006	1/2 - 1 Mile NW
O53	3-3955-001	1/2 - 1 Mile NNW
N54	3-3956-005	1/2 - 1 Mile NW
N57	3-3956-007	1/2 - 1 Mile NW
N59	3-3956-003	1/2 - 1 Mile NW
P60	3-3856-007	1/2 - 1 Mile NW
62	3-3956-004	1/2 - 1 Mile NW
Q64	3-3856-008	1/2 - 1 Mile WNW
R65	3-3755-004	1/2 - 1 Mile SSE

PHYSICAL SETTING SOURCE MAP - 1136058.2s



County Boundary
Major Roads
Contour Lines
Earthquake epicenter, Richter 5 or greater
Water Wells
Public Water Supply Wells
Cluster of Multiple Icons

Groundwater Flow Direction
G I Indeterminate Groundwater Flow at Location
G V Groundwater Flow Varies at Location

TARGET PROPERTY:	Wailele Stream	CUSTOMER:	Environet
ADDRESS:	Cane Haul Rd.	CONTACT:	Ida Knutsen
CITY/STATE/ZIP:	Laie HI 96762	INQUIRY #:	1136058.2s
LAT/LONG:	21.6379 / 157.9259	DATE:	February 26, 2004 2:16 pm

Map ID Direction Distance Elevation		Database	EDR ID Number
A1 **SE** **0 - 1/8 Mile** **Higher**		**FED USGS**	**USGS0225976**

Agency:	USGS	Site ID:	213824157554001
Site Name:	3-3855-10 W382		
Dec. Latitude:	21.63682		
Dec. Longitude:	-157.92503		
Coord Sys:	NAD83		
State:	HI		
County:	Honolulu County		
Altitude:	19.00		
Hydrologic code:	20060000		
Topographic:	Not Reported		
Site Type:	Ground-water other than Spring		
Const Date:	19270101	Inven Date:	Not Reported
Well Type:	Single well, other than collector or Ranney type		
Primary Aquifer:	Not Reported		
Aquifer type:	Not Reported		
Well depth:	447		
Hole depth:	Not Reported	Source:	Not Reported
Project no:	Not Reported		

Ground-water levels, Number of Measurements: 0

		Database	EDR ID Number
A2 **SE** **0 - 1/8 Mile** **Higher**		**FRDS PWS**	**HI0000325**

PWS ID:	HI0000325	PWS Status:	Not Reported
Date Initiated:	Not Reported	Date Deactivated:	Not Reported
PWS Name:	ZIONS LAIE ZIONS SECURITIES CORP. 55-510 KAMEHAMEHA HIGHWAY LAIE, OAHU, HI 96762		

Treatment Objective: DISINFECTION
Treatment Process: GASEOUS CHLORINATION, POST
Source: Ground water

Addressee / Facility:	System Owner/Responsible Party MR. LUCKY FONOIMOANA ZIONS SECURITIES COPRORATION 55-510 KAMEHAMEHA HIGHWAY LAIE, HI 96762

Facility Latitude:	21 38 24.0000	Facility Longitude:	157 55 40.0000
Facility Latitude:	21 38 38.0000	Facility Longitude:	157 55 45.0000
Facility Latitude:	21 38 42.0000	Facility Longitude:	157 55 49.0000
Facility Latitude:	21 38 46.0000	Facility Longitude:	157 55 46.0000
Facility Latitude:	21 39 2.0000	Facility Longitude:	157 56 13.0000
City Served:	LAIE		
Treatment Class:	Mixed (treated and untreated)	Population:	7000

PWS currently has or had major violation(s) or enforcement: No

Map ID Direction Distance Elevation	Database	EDR ID Number
A3 **SE** **0 - 1/8 Mile** **Higher**	**HI WELLS**	**3-3855-010**

Wid:	3-3855-010	Island Code:	3
Island Name:	Oahu	Well no:	3855-10
Well name:	Laie-Child	Old name:	Not Reported
Yr drilled:	1927	Driller:	MCCANDLESS
Quad_map:	07	Latitude:	213824
Longitude:	1575540	UTM:	Y
Gps:	N	Owner/user:	Hawaii Res Inc
Old number:	Not Reported	Well_type:	Not Reported
Type:	Not Reported	Casing dia:	12
Ground Elev:	19	Well depth:	447
Solid casing Depth:	116	Perf casing Depth:	Not Reported
Use:	SLD	Use Desc:	Sealed
Use year:	93	Water Top Elev:	0
Chloride value:	0	Test date:	Not Reported
Pumping Test rate:	Not Reported	Drop in water Lvl:	Not Reported
Chloride Test:	Not Reported	Temperature:	Not Reported
Units:	Not Reported	Pump Capacity:	0
Annual Draft:	Not Reported	Static Water Lvl:	Not Reported
Geology:	TKB	Geology desc:	Tertiary Koolau basalt
Installed:	Not Reported	Last Measured:	Not Reported
Max chlorides:	Not Reported	Max Cl year:	0
Min chlorides:	Not Reported	Min Cl year:	0
Bot_hole depth:	-428	bot_solid depth:	-97
Bot_perf depth:	Not Reported	Well Capacity:	Not Reported
Pump Capacity:	Not Reported	Draft (mgd):	Not Reported
Tax map key:	5-5-006:001	Aquifer code:	30601
Latest head mmt:	0	Cur head mmt:	Not Reported
Current Cl mmt:	Not Reported	Const. Date:	01/01/1927 00:00:00
Pump Inst. Date:	Not Reported	Surveyor:	Not Reported
Transmissivity:	0	Pump intake elev:	Not Reported
Pump depth:	Not Reported		

B4 **ENE** **0 - 1/8 Mile** **Lower**	**HI WELLS**	**3-3855-002**

Wid:	3-3855-002	Island Code:	3
Island Name:	Oahu	Well no:	3855-02
Well name:	Laie	Old name:	Not Reported
Yr drilled:	Not Reported	Driller:	Not Reported
Quad_map:	07	Latitude:	213830
Longitude:	1575537	UTM:	Y
Gps:	N	Owner/user:	Kahuku Plantn
Old number:	381-	Well_type:	Not Reported
Type:	Not Reported	Casing dia:	6
Ground Elev:	15	Well depth:	388

Solid casing Depth:	160	Perf casing Depth:	Not Reported
Use:	SLD	Use Desc:	Sealed
Use year:	51	Water Top Elev:	16.8
Chloride value:	0	Test date:	Not Reported
Pumping Test rate:	Not Reported	Drop in water Lvl:	Not Reported
Chloride Test:	Not Reported	Temperature:	Not Reported
Units:	Not Reported	Pump Capacity:	0
Annual Draft:	Not Reported	Static Water Lvl:	Not Reported
Geology:	Not Reported	Geology desc:	Not Reported
Installed:	Not Reported	Last Measured:	Not Reported
Max chlorides:	Not Reported	Max Cl year:	Not Reported
Min chlorides:	Not Reported	Min Cl year:	Not Reported
Bot_hole depth:	-373	bot_solid depth:	-145
Bot_perf depth:	Not Reported	Well Capacity:	Not Reported
Pump Capacity:	Not Reported	Draft (mgd):	Not Reported
Tax map key:	5-5-006:005	Aquifer code:	30601
Latest head mmt:	0	Cur head mmt:	Not Reported
Current Cl mmt:	Not Reported	Const. Date:	Not Reported
Pump Inst. Date:	Not Reported	Surveyor:	Not Reported
Transmissivity:	0	Pump intake elev:	Not Reported
Pump depth:	Not Reported		

B5
ENE
0 - 1/8 Mile
Lower

FED USGS **USGS0226040**

Agency:	USGS	Site ID:	213830157553701
Site Name:	3-3855-02 W381		
Dec. Latitude:	21.63849		
Dec. Longitude:	-157.92419		
Coord Sys:	NAD83		
State:	HI		
County:	Honolulu County		
Altitude:	15.00		
Hydrologic code:	20060000		
Topographic:	Not Reported		
Site Type:	Ground-water other than Spring		
Const Date:	Not Reported	Inven Date:	Not Reported
Well Type:	Single well, other than collector or Ranney type		
Primary Aquifer:	Not Reported		
Aquifer type:	Not Reported		
Well depth:	388		
Hole depth:	Not Reported	Source:	Not Reported
Project no:	Not Reported		

Ground-water levels, Number of Measurements: 0

C6
North
1/8 - 1/4 Mile
Lower

FED USGS **USGS0226048**

Agency:	USGS	Site ID:	213836157554301
Site Name:	3-3855-01 W379		
Dec. Latitude:	21.64015		
Dec. Longitude:	-157.92586		
Coord Sys:	NAD83		
State:	HI		
County:	Honolulu County		
Altitude:	16.00		
Hydrologic code:	20060000		
Topographic:	Not Reported		
Site Type:	Ground-water other than Spring		
Const Date:	Not Reported	Inven Date:	Not Reported
Well Type:	Single well, other than collector or Ranney type		
Primary Aquifer:	Not Reported		
Aquifer type:	Not Reported		
Well depth:	250		
Hole depth:	Not Reported	Source:	Not Reported
Project no:	Not Reported		

Ground-water levels, Number of Measurements: 0

C7
North
1/8 - 1/4 Mile
Lower

HI WELLS **3-3855-001**

Wid:	3-3855-001	Island Code:	3
Island Name:	Oahu	Well no:	3855-01
Well name:	Laie	Old name:	Not Reported
Yr drilled:	Not Reported	Driller:	Not Reported
Quad_map:	07	Latitude:	213836
Longitude:	1575543	UTM:	Y
Gps:	N	Owner/user:	Kahuku Plantn
Old number:	379-	Well_type:	Not Reported
Type:	Not Reported	Casing dia:	8
Ground Elev:	16	Well depth:	250
Solid casing Depth:	157	Perf casing Depth:	Not Reported
Use:	SLD	Use Desc:	Sealed
Use year:	40	Water Top Elev:	0
Chloride value:	0	Test date:	Not Reported
Pumping Test rate:	Not Reported	Drop in water Lvl:	Not Reported
Chloride Test:	Not Reported	Temperature:	Not Reported
Units:	Not Reported	Pump Capacity:	0
Annual Draft:	Not Reported	Static Water Lvl:	Not Reported
Geology:	Not Reported	Geology desc:	Not Reported
Installed:	Not Reported	Last Measured:	Not Reported
Max chlorides:	Not Reported	Max Cl year:	0
Min chlorides:	Not Reported	Min Cl year:	0
Bot_hole depth:	-234	bot_solid depth:	-141
Bot_perf depth:	Not Reported	Well Capacity:	Not Reported
Pump Capacity:	Not Reported	Draft (mgd):	Not Reported
Tax map key:	5-5-006:005	Aquifer code:	30601
Latest head mmt:	0	Cur head mmt:	Not Reported
Current Cl mmt:	Not Reported	Const. Date:	Not Reported
Pump Inst. Date:	Not Reported	Surveyor:	Not Reported
Transmissivity:	0	Pump intake elev:	Not Reported
Pump depth:	Not Reported		

Map ID Direction Distance Elevation	Database	EDR ID Number
A8 **SSE** **1/8 - 1/4 Mile** **Lower**	**FED USGS**	**USGS0225973**

Agency:	USGS	Site ID:	213820157553801
Site Name:	3-3855-04 W384		
Dec. Latitude:	21.63571		
Dec. Longitude:	-157.92447		
Coord Sys:	NAD83		
State:	HI		
County:	Honolulu County		
Altitude:	14.00		
Hydrologic code:	20060000		
Topographic:	Not Reported		
Site Type:	Ground-water other than Spring		
Const Date:	Not Reported	Inven Date:	Not Reported
Well Type:	Single well, other than collector or Ranney type		
Primary Aquifer:	Not Reported		
Aquifer type:	Not Reported		
Well depth:	446		
Hole depth:	Not Reported	Source:	Not Reported
Project no:	Not Reported		

Ground-water levels, Number of Measurements: 0

	Database	EDR ID Number
A9 **SSE** **1/8 - 1/4 Mile** **Lower**	**HI WELLS**	**3-3855-004**

Wid:	3-3855-004	Island Code:	3
Island Name:	Oahu	Well no:	3855-04
Well name:	Welfare Farm	Old name:	Not Reported
Yr drilled:	Not Reported	Driller:	Not Reported
Quad_map:	07	Latitude:	213820
Longitude:	1575538	UTM:	Y
Gps:	N	Owner/user:	Hawaii Res Inc
Old number:	384-	Well_type:	Not Reported
Type:	Not Reported	Casing dia:	10
Ground Elev:	14	Well depth:	446
Solid casing Depth:	104	Perf casing Depth:	Not Reported
Use:	IRR	Use Desc:	Irrigation
Use year:	Not Reported	Water Top Elev:	17.6
Chloride value:	36	Test date:	Not Reported
Pumping Test rate:	Not Reported	Drop in water Lvl:	Not Reported
Chloride Test:	Not Reported	Temperature:	Not Reported
Units:	Not Reported	Pump Capacity:	90
Annual Draft:	Not Reported	Static Water Lvl:	Not Reported
Geology:	TKB	Geology desc:	Tertiary Koolau basalt
Installed:	Not Reported	Last Measured:	Not Reported

Max chlorides:	Not Reported	Max Cl year:	0
Min chlorides:	Not Reported	Min Cl year:	0
Bot_hole depth:	-432	bot_solid depth:	-90
Bot_perf depth:	Not Reported	Well Capacity:	Not Reported
Pump Capacity:	.129	Draft (mgd):	Not Reported
Tax map key:	5-5-006:001	Aquifer code:	30601
Latest head mmt:	0	Cur head mmt:	Not Reported
Current Cl mmt:	Not Reported	Const. Date:	Not Reported
Pump Inst. Date:	Not Reported	Surveyor:	Not Reported
Transmissivity:	0	Pump intake elev:	Not Reported
Pump depth:	Not Reported		

C10
North
1/8 - 1/4 Mile
Lower

HI WELLS 3-3855-008

Wid:	3-3855-008	Island Code:	3
Island Name:	Oahu	Well no:	3855-08
Well name:	Byu Library	Old name:	Not Reported
Yr drilled:	1890	Driller:	MCCANDLESS
Quad_map:	07	Latitude:	213838
Longitude:	1575545	UTM:	Y
Gps:	N	Owner/user:	Laie Water Co
Old number:	Not Reported	Well_type:	Not Reported
Type:	Not Reported	Casing dia:	8
Ground Elev:	13	Well depth:	384
Solid casing Depth:	168	Perf casing Depth:	Not Reported
Use:	DOM	Use Desc:	Domestic
Use year:	Not Reported	Water Top Elev:	16
Chloride value:	0	Test date:	Not Reported
Pumping Test rate:	Not Reported	Drop in water Lvl:	Not Reported
Chloride Test:	Not Reported	Temperature:	21.2
Units:	C	Pump Capacity:	0
Annual Draft:	Not Reported	Static Water Lvl:	Not Reported
Geology:	TKB	Geology desc:	Tertiary Koolau basalt
Installed:	Not Reported	Last Measured:	Not Reported
Max chlorides:	Not Reported	Max Cl year:	0
Min chlorides:	Not Reported	Min Cl year:	0
Bot_hole depth:	-371	bot_solid depth:	-155
Bot_perf depth:	Not Reported	Well Capacity:	Not Reported
Pump Capacity:	Not Reported	Draft (mgd):	Not Reported
Tax map key:	5-5-006:005	Aquifer code:	30601
Latest head mmt:	0	Cur head mmt:	Not Reported
Current Cl mmt:	Not Reported	Const. Date:	01/01/1890 00:00:00
Pump Inst. Date:	Not Reported	Surveyor:	Not Reported
Transmissivity:	0	Pump intake elev:	Not Reported
Pump depth:	Not Reported		

D11
NNW
1/8 - 1/4 Mile
Lower

FED USGS USGS0225978

Agency:	USGS	Site ID:	213840157554601
Site Name:	3-3855-08 W376		
Dec. Latitude:	21.64126		
Dec. Longitude:	-157.92669		
Coord Sys:	NAD83		
State:	HI		
County:	Honolulu County		
Altitude:	13.00		
Hydrologic code:	20060000		
Topographic:	Not Reported		
Site Type:	Ground-water other than Spring		
Const Date:	18900101	Inven Date:	Not Reported
Well Type:	Single well, other than collector or Ranney type		
Primary Aquifer:	Not Reported		
Aquifer type:	Not Reported		
Well depth:	384		
Hole depth:	Not Reported	Source:	Not Reported
Project no:	Not Reported		

Ground-water levels, Number of Measurements: 0

D12
NNW
1/4 - 1/2 Mile
Lower

FED USGS **USGS0225980**

Agency:	USGS	Site ID:	213842157554800
Site Name:	3-3855-06 TO 08		
Dec. Latitude:	21.64182		
Dec. Longitude:	-157.92725		
Coord Sys:	NAD83		
State:	HI		
County:	Honolulu County		
Altitude:	9.00		
Hydrologic code:	20060000		
Topographic:	Not Reported		
Site Type:	Ground-water other than Spring		
Const Date:	Not Reported	Inven Date:	Not Reported
Well Type:	Multiple wells (a group of wells that are pumped through a single header)		
Primary Aquifer:	Not Reported		
Aquifer type:	Not Reported		
Well depth:	Not Reported		
Hole depth:	Not Reported	Source:	Not Reported
Project no:	Not Reported		

Ground-water levels, Number of Measurements: 0

D13
NNW
1/4 - 1/2 Mile
Lower

HI WELLS **3-3855-007**

Wid:	3-3855-007	Island Code:	3
Island Name:	Oahu	Well no:	3855-07
Well name:	Byu Ceramic	Old name:	Not Reported
Yr drilled:	1890	Driller:	MCCANDLESS
Quad_map:	07	Latitude:	213842
Longitude:	1575549	UTM:	Y
Gps:	N	Owner/user:	Laie Water Co
Old number:	Not Reported	Well_type:	Not Reported
Type:	Not Reported	Casing dia:	6
Ground Elev:	11	Well depth:	251
Solid casing Depth:	138	Perf casing Depth:	Not Reported
Use:	DOM	Use Desc:	Domestic
Use year:	Not Reported	Water Top Elev:	16
Chloride value:	0	Test date:	Not Reported
Pumping Test rate:	Not Reported	Drop in water Lvl:	Not Reported
Chloride Test:	Not Reported	Temperature:	21.5
Units:	C	Pump Capacity:	850
Annual Draft:	300	Static Water Lvl:	Not Reported
Geology:	TKB	Geology desc:	Tertiary Koolau basalt
Installed:	Not Reported	Last Measured:	Not Reported
Max chlorides:	Not Reported	Max Cl year:	0
Min chlorides:	Not Reported	Min Cl year:	0
Bot_hole depth:	-240	bot_solid depth:	-127
Bot_perf depth:	Not Reported	Well Capacity:	Not Reported
Pump Capacity:	1.224	Draft (mgd):	0.8
Tax map key:	5-5-006:005	Aquifer code:	30601
Latest head mmt:	0	Cur head mmt:	Not Reported
Current Cl mmt:	Not Reported	Const. Date:	01/01/1890 00:00:00
Pump Inst. Date:	Not Reported	Surveyor:	Not Reported
Transmissivity:	0	Pump intake elev:	Not Reported
Pump depth:	Not Reported		

D14
NNW
1/4 - 1/2 Mile
Lower

FED USGS **USGS0225981**

Agency:	USGS	Site ID:	213842157555001
Site Name:	3-3855-07 W375		
Dec. Latitude:	21.64182		
Dec. Longitude:	-157.9278		
Coord Sys:	NAD83		
State:	HI		
County:	Honolulu County		
Altitude:	11.69		
Hydrologic code:	20060000		
Topographic:	Flat surface		
Site Type:	Ground-water other than Spring		
Const Date:	18900101	Inven Date:	Not Reported
Well Type:	Single well, other than collector or Ranney type		
Primary Aquifer:	Not Reported		
Aquifer type:	Not Reported		
Well depth:	251		
Hole depth:	251	Source:	Not Reported
Project no:	Not Reported		

Ground-water levels, Number of Measurements: 1

Date	Feet below Surface	Feet to Sealevel
1939-10-03	-4.31	

E15
ESE
1/4 - 1/2 Mile
Lower

FED USGS **USGS0225975**

Agency:	USGS	Site ID:	213823157552601
Site Name:	3-3855-03 W383		
Dec. Latitude:	21.63654		
Dec. Longitude:	-157.92114		
Coord Sys:	NAD83		
State:	HI		
County:	Honolulu County		
Altitude:	11.00		
Hydrologic code:	20060000		
Topographic:	Not Reported		
Site Type:	Ground-water other than Spring		
Const Date:	Not Reported	Inven Date:	Not Reported
Well Type:	Single well, other than collector or Ranney type		
Primary Aquifer:	Not Reported		
Aquifer type:	Not Reported		
Well depth:	482		
Hole depth:	Not Reported	Source:	Not Reported
Project no:	Not Reported		

Ground-water levels, Number of Measurements: 0

E16
ESE
1/4 - 1/2 Mile
Lower

HI WELLS **3-3855-003**

Wid:	3-3855-003	Island Code:	3
Island Name:	Oahu	Well no:	3855-03
Well name:	PCC Backup	Old name:	Not Reported
Yr drilled:	Not Reported	Driller:	Not Reported
Quad_map:	07	Latitude:	213823
Longitude:	1575526	UTM:	Y
Gps:	N	Owner/user:	Hawaii Res Inc
Old number:	383-	Well_type:	Not Reported
Type:	Not Reported	Casing dia:	10
Ground Elev:	11	Well depth:	482
Solid casing Depth:	158	Perf casing Depth:	Not Reported
Use:	SLD	Use Desc:	Sealed
Use year:	93	Water Top Elev:	16.5
Chloride value:	0	Test date:	Not Reported
Pumping Test rate:	Not Reported	Drop in water Lvl:	Not Reported
Chloride Test:	Not Reported	Temperature:	Not Reported
Units:	Not Reported	Pump Capacity:	0
Annual Draft:	Not Reported	Static Water Lvl:	Not Reported
Geology:	TKB	Geology desc:	Tertiary Koolau basalt
Installed:	Not Reported	Last Measured:	Not Reported

Max chlorides:	Not Reported	Max Cl year:	0
Min chlorides:	Not Reported	Min Cl year:	0
Bot_hole depth:	-471	bot_solid depth:	-147
Bot_perf depth:	Not Reported	Well Capacity:	Not Reported
Pump Capacity:	Not Reported	Draft (mgd):	Not Reported
Tax map key:	5-5-006:030	Aquifer code:	30601
Latest head mmt:	0	Cur head mmt:	Not Reported
Current Cl mmt:	Not Reported	Const. Date:	Not Reported
Pump Inst. Date:	Not Reported	Surveyor:	Not Reported
Transmissivity:	0	Pump intake elev:	Not Reported
Pump depth:	Not Reported		

F17
West
1/4 - 1/2 Mile
Higher

HI WELLS 3-3856-003

Wid:	3-3856-003	Island Code:	3
Island Name:	Oahu	Well no:	3856-03
Well name:	Laie Battery	Old name:	Not Reported
Yr drilled:	Not Reported	Driller:	Not Reported
Quad_map:	07	Latitude:	213831
Longitude:	1575602	UTM:	Y
Gps:	N	Owner/user:	Hawaii Res Inc
Old number:	BATT C	Well_type:	Not Reported
Type:	Not Reported	Casing dia:	Not Reported
Ground Elev:	32	Well depth:	Not Reported
Solid casing Depth:	Not Reported	Perf casing Depth:	Not Reported
Use:	OTH	Use Desc:	Other
Use year:	95	Water Top Elev:	0
Chloride value:	0	Test date:	Not Reported
Pumping Test rate:	Not Reported	Drop in water Lvl:	Not Reported
Chloride Test:	Not Reported	Temperature:	Not Reported
Units:	Not Reported	Pump Capacity:	0
Annual Draft:	Not Reported	Static Water Lvl:	Not Reported
Geology:	TKB	Geology desc:	Tertiary Koolau basalt
Installed:	Not Reported	Last Measured:	Not Reported
Max chlorides:	Not Reported	Max Cl year:	0
Min chlorides:	Not Reported	Min Cl year:	0
Bot_hole depth:	Not Reported	bot_solid depth:	Not Reported
Bot_perf depth:	Not Reported	Well Capacity:	Not Reported
Pump Capacity:	Not Reported	Draft (mgd):	Not Reported
Tax map key:	5-5-006:001	Aquifer code:	30601
Latest head mmt:	0	Cur head mmt:	Not Reported
Current Cl mmt:	Not Reported	Const. Date:	Not Reported
Pump Inst. Date:	Not Reported	Surveyor:	Not Reported
Transmissivity:	0	Pump intake elev:	Not Reported
Pump depth:	Not Reported		

F18
West
1/4 - 1/2 Mile
Higher

HI WELLS 3-3856-002

Wid:	3-3856-002	Island Code:	3
Island Name:	Oahu	Well no:	3856-02
Well name:	Laie Battery	Old name:	Not Reported
Yr drilled:	Not Reported	Driller:	Not Reported
Quad_map:	07	Latitude:	213831
Longitude:	1575602	UTM:	Y
Gps:	N	Owner/user:	Hawaii Res Inc
Old number:	BATT B	Well_type:	Not Reported
Type:	Not Reported	Casing dia:	Not Reported
Ground Elev:	32	Well depth:	Not Reported
Solid casing Depth:	Not Reported	Perf casing Depth:	Not Reported
Use:	OTH	Use Desc:	Other
Use year:	95	Water Top Elev:	0
Chloride value:	0	Test date:	Not Reported
Pumping Test rate:	Not Reported	Drop in water Lvl:	Not Reported
Chloride Test:	Not Reported	Temperature:	Not Reported
Units:	Not Reported	Pump Capacity:	0
Annual Draft:	Not Reported	Static Water Lvl:	Not Reported
Geology:	TKB	Geology desc:	Tertiary Koolau basalt
Installed:	Not Reported	Last Measured:	Not Reported
Max chlorides:	Not Reported	Max Cl year:	Not Reported
Min chlorides:	Not Reported	Min Cl year:	Not Reported
Bot_hole depth:	Not Reported	bot_solid depth:	Not Reported
Bot_perf depth:	Not Reported	Well Capacity:	Not Reported
Pump Capacity:	Not Reported	Draft (mgd):	Not Reported
Tax map key:	5-5-006:001	Aquifer code:	30601
Latest head mmt:	0	Cur head mmt:	Not Reported
Current Cl mmt:	Not Reported	Const. Date:	Not Reported
Pump Inst. Date:	Not Reported	Surveyor:	Not Reported
Transmissivity:	0	Pump intake elev:	Not Reported
Pump depth:	Not Reported		

F19
West
1/4 - 1/2 Mile
Higher

HI WELLS 3-3856-004

Wid:	3-3856-004	Island Code:	3
Island Name:	Oahu	Well no:	3856-04
Well name:	Quarry D	Old name:	Not Reported
Yr drilled:	1931	Driller:	KAHUKU PLANTN
Quad_map:	07	Latitude:	213831
Longitude:	1575602	UTM:	Y
Gps:	N	Owner/user:	Hawaii Res Inc
Old number:	BATT D	Well_type:	Not Reported
Type:	Not Reported	Casing dia:	12
Ground Elev:	32	Well depth:	360
Solid casing Depth:	131	Perf casing Depth:	Not Reported
Use:	UNU	Use Desc:	Unused
Use year:	93	Water Top Elev:	0
Chloride value:	0	Test date:	Not Reported
Pumping Test rate:	Not Reported	Drop in water Lvl:	Not Reported
Chloride Test:	Not Reported	Temperature:	Not Reported
Units:	Not Reported	Pump Capacity:	210
Annual Draft:	Not Reported	Static Water Lvl:	Not Reported
Geology:	TKB	Geology desc:	Tertiary Koolau basalt
Installed:	Not Reported	Last Measured:	Not Reported

Max chlorides:	Not Reported	Max Cl year:	0
Min chlorides:	Not Reported	Min Cl year:	0
Bot_hole depth:	-328	bot_solid depth:	-99
Bot_perf depth:	Not Reported	Well Capacity:	Not Reported
Pump Capacity:	.302	Draft (mgd):	Not Reported
Tax map key:	5-5-006:001	Aquifer code:	30601
Latest head mmt:	0	Cur head mmt:	Not Reported
Current Cl mmt:	Not Reported	Const. Date:	01/01/1931 00:00:00
Pump Inst. Date:	Not Reported	Surveyor:	Not Reported
Transmissivity:	0	Pump intake elev:	Not Reported
Pump depth:	Not Reported		

F20
West
1/4 - 1/2 Mile
Higher

HI WELLS 3-3856-006

Wid:	3-3856-006	Island Code:	3
Island Name:	Oahu	Well no:	3856-06
Well name:	Quarry F	Old name:	Not Reported
Yr drilled:	1931	Driller:	KAHUKU PLANTN
Quad_map:	07	Latitude:	213831
Longitude:	1575602	UTM:	Y
Gps:	N	Owner/user:	Hawaii Res Inc
Old number:	BATT F	Well_type:	Not Reported
Type:	Not Reported	Casing dia:	12
Ground Elev:	35	Well depth:	300
Solid casing Depth:	121	Perf casing Depth:	Not Reported
Use:	MUN	Use Desc:	Municipal
Use year:	98	Water Top Elev:	0
Chloride value:	0	Test date:	11/10/1998 00:00:00
Pumping Test rate:	1190	Drop in water Lvl:	25.8
Chloride Test:	50	Temperature:	20.7
Units:	C	Pump Capacity:	1075
Annual Draft:	Not Reported	Static Water Lvl:	15.0
Geology:	TKB	Geology desc:	Tertiary Koolau basalt
Installed:	98	Last Measured:	Not Reported
Max chlorides:	Not Reported	Max Cl year:	0
Min chlorides:	Not Reported	Min Cl year:	0
Bot_hole depth:	-265	bot_solid depth:	-86
Bot_perf depth:	Not Reported	Well Capacity:	46
Pump Capacity:	1.548	Draft (mgd):	Not Reported
Tax map key:	5-5-006:001	Aquifer code:	30601
Latest head mmt:	0	Cur head mmt:	Not Reported
Current Cl mmt:	Not Reported	Const. Date:	01/01/1931 00:00:00
Pump Inst. Date:	08/07/1998 00:00:00	Surveyor:	Not Reported
Transmissivity:	152282	Pump intake elev:	-38
Pump depth:	73		

F21
West
1/4 - 1/2 Mile
Higher

HI WELLS 3-3856-005

Wid:	3-3856-005	Island Code:	3
Island Name:	Oahu	Well no:	3856-05
Well name:	Quarry E	Old name:	Not Reported
Yr drilled:	1931	Driller:	KAHUKU PLANTN
Quad_map:	07	Latitude:	213831
Longitude:	1575602	UTM:	Y
Gps:	N	Owner/user:	Hawaii Res Inc
Old number:	BATT E	Well_type:	Not Reported
Type:	Not Reported	Casing dia:	12
Ground Elev:	36	Well depth:	370
Solid casing Depth:	125	Perf casing Depth:	Not Reported
Use:	MUN	Use Desc:	Municipal
Use year:	98	Water Top Elev:	0
Chloride value:	0	Test date:	11/05/1998 00:00:00
Pumping Test rate:	1197	Drop in water Lvl:	7.39
Chloride Test:	50	Temperature:	20.7
Units:	C	Pump Capacity:	1075
Annual Draft:	Not Reported	Static Water Lvl:	15.0
Geology:	TKB	Geology desc:	Tertiary Koolau basalt
Installed:	98	Last Measured:	Not Reported
Max chlorides:	Not Reported	Max Cl year:	0
Min chlorides:	Not Reported	Min Cl year:	0
Bot_hole depth:	-334	bot_solid depth:	-89
Bot_perf depth:	Not Reported	Well Capacity:	162
Pump Capacity:	1.548	Draft (mgd):	Not Reported
Tax map key:	5-5-006:001	Aquifer code:	30601
Latest head mmt:	0	Cur head mmt:	Not Reported
Current Cl mmt:	Not Reported	Const. Date:	01/01/1931 00:00:00
Pump Inst. Date:	08/07/1998 00:00:00	Surveyor:	Not Reported
Transmissivity:	457650	Pump intake elev:	-37
Pump depth:	73		

F22
West
1/4 - 1/2 Mile
Higher

HI WELLS 3-3856-001

Wid:	3-3856-001	Island Code:	3
Island Name:	Oahu	Well no:	3856-01
Well name:	Laie Battery	Old name:	Not Reported
Yr drilled:	Not Reported	Driller:	Not Reported
Quad_map:	07	Latitude:	213831
Longitude:	1575602	UTM:	Y
Gps:	N	Owner/user:	Hawaii Res Inc
Old number:	BATT A	Well_type:	Not Reported
Type:	Not Reported	Casing dia:	Not Reported
Ground Elev:	32	Well depth:	Not Reported
Solid casing Depth:	Not Reported	Perf casing Depth:	Not Reported
Use:	OTH	Use Desc:	Other
Use year:	95	Water Top Elev:	0
Chloride value:	0	Test date:	Not Reported
Pumping Test rate:	Not Reported	Drop in water Lvl:	Not Reported
Chloride Test:	Not Reported	Temperature:	Not Reported
Units:	Not Reported	Pump Capacity:	0
Annual Draft:	160	Static Water Lvl:	Not Reported
Geology:	TKB	Geology desc:	Tertiary Koolau basalt
Installed:	Not Reported	Last Measured:	Not Reported

Max chlorides:	Not Reported	Max Cl year:	0
Min chlorides:	Not Reported	Min Cl year:	0
Bot_hole depth:	Not Reported	bot_solid depth:	Not Reported
Bot_perf depth:	Not Reported	Well Capacity:	Not Reported
Pump Capacity:	Not Reported	Draft (mgd):	0.4
Tax map key:	5-5-006:001	Aquifer code:	30601
Latest head mmt:	0	Cur head mmt:	Not Reported
Current Cl mmt:	Not Reported	Const. Date:	Not Reported
Pump Inst. Date:	Not Reported	Surveyor:	Not Reported
Transmissivity:	0	Pump intake elev:	Not Reported
Pump depth:	Not Reported		

F23
West **FED USGS** **USGS0226041**
1/4 - 1/2 Mile
Higher

Agency:	USGS	Site ID:	213831157560100
Site Name:	3-3856-01-6 W377A-F		
Dec. Latitude:	21.63877		
Dec. Longitude:	-157.93114		
Coord Sys:	NAD83		
State:	HI		
County:	Honolulu County		
Altitude:	32.00		
Hydrologic code:	20060000		
Topographic:	Not Reported		
Site Type:	Ground-water other than Spring		
Const Date:	Not Reported	Inven Date:	Not Reported
Well Type:	Multiple wells (a group of wells that are pumped through a single header)		
Primary Aquifer:	Not Reported		
Aquifer type:	Not Reported		
Well depth:	Not Reported		
Hole depth:	Not Reported	Source:	Not Reported
Project no:	Not Reported		

Ground-water levels, Number of Measurements: 0

F24
West **FED USGS** **USGS0226042**
1/4 - 1/2 Mile
Higher

Agency:	USGS	Site ID:	213831157560200
Site Name:	3-3856-01 W377-A		
Dec. Latitude:	21.63877		
Dec. Longitude:	-157.93114		
Coord Sys:	NAD83		
State:	HI		
County:	Honolulu County		
Altitude:	32.00		
Hydrologic code:	20060000		
Topographic:	Not Reported		
Site Type:	Ground-water other than Spring		
Const Date:	Not Reported	Inven Date:	Not Reported
Well Type:	Single well, other than collector or Ranney type		

Primary Aquifer:	Not Reported		
Aquifer type:	Not Reported		
Well depth:	Not Reported		
Hole depth:	Not Reported	Source:	Not Reported
Project no:	Not Reported		

Ground-water levels, Number of Measurements: 0

F25
West
1/4 - 1/2 Mile
Higher

FED USGS **USGS0226043**

Agency:	USGS	Site ID:	213831157560201
Site Name:	3-3856-06 W377-F		
Dec. Latitude:	21.63877		
Dec. Longitude:	-157.93114		
Coord Sys:	NAD83		
State:	HI		
County:	Honolulu County		
Altitude:	32.00		
Hydrologic code:	20060000		
Topographic:	Not Reported		
Site Type:	Ground-water other than Spring		
Const Date:	19310101	Inven Date:	Not Reported
Well Type:	Single well, other than collector or Ranney type		
Primary Aquifer:	Not Reported		
Aquifer type:	Not Reported		
Well depth:	300		
Hole depth:	Not Reported	Source:	Not Reported
Project no:	Not Reported		

Ground-water levels, Number of Measurements: 0

F26
West
1/4 - 1/2 Mile
Higher

FED USGS **USGS0226046**

Agency:	USGS	Site ID:	213831157560204
Site Name:	3-3856-04 W377-D		
Dec. Latitude:	21.63877		
Dec. Longitude:	-157.93114		
Coord Sys:	NAD83		
State:	HI		
County:	Honolulu County		
Altitude:	32.00		
Hydrologic code:	20060000		
Topographic:	Not Reported		
Site Type:	Ground-water other than Spring		
Const Date:	19310101	Inven Date:	Not Reported
Well Type:	Single well, other than collector or Ranney type		
Primary Aquifer:	Not Reported		
Aquifer type:	Not Reported		
Well depth:	360		
Hole depth:	Not Reported	Source:	Not Reported
Project no:	Not Reported		

Ground-water levels, Number of Measurements: 0

Map ID Direction Distance Elevation	Database	EDR ID Number
F27 **West** **1/4 - 1/2 Mile** **Higher**	**FED USGS**	**USGS0226045**

Agency:	USGS	Site ID:	213831157560203
Site Name:	3-3856-03 W377-C		
Dec. Latitude:	21.63877		
Dec. Longitude:	-157.93114		
Coord Sys:	NAD83		
State:	HI		
County:	Honolulu County		
Altitude:	32.00		
Hydrologic code:	20060000		
Topographic:	Not Reported		
Site Type:	Ground-water other than Spring		
Const Date:	Not Reported	Inven Date:	Not Reported
Well Type:	Single well, other than collector or Ranney type		
Primary Aquifer:	Not Reported		
Aquifer type:	Not Reported		
Well depth:	Not Reported		
Hole depth:	Not Reported	Source:	Not Reported
Project no:	Not Reported		

Ground-water levels, Number of Measurements: 0

F28 **West** **1/4 - 1/2 Mile** **Higher**	**FED USGS**	**USGS0226044**

Agency:	USGS	Site ID:	213831157560202
Site Name:	3-3856-02 W377-B		
Dec. Latitude:	21.63877		
Dec. Longitude:	-157.93114		
Coord Sys:	NAD83		
State:	HI		
County:	Honolulu County		
Altitude:	32.00		
Hydrologic code:	20060000		
Topographic:	Not Reported		
Site Type:	Ground-water other than Spring		
Const Date:	Not Reported	Inven Date:	Not Reported
Well Type:	Single well, other than collector or Ranney type		
Primary Aquifer:	Not Reported		
Aquifer type:	Not Reported		
Well depth:	Not Reported		
Hole depth:	Not Reported	Source:	Not Reported
Project no:	Not Reported		

Ground-water levels, Number of Measurements: 0

F29 **West** **1/4 - 1/2 Mile** **Higher**	**FED USGS**	**USGS0226047**

Agency:	USGS	Site ID:	213831157560205
Site Name:	3-3856-05 W377-E		
Dec. Latitude:	21.63877		
Dec. Longitude:	-157.93114		
Coord Sys:	NAD83		
State:	HI		
County:	Honolulu County		
Altitude:	32.00		
Hydrologic code:	20060000		
Topographic:	Not Reported		
Site Type:	Ground-water other than Spring		
Const Date:	19310101	Inven Date:	Not Reported
Well Type:	Single well, other than collector or Ranney type		
Primary Aquifer:	Not Reported		
Aquifer type:	Not Reported		
Well depth:	370		
Hole depth:	Not Reported	Source:	Not Reported
Project no:	Not Reported		

Ground-water levels, Number of Measurements: 0

G30
North
1/4 - 1/2 Mile
Lower

HI WELLS 3-3855-006

Wid:	3-3855-006	Island Code:	3
Island Name:	Oahu	Well no:	3855-06
Well name:	BYU Campus	Old name:	Not Reported
Yr drilled:	1890	Driller:	MCCANDLESS
Quad_map:	07	Latitude:	213846
Longitude:	1575546	UTM:	Y
Gps:	N	Owner/user:	Laie Water Co
Old number:	Not Reported	Well_type:	Not Reported
Type:	Not Reported	Casing dia:	6
Ground Elev:	9	Well depth:	288
Solid casing Depth:	166	Perf casing Depth:	Not Reported
Use:	DOM	Use Desc:	Domestic
Use year:	Not Reported	Water Top Elev:	16.1
Chloride value:	0	Test date:	Not Reported
Pumping Test rate:	Not Reported	Drop in water Lvl:	Not Reported
Chloride Test:	Not Reported	Temperature:	Not Reported
Units:	Not Reported	Pump Capacity:	210
Annual Draft:	6986	Static Water Lvl:	Not Reported
Geology:	TKB	Geology desc:	Tertiary Koolau basalt
Installed:	Not Reported	Last Measured:	Not Reported
Max chlorides:	Not Reported	Max Cl year:	0
Min chlorides:	Not Reported	Min Cl year:	0
Bot_hole depth:	-279	bot_solid depth:	-157
Bot_perf depth:	Not Reported	Well Capacity:	Not Reported
Pump Capacity:	.302	Draft (mgd):	19.1
Tax map key:	5-5-006:005	Aquifer code:	30601
Latest head mmt:	0	Cur head mmt:	Not Reported
Current Cl mmt:	Not Reported	Const. Date:	01/01/1890 00:00:00
Pump Inst. Date:	Not Reported	Surveyor:	Not Reported
Transmissivity:	0	Pump intake elev:	Not Reported
Pump depth:	Not Reported		

Map ID
Direction
Distance
Elevation

Map ID / Direction / Distance / Elevation			Database	EDR ID Number
G31 North 1/4 - 1/2 Mile Lower			**FED USGS**	**USGS0225982**

Agency:	USGS	Site ID:	213846157554701
Site Name:	3-3855-06 W374		
Dec. Latitude:	21.64293		
Dec. Longitude:	-157.92697		
Coord Sys:	NAD83		
State:	HI		
County:	Honolulu County		
Altitude:	9.00		
Hydrologic code:	20060000		
Topographic:	Not Reported		
Site Type:	Ground-water other than Spring		
Const Date:	18900101	Inven Date:	Not Reported
Well Type:	Single well, other than collector or Ranney type		
Primary Aquifer:	Not Reported		
Aquifer type:	Not Reported		
Well depth:	288		
Hole depth:	Not Reported	Source:	Not Reported
Project no:	Not Reported		

Ground-water levels, Number of Measurements: 0

Map ID / Direction / Distance / Elevation			Database	EDR ID Number
32 NE 1/4 - 1/2 Mile Lower			**HI WELLS**	**3-3855-012**

Wid:	3-3855-012	Island Code:	3
Island Name:	Oahu	Well no:	3855-12
Well name:	Pahumoa	Old name:	Not Reported
Yr drilled:	Not Reported	Driller:	Not Reported
Quad_map:	07	Latitude:	213842
Longitude:	1575530	UTM:	Y
Gps:	N	Owner/user:	Nihipali Gn
Old number:	Not Reported	Well_type:	DUG
Type:	Dug Well	Casing dia:	30
Ground Elev:	Not Reported	Well depth:	12
Solid casing Depth:	10	Perf casing Depth:	Not Reported
Use:	IRR	Use Desc:	Irrigation
Use year:	91	Water Top Elev:	0
Chloride value:	0	Test date:	Not Reported
Pumping Test rate:	Not Reported	Drop in water Lvl:	Not Reported
Chloride Test:	Not Reported	Temperature:	Not Reported
Units:	Not Reported	Pump Capacity:	0
Annual Draft:	Not Reported	Static Water Lvl:	Not Reported
Geology:	Not Reported	Geology desc:	Not Reported
Installed:	Not Reported	Last Measured:	Not Reported

Max chlorides:	Not Reported	Max Cl year:	0
Min chlorides:	Not Reported	Min Cl year:	0
Bot_hole depth:	Not Reported	bot_solid depth:	Not Reported
Bot_perf depth:	Not Reported	Well Capacity:	Not Reported
Pump Capacity:	Not Reported	Draft (mgd):	Not Reported
Tax map key:	5-5-001:044	Aquifer code:	30601
Latest head mmt:	0	Cur head mmt:	Not Reported
Current Cl mmt:	Not Reported	Const. Date:	Not Reported
Pump Inst. Date:	Not Reported	Surveyor:	Not Reported
Transmissivity:	0	Pump intake elev:	Not Reported
Pump depth:	Not Reported		

H33
ENE
1/4 - 1/2 Mile
Lower

HI WELLS 3-3855-009

Wid:	3-3855-009	Island Code:	3
Island Name:	Oahu	Well no:	3855-09
Well name:	Pcc Lagoon	Old name:	Not Reported
Yr drilled:	1890	Driller:	MCCANDLESS
Quad_map:	07	Latitude:	213837
Longitude:	1575524	UTM:	Y
Gps:	N	Owner/user:	Islands Found
Old number:	Not Reported	Well_type:	Not Reported
Type:	Not Reported	Casing dia:	10
Ground Elev:	7	Well depth:	469
Solid casing Depth:	247	Perf casing Depth:	Not Reported
Use:	OTH	Use Desc:	Other
Use year:	74	Water Top Elev:	18.4
Chloride value:	303	Test date:	Not Reported
Pumping Test rate:	Not Reported	Drop in water Lvl:	Not Reported
Chloride Test:	Not Reported	Temperature:	Not Reported
Units:	Not Reported	Pump Capacity:	0
Annual Draft:	90	Static Water Lvl:	Not Reported
Geology:	TKB	Geology desc:	Tertiary Koolau basalt
Installed:	Not Reported	Last Measured:	Not Reported
Max chlorides:	Not Reported	Max Cl year:	0
Min chlorides:	Not Reported	Min Cl year:	0
Bot_hole depth:	-462	bot_solid depth:	-240
Bot_perf depth:	Not Reported	Well Capacity:	Not Reported
Pump Capacity:	Not Reported	Draft (mgd):	0.2
Tax map key:	5-5-006:028	Aquifer code:	30601
Latest head mmt:	0	Cur head mmt:	Not Reported
Current Cl mmt:	Not Reported	Const. Date:	01/01/1890 00:00:00
Pump Inst. Date:	Not Reported	Surveyor:	Not Reported
Transmissivity:	0	Pump intake elev:	Not Reported
Pump depth:	Not Reported		

H34
ENE
1/4 - 1/2 Mile
Lower

FED USGS USGS0225977

Agency:	USGS	Site ID:	213837157552401
Site Name:	3-3855-09 W378		
Dec. Latitude:	21.64043		
Dec. Longitude:	-157.92058		
Coord Sys:	NAD83		
State:	HI		
County:	Honolulu County		
Altitude:	11.00		
Hydrologic code:	20060000		
Topographic:	Not Reported		
Site Type:	Ground-water other than Spring		
Const Date:	18900101	Inven Date:	Not Reported
Well Type:	Single well, other than collector or Ranney type		
Primary Aquifer:	Not Reported		
Aquifer type:	Not Reported		
Well depth:	494		
Hole depth:	Not Reported	Source:	Not Reported
Project no:	Not Reported		

Ground-water levels, Number of Measurements: 0

I35
SSE
1/4 - 1/2 Mile
Lower

FED USGS **USGS0225971**

Agency:	USGS	Site ID:	213807157553601
Site Name:	3-3855-11		
Dec. Latitude:	21.6321		
Dec. Longitude:	-157.92392		
Coord Sys:	NAD83		
State:	HI		
County:	Honolulu County		
Altitude:	15.00		
Hydrologic code:	20060000		
Topographic:	Not Reported		
Site Type:	Ground-water other than Spring		
Const Date:	19761101	Inven Date:	Not Reported
Well Type:	Single well, other than collector or Ranney type		
Primary Aquifer:	Not Reported		
Aquifer type:	Not Reported		
Well depth:	251		
Hole depth:	Not Reported	Source:	Not Reported
Project no:	Not Reported		

Ground-water levels, Number of Measurements: 0

I36
SSE
1/4 - 1/2 Mile
Lower

HI WELLS **3-3855-011**

Wid:	3-3855-011	Island Code:	3
Island Name:	Oahu	Well no:	3855-11
Well name:	Caldeira	Old name:	Not Reported
Yr drilled:	1977	Driller:	CONTINENTAL
Quad_map:	07	Latitude:	213807
Longitude:	1575536	UTM:	Y
Gps:	N	Owner/user:	Caldeira R
Old number:	Not Reported	Well_type:	Not Reported
Type:	Not Reported	Casing dia:	4
Ground Elev:	Not Reported	Well depth:	251
Solid casing Depth:	Not Reported	Perf casing Depth:	Not Reported
Use:	DOM	Use Desc:	Domestic
Use year:	84	Water Top Elev:	0
Chloride value:	0	Test date:	Not Reported
Pumping Test rate:	Not Reported	Drop in water Lvl:	Not Reported
Chloride Test:	Not Reported	Temperature:	Not Reported
Units:	Not Reported	Pump Capacity:	40
Annual Draft:	Not Reported	Static Water Lvl:	Not Reported
Geology:	Not Reported	Geology desc:	Not Reported
Installed:	Not Reported	Last Measured:	Not Reported
Max chlorides:	Not Reported	Max Cl year:	0
Min chlorides:	Not Reported	Min Cl year:	0
Bot_hole depth:	Not Reported	bot_solid depth:	Not Reported
Bot_perf depth:	Not Reported	Well Capacity:	Not Reported
Pump Capacity:	.057	Draft (mgd):	Not Reported
Tax map key:	5-5-001:060	Aquifer code:	30601
Latest head mmt:	0	Cur head mmt:	Not Reported
Current Cl mmt:	Not Reported	Const. Date:	01/01/1977 00:00:00
Pump Inst. Date:	Not Reported	Surveyor:	Not Reported
Transmissivity:	0	Pump intake elev:	Not Reported
Pump depth:	Not Reported		

I37
SSE
1/4 - 1/2 Mile
Lower

HI WELLS 3-3855-013

Wid:	3-3855-013	Island Code:	3
Island Name:	Oahu	Well no:	3855-13
Well name:	Chapman	Old name:	Not Reported
Yr drilled:	1998	Driller:	ROSCOE MOSS
Quad_map:	07	Latitude:	213807
Longitude:	1575534	UTM:	Y
Gps:	N	Owner/user:	Chapman E L
Old number:	Not Reported	Well_type:	PER
Type:	Percussion Drill	Casing dia:	6
Ground Elev:	17	Well depth:	220
Solid casing Depth:	146	Perf casing Depth:	Not Reported
Use:	UNU	Use Desc:	Unused
Use year:	98	Water Top Elev:	0
Chloride value:	0	Test date:	10/23/1998 00:00:00
Pumping Test rate:	82	Drop in water Lvl:	8.83
Chloride Test:	60	Temperature:	20.5
Units:	C	Pump Capacity:	0
Annual Draft:	Not Reported	Static Water Lvl:	16.60
Geology:	Not Reported	Geology desc:	Not Reported
Installed:	Not Reported	Last Measured:	Not Reported

Max chlorides:	Not Reported	Max Cl year:	Not Reported
Min chlorides:	Not Reported	Min Cl year:	Not Reported
Bot_hole depth:	-203	bot_solid depth:	-129
Bot_perf depth:	Not Reported	Well Capacity:	9
Pump Capacity:	Not Reported	Draft (mgd):	Not Reported
Tax map key:	5-5-001:047	Aquifer code:	30601
Latest head mmt:	0	Cur head mmt:	Not Reported
Current Cl mmt:	Not Reported	Const. Date:	11/25/1998 00:00:00
Pump Inst. Date:	Not Reported	Surveyor:	JAMES THOMPSON
Transmissivity:	39963	Pump intake elev:	Not Reported
Pump depth:	Not Reported		

I38
SSE
1/4 - 1/2 Mile
Lower

FED USGS **USGS0225970**

Agency:	USGS	Site ID:	213806157553301
Site Name:	3-3855-05 W385		
Dec. Latitude:	21.63182		
Dec. Longitude:	-157.92308		
Coord Sys:	NAD83		
State:	HI		
County:	Honolulu County		
Altitude:	18.00		
Hydrologic code:	20060000		
Topographic:	Not Reported		
Site Type:	Ground-water other than Spring		
Const Date:	Not Reported	Inven Date:	Not Reported
Well Type:	Single well, other than collector or Ranney type		
Primary Aquifer:	Not Reported		
Aquifer type:	Not Reported		
Well depth:	Not Reported		
Hole depth:	Not Reported	Source:	Not Reported
Project no:	Not Reported		

Ground-water levels, Number of Measurements: 0

I39
SSE
1/4 - 1/2 Mile
Lower

HI WELLS **3-3855-005**

Wid:	3-3855-005	Island Code:	3
Island Name:	Oahu	Well no:	3855-05
Well name:	Laie	Old name:	Not Reported
Yr drilled:	Not Reported	Driller:	Not Reported
Quad_map:	07	Latitude:	213805
Longitude:	1575533	UTM:	Y
Gps:	N	Owner/user:	White R E
Old number:	385-	Well_type:	Not Reported
Type:	Not Reported	Casing dia:	12
Ground Elev:	18	Well depth:	Not Reported

Solid casing Depth:	Not Reported	Perf casing Depth:	Not Reported
Use:	DOM	Use Desc:	Domestic
Use year:	93	Water Top Elev:	17.4
Chloride value:	0	Test date:	Not Reported
Pumping Test rate:	Not Reported	Drop in water Lvl:	Not Reported
Chloride Test:	Not Reported	Temperature:	20.8
Units:	C	Pump Capacity:	0
Annual Draft:	Not Reported	Static Water Lvl:	Not Reported
Geology:	Not Reported	Geology desc:	Not Reported
Installed:	Not Reported	Last Measured:	Not Reported
Max chlorides:	Not Reported	Max Cl year:	0
Min chlorides:	01/01/1994 00:00:00	Min Cl year:	0
Bot_hole depth:	Not Reported	bot_solid depth:	Not Reported
Bot_perf depth:	Not Reported	Well Capacity:	Not Reported
Pump Capacity:	Not Reported	Draft (mgd):	Not Reported
Tax map key:	5-5-001:021	Aquifer code:	30601
Latest head mmt:	0	Cur head mmt:	Not Reported
Current Cl mmt:	Not Reported	Const. Date:	Not Reported
Pump Inst. Date:	Not Reported	Surveyor:	Not Reported
Transmissivity:	0	Pump intake elev:	Not Reported
Pump depth:	Not Reported		

J40
SSE
1/2 - 1 Mile
Higher

HI WELLS 3-3755-008

Wid:	3-3755-008	Island Code:	3
Island Name:	Oahu	Well no:	3755-08
Well name:	Laie-Akana	Old name:	Not Reported
Yr drilled:	1990	Driller:	P R DRILLING
Quad_map:	07	Latitude:	213759
Longitude:	1575536	UTM:	Y
Gps:	N	Owner/user:	Akana W
Old number:	Not Reported	Well_type:	ROT
Type:	Rotary Drill	Casing dia:	4
Ground Elev:	9	Well depth:	150
Solid casing Depth:	130	Perf casing Depth:	Not Reported
Use:	DOM	Use Desc:	Domestic
Use year:	90	Water Top Elev:	13.4
Chloride value:	0	Test date:	10/12/1990 00:00:00
Pumping Test rate:	103	Drop in water Lvl:	66.9
Chloride Test:	75	Temperature:	Not Reported
Units:	Not Reported	Pump Capacity:	20
Annual Draft:	Not Reported	Static Water Lvl:	Not Reported
Geology:	Not Reported	Geology desc:	Not Reported
Installed:	90	Last Measured:	Not Reported
Max chlorides:	Not Reported	Max Cl year:	0
Min chlorides:	Not Reported	Min Cl year:	0
Bot_hole depth:	-141	bot_solid depth:	-121
Bot_perf depth:	Not Reported	Well Capacity:	2
Pump Capacity:	.028	Draft (mgd):	Not Reported
Tax map key:	5-5-001:019	Aquifer code:	30601
Latest head mmt:	0	Cur head mmt:	Not Reported
Current Cl mmt:	Not Reported	Const. Date:	10/25/1990 00:00:00
Pump Inst. Date:	11/25/1990 00:00:00	Surveyor:	Not Reported
Transmissivity:	0	Pump intake elev:	Not Reported
Pump depth:	Not Reported		

Map ID Direction Distance Elevation	Database	EDR ID Number
J41 **SSE** **1/2 - 1 Mile** **Lower**	**HI WELLS**	**3-3755-009**

Wid:	3-3755-009	Island Code:	3
Island Name:	Oahu	Well no:	3755-09
Well name:	Laie-Almieda	Old name:	Not Reported
Yr drilled:	1997	Driller:	GEOLABS HAW
Quad_map:	07	Latitude:	213759
Longitude:	1575533	UTM:	Y
Gps:	N	Owner/user:	Almeida A
Old number:	Not Reported	Well_type:	ROT
Type:	Rotary Drill	Casing dia:	4
Ground Elev:	14	Well depth:	190
Solid casing Depth:	175	Perf casing Depth:	190
Use:	DOM	Use Desc:	Domestic
Use year:	97	Water Top Elev:	17.4
Chloride value:	30	Test date:	05/16/1997 00:00:00
Pumping Test rate:	22	Drop in water Lvl:	1.5
Chloride Test:	30	Temperature:	22.1
Units:	C	Pump Capacity:	15
Annual Draft:	Not Reported	Static Water Lvl:	Not Reported
Geology:	Not Reported	Geology desc:	Not Reported
Installed:	97	Last Measured:	Not Reported
Max chlorides:	Not Reported	Max Cl year:	0
Min chlorides:	Not Reported	Min Cl year:	0
Bot_hole depth:	-176	bot_solid depth:	-161
Bot_perf depth:	-176	Well Capacity:	15
Pump Capacity:	.021	Draft (mgd):	Not Reported
Tax map key:	5-5-001:020	Aquifer code:	30601
Latest head mmt:	0	Cur head mmt:	Not Reported
Current Cl mmt:	Not Reported	Const. Date:	06/06/1997 00:00:00
Pump Inst. Date:	07/19/1997 00:00:00	Surveyor:	HARRY H S AU
Transmissivity:	0	Pump intake elev:	Not Reported
Pump depth:	Not Reported		

K42 **South** **1/2 - 1 Mile** **Higher**	**FED USGS**	**USGS0225968**

Agency:	USGS	Site ID:	213755157554001
Site Name:	3-3755-01 W386		
Dec. Latitude:	21.62877		
Dec. Longitude:	-157.92503		
Coord Sys:	NAD83		
State:	HI		
County:	Honolulu County		
Altitude:	22.00		
Hydrologic code:	20060000		
Topographic:	Not Reported		
Site Type:	Ground-water other than Spring		
Const Date:	Not Reported	Inven Date:	Not Reported
Well Type:	Single well, other than collector or Ranney type		

Primary Aquifer:	Not Reported		
Aquifer type:	Not Reported		
Well depth:	Not Reported		
Hole depth:	Not Reported	Source:	Not Reported
Project no:	Not Reported		

Ground-water levels, Number of Measurements: 0

K43
South
1/2 - 1 Mile
Higher

HI WELLS 3-3755-001

Wid:	3-3755-001	Island Code:	3
Island Name:	Oahu	Well no:	3755-01
Well name:	Laie	Old name:	Not Reported
Yr drilled:	Not Reported	Driller:	Not Reported
Quad_map:	07	Latitude:	213755
Longitude:	1575540	UTM:	Y
Gps:	N	Owner/user:	Kahuku Plantn
Old number:	386-	Well_type:	Not Reported
Type:	Not Reported	Casing dia:	Not Reported
Ground Elev:	22	Well depth:	Not Reported
Solid casing Depth:	Not Reported	Perf casing Depth:	Not Reported
Use:	OTH	Use Desc:	Other
Use year:	95	Water Top Elev:	0
Chloride value:	0	Test date:	Not Reported
Pumping Test rate:	Not Reported	Drop in water Lvl:	Not Reported
Chloride Test:	Not Reported	Temperature:	Not Reported
Units:	Not Reported	Pump Capacity:	0
Annual Draft:	Not Reported	Static Water Lvl:	Not Reported
Geology:	Not Reported	Geology desc:	Not Reported
Installed:	Not Reported	Last Measured:	Not Reported
Max chlorides:	Not Reported	Max Cl year:	0
Min chlorides:	Not Reported	Min Cl year:	0
Bot_hole depth:	Not Reported	bot_solid depth:	Not Reported
Bot_perf depth:	Not Reported	Well Capacity:	Not Reported
Pump Capacity:	Not Reported	Draft (mgd):	Not Reported
Tax map key:	5-5-006:001	Aquifer code:	30601
Latest head mmt:	0	Cur head mmt:	Not Reported
Current Cl mmt:	Not Reported	Const. Date:	Not Reported
Pump Inst. Date:	Not Reported	Surveyor:	Not Reported
Transmissivity:	0	Pump intake elev:	Not Reported
Pump depth:	Not Reported		

L44
SW
1/2 - 1 Mile
Higher

HI WELLS 3-3856-009

Wid:	3-3856-009	Island Code:	3
Island Name:	Oahu	Well no:	3856-09
Well name:	Wailele	Old name:	Not Reported
Yr drilled:	1982	Driller:	FRED PAGE
Quad_map:	07	Latitude:	213803
Longitude:	1575607	UTM:	Y
Gps:	N	Owner/user:	Honolulu Bws
Old number:	Not Reported	Well_type:	Not Reported
Type:	Not Reported	Casing dia:	14
Ground Elev:	109	Well depth:	281
Solid casing Depth:	160	Perf casing Depth:	Not Reported
Use:	UNU	Use Desc:	Unused
Use year:	87	Water Top Elev:	17.4
Chloride value:	0	Test date:	Not Reported
Pumping Test rate:	1300	Drop in water Lvl:	3.5
Chloride Test:	34	Temperature:	21.2
Units:	C	Pump Capacity:	0
Annual Draft:	Not Reported	Static Water Lvl:	Not Reported
Geology:	TKB	Geology desc:	Tertiary Koolau basalt
Installed:	Not Reported	Last Measured:	Not Reported
Max chlorides:	Not Reported	Max Cl year:	0
Min chlorides:	Not Reported	Min Cl year:	0
Bot_hole depth:	-172	bot_solid depth:	-51
Bot_perf depth:	Not Reported	Well Capacity:	371
Pump Capacity:	Not Reported	Draft (mgd):	Not Reported
Tax map key:	5-5-007:001	Aquifer code:	30601
Latest head mmt:	0	Cur head mmt:	Not Reported
Current Cl mmt:	Not Reported	Const. Date:	09/01/1982 00:00:00
Pump Inst. Date:	Not Reported	Surveyor:	Not Reported
Transmissivity:	0	Pump intake elev:	Not Reported
Pump depth:	Not Reported		

K45
South
1/2 - 1 Mile
Higher

HI WELLS 3-3755-006

Wid:	3-3755-006	Island Code:	3
Island Name:	Oahu	Well no:	3755-06
Well name:	Laie-Truck Farm	Old name:	Not Reported
Yr drilled:	1932	Driller:	KAHUKU PLANTN
Quad_map:	07	Latitude:	213753
Longitude:	1575537	UTM:	Y
Gps:	N	Owner/user:	Hawaii Res Inc
Old number:	387-	Well_type:	Not Reported
Type:	Not Reported	Casing dia:	12
Ground Elev:	20	Well depth:	315
Solid casing Depth:	146	Perf casing Depth:	Not Reported
Use:	IRR	Use Desc:	Irrigation
Use year:	Not Reported	Water Top Elev:	0
Chloride value:	69	Test date:	Not Reported
Pumping Test rate:	Not Reported	Drop in water Lvl:	Not Reported
Chloride Test:	Not Reported	Temperature:	Not Reported
Units:	Not Reported	Pump Capacity:	0
Annual Draft:	137	Static Water Lvl:	Not Reported
Geology:	TKB	Geology desc:	Tertiary Koolau basalt
Installed:	Not Reported	Last Measured:	Not Reported

Max chlorides:	Not Reported	Max Cl year:	0
Min chlorides:	Not Reported	Min Cl year:	0
Bot_hole depth:	-295	bot_solid depth:	-126
Bot_perf depth:	Not Reported	Well Capacity:	Not Reported
Pump Capacity:	Not Reported	Draft (mgd):	0.4
Tax map key:	5-5-006:011	Aquifer code:	30601
Latest head mmt:	0	Cur head mmt:	Not Reported
Current Cl mmt:	Not Reported	Const. Date:	01/01/1932 00:00:00
Pump Inst. Date:	Not Reported	Surveyor:	Not Reported
Transmissivity:	0	Pump intake elev:	Not Reported
Pump depth:	Not Reported		

K46
South
1/2 - 1 Mile
Higher

FED USGS **USGS0226039**

Agency:	USGS	Site ID:	213753157553701
Site Name:	3-3755-06 W387		
Dec. Latitude:	21.62821		
Dec. Longitude:	-157.92419		
Coord Sys:	NAD83		
State:	HI		
County:	Honolulu County		
Altitude:	20.00		
Hydrologic code:	20060000		
Topographic:	Not Reported		
Site Type:	Ground-water other than Spring		
Const Date:	19320101	Inven Date:	Not Reported
Well Type:	Single well, other than collector or Ranney type		
Primary Aquifer:	Not Reported		
Aquifer type:	Not Reported		
Well depth:	315		
Hole depth:	Not Reported	Source:	Not Reported
Project no:	Not Reported		

Ground-water levels, Number of Measurements: 0

M47
North
1/2 - 1 Mile
Lower

FED USGS **USGS0226053**

Agency:	USGS	Site ID:	213904157554601
Site Name:	3-3955-02 W372		
Dec. Latitude:	21.64793		
Dec. Longitude:	-157.92669		
Coord Sys:	NAD83		
State:	HI		
County:	Honolulu County		
Altitude:	10.00		
Hydrologic code:	20060000		
Topographic:	Not Reported		
Site Type:	Ground-water other than Spring		
Const Date:	18900101	Inven Date:	Not Reported
Well Type:	Single well, other than collector or Ranney type		

Primary Aquifer:	Not Reported		
Aquifer type:	Not Reported		
Well depth:	529		
Hole depth:	Not Reported	Source:	Not Reported
Project no:	Not Reported		

Ground-water levels, Number of Measurements: 0

M48
North
1/2 - 1 Mile
Lower

HI WELLS **3-3955-002**

Wid:	3-3955-002	Island Code:	3
Island Name:	Oahu	Well no:	3955-02
Well name:	Laie	Old name:	Not Reported
Yr drilled:	1890	Driller:	MCCANDLESS
Quad_map:	07	Latitude:	213904
Longitude:	1575546	UTM:	Y
Gps:	N	Owner/user:	Savaiigaea T
Old number:	372-	Well_type:	Not Reported
Type:	Not Reported	Casing dia:	8
Ground Elev:	10	Well depth:	529
Solid casing Depth:	215	Perf casing Depth:	Not Reported
Use:	IRR	Use Desc:	Irrigation
Use year:	74	Water Top Elev:	0
Chloride value:	0	Test date:	Not Reported
Pumping Test rate:	Not Reported	Drop in water Lvl:	Not Reported
Chloride Test:	Not Reported	Temperature:	Not Reported
Units:	Not Reported	Pump Capacity:	0
Annual Draft:	Not Reported	Static Water Lvl:	Not Reported
Geology:	TKB	Geology desc:	Tertiary Koolau basalt
Installed:	Not Reported	Last Measured:	Not Reported
Max chlorides:	Not Reported	Max Cl year:	0
Min chlorides:	Not Reported	Min Cl year:	0
Bot_hole depth:	-519	bot_solid depth:	-205
Bot_perf depth:	Not Reported	Well Capacity:	Not Reported
Pump Capacity:	Not Reported	Draft (mgd):	Not Reported
Tax map key:	5-5-012:054	Aquifer code:	30601
Latest head mmt:	0	Cur head mmt:	Not Reported
Current Cl mmt:	Not Reported	Const. Date:	01/01/1890 00:00:00
Pump Inst. Date:	Not Reported	Surveyor:	Not Reported
Transmissivity:	0	Pump intake elev:	Not Reported
Pump depth:	Not Reported		

L49
SW
1/2 - 1 Mile
Higher

FED USGS **USGS0225969**

Agency:	USGS	Site ID:	213801157561001
Site Name:	3-3856-09 LAIE		
Dec. Latitude:	21.63043		
Dec. Longitude:	-157.93336		
Coord Sys:	NAD83		
State:	HI		
County:	Honolulu County		
Altitude:	109.00		
Hydrologic code:	20060000		
Topographic:	Hillside (slope)		
Site Type:	Ground-water other than Spring		
Const Date:	19820901	Inven Date:	Not Reported
Well Type:	Single well, other than collector or Ranney type		
Primary Aquifer:	Not Reported		
Aquifer type:	Not Reported		
Well depth:	280		
Hole depth:	280	Source:	Not Reported
Project no:	Not Reported		

Ground-water levels, Number of Measurements: 1

Date	Feet below Surface	Feet to Sealevel
1982-10-04	91.60	

N50
NW
1/2 - 1 Mile
Lower

FED USGS **USGS0226049**

Agency:	USGS	Site ID:	213900157561301
Site Name:	3-3956-06 W368		
Dec. Latitude:	21.64682		
Dec. Longitude:	-157.93419		
Coord Sys:	NAD83		
State:	HI		
County:	Honolulu County		
Altitude:	4.00		
Hydrologic code:	20060000		
Topographic:	Not Reported		
Site Type:	Ground-water other than Spring		
Const Date:	18900101	Inven Date:	Not Reported
Well Type:	Single well, other than collector or Ranney type		
Primary Aquifer:	Not Reported		
Aquifer type:	Not Reported		
Well depth:	216		
Hole depth:	Not Reported	Source:	Not Reported
Project no:	Not Reported		

Ground-water levels, Number of Measurements: 0

N51
NW
1/2 - 1 Mile
Lower

HI WELLS **3-3956-006**

Wid:	3-3956-006	Island Code:	3
Island Name:	Oahu	Well no:	3956-06
Well name:	Laie	Old name:	Not Reported
Yr drilled:	1890	Driller:	MCCANDLESS
Quad_map:	07	Latitude:	213900
Longitude:	1575613	UTM:	Y
Gps:	N	Owner/user:	Hawaii Res Inc
Old number:	368-	Well_type:	Not Reported
Type:	Not Reported	Casing dia:	7
Ground Elev:	4	Well depth:	216
Solid casing Depth:	90	Perf casing Depth:	Not Reported
Use:	SLD	Use Desc:	Sealed
Use year:	57	Water Top Elev:	13.3
Chloride value:	42	Test date:	Not Reported
Pumping Test rate:	Not Reported	Drop in water Lvl:	Not Reported
Chloride Test:	Not Reported	Temperature:	Not Reported
Units:	Not Reported	Pump Capacity:	0
Annual Draft:	Not Reported	Static Water Lvl:	Not Reported
Geology:	Not Reported	Geology desc:	Not Reported
Installed:	Not Reported	Last Measured:	Not Reported
Max chlorides:	Not Reported	Max Cl year:	0
Min chlorides:	Not Reported	Min Cl year:	0
Bot_hole depth:	-212	bot_solid depth:	-86
Bot_perf depth:	Not Reported	Well Capacity:	Not Reported
Pump Capacity:	Not Reported	Draft (mgd):	Not Reported
Tax map key:	Not Reported	Aquifer code:	30601
Latest head mmt:	0	Cur head mmt:	Not Reported
Current Cl mmt:	Not Reported	Const. Date:	01/01/1890 00:00:00
Pump Inst. Date:	Not Reported	Surveyor:	Not Reported
Transmissivity:	0	Pump intake elev:	Not Reported
Pump depth:	Not Reported		

O52
NNW
1/2 - 1 Mile
Lower

FED USGS **USGS0226054**

Agency:	USGS	Site ID:	213908157555901
Site Name:	3-3955-01 W371		
Dec. Latitude:	21.64904		
Dec. Longitude:	-157.9303		
Coord Sys:	NAD83		
State:	HI		
County:	Honolulu County		
Altitude:	7.00		
Hydrologic code:	20060000		
Topographic:	Not Reported		
Site Type:	Ground-water other than Spring		
Const Date:	Not Reported	Inven Date:	Not Reported
Well Type:	Single well, other than collector or Ranney type		
Primary Aquifer:	Not Reported		
Aquifer type:	Not Reported		
Well depth:	Not Reported		
Hole depth:	Not Reported	Source:	Not Reported
Project no:	Not Reported		

Ground-water levels, Number of Measurements: 0

Map ID Direction Distance Elevation	Database	EDR ID Number
O53 **NNW** **1/2 - 1 Mile** **Lower**	**HI WELLS**	**3-3955-001**

Wid:	3-3955-001	Island Code:	3
Island Name:	Oahu	Well no:	3955-01
Well name:	Laie	Old name:	Not Reported
Yr drilled:	1890	Driller:	MCCANDLESS
Quad_map:	07	Latitude:	213908
Longitude:	1575559	UTM:	Y
Gps:	N	Owner/user:	Navalta S
Old number:	371-	Well_type:	Not Reported
Type:	Not Reported	Casing dia:	12
Ground Elev:	7	Well depth:	Not Reported
Solid casing Depth:	Not Reported	Perf casing Depth:	Not Reported
Use:	UNU	Use Desc:	Unused
Use year:	58	Water Top Elev:	0
Chloride value:	0	Test date:	Not Reported
Pumping Test rate:	Not Reported	Drop in water Lvl:	Not Reported
Chloride Test:	Not Reported	Temperature:	Not Reported
Units:	Not Reported	Pump Capacity:	0
Annual Draft:	Not Reported	Static Water Lvl:	Not Reported
Geology:	Not Reported	Geology desc:	Not Reported
Installed:	Not Reported	Last Measured:	Not Reported
Max chlorides:	Not Reported	Max Cl year:	0
Min chlorides:	Not Reported	Min Cl year:	0
Bot_hole depth:	Not Reported	bot_solid depth:	Not Reported
Bot_perf depth:	Not Reported	Well Capacity:	Not Reported
Pump Capacity:	Not Reported	Draft (mgd):	Not Reported
Tax map key:	5-5-004:001	Aquifer code:	30601
Latest head mmt:	0	Cur head mmt:	Not Reported
Current Cl mmt:	Not Reported	Const. Date:	01/01/1890 00:00:00
Pump Inst. Date:	Not Reported	Surveyor:	Not Reported
Transmissivity:	0	Pump intake elev:	Not Reported
Pump depth:	Not Reported		

N54 **NW** **1/2 - 1 Mile** **Lower**	**HI WELLS**	**3-3956-005**

Wid:	3-3956-005	Island Code:	3
Island Name:	Oahu	Well no:	3956-05
Well name:	Egg Farm	Old name:	Not Reported
Yr drilled:	1890	Driller:	MCCANDLESS
Quad_map:	07	Latitude:	213901
Longitude:	1575613	UTM:	Y
Gps:	N	Owner/user:	Hawaii Res Inc
Old number:	367-	Well_type:	Not Reported
Type:	Not Reported	Casing dia:	8
Ground Elev:	7	Well depth:	220

Solid casing Depth:	90	Perf casing Depth:	Not Reported
Use:	IRR	Use Desc:	Irrigation
Use year:	Not Reported	Water Top Elev:	13.1
Chloride value:	48	Test date:	Not Reported
Pumping Test rate:	Not Reported	Drop in water Lvl:	Not Reported
Chloride Test:	Not Reported	Temperature:	21.7
Units:	C	Pump Capacity:	0
Annual Draft:	Not Reported	Static Water Lvl:	Not Reported
Geology:	TKB	Geology desc:	Tertiary Koolau basalt
Installed:	Not Reported	Last Measured:	Not Reported
Max chlorides:	Not Reported	Max Cl year:	0
Min chlorides:	Not Reported	Min Cl year:	0
Bot_hole depth:	-213	bot_solid depth:	-83
Bot_perf depth:	Not Reported	Well Capacity:	Not Reported
Pump Capacity:	Not Reported	Draft (mgd):	Not Reported
Tax map key:	5-5-008:023	Aquifer code:	30601
Latest head mmt:	0	Cur head mmt:	Not Reported
Current Cl mmt:	Not Reported	Const. Date:	01/01/1890 00:00:00
Pump Inst. Date:	Not Reported	Surveyor:	Not Reported
Transmissivity:	0	Pump intake elev:	Not Reported
Pump depth:	Not Reported		

N55
NW
1/2 - 1 Mile
Lower

FED USGS **USGS0226051**

Agency:	USGS	Site ID:	213902157561302
Site Name:	3-3956-05 W367		
Dec. Latitude:	21.64738		
Dec. Longitude:	-157.93419		
Coord Sys:	NAD83		
State:	HI		
County:	Honolulu County		
Altitude:	7.00		
Hydrologic code:	20060000		
Topographic:	Not Reported		
Site Type:	Ground-water other than Spring		
Const Date:	18900101	Inven Date:	Not Reported
Well Type:	Single well, other than collector or Ranney type		
Primary Aquifer:	Not Reported		
Aquifer type:	Not Reported		
Well depth:	220		
Hole depth:	Not Reported	Source:	Not Reported
Project no:	Not Reported		

Ground-water levels, Number of Measurements: 0

N56
NW
1/2 - 1 Mile
Lower

FED USGS **USGS0226050**

Agency:	USGS	Site ID:	213902157561301
Site Name:	3-3956-03 W365		
Dec. Latitude:	21.64738		
Dec. Longitude:	-157.93419		
Coord Sys:	NAD83		
State:	HI		
County:	Honolulu County		
Altitude:	6.00		
Hydrologic code:	20060000		
Topographic:	Not Reported		
Site Type:	Ground-water other than Spring		
Const Date:	Not Reported	Inven Date:	Not Reported
Well Type:	Single well, other than collector or Ranney type		
Primary Aquifer:	Not Reported		
Aquifer type:	Not Reported		
Well depth:	345		
Hole depth:	Not Reported	Source:	Not Reported
Project no:	Not Reported		

Ground-water levels, Number of Measurements: 0

N57
NW
1/2 - 1 Mile
Lower

HI WELLS 3-3956-007

Wid:	3-3956-007	Island Code:	3
Island Name:	Oahu	Well no:	3956-07
Well name:	Kaio	Old name:	Not Reported
Yr drilled:	1936	Driller:	Not Reported
Quad_map:	07	Latitude:	213901
Longitude:	1575615	UTM:	Y
Gps:	N	Owner/user:	Kaio P
Old number:	Not Reported	Well_type:	Not Reported
Type:	Not Reported	Casing dia:	8
Ground Elev:	Not Reported	Well depth:	Not Reported
Solid casing Depth:	Not Reported	Perf casing Depth:	Not Reported
Use:	IRR	Use Desc:	Irrigation
Use year:	90	Water Top Elev:	0
Chloride value:	0	Test date:	Not Reported
Pumping Test rate:	Not Reported	Drop in water Lvl:	Not Reported
Chloride Test:	80	Temperature:	22.2
Units:	C	Pump Capacity:	0
Annual Draft:	Not Reported	Static Water Lvl:	Not Reported
Geology:	Not Reported	Geology desc:	Not Reported
Installed:	Not Reported	Last Measured:	Not Reported
Max chlorides:	Not Reported	Max Cl year:	0
Min chlorides:	Not Reported	Min Cl year:	0
Bot_hole depth:	Not Reported	bot_solid depth:	Not Reported
Bot_perf depth:	Not Reported	Well Capacity:	Not Reported
Pump Capacity:	Not Reported	Draft (mgd):	Not Reported
Tax map key:	5-5-008:040	Aquifer code:	30601
Latest head mmt:	0	Cur head mmt:	Not Reported
Current Cl mmt:	Not Reported	Const. Date:	01/01/1936 00:00:00
Pump Inst. Date:	Not Reported	Surveyor:	Not Reported
Transmissivity:	0	Pump intake elev:	Not Reported
Pump depth:	Not Reported		

Map ID Direction Distance Elevation	Database	EDR ID Number
N58 **NW** **1/2 - 1 Mile** **Lower**	**FED USGS**	**USGS0226052**

Agency:	USGS	Site ID:	213902157561601
Site Name:	3-3956-04 Laie Oahu HI		
Dec. Latitude:	21.64738		
Dec. Longitude:	-157.93503		
Coord Sys:	NAD83		
State:	HI		
County:	Honolulu County		
Altitude:	9.00		
Hydrologic code:	20060000		
Topographic:	Flat surface		
Site Type:	Ground-water other than Spring		
Const Date:	Not Reported	Inven Date:	Not Reported
Well Type:	Single well, other than collector or Ranney type		
Primary Aquifer:	Not Reported		
Aquifer type:	Not Reported		
Well depth:	340		
Hole depth:	340	Source:	Not Reported
Project no:	Not Reported		

Ground-water levels, Number of Measurements: 0

Map ID Direction Distance Elevation	Database	EDR ID Number
N59 **NW** **1/2 - 1 Mile** **Lower**	**HI WELLS**	**3-3956-003**

Wid:	3-3956-003	Island Code:	3
Island Name:	Oahu	Well no:	3956-03
Well name:	Laie Temple	Old name:	Not Reported
Yr drilled:	Not Reported	Driller:	Not Reported
Quad_map:	07	Latitude:	213903
Longitude:	1575615	UTM:	Y
Gps:	N	Owner/user:	Laie Water Co
Old number:	365-	Well_type:	Not Reported
Type:	Not Reported	Casing dia:	8
Ground Elev:	6	Well depth:	345
Solid casing Depth:	104	Perf casing Depth:	Not Reported
Use:	DOM	Use Desc:	Domestic
Use year:	Not Reported	Water Top Elev:	0
Chloride value:	0	Test date:	Not Reported
Pumping Test rate:	Not Reported	Drop in water Lvl:	Not Reported
Chloride Test:	Not Reported	Temperature:	Not Reported
Units:	Not Reported	Pump Capacity:	300
Annual Draft:	Not Reported	Static Water Lvl:	Not Reported
Geology:	TKB	Geology desc:	Tertiary Koolau basalt
Installed:	Not Reported	Last Measured:	Not Reported

Max chlorides:	Not Reported	Max Cl year:	0
Min chlorides:	Not Reported	Min Cl year:	0
Bot_hole depth:	-339	bot_solid depth:	-98
Bot_perf depth:	Not Reported	Well Capacity:	Not Reported
Pump Capacity:	Not Reported	Draft (mgd):	Not Reported
Tax map key:	5-5-008:058	Aquifer code:	30601
Latest head mmt:	0	Cur head mmt:	Not Reported
Current Cl mmt:	Not Reported	Const. Date:	Not Reported
Pump Inst. Date:	Not Reported	Surveyor:	Not Reported
Transmissivity:	0	Pump intake elev:	Not Reported
Pump depth:	Not Reported		

P60
NW
1/2 - 1 Mile
Lower

HI WELLS 3-3856-007

Wid:	3-3856-007	Island Code:	3
Island Name:	Oahu	Well no:	3856-07
Well name:	Prawn Farm	Old name:	Not Reported
Yr drilled:	1933	Driller:	KAHUKU PLANTN
Quad_map:	07	Latitude:	213858
Longitude:	1575621	UTM:	Y
Gps:	N	Owner/user:	Hawaii Res Inc
Old number:	373-	Well_type:	Not Reported
Type:	Not Reported	Casing dia:	Not Reported
Ground Elev:	15	Well depth:	306
Solid casing Depth:	121	Perf casing Depth:	Not Reported
Use:	IRR	Use Desc:	Irrigation
Use year:	74	Water Top Elev:	0
Chloride value:	0	Test date:	Not Reported
Pumping Test rate:	Not Reported	Drop in water Lvl:	Not Reported
Chloride Test:	Not Reported	Temperature:	21.0
Units:	C	Pump Capacity:	0
Annual Draft:	149	Static Water Lvl:	Not Reported
Geology:	TKB	Geology desc:	Tertiary Koolau basalt
Installed:	Not Reported	Last Measured:	Not Reported
Max chlorides:	Not Reported	Max Cl year:	0
Min chlorides:	Not Reported	Min Cl year:	0
Bot_hole depth:	-291	bot_solid depth:	-106
Bot_perf depth:	Not Reported	Well Capacity:	Not Reported
Pump Capacity:	Not Reported	Draft (mgd):	0.4
Tax map key:	5-5-005:001	Aquifer code:	30601
Latest head mmt:	0	Cur head mmt:	Not Reported
Current Cl mmt:	Not Reported	Const. Date:	01/01/1933 00:00:00
Pump Inst. Date:	Not Reported	Surveyor:	Not Reported
Transmissivity:	0	Pump intake elev:	Not Reported
Pump depth:	Not Reported		

P61
NW
1/2 - 1 Mile
Lower

FED USGS USGS0225985

Agency:	USGS	Site ID:	213858157562101
Site Name:	3-3856-07 W373		
Dec. Latitude:	21.64627		
Dec. Longitude:	-157.93642		
Coord Sys:	NAD83		
State:	HI		
County:	Honolulu County		
Altitude:	15.00		
Hydrologic code:	20060000		
Topographic:	Flat surface		
Site Type:	Ground-water other than Spring		
Const Date:	19330101	Inven Date:	Not Reported
Well Type:	Single well, other than collector or Ranney type		
Primary Aquifer:	Not Reported		
Aquifer type:	Not Reported		
Well depth:	306		
Hole depth:	306	Source:	Not Reported
Project no:	Not Reported		

Ground-water levels, Number of Measurements: 0

62
NW
1/2 - 1 Mile
Lower

HI WELLS 3-3956-004

Wid:	3-3956-004	Island Code:	3
Island Name:	Oahu	Well no:	3956-04
Well name:	Laie	Old name:	Not Reported
Yr drilled:	Not Reported	Driller:	Not Reported
Quad_map:	07	Latitude:	213904
Longitude:	1575616	UTM:	Y
Gps:	N	Owner/user:	Kahawai S
Old number:	366-	Well_type:	Not Reported
Type:	Not Reported	Casing dia:	10
Ground Elev:	9	Well depth:	340
Solid casing Depth:	Not Reported	Perf casing Depth:	Not Reported
Use:	IRR	Use Desc:	Irrigation
Use year:	74	Water Top Elev:	13.1
Chloride value:	54	Test date:	Not Reported
Pumping Test rate:	Not Reported	Drop in water Lvl:	Not Reported
Chloride Test:	Not Reported	Temperature:	22.5
Units:	C	Pump Capacity:	0
Annual Draft:	Not Reported	Static Water Lvl:	Not Reported
Geology:	TKB	Geology desc:	Tertiary Koolau basalt
Installed:	Not Reported	Last Measured:	Not Reported
Max chlorides:	Not Reported	Max Cl year:	0
Min chlorides:	Not Reported	Min Cl year:	0
Bot_hole depth:	-331	bot_solid depth:	Not Reported
Bot_perf depth:	Not Reported	Well Capacity:	Not Reported
Pump Capacity:	Not Reported	Draft (mgd):	Not Reported
Tax map key:	5-5-008:051	Aquifer code:	30601
Latest head mmt:	0	Cur head mmt:	Not Reported
Current Cl mmt:	Not Reported	Const. Date:	Not Reported
Pump Inst. Date:	Not Reported	Surveyor:	Not Reported
Transmissivity:	0	Pump intake elev:	Not Reported
Pump depth:	Not Reported		

Map ID Direction Distance Elevation	Database	EDR ID Number
Q63 **WNW** **1/2 - 1 Mile** **Higher**	**FED USGS**	**USGS0225979**

Agency:	USGS	Site ID:	213841157563201
Site Name:	3-3856-08 LAIE		
Dec. Latitude:	21.64154		
Dec. Longitude:	-157.93947		
Coord Sys:	NAD83		
State:	HI		
County:	Honolulu County		
Altitude:	185.00		
Hydrologic code:	20060000		
Topographic:	Flat surface		
Site Type:	Ground-water other than Spring		
Const Date:	19820512	Inven Date:	Not Reported
Well Type:	Single well, other than collector or Ranney type		
Primary Aquifer:	Not Reported		
Aquifer type:	Not Reported		
Well depth:	391		
Hole depth:	391	Source:	Not Reported
Project no:	Not Reported		

Ground-water levels, Number of Measurements: 1

Date	Feet below Surface	Feet to Sealevel
1982-05-14	165.80	

Map ID Direction Distance Elevation	Database	EDR ID Number
Q64 **WNW** **1/2 - 1 Mile** **Higher**	**HI WELLS**	**3-3856-008**

Wid:	3-3856-008	Island Code:	3
Island Name:	Oahu	Well no:	3856-08
Well name:	Laie	Old name:	Not Reported
Yr drilled:	1982	Driller:	ROSCOE MOSS
Quad_map:	07	Latitude:	213841
Longitude:	1575632	UTM:	Y
Gps:	N	Owner/user:	Honolulu Bws
Old number:	Not Reported	Well_type:	PER
Type:	Percussion Drill	Casing dia:	14
Ground Elev:	185	Well depth:	392
Solid casing Depth:	215	Perf casing Depth:	Not Reported
Use:	UNU	Use Desc:	Unused
Use year:	87	Water Top Elev:	19.2
Chloride value:	0	Test date:	05/14/1982 00:00:00
Pumping Test rate:	1132	Drop in water Lvl:	12.0
Chloride Test:	36	Temperature:	21.9
Units:	C	Pump Capacity:	0
Annual Draft:	Not Reported	Static Water Lvl:	Not Reported
Geology:	TKB	Geology desc:	Tertiary Koolau basalt
Installed:	Not Reported	Last Measured:	Not Reported

Max chlorides:	Not Reported	Max Cl year:	0
Min chlorides:	Not Reported	Min Cl year:	0
Bot_hole depth:	-207	bot_solid depth:	-30
Bot_perf depth:	Not Reported	Well Capacity:	94
Pump Capacity:	Not Reported	Draft (mgd):	Not Reported
Tax map key:	5-5-007:001	Aquifer code:	30601
Latest head mmt:	0	Cur head mmt:	Not Reported
Current Cl mmt:	Not Reported	Const. Date:	05/01/1982 00:00:00
Pump Inst. Date:	Not Reported	Surveyor:	Not Reported
Transmissivity:	0	Pump intake elev:	Not Reported
Pump depth:	Not Reported		

R65
SSE
1/2 - 1 Mile
Higher

HI WELLS 3-3755-004

Wid:	3-3755-004	Island Code:	3
Island Name:	Oahu	Well no:	3755-04
Well name:	Laie-Maloo	Old name:	Not Reported
Yr drilled:	1890	Driller:	MCCANDLESS
Quad_map:	07	Latitude:	213738
Longitude:	1575527	UTM:	Y
Gps:	N	Owner/user:	Hawaii Res Inc
Old number:	388-	Well_type:	Not Reported
Type:	Not Reported	Casing dia:	8
Ground Elev:	12	Well depth:	204
Solid casing Depth:	71	Perf casing Depth:	Not Reported
Use:	OTH	Use Desc:	Other
Use year:	Not Reported	Water Top Elev:	17.1
Chloride value:	30	Test date:	Not Reported
Pumping Test rate:	Not Reported	Drop in water Lvl:	Not Reported
Chloride Test:	Not Reported	Temperature:	Not Reported
Units:	Not Reported	Pump Capacity:	0
Annual Draft:	Not Reported	Static Water Lvl:	Not Reported
Geology:	TKB	Geology desc:	Tertiary Koolau basalt
Installed:	Not Reported	Last Measured:	Not Reported
Max chlorides:	Not Reported	Max Cl year:	0
Min chlorides:	Not Reported	Min Cl year:	0
Bot_hole depth:	-192	bot_solid depth:	-59
Bot_perf depth:	Not Reported	Well Capacity:	Not Reported
Pump Capacity:	Not Reported	Draft (mgd):	Not Reported
Tax map key:	5-5-006:011	Aquifer code:	30601
Latest head mmt:	0	Cur head mmt:	Not Reported
Current Cl mmt:	Not Reported	Const. Date:	01/01/1890 00:00:00
Pump Inst. Date:	Not Reported	Surveyor:	Not Reported
Transmissivity:	0	Pump intake elev:	Not Reported
Pump depth:	Not Reported		

R66
SSE
1/2 - 1 Mile
Higher

FED USGS USGS0226038

GEOCHECK® - PHYSICAL SETTING SOURCE MAP FINDINGS

Agency:	USGS	Site ID:	213738157552701
Site Name:	3-3755-04 W388		
Dec. Latitude:	21.62404		
Dec. Longitude:	-157.92142		
Coord Sys:	NAD83		
State:	HI		
County:	Honolulu County		
Altitude:	12.00		
Hydrologic code:	20060000		
Topographic:	Not Reported		
Site Type:	Ground-water other than Spring		
Const Date:	18900101	Inven Date:	Not Reported
Well Type:	Single well, other than collector or Ranney type		
Primary Aquifer:	Not Reported		
Aquifer type:	Not Reported		
Well depth:	204		
Hole depth:	Not Reported	Source:	Not Reported
Project no:	Not Reported		

Ground-water levels, Number of Measurements: 0

GEOCHECK® - PHYSICAL SETTING SOURCE MAP FINDINGS
RADON

AREA RADON INFORMATION

Federal EPA Radon Zone for HONOLULU County: 3

Note: Zone 1 indoor average level > 4 pCi/L.
: Zone 2 indoor average level >= 2 pCi/L and <= 4 pCi/L.
: Zone 3 indoor average level < 2 pCi/L.

Federal Area Radon Information for Zip Code: 96762

Number of sites tested: 1

Area	Average Activity	% <4 pCi/L	% 4-20 pCi/L	% >20 pCi/L
Living Area - 1st Floor	-0.500 pCi/L	100%	0%	0%
Living Area - 2nd Floor	Not Reported	Not Reported	Not Reported	Not Reported
Basement	Not Reported	Not Reported	Not Reported	Not Reported

PHYSICAL SETTING SOURCE RECORDS SEARCHED

TOPOGRAPHIC INFORMATION

USGS 7.5' Digital Elevation Model (DEM)
Source: United States Geologic Survey
EDR acquired the USGS 7.5' Digital Elevation Model in 2002. 7.5-Minute DEMs correspond to the USGS 1:24,000- and 1:25,000-scale topographic quadrangle maps.

HYDROLOGIC INFORMATION

Flood Zone Data: This data, available in select counties across the country, was obtained by EDR in 1999 from the Federal Emergency Management Agency (FEMA). Data depicts 100-year and 500-year flood zones as defined by FEMA.

NWI: National Wetlands Inventory. This data, available in select counties across the country, was obtained by EDR in 2002 from the U.S. Fish and Wildlife Service.

HYDROGEOLOGIC INFORMATION

AQUIFLOW^R Information System
Source: EDR proprietary database of groundwater flow information
EDR has developed the AQUIFLOW Information System (AIS) to provide data on the general direction of groundwater flow at specific points. EDR has reviewed reports submitted to regulatory authorities at select sites and has extracted the date of the report, hydrogeologically determined groundwater flow direction and depth to water table information.

GEOLOGIC INFORMATION

Geologic Age and Rock Stratigraphic Unit
Source: P.G. Schruben, R.E. Arndt and W.J. Bawiec, Geology of the Conterminous U.S. at 1:2,500,000 Scale - A digital representation of the 1974 P.B. King and H.M. Beikman Map, USGS Digital Data Series DDS - 11 (1994).

STATSGO: State Soil Geographic Database
Source: Department of Agriculture, Natural Resources Conservation Services
The U.S. Department of Agriculture's (USDA) Natural Resources Conservation Service (NRCS) leads the national Conservation Soil Survey (NCSS) and is responsible for collecting, storing, maintaining and distributing soil survey information for privately owned lands in the United States. A soil map in a soil survey is a representation of soil patterns in a landscape. Soil maps for STATSGO are compiled by generalizing more detailed (SSURGO) soil survey maps.

ADDITIONAL ENVIRONMENTAL RECORD SOURCES

FEDERAL WATER WELLS

PWS: Public Water Systems
Source: EPA/Office of Drinking Water
Telephone: 202-564-3750
Public Water System data from the Federal Reporting Data System. A PWS is any water system which provides water to at least 25 people for at least 60 days annually. PWSs provide water from wells, rivers and other sources.

PWS ENF: Public Water Systems Violation and Enforcement Data
Source: EPA/Office of Drinking Water
Telephone: 202-564-3750
Violation and Enforcement data for Public Water Systems from the Safe Drinking Water Information System (SDWIS) after August 1995. Prior to August 1995, the data came from the Federal Reporting Data System (FRDS).

USGS Water Wells: USGS National Water Inventory System (NWIS)
This database contains descriptive information on sites where the USGS collects or has collected data on surface water and/or groundwater. The groundwater data includes information on wells, springs, and other sources of groundwater.

PHYSICAL SETTING SOURCE RECORDS SEARCHED

STATE RECORDS

Ground Water Wells
Source: Department of Land and Natural Resources
Telephone: 808-587-0242

RADON

Area Radon Information
Source: USGS
Telephone: 703-356-4020
The National Radon Database has been developed by the U.S. Environmental Protection Agency (USEPA) and is a compilation of the EPA/State Residential Radon Survey and the National Residential Radon Survey. The study covers the years 1986 - 1992. Where necessary data has been supplemented by information collected at private sources such as universities and research institutions.

EPA Radon Zones
Source: EPA
Telephone: 703-356-4020
Sections 307 & 309 of IRAA directed EPA to list and identify areas of U.S. with the potential for elevated indoor radon levels.

OTHER

Airport Landing Facilities: Private and public use landing facilities
Source: Federal Aviation Administration, 800-457-6656

Epicenters: World earthquake epicenters, Richter 5 or greater
Source: Department of Commerce, National Oceanic and Atmospheric Administration

Appendix J
Cost Engineering

COST APPENDIX

Cost Estimate

Based on quantity takeoffs that were developed by the project team, the POH Cost Engineering experts developed a total project cost summary for each of the proposed alternatives. These cost summaries provide the estimated total costs for construction; land and damages; planning, engineering, and design; and construction management. For each of these cost categories, contingency percentages were calculated based on input from the project team's cost risk analysis.

The estimated total project cost was significantly higher for Alternative 3A ($19,271,000) than for Alternative 2 ($13,279,000). The difference was due to the high costs required to construct the detention basins associated with Alternative 3A.

The estimate date for Alternative 2 and Alternative 3A is October 2019/EPL 1 Oct 15.

****** TOTAL PROJECT COST SUMMARY ******

PROJECT: **Wailele Stream Flood Risk Management - Alternative 2 (Without Basins)** DISTRICT: **POH** PREPARED: **5/20/2019**
PROJECT NO:
LOCATION: **Laie, Oahu, HI** POC: **CHIEF, COST ENGINEERING, Alex M. Tseng**

This Estimate reflects the scope and schedule in report; CAP Feasibility STUDY - Flood Protection

Civil Works Work Breakdown Structure		**ESTIMATED COST**				**PROJECT FIRST COST (Constant Dollar Basis)**						**TOTAL PROJECT COST (FULLY FUNDED)**			
						Program Year (Budget EC):				2020					
						Effective Price Level Date:				1-Oct- 19					
WBS NUMBER	Civil Works Feature & Sub-Feature Description	COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	REMAINING COST ($K)	Spent Thru: 10/1/2018 ($K)	**TOTAL FIRST COST ($K)**	ESC (%)	COST ($K)	CNTG ($K)	FULL ($K)
15	FLOODWAY CONTROL & DIVERSION STR	$3,342	$882	26%	$4,224	7.8%	$3,604	$951	$4,554		$4,554	3.5%	$3,731	$984	$4,715
15	FLOODWAY CONTROL & DIVERSION STR	$1,472	$360	24%	$1,832	7.8%	$1,587	$388	$1,975		$1,975	3.5%	$1,643	$402	$2,045
15	FLOODWAY CONTROL & DIVERSION STR	$1,526	$564	37%	$2,090	7.8%	$1,645	$608	$2,253		$2,253	3.5%	$1,703	$630	$2,333
02 01	ROADS, Construction Activities	$273	$25	9%	$298	7.8%	$295	$27	$321		$321	3.5%	$305	$28	$333
			-												
			-												
	CONSTRUCTION ESTIMATE TOTALS:	$6,613	$1,831		$8,444	7.8%	$7,130	$1,974	$9,104		$9,104	3.5%	$7,383	$2,044	$9,426
01	LANDS AND DAMAGES	$293	$73	25%	$366	7.8%	$316	$79	$395		$395	-1.0%	$313	$78	$391
30	PLANNING, ENGINEERING & DESIGN	$1,817	$262	14%	$2,079	16.5%	$2,118	$306	$2,423		$2,423	-0.3%	$2,111	$305	$2,416
31	CONSTRUCTION MANAGEMENT	$859	$77	9%	$936	7.9%	$927	$83	$1,010		$1,010	3.5%	$960	$86	$1,046
	PROJECT COST TOTALS:	$9,582	$2,243	23%	$11,825		$10,491	$2,442	$12,932		**$12,932**	2.7%	$10,767	$2,513	$13,279

____________________ CHIEF, COST ENGINEERING, Alex M. Tseng

____________________ PROJECT MANAGER, Michael D. Wyatt

____________________ CHIEF, REAL ESTATE, Stephen Cayetano

____________________ CHIEF, PLANNING, William R. G. Borengasser

____________________ CHIEF, ENGINEERING, Todd C. Barnes

____________________ CHIEF, OPERATIONS, Michael F. Wong

____________________ CHIEF, CONSTRUCTION, Olson Okada

____________________ CHIEF, CONTRACTING, Leigh A. Lucas

____________________ CHIEF, PM-PB, Roxanne E. Iseri

____________________ CHIEF, DPM, William R. G. Borengasser

ESTIMATED TOTAL PROJECT COST:		**$13,279**
ESTIMATED FEDERAL COST:	**65%**	$8,632
ESTIMATED NON-FEDERAL COST:	**35%**	$4,648
22 - FEASIBILITY STUDY (CAP studies):		**$1,011**
ESTIMATED FEDERAL COST:		$692
ESTIMATED NON-FEDERAL COST:		$319
ESTIMATED FEDERAL COST OF PROJECT		**$9,324**

**** TOTAL PROJECT COST SUMMARY ****

**** CONTRACT COST SUMMARY ****

PROJECT: Wailele Stream Flood Risk Management - Alternative 2 (Without Basins)
LOCATION: Laie, Oahu, HI
This Estimate reflects the scope and schedule in report; CAP Feasibility STUDY - Flood Protection

DISTRICT: POH
POC: CHIEF, COST ENGINEERING, Alex M. Tseng
PREPARED: 5/20/2019

WBS Structure		ESTIMATED COST				PROJECT FIRST COST (Constant Dollar Basis)				TOTAL PROJECT COST (FULLY FUNDED)				
		Estimate Prepared: 10/1/2015 Estimate Price Level: 1-Oct-15				Program Year (Budget EC): 2020 Effective Price Level Date: 1 -Oct-19								
WBS NUMBER	Civil Works Feature & Sub-Feature Description	COST ($K)	CNTG ($K)	RISK BASED CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	Mid-Point Date	ESC (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	*B*	*C*	*D*	*E*	*F*	*G*	*H*	*I*	*J*	*P*	*L*	*M*	*N*	*O*
	PHASE 1 or CONTRACT 1													
15	FLOODWAY CONTROL & DIVERSION STR	$3,342	$882	26.4%	$4,224	7.8%	$3,604	$951	$4,554	2021Q4	3.5%	$3,731	$984	$4,715
15	FLOODWAY CONTROL & DIVERSION STR	$1,472	$360	24.5%	$1,832	7.8%	$1,587	$388	$1,975	2021Q4	3.5%	$1,643	$402	$2,045
15	FLOODWAY CONTROL & DIVERSION STR	$1,526	$564	37.0%	$2,090	7.8%	$1,645	$608	$2,253	2021Q4	3.5%	$1,703	$630	$2,333
02 01	ROADS, Construction Activities	$273	$25	9.1%	$298	7.8%	$295	$27	$321	2021Q4	3.5%	$305	$28	$333
	CONSTRUCTION ESTIMATE TOTALS:	$6,613	$1,831	27.7%	**$8,444**		$7,130	$1,974	$9,104			$7,383	$2,044	$9,426
01	LANDS AND DAMAGES	$293	$73	25.0%	$366	7.8%	$316	$79	$395	2019Q3	-1.0%	$313	$78	$391
30	PLANNING, ENGINEERING & DESIGN													
0.025	Project Management	$165	$24	14.4%	$189	16.5%	$192	$28	$220	2019Q3	-1.9%	$189	$27	$216
0.02	Planning & Environmental Compliance	$132	$19	14.4%	$151	16.5%	$154	$22	$176	2019Q3	-1.9%	$151	$22	$173
0.15	Engineering & Design	$992	$143	14.4%	$1,135	16.5%	$1,156	$167	$1,323	2019Q3	-1.9%	$1,134	$164	$1,297
0.01	Engineering Tech Review ITR & VE	$66	$10	14.4%	$76	16.5%	$77	$11	$88	2019Q3	-1.9%	$75	$11	$86
0.01	Contracting & Reprographics	$66	$10	14.4%	$76	16.5%	$77	$11	$88	2019Q3	-1.9%	$75	$11	$86
0.03	Engineering During Construction	$198	$29	14.4%	$227	16.5%	$231	$33	$264	2021Q4	7.2%	$247	$36	$283
0.02	Planning During Construction	$132	$19	14.4%	$151	16.5%	$154	$22	$176	2021Q4	7.2%	$165	$24	$189
0.01	Project Operations	$66	$10	14.4%	$76	16.5%	$77	$11	$88	2019Q3	-1.9%	$75	$11	$86
31	CONSTRUCTION MANAGEMENT													
0.1	Construction Management	$661	$59	9.0%	$720	7.9%	$713	$64	$777	2021Q4	3.5%	$739	$66	$805
0.01	Project Operation:	$66	$6	9.0%	$72	7.9%	$71	$6	$78	2021Q4	3.5%	$74	$7	$80
0.02	Project Management	$132	$12	9.0%	$144	7.9%	$142	$13	$155	2021Q4	3.5%	$147	$13	$161
	CONTRACT COST TOTALS:	$9,582	$2,243		**$11,825**		$10,491	$2,442	$12,932			$10,767	$2,513	**$13,279**

Filename: CAP TPCS Wailele TSP(20May19).xlsx
TPCS

**** TOTAL PROJECT COST SUMMARY ****

PROJECT: **Wailele Stream Flood Risk Management - Alternative 3A (With Basins)** DISTRICT: **POH** PREPARED: **5/20/2019**
PROJECT NO:
LOCATION: **Laie, Oahu, HI** POC: **CHIEF, COST ENGINEERING, Alex M. Tseng**

This Estimate reflects the scope and schedule in report; CAP Feasibility STUDY - Flood Protection

Civil Works Work Breakdown Structure		**ESTIMATED COST**				**PROJECT FIRST COST (Constant Dollar Basis)**						**TOTAL PROJECT COST (FULLY FUNDED)**			
						Program Year (Budget EC): 2020 / Effective Price Level Date: 1-Oct- 19									
WBS NUMBER	Civil Works Feature & Sub-Feature Description	COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	REMAINING COST ($K)	Spent Thru: **10/1/2018** ($K)	**TOTAL FIRST COST** ($K)	ESC (%)	COST ($K)	CNTG ($K)	FULL ($K)
15	FLOODWAY CONTROL & DIVERSION STR	$2,520	$612	24%	$3,132	7.8%	$2,717	$659	$3,376		$3,376	3.5%	$2,813	$683	$3,496
15	FLOODWAY CONTROL & DIVERSION STR	$1,370	$306	22%	$1,676	7.8%	$1,477	$330	$1,807		$1,807	3.5%	$1,529	$342	$1,871
15	FLOODWAY CONTROL & DIVERSION STR	$2,911	$390	13%	$3,301	7.8%	$3,139	$421	$3,559		$3,559	3.5%	$3,250	$435	$3,685
15	FLOODWAY CONTROL & DIVERSION STR	$1,789	$318	18%	$2,107	7.8%	$1,929	$343	$2,272		$2,272	3.5%	$1,997	$355	$2,352
15	FLOODWAY CONTROL & DIVERSION STR	$926	$303	33%	$1,229	7.8%	$998	$327	$1,326		$1,326	3.5%	$1,034	$339	$1,372
02	RELOCATIONS	$274	$25	9%	$299	7.8%	$295	$27	$322		$322	3.5%	$306	$28	$334
	CONSTRUCTION ESTIMATE TOTALS:	$9,790	$1,954		$11,744	7.8%	$10,555	$2,107	$12,662		$12,662	3.5%	$10,929	$2,181	$13,110
01	LANDS AND DAMAGES	$819	$205	25%	$1,024	7.8%	$883	$221	$1,104		$1,104	-1.0%	$875	$219	$1,093
30	PLANNING, ENGINEERING & DESIGN	$2,694	$333	12%	$3,027	16.5%	$3,140	$388	$3,527		$3,527	-0.3%	$3,131	$387	$3,517
31	CONSTRUCTION MANAGEMENT	$1,273	$114	9%	$1,387	7.9%	$1,374	$123	$1,497		$1,497	3.5%	$1,422	$128	$1,550
	PROJECT COST TOTALS:	$14,576	$2,606	18%	$17,182		$15,952	$2,839	$18,791		**$18,791**	2.6%	$16,357	$2,914	$19,271

CHIEF, COST ENGINEERING, Alex M. Tseng

PROJECT MANAGER, Michael D. Wyatt

CHIEF, REAL ESTATE, Stephen Cayetano

CHIEF, PLANNING, William R. G. Borengasser

CHIEF, ENGINEERING, Todd C. Barnes

CHIEF, OPERATIONS, Michael F. Wong

CHIEF, CONSTRUCTION, Olson Okada

CHIEF, CONTRACTING, Leigh A. Lucas

CHIEF, PM-PB, Roxanne E. Iseri

CHIEF, DPM, William R. G. Borengasser

ESTIMATED TOTAL PROJECT COST:		**$19,271**
ESTIMATED FEDERAL COST:	**65%**	$12,526
ESTIMATED NON-FEDERAL COST:	**35%**	$6,745
22 - FEASIBILITY STUDY (CAP studies):		**$1,011**
ESTIMATED FEDERAL COST:		$692
ESTIMATED NON-FEDERAL COST:		$319
ESTIMATED FEDERAL COST OF PROJECT		**$13,218**

****** TOTAL PROJECT COST SUMMARY ******

****** CONTRACT COST SUMMARY ******

PROJECT: Wailele Stream Flood Risk Management - Alternative 3A (With Basins) DISTRICT: POH PREPARED: 5/20/2019
LOCATION: Laie, Oahu, HI POC: CHIEF, COST ENGINEERING, Alex M. Tseng
This Estimate reflects the scope and schedule in report; CAP Feasibility STUDY - Flood Protection

WBS Structure		ESTIMATED COST				PROJECT FIRST COST (Constant Dollar Basis)				TOTAL PROJECT COST (FULLY FUNDED)				
		Estimate Prepared: Estimate Price Level:			10/1/2015 1-Oct-15	Program Year (Budget EC): Effective Price Level Date:			2020 1 -Oct-19					
WBS NUMBER	Civil Works Feature & Sub-Feature Description	COST ($K)	CNTG ($K)	RISK BASED CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	Mid-Point Date	ESC (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	*B*	*C*	*D*	*E*	*F*	*G*	*H*	*I*	*J*	*P*	*L*	*M*	*N*	*O*
	PHASE 1 or CONTRACT 1													
15	FLOODWAY CONTROL & DIVERSION STF	$2,520	$612	24.3%	$3,132	7.8%	$2,717	$659	$3,376	2021Q4	3.5%	$2,813	$683	$3,496
15	FLOODWAY CONTROL & DIVERSION STF	$1,370	$306	22.4%	$1,676	7.8%	$1,477	$330	$1,807	2021Q4	3.5%	$1,529	$342	$1,871
15	FLOODWAY CONTROL & DIVERSION STF	$2,911	$390	13.4%	$3,301	7.8%	$3,139	$421	$3,559	2021Q4	3.5%	$3,250	$435	$3,685
15	FLOODWAY CONTROL & DIVERSION STF	$1,789	$318	17.8%	$2,107	7.8%	$1,929	$343	$2,272	2021Q4	3.5%	$1,997	$355	$2,352
15	FLOODWAY CONTROL & DIVERSION STF	$926	$303	32.8%	$1,229	7.8%	$998	$327	$1,326	2021Q4	3.5%	$1,034	$339	$1,372
02 01	ROADS, Construction Activities	$274	$25	9.1%	$299	7.8%	$295	$27	$322	2021Q4	3.5%	$306	$28	$334
	CONSTRUCTION ESTIMATE TOTALS:	$9,790	$1,954	20.0%	**$11,744**		$10,555	$2,107	$12,662			$10,929	$2,181	$13,110
01	LANDS AND DAMAGES	$819	$205	25.0%	$1,024	7.8%	$883	$221	$1,104	2019Q3	-1.0%	$875	$219	$1,093
30	PLANNING, ENGINEERING & DESIGN													
0.025	Project Management	$245	$30	12.4%	$275	16.5%	$286	$35	$321	2019Q3	-1.9%	$280	$35	$315
0.02	Planning & Environmental Compliance	$196	$24	12.4%	$220	16.5%	$228	$28	$257	2019Q3	-1.9%	$224	$28	$252
0.15	Engineering & Design	$1,469	$181	12.4%	$1,650	16.5%	$1,712	$211	$1,923	2019Q3	-1.9%	$1,679	$207	$1,886
0.01	Engineering Tech Review ITR & VE	$98	$12	12.4%	$110	16.5%	$114	$14	$128	2019Q3	-1.9%	$112	$14	$126
0.01	Contracting & Reprographics	$98	$12	12.4%	$110	16.5%	$114	$14	$128	2019Q3	-1.9%	$112	$14	$126
0.03	Engineering During Construction	$294	$36	12.4%	$330	16.5%	$343	$42	$385	2021Q4	7.2%	$367	$45	$413
0.02	Planning During Construction	$196	$24	12.4%	$220	16.5%	$228	$28	$257	2021Q4	7.2%	$245	$30	$275
0.01	Project Operations	$98	$12	12.4%	$110	16.5%	$114	$14	$128	2019Q3	-1.9%	$112	$14	$126
31	CONSTRUCTION MANAGEMENT													
0.1	Construction Management	$979	$88	9.0%	$1,067	7.9%	$1,057	$95	$1,151	2021Q4	3.5%	$1,094	$98	$1,192
0.01	Project Operation:	$98	$9	9.0%	$107	7.9%	$106	$9	$115	2021Q4	3.5%	$110	$10	$119
0.02	Project Management	$196	$18	9.0%	$214	7.9%	$212	$19	$231	2021Q4	3.5%	$219	$20	$239
	CONTRACT COST TOTALS:	$14,576	$2,606		**$17,182**		$15,952	$2,839	$18,791			$16,357	$2,914	**$19,271**

Wailele Stream Flood Risk Management Project			
Estimated Quantities for Revised TSP and Revised TSP with Diversion Channel			
(Work within Wailele Stream only; construction of Diversion Channel by others)			
6/7/2017			
Area / Item	Original TSP Quantity	Unit	Notes
1. Wailele Stream Improvements			
Clearing & Grubbing	23.6	Ac	25% trees, 20 ft high
Excavation	18,407.	CY	10% rock (based on borings from BYUH Multi-Use and Student Hsng bldgs Geotech rpt)
Berm Embankment	8,519.	CY	Use excavated material from ______
Hydromulch of channel walls and invert	291,209.	SF	
Excess material to be hauled for removal offsite	9,888.	CY	
Permanent Access Road			
Asphalt	297.	CY	2" THICK AC
Base course	889.	CY	6" THICK
Box culvert (13.74Wx7'Hx20'L)			Invert at 6.81 ft MSL
Concrete	34.	CY	1' thick walls
Rebar	1,135.	lbs	rebar 12" spacing o.c. both ways
Formwork	903.	SF	
Embankment	200.	CY	
Rip rap scour protection	11,790.	SF	Revised, added quantity from rip rap @ diversion channel connection point
Conc. For access ramp	20.	CY	100' long, 16' wide, 4" thick
2. Overflow Channel (51' wide)			For Revised TSP, width transitions to 56' at highway
Clearing & Grubbing	2.7	Ac	100% trees, 20 ft high
Excavation	48,235.	CY	30% rock (based on borings for Koloa bridge & borings for Wailele Strm Crossing prop. culvert)
Berm Embankment	50.	CY	Use excavated material from ______
Hydromulch of channel walls and invert	117,510.	SF	
Excess material to be hauled for removal offsite	48,185.	CY	
Conc. For access ramp	12.	CY	60' long, 16' wide, 4" thick
Rebar	1,164.	lbs	rebar 12" spacing o.c. both ways
3. Kamehameha Highway Culvert Crossing			
Clearing & Grubbing	0.3	Ac	100% trees, 20 ft high
Pavement Demolition	7,500.	SF	
Excavation	2,748.	CY	40% rock (based on borings for Wailele stream crossing proposed culvert)
Temporary AC pavement			
Asphalt	115.	CY	2" thick
Base course	343.	CY	6" thick
Box culvert (3-17.25'Wx6.8'Hx32'L)			Invert at 1.68 ft MSL
Concrete	186.	CY	1' thick walls
Rebar	8,091.	lbs	rebar 12" spacing o.c.both ways
Formwork	3,524.8	SF	
Culvert headwall & wingwalls			
Concrete	35.	CY	
Rebar	1,440.	lbs	rebar 12" spacing o.c.both ways
Formwork	1,320.	SF	
Drilled shafts	15.	EA	2' dia, 35' deep
Dewatering			
Removal of temporary pavement	18,480.	SF	
Backfill	559.	CY	Use suitable excavated material
Permanent AC pavement			
Asphalt	93.	CY	4" thick

Wailele Stream Flood Risk Management Project			
Estimated Quantities for Revised TSP and Revised TSP with Diversion Channel			
(Work within Wailele Stream only; construction of Diversion Channel by others)			
6/7/2017			
	Original		
	TSP		
Area / Item	Quantity	Unit	Notes
Base course	139.	CY	6" thick
Excess material to be hauled for removal offsite	2,189.	CY	
Vehicular Access Ramp			
Rip rap scour protection	15,135.	SF	
Detour of Kamehameha Highway during constr.	770.	LF	
Relocation of Water line	150.	LF	size unknown, no as-builts, but FH present on shoulder so min. 6" pipe
Temporary relocation of utility poles	5.	ea	
Temp. relocation of overhead utility lines & st. lights	650.	LF	(2 street lights)
Restoration of utility poles & overhead utility lines	3.	ea	
4. Temporary Construction Access Roads			
Gravel	889.	CY	10' wide gravel road, 4800 LF long
Summary of changes made			

8/1/2016	Changed the Original TSP quantity of embankment for Box Culvert in Wailele Stream from 1079 CY to 220 CY (previous number was based on outdated figure)
8/1/2016	Added Revised TSP quantities for Box Culvert in Wailele Stream at Overflow Channel
8/1/2016	Added Revised TSP quantities for Kamehameha Hwy Culvert Crossing
8/1/2016	Added Revised TSP quantities for Overflow Channel (width transitions to 56' at highway)
8/1/2016	Changed the Original TSP quantity of berm embankment for overflow channel from 650 CY to 73 CY (previous number was based on outdated figure)
8/1/2016	Added Revised TSP With Diversion Channel (60' wide bottom width) quantities
9/13/2016	Removed quantities for Diversion Channel, adjusted rip rap quantity for only within Wailele Stream
6/7/2017	Revised rip rap quantity for Kamehameha Hwy Culvert crossing

Wailele Stream Flood Risk Management Project
Estimated Quantities for Proposed Project (Alternative 3A) WITH BASINS
9/16/2015

Area / Item		Quantity	Unit	Notes
1.	Wailele Stream Improvements			
	Clearing & Grubbing	23.6	Ac	25% trees, 20 ft high
	Excavation	18407	CY	10% rock (based on borings from BYUH Multi-Use and Student Housing bldgs Geotech report)
	Berm Embankment	8519	CY	Use excavated material from ______
	Hydromulch of channel walls and invert	291209	SF	
	Excess material to be hauled for removal offsite	9888	CY	
	Permanent Access Road			
	Asphalt	297	CY	2" THICK AC
	Base course	889	CY	6" THICK
	Box culvert (8'Wx7'Hx20'L)			Invert at 6.81 ft MSL
	Concrete	25	CY	1' thick walls
	Rebar	895	lbs	rebar 12" spacing o.c. both ways
	Formwork	600	SF	
	EMBANKMENT	1079	CY	
	Rip rap scour protection	3710	SF	
	Conc. For access ramp	20	CY	100' long, 16' wide, 4" thick
2.	Diversion Channel (36' wide)			
	Clearing & Grubbing	2.2	Ac	100% trees, 20 ft high
	Excavation	38774	CY	30% rock (based on borings for Koloa bridge & borings for Wailele stream crossing proposed culvert)
	Berm Embankment	36	CY	Use excavated material from ______
	Hydromulch of channel walls and invert	109505	SF	
	Excess material to be hauled for removal offsite	38738	CY	
	Conc. For access ramp	12	CY	60' long, 16' wide, 4" thick
	Rebar	1164	lbs	rebar 12" spacing o.c. both ways
3.	Storage Basin 1 (34.8 ac-ft storage volume)			
	Clearing & Grubbing	11.8	Ac	25% trees, 20 ft high
	Excavation	71532	CY	LESS THAN_5_% rock (based on borings from BYUH Multi-Use and Student Housing bldgs Geotech report)
	Berm Embankment	1034	CY	Use excavated material from ______
	Hydromulch of basin walls and invert	502385	SF	Includes top of berm and outside banks
	Entrance Weir			
	Concrete	204	CY	1' thick. 100' long crest, 10' wide; 25' long side slopes, 10' wide; 150' long, 20' deep face of crest; 100' long, 10' wide base of crest
	Rebar	9021.95	lbs	rebar 12" spacing o.c.both ways
	Formwork	790	SF	
	Excess material to be hauled for removal offsite	70498	CY	
	Conc. For access ramp	6	CY	30' x 16', 4" thick
	Rebar	861.518	lbs	rebar 12" spacing o.c.both ways
4.	Storage Basin 9 (18.5 ac-ft storage volume)			
	Clearing & Grubbing	8.6	Ac	25% trees, 15 ft high (mostly coconut trees)
	Excavation	35204	CY	LESS THAN_5_% rock (based on borings from BYUH Multi-Use and Student Housing bldgs Geotech report)
	Berm Embankment	1953	CY	Use excavated material from ______
	Hydromulch of basin walls and invert	328829	SF	Includes top of berm and outside banks
	Entrance Weir			
	Concrete	282	CY	1' thick. 300' long crest, 10 wide; 25' long side slopes, 10' wide; 300' long, 10' deep face of crest; 350' long, 10' wide base of crest
	Rebar	19764.85	lbs	rebar 12" spacing o.c.both ways
	Formwork	1370	SF	
	Excess material to be hauled for removal offsite	33251	CY	
	Conc. For access ramp	8	CY	40' x 16' x 4" thick
	Rebar	1164	lbs	

Wailele Stream Flood Risk Management Project

Estimated Quantities for Proposed Project (Alternative 3A) WITH BASINS

9/16/2015

Area / Item	Quantity	Unit	Notes
5. Kamehameha Highway Culvert Crossing			
Clearing & Grubbing	0.23	Ac	100% trees, 20 ft high
Pavement Demolition	5000	SF	
Excavation	1513	CY	40% rock (based on borings for Wailele stream crossing proposed culvert)
Temporary AC pavement			
Asphalt	115	CY	2" thick
Base course	343	CY	6" thick
Box culvert (2-18'Wx6.8'Hx32'L)			Invert at 1.68 ft MSL
Concrete	130	CY	1' thick walls
Rebar	5753	lbs	rebar 12" spacing o.c.both ways
Formwork	1318.4	SF	
Culvert headwall & wingwalls			
Concrete	28	CY	
Rebar	1402	lbs	rebar 12" spacing o.c.both ways
Formwork	1122	SF	
Drilled shafts	10	EA	2' dia, 35' deep - 50% rock (based on borings for Wailele stream crossing proposed culvert)
Dewatering			
Removal of temporary pavement	18480	SF	
Backfill	379	CY	Use suitable excavated material
Permanent AC pavement			
Asphalt	62	CY	4" thick
Base course	93	CY	6" thick
Excess material to be hauled for removal offsite	1134	CY	
Vehicular Access Ramp			
Rip rap scour protection	4500	SF	
Detour of Kamehameha Highway during Construction	770	LF	
Relocation of Water line	100	LF	size unknown, no as-builts, but FH present on shoulder so min. 6" pipe
Temporary relocation of utility poles	5	ea	
Temporary relocation of overhead utility lines & St. lights	650	LF	(2 street lights)
Restoration of utility poles & overhead utility lines	3	ea	
6. Temporary Construction Access Roads			
Gravel	889	CY	10' wide gravel road, 4800 LF long

Summary of changes made

7/27/2015	Changed quantity of Gravel for Temporary Construction Access Roads from 8889 CY to 889 CY
7/28/2015	Changed quantity of Asphalt for Temporary AC Pavement from 62 CY to 115 CY
7/28/2015	Changed thickness of Asphalt for Temporary AC Pavement from 4" to 2"
7/28/2015	Changed quantity of Base Course for Temporary AC Pavement from 93 CY to 343 CY
7/28/2015	Changed quantity of Removal Temporary Pavement from 5000 SF to 18480 SF
7/29/2015	Changed quantity of Excavation for Kamehameha Hwy Culvert Crossing from 2223 CY to 1513 CY
7/29/2015	Changed quantity of Backfill for Kamehameha Hwy Culvert Crossing from 2778 CY to 559 CY
7/29/2015	Changed quantity of Excess Material for Kamehameha Hwy Culvert Crossing from 371 CY to 1134 CY
9/14/2015	Changed quantities of Excavation, Berm Embankment and Excess Material for Storage Basins 1 & 9.
9/15/2015	Added in items for temporary relocation of utility poles and overhead utility lines and street lights

Wailele Stream Flood Risk Management Project
Estimated Quantities for Proposed Project
6/7/2017

Quantities Assumptions

Kamehameha Highway culvert to be built first to allow traffic to be temporarily detoured mauka of existing highway. Diversion channel to be dug out after culvert is completed.

% of rocks to be excavated for Wailele Stream widening & diversion channel based off of borings for BYUH Multi-Use and Student Housing bldgs Geotech report and borings for Wailele stream crossing proposed culvert

Wailele Stream widening to be done towards the south bank to reduce excavation quantity

water line within shoulder of Kam Highway for transmission & for FH's

Overflow channel has higher invert than Wailele Stream channel, so it should be normally dry. Access ramp is provided for maintenance.

24' wide AC pav't for temporary detour for Kam Hwy culvert work

Wailele Stream Flood Risk Management Project
Estimated Quantities for Proposed Project
6/7/2017

Figures - 11x17

- General Plan
  - Wailele Stream, Diversion Channel, Storage Basins, Permanent Maintenance Access Road
  - Staging Area, Temporary Construction Access Road, Stockpile Location
  - Locations of Geotechnical Information

- Wailele Stream Improvements - Plan & Profile
  - With Stationing

- Wailele Stream Improvements - Typical Sections and Details
  - Berms
  - Channel Widnening / Lowering

- Wailele Diversion - Plan & Profile
  - With Stationing

- Wailele Diversion - Typical Sections and Details
  - Channel
  - Entrance Weir

- Storage Basins - Plan

- Storage Basins - Sections and Details
  - Entrance Weirs

- Kamehameha Highway Culvert Crossing Plan, Profile, Section
  - Temporary Detour of Highway and Utilities
  - Utility Relocations (if necessary)

- Miscellaneous Details
  - Pavement
    - Kamehameha Hwy
    - Permanent Access Road
    - Temporary Construction Road

  - Utility Relocations (if necessary)

- Property Acquisition
  - Project Footprint
  - TMK numbers of all properties where temporary or permanent improvements are located
  - Area of acquisition required for all temporary or permanent improvements

Appendix K
Correspondence

From:	Desilets, Michael E CIV USARMY CEPOH (USA)
To:	Lebo, Susan A
Cc:	Norris, Jason M CIV USARMY CELRH (US); Herzog, Jeffrey A CIV USARMY CEPOH (USA); alan.s.downer@hawaii.gov
Subject:	FW: Section 106 and 6E consultation for Wailele Flood Control (Laie, Oahu)
Date:	Friday, June 7, 2019 10:39:45

Happy Aloha Friday Susan,

The Corps would like meet regarding the Wailele Flood Control Project (Laie) as soon as you are able (see below chain). I know many of us will be in and out on vacation as we hit summer, and I would very much like to meet before that happens.

Given the amount of time that USACE has been working on this project, it is vital to now reintroduce the undertaking, it's APE, known resources that may be impacted, our proposed determination of effect, and path forward. We are flexible on meeting date. Anytime next week would be fine, for example.

Thanks for your attention to this and have a good weekend. See you soon!

Cheers,

Mike

Michael Desilets
Environmental Compliance
CEPOH-PPE
808-227-6655

-----Original Message-----
From: Desilets, Michael E CIV USARMY CEPOH (USA)
Sent: Monday, April 29, 2019 9:38 AM
To: Lebo, Susan A <susan.a.lebo@hawaii.gov>
Cc: Norris, Jason M CIV USARMY CELRH (US) <Jason.M.Norris@usace.army.mil>
Subject: FW: Section 106 and 6E consultation for Wailele Flood Control (Laie, Oahu)

Aloha Susan,

Just checking up on the status of our request for a consultation meeting. Please let me know when you are available. I have a two-week window before I head of island for a couple weeks. Thanks,

Mike

Michael Desilets
Environmental Compliance
CEPOH-PPE
808-227-6655

-----Original Message-----
From: Desilets, Michael E CIV USARMY CEPOH (USA)
Sent: Monday, April 22, 2019 10:09 AM
To: Lebo, Susan A <susan.a.lebo@hawaii.gov>
Cc: Norris, Jason M CIV USARMY CELRH (US) <Jason.M.Norris@usace.army.mil>
Subject: Section 106 and 6E consultation for Wailele Flood Control (Laie, Oahu)

Aloha Dr. Lebo,

I would like to schedule a consultation meeting with yourself and Dr. Downer for resumption of Section 106 consultation on USACE's Wailele Flood Control project. This project is relatively new to me, however I understand that it has been on-again-off again for a decade or more now. Although I can find no formal documentation here in the files, I am pretty sure this project has been "consulted" on at various points over the years. Hence "resumption" of consultation.

As a refresher, the Wailele Flood Control project consists modifications to the lower part of the Wailele watershed to prevent flooding of adjacent suburban Laie, as happened dramatically back in the 1990s. The modifications are principally focused at the mouth of the river, where it crosses Kamehameha Highway. I will show you the exact proposed design when we meet.

Our Civil Works branch is working with the state to bring about this project, and they are moving rapidly to wrap up the feasibility phase. Thus they would like to have consultation completed, with some form of agreement in place, as soon as possible. Extensive archaeological background research has been done for the project (see attached). From my review of the material, I believe we have enough information to evaluate potential effects to historic properties and work toward an agreement document. Due to certain factors which we can discuss at the meeting, USACE currently envisions a Programmatic Agreement.

I have attached a document containing some refresher information on the project, as well as the archaeological study conducted in 2015. Note that the scope of the project is now much more defined than when the study was conducted. I will bring the design drawings, of course. I believe the APE is now quite simple to delineate.

Please let me know when your earliest availability is. I think this should take no more than 1 hour. I am quite flexible and can meet any time. Hope to hear from you soon.

Regards,

Mike

Michael Desilets
Environmental Compliance
CEPOH-PPE
808-227-6655

DEPARTMENT OF THE ARMY
U.S. ARMY CORPS OF ENGINEERS, HONOLULU DISTRICT
FORT SHAFTER, HAWAII 96858-5440

Civil and Public Works Branch
Programs and Project Management Division

Mr. Michael Tosatto
Regional Administrator
National Marine Fisheries Service, Pacific Islands Regional Office
1845 Wasp Boulevard
Building 176
Honolulu, Hawaii 96818

Dear Mr. Tosatto:

The Honolulu District, U.S. Army Corps of Engineers (Corps) seeks to initiate informal consultation with the National Marine Fisheries Service (NMFS) in accordance with Section 7 of the Endangered Species Act (ESA) of 1973, as amended, (16 U.S.C. 1531 *et. seq.*) for the Wailele Stream Flood Risk Management (FRM) study, as described below. The Corps would like to request a list of endangered species that may occur within the study area for the study.

The Corps is conducting a feasibility study to address flood risks associated with the Wailele Stream located in northern Oahu, Hawaii. Pursuant to Section 102 of the National Environmental Policy Act (NEPA) as implemented by the regulations promulgated by the Council on Environmental Quality (40 CFR Parts 1500-1508 and Corps Engineering Regulation 200-2-2), an Environmental Assessment (EA) will be included in an Integrated Feasibility Report (FR) for this study. The NEPA and Hawai'i Environmental Policy Act (HEPA) compliant Integrated FR/EA is being prepared for the proposed action under the authority of Section 205 of the Flood Control Act of 1948, as amended (33 CFR 263.23). The Project is necessary to address periodic flooding, with a focus on reducing flood risk to property and safety within the Wailele Stream watershed. The City and County of Honolulu (C&C), as represented by the Department of Design and Construction (DDC), in coordination with the Hawaii Reserves Incorporated are the non-Federal sponsors and the requesting agency for concurrent compliance with NEPA and HEPA.

The FR/EA will consider detention, conveyance modification, and berms/levees to address flood risk in the Wailele Stream watershed, providing flood risk protection to the community of Lā'ie, Brigham Young University - Hawaii, and the Polynesian Cultural Center (PCC). Measures will be evaluated based on their potential for flood risk reduction, relative development cost, environmental impacts, and acceptability by the public and the project sponsors. A suite of FRM study alternatives has been screened to develop a final array consisting of two alternatives and a no action alternative. The alternatives incorporate the creation of a detention basin and/or an overflow channel to divert larger flood events of Wailele Stream. The preferred alternative consists of the overflow channel without the detention basin (Alternative 2). The study area and plan view of the proposed alternative maps are presented in the Enclosures 1 and 2.

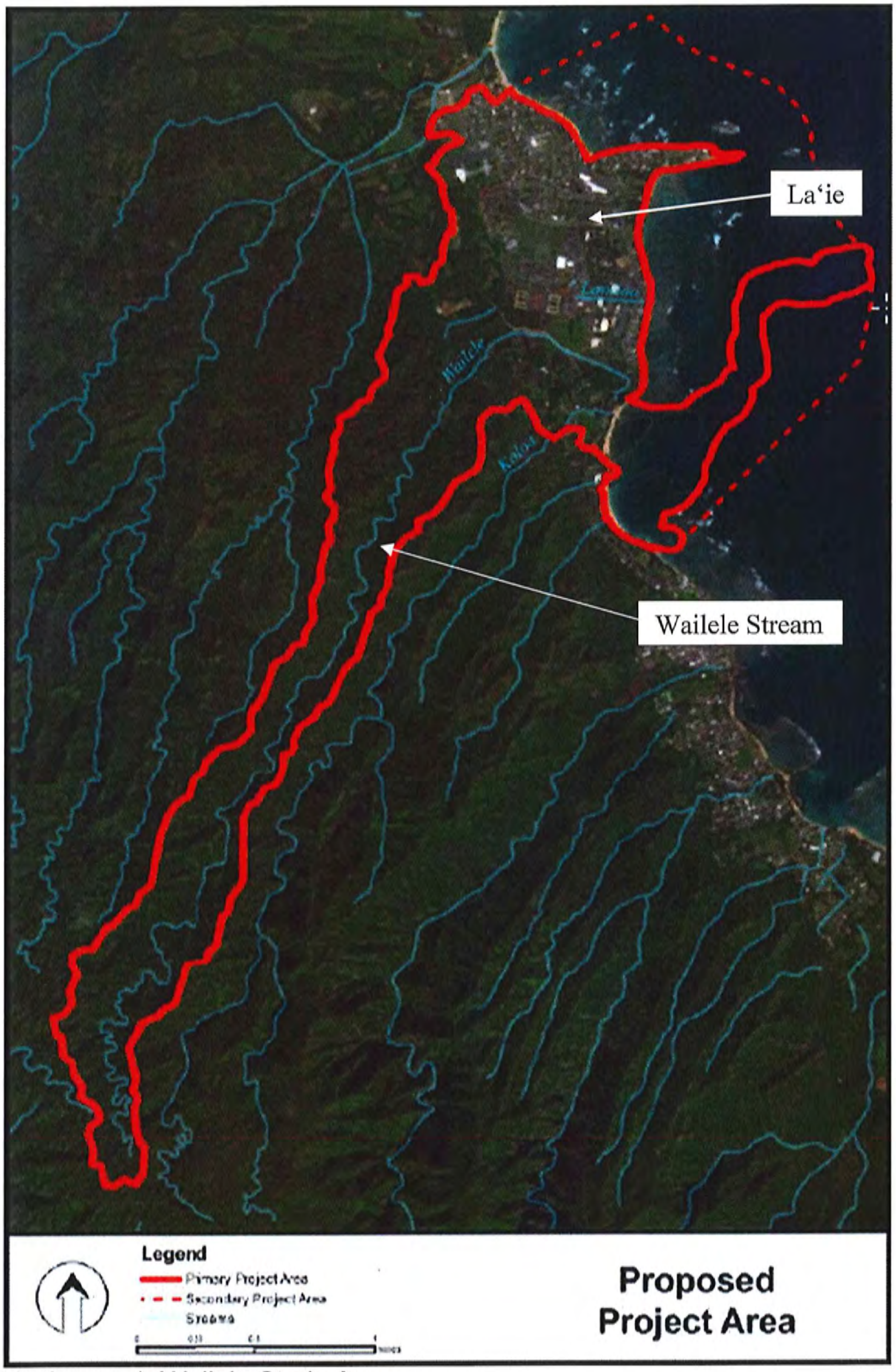
If you have any questions or require additional information, please contact Mr. Michael Wyatt, Civil Works Branch, at (808) 835-4031 or e-mail michael.d.wyatt@usace.army.mil.

Sincerely,

Stephen N. Cayetano, P.E.
Deputy District Engineer for
Programs and Project Management

Enclosures

cc:
Ian Lundgren, NOAA
Steve Kolinsky, NOOA



Enclosure 1: Wailele Study Area

Enclosure 2: Final Array of Alternatives for the Wailele Feasibility Study

DEPARTMENT OF THE ARMY
U.S. ARMY CORPS OF ENGINEERS, HONOLULU DISTRICT
FORT SHAFTER, HAWAII 96858-5440

Civil and Public Works Branch
Programs and Project Management Division

Dr. Mary M. Abrams
Field Supervisor
U.S. Fish and Wildlife Service (USFWS)
Pacific Islands Fish and Wildlife Office
300 Ala Moana Blvd., Room 3-122
Box 50088
Honolulu, Hawaii 96850

Dear Dr. Abrams:

The Honolulu District, U.S. Army Corps of Engineers (Corps) seeks to initiate informal consultation with your agency in accordance with Section 7 of the Endangered Species Act (ESA) of 1973, as amended, (16 U.S.C. 1531 *et. seq.*) for the proposed project, as described below. Preliminary alternatives were originally provided to the USFWS on 29 August, 1999 and a Draft Coordination Act Report was provide by the USFWS on April 2000. The study was put on hold and reinitiated in FY19. Therefore, the Corps would like to request an updated list of endangered species that may occur within the study area for the Wailele Flood Risk Management (FRM) feasibility study.

The Corps is conducting a feasibility study to address flood risks associated with the Wailele Stream located in northern Oahu, Hawaii. Pursuant to Section 102 of the National Environmental Policy Act (NEPA) as implemented by the regulations promulgated by the Council on Environmental Quality (40 CFR Parts 1500-1508 and Corps Engineering Regulation 200-2-2), an Environmental Assessment (EA) will be included in an Integrated Feasibility Report (FR) for this study. The NEPA and Hawai'i Environmental Policy Act (HEPA) compliant Integrated FR/EA is being prepared for the proposed action under the authority of Section 205 of the Flood Control Act of 1948, as amended (33 CFR 263.23). The Project is necessary to address periodic flooding, with a focus on reducing flood risk to property and safety within the Wailele Stream watershed. The City and County of Honolulu (C&C), as represented by the Department of Design and Construction (DDC), in coordination with the Hawaii Reserves Incorporated are the non-Federal sponsors and the requesting agency for concurrent compliance with NEPA and HEPA.

The FR/EA will consider detention, conveyance modification, and berms/levees to address flood risk in the Wailele Stream watershed, providing flood risk protection to the community of Lā'ie, Brigham Young University - Hawaii, and the Polynesian Cultural

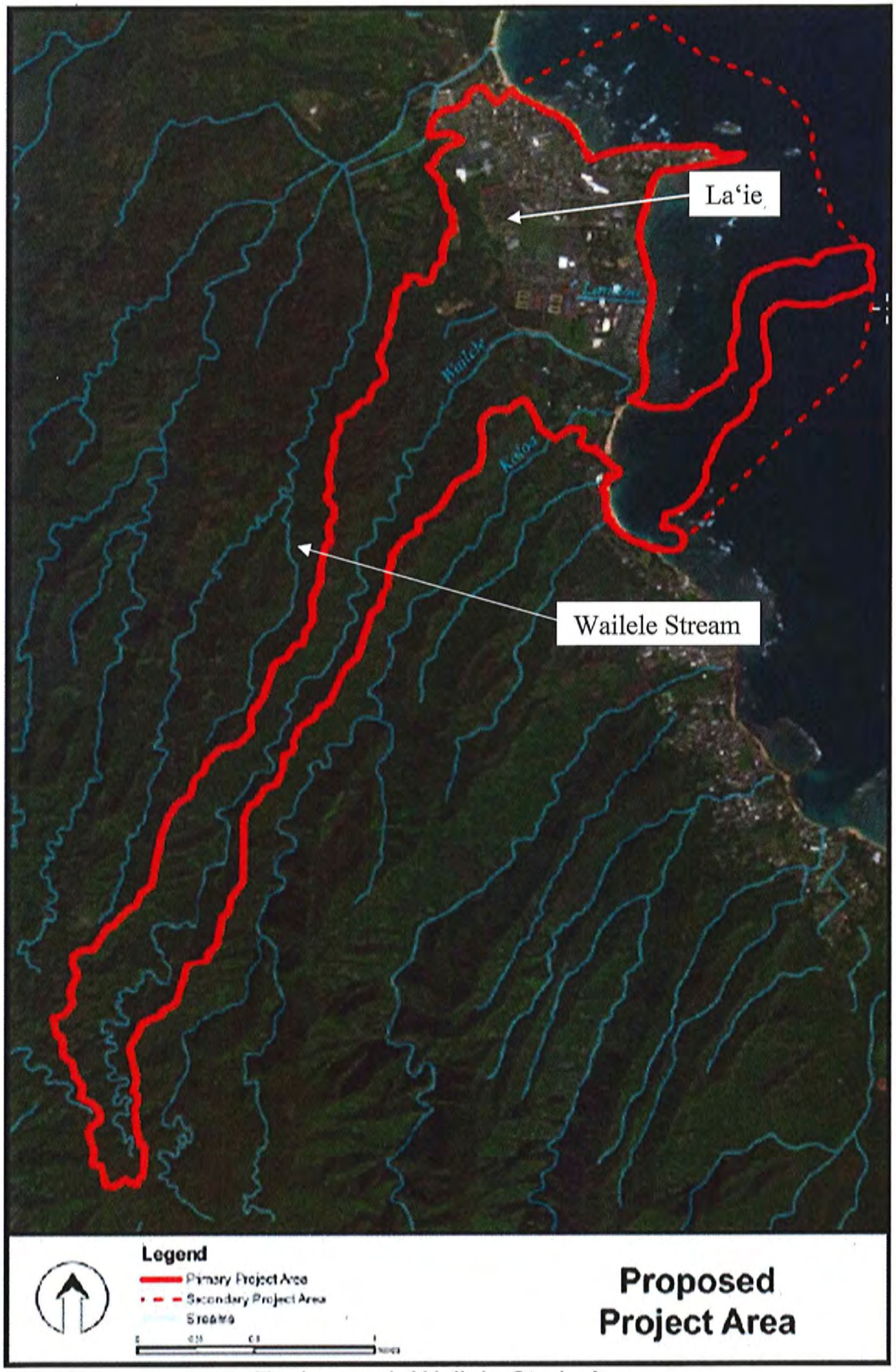
Center (PCC). Measures will be evaluated based on their potential for flood risk reduction, relative development cost, environmental impacts, and acceptability by the public and the project sponsors. A suite of FRM study alternatives has been screened to develop a final array consisting of two alternatives and a no action alternative. The alternatives incorporate the creation of a detention basin and/or an overflow channel to divert larger flood events of Wailele Stream. The preferred alternative consists of the overflow channel without the detention basin. The study area and plan view of the proposed alternative maps are presented in the Enclosures 1 and 2.

If you have any questions or require additional information, please contact Mr. Michael Wyatt, Civil Works Branch, at (808) 835-4031 or e-mail michael.d.wyatt@usace.army.mil.

Sincerely,

Stephen N. Cayetano, P.E.
Deputy District Engineer for
Programs and Project Management

Enclosures



Enclosure 1: Wailele Study Area

Enclosure 2: Final Array of Alternatives for the Wailele Feasibility Study

DEPARTMENT OF THE ARMY
U.S. ARMY CORPS OF ENGINEERS, HONOLULU DISTRICT
FORT SHAFTER, HAWAII 96858-5440

Civil and Public Works Branch
Programs and Project Management Division

Dr. Mary M. Abrams
Field Supervisor
U.S. Fish and Wildlife Service (USFWS)
Pacific Islands Fish and Wildlife Office
300 Ala Moana Blvd., Room 3-122
Box 50088
Honolulu, Hawaii 96850

Dear Dr. Abrams:

The Honolulu District, U.S. Army Corps of Engineers (Corps) seeks to reinitiate consultation with USFWS in compliance with the Fish and Wildlife Coordination Act FWCA of 1934, as amended for the Wailele Flood Risk Management (FRM) feasibility study.

The Corps is conducting a feasibility study to address flood risks associated with the Wailele Stream located in northern Oahu, Hawaii. Pursuant to Section 102 of the National Environmental Policy Act (NEPA) as implemented by the regulations promulgated by the Council on Environmental Quality (40 CFR Parts 1500-1508 and Corps Engineering Regulation 200-2-2), an Environmental Assessment (EA) will be included in an Integrated Feasibility Report (FR) for this study. The NEPA and Hawai'i Environmental Policy Act (HEPA) compliant Integrated FR/EA is being prepared for the proposed action under the authority of Section 205 of the Flood Control Act of 1948, as amended (33 CFR 263.23). The Project is necessary to address periodic flooding, with a focus on reducing flood risk to property and safety within the Wailele Stream watershed. The City and County of Honolulu (C&C), as represented by the Department of Design and Construction (DDC), in coordination with the Hawaii Reserves Incorporated are the non-Federal sponsors and the requesting agency for concurrent compliance with NEPA and HEPA.

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A Draft Coordination Act Report (CAR) was drafted by USFWS dated April, 2000. A site visit to the project area was conducted on 21 February 2019 with Mr. Dan Polhemus (USFWS) to assess existing conditions of the project area. Based on the Draft Wailele Stream FRM CAR and the site visit, the Corps would like to request a scope of work and cost estimate for completing the FWCA coordination, including an appropriate final FWCA document, by June 2019.

If you have any questions or require additional information, please contact Mr. Michael Wyatt, Civil Works Branch, at (808) 835-4031 or e-mail michael.d.wyatt@usace.army.mil.

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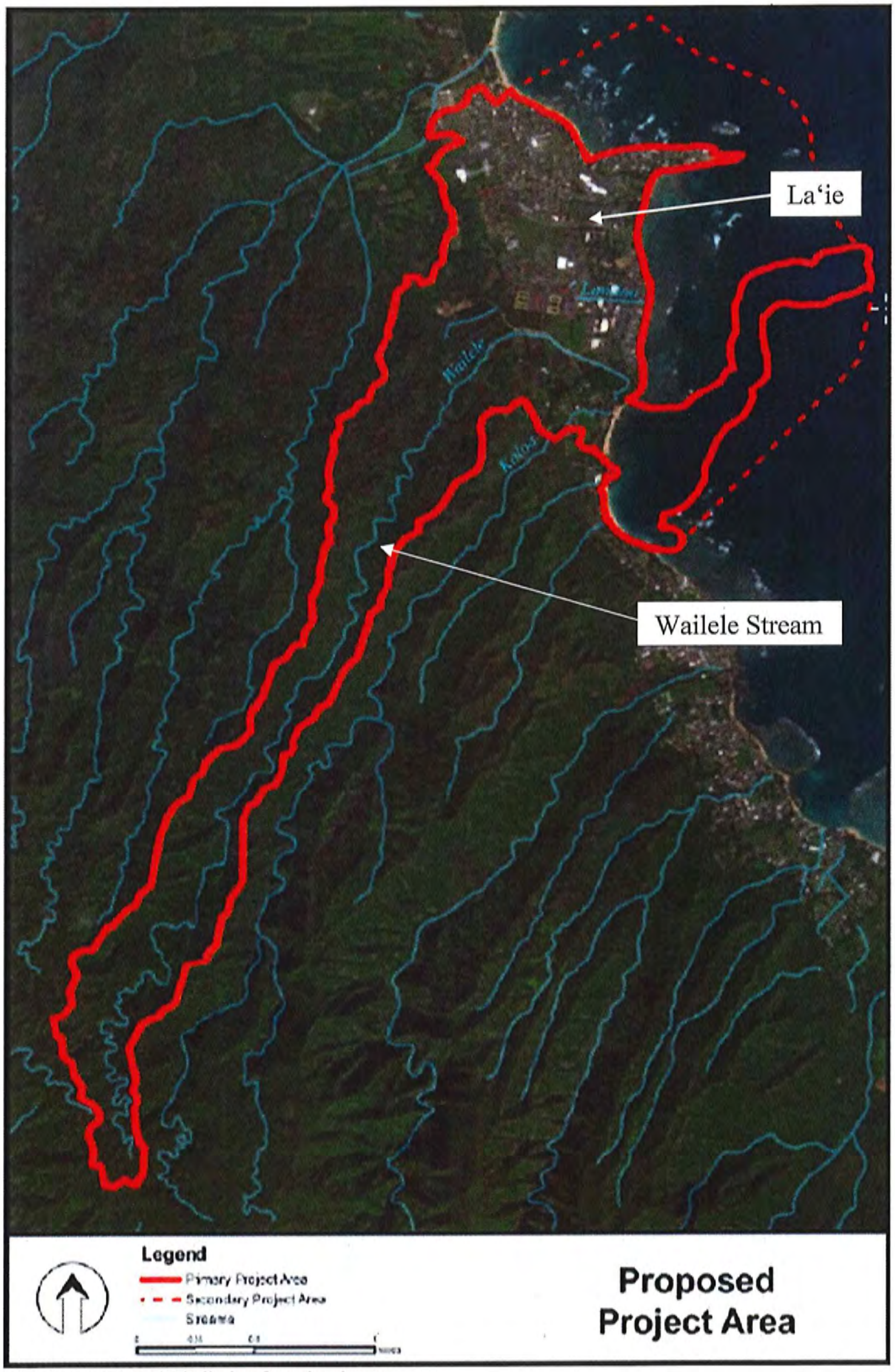

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Civil and Public Works Branch
Programs and Project Management Division

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PACIFIC ISLANDS FWO
HONOLULU, HI 96850

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Field Supervisor
U.S. Fish and Wildlife Service (USFWS)
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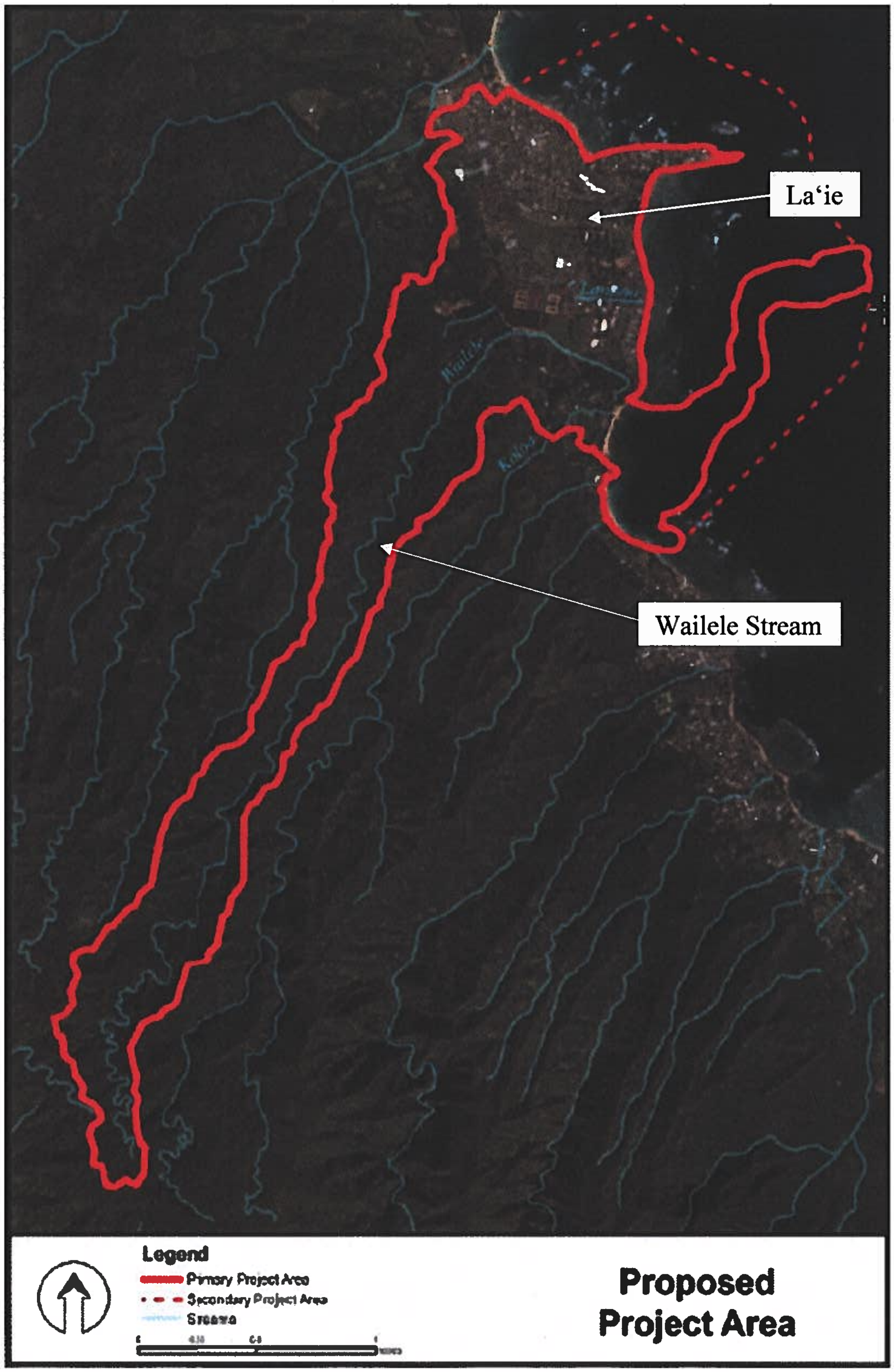

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